Street Railway Journal.

VOL. XII. NEW YORK AND CHICAGO, MARCH, 1896. No. 3.

FUNDAMENTAL ELECTRIC RAILWAY PATENTS OF THE GENERAL ELECTRIC COMPANY.

The recent decisions sustaining the Van Depoele under-running trolley railway patents are of the greatest interest to all who own or operate electric street railways by reason of the fundamental character of the patents and well-nigh universal use of the inventions on all trolley roads.

It is well known that Mr. Van Depoele was a pioneer in electric railroading and gave especial attention to the development of a practicable system in which the current should be supplied to the motors from an overhead conductor. The roads installed by the Van Depoele Company were the first in which the overhead trolley towed by the car was discarded and replaced by the under-running trolley system now in such universal use.

The Van Depoele railway patents were acquired by the Thomson-Houston Electric Company in 1888, and are now controlled by the General Electric Company. After proceedings in the Patent Office running over some years, there was granted Mr. Van Depoele a most important patent for his under-running trolley system, No. 495,443, dated April 11, 1893. A suit for infringement upon this patent was instituted by the Thomson-Houston Electric Company against the Winchester Avenue Railroad Company, of New Haven, shortly after the grant of the patent. The case was most vigorously contested and over five thousand pages of testimony taken on both sides, discussing most minutely the prior state of the art, the validity of the patent and the real merit of Mr. Van Depoele's early contributions to electric railroading.

A decision has recently been rendered by Judge Townsend, of the United States Circuit Court for the District of Connecticut, completely sustaining the patent and the claims of the Thomson-Houston Electric Company thereunder. The opinion of the Court finds that the Van Depoele system is one of great utility and that Van Depoele was the first to put into practical operation a trolley road of this character. The Court held:

"The combination of devices, described in Patent No. 495,443, is of great utility in the art of electric railroading, and has superseded every other known apparatus. The experts for defendant admit that they do not know that any one other than Van Depoele, prior to September, 1885, when he put said apparatus into practical operation, had proposed to equip the car of an electrically propelled road with a contact device mounted on the end of a long pole upwardly pressed by means of a spring, and to hinge the pole to the car and make it turn on a pivot; nor that any one, prior to March 12, 1887, the date of the application for the first patent, had described, in an electric railway, the combination specified in the infringed claims."

"The earlier electric railways, when equipped with wire conductors above the car, maintained contact therewith by means of 'over-running' trolleys, connected by a cord or wire with the car, and towed along above the surface of the conductor. These devices were impracticable for general use, because of uncertainty of connection, lack of adaptability to various forms of switches, varying tension, liability to derailment, and for other reasons."

The claims of the patent upon which infringement was charged are of generic scope, one of them reading:

"6. In an electric railway, the combination with a suitable track and a supply conductor suspended above the track of a car provided with a swinging arm carrying a contact device in its outer extremity, and means for imparting upward pressure to the outer portion of the arm and contact, to hold the latter in continuous working relation with the under side of the supply conductor, substantially as described."

Other claims mention the grooved contact-wheel and a tension spring for pressing the wheel upwards into contact with the trolley wire.

The opinion of the Court endorses the generic character of these claims by holding:

"The patented invention No, 495,443, as stated by complainant's expert, 'consists generally in an electric railway having an overhead conductor and a car for said railway provided with a contact device carried by the car so as to form a unitary structure therewith, and consisting of a trailing-arm, hinged and pivoted to the car so as to bridge the space between it and the conductor and move freely both laterally and vertically, and said arm carrying at its outer end a contact device capable of being pressed upward by a suitable tension device into engagement with the under side of the conductor.'"

The Court further recognizes the meritorious character of Mr. Van Depoele's work by saying:

"No one can read this record without being impressed by the fact that Van Depoele was more than a skilled mechanic in the art of electric railway propulsion. The Patent

Office has raised a presumption in his favor as an inventor by the grant of numerous patents to him. Some thirty have been introduced by defendant, several of which cover highly meritorious inventions which have largely contributed to the successful practical operation of the trolley roads throughout the country."

The prior state of the art is reviewed at length in the Court's opinion, but nothing was found to anticipate Van Depoele. On the contrary, the opinion holds:

"He (Van Depoele) made an invention within all the rules applicable to this question."

A second invention of Mr. Van Depoele's comprises the familiar apparatus and combination of apparatus whereby cars, operated in accordance with his under-running system, may run not only on a straight-away track, but be switched from one track to another automatically without any manual manipulation of the trolley arm. This, as is well known, consists in general of an overhead switch or frog attached to the trolley wire and properly designed to receive the trolley wheel, and a track switch so arranged in combination with the trolley and frog, that the trolley is automatically guided in the desired direction. This, of course, is essential to the operation of all overhead roads.

Such an arrangement is described and protected by a number of fundamental claims in the Van Depoele patent No. 424,695, dated April 1, 1890, and likewise controlled by the General Electric Company. This patent was first sustained by Judge Coxe, of the United States Circuit Court, for the Northern District of New York, in a suit brought by the Thomson-Houston Electric Company against the Elmira & Horseheads Railroad Company, of Elmira. The opinion was rendered last summer, whereupon an appeal was immediately taken by the defendant to the Circuit Court of Appeals for the Second Circuit, and in December last the Court of Appeals filed an opinion sustaining a number of claims of the most important character. The opinion was written by Judge Wallace, and for convenience the claims were divided into three groups. One of these groups comprises claims for an overhead trolley wire and a switch-plate attached thereto for receiving the under-running trolley wheel, as specified below.

"The combination, with an overhead wire for receiving an underneath contact, of a switch-plate attached to the wire in about the same horizontal plane as the wire."

Another group relates to the combination of a trolley and conductor-switch with a car and track-switch, all so arranged that the trolley is properly guided on the conductor switch by the action of the track-switch. This group comprises a number of claims, one of which reads as follows:

"In a branching electric railway, the combination with a vehicle of a track-switch, an overhead conductor-switch and a contact-arm extending upward from the vehicle to the conductor, and so located relatively to the length of the vehicle and the two switches that the lateral movement of the vehicle will give a corresponding movement of the contact-device on the conductor-switch."

It will be seen that this describes and embraces the prevailing arrangement employed on all trolley roads.

The third group of claims relates to an under-running trolley system in which the trolley is provided with a spring tending to restore it to its normal central position. One of these reads:

"In an electric railway, the combination, with an overhead conductor and a vehicle, of a trailing contact-arm guided at its outer end by the overhead conductor, and movable laterally relatively to the vehicle, but having a normal centralizing tendency by means of a spring or weight."

After the decision of the Circuit Court of Appeals, the defendant made application to the Supreme Court of the U. S. for a writ of certiorari, with a view of having the case carried to the Supreme Court by the only method of appeal possible, where the Circuit Court of Appeals has no doubt as to the correctness of its decision, as was the case here. This attempt to secure further consideration of the case has been denied, and the Circuit Court has granted a decree in accordance with the instructions of the Court of Appeals, definitely and finally sustaining the claims already referred to, and ordering the issuing of an injunction.

A number of other suits have been started against infringers of the Van Depoele patents, and preliminary injunctions have already been granted against the New York Electrical Works and the Fiberite Company restraining further infringement of patent No. 424,695.

It will be of interest to foreign readers of the STREET RAILWAY JOURNAL to know that the Van Depoele inventions are protected by a large number of patents in foreign countries which patents are controlled either by the General Electric Company or the various foreign companies with which the General Electric Company has established business relations.

Street Railway Journal.

Vol. XII. *NEW YORK AND CHICAGO, MARCH, 1896.* *No. 3.*

THE SYSTEM OF THE PORTLAND RAILROAD COMPANY.

No city on the Atlantic Coast can boast of a more picturesque situation than Portland, Me. Occupying a bold promontory at the head of Casco Bay, beautiful views can be obtained from the city of this sheet of water and of the neighboring ocean and rock-bound coast. The bay is thirty miles in length, is studded with many islands and in summer is covered with excursion boats which ply in all directions. On the coast, a few miles to the south lie the famous seashore resorts of Old Orchard Beach and Kennebunkport, while the shores of Casco Bay and the coast to the east of Portland are being built up with handsome summer residences and villas.

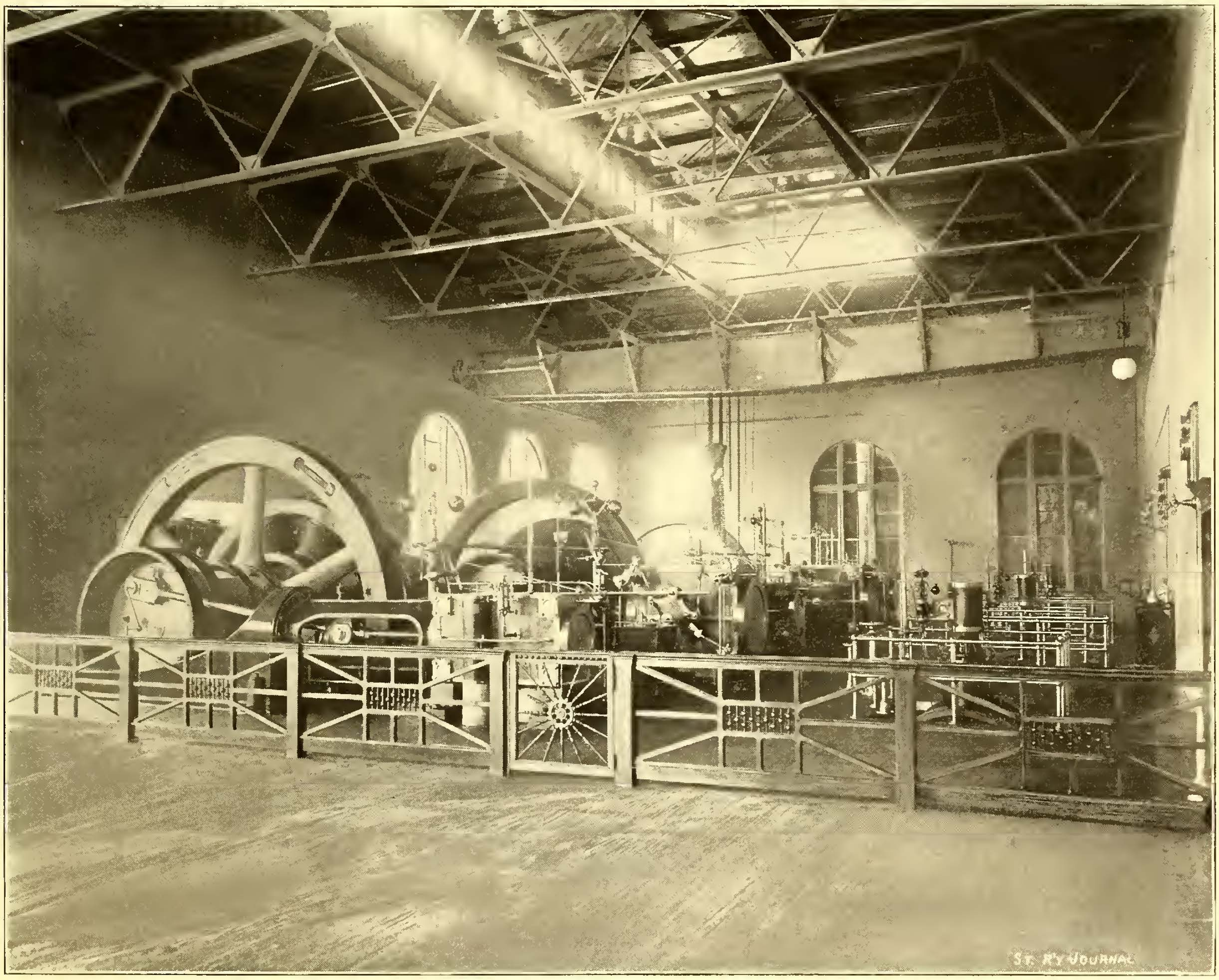


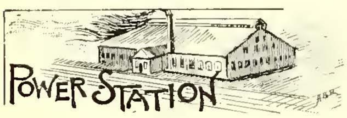
FIG. 1.—INTERIOR OF POWER STATION—PORTLAND RAILROAD CO.

The city possesses fine shipping facilities and is the winter port for a large part of the commerce of Canada. From Portland regular sailings are made by two steamship lines through the winter to European ports, and throughout the year regular connections are maintained by steamer with New York, Boston and the Maritime Provinces. About 6300 hands are employed in the manufacturing industries of the city, which are quite varied, the principal productions being locomotives, railroad cars, marine and other engines, ships, canned goods, refined petroleum and paper. The capital invested in manufacturing enterprises is about $7,000,000, and the value of the product is about $4,775,000 annually. The city has a population of about 40,000.

The peninsula upon which Portland is situated is something more than two miles long and less than a mile wide, conditions favorable to street car traffic. With the exception of a line owned by the Portland & Cape Elizabeth

Railroad Company, about six miles in length, the entire system is owned and operated by the Portland Railroad Company, whose lines occupy the main streets of the city and connect it with the neighboring towns of East Deering, Stroudwater and Saccarappa. The general arrangement of the system is shown on the accompanying map.

The company completed the equipment of its line with electric power during last summer. It had been operating a branch about five miles in length with electricity for several years, and the results secured were so favorable as to demonstrate the advisability of the equipment of the entire system. In the beginning of April ground was broken for the new power house, and in the following month work began on the track and line construction. No expense seems to have been spared to make the road a model one for its size, and this fact makes a study of its engineering features an interesting one. The line is equipped with General Electric apparatus throughout and was built by Sheaff & Jaastad, who furnished all the plans and superintended the work of construction.



THE power house is located near Deering Bridge very near the center of the system, and is of brick with ornamental front. It is close to the Back Bay, an arm of Portland Harbor, and coal is received directly by water. The station being on reclaimed land, piles had to be driven, about 1650 in all, for foundation. These piles were sawed off about one foot below mean high water line and concreted flush with their heads to the depth of one foot with Portland cement. The piles were then capped with granite blocks of such dimensions that every capping stone rested firm on at least three piles. The granite was carried up for six feet and was grouted. On top of this the brick foundations, which are twelve feet in height, were erected. The building foundations are carried up entirely distinct from those for the machinery.

The inside dimensions of the engine room are 110 ft. × 51 ft. The room is well lighted and ventilated by long windows and monitor roof, and is served by a thirty ton traveling crane.

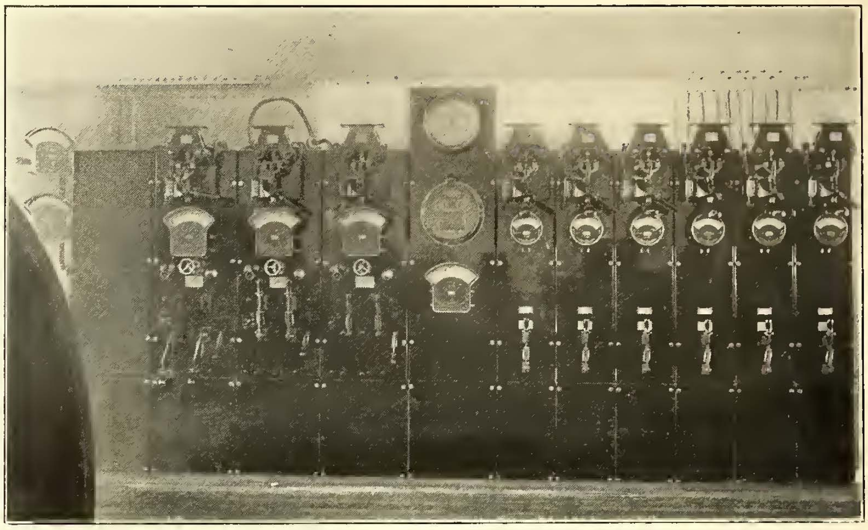


FIG. 3.—STATION SWITCHBOARD.

The present engine equipment is three direct connected units. Two of the generators are 400 k. w. and one of 225 k. w. capacity. The 400 k. w. generators run at a speed of 100 rev. p. m., the 225 k. w. at a speed of 120 rev. p. m. The generators are the multipolar, iron clad type steel frame, built by the General Electric Company.

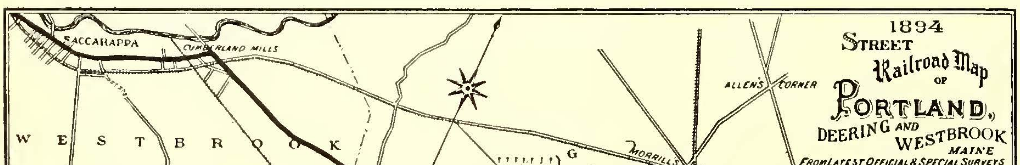


FIG. 2.—MAP OF PORTLAND, SHOWING STREET RAILWAY LINES.

Fronting on street in the engine room, a bay is built, four feet deep, in which the switchboard is located. The front of this board is flush with the inside line of the engine room wall. This arrangement gives plenty of light and room in the rear of the switchboard so that the connections can be easily inspected. The board is of the G. E. panel type with the usual equipment of appliances, including a wattmeter. The feeders are brought from the switchboard inside of the bay, through the roof and from there over to the poles. No wires of any kind are visible inside of building.

The engines are Allis horizontal, cross compound, condensing, with cylinders 14 and 26 × 36 ins. for driving the 225 k. w. and 18 and 34 × 42 ins. for driving the 400 k. w. generators. They were built extra heavy throughout so as to be able to withstand the excessive strain, due to the great variation of load that will necessarily arise on a road like this, where there are so many very heavy grades. They are so arranged that either side, high or low, can be run independently, condensing or non-condensing if so desired. Room is provided for the future installation of a 2,000 h.p. unit.

There is one independent vertical flywheel condenser connected to each engine. These condensers are so arranged that their steam cylinders come up through the floor, making them easy of access.

The boiler room measures 110 ft. × 94 ft. Twelve feet of this width is partitioned off by a wall and used for a machine shop and oil room. In the boiler room there are at present two batteries of Babcock & Wilcox's latest improved water tube boilers, each of a rated capacity of 500 h. p. The boilers are all faced with white glazed bricks and present a very attractive and clean appearance. In the boiler room there are two Blake feed pumps 10 × 16 × 12 in. Either pump is of ample size to take care of the whole plant.

There is one heater between each engine and condenser in engine room, and one auxiliary heater in the boiler room, built by the Goubert Manufacturing Company.

Figs. 6 and 7 give an excellent idea of the arrangement of the piping. The steam main is carried on adjustable brackets bolted to the wall, back of boilers, in boiler room and in such a proximity to the boiler room floor that the valves can be conveniently reached and operated from the floor by hand. The steam from the boilers enters this main through eight inch pipes bolted to the nozzles of the boilers. These eight inch pipes have long copper bends so as to take care of the expansion and contraction.

The steam pipes from the main to the engines are carried through the partition wall, between the engine and boiler rooms, under the engine floor to a Stratton separator, located near the throttle valve of engine. As will be noted on the plan these pipes are also provided with long, easy bends so as to better take care of the expansion, and at the same time retard the speed of the steam as little as possible. The exhaust steam, after leaving the engines, goes through a heater into the condenser, or it can go around the condenser out into the free atmosphere, as the case may be, dependent on whether the plant is running condensing or non-condensing.

The free atmospheric exhaust pipes from all engines connect into one main exhaust pipe, which is carried to the boiler room, then up through the roof, ending into a Stein's exhaust head. The suction pipe to the condensers is fitted with a strainer placed in basement inside of building. It is by-passed, and so arranged that it can readily be gotten at and cleaned. All steam valves are also fitted with by-passes. The overflow pipe from the condensers discharges into the river.

The feedwater, which is city water, passes through a meter to the pumps in boiler room. From here it is pumped first through the primary heater in engine room. It leaves this heater at a temperature of from 126 to 130 degs. It then passes to the auxiliary heater in boiler room, where the temperature rises to from 200 to 212 degs., at which heat it enters the boilers.

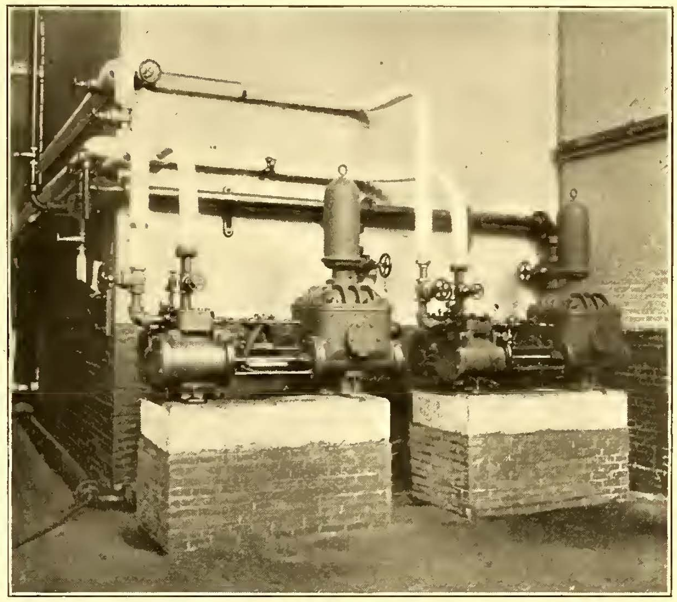


FIG. 5.—PUMPS.

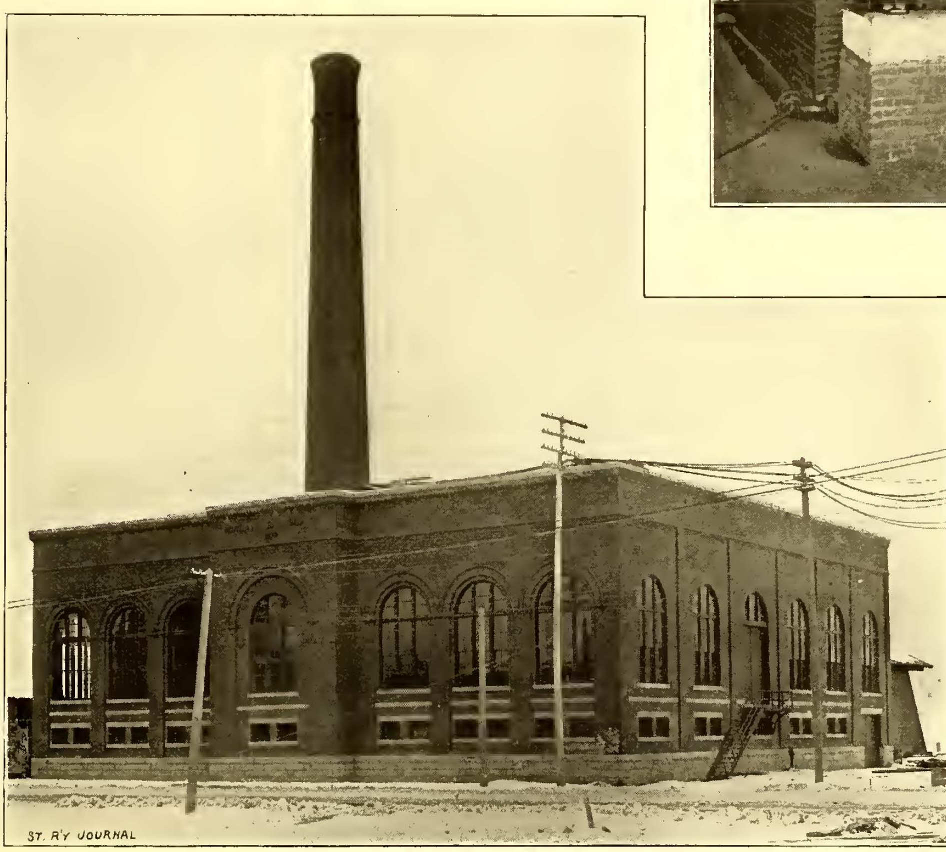


FIG. 4.—EXTERIOR OF POWER STATION.

The piping for this circuit is so arranged that any or all of the primary heaters can be cut out and the water pass direct from the pumps through the auxiliary heater to the boilers, or the auxiliary heater can be cut out, and the water made to pass through the primary heaters direct to boilers, or all heaters primary and auxiliary can be cut out and the feedwater can be pumped direct into the boilers. All drips from steam piping separators and receivers are carried back to the boilers by the Holly return gravity system.

It will be noted that the piping is so arranged that only a partial breakdown is possible, as all is in duplicate, with exception of the steam main, which, however, by valves is divided into sections, so that if anything should happen to one of the sections, the rest can be operated.

The floor of the boiler room is laid with concrete and that of the engine room, office, etc., with hard wood, oiled. The railings in the engine room are of brass, highly polished, giving it a very handsome appearance.

The office and machine shop is on a level with engine room floor and opens directly into the engine room. Below the office is the oil room, which is fireproof throughout, and above the office is the storage room and lavatory. The latter is furnished with all conveniences, including lockers for the employes.

The chimney, the base of which is in the boiler room,

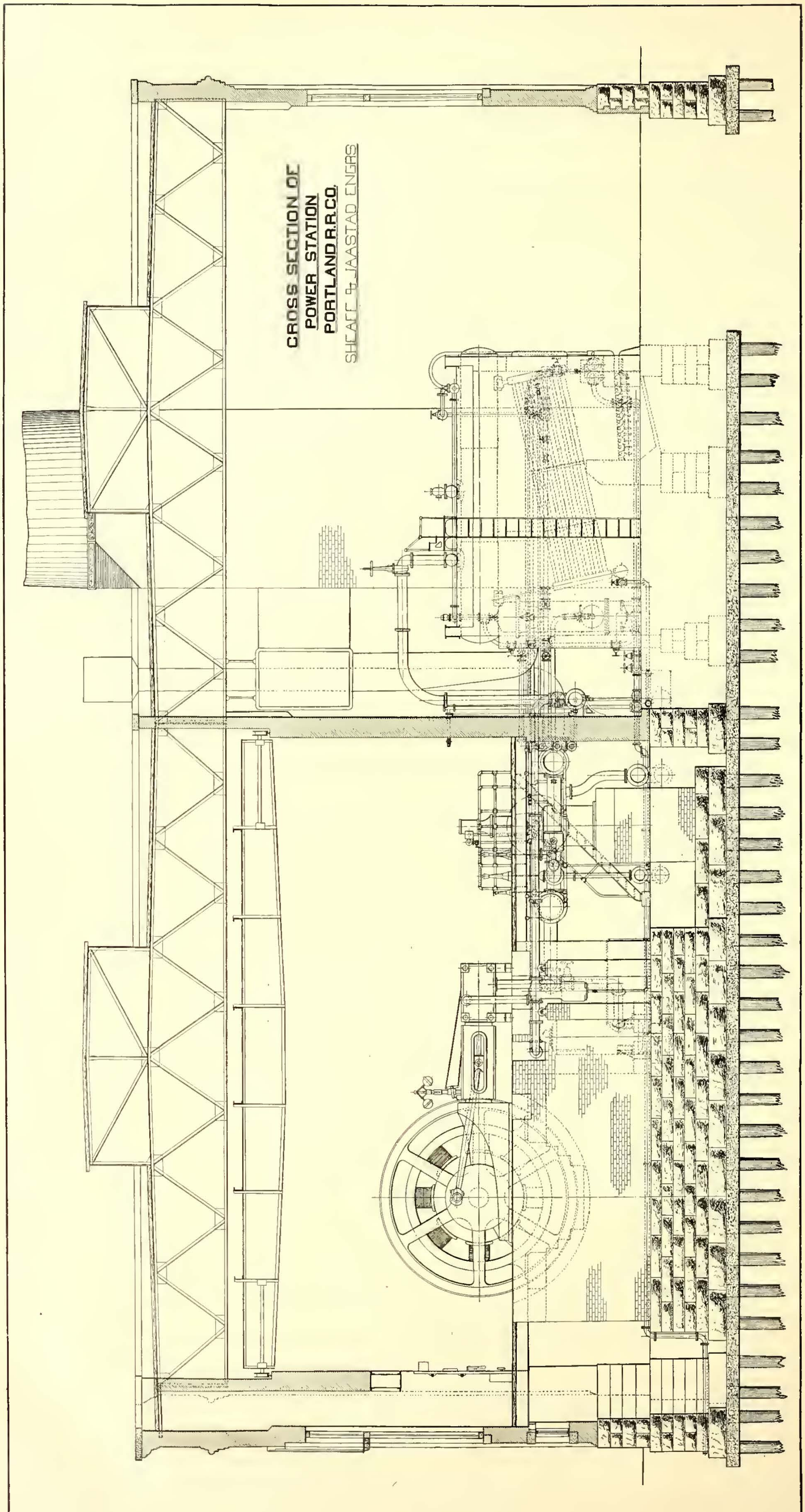


FIG. 6.—SECTION OF POWER STATION.—PORTLAND.

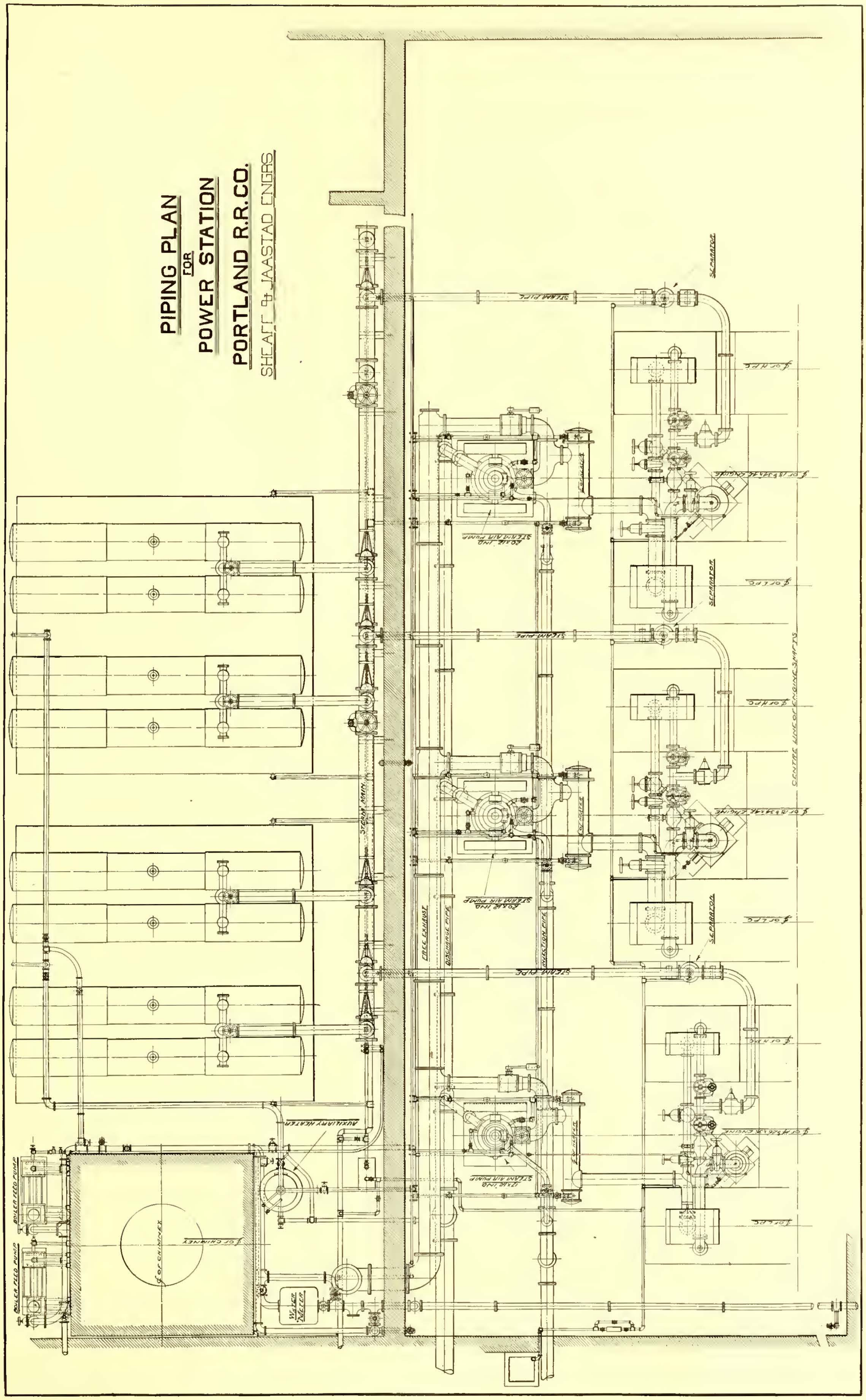


FIG. 7.—PLAN OF POWER STATION SHOWING PIPING.—PORTLAND.

is 16 × 16 ft. square at the bottom, and is carried up with this section to about three feet above the roof of the building. From this point the section is circular, and the chimney tapers to near the top, where it bulges out in a neat design. The total height from the base is 145 ft. and the inside diameter of the core is six feet three inches.

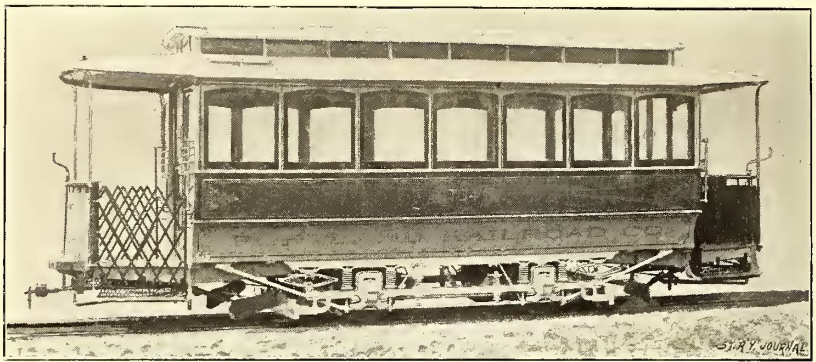


FIG. 8.—CLOSED CAR.

While the plant has not been in operation very long, the results secured have been very favorable from an economical standpoint. The generators run very smoothly and without spark, and the managers of the company speak in the highest terms of them.

ROADBED CONSTRUCTION

THE company's lines have a length of about twenty-five miles. In the streets within the city limits the track is laid with ninety pound, nine inch girder rails, furnished by the Pennsylvania Steel Company, spiked to ties two feet six inches between centers. The track is thoroughly ballasted with clean, sharp gravel and is paved with granite blocks. The joint plates are thirty-eight inches long, furnished with twelve bolts and double bonded with No. 0000 Chicago rail bonds. On the suburban lines fifty-eight pound T rails are used. The special work was furnished by the Pennsylvania Steel Company and the Johnson Company.

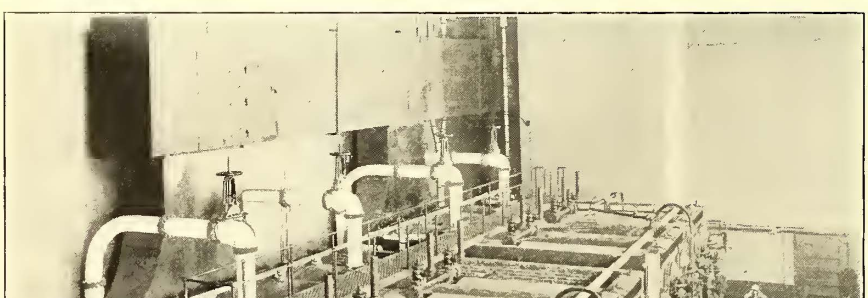


FIG. 10.—BOILER ROOM.

OVERHEAD CONSTRUCTION

THE overhead system is mainly of the span wire construction. There are nine feeders, each of 500,000 c. m., and in no place on the line is the maximum drop more than ten per cent. One overhead return wire is used. This is of 500,000 c. m. and is carried on the poles, and connections are made to the track at distances of about every 500 ft. The track is bonded as described. No cross connections are used, other than crossovers which are quite frequent and which are well bonded.

The generator ground return is led at the station into a well, reaching to tide water and is connected here to a large copper plate, and the track just outside of the station is grounded to a car wheel buried under tide water.

ROLLING STOCK

THE cars are particularly handsome and attractively finished, a rich wine color, with gold lining, being used in the exterior for the main line on Congress Street. All recent cars have been supplied by the J. G. Brill Company, with the exception of four which were built by the Wason Manufacturing Company. The railway company has also a number of cars built in its own shops, which are giving good satisfaction, but has given up the manufacture of cars, finding that it is more profitable to purchase than to build directly. While the facilities for the manufacture of cars in Portland were very good the manager stated that, in his opinion, this branch of the business could best be conducted on a large scale by persons devoting their attention exclusively to the work.

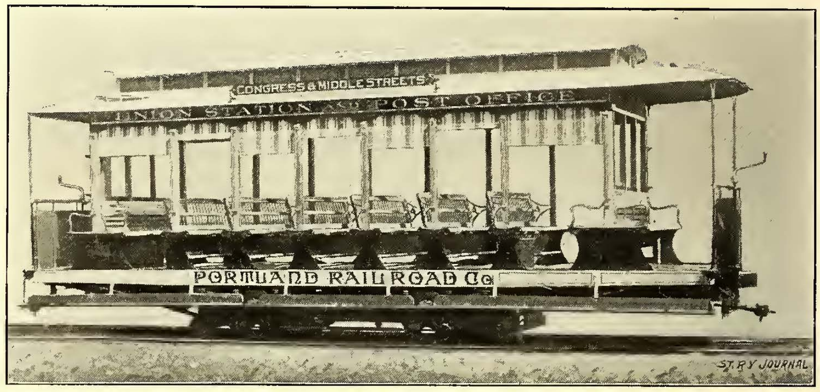


FIG. 9.—OPEN CAR.

The closed cars are twenty and twenty-five feet long in body, and are of solid mahogany finish throughout, with bronze metallic trimmings, cushion upholstered seats and backs and crystal plate glass.

A part of the equipment of twenty foot cars is mounted on Brill No. 21 C trucks, and a part on Peckham trucks. The twenty-five foot cars are mounted on Brill Eureka maximum traction trucks. The open cars are ten and twelve benches in length, and are finished with decorated ceilings, solid bronze metal trimmings, entrance guards, etc.

The motors are of G. E. 800 type, with K 2 controllers. Consolidated car heaters are used, and according to the general manager, from eight to twelve amperes per car are required in winter weather. While this is a large drain on the station the advantages are thought to more than counterbalance the expense.

PARKS AND AMUSEMENTS

PORTLAND is well supplied with parks and recreation grounds. Fronting the bay is a handsome esplanade, Fort Allen Park, from which a fine view is obtained of the harbor and shipping, and directly back of the city is another attractive resort, Deering Park, owned by the city and tastefully laid out. In addition there are a number of smaller parks and promenades within easy access of the inhabitants.

The managers of the railroad company were very anxious to have a pleasure resort of their own in addition, and recently secured thirty-six acres on the Presumpscot River, about five miles from the center of the city, and containing a great many natural attractions. This land will be left largely in its present state, but a casino will be built at the terminus of the railway line where light refreshments can be secured.

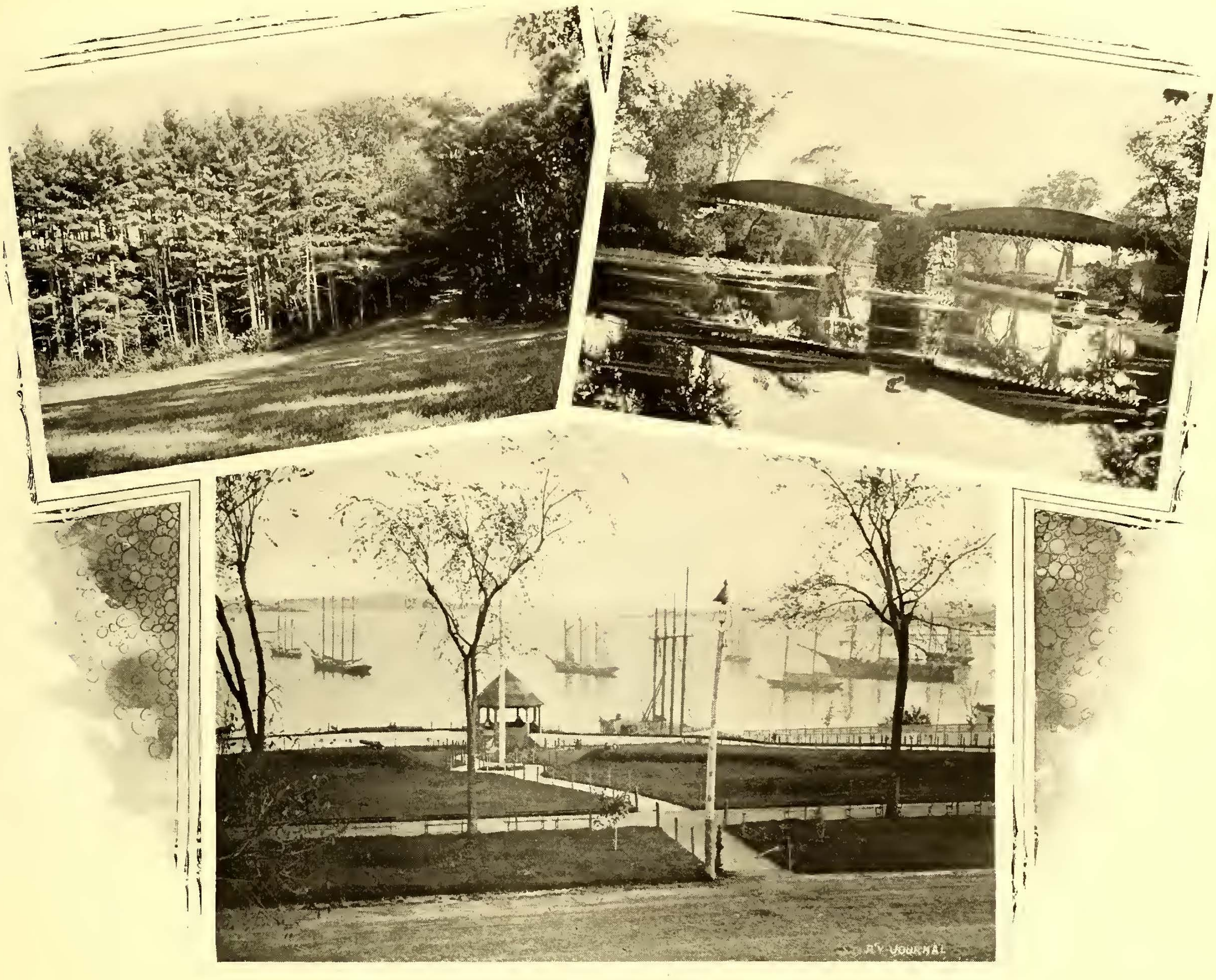


FIG. 11.—VIEWS IN PARKS—PORTLAND.

OFFICERS.

The officers of the company are W. R. Wood, president; E. A. Newman, general manager.

ONE of the results of the recent war between Japan and China has been the stimulation of internal improvements in the former kingdom. It is not surprising then that Japan has had for several months a system of electric railways. These are in operation at Kioto. The power is supplied from a station of 2000 h. p., operated by water. The station contains twenty Pelton wheels of 120 h. p., operating railway, lighting and triphase power generators. The cars are equipped with G. E. 800 motors.

The Electric Railways of Aix-La-Chapelle.

Among the German cities which have recently equipped their lines with electricity is the historic town of Aix-La-Chapelle. The line here measures between sixteen and seventeen miles in length, and forty motor cars are in operation. The overhead system is used, but all feeders are underground. The rails are laid to a gauge of thirty-nine inches, and in the paved streets are six and three-quarters inches high and weigh seventy-three pounds per yard. In the streets laid with macadam, and in the suburbs, a four inch rail weighing thirty-seven pounds per yard is used.

The total weight of the cars with their equipment is about 12,000 lbs. On account of the severe grades which exist in certain sections, and in order to permit of the drawing of trailers, fifteen of the cars are equipped with two motors of twenty horse power. The other cars are equipped with motors of only fifteen horse power.

The power station contains two compound condensing engines built at Stuttgart. Each drives a Schuckert dynamo. The fields of these dynamos are excited by accumulator cells charged from a lighting circuit.

An interesting and novel feature of this station is a rotary transformer with a capacity of 450 h. p. which provides the reserve for Sundays and holidays. It is composed of two dynamos connected on to one axle, the armature of one wound for 220 volts, which is the potential of the lighting circuit, the other 550 volts. Depending upon circumstances, each of the machines is able to serve as a motor and operate the other as a generator, so that the machine acts as a reserve for the two services.

Some Recent Electric Railways in France.

Two new electric street railways were inaugurated during the past summer in France; one running between

FIG. 1.—IN THE SUBURBS—RAINCY.

the well known manufacturing towns in the North—Roubaix and Tourcoing—the other between Raincy and Montfermeil, two pretty suburban villages in the vicinity of Paris. The starting of these roads so quickly, the one after the other, and so shortly after the installation of the Lyons and Bordeaux roads, bear evidence to the rapidity with which the French people are overcoming their conservative attachments to older methods. Reports of the most encouraging nature are coming to this country from France, of electric railway installations under way and projects in course of realization.

The Roubaix and Tourcoing road provides for the first time in these busy cities, a cheap and speedy method of travel to the large manufacturing population. Hitherto they have been compelled to use the old horse

FIG. 2.—VIEW IN ROUBAIX.

FIG. 3.—THE MAIN SQUARE—ROUBAIX.

cars, drawn at a hearse-like speed. Electricity has galvanized this road, and since the installation of the system the street car network has already undergone considerable extension, the total length of the road being now 14,591 meters, or about nine miles, divided into three branches.

The track is laid in Broca rails, seventy-three pounds to the yard, with a gauge of thirty-nine inches. The road is single track, with frequent turnouts, and has numerous curves, the sharpest having a radius of sixty-one feet.

The Grand Place of Roubaix is the starting point of the three systems, and the traffic being considerable, two feeders are brought to it—one aerial, the other under-ground. The trolley line is suspended from span wires stretched between latticed poles, and some very pretty overhead work is to be seen where the line crosses the canal at several points over lift bridges, as in Fig. 5.

The generating station occupies a place in the old Laboureur Depot. Current is furnished by three 100 k.w., four pole, 625 revolution, General Electric generators, overcompounded for 550 volts at full load. Each dynamo is belt driven from a Corliss-Garnier tandem condensing engine, of 145 h. p., running at 160 revolutions per minute. Steam is furnished by three Babcock & Wilcox boilers, accompanied by a Green economizer. The switchboard is of the panel type, equipped with the usual measuring, indicating and controlling instruments.

The rolling stock consists of eighteen cars, each equipped with a "N. W. P. 12" motor. This motor is our old friend the "G. E. 800" motor, but somewhat smaller, and adapted to narrow gauge work. The controller is the "K. R.," for use with G. E. 800 single motor equipments. Each car is built to carry thirty-two passengers and pull a trailer having the same capacity.

At Raincy the installation of electricity was the only resource left for the steam tramway company operating the road, to avoid speedy dissolution. Raincy and Montfermeil are essentially suburban communities, and their approximate location in a beautiful wooded section rendered them favorite locations for cottages and suburban homes. In order to bring them within easy reach of Paris a steam tramway was laid down, and for a time served to build up the section, but its drawbacks far outweighed its benefits. The soft smoke from the little locomotives, the terrible noise they made as they climbed the steep hill which starts at Raincy, the uncomfortable cars, the poor service, and the thirty trips a day to meet eighty trains on the main line stopping at Raincy, acted to discourage the would-be suburbanites and fire them back into Paris. The frequency of the service could not be increased nor the rolling stock improved with any chance of making the road pay, and the operating company found itself, therefore, on the horns of an embarrassing dilemma.

About this time the success of the Lyons road became assured, and the Raincy & Montfermeil Company turned to electricity as its savior. At one stroke it abolished the black smoke and deafening locomotive and substituted the practical American trolley car.

The road has a gauge of thirty-nine inches, is about three and one-half miles long, and follows the highway between Raincy and Montfermeil for about one mile. The road has a uniform grade of 4.5 p. c., but after reaching the plateau of Montfermeil the grades become less pronounced, the sharpest curves having a radius of sixty-six feet.

The generating station is installed at the company's station at Montfermeil. Two Babcock & Wilcox boilers furnish steam to two Garnier horizontal engines, each of 100 h. p,, at eighty-five revolutions. These drive by belt two General Electric generators, each of 62 k. w. capacity. The switchboard is provided with quick-break switches, automatic circuit breakers and the other usual instruments.

The old steam equipment consisted of four fourteen ton locomotives, each drawing a car carrying forty-two passengers. On Sundays and fete days the number of cars per locomotive was usually increased to three. The electric cars are usually arranged to carry forty passengers, ten in the first class, ten second class and ten on each platform. Each car is equipped with two twenty-five horse power motors, and each motor car can draw two trailers up a maximum grade at a speed of eight miles per hour. The trolley wire in Raincy is suspended from span wires stretched between tubular steel poles. Outside the town the line is suspended from single brackets placed on one side of the highway.

The two communities are already benefiting by the change. Instead of trains running at long intervals, stopping only at certain points, the cars now stop at any point and run under a fifteen minute headway. So successful have been these modern plants that the suburban communities of Paris are already joining the procession, and it is expected that electric roads will be installed by the French Thomson-Houston Company within a very short time at Enghien, Montmorency, Saint Gratien and other places within easy reach of Paris.

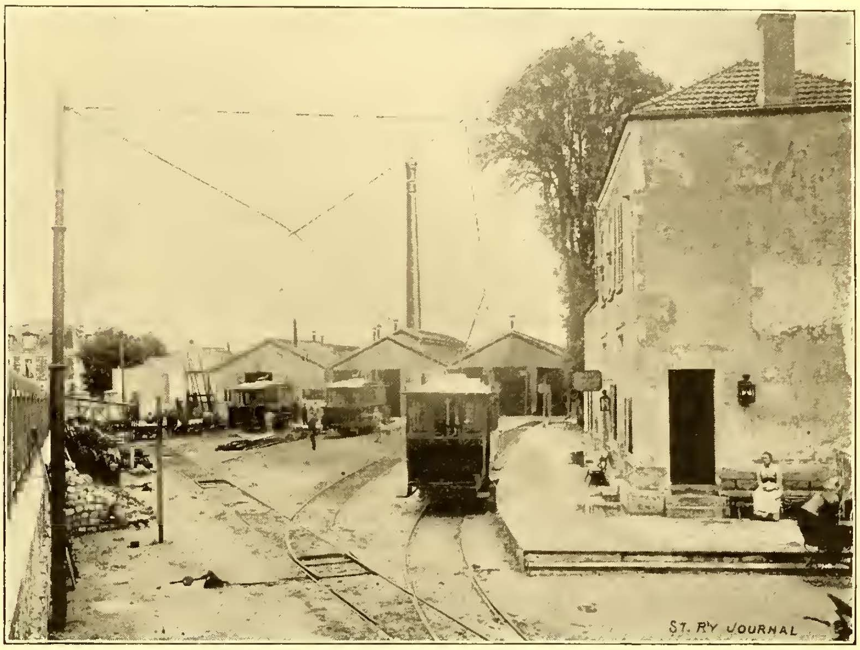


FIG. 4.—CAR HOUSE AND STATION—RAINCY.

The French are a pushing, energetic people, ready to adopt any improvement when once its value is proved, so that the future for electric railway work in that country seems extremely bright.

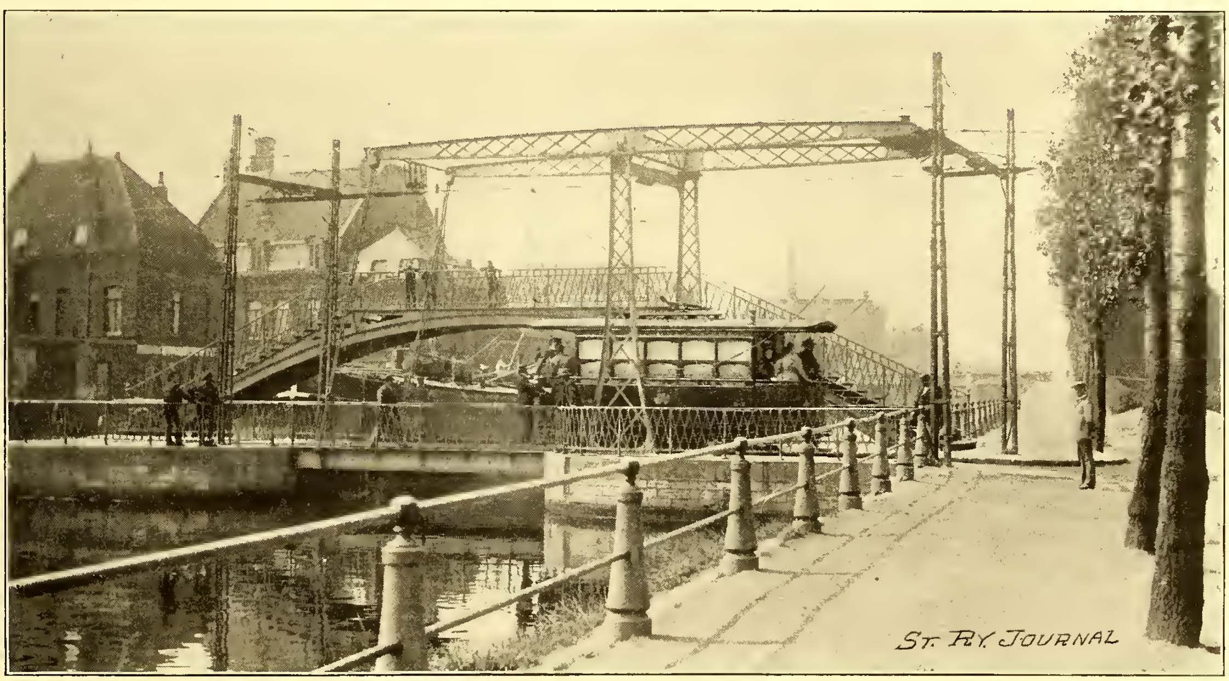


FIG. 5.—CROSSING A LIFT BRIDGE—ROUBAIX.

Contracts have been signed for the construction of a tunnel under the famous Simplon Pass in Switzerland. The work, it is expected, will be completed in five and a half years at a total cost of $14,000,000, exclusive of the laying of the track. Instead of a double track tunnel, two single track tunnels will be built, separated by a distance of fifty feet center to center from each other.

OPERATION

Power Distribution for Electric Railroads

By Louis Bell, Ph. D.

II.—Fundamental Principles. (*Continued.*)

For example, take the case of a circular area with an electric system made up of equally and uniformly loaded lines radiating from a power station at the center. It has already been shown that the cross section of copper needed for a uniformly loaded line is the same as if the load were concentrated at the center. The weight is proportional to the cross section multiplied by the length. In the circular distribution of Fig. 12, therefore, the area of the conductors is proportional to $\frac{1}{2}r$, the radius of the circle, while their lengths equal r. Hence, the weight of copper for

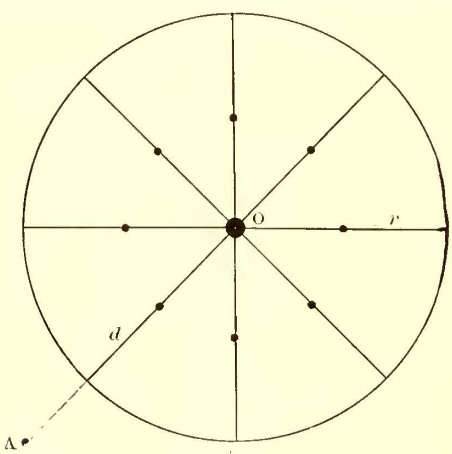


FIG. 12.

such a distribution is directly proportional to the product of these factors and equals $\frac{1}{2}$ K r^2.

If, now, the system is fed from another point than O, the center, such as A, the weight of copper will be proportional to the new moment of inertia, and, since this is made up of the sum of the terms mentioned, the copper will be doubled when $d^2 = \frac{1}{2} r^2$, i. e. when $d = \frac{r}{\sqrt{2}}$. It will be multipled by 3 when $d^2 = r^2$ and so on, rapidly increasing. The following table gives the relative weights of copper corresponding to a few values of W.

If $W = 1,\ d = 0$

" " $= 2,\ \frac{r}{\sqrt{2}}$

" " $= 3,\ r\sqrt{\frac{3}{2}}$

" " $= 4,\ r\sqrt{2}$

" " $= 5,\ r\sqrt{\frac{5}{2}}$

" " $= n,\ r\sqrt{\frac{n}{2}}$

It is worth noting that $\frac{1}{2} r^2$ is the square of the radius of gyration of a uniform circular disk. In any sort of distribution the mechanical analogue furnishes a solution of the copper problem in the ways just indicated.

It at once appears from these considerations that the cost of copper runs up with disastrous rapidity if the center of distribution is distant from the center of load. From the data given one can figure out readily the extra investment in real estate that it will pay to make in order to put the station near the center of load.

The facts set forth are a powerful argument for the economy of an alternating current distribution with high tension feeders, if such can be rendered available for ordinary railway work. The main objection to locating a center of supply at or near the center of gravity of the load is the cost of site. For a regularly constituted generating station this cost is often prohibitive, so that it is far cheaper to endure the great increase of copper necessary for feeding from a distance. If the central plant be reduced to a substation for supplying an alternating current to the working conductors, the space taken up is so trivial that its cost is almost nominal. The reducing transformers for a capacity of 1000 k. w., together with switchboard and all necessary station apparatus can easily be accommodated in a room ten feet square, if compactness be necessary. Nor is there any need of extreme care in the matter of foundations, since there is no moving machinery, save motors for ventilation in such a substation.

Even if the day of alternating motors for railway service be delayed far longer than now seems probable, there are not a few cases in which substations with motor-generators are preferable in point of economy to an immense investment in feeders. At present prices of apparatus such a condition will be met far oftener than would at first glance seem probable. In large cities, where there is a strong and growing tendency to force all feed wires underground, the cost of installing and keeping up conduits adds very materially to the disadvantage of elaborate feeding systems from a distant point.

Another class of cases in which special attention to the location of power station is needed may be found in the interurban and cross country roads now becoming common.

Generally the distribution is linear or branched, rather than a network. We should not, however, assume that the power station should lie at the middle, end or any other point on the line of the road. It very often happens that the center of gravity of the load, which is the most economical point for distribution, as we have just seen, is not on the line at all. For example, take the line shown in Fig. 13. It consists of three sections connecting, we

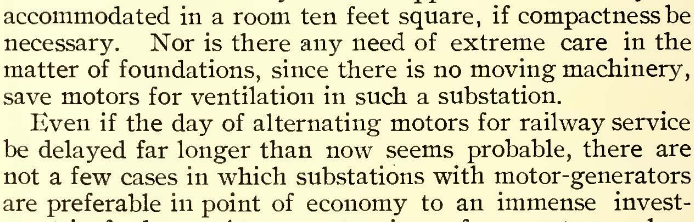


FIG. 13

may suppose, four towns, A, B, C, D. The configuration of the system is here determined by the topography of the region, the amount of business at each point, and similar considerations familiar in the art of railway location. We may suppose the load of each section concentrated at its middle point as before, forming the load points, *a*, *b*, *c*. Suppose the loads to be as follows: $a = 15$, $b = 10$, $c = 5$. These loads may be taken in any convenient units provided the same units are used throughout.

Now, proceeding as before, draw *b c* and locate the center of gravity of the loads, *b* and *c*. This proves to be *d*, where the concentrated load is 15. Then drawing *a d*, the center of gravity of the system is found to be at O, quite off the line of the road, although not inconveniently distant from B. In other instances the center of gravity might very readily be as much further from any of the towns, A, B, C, D as each is from the other. This example, however, shows a common characteristic of long lines.

The network type of distribution met in railway practice is quite different in character and needs from the lighting network. It is, save in a few instances, such as Fig. 4 (see STREET RAILWAY JOURNAL, February, p. 100), much less complex and much more irregular in load. In a well ordered central station for electric lighting, every street in the business district has its main, and the load,

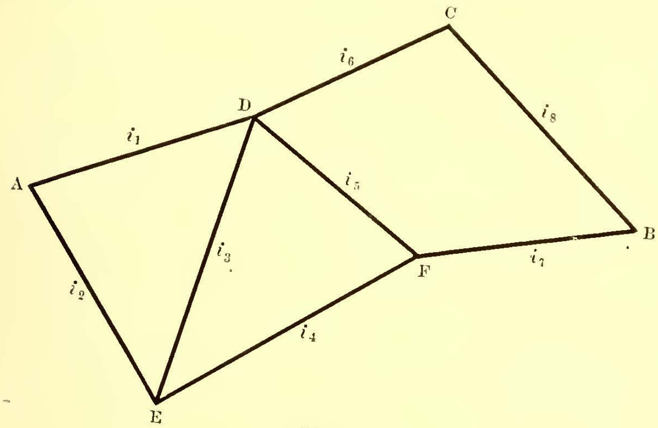


FIG. 14.

while far from regular, does not exhibit the extreme variations found in electric railway work.

The general solution of even a simple network, to find the current (and thence the drop) in each line due to one or more known load points, involves a most forbidding amount of tedious computation. But for the purpose in hand exact solutions are not needed so much as easy approximations.

Consider, for example, the simple network of conductors shown in Fig. 14. A is here the source of supply, either the station or the end of a feeder. The load is distributed along the lines, A D, A E, D E, D F, E F, D C, F B and C B. Such a circuit may be said to consist of three meshes, and it contains eight currents which we may call i_1, i_2 etc. In lighting practice it is necessary, knowing the load to be supplied by each line, to figure the conductors so as to maintain uniform voltage throughout the network. This involves algebraic processes too complex for convenient use; in fact the complete solution is a very pretty problem in determinants, which those interested may find elucidated in "Maxwell's Elementary Treatise on Electricity and Magnetism," and somewhat simplified in a paper by Herzog and Stark and published in the *Electrical World* in 1890. For railway work the conditions are, fortunately, simpler. We know, or can assume with sufficient accuracy, the normal distributed load on each of the lines. But we are absolved from any necessity for keeping closely uniform voltage throughout the system, since, even were it a matter of very considerable importance, it could only be accomplished by using an enormous excess of copper, for a large part of the load is liable at any time to be concentrated on almost any part of the network.

Two conditions must at all events be fulfilled. First, each one of the lines, A D, A E, etc., must be able to carry its own proper load without exceeding a standard drop; and, second, the sum of the distributed loads must be carried at certain points, which can be prejudged, without exceeding a certain maximum drop.

It must be noted that the conducting system of a railway differs from that of a lighting plant in having a much greater proportion of feeders to mains. In fact the working conductor of a railway is generally of quite limited carrying capacity. Practically, in laying out a network like that of Fig. 14, one has to cut loose from lighting precedents and deal with a special problem.

Following the first of the conditions just named, a convenient first step is to compute the conductors as isolated lines, on the assumption that i_1, i_2, i_3, etc., are the currents due to the normal load on each line. This furnishes the skeleton, as it were, of the conducting system. This work can often be simplified by bearing in mind the main line of traffic and treating as one their component conductors. For instance, in Fig. 14, if A be the station it may be convenient to take A D C B as a single conductor carrying a load $i_1+i_6+i_8$, and A E F B as another loaded with $i_2+i_4+i_7$. D E and D F may then be taken separately.

Now, this skeleton must be padded with reference to the second condition mentioned. Suppose that traffic is liable to be congested at or near B. This point is fed by the two main lines in multiple. If the drop chosen for these in making the skeleton would mean a drop at B sufficient to seriously impede traffic, enough copper must be added to relieve this condition. Just where this addition should be made requires the exercise of considerable discretion. If F is a point where congestion is also to be feared the line, A D F, should be strengthened, being the nearest route. If C be threatened, A D C should be reinforced. In either case the addition should be sufficient to put B out of danger. In any case i_3 and i_5 should be considered with reference to the lines, A D and A E, and the drops in D E and D F so taken as to keep them at good working pressure in spite of any excessive demands near the terminus of the system. In other words, for railway work it is nearly always possible to split up a network into a combination of linear systems and branches, since the loads are, or may be, so diverse that fine discrimination in minor lines is out of the question.

A good development of this splitting principle may be found in Fig. 15, which is a network of three meshes composed of two parallel lines, A and B, cross tied by the lines, C D, E F, G H, I J. Let A be a feeder and B the trolley wire and we have the well known "ladder" system of feeding in. As, in practice, C D, E F, etc., are very short compared with C E, E G, etc., the system may be regarded as composed of A and B in parallel, the only qualification being due consideration of the possible drop in B between a load point and the two nearest feeding points. But we may suppose A and B to run in adjacent streets and the former to be connected to another trolley wire on its own street, then a track to run along G H, and so on until the full network is developed. At each stage of complication the system may be considered as composed of one or more mains with branches, without sensible error, the

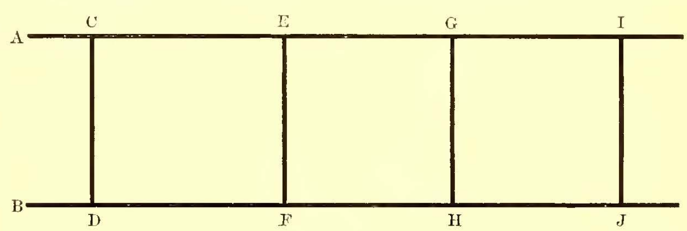


FIG. 15.

inaccuracy of the assumption being negligible compared with the uncertainty produced by the irregular load.

The variations of load in an electric railway system are so prodigious as to render the most careful calculations only roughly approximate. They are, in general, of three kinds. First, the momentary variations due to accidental changes of load incident to the nature of the service. Second, periodic general variation of the aggregate load caused by the varying conditions of service throughout the day. Third, shifting of the load to various points of the system, concurrent with the daily variations in total load, but bearing to them no simple relation.

The momentary variations are constantly occurring from minute to minute, almost from second to second. They are most considerable in street railway systems operating but few cars, and their amplitude may then be equal even to the maximum total load, and occur in a fraction of a minute. Such a condition may easily exist in a plant operating eight or ten cars. As the number of cars increases, the chance of so great variations diminishes, though somewhat slowly. In very large systems, the extreme amplitude of these oscillations of load may be reduced to twenty or twenty-five per cent. of the total load, but they can never disappear entirely. Their effect on the design of the conducting system is but small, for the voltage does not have to be kept closely uniform, and the conductors will be laid out for the average load based on the average consumption of energy per car. With a normal drop so computed and with care taken to allow a reasonable margin for maximum loads, these variations of the first class need not constitute a serious embarrassment.

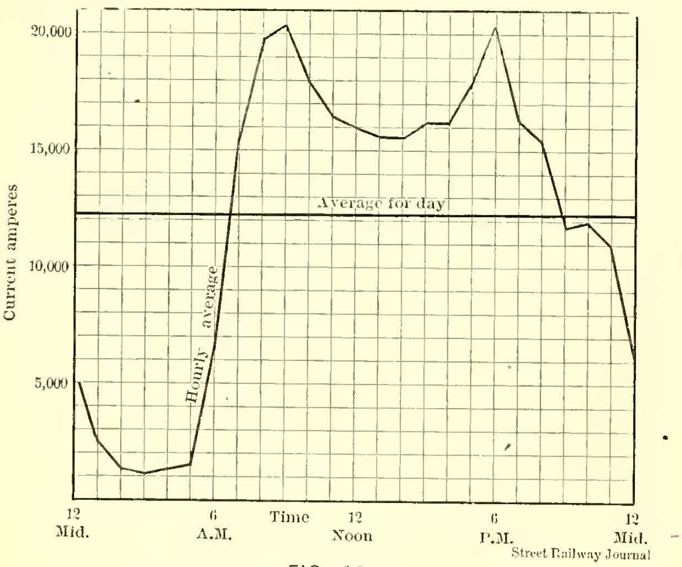


FIG. 16.

The diurnal changes of load based on average readings in which the oscillations are suppressed, are great in amount and of much interest. They are due to the habits and occupations of the community served, and often exhibit very curious peculiarities. Further, they are almost as strongly marked in very large systems as in very small ones and serve to determine the relation of average to maximum load, which in turn determines the allowance which must be made for drop at extreme loads. Even under very favorable circumstances the difference between average and maximum load is great. This is very forcibly shown in Fig. 16, which gives the load line on one of the largest electric railway systems for a December day, just before the holidays.

The minimum load is quite uniform from 2 A. M. until 5 A. M. and is only about six per cent of the maximum. At about 5 A. M. the load comes on quite suddenly and continues to rise until about 9 A. M., when it begins to fall, and keeps diminishing until about 2 P. M. Then it rises, slowly at first and then more rapidly until it reaches a second maximum, about equal to the first, at 6 P. M. Then it falls somewhat irregularly until only the night cars are left.

The average load for the twenty-four hours is about six-tenths of that at the two maxima. This difference is what must be kept in mind in providing a due factor of safety in the conductors. The load line is not, of course, invariable, being subject both to accidental and yearly variations, but, in spite of these, it preserves its characteristics and the value of its "load factor" with remarkable uniformity. In smaller systems there are practically no night cars, the service being generally about eighteen hours. Were such the case in Fig. 16, the "load factor" would be materially improved, rising in fact to about three-fourths under this supposition. But in small plants the day minimum is relatively smaller than in Fig. 16, so that the load factor is worse. Indeed it only too frequently falls to one-quarter or one-third in roads operating five to ten cars. Any value of load factor over one-half may be considered good in any but the largest plants.

In long roads operating a few large cars or trains at high speed, the load is subject to smaller casual variations, but the load factor is apt to be low by reason of the great change made by the stopping or starting of a single unit. The load during the period of acceleration is likely to be about double the running load even with carefully handled motors, and as this period is often several minutes, there is an excellent chance for the superposition of several such loads.

More serious than any others are the variations in the location of load, since these may cause a heavy call for power at some distant part of the system. Such shifting of the load occurs in nearly all cases of linear distribution, and has already been noted, but it also occurs on all sorts of systems, and is the more serious as it is less to be regularly expected. A single blockade may fill a limited district with stalled cars, and when at last it is broken the call for power is of a most abnormal kind. It does not appear on the load line, but shows in the shifting of load from one feeder to another. On systems of moderate size this shifting of load may be very serious. For example, through the baseball season many roads will find nearly their full output demanded at the ball park once or twice a week. The next maximum output may be at the other end of the system, to accommodate some special celebration. Even in a large network, at certain hours, during, and just before, maximum load, the locus of the load will be within a small district, and within the same district only when the same causes produce the shifting.

This wandering of the main load over the system is one of the most exasperating factors in the design of the conductors. It may easily amount to a concentration of a quarter or third of the total load at some quite unexpected point. It can be dealt with only by a minute study of the local conditions which generally will furnish some clue to the probable magnitude and position of such wandering loads. Whatever may be the general conditions of drop, the conductors must be so distributed as to prevent the system breaking down when loaded in some abnormal manner at some unusual point. No theory can take account of such occurrences; their ill effects can be obviated only by good judgment which is of more value than many theories.

Announcing Routes by Gongs.

The usual method of announcing the route of the different lines which operate over the same main track in the center of a city is by signs, different colors of car body or various colored lights. There are many, however, who cannot read the signs, and at times it is difficult to distinguish the different colors, even by persons who are not near sighted or color blind. An additional method of distinguishing such cars is employed on the lines of the Detroit Railway, of Detroit, Mich. The motormen on each route use a different gong code. Thus, if cars of four routes are running on one main track, the motormen of the first will strike the gong single blows ; those of the second two sharp blows in succession ; those of the third three sharp blows, and those of the fourth, one stroke and then two strokes, as follows:

Line A	.	.	.	.	.	.
" B	..	..	..	..	..	..
" C	...	...	...	...	...	...
" D	. ..	. ..	. ..	. ..	. ..	. ..

THE Milwaukee Street Railway Company has placed in its new book of instructions regarding the transfer system, a complete list of the telephones along the various lines of its road, this list being arranged in a manner suitable for ready reference. Each telephone user named in the book has been interviewed and has in every case cheerfully agreed to allow the company's conductors to use the telephones in any emergency case.

Experience With the Electric Locomotive in Baltimore.

BY LEE H. PARKER.

After a short period of experimental work, electric locomotive No. 1 on Aug. 4, 1895, took up the regular freight service through the Belt Line Tunnel of the Baltimore & Ohio Railroad in the city of Baltimore. A brief restatement of the reasons adopting for electricity in this tunnel will not be out of place.

The tunnel, which is the largest "soft dirt" tunnel ever built, extends from the present Camden passenger station of the Baltimore & Ohio Railroad, a distance of 7350 ft. north under the heart of the city. Beyond the northern portal, the Belt Line continues through a series of short tunnels and cuts for a distance of about five miles where it joins the old main line. The main tunnel has an up grade of 0.8 p. c. going north. The heavy work that would be required of steam locomotives hauling freight trains up this grade would occasion the filling of the tunnel with so much gas and smoke as to seriously interfere with the passenger service. To show how true this is, it may be said that before the electric locomotives were put into service a few freight trains were run through the tunnel but the result was that several men were asphyxiated,

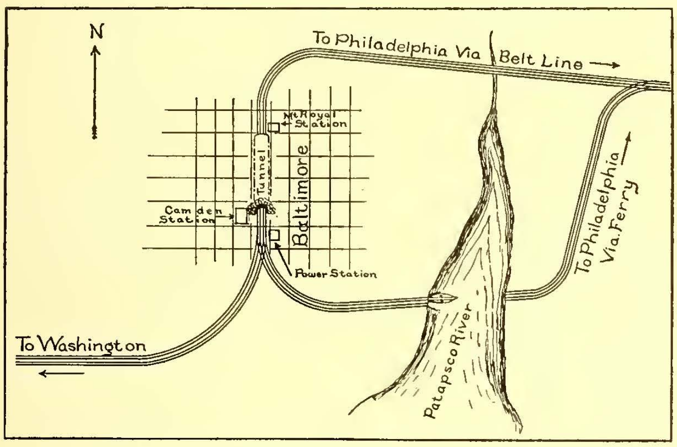


FIG. 1.—MAP SHOWING LOCATION OF BALTIMORE & OHIO TUNNEL IN BALTIMORE.

and it was therefore determined not to commence even a part of the regular freight service until the completion of the electric equipment.

The illustration (Fig. 1) gives an idea of the location of the tunnel and of what its use accomplishes. By its means a reduction of sixteen minutes in the running time of the "Blue Line" trains between New York and Washington is now made possible and it is probable that this saving will be increased later on. Morever, all delays in winter due to ice in the river are done away with.

Shortly after locomotive No. 1 had been put into service, and had given an exhibition of its ability to haul the heaviest freight trains, it became a matter of general interest as to how much it could pull and how fast it could go. The locomotive was, therefore, given a trial at hauling several of the passenger trains at high speeds, which it did satisfactorily to all concerned. As the conditions for operating the passenger trains entirely by the electric locomotive could not, on account of track facilities, be perfected until the new Mount Royal station, at the northern portal of the tunnel, was completed, it was decided to operate them in the meanwhile by coke burning steam locomotives. The new Mount Royal station will be ready in April or before, and preparations are now being made to then operate all trains, both freight and passenger, by the electric locomotives.

It was shown, from the few trials made with passenger trains, that not only could the guaranteed speed of thirty miles an hour be attained, but speeds of thirty-five and forty miles, with 500 ton trains, were possible. An exhibition of high speed was made with the locomotive running light up the 0.8 p. c. grade, and a speed of sixty-one miles per hour was attained for a short time, without the slightest trouble from trolley or motors. Several of the many exhibitions made by the locomotives in pulling heavy loads have been described in the newspapers. Probably the most striking was when two trains were coupled together and hauled through the tunnel. For some reason the freight trains had become "bunched" on the Washington division, and when they did get through they came so fast that it was decided to have the electric locomotive haul them two at a time. The first composite train, therefore, consisted of forty-four cars, loaded with coal and lumber, two regular steam freight engines and a steam "pusher" engine. The whole weight was approximately 1900 tons, and was equivalent to about fifty-two loaded cars. The steam locomotives did no work to assist the electric locomotive. The start was made easily and gradually, but when the train was in the tunnel and entirely on the grade the steady, heavy pull was too severe on a defective coupling near the head of the train, and it parted. After coupling together again, the electric locomotive started the heavy train, with all drawbars stretched—no slack in the train—and accelerated it to a speed of twelve miles an hour, without slipping a wheel, and in every way with the greatest ease. It reminded one of the start of an ocean steamship, so noiseless was it and free from any manifestations other than those of mighty power. The current recorded on the ammeter was about 2200 amperes during the acceleration period, and after the train was up to speed it settled down to about 1800 amperes. The voltage on the line was 625. By reading the amperes we were able to readily compute the drawbar pull, and found it to be about 63,000 lbs. All four motors were in series, and we were, therefore, getting the maximum pull for that current.

It may be of interest to steam railway engineers to know how we determined the drawbar pull exerted for each ampere of current put into the locomotive. The Pennsylvania Railroad Company's dynamometer car was secured and coupled in between the electric locomotive and a train of known weight. The weight of each car in pounds had been accurately determined beforehand. The regular two mile haul up grade was then made. When the train was in the tunnel on the grade the pull was uniform, as was shown in the diagrams taken on the dynamometer car.

When no drawbar pull was recorded the pen rested on base line No. 1. The height or ordinate of the irregular curve at any point represented the drawbar pull at that instant. Measuring the same in inches and subtracting a constant and then multiplying by 4000, gave the drawbar pull in pounds, i.e., every inch in height represented 4000 lbs. The paper traveled under the pen at a rate proportional to that of the train. An irregular line marked No. 2, above the base line, was the planimeter record, from which was determined the mean pull for any time. Having, then, the velocity, or the feet per minute and the mean pounds pull exerted during any period, we readily obtained the horse power developed.

Another line on the diagram showed the chronograph record, each of the small offsets in the line occurring every five seconds. For every hundred feet the train moved, the paper moved an inch. The distance in inches between any two of these offsets gave us readily the velocity of the train. Another line represented the time readings of current and voltage which were taken in the locomotive, a push-button in the locomotive being electrically connected with this recording apparatus. These readings were numbered, so it was easy to tell the current at any time and location. Still another line showed a record of the different stations in the tunnel. From this we determined the location of the train at any time.

The first test showed (a) how the start was made on the down grade leading to the tunnel; (b) how after the train was fully started, the drawbar pull dropped off; then (c) how it gradually increased as the train came on to the 0.8 p. c. grade in the tunnel; and (d) after the train was wholly on the grade, how even the pull was, until near the stop, when the grade increases to 1.2 p. c. Mr. Dunbar, the official of the Pennsylvania Railroad Company in charge of the car, showed some diagrams of steam locomotive work under similar conditions, and it was seen that their amplitude of vibrations was considerably greater than those of the electric locomotive. This was undoubtedly due to the absence of the angle crank on the electric locomotive, and because its pull is uniform throughout the entire revolution of the armature. Most of the vibrations of the pen shown on these curves were due to vibrations of the dynamometer car which was mounted on a single truck.

From test No. 1 we obtained the total drawbar pull in pounds, and, knowing the weight of train, we found the drawbar pull to be 22 + lbs per ton of weight. Subtracting the grade pull which, in the case of an 0.8 p. c. grade, is sixteen pounds, we obtained 6 + lbs. per ton as the train resistance. This confirms the usual allowances made for freight train resistance. These observations were taken in September 1895, on a very hot day. During the past winter months the train resistance has increased, due, no doubt, to greater journal friction caused by thickened lubricants, and we find it to be from our records about 20 p. c. to 30 p. c. greater than in September.

Test No. 2 was made after we had switched off six cars. The run was made under similar conditions and the same character of observations were made. The difference in drawbar pull of the two trains would naturally be the drawbar pull necessary for the six cars switched off. We had their exact weight and were thus again able to find what the drawbar pull per ton was. It was a check on our first figure and was very close to it, the slight difference we found being due to one brake on the six cars being partially set during the first run and unknown to anyone.

We had the readings of current during the first run, also during the second. The difference of these should show the current required to haul the six cars switched off. Dividing the difference in the drawbar pulls recorded in the two tests, by the difference in current recorded, gives us directly the net drawbar pull in pounds per ampere of current. This was 28.6 lbs.

It will, of course, be noted that by this method we eliminated the current required to drive the locomotive. To determine how much this was, and to check our conclusions, we divided the drawbar pull in pounds recorded in the first test by 28.6 and thus obtained the current that should exert that net drawbar pull. Subtracting this current from the current actually recorded on the locomotive would give the current required to drive the locomotive. We found it took 144 amperes. As a further check we figured similarly for the second test and obtained precisely the same, i. e., 144 amperes. So at any time now when hauling a train with the four motors in series if we take the current indicated on the amperemeter and subtract the 144 amperes needed for the locomotive, and multiply the remainder by 28.6, we have the total net drawbar pull in pounds, and if we divide this by the drawbar pull per ton we get the tons of load we are pulling.

From the results obtained above we were able to show the current and drawbar pull at any moment while accelerating a train. The curves (Figs. 2 and 3), explain themselves very fully.

The acceleration curve, Fig. 3, was obtained in a rather humorous manner. It was necessary to have a means of marking the location of the locomotive at the end of every interval of two seconds. It was first attempted to count the number of incandescent lamps passed in each interval, as they are fifteen feet apart, but it would often occur that the interval would end when the pointer was at some position between two lamps, and therefore it was impossible to estimate accurately how far we were from the next lamp. Someone suggested dropping something as a marker on the track at the expiration of each interval. That suggestion was followed by a large number of others as to the nature of that "something". The roadbed in the tunnel is very dark colored in the dim light and is rock ballasted, consequently the "something" should be light colored, non-breakable, and what would not bound out of place when dropped. Someone then suggested a handful of flour. This was adopted and it was soon tried. It was all right for slow speeds but at sixteen feet a second it was impossible to prevent it from blowing away. Having procured a large supply of flour, perhaps twenty pounds, and wishing to make use of it somehow some one volunteered the suggestion that flour and water made dough, and that a doughball was light colored and that it would not bound, etc. It was decided at once to use doughballs and they were the markers used in determining the distances traveled in each interval as shown on the curves in Fig. 3.

When it comes to a comparison of the economy of electric and steam locomotives it is readily seen that it is a difficult undertaking, knowing as we do the figures of only a single isolated electric plant operating under special conditions and for a comparatively short time. One great incidental advantage of electric locomotives in tunnel service is that they are smokeless. This is an important moral consideration, but one which can hardly be computed in

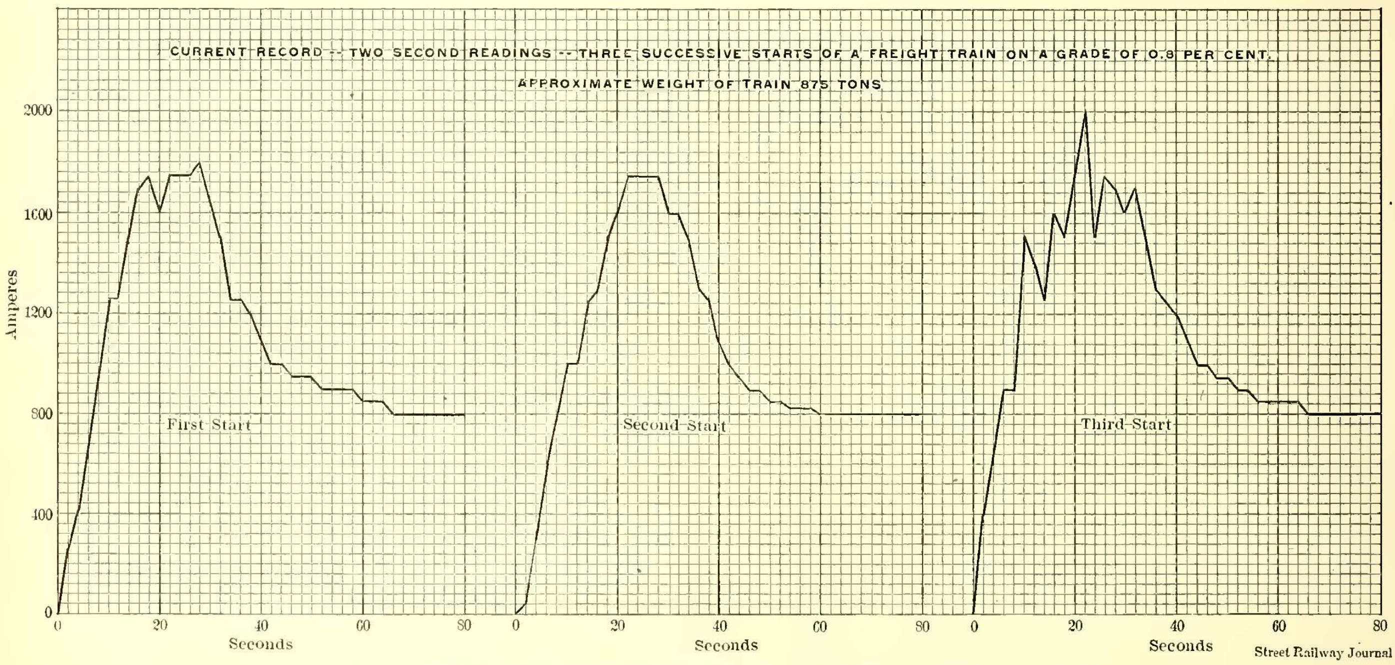


FIG. 2.—CURRENT RECORDS—BALTIMORE & OHIO ELECTRIC LOCOMOTIVE.

dollars and cents. But it may be of general interest to know how the actual operating expenses per engine mile of the electric locomotives during October, 1895, compare with those of a prominent and large Eastern railway for the same month.

For the operation of the Baltimore & Ohio Tunnel power house for the month of October, 1895, the itemized expenses were as follows:

Labor	$1,345.70
Coal ($1.35 per ton)	400.96
Oil and waste	151.26
Water	50.66
Maintenance	25.42
Total	$1,974.00

The expense on electrical locomotives was:

Motor engineers	$200.00
Oil and waste	12.16
Total	$212.16
Total expense	$2186.16

There were hauled through the tunnel 353 trains.

Average weight of train	1,095 tons
" time of trip	20 minutes
" current	986 amperes
Distance of trip	4 miles
Total engine travel	1,412 "
" " " "idle"	3,756 "
Actual time consumed for above service	118 hours
Idle time for month	626 "

It is customary to consider an engine with steam up as equivalent to six engine miles for each hour it is idle, so that, for comparison, the actual mileage made by the engines must be increased 6 × 626 = 3756 miles.

The large charge of labor at power house will be the same for one, two or three locomotives in service. The items, coal, water and maintenance, and the expense on locomotives, increase with the number of locomotives in service. If we assume this increase to be proportional, the total expense and cost per engine mile are as follows:

	Total cost.	Engine miles.	Cost per engine mile
For one locomotive	$2,186.16	5,168	$.423
" two locomotives	2,875.36	10,336	.278
" three "	3,564.56	15,504	.23

The steam railway records referred to above are for October, 1895, and may be briefly abstracted as follows:

STEAM LOCOMOTIVE PERFORMANCE.

	East Div.	West Div.	Central Div.	N. & W. Div.	Entire Line.
Locomotives in service	74	57	33	28	192
Average engine mileage in service	2834	2966	2293	2305	2703
Average cost per engine mile.					
Passenger engines	.1926	.1666	.1629	.1552	.1765
Freight "	.2472	.2656	.3428	.2303	.2615
Switching "	.1489	.1659	.1828	.1425	.1577
Work "	.2391	.2258	.2617	.2169	.2354
Total "	.2084	.2193	.2121	.1797	.2095

From the figures given above it is seen that the actual operating expenses of the electric locomotives for that particular month are about the same as for the freight locomotives on the steam railroad, i. e., twenty-three cents per engine mile. The service of the electric locomotives at that time was only about one-third that which it is expected they will have to do when the passenger service is taken up and the line extended the full distance.

As originally intended, a method of using to advantage the power of the station while the electric locomotives are idle is soon to be incorporated in the plant. Under the new conditions the cost per engine mile for the electric locomotives will be far under that of steam.

A comparison of the efficiencies of steam and electric locomotives shows slightly in favor of the electric. Observations made on French railways and on the Pennsylvania Railroad show that about 45 p. c. to 55 p. c. only of the i. h. p. of steam locomotives is applied to hauling trains. The efficiency of the Baltimore & Ohio plant is in the vicinity of 60 p. c. to 65 p. c. under normal conditions.

A word may be added as to our experience with the overhead conductor system. The conductor in the tunnel has now been in position for nine months. During all of this time coke burning locomotives have been used, for passenger service with the consequent presence of a good deal of gas and vapor. For the first six months about half of the conductor was constantly wet from the drip due to

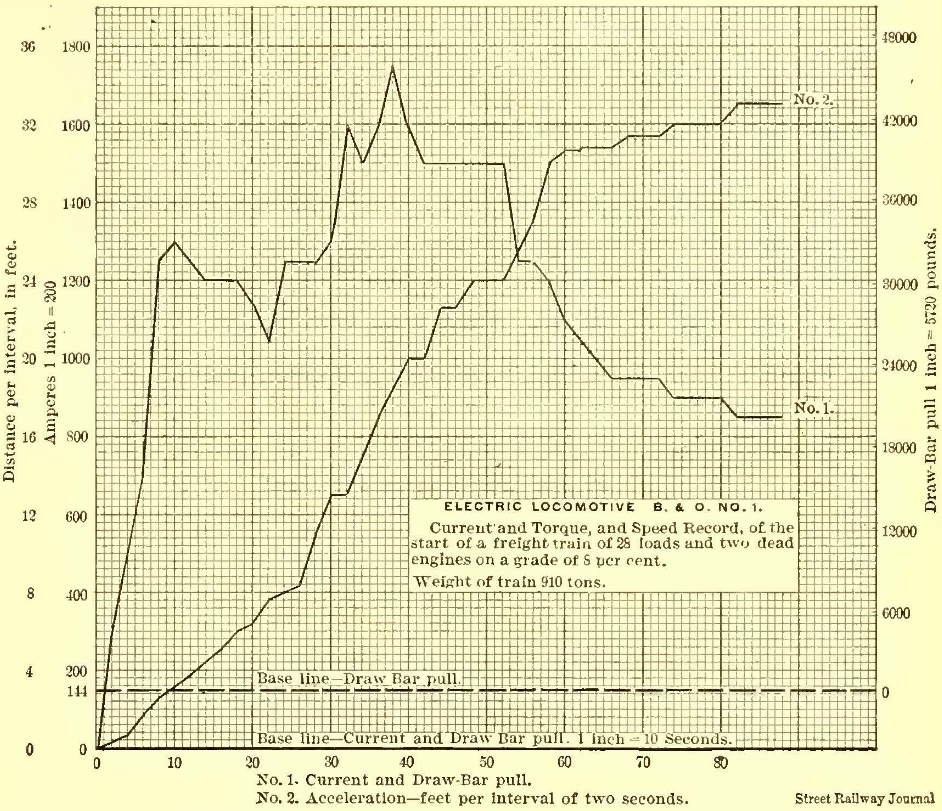


FIG. 3.—CURRENT AND ACCELERATION CURVES—BALTIMORE & OHIO ELECTRIC LOCOMOTIVE.

leaks in the masonry. This occasioned a muddy, slimy deposit over the insulators and a considerable portion of the conductor. The porcelain insulators are almost entirely obscured in some places by this deposit and that of small particles of carbon given off by the locomotives.

Current was first turned on the line about three months after the tunnel structure was erected. The leak to earth was at first twenty-one amperes, but, in a day or two, this dropped to about four amperes—the present leakage. The inside of the conductor was coated with a combined deposit of rust and muddy sediment. Heavy currents were taken from it by the contact shoe only with difficulty and the presence of much arcing, heating and showers of sparks. It was found impracticable to run on this surface. By applications of kerosene and frequent scraping with special shoes, a direct contact of the trolley shoe with the conductor was made possible. Although a single contact shoe then worked with little or no sparking, two shoes in tandem were adopted. Their operation through the conductor is smoother, and the contact over muddy portions of it is more nearly positive. At intervals of about three weeks the conductor is treated with kerosene, and brushing shoes are run through it, about one or two trips with these brushing shoes being all that is necessary. This serves to prevent the further accumulation of rust and to remove the sediment from the contact surfaces. An inspection shows a smooth surface over which the shoes run. Contact with the metal is seen to be in high spots and thin lines which are slowly increasing in extent.

No considerable sparking now occurs, except at the wet places, where it is occasioned by the presence of water and sediment. With the exception of three places, about 200 ft. long, each, the conductor is at present dry.

The bolts to the arch of the tunnel are both galvanized and painted. They show no signs of rusting. The painting has, in general, protected the surfaces of the conductor and channels. The sides and top of the inside of the conductor are coated with rust. Most of this is hard and close grained, some of it, however, flaky. In no case is there apparent a reduction of thickness of any of the ironwork, due to rusting. Outside the tunnels the conductor is in uniformly good condition. It adapts itself to changes of temperature without trouble. The inside of the conductor is coated with rust, but in no case has there been any trouble from it. The deposit appears to be very light. There was at no time any sparking between contact shoes and conductor outside of the tunnel.

FIG. 1.—VIEW OF BROOKLYN BRIDGE FROM THE NEW YORK PIER.

Dry Oak.

It is sometimes important to know whether oak is really dry or only partially free from moisture. One of the first tests is that of smell. When perfectly dry there is a powdery odor which is quite unmistakable and is very different from that of the green lumber. It can hardly be described, but is not easily forgotten. The second test is that of working. If the tools leave a dark bluish or inky stain upon any part of the wood it is a sure sign of moisture. Dry oak will not discolor when in contact with wood working tools. Without moisture there can be no iron stain. To the expert there is a difference in the feeling of oak when dry. The wood, even when nearly dry, has a cool, moist feeling which is quite characteristic. It also has a wet or damp appearance when cut which may sometimes reveal in an unmistakable manner the condition of the timber.

For street car work if dry oak cannot be obtained it will be far better to substitute some other timber for it.

The Reasons Why Electric Motors Will be Used on the Brooklyn Bridge.

One of the most remarkable and interesting applications of electricity that has yet been made in the transportation field is the adoption of electric motors for switching purposes on the Brooklyn Bridge, in place of the locomotives hitherto employed. The change has not yet been made in its entirety, but a wholly successful test has been made upon apparatus installed during the past month on a single train, and as a result of this test, the bridge trustees have passed a preliminary vote to enter into a contract for the equipment of sixteen cars, one for each train.

The sixteen cars will each be equipped with four motors, one on each axle, and will be known as motor cars. They are similar in all outward respects to the regular grip cars on the train. Each motor car will remain with its own train at all times, switching it from the incoming to the outgoing tracks and starting up the trains from the platforms until they reach the tilting sheaves, when the grips will take up the cable and the motors cease work during the trip across the bridge. If, however, the grips should at any time slip while the train is mounting the 3.78 p. c. grade to the center of the bridge, the motors may again be placed in requisition to assist the trains over the summit, and the trolley wires now crossing the bridge for lighting service will be reinforced by feeders to serve as a supply for the motors in these emergency cases. Moreover, it is also intended that during the night and early morning hours when the traffic is light and the cable is shut down, the trains will be run by motor cars instead of the locomotives.

The doing away with the locomotives on the bridge means far more to the management and to the public than is ordinarily understood. The first and most obvious advantage lies, of course, in the decrease of moving units and the consequent reduction of accidents from collisions with trains and bumpers. This is a very serious matter, and only the utmost care and vigilance on the part of the employes keep the trains in reasonably regular and safe operation. It is especially important to do away with as many moving units as possible in view of the plans adopted for

FIG 2.—VIEW OF TILTING SHEAVES AND OVERHEAD WIRE SYSTEM ON BROOKLYN BRIDGE.

increasing the train capacity at the bridge terminals, those plans having in view the building of island platforms and the reduction of train headway from ninety seconds to forty-five seconds.

In the next place, the locomotives frequently—much more frequently than is generally supposed—run off the track at the switches, from one cause and another, and this means a blockade of traffic until they can be jacked on again. The number of times that moving units will have to be switched is, of course, greatly reduced by the new method.

The locomotives are necessarily exceedingly heavy, since they are often obliged to pull a one hundred ton train up a grade of nearly four per cent across the bridge, and nearly their entire weight (about thirty out of forty tons) is concentrated on a five foot wheel base, which brings about great wear at the switch points and on the track oints.

In mounting the grade at the Brooklyn terminus the train sometimes loses momentum and cannot reach the platforms. In mounting the grade near the center of the bridge the grips sometimes slip in wet weather, and the train has to be stopped. Both these contingencies make it necessary to send out a locomotive from the station to assist the train, and the second contingency is particularly vexatious, as it is necessary to draw the train back to the platform and start over again, thus blockading traffic for several minutes. In both cases the presence of electric motive power on the train itself completely does away with the difficulty.

There will be some time saved in switching at the terminals, although this saving will not, probably, be more than a few seconds. It will be due, chiefly, to the more rapid acceleration obtained from electric motors than is possible with the locomotives.

There will be a material saving in labor when locomotives are done away with, since the control of the motor car can be readily placed in the hands of the regular gripmen on the train, and all necessity for engineers and firemen on six locomotives will be done away with. It is said that about sixty per cent of the entire expenses for motive power are at present chargeable to switching at the termini, and only forty per cent to actual movement of trains on the bridge.

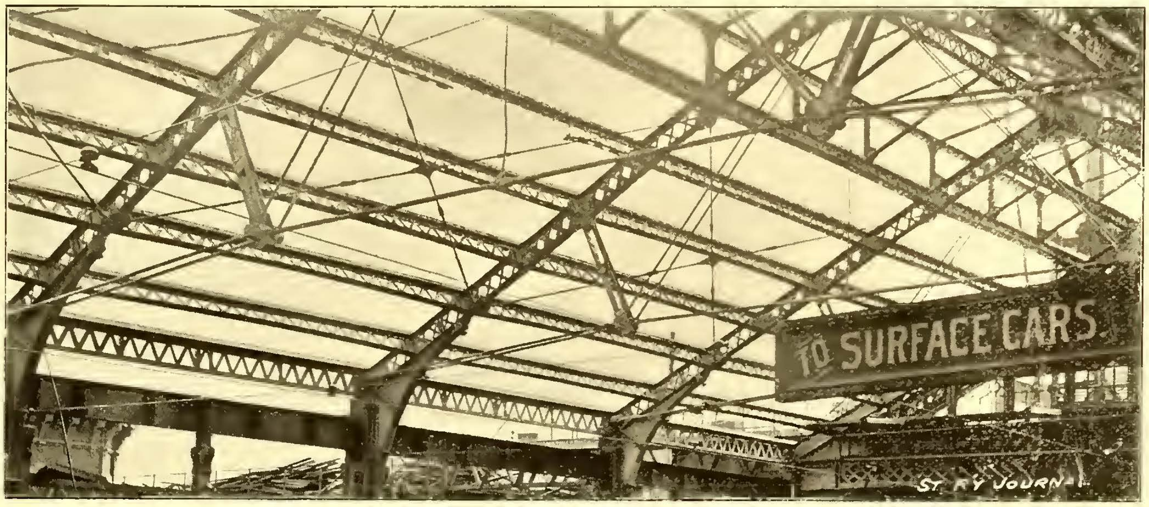


FIG. 3.—VIEW OF ROOF GIRDER SHOWING DESTRUCTIVE INFLUENCE OF LOCOMOTIVE GASES.

There are also apparently small, but really important, objections to locomotives, which have had much influence upon the minds of the bridge engineers. The use of locomotives in any roofed structure involves many inconveniences and even dangers. In the first place they emit acid gases which attack the ironwork and actually weaken the structure. This is clearly shown in the accompanying illustration (Fig. 3), in which is seen one of the roof girders at a terminal of the bridge, under which the locomotives have to stand while waiting for the trains. It will be noticed that the whole lower flange and part of the lattice work of this girder have been actually destroyed by the acids from the engine gases, and it will not be long before this girder will have to be replaced. It has been found impossible to paint ironwork in such a way as to prevent this destruction from engine gases, although many inventive minds are hard at work on the problem of producing such a paint.

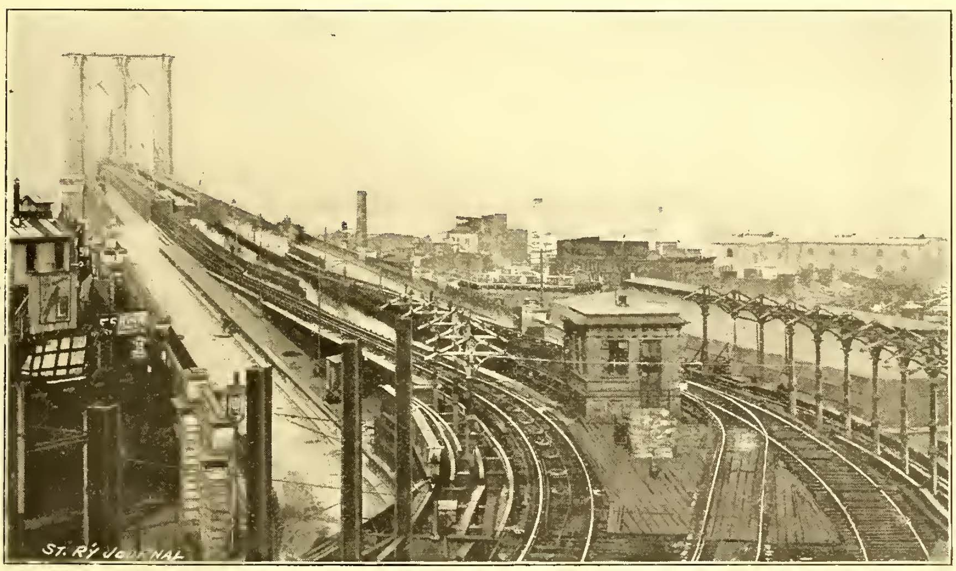


FIG. 4.—VIEW OF BROOKLYN TERMINAL—BROOKLYN BRIDGE.

Again, the steam from the locomotives condenses on the roofs and, with the other products of combustion, forms a kind of alkaline mud which drops upon the tracks, platforms and sometimes the passengers themselves. The presence of ice on the platforms is of very frequent occurrence in winter, and the tracks are often so greasy as to make it difficult to start the trains.

For all these reasons the use of electricity for the purposes mentioned appears to be a distinct advance on the present practice. It is not expected by the bridge trustees, however, that electricity will ever do away with the cable system for the regular propulsion of trains, and the reasons which are given why this is not likely to be true appear conclusive. The density of traffic is, of course, enormous and the trains are run at the shortest possible headway consistent with the avoidance of collisions. Now, if each train were an independent unit controlled by individual judgment, the dangers of running trains at such short headway on the steep grades of the bridge would be far greater than at present. By the present system four or five men combine in controlling the train. The maximum speed is fixed by the speed of the cable. The (vacuum) brakes of each car are independent of the others, but all the train men are held responsible for bringing trains to a stop exactly at the proper part of the platforms, and the braking power of each car is large.

As to the matter of reliability of service, it is claimed for the bridge cable system that during twelve years of operation it has never given trouble but twice, and then in an unimportant way. This is certainly a marvelous record.

It is necessary that the whole bridge service should be a matter of clockwork in its absolute regularity, and it is not believed by the trustees that any system superior to the cable can be devised for this purpose.

Some of the details of the equipment will be of interest. The trustees have adopted the McGuire "L" motor truck for this first equipment. In these trucks double equalizing bars are spring mounted on the four journal boxes. On these equalizers are mounted two cross sills, from which are suspended the electric motors, so that the wheels, axles, equalizers and motors move together independent of the truck frame and car body. The brakes are located inside the wheels and surround the motor without interfering in any way with it. It will be seen that this is an exceedingly short and compact truck. [It was more fully described and illustrated in the STREET RAILWAY JOURNAL for February.]

The general character of the motor equipment, which was furnished by the General Electric Company, is similar to that in use on the Metropolitan West Side Railway, of Chicago, and the Nantasket Beach Railroad. The motors will exert a horizontal effort of 1200 lbs. when mounted on a thirty-three inch wheel running ten miles an hour. They are completely enclosed and practically water and dust tight. Each motor weighs about three thousand pounds. At the base of each motor facing the ends of the car is a small sheave which depresses the cable and allows it to pass the motor without injury, and a long iron bar runs beneath the truck and depresses the tilting sheaves so as to prevent them from striking the motor.

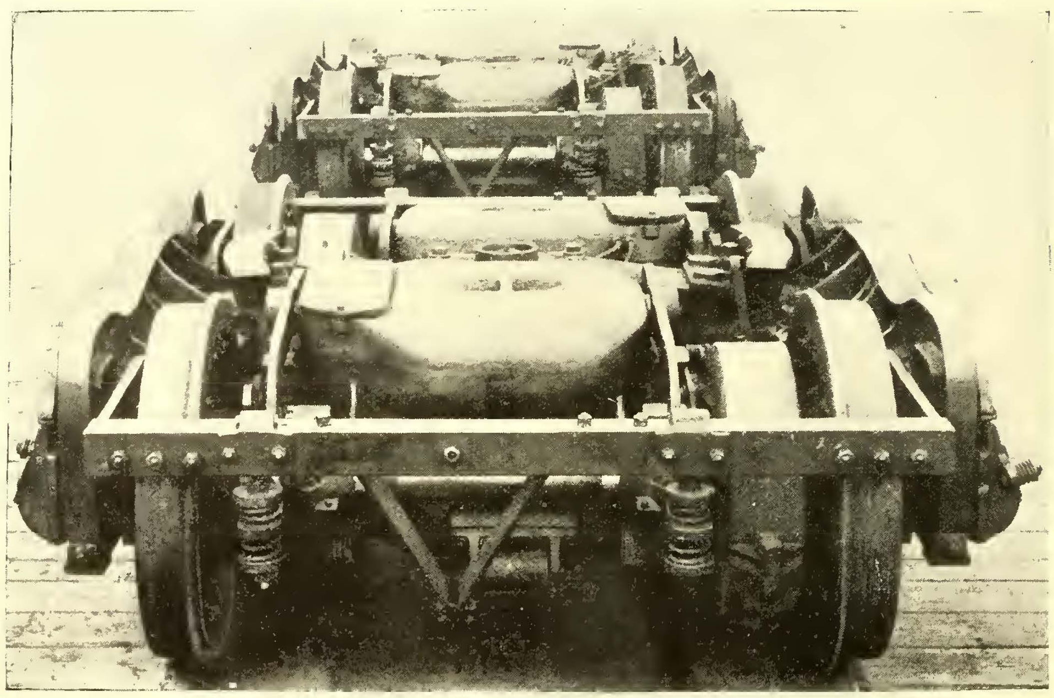


FIG. 5.—MOTOR TRUCK ADOPTED FOR SWITCHING PURPOSES ON BROOKLYN BRIDGE.

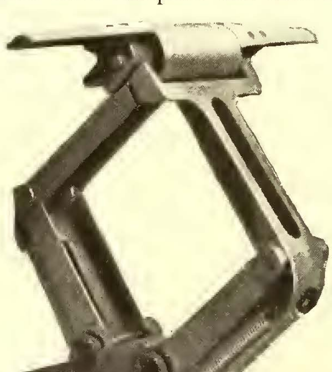


FIG. 6.—TROLLEY ON BROOKLYN BRIDGE CARS.

The motors are operated by the "L 4" controller of the General Electric Company, which has been used with great satisfaction on the Chicago elevated roads. The indicating dial is placed at the top of the platform rail. There are two controllers, each operated from its own platform and each controller will operate the four motors or any two of them, as may be desired. All the remainder of the controlling apparatus is placed beneath the car floor, as usual, except that under the hood of the car is an automatic circuit breaker placed within easy reach of the motorman.

A Weston ammeter inside the car indicates the current used by the meters in service. The car is equipped with twelve electric heaters of the Consolidated type.

The trolley is diamond shaped, and is set longitudinally upon the roof of the car. It carries at right angles a bar, in the center of which is the trolley wheel or roller. The arms are wide enough to preclude any possibility of missing contact.

The official test of the first car equipped, made on Feb. 8th, was in charge of Kingsley Martin, assistant engineer of the bridge and was completely successful in every particular.

The power for traction purposes is at present supplied through a Fulton Street feeder, from the Kent Avenue station of the Brooklyn Heights Railroad Company, and the return wire is connected to the rails of the surface road. For the complete equipment, however, an independent plant will be installed by the bridge management.

LETTERS AND HINTS FROM PRACTICAL MEN.

Power Station Results and Economies.

BELLE CITY STREET RAILWAY COMPANY,
RACINE, WIS., Feb. 7, 1896.

EDITORS STREET RAILWAY JOURNAL:

Our plant consists of three 100 h. p. tubular boilers and two 200 h. p. Stirling water tube boilers, one of which is equipped with a Hawley down draft furnace. The tubulars are used in case of any shutdown to the Stirlings, and were our first boilers. They are run at 100 lbs. and the Stirling at 125 lbs.

We have one Westinghouse compound condensing and one McIntosh & Seymour tandem compound condensing engine, both of which are used for street railway work and the furnishing of a power circuit. These engines are 250 h. p. each and are belted to Detroit 150 k. w. generators. The limit switches are set to throw out at 400 amperes each. We also have a Bullock condensing Corliss of 250 h. p. which drives by means of a line shaft and friction clutch two Wood arc lighting machines of 75 light capacity each, and a Wood alternator of 1500 light capacity. These three engines are all run from the above boilers and a Worthington condenser. Therefore to figure our cost for fuel per car mile, it is necessary to estimate the amount used for lights and power. This we do by taking half hour readings; striking an average and charging to lighting and power the proportion thus figured.

We burn for steam fuel Pittsburgh nut coal, costing us delivered in our boiler room $3.25 per long ton.

Our electrical output at this time of year is as follows: railway plant from 6 A. M. to 5 P. M. average 250 amperes; from 5 to 6 P. M. average 430 amperes; and from 6 to 11 : 30 P. M. average 220 amperes; all at 500 volts.

Our power circuit averaged for January, 1896, 15½ hrs. per day, 51.8 amperes or 34.85 e. h. p.

Our incandescent circuit averaged 36.53 amperes, or 73.06 e. h. p., which, with 116 1200 c. p. arc lights on an average of 7 hrs. per night, brings our lighting and power coal bill for January to $483.40, to which add fuel for car stoves and heating car barns, station and offices $108.83, making $592.23.

Deducting this from our total bill of $1,202.88, leaves for car mileage fuel $610.65. Our total car mileage for January, not including snowplows or salt cars, was 41,578.54, making our cost for fuel per car mile $.014686. January was a very dry and dusty month, and as our city does no sprinkling after Nov. 15, we had a very dirty rail, which added to the expense of power.

Our cost per car mile for 1895 was as follows:

Fuel	.013575
Oil and waste, repairs and attendance	.005417
Total mileage (537,607)	.018992

Our car bodies are sixteen feet long mounted on Brill and McGuire trucks, and equipped with Detroit motors, six single reduction and fourteen Rae's.

Our tracks as operated are thirteen miles in length, containing twenty-two curves, eighteen switches and sixteen grades, of which the heaviest is 2.88 degs.

For oils we use the Standard Oil Company's brands, "Capital" for cylinders and "Renown" for engines and dynamos, and we strain or filter them.

Our power house is located centrally and every car passes the station and offices on each trip. The farthest point on our lines from the power station is 2.57 miles. We have at present no feeders up, but have the wire and material on hand and will run the line as soon as spring opens up. We expect then to make a better report.

Yours truly,
JACKSON I. CASE, Pres.

MARINETTE GAS, ELECTRIC LIGHT & STREET RAILWAY COMPANY.
MARINETTE, WIS., FEB. 8, 1896.

EDITORS STREET RAILWAY JOURNAL:

The oils we use in our power house are Standard Oil Company oils, "Capital" cylinder, and "Red Cross" engine oil. We strain the oils over and over again, until they are entirely worn out. Our station is a small one, about 600 h. p., about one-half of which is used in the evening, and from 75 to 100 h. p. during the day. Our oil consumption per year for this purpose is from $250 to $300. We use but little coal, our fuel being mostly slabs, which we get at a very low figure, owing to our being in a lumber district.

The only information I can give you on this subject is, that our fuel bill for electric light and street railway service is about $4000 per year. We do not keep track of our car mileage, our line being a small one, running five cars in the winter and from six to ten in the summer. Our cars are sixteen feet long and our grades are light and few. We have yet not commenced to keep a regular schedule of our mileage run by cars, or the power output of our station, and I should be very happy to be able to furnish you such data if I had it. We are now putting in such station instruments as will enable us to keep a regular schedule of our power output, and I hope to be able next year to give you a better account of our operating expenses.

Yours truly,
H. C. HIGGINS, Pres.

MIDDLETOWN STREET RAILWAY COMPANY,
MIDDLETOWN, CONN., Feb. 11, 1896.

EDITORS STREET RAILWAY JOURNAL:

We have been hiring our power, paying for the same by the kilowatt. For the nine months ending Sept. 30, 1895, our power cost us $.0389 per car mile and the average current required per car mile, we found to be .84 k. w. and the cost per kilowatt was $.0464. Our average mileage per day was 312 and average current required 262 k. w. The number of cars in service is three all day and one extra from 11 : 40 A. M. to 7 : 40 P. M. The track is 4½ miles long, of which ½ mile is double track, and the road is run in three divisions, either of which is not quite two miles long.

Yours truly,
E. W. GOSS, Supt.

Methods of Feeding a Long Suburban Line.

HAMILTON, GRIMSBY & BEAMSVILLE ELECTRIC RAILWAY COMPANY.
HAMILTON, Can., Jan. 18, 1896.

EDITORS STREET RAILWAY JOURNAL:

Will you kindly inform me through your valuable paper, if you know of any long distance electric railway using storage batteries at the ends of their line farthest from the power house to assist in keeping up the voltage. Our power house is ten and a half miles from the eastern end of the line and we purpose extending five miles further east. We have an idea that by using storage batteries ten and a half miles from the power house we could run our engines steadily at full power storing up all excess in our batteries for use on the extension.

Yours very truly,
CHAS. J. MYLES, Pres.

[The use of storage batteries in such a way as that referred to would not be effective or economical, as there are much better ways of accomplishing the same object. One way would be to divide the line into two sections and to feed the distant section by dynamos run at a higher voltage than those which feed the nearer section. This, however, might not be a satisfactory plan if the number of cars in service was so small that only two or three dynamos were in service, because the fluctuations of power on a section fed by a single dynamo are too great to permit of running engine and dynamo at anywhere near the full load.

Another way would be to run the entire station at a comparatively high voltage—say 600 volts—and to feed the further section direct, with a drop of 100 to 150 volts, and the nearer section through a station rheostat which would take up the excess of voltage so as to prevent danger to motors on the nearer section. This would probably only be economical where water power is used or where coal is cheap, particularly if the number of cars on the nearer section is much greater than on the further, which is often the case.

Still another way is to make use of the "booster system," to raise the voltage on the particular long distance feeder line to a point where the loss through the feeders will be considerably greater than on the other feeders of the general distribution system, while the final voltage at the cars will be substantially normal. This is accomplished by installing in the station a special dynamo of small capacity wound for low voltage—say 25 to 50 volts—and heavy current, sufficient, as far as current is concerned, for the operation of all the cars on the distant section. The positive terminal of this "booster dynamo" is connected to the station end of the long distance feeder, and the negative terminal is connected with the positive station bus bar. The "booster dynamo" thus has, of course, no ground connection, and its effect is to raise the potential on the positive bus bar—say 550 volts—to, say, 600 volts.

The most economical way of all so far as power consumption is concerned is, of course, to run additional feed wires to the distant section. It is a matter of calculation as to whether the saving in coal consumption brought about by a reduction in loss of power on the line would be enough to return a reasonable interest upon the extra money invested in copper wire—EDS.]

A Street Railway Labor Force.

[The superintendent of a Western road operating twenty-eight miles of track, thirty-five motor cars and fourteen trail cars writes us as follows:—EDS.]

Jan. 23, 1896.

EDITORS STREET RAILWAY JOURNAL:

I notice in your January number an article on the "Duties of a Car House Force." I have sixteen men at a cost of $768.50 per month. They handle all electrical and mechanical repairs to cars, line, track, etc. This force also includes two men and the fireman at the power station running three Corliss engines. We do our own armature and field winding. Our engineer does all the lathe work such as turning commutators, making bearings and all work that can be done on a light lathe. We have the Sprague No. 6 and Westinghouse No. 3 motors. The force here have learned their work from actual practice and they know their business. I am a practical electrician and mechanic.

Yours truly, C. L. H.

A Conductors' Pocket Record Book.

THE MILWAUKEE STREET RAILWAY COMPANY.
MILWAUKEE, WIS., Jan. 8, 1896.

EDITORS STREET RAILWAY JOURNAL:

I send you under separate cover a new conductors' book which we have just gotten up for our men, and which we think will put them in possession of a good deal of valuable information within a narrow compass, and be useful.

You will note that on the inside of the cover one sheet has a sample conductors' ticket already made out, showing precisely how the conductors' slips are to be made, both front and back, and on the inside of the other cover are instructions as to what to do in case of accident, where to report, etc.

Posssibly, the matter may interest you.

Very truly yours, C. D. WYMAN.

COPYRIGHT. 1896

Milwaukee Street Railway.
FRONT.

Date, *January 1st*, 189*6*

Run *2* Badge *201* Route *Lake Park.*

		No. Car.	Time.	5 Cts.	8 Cts.	T'kts.	Tr'nsf'r T'kts.	D. H.	Total Pass.	Total Cash	
1	N	124	6.02								
	S	"	6.34	3					3		15
2	N	"	7.06				5	2	7		—
	S	"	7.38	17					17		85
3	N	"	8.10	4			5		9		20
	S	"	8.42	34	1	4			39	1	73
4	N	"	9.14	6			1		7		30
	S	"	9.46				17		17		—
5	N	"	10.18	3			3		6		15
	S	Totals		67	1	4	31	2	105	3	38
6	N	124	12.26								
	S	"	12.58	12			1	2	15		60
7	N	"	1.30	12			1		13		60
	S	"	2.02	37				2	39	1	85
Total				128	1	4	33	6	172	6	43

Conductor *H. Mueller.*

M. M. *S. Rowe.*

BACK.

Conductors put the Numbers of their Transfers Commencing and Ending here, as follows:

Time On.	Number Commencing.	Number Ending.	Total No of Tr'nsf'rs Issued.	Time Off.
6:02 A. M.	65210	65270	60	10:18 A. M
12:26 P. M.	65270	65310	40	2:02 P. M.

Conductors Put Their Total Register Readings Here.

CAR.	REGISTER.		TIME.
124	In	1517	10:18 A. M.
124	Out	1412	6:02 A. M.
		105	
124	In	1835	2:02 P. M.
105 / 67	Out	1768	12:26 P. M.
172		67	

The above shows both sides of a Trip Sheet properly filled out.

Be sure that the record of Transfers used is correctly given, and that there is no discrepancy either in the report of collections or in the record of your Register, and that your Register readings agree with your tally, also with Register Inspector's readings.

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Milwaukee Street Railway Co.

WHAT TO DO IN CASE OF ACCIDENT.

THE MOTORMAN WILL

Stop the car immediately
Go to assistance of injured person.
Secure their name and address.

THE CONDUCTOR WILL

Secure names and address of all available witnesses, whether passengers or bystanders.
If accident is serious, notify 'Phone No. 478.

IF PROPERTY HAS BEEN DAMAGED

The Motorman will assist Conductor in securing:
Name and address of owner.
Name and address of witnesses.
The extent of damage.
Also in making out report.
Notify Inspector as soon as possible.

THE CONDUCTOR WILL

Report on Accident Blank:
Injury to person or property occurring in connection with, or caused by your car.
Falling of passenger when taking or leaving car, no matter how slight the injury.
Ejectment of passengers.
Turn report over to Station Master before going off duty.

WIRE DOWN.

When first car arrives at break, Motorman will immediately take charge of the prostrate wire, warning all persons away from it, until relieved by another representative of the company.
The Conductor will run to the nearest telephone and notify 'Phone No. 478. When necessary to pay toll it will be returned upon application to the Station Master.

SPECIAL NOTICE.

CONDUCTORS WILL NOT PERMIT PASSENGERS TO OBSTRUCT THE PASSAGEWAY ON REAR PLATFORM.

A CONDUCTORS' POCKET RECORD BOOK.

Construction of Steam Pipe Lines in Power Stations.

[We have obtained permission to reproduce the following private letter written to a prominent street railway manager who was experiencing trouble with leakage of joints in his steam pipes.—EDS.]

KANSAS CITY, Apr. 20, 1895.

DEAR SIR:—Your favor of the 19th inst., received. I have had plenty of the trouble of which you speak. Such trouble does not arise so much from vibration as it does from a failure to let the pipe be free to expand and contract under different temperatures. Such a pipe should have as few fixed points as possible and should be swung, not anchored. Long lines of straight pipe should be avoided where one end is not comparatively free to move. The line L (Fig. 1) should never be long when A C is short and when the points A and B are comparatively rigid. In such a case the expansion of L will strain the joints A and B.

The best way to avoid the strains on the joints is to introduce lengths in such a way as to yield by torsion, thus (Fig. 2).

When the long horizontal lengths of pipe expand or contract the vertical pieces twist slightly on their axes and by the corresponding angular displacement the pipe readily moves so as to accommodate itself to the change without straining the joints unduly. The same thing takes place at the engine. Engineers are too apt to lay their pipes too nearly in a single plane. This causes a transverse strain on the pipe and joints which is objectionable.

If you will carry your pipe high enough above your boiler so as to get as much vertical pipe as is practicable,

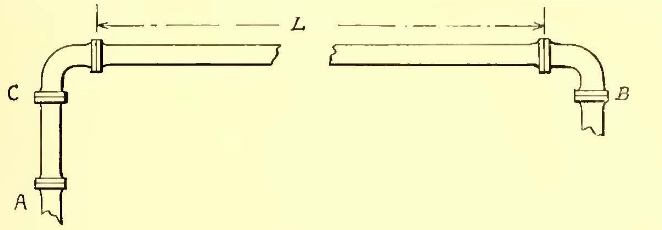

FIG. 1.

and then adjust your horizontal piping so as to conform to the above theory, and then swing your pipe and leave it free to move, except at boiler and engine, you should have no trouble. It is better to put in an arbitrary bend than to strain the joints unduly.

For example and further illustration. If you should rise eight feet at boiler, then go east ten feet, then north forty feet, then west ten feet and drop sixteen feet to your engine you would have no trouble. But should you rise three feet, then go north forty feet, and then drop nine feet

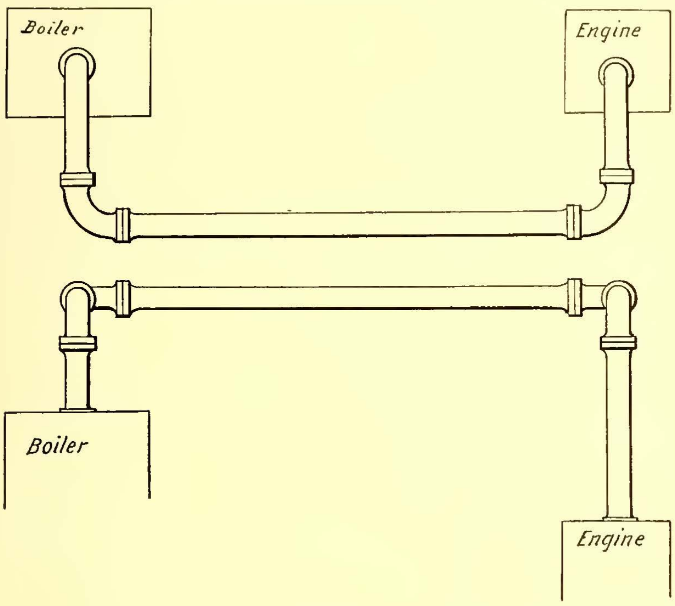

FIG. 2.

to engine, the chances are you would blow steam at your joints the greater part of the time.

The above is about all there is to it, and your good sense will enable you to do as good a job as any body can for you.

If there is anything more I can do for you please advise,

Yours truly,
R. J. McCARTY.

Some Railway Experience With Wheel Records.

In a recent interview with Pres. H. C. Moore, of the Trenton (N. J.) Traction Company, he described at length the system used on that road for keeping accurate wheel mileages and also the system employed for checking the mileage records and ascertaining at any moment the approximate life of any wheel.

The first step in this record is the consecutive numbering of every axle in use, new axles being numbered as they are received. This is done with ordinary numbering punches and has, Mr. Moore said, an advantage over any other system, in that the numbers are always definite and there is no doubt about it, neither mud nor corrosion interfering with reading the figures, which are always easily accessible. The number is put upon the end of the axle where it can always be found, and where no mistake need be made in regard to it or the wheels upon it. Having in this way definitely located the axle and the wheels upon it, the next step is to keep a record to show whether it goes on the register end or the other.

The record mileage book is kept by a clerk who uses the conductors' slips for entering up the mileage. When the axle comes out, all the miles from the time it went into service to the time it is removed, are added together, and the causes for the taking out noted in the book, which then shows a complete history of the wheels from the time they went into service until they were removed.

Looking over the record book, Mr. Moore said: "I find that a large proportion of the wheels removed were on account of flats. There are a few bent axles and a few broken flanges, but flat wheels are by far the largest cause."

In reply to a question concerning the life of the wheels, Mr. Moore gave the following tables, one covering thirteen wheels of the make which they are using at the present time, and the other four wheels from makers whose wheels were in use a short time since. The averages are remarkably close, and may be considered as practically identical at, say, 22,000 miles. "I reasoned from this that the wheels, after this amount of service, are practically worn through the chill, and, therefore, a small amount of skidding flattens them. This is more probable because, in looking over the figures, it will be seen that they are very uniform; only five wheels in the whole list have fallen below 20,000 miles. Once in a great while we find a wheel with a slightly deficient mileage, but manufacturers have been, as a rule, so well satisfied with the records which the road has kept that they have been uniformly willing to deduct the cost of such wheels from the bill.

Life of 13 wheels.				Life of 4 wheels.	
No. 1	19,000	No. 8	11,350	No. 14	24,373
" 2	15,706	" 9	26,270	" 15	24,399
" 3	24,336	" 10	25,109	" 16	18,748
" 4	21,062	" 11	23,714	" 17	20,016
" 5	21,017	" 12	30,794		
" 6	18,905	" 13	27,171	Average	21,884
" 7	21,554				
		Average	21,996		

"There is no excuse for managers not knowing whether their wheel records are accurately kept. There are short methods which are used for a check upon these figures which put me in possession of the principal facts without making it necessary to wait for the detailed figures. For example, here is a wheel which was put in service Jan. 22 and removed Aug. 1, 191 days in all. The average mileage of our cars is 130 miles. The total mileage, roughly approximated is, therefore, 24,830. I deduct 2,483 or ten per cent for the average time for which our cars are in the shop or out of service; we then have 22,347 as the probable net mileage which this wheel made during the time it was in service. Comparing this with the figures just given shows that this wheel has probably made its average mileage and perhaps a little more. The accuracy is sufficient to tell whether the storekeeper is keeping up his records properly. An occasional computation of this kind is all that is necessary."

The following is the form of account used with the memorandum in each column showing where the information it contained is obtained.

Axle No.	Shipped.	In Service.	Out of Service.	Cause.	Shipped.	In Service.
13	Jan. 16.	Jan. 22.	Aug. 1.	Broken flange.	Aug. 2.	Oct. 8.
Number on the axle.	This date from Bill of Lading.	Store-keeper.	Store-keeper.	Store-keeper's report to office.	Bill of lading.	

Taking up the question of the wear of wheels, and brake shoes, Mr. Moore said: "We are working at the wrong end of the line. We are trying to save brake shoes and figuring in all sorts of ways to make them last as long as possible while we are wearing out cast iron wheels for which we pay from $10 to $13 per pair. The average cost of a change I figure as about $5. We do this, in face of the fact that shoes cost only seventy-five cents or so. We are seeking the long wear of the shoes, while the loss of time of the car and the cost of changing wheels is not considered. On our road as soon as a flat wheel makes its appearance the car is ordered in at once if there is a car to take its place, for flat wheels tell their story all over town further than the car can be seen. Now if the brake shoes which have been making these flat wheels cost $1.30 and last while a wheel is making, say, 20,000 miles, we think we have done well, but supposing we use a pair of soft iron shoes costing eighty cents per pair, and use four pairs and increase the wheel mileage to 40,000 this would be $3.20 apiece in cost of brake shoes while doubling the life of the wheels would be $9.80 at a cost of $13.00 per pair. The labor of making such a saving would be trivial. These figures show that this effort to save brake shoes is all wrong. What we need is a shoe which will wear the wheel least, even though it wears out itself with considerable rapidity."

In reply to the question how much mileage he called for in his guarantee, Mr. Moore said: "The guarantee is always on our road for a certain length of time, and so far, wheels always come up to it. This time is ten months. Any loss of service of a car is a gain for the wheel maker and is, in one sense, a just punishment for us, if we fail to keep our wheels turning. The date that the wheels go out from the storekeeper's hands is the date at which they begin service, for they never leave his charge until they go under a car."

Mr. Moore has had an interesting experience with trucks which may be described in a word as "more true than tellable." The fundamental lesson seems to be that trucks must be kept quiet at any expense, for when they begin to chatter from parts becoming loose they are in a condition which is intolerable to the public and which is a constant expense to the company. Numerous crossings, grades, and various other things which combine to give a truck hard service are encountered on the Trenton lines, and the trucks have received a service which has searched out every weak joint and defective part. The large variety which have been tested on the company's lines have put it in possession of a fund of experience which is exceedingly valuable and it is now placing its cars upon trucks which it expects will successfully stand the severe usage of its road.

Wheel Notes.

NOT long ago a general manager was troubled with sharp flanges on his lines. They usually came upon one side of each car. About this time, when the sharp flanges were giving the most trouble, a wheel press was purchased and a man put in charge of the wheels of the road. He found much inaccuracy of gauge, and instituted a reform. As soon as possible all wheels were set to gauge, and since that time there has been no further trouble with the flanges.

ON one of the nicest running cable roads of the country the trailing wheels on the curves cut a groove from one-half to three-quarters of an inch inside of that made by the leading wheels. The wheels on the leading axles do not touch the guard rail on the outside at any point, while the trailing axle is frequently guided by the inside of the flange of the outside wheel. This shows the needlessness of the outside guard rail and also the fact that the gauge of the wheels is not suited to the track or that the track is unsuitable for the wheels.

To illustrate the need of expert advice in wheel and rail matters, a case of trouble is cited where a railway company attempted for some time to force a car with a nine foot wheel base around short curves, the result being that flanges were stripped off and wheels broken for a considerable time before the cause of the trouble was found out. In another case a short wheel base was used with a very long car, the result being that the side leverage brought about in running a loaded car around curves twisted and broke the wheels. In this case the overhang of the car was much greater than the length of the wheel base. In still a third case, the wheel base, though long, was not so long as to break flanges in running around curves, but did cause rapid grinding and consequent rapid flange wear.

ON a cable railway last year, when a spindle brake was put on to the road, the number of flat wheels which made their appearance was something extraordinary. There seemed to be no unusual cause, and yet as many as seven flat wheels would be reported in a single day. The superintendent, sitting in his office one afternoon, watching cars as they started from the office, noted the fact that on one car, when the man let off the handle he forgot to relieve the dog, and the car started down the grade with one pair of wheels skidding. It did not take many seconds to send orders by telephone to the different repair shops along the line to take off the dogs entirely from the cars as fast as they passed. The result was the complete stoppage of the epidemic of flat wheels.

IN considering the value of wheel guarantees the fact must not be forgotten that makers are released from their guarantee obligations to a very large extent owing to flatted wheels, which, on some roads, form from fifty to seventy-five per cent of the total number of wheels taken out of service. In fact, on one large road the expense of regrinding and replacing flatted wheels at present considerably exceeds $1000 a month and there is no recourse from the wheel maker. In the opinion of many managers, the only solution to this difficulty with flatted wheels is in the rigid enforcement of a rule to suspend for one or more days every motorman who brings in a flat wheel, and it is certainly true that this rule has in many cases absolutely stopped the practice of excessive use of sand.

THE change of shape, which takes place in cast iron wheels when they cool in the mould, is greater and more distinct than would be supposed possible to many not familiar with such matters. An ordinary car wheel is dished to the extent of, perhaps, 2⅜ ins. Such a wheel on cooling will drop to the extent of about $\frac{3}{16}$ in., flatter or more convex wheels changing their convexity in proportion. This is really the movement of the hub inward while the rim of the wheel is cooling. The reason for the movement of the hub downward when the wheel is cooling is that the center cools last, and as the metal in the tire and web contracts there is a tendency to draw metal away from the hub, and the wheel is necessarily flattened. Dished wheels are not objectionable, as some suppose. The curved form has some effect in taking up the blow, for the metal itself has, within certain limits, a high degree of elasticity. Few men would credit the fact that cast iron is a good spring, yet, within its limit of motion, it is one of the most perfect springs which we know of.

Seasoned Oak.

The experience of Mr. Fisk, the president of the Wason Car Manufacturing Company, in the matter of seasoning oak is a most interesting one, and some parts of it illustrate the changes in opinion which have prevailed in regard to the best method of handling oak timber. For several years before the war the Government was keeping great stocks of oak timber of very large sizes. When the Wason Company, like all other car companies during the early years of the war, was called upon to manufacture gun carriages it found itself, after a few months' work, confronted with the fact that there was no more dry oak timber to be had. The company was ready to manufacture, but it was unable to furnish the material. At the Watertown Arsenal, however, they had a large supply of beautiful hewn oak. The stock was of 12, 14 and 16 in. square timber. It had been placed under cover with the ends carefully painted to prevent checking or seasoning cracks. It was timber of which the Government officers were proud, and it was with no little hesitation that they gave up a portion of it for the purpose. Two car loads were obtained and sent to Springfield. The first half dozen sticks that went under the saws produced consternation among the men, and Mr. Fisk was called for at once. On the outside of each piece there were three inches of sound dry oak; the center of the stick was entirely rotten. Under his inspection stick after stick was cut open and not one was found otherwise than rotten at the core. The Government officers were sent for as quickly as telegrams could reach them. Their consternation was great. "Is it possible," remarked one, "that all these years we have been absolutely wrong in our treatment of timber, and that this entire stock is useless?" But such was the fact. Oak parts with its water and sap very slowly. If the albumen and acids of the sap are not removed either by water soaking or by drying they soon undergo fermentation, and either a chemical or organic decay of the interior takes place. Experiments resulting from this sad experience showed that water soaking or some heating process, or both combined, was very desirable in the case of oak in order to remove the easily decomposible constituents of the sap. Painting the ends of the timber, while preventing seasoning cracks, is more or less dangerous, especially if the sticks be of large size; although it prevents cracking yet it may prevent the escaping of the sap to such an extent as to produce a more serious weakening of the stick than would be produced by the checking.

John Stephenson's experiments during the war were not dissimilar. The Government officers stationed at New York found that a very fair quality of oak could be obtained by a gradual steaming and drying process. It was necessary, however, to keep the heat to which the oak was subjected down to what corresponded to a comparatively low steam pressure, otherwise the strength of the wood was considerably reduced.

Car Notes.

WHEN a man cuts the step strap or bracket into the side of a sill on an open car, he usually thinks of nothing but making a good, smooth job. But when he has done so and made the outside of the iron flush with the wood he has probably cut away more than half the strength of the timber. In old open cars where such butchering has been practiced the sills are usually found to be cracked or broken, and the break invariably starts from the score where the iron has been let flush into the wood. Every cut in a sill is a misfortune. The fibre of the wood should never be cut when it is possible to avoid it. This rule is never violated by the best workmen.

WHEN cracks begin to show along battens and at the edge of guard and other rails, it is time to take the car into the paint shop. No matter how well the paint may look and how bright the varnish may be in other places, these cracks or openings need to be stopped. The car is without protection at vital points. If left for long in this condition decay will begin at vital parts. They are points at which the strength of the car is, as it were, concentrated, and its durability depends upon the structure being sound at these points. Varnish and paint will crack at the angles long before it shows signs of wear on any portion of the body panels. Water may be having access to the frame before the varnish in the center of the panels has lost its gloss. What is needed is not repainting, but touching up.

THE weights of cars are steadily increasing in a way that is not wholly satisfactory. In the early horse car times weights were larger than was profitable and Ebbitt and Stephenson brought cars down to much less weights, even as low as 3,200 lbs. This weight, however, was probably too small and was afterwards considerably increased. At the present time not a few single truck electric cars weigh as much as 17,000 lbs. Cable grip cars in Baltimore are said to weigh about 4,800 lbs., while the sixteen foot trailers weigh 4,500 lbs. Every pound above that necessary is a disadvantage, costing money to haul and contributing its share to the destruction of rails, rolling stock and roadbed. As the weight increases the time required to stop and start diminishes and the running time is increased.

IN repainting or in touching up a car one point should never be missed. The paint should form a continuous coating. There should be no hair cracks where a rail joins a panel or where a band or strap is fastened upon the body. Cracks at these places are often hard to fill, and hence are neglected. They do not show to the non-professional observer, and hence they commonly pass muster. Painting in general, being put on to please the passenger, is not regarded as a matter for close scrutiny. If water and dampness never have an opportunity to kiss the wood the car has a fair chance to reach a good old age. For stopping cracks white lead costs more than putty and is worth ten times the difference in price. It stays and makes a good cement, while it does not shrink and crack as putty invariably does.

THE scrim or canvas, applied to the inside of the panels of street cars has a double purpose. It strengthens the wood and it forms a union between the ribs and posts and the panels themselves. In very many cases this canvas is the only union between the ribs and panels. When not protected from water, canvas of any kind rots with great rapidity, and soon loses all its cohesion. Painting canvas prevents this for a long time and if the painting be thoroughly done the canvas will last until some accident destroys the panel. When the ordinary workman puts a canvas in place the general theory is that if it is thoroughly fastened on to the rib and panel there is no harm if the edge of the canvas stands up loose or projects. This is a great mistake. Wherever an edge of canvas projects, even if coated with paint, water enters the ends of the fibres and the canvas will gradually rot beneath the paint for considerable distance, sometimes an inch or two, thus destroying the greater portion of the advantage of scrims. In judging of the durability of a car it is safe to predict that where the canvas and edges are all fastened smoothly down and nicely covered with paint, or where the edges are reduced to the smallest number and are not projecting the durability will be much greater than where this part of the work is carelessly done.

SOME time since a large road changed its motive power very suddenly and put a large number of cars of various ages in its yards for sale. Such a collection of bird cages has rarely been seen together. An examination of them was equal to a liberal education in car building by showing what should be avoided. There was a very large number of trail cars, many of which were built by the company. There were but three posts on a side, the idea being to get large, beautiful windows. There were no blinds. The roofs were of the Bombay pattern. That the roof had been whipping was evident from the remarkable condition of the letter boards which, in nearly every instance, were loose on the posts. These panels were too light to cut off the screws, but the screws had worked and spoilt the panels or enlarged the holes so that no stiffness was obtained. Water could enter at opened joints in all parts of the bodies. The panels were split at the ends and joints. Decay had not begun because none of the cars were very old. Bad design and ignorant workmanship was written all over these wrecks. Had the letter boards and panels been worked from a single piece with the rail and boxed upon the posts; had the windows been kept down to a reasonable size so as to have a sufficient number of posts to carry the roof, a very different story could have been told. Had the roof been of any other pattern the destruction would have been much more rapid.

LEGAL NOTES AND COMMENTS.*

EDITED BY J. ASPINWALL HODGE, JR., AND GEORGE L. SHEARER,

OF THE NEW YORK BAR.

Six Cent Verdicts for Death by Wrongful Act.

Recent newspaper criticisms of the propriety of verdicts for nominal damages in actions by personal representives for injuries causing death would seem to justify a few observations here, tending to show that a verdict in such a case for six cents is not necessarily absurd, but is often proper.

From the maxim *actio personalis moritur cum persona* it followed at common law that if the personal injuries resulted in death no cause of action for such injuries survived. The law did not even give a right of action to those entitled to the services of the deceased for the permanent loss of such services consequent upon death.

Lord Campbell's Act, in 1846 (9 & 10 Vict. c. 93), created a new cause of action in favor of the husband or wife or next of kin of the deceased, for such pecuniary damages as the person or persons for whose benefit the action should be brought might have sustained by reason of the death. This act has served as a model for similar enactments in this country. Every state and territory affords some remedy that survives the death of the person injured.

It is not possible here to consider the propriety of six cent verdicts under such statutes as that of Connecticut, which provides that the cause of action that the person injured would have had shall survive his death, or that of Massachusetts giving a remedy by indictment with a minimum fine of $500, or those of the other states that have not practically followed the provisions of Lord Campbell's Act. But the English statute has been substantially reenacted in so many states that a discussion of this question will be very generally applicable.

Such *pecuniary* damages as have resulted to those for whose benefit the action is brought may be recovered. The word *pecuniary* which is usually applied to designate the nature of the damages recoverable does not denote damages only that can be certainly estimated in money. The word is used rather to exclude all consideration of elements which, not only cannot be measured in dollars and cents, but for which money can only be given as a consolation, and to limit damages to the loss of those benefits which at least money can ordinarily secure. No recovery can be had for injury to feelings and affections nor for any loss of society and companionship that the beneficiaries may have suffered. Then, too, many elements of damage which it is proper to consider in actions brought by the person injuried are eliminated. One who has been injured may recover damages for the pain and suffering he has been caused and also for the physical effects of his injuries; to such damages there can be no offsets. The question of damage in actions for death, on the other hand, has a credit and a debit side; the probable pecuniary benefits must be weighed against the probable pecuniary losses to the beneficiaries that would result from a continuance of the life destroyed. The reasonable expectation of benefit in excess of the probable pecuniary detriment forms the measure of damage.

A child sustains, by the death of its parent, a pecuniary loss of support, of education and of the personal care and training it could have reasonably expected to receive from such parent. When a husband loses his wife or a minor child he may have suffered pecuniary damage in the loss of the services of the deceased. A wife is entitled to be supported by her husband, and by his death the amount he would probably have earned and devoted to that purpose, had he lived, is a loss to her. If the husband were an invalid entirely dependent upon her exertions for his maintenance, no loss to her would result from his death.

All beneficiaries, whether wives, husbands, children or collateral relatives are entitled to compensation for such net benefit as would have resulted from the continuance of the life either from increased estate in which they would have been legally entitled to share, or from gifts and bounty which they would have had reasonable expectation of receiving from the deceased.

In determining the amount of these various kinds of pecuniary loss regard must of course be had to the past relations and situation of the parties, the character, habits and earning capacity of the deceased, and, not least of all, to the probable duration of life of both beneficiary and decedent. Other things being equal, the pecuniary loss is in direct proportion to the duration of their joint lives, for all benefit must accrue before the probable termination of either life. Where the beneficiary is very old and the deceased a young infant, the probable period of their joint lives would be shorter than decedent's period of useless infancy, consequently there could be no damage to the beneficiary.

But it is not sufficient to ascertain the probable annual receipt of pecuniary benefits and multiply that amount by the number of years in the probable joint life. It may be that the deceased during life has been and would probably have been in the future an expense to the beneficiary. This will constitute an offset to the benefits received which may reduce them to nothing or even overbalance them. In the latter case would not the death be a pecuniary benefit instead of a pecuniary loss?

Where a minor child recovers damages for the death of his father does not the verdict, besides establishing that the child has sustained a loss, also establish the fact that if the child had been killed instead of the father, the father would have been pecuniarily benefited by its death.

It must follow if this is so that there is only one of any two kinsmen who is pecuniarily benefited by the continuance of the life of the other. Therefore in accordance with the doctrine of chances in one half the cases where death is caused by the fault of another, a pecuniary benefit results instead of a pecuniary loss. It is a fact of common observation and experience that more than one half of the people in this world are a burden rather than a benefit to their relations. Nor is this proposition proved absurd by the further fact that in a very large proportion of the cases where the wrongfulness of the act causing death is established a substantial recovery is obtained by the beneficiaries.

If in so large a number of cases no pecuniary damage is caused by death a verdict for nominal damages is neither always absurd nor always improper.

There are many instances where nominal damages are amply warranted by the remoteness of the relationship between the deceased and the next of kin and by the improbability, in view of past events, of any pecuniary benefit being derived in case of the continuance of the life of the deceased. Take the case where a nephew is his uncle's next of kin. They scarcely know each other and no past relations justify any inference that the nephew ever will receive the slightest benefit from his uncle's life. Though a jury in such a case may give the nephew a substantial verdict, nominal damages are certainly adequate to compensate him for all his loss resulting from his uncle's death.

Bearing in mind always that the verdict does not rep-

*Communications relating to this department may be addressed to the editors, No. 32 Nassau Street, New York.

resent the price of a human life, but merely the pecuniary damage to the benefeiary eaused by the loss of that life, sueh considerations as have been mentioned should make one slow to criticise verdiets for nominal damages in eases of death caused by the wrongful act, of another. S.

COMPENSATION FOR USE OF TRACKS.

MISSOURI.—In estimating the compensation which an electric railway company should pay a cable company for the use of the latter's tracks under the provisions of a city charter, the cost of building the cable conduit should be considered, though it cannot be used by the electric company, and its construction made the cost of the cable road much greater than that of an electric road.

Under an ordinance providing that in a proceeding to fix the compensation one railroad company should pay another for the use of its tracks the court may make such order as justice may require, The court may require the company seeking the use of the tracks to give a bond for the payment to the other company of one-half the cost of renewals, of rails and pavement, where the ordinance further provides that either party may once in each two years apply for a readjustment of the compensation to be paid.—(Grand Ave. Ry. v. Peoples Ry. 33 S. W. Rep. 472.)

EJECTION OF PASSENGERS.

PENNSYLVANIA.—A passenger on a street railway, when requested by the conductor to go from the platform to the inside of the car, where there were vacant seats, refused to do so, though he knew that a rule of the company forbade passengers to stand on the platform when there was room in the car. As a reason for refusing he said he was not going far enough to justify him in going inside, but how far he was going he refused to say. The car was then stopped, and he was told that he must go inside or get off, and, refusing to do either, he was put off by the conductor, who used sufficient force to loosen his hold of the railing, and to remove him from the platform, and to prevent him from reboarding the car. *Held*, that he had no right of action against the company, the rule being a reasonable one.

The passenger having resisted the conductor in the proper performance of his duty, he was not entitled to recover punitive damages because the conductor used force in removing him from the car. —(McMillan v. Federal St. & P. V. Ry., 33 At. Rep. 560.)

WISCONSIN.—A judgment for $750 for the wrongful ejectment of a passenger from a train on a rainy day, more than a mile from any house, and three or four miles from a station, is excessive, in the absence of any ground for substantial damages other than physical and mental suffering and in the absence of any facts entitling him to exemplary damages. The verdict was reduced to $350 and as so reduced affirmed.—(Gillan v. M. St. P. & S. S. M. Ry., 65 N. W. Rep. 373.)

INJUNCTION.

NEW JERSEY.—Whether the building and operation of an electric railroad on a country highway impose an additional servitude on land already subject to such highway having never been determined in New Jersey, a preliminary injunction will not issue on that ground alone, at the instance of the landowner.

General allegations "that the building and conducting of said railroad upon the roadbed of said public highway will work irreparable injury" to complainant and his property," and that the necessary grading and excavations * * * and the setting of poles in the sidewalks, etc., will work irreparable injury," are insufficient to support an application for preliminary injunction.

A person whose land is subject to the servitude of a public highway is not entitled to a preliminary injunction to restrain the construction of an electric railroad on such way, merely because defendant is proceeding without legal authority, but must show, either that the proposed railroad will impose an additional servitude on his land, or that he will suffer some special injury.—(Borden v. Atlantic Highlands, R. B. & L. B. Electric Ry. Co., 33 At. Rep. 276.)

LIABILITY FOR NEGLIGENCE.

ARKANSAS.—An electric street railway company is liable jointly with one who has negligently allowed his telephone wire to drop across the company's trolley wire, for injuries caused to a person accidently coming in contact with the telephone wire, by the current of electricity conveyed through it from the trolley wire.—(City El. St. Ry. v. Conery, 33 S. W. Rep. 426.)

CALIFORNIA.—In an action against two street railroad companies for injuries to a passenger on the car of one, received in a collision at a crossing, evidence of a custom between street railroad companies of giving the older company the right of way at crossings was admissible to show which defendant was guilty of the greater negligence.—(Howland v. Oakland Con. St. Ry., 42 Pac. Rep. 983.)

LOUISIANA.—The motorman had a right to suppose that plaintiff's son would not, after warning, attempt to cross immediately in front of the car, at a distance too near to prevent the accident.

While no one should be held to a degree of care and caution beyond his years, a boy eleven years and four months of age cannot be relieved from the exercise of all care and prudence.—(McLaughlin v. N. O. & C. R. Co., 18 South. Rep. 703.)

WISCONSIN.—In an action against an electric street railway company for death of plaintiff's decedent, caused by a collision with one of defendant's moving cars, it appeared that decedent's horse, which he was driving in a buggy, became unmanageable, and in attempting to suddenly cross in front of the car threw decedent from the buggy beneath the car. *Held*, that the fact that the motorman did not stop the car, instead of proceeding slowly, did not warrant a finding that he was negligent.

That a horse which is being driven on a street becomes frightened at an approaching street car does not render the company liable for injuries received by the driver.—(Bishop v. Belle City, St. Ry., 65 N. W. Rep. 733.

TEXAS.—It is negligence for one operating a street car to continue sounding its bell after he sees, or by the exercise of ordinary care could see, that horses attached to a wagon in front of it were being frightened and rendered unmanageable.—(Citizens' Ry. Co. v. Hair, 32 S. W. Rep. 1050.)

MASSACHUSETTS.—Failure of a person to look and listen before crossing the tracks of an electric railway in a public street, where the cars have not an exclusive right of way, is not negligence, as a matter of law.—(Robbins v. Springfield St. Ry. Co., 42 N. E. Rep. 334.)

INDIANA.—It cannot be assumed as matter of law that one run into by a street car would, by listening, have heard it in time to have avoided the accident; it having given no signal, and there having been a noise from the running of a car just passing in the opposite direction.—(Citizens' St. Ry. Co. v. Albright, 42 N. E. Rep. 238.

NEW YORK.—One who in daylight undertakes, with full knowledge of the danger involved, to drive a horse over a temporary switch of a street railroad, into which granite blocks have been loosely thrown, will be *held* to have assumed the risk.—(Watson v. Brooklyn City R. Co., 35 N. Y. S. 1039.)

CALIFORNIA—Decedent was riding on a bicycle between the tracks of the defendant electric railroad company, at the rate of six miles an hour, without watching for the approach of cars from behind. As the car by which decedent was killed approached from behind, at the rate to ten miles an hour, the motorman sounded the gong when twenty to forty feet from him, and cried out for him to get off the track, to which decedent paid no attention. Thereupon the motorman, when ten to twenty feet from decedent, reversed the current, and attempted to stop the car, but was unable to do so in time. There was no evidence that the rails of the track were not on a level with the ground between the tracks, and decedent was seen when about a block and a half ahead of the car to pass from the north track, on which he had been riding, to the south track, to escape a north bound car. *Held*, that decedent was guilty of contributory negligence.—(Everett v. Los Angeles Ry., 43 Pac. Rep. 207.)

EXCESSIVE DAMAGES.

COLORADO.—A verdict for $37,500, awarded to a miner for loss of eyesight, appearing to have been given by some motive other than the desire to make merely a reasonable compensation, is excessive. The Court say: "In a case of this kind, the true rule, however expressed, is that the jury should, in the exercise of a reasonable and sound judgment, give to the plaintiff reasonable compensation, and no more, for the consequences of the injuries; and necessarily the amount is largely discretionary with the jury.

"It is no answer to this to say that no man would be willing to lose his eyesight for the amount of the verdict rendered in this case, because that is no proper criterion for the measure of damages in a case of this sort, and all the money in the world, if offered, would be no inducement to a sane person to part voluntarily with this "priceless gift to man.

"Distressing and painful as were the plaintiff's injuries, and attended by consequences so permanently disastrous to him, their simple recital before the jury unavoidably aroused the sentiment of pity that every man possesses, and strongly appealed to their kindly nature. It therefore behooves the trial court in such a case to keep within proper bounds the deliberations of the jury."—(Deep Mining & Drainage Co. v. Fitzgerald, 43 Pac. Rep. 210.)

TEXAS.—Five thousand dollars damages for loss of an eye is not excessive.—(Texas & P. Ry. Co. v. Bowlin 32 S. W., Rep. 918.)

CALIFORNIA.—In an action by a passenger of a street railway company for injuries, where it appeared that plaintiff was pregnant at the time of the accident, and that a miscarriage resulted, and that her eyesight and the action of her heart were impaired, a verdict of $10,000 was not excessive.—(Howland v. Oakland Con. St. Ry. Co., 42 Pac. Rep. 983.)

TEXAS.—A verdict for $10,000 in an action for personal injuries will not be set aside as excessive, where there is evidence that plaintiff, a man twenty-five years of age, and, previous to his injuries, of good health, was, on account of the injuries, confined to his bed for several months; that three years after the injury he was unable to get around without the use of crutches; that he was unable to sleep well; that his urinal and sexual organs were impaired, and that he had symptoms of paralysis and might never get well.—(M. K. & T. Ry. v. Cook, 33 S. W. Rep. 671.)

WASHINGTON.—A verdict of $8,000 *held* not excessive, where the injury resulted in a shortening of a leg, and plaintiff was confined to her bed for eighteen months, and the suffering was likely to continue.—(Lorence v. City of Ellensburgh, 43 Pac. Rep. 20.)

TEXAS.—In an action for causing the death of an employe, brought by the surviving wife and children, a verdict for $16,000, though more than the court would award under the circumstances, is not so clearly excessive as to authorize a reversal.—(S. A. & A. P. Ry. v. Harding, 33 S. W. Rep. 373.)

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THE work of standardizing the rules for electrical construction and operation, which is soon to be undertaken by a joint committee composed of delegates from all of the great engineering and insurance associations of the country and from a number of the principal manufacturing and construction corporations, is one which should have the hearty good will and cooperation of all who are interested in the improvement of constructive methods in the great industries which use electricity. The members of this joint committee are all men of high professional standing and are well qualified in every respect to deal with the problems presented. We confidently expect results of value to come from their deliberations.

WHAT have been found to be the real facts as to the relative economy of electric over horse traction? The general public appears to believe that an electric railway franchise is a gold mine and is coming to demand the most extravagant price for such franchises. Now, the results of experience do not warrant any such belief. In another column will be found a careful discussion of the comparative cost at present prices—the lowest ever known—of equipping and operating an electric and a horse railway of the same track and car mileage in the same city. From the estimates there made, it is shown that an electric railway, built in the most perfect manner, and without allowance for engineering mistakes, might be expected, in this particular city, to earn fourteen per cent on the necessary capital investment, while a horse railway might be expected to earn nine per cent upon its required investment. The difference is material, it is true, and one which is well worth taking some chances to obtain, but it is not so large as to warrant the imposition of heavy additional burdens of taxation, or of a reduction in fares. Sooner or later the public will come to understand this—not improbably through the financial insolvency of many too heavily burdened companies—and will, perhaps, be less urgent in its demands for additional concessions.

T RAILS, by affording a clean head to the travel of the car wheels, are generally considered as presenting as little resistance to a moving car as any form of rail in use. But when they are used in paved streets, the amount and nature of the vehicular traffic in the street in question is an important consideration. Where the head of the rail is close to, or even with the paving, the vehicles will naturally follow the track closely, and when the traffic is great, it has often been found to cut the paving blocks on one or both sides of the rails. The result has usually been to produce a rut by breaking the edges of the blocks close to the side of the rail. While it may not be the province of a rail to provide a smooth surface for the street traffic, this tendency of other vehicles to seek the track must be considered in cases where the duty of maintaining the paving between the rails devolves upon the railway company. The method employed in San Francisco, as pointed out by a correspondent this month and adopted after the damage was done, was the use of a flat rail inside the T head to care for the vehicle wheels. This made essentially a girder or side bearing head, which could have been laid in the first place at a fraction of the total expense. Where the street traffic is considerable, yet not so great as to make a side bearing rail a necessity, another method can be adopted. This is the elevation of the T head, as much above the surface of the pavement as may be permitted. If it can be raised so high as to discourage crossing, except at right angles, the vehicles will be driven with their wheels a foot or more from the rails, and the tendency to cut ruts near the rails will be avoided.

IT hardly seems possible that there can be serious thought in any quarter of effecting a consolidation between the American Street Railway Association and the National Electric Light Association, although the effort is being made to bring about the consideration of the question by the executive committees of the two bodies. Certainly there is little to commend such a suggestion. Almost the only bond of union between the two associations lies in their use of a single great form of energy, electricity. This is not sufficient. The problems involved in electric lighting and electric railroading are just as different as are those involved in the handling of locomotive engines, marine engines, stationary engines, boilers, etc.—all dependent upon steam as a form of energy. The operation of a power station plant and feeder lines is only a small part of the responsibilities resting upon the street railway manager, whereas it is almost the sole responsibility of the electric light manager. Nearly all the papers and discussions in the meetings of the American Street Railway Association are devoted to methods of handling cars and men, construction of roadbed, laying out of new routes, and many others in which the electric light people would have no interest whatever. On the other hand, the latter must necessarily discuss problems which will not interest street railway men. Any joint exhibition of apparatus would likewise be classified along the lines of the respective interests, so that the only advantage of bringing all the apparatus together would be the reduction in expenses and the possible increase of popular interest in the city where the exhibition might be held. To attempt to crowd the work of two four day conventions into one would be simply impossible, and to attempt to properly accommodate some two thousand attendants at a joint convention in any city save the two or three largest of the country would likewise be impossible. All that can be said in favor of the consolidation is far outweighed, we believe, by the considerations stated and we do not look for any general movement in its favor.

THE first published reports, printed elsewhere in this issue, of the performance of the electric locomotives in the Belt Line Tunnel of the Baltimore & Ohio Railroad, will be found a valuable contribution to our knowledge on the subject of moving heavy trains by electricity. The desire on the part of the railroad officials to avoid in the tunnel the smoke and gas inseparable from the use of steam would probably have dictated the use of electricity, even at a considerable addition to working expense. It is therefore particularly gratifying to electric railway engineers that the figures show an increase in both efficiency and economy of electricity over steam. The construction of electric locomotives for this service was largely in the nature of an experiment, since there had been no experience in the application of electric power to such large loads. Nevertheless the installation has been an entire engineering and practical success. Trouble was experienced at first in taking the current from the wire, a point which might easily have proven serious at the high speeds reached in the tests. It was overcome, however, by largely increasing the surface of contact, which was a sliding one. The best solution of this problem for heavy traffic and high speed is a question worthy of careful study by the engineers of future trunk line construction. The dynamometer curves will be found instructive as showing the rapid acceleration produced by an electric locomotive. The pull by the armature on the axles being uniform, the curve is fairly smooth until the maximum is reached. It would be interesting in future experiments to determine the coefficient of adhesion of the electric locomotive under different conditions of track. This for steam locomotives on dry rails is usually estimated at from .20 to .25 of the weight on the drivers. For electric locomotives we believe a much higher figure will be found, not only on account of the continuous torque on the axles, but probably, also, from the greater flexibility of the locomotive, permitting better adaptation to the inequalities of the track.

A PROPER spirit of emulation in employes is one which can be often cultivated with great advantage to the service and benefit to the company. A friendly rivalry acts as a spur toward efficiency, and if properly directed will often find an outlet for the energies of the men, which otherwise might take a direction inimical to the interests of the company. A system of keeping records of the performance of each man for the purpose of comparisons is one which has been successfully extended on different roads to all branches of the service, conductors, motormen and power house employes alike. The principle is sound, for it not only shows the men that individual good work is appreciated, but an added stimulus is given from the fact that comparative records are kept by the company, from which future promotions may be made. Such a record is, of course, of equal value to the company in assisting in the selection of the best men for advancement. Different methods can be employed with car crews to advantage, not only in the way of avoiding accidents, but in increasing traffic. On some roads a record is kept of the accidents per one thousand miles run by each motorman or crew, and at the end of each quarter rewards are given to those who have made the best showing. The flattening of wheels, as we have repeatedly pointed out, can be largely, if not entirely, prevented by such a system as this. Traffic can even be created in individual cases by the exercise of care and discretion on the part of conductors in looking out and stopping for intending passengers. To those who think it is doubtful whether this can be done to any extent we will say that we know of a company where the records showed that certain conductors year after year have a higher average of passengers per trip than others. As the routes were constantly changed, there was no possibility that these results were secured by more favorable conditions of traffic, but were undoubtedly due to the exercise of more individual care and attention. In the case of large systems where there are a number of subdivisions, the same spirit of comparisons can be equally well applied to show the relation between the different sections, due regard being had to the local conditions of traffic and liability to accident. It might be said that the offer of actual cash prizes is not necessary to secure results of the kinds ought. Where a "bulletin" or other official paper is published by the company, the names of the employes showing the best record could be published, and this, with the fact that their superiority is known to the superintendent, will often be found sufficient. On smaller roads, the names of those holding the highest percentage for traffic, or lowest percentage for accidents, can be posted on the car house bulletin boards and published as a news item in the local newspaper. In the power station the system outlined is equally applicable to certain employes. The firemen can certainly be encouraged to exercise economy in their care of the furnaces under their charge by a system of comparisons, and this is done on a number of roads. Where there are several stations of one system, the work of the employes of each can also be often compared with advantage and profit.

WHAT is "overcapitalization?" We hear from numerous legislative committees, commissions and politicians, that "our street railways are overcapitalized," The Nixon Committee of the New York Legislature, which has been devoting much attention to the wicked street railway companies of New York State, informed us last month that they are overcapitalized; the Mayor of Detroit is sure that something is wrong with street railway matters in that city; the citizens of Philadelphia are gravely considering the best way to extract the "water" from the local street railway capitalization; and, in general, there seems to be a feeling on the part of the public that highway robbers are in our midst disguised as the managers and stockholders of our street railway corporations. What then, we repeat, is "overcapitalization?" How is its existence to be determined? Upon whom do its evils fall?

* * * * *

Let us consider for a moment what the capital liabilities of our city systems represent. It is a matter of history that, as horse railways, they paid, with few exceptions, only moderate dividends and were not generally popular as investments. Many of them had hard work to maintain solvency, and nearly all were obliged to spend a large portion of their annual income, when there was an income, in making extensions which they knew would be immediately unprofitable, but which were necessary for the accommodation of the public and for the expansion of their territory. When the time came for the adoption of electricity, nearly all this old investment was found worthless and had to be thrown away—track, stables, horses, cars, everything almost except real estate, and to some extent buildings. The old capitalization represented franchises, and franchises only. Everything had to be new and of an entirely different kind for electric traction purposes. Was it overcapitalization to add the cost of the new roadbed and equipment to the old investment account? Clearly not. Such a burden could not possibly be borne out of earnings—the only other source for obtaining the requisite money.

* * * * *

Time went on, and there came evidence that serious mistakes had been made in the equipment of these roads. Rails were found worthless, motors of inadequate power, car bodies too light for electric service, the overhead structure weak and imperfect. Engineers had had too little previous experience in the requirements of the new motive power to properly serve their clients. How were these mistakes to be remedied? The purist in street railway accounting would say, perhaps, "out of income," but he would be met by the fact that income was again wholly insufficient for the purpose. The defects required immediate action. Under this pressure the stockholders did what any business men would do in conducting a private enterprise—they put their hands in their pockets and supplied the necessary funds, or, perhaps, borrowed money. These new supplies of capital had to be recognized in some way, and stock or bonds or notes were issued, according to circumstances. Such a process as this might be technically overcapitalization from a book-keeping point of view but the public, so far at least, could have no possible grievance or right to interfere. Later on new supplies of capital—actual cash—were called for to build extensions, to carry new lines out into the country and to anticipate the new demands of traffic in every possible direction. The danger of destructive competition was, and has always been such a constant spur to enterprise as to have been the public safeguard against abuse of franchises. Increased capital obligations thus, again, became necessary, but even this was not overcapitalization.

* * * * *

Overcapitalization of costs is the deliberate creation of a mass of capital liabilities which are not, to the extent of the overcapitalization, represented by the actual investment of cash or other values. The object of such overcapitalization is usually the desire to anticipate future profits, by the sale to others of the right to enjoy those profits. Nearly all purchasers of so-called "securities" are, in reality, purchasers of an earning power, not of an actual thing. They do not even care about the value of the tangible assets unless these assets are able to earn an income. It is overcapitalization of earning power that is the really serious evil—the blind or oversanguine belief that the earning power of a property will be far more than later experience proves to be the case. Nevertheless, the State may rightly interfere to prevent overcapitalization of costs in public enterprises, difficult though the task is, and must of necessity be. It is hard enough to permanently earn a six or eight per cent income upon invested money without adding a large margin for "promoters profits." The principles governing State interference are the same as those which determine regulation of insurance and banking corporations, and are, in brief, based on the necessity of protecting the "widows and orphans" against the results of fraud and misrepresentation on the part of designing and unscrupulous money makers. If the bars were let down so that there should be no such protection to the investor, the amount of misery and misfortune might be infinitely greater than that produced by the deeds of violence which the State is at great expense to prevent. But if the State neglects its duty in this respect until too late, it should not then add to the burdens which fall upon the ultimate investor—the purchaser of the "watered" securities—by attempting to reduce fares or otherwise destroy what value remains. The real culprits have escaped with their profits and cannot be reached.

* * * * *

Overcapitalization of costs in street railway building is not always, nor, indeed, often against the interests of the public, considered as riders or as taxpayers. In the effort to pay interest and dividends on a heavy capitalization, the street railway manager endeavors to increase gross receipts by attracting passengers—not to reduce operating expenses in such a way as to repel them. The latter plan has never yet been tried, we think, except in times of actual insolvency, and even in such cases, the first step taken towards financial rehabilitation is always in the line of improving the service. It is hard to tell, as yet, whether or not many of our street railway properties are seriously overcapitalized on the basis of permanent earning power. We have been passing through severe financial storms in these last few years—storms which have wrecked many a promising investment in all lines of industry. Street railway properties have stood the test remarkably well, all things considered, and the proportion of the mileage in the hands of receivers is wonderfully small, as compared with the great steam railroad properties. It is probable that fixed charges are reasonably secure on most of our large properties and that insolvencies will continue to be rare, but stockholders may, in some instances, have to await the increase of population and the development of city area before the period of large dividends shall come.

CONSTRUCTION

Recent Work of the West End Street Railway Company.

The recent extensions and increase in traffic of the West End Railway Company, of Boston, have compelled that company to make important additions to its rolling stock and power equipment, while others still more important are contemplated. The car house capacity of the company has been increased since October 1, so as to accommodate 391 additional cars, and within the last month orders for 400 new motors have been placed with the General Electric Company. An order for a small number of motors has also been given to the Walker Company.

The power equipment of the company has been increased by a new station at Charlestown with a capacity of 1600 k. w. and will be still further augmented by a new station which will be erected at Dorchester. These stations are so located as to supply current to sections of the district covered by the West End lines, which have heretofore been at a considerable distance from any of the other power stations, and hence will save a considerable amount of power which has heretofore been lost in transmission.

The Charlestown power station is located on George Street, at Charlestown Neck, at tide water. It embodies a number of novel features in construction, and represents the ideas of the engineers of the West End Company derived from a long experience in station construction. It is shown in plan in Fig. 4.

The station, which is of brick, measures 93 ft. 8 ins. $\times$ 118 ft. 4 ins. outside dimensions. The roof is of the Gustavino type, and no wood work is used in any part of the station except on the floor. The contract for the power house was given August 16, 1895, and the plant was in operation January 8, 1896.

The engine room measures 63 ft. $\times$ 90 ft. 4 ins. and contains two twin cross compound Allis engines with cylinder dimensions 26 and 50 $\times$ 48 in. stroke. The receiver for the engines is vertical and is located between the cylinders. The engines are so arranged that either high pressure or low pressure cylinders can be used independently. The piping, as will be seen from the drawing, is extremely short and is so arranged as to be practically in duplicate.

The generators are of the G. E. 800 k. w. direct connected type and run at a speed of ninety revolutions per minute, giving current at 1350 amperes each. The switchboard is of the General Electric type with eight feeder panels and four generator panels.

The height of the traveling crane over the engine floor is 22 ft. 3 ins.

FIG 1.—EXTERIOR OF CHARLESTOWN STATION

FIG. 2.—INTERIOR OF STATION, SHOWING PLATE FLYWHEELS IN MOTION.

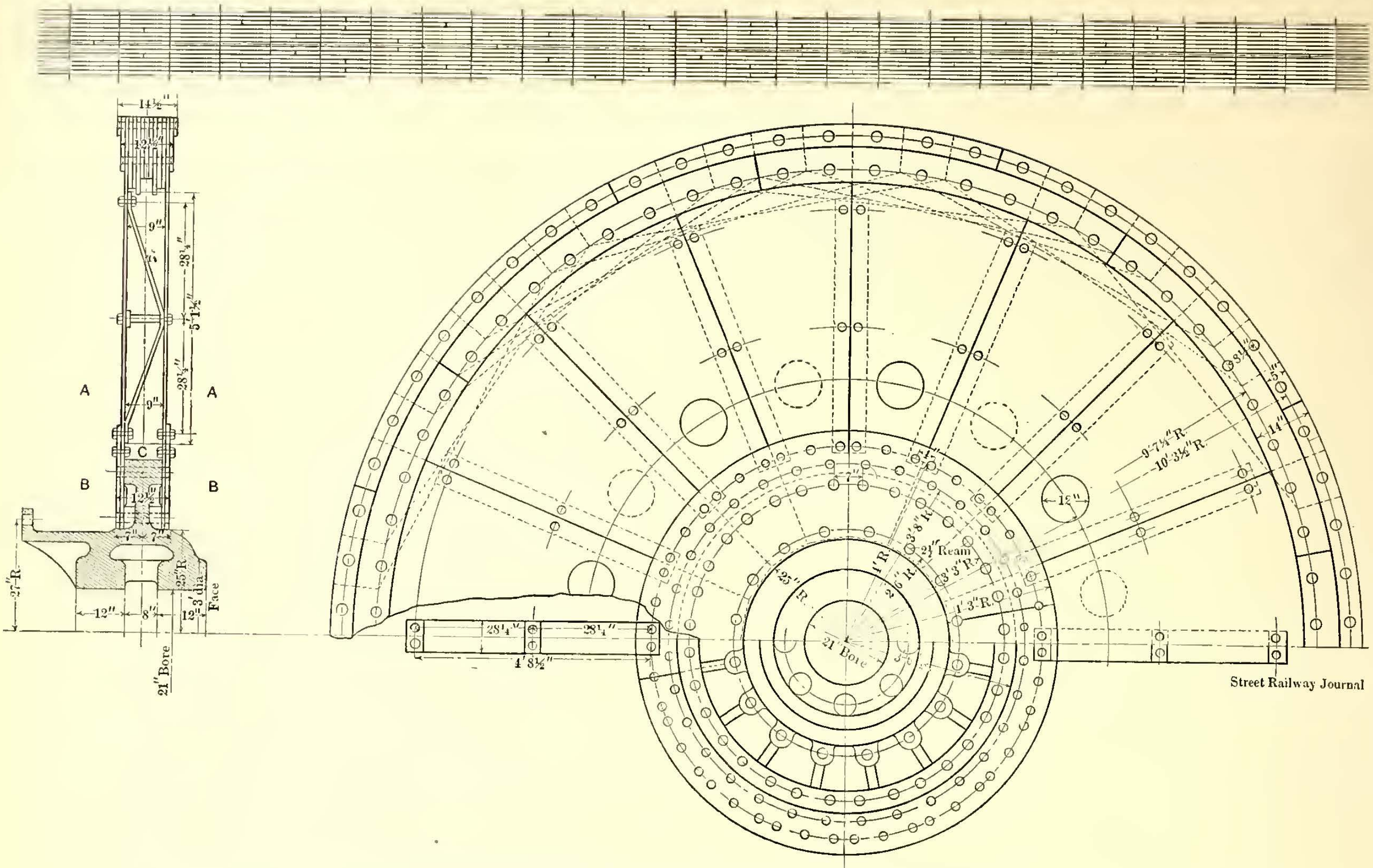


FIG. 3.—STEEL PLATE FLYWHEEL—CHARLESTOWN STATION.

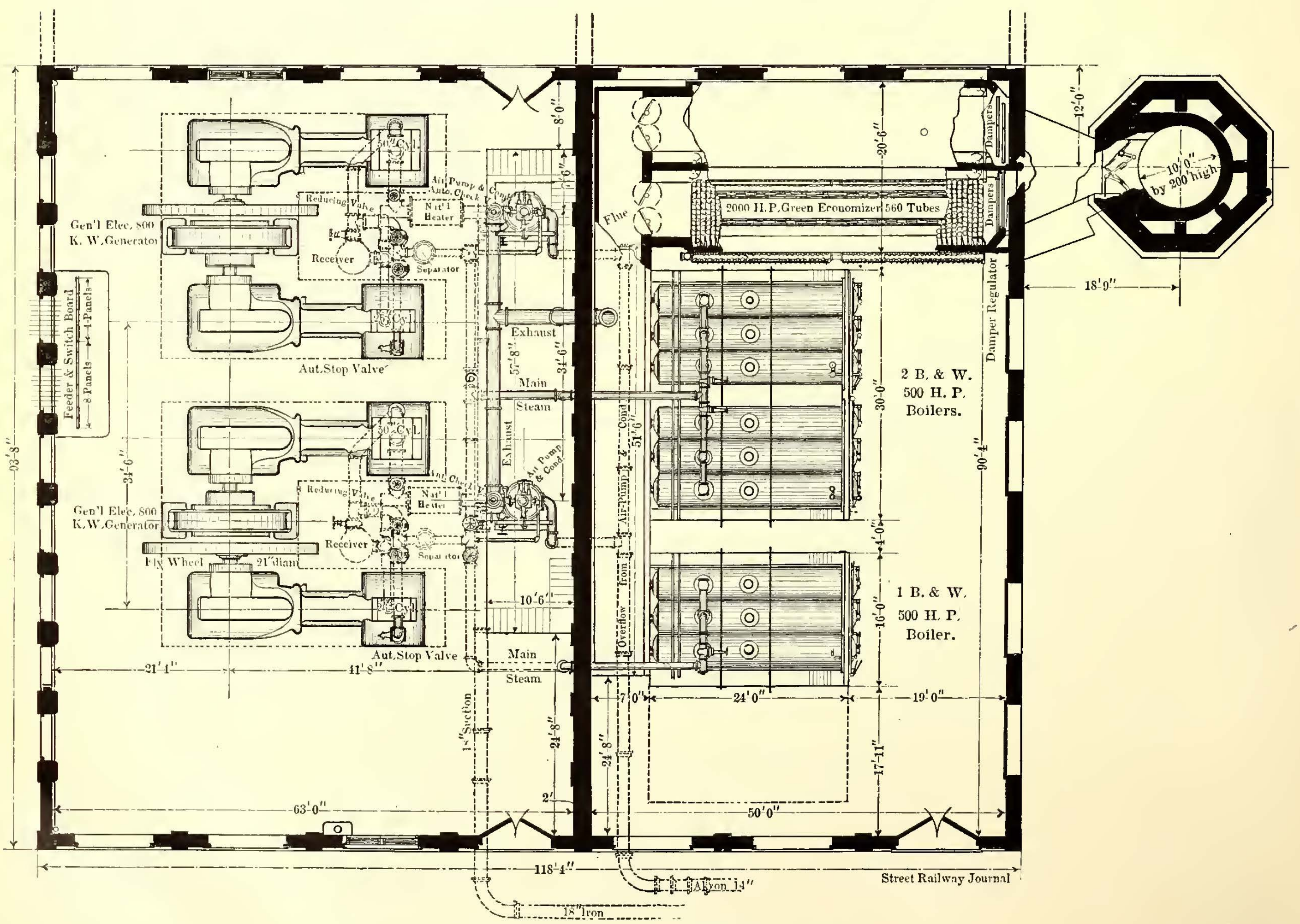


FIG. 4.—PLAN OF CHARLESTOWN STATION.

One of the most interesting features of the station is the steel flywheels used on both engines. The increasing frequency of flywheel accidents has led the company to adopt as standard in its future construction the use of wrought steel wheels instead of cast iron. A section and half side elevation of one of the twenty-one foot wheels is

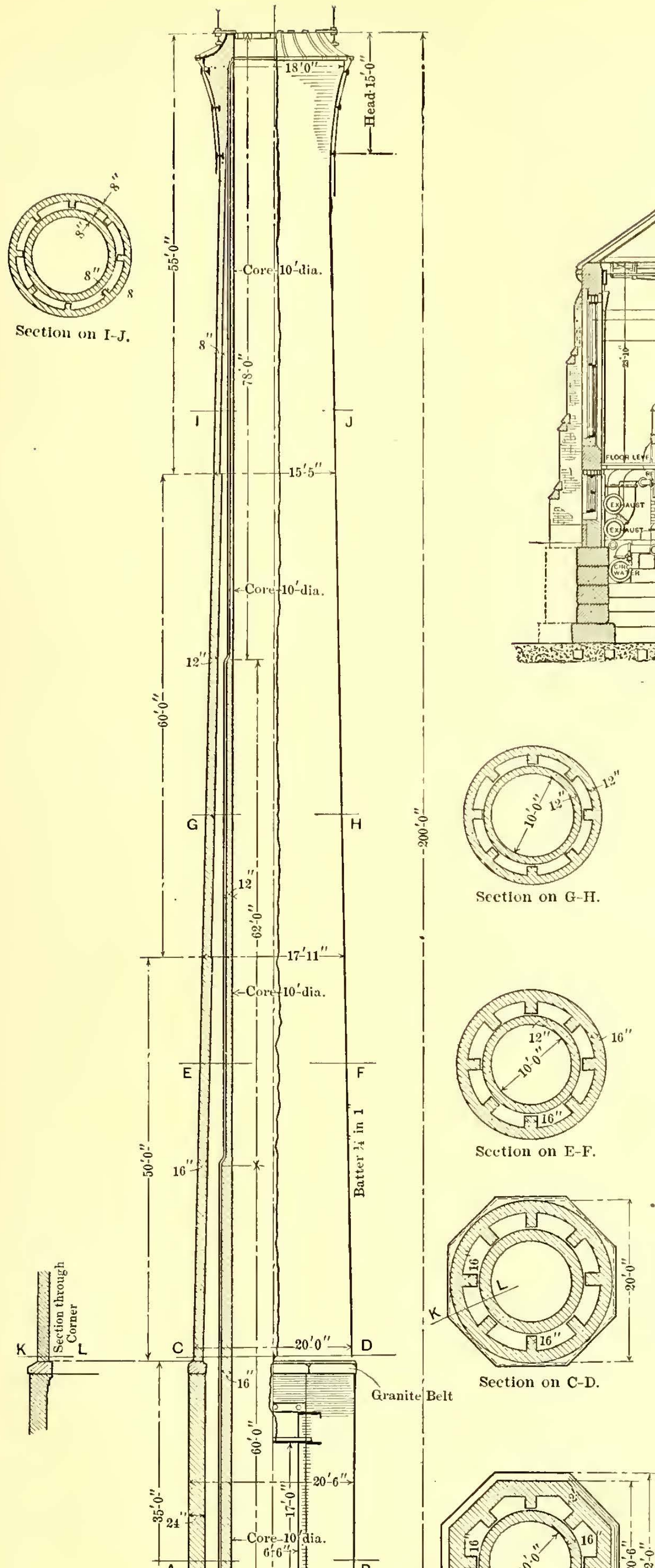


FIG. 5.—STACK.

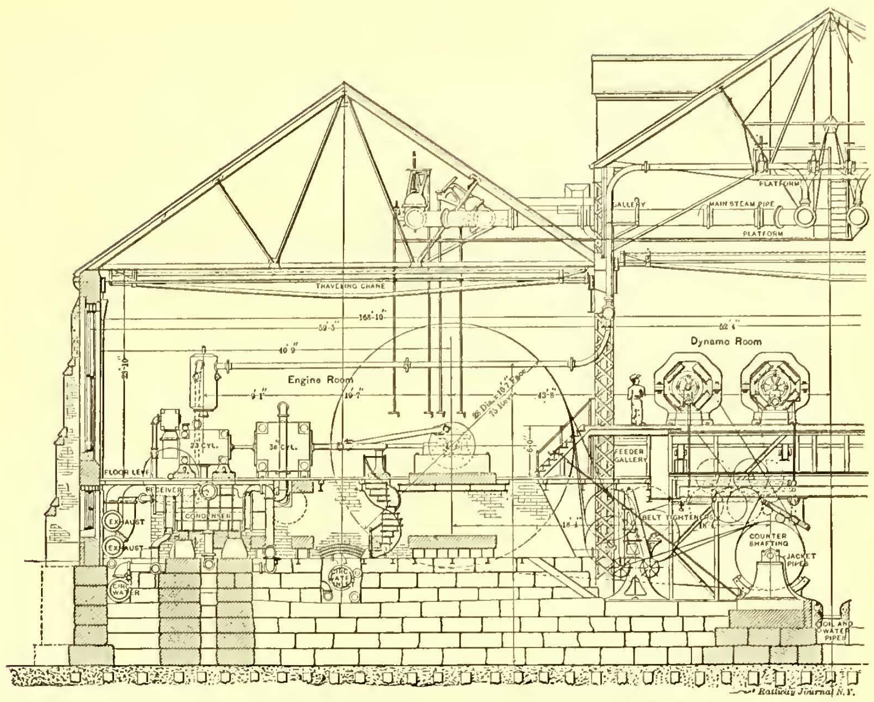


FIG. 6.—SECTION OF CENTRAL POWER STATION, SHOWING ORIGINAL ARRANGEMENT OF MACHINERY.

given in Fig 3. As will be seen, the wheel is made of a large number of rolled plate segments bolted together instead of being cast in segments and fastened together by bolts and rings. This construction permits a much greater velocity of rim than in wheels made of cast iron. The speed at which this wheel will run is ninety revolutions, giving a speed at the circumference of more than a mile per minute. The weight is distributed as follows :

Center cast iron	20,000 lbs.
Web	22,560 "
Rim	42,460 "
Total	85,020 lbs.

The hub shown in Fig. 3 is seven feet in diameter, with twenty-one inch bore and it is fitted at one side with brackets to hold the armature of the 800 k. w. generator. To the center of this hub are connected the web plates, sixteen in number on each side, or a total of thirty-two, extending to the extreme outside diameter of the wheel. These plates are ¾ in. in thickness and are faced along their edges so as to form a good joint. Outside of these segments are two circular plates, B B, bolted through each segment by five 1½ in. bolts and through both plate and hub, C, by three 2½ in. bolts. The segments are braced by truss pieces, ¾ in. in thickness by 8 ins., held in the center by two 1¾ in. cross bolts which act as struts. The center of the rim between the web plates consists of nine 1 in. plates each eight feet long and twenty inches deep joining on the ends, as shown in the engraving. Each plate covers five joints of other plates and no joints occur where the web plates join. Outside of the web plates surrounding the rim is a strip of one inch plate fourteen inches in depth riveted through the rim by rivets every 11½ ins. and outside of this is another strip of one inch plate five inches in depth, also riveted through the rim by the same number of rivets. The heads of both these lines of rivets are countersunk.

The wheels are fitted complete on the floor of the works of the manufacturers at Milwaukee before shipment and all holes are drilled within one-quarter inch of their size. When the wheels were erected in place at the power house, the bolt holes were reamed out and turned rivets driven in them. The wheels have not as yet been turned, but are so accurately constructed that they vibrate but little when running. It is proposed to turn the wheels as soon as opportunity offers.

The stack is of brick 200 ft. high, with core ten feet

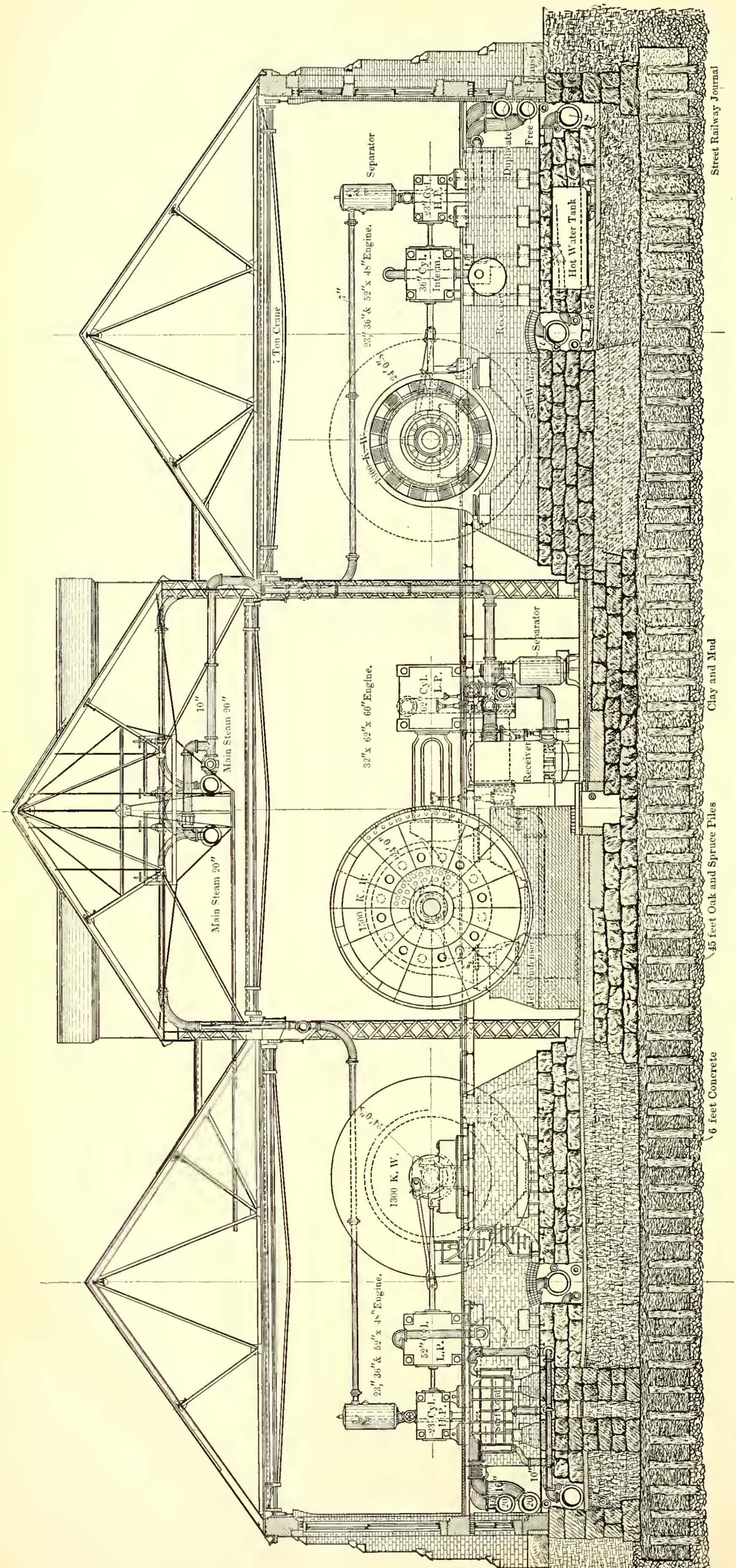


FIG. 7.—SECTION OF CENTRAL POWER STATION, SHOWING PRESENT ARRANGEMENT OF MACHINERY.

in diameter. The foundation consists of four feet of concrete, thirty-five feet square, upon which is laid granite rubble to the depth of ten feet. Above this the stack rises octagonal in section to a height of thirty-five feet. From this point it is circular in section tapering from twenty feet in diameter at thirty-five feet above the octagonal base to 13 ft. 9 ins., fifteen feet from the top. At the crown it is eighteen feet in diameter. The general construction is shown in Fig. 5.

There are three batteries of Babcock & Wilcox boilers of 500 h. p. each, each boiler containing 252 four inch tubes, eighteen feet long and designed for a pressure of 180 lbs. The boilers are faced with white glazed brick, giving a very handsome appearance. The economizer is of the Green type and of 2000 h. p. capacity. It contains 560 tubes and is arranged with by-pass so that it can be thrown in and out of circuit as desired.

The passage of the feedwater is first into the primary heater, then into the feed pump, then into the secondary heater, then into the economizer. The primary heater takes steam from the engine exhaust, and the secondary from the feed pump exhaust.

Fig. 7 shows the new arrangement of machinery adopted at the Albany Street or central station of the West End Company. The conditions presented here were those of converting a station using belts and countershaft to direct connection. This station when completed in 1892 was by far the largest in the world, devoted to electric power purposes exclusively. A full description appeared in the STREET RAILWAY JOURNAL for September, 1892. There were six triple expansion Allis-Corliss engines in two rows of three each, belted to a countershaft measuring 120 ft. in length and nine feet in diameter. The generators, which were of 400 k. w. capacity each, were mounted on a gallery extending through the building and over the countershaft to which they were belted.

This arrangement which seemed at the time the most desirable has proved in the light of modern practice extremely uneconomical, and the West End Company has recently commenced the reconstruction of the station to fit it more nearly with modern ideas. The plan contemplates the abolition entirely of the countershaft, and the use of direct connected generators. This will be accomplished gradually by the fitting of a 1300 k. w. direct connected G. E. generator to the shaft of each triple expansion engine, and by the erection in the space between each set of two engines, left vacant by the removal of the generator gallery, of a cross compound Allis-Corliss engine with 1500 k. w. generator.

The cylinders of the triple expansion engines measured 23 ins., 36 ins. and 52 ins. × 48 ins. stroke and ran at 70 r. p. m. Under the most economical conditions the engines were designed to develop a horse power of about 1000 and to work up to 2000 h. p. as a maximum.

Under the new conditions the engines are speeded up ten revolutions so that they now make eighty revolutions, and with the increase in efficiency of the generators an increase in power of each of about 350 h. p. under ordinary conditions of working can be secured. The increase in efficiency by direct connection is estimated at from 10 to 12 p. c.

The triple expansion engines were equipped formerly with cast flywheels which were employed for driving the belts. They were 28 ft. in diameter with 10 ft. 7 in. face. By removing this wheel sufficient space was secured on the shaft to mount a plate flywheel which occupies only forty inches of shaft room and also a 1300 k. w. G. E. generator. The old flywheel weighed 157,000 lbs. The new flywheel weighs only 120,000 lbs. and measures 16½ ins. across the face. The size of the shaft was increased from 18 ins. to 24 ins. and a new pillow block was supplied strong enough to sustain this additional weight.

The cylinders of the new cross compound engine measure 32 ins. and 62 ins. × 60 ins. stroke, making the total capacity in power when the station is completed of 12,300 k. w., with no increase of floor space. The former output was about 7500 k. w.

The new compound engine is fitted with a plate steel flywheel similar in general construction to that in use in the Charlestown power station, illustrated on page 178. It is twenty-four feet in diameter and weighs 150,000 lbs. and runs at a speed of seventy-five revolutions a minute.

Why the T Rail is Not Satisfactory on Paved Streets in San Francisco.

By S. L. FOSTER.

About a year ago the STREET RAILWAY JOURNAL contained interesting accounts month by month of how ingeniously and successfully the problem of paving to a T rail was solved in various Eastern cities. In one city Belgian blocks were used, the space between the blocks and the rail being filled with two inches of concrete and two inches of asphalt, the asphalt taking the wagon traffic; in another a wooden filling block was used between the head and the flange of the rail, and the paving was laid against this; an oak strip was put outside the filling block for a flangeway in another city and paved to; brick paving of special shape was used in still another, and the city's engineer had pronounced this last method of paving to a T rail so good that that city would have no other rail.

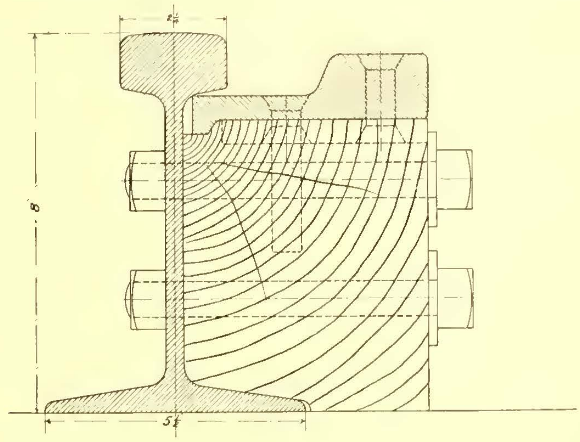


FIG. 1.—T RAIL WITH FLAT RAIL LIP.

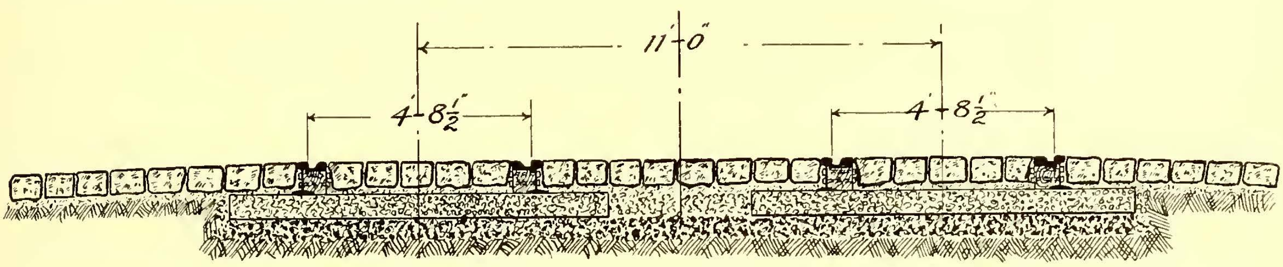


FIG. 2.—SECTION OF T RAIL TRACK, SHOWING METHOD OF PROTECTING AGAINST VEHICULAR WEAR.

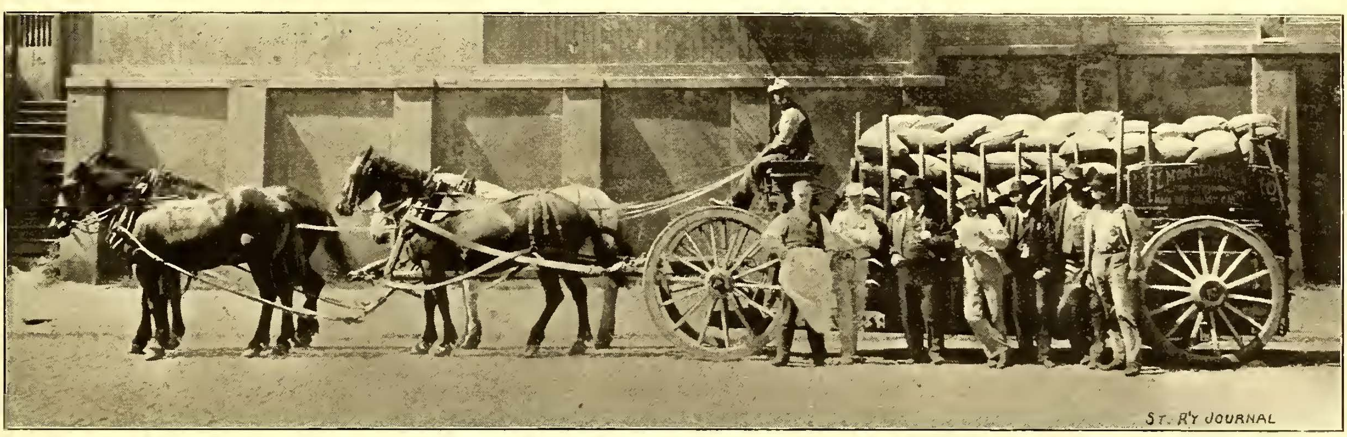


FIG. 3.—A PAVEMENT DESTROYER—SAN FRANCISCO.

All these accounts seemed so alluring that the Market Street Railway Company, of San Francisco, decided to try some T rail construction on one of its new lines. A seventy-four pound eight-inch T rail was selected and laid with great care on Third Street from Brannan to Howard. Third Street is the main highway for the passage of heavy freight teams to and fro between the wholesale business portion of the city and the depots of the Southern Pacific Railway, and is paved with basalt blocks.

A trench the full width of the double track was opened in the sandy soil and after being rolled was filled to the depth of six inches with a cheap concrete and well tamped.

On this were laid the 8 in. × 6 in. × 8 ft. redwood ties set three feet centers to which were spiked the rails. These rails were held erect by 3/8 in. × 4½ in. tie bars fastened to the rail web by means of ¾ in. rivets and × in. × 3 in. × 3½ in. angle plates spaced 3 ft. apart. Between the ties there was put a filling of broken rock well tamped and having the voids filled with sand washed in. A top dressing of two inches of sand served as a bed for the paving blocks which were snugly and evenly laid and solidly rammed with seventy-five pound rammers. Various methods of paving next to the rail were tried. On a portion of the street the blocks were chipped off like the special bricks just mentioned, leaving a flangeway and yet having the blocks set tightly against the rail; again the wooden filler was tried; the oak strip idea was utilized for a part of the way, Oregon pine being substituted for the oak, and for a short distance the blocks were grouted in Portland cement. All the work was carefully and conscientiously done, but before two weeks had elapsed and even before the cars began running, the pavement began to yield to the wagon traffic.

San Francisco's streets in the downtown districts are afflicted with a transportation device called by some witty reformer a "pavement destroyer." This "pavement destroyer" is a four-wheeled dray, seven foot gauge and sixteen feet between axles. Its bed sets low—within eight inches of the pavement and it is drawn by two or four heavy Norman or Percheron horses. The axles are four inches square, and the width of tire five inches. On one of these drays wheat is frequently piled six feet high, giving a total load of at least ten tons. Of this load seventy-five per cent, or over seven and a half tons, is supported by the rear axle and as this load drops from one paving block to another—say half an inch—a terrific hammer blow is delivered by each wheel of 300 foot pounds on the succeeding block.

Such traffic would undoubtedly have crushed the asphalt, the cedar blocks, and the bricks of the Eastern construction; and a succession of these blows on Third Street drove down the paving at the rail between the ties and wore out the tough basalt blocks in a remarkably short time. This basalt is an excellent rock for paving where there is heavy traffic, as it does not crush like brick or wood, nor splinter like granite. The squared blocks of it slowly wear away, becoming smooth and rounded where the traffic is evenly distributed. When the wear was concentrated, however, just inside the head of the T rail on a strip necessarily but two and a half inches wide, on account of the flangeway left for the car wheel, and a successive of heavy blows was regularly delivered by the endless caravan of drays that pour up and down the street, the pavement quickly wore into deep ruts. New blocks were laid to replace the worn ones, blocks were tried parallel to the rail—"runners" or "stretchers"—instead of at right angles—"headers." The ruts were filled with fine trap rock screenings, but it was soon seen that something heroic had to be done, as the "pavement destroyer" ruined the pavement faster than it could be repaired. It has often been said that it is cheaper for a street railway company to furnish a metal tramway for the wagon traffic than one of paving materials, and as the tramway of rock had failed, a metal one was inevitably in order. The eight-inch rails had been spiked and riveted together too firmly to consider the proposition of changing to a girder rail and accordingly the girder rail lip was added to the T rail as shown in Fig. 2. Redwood stringers were laid against the inside of the rails and bolted to them through the web. On these stringers were laid continuous lengths of old horse car tram rails. These rails were spiked to the stringers and at the abutting ends were riveted to heavy tie plates bedded in the stringer. This made substantial construction and prevented "snake heads."

THE Newburgh Street Railway Company has been awarded the United States mail contract between Newburgh and Walden, commencing the first of March. The company will carry the mail bags in the combination cars.

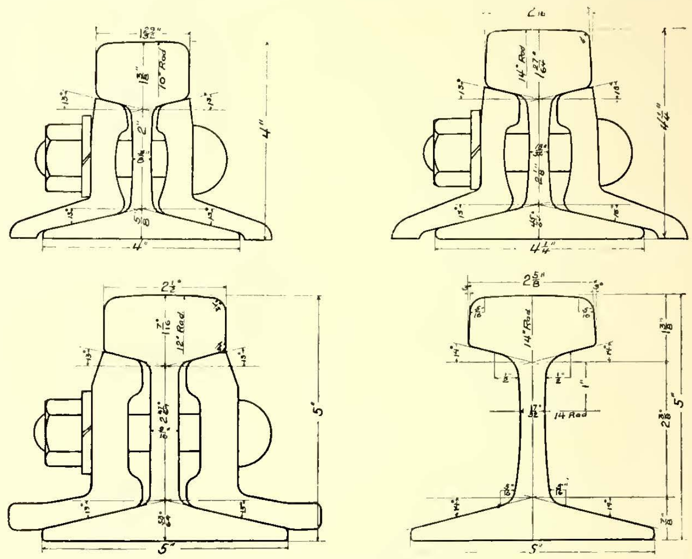
Street Railway Roadbed.

By MASON D. PRATT.

III.—The T Rail as Adapted to Street Railways.

The rail sections considered in the two previous chapters are called "girder rails" to distinguish them from the old flat rail, which was in no sense a girder.

The rails commonly used on steam roads in this country are called T rails, and have the properties of the girder, as much as the special street railway rails to which that term is applied. In fact, they more nearly resemble a girder, in that they are symmetrical about a vertical axis, a property which only center bearing girder rails possess.



FIGS. 68-71.—STEAM RAILROAD RAILS.

The term "T rail" is, strictly speaking, a no more accurate one than "girder rail," but both are accepted as sufficiently so by common usage.

The T rail is used exclusively on the 175,000 miles of steam railroads in the United States, and so far superior is it to any other section, that there is little wonder that we find it used in an ever increasing percentage on the 13,000 miles of street railways.

The number of sections and the variety in designs far exceed those of the girder rail, which fact is the more remarkable when it is considered how much simpler the sections are, and the almost uniform conditions under which they are employed.

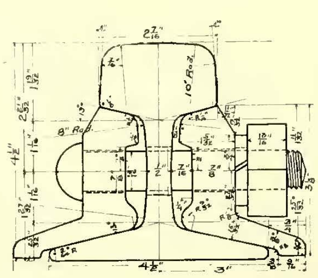


FIG. 72.—PENNSYLVANIA RAILROAD STANDARD —70 LBS.

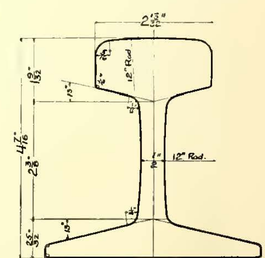


FIG. 73.—SOCIETY CIVIL ENGINEERS STANDARD—65 LBS.

Figs. 68, 69, 70, 71, 72 show sections that are standard on several of our most important steam roads, and Fig. 73 one of the samples of the American Society of Civil Engineers. For the sake of comparison I have selected those of about equal weight, and they would be suitable for a well built electric railway carrying a heavy traffic. The difference in design is quite marked, even to the unpracticed eye.

The conditions on steam roads differ materially from those on street railways, mainly in the fact that the track is exposed, so that joints and all other fastenings are accessible, and also in that they are subject to heavier traffic at higher speeds. On street railways the conditions met with in suburban and interurban lines differ from those in the cities and more populous districts, and approach more nearly to those of the steam roads in so far as the construction of the roadbed is concerned. They are often such as to admit of the use of the T rail, and since this section possesses many advantages over the girder rail, the privilege of using it is gladly embraced. The T rail is held in such great favor by street railway men, that many successful efforts are being made to use it, though in a modified form, in city streets, in a manner that I will show later on.

Naturally, therefore, the use of T rail on street railways should be considered under two heads, (*a*) that in suburban and interurban lines, or in unpaved track, and (*b*) that in city lines, or in paved track. In this order, then, they will be taken up.

The points of superiority of the T over girder rails, briefly stated, are as follows:

1. It is cheaper, for the price per ton is less than the girder rail, and owing to the absence of the tram or groove and also owing to its symmetrical section, a much lighter rail may be used than in a girder track under similar conditions, at the same time obtaining an equally substantial track.

2. It is easier to lay, for the section being symmetrical the application of the joints becomes a simpler matter, although this requires careful attention in all track laying. Easy curves may be sprung in, and sharper ones be laid by means of a portable bender, with a greater certainty of the track keeping its alignment than with girder rails. Then there may always be found a greater number of trackmen familiar with the laying of T rails than girder. These points are of vast importance, for on them depends the durability of the track, more than upon the shape of the rail or fastenings or any other feature.

3. It has a cleaner head, owing to the absence of the tram and groove of the girder rail. It offers no attraction to street traffic, and if properly laid in a well macadamized, brick paved or asphalted street, the track will usually be found in a much better condition than with any girder rail.

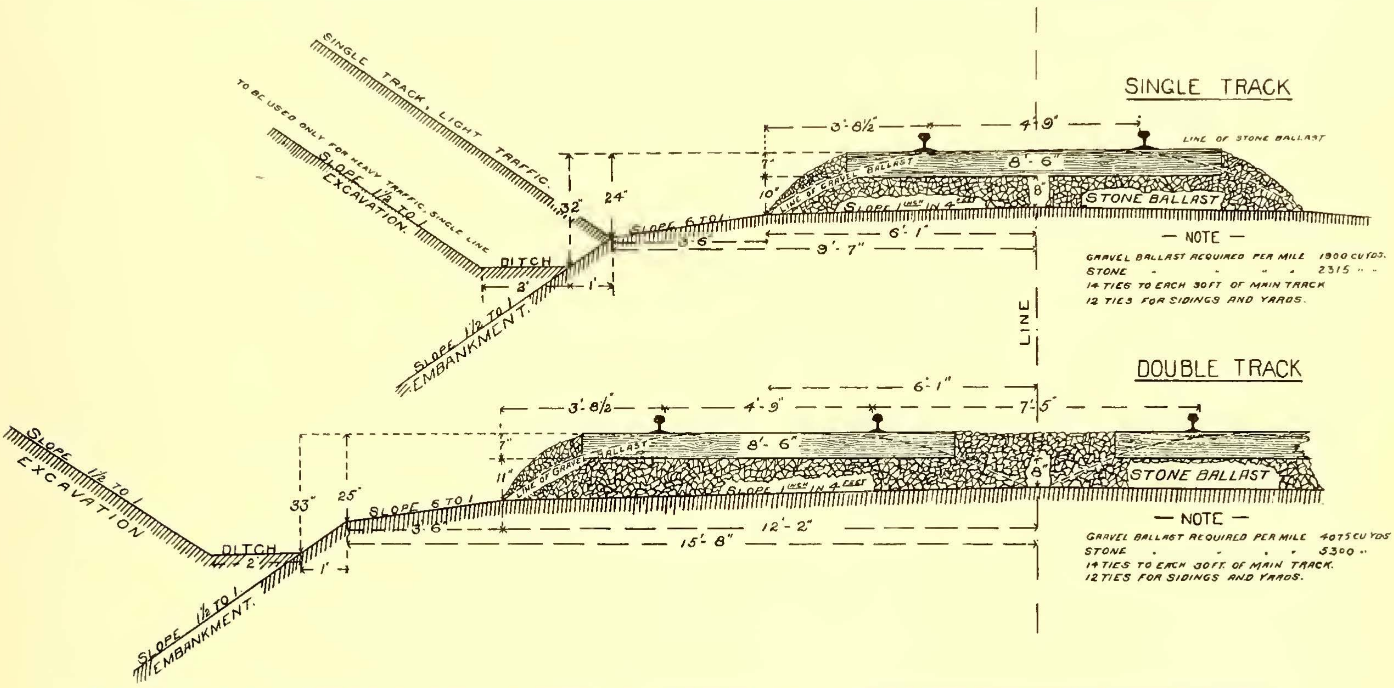
The last two conditions contribute, of course, to a better track in every way for operation, for track frictions are reduced to a minimum. And since the track surfacing is not hampered by street grades, the outer rail of curves may have their proper elevation, and cars may run at the maximum speed at all points.

Steam road practice may be followed very closely on interurban lines, where the track may be exposed, and I have given in Figs. 74 and 75 standard cross sections of single and double track construction on the Pennsylvania Railroad, which probably represent the best practice. These sections show in a complete and comprehensive manner the method of grading, draining, ballasting, etc. Below are given extracts from the Pennsylvania Railroad Company's general specifications governing the construction, all of which could be followed to advantage on that class of electric track under consideration.

SPECIFICATIONS FOR LAYING ROADBED.

Roadbed.—The surface of the roadbed should be graded to a regular and uniform sub-grade, sloping gradually from the center towards the ditches.

Ballast.—There shall be a uniform depth of six to twelve inches of well broken stone or gravel, cleaned from dust, by passing over a screen of one-quarter inch mesh, spread over the roadbed and surfaced to a true grade, upon which the ties are to be laid. After the ties and rails have been properly laid and surfaced, the ballast must be filled up as shown on standard plan; and also between the main tracks and sidings where stone ballast is used. All stone ballast is to be of uniform size and the stone used must be of an approved quality, broken uniformly, not larger than a cube that will pass through a 2½ in. ring. On embankments that are not well settled, the surface of the roadbed shall be brought up with cinder, gravel, or some other suitable material.



FIGS. 74 AND 75.—CROSS SECTIONS OF SINGLE AND DOUBLE TRACK CONSTRUCTION—PENNSYLVANIA RAILROAD.

Cross ties.—The ties are to be regularly placed upon the ballast. They must be properly and evenly placed, with ten inches between the edges of bearing surface at joints, with intermediate ties evenly spaced; and the ends on the outside on double track, and on the right hand side going north or west on single track, lined up parallel with the rails. The ties must not be notched under any circumstances; but, should they be twisted, they must be made true with the adze, that the rails may have an even bearing over the whole breadth of the tie.

Line and Surface.—The track shall be laid in true line and surface; the rails are to be laid and spiked after the ties have been bedded in the ballast; and on curves, the proper elevation must be given to the outer rail and carried uniformly around the curve. This elevation should be commenced from 50 to 300 ft. back of the point of curvature, depending on the degree of the curve and speed of trains, and increased uniformly to the latter point, where the full elevation is attained. The same method should be adopted in leaving the curve.

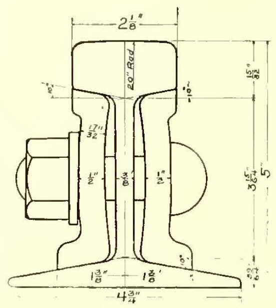
Joints.—The joints of the rails shall be exactly midway between the joint ties, and the joint on one line of rail must be opposite the center of the rail on the other line of the same track. A Fahrenheit thermometer should be used when laying rails, and care taken to arrange the openings between rails in direct proportion to the following temperatures and distances: at a temperature of 0 deg., a distance of 5-16 in.; at 50 degs, 5-32 in.; and in extreme summer heat, of, say, 100 degs. and over, 1-16 in. must be left between the ends of the rails to allow for expansion. The splices must be properly put on with the full number of bolts, nuts and nut locks, and the nuts placed on inside of rails, except on rails of sixty pounds per yard and under, where they shall be placed on the outside, and screwed up tight. The rails must be spiked both on the inside and outside at each tie, on straight lines as well as on curves, and the spikes driven in such position as to keep the ties at right angles to the rails.

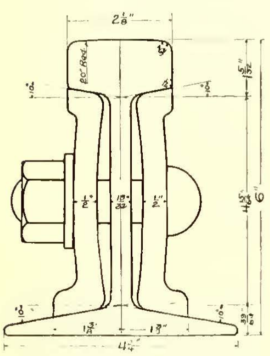
Switches.—The switches and frogs should be kept well lined up and in good surface. Switch signals must be kept bright and in good order, and the distant signal and facing point lock used for all switches where trains run against the points, except on single track branch roads.

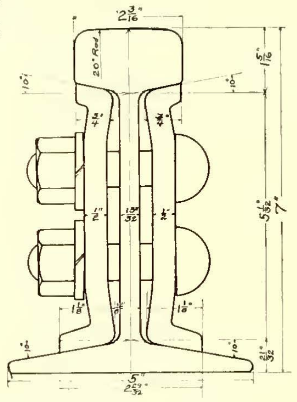
Ditches.—The cross section of ditches at the highest point must be of the width and depth as shown on the standard drawing, and graded parallel with the track, so as to pass water freely during heavy rains and thoroughly drain the ballast and roadbed. The line of the bottom of the ditch must be made parallel with the rails, and well and neatly defined, at the standard distance from the outside rail. All necessary cross drains must be put in at proper intervals. Earth taken from ditches or elsewhere must not be left at or near the ends of the ties, thrown up on the slopes of cuts, nor on the ballast, but must be deposited over the sides of embankments. Berm ditches shall be provided to protect the slopes of cuts, where necessary. The channels of streams for a considerable distance above the road should be examined, and brush, drift and other obstructions removed. Ditches, culverts and box drains should be cleared of all obstructions, and the outlets and inlets of the same kept open to allow a free flow of water at all times.

Road Crossings.—The road crossing planks shall be securely spiked; the planking on inside of rails should be ¾ in., and on outside of rails it should be ⅛ in., below the top of rail, and 2½ ins. from the gauge line. The ends and inside edges of planks should be beveled off as shown on standard plan.

It often happens, however, on suburban lines, that the track is laid in or alongside of the public highway, and it is required to fill the track and keep the surface to its level. In these cases the sub-construction should be the same as above described, and the ballast be brought up to the level of the top of the rail. This construction offers less obstruction to travel, and permits teams to cross at any point; although it is not







FIGS. 76-78.—5, 6 AND 7 IN. STREET RAILWAY T RAILS.

intended that the track itself shall be used for street traffic. A model example of this style of track is shown in the STREET RAILWAY JOURNAL for March, 1894, page 161.

When T rail track is laid in macadamized streets, the only change in construction necessary is the use of a layer of finer material for the top course, with a free use of a heavy road roller.

It is a gradual transition from the open track to the track in paved streets. With the latter comes not only a change in the general style of construction, but one in the rail itself. All pavements, save asphalt, require a deep rail, and the manner in which this change is brought about in the T rail is well shown by Figs. 76, 77, 78, of five, six and seven inch rails. Rails of even eight and nine inches have been proposed.

These all have the characteristic square head. The base increases in width with the height. The fillet at the lower outer corner of the head is made as small as practicable, in order to obtain all the bearing possible for the splice bars, a very essential point. There is one point, however, wherein these high T's show up to a disadvantage, and that is in the alignment. Not having the lateral stiffness of the girder rail, with its tram or lip, the track is apt to present a "wavy" appearance which braces and tie rods will hardly prevent. This is a matter which appeals more to the eye of a good trackman than to the operator. These rails have been very successfully laid in the smaller cities, in connection with well macadamized roads and brick pavements. Even the more shallow granite block pavement may be laid with this track with success. This construction is becoming more popular as the prejudice to T rails wears away. New England has many examples of well laid T rail track in city streets, and in connection with nearly all kinds of pavement—notably at New Haven, Bridgeport and Waterbury. There is also a notable example of good roadbed in the West at Terre Haute, where, however, the construction is unusual in that a concrete base is employed and steel ties used—a construction that would do full justice to any rail.

Power Brakes Upon Electric Cars.

By A. K. BAYLOR.

One of the most noticeable phases in the development of mechanical power for street railway work, has been the increase in the weights and dimensions of rolling stock, and this is especially true of electric traction.

In the old days of horse railways, no truck (using the term in the modern sense) was used, the bearing jaws being bolted directly to the lower frame of the car, and quite independent of each other, so far as any metallic bracing was concerned. The first electric railway motors were hung upon the axles of such cars, with the free end depending from the car floor itself, but it was soon found that, while independent axles fulfilled the requirements of animal traction and light trailers where the wheels had practically nothing to do but support the car, and where the connections between bearings and car frame were never strained except in braking, a more rigid construction was necessary upon motor cars where the wheels became the medium by which the car itself was pulled along. Then followed the practice of using independent trucks, carrying the motors and braking apparatus, which materially increased the total weight of the unit. To accommodate increasing traffic, car bodies have been gradually lengthened until we have standards nearly twice as large and over twice as heavy as the old-fashioned horse cars. Furthermore, the average speeds of street service have been practically doubled.

Doubling the weight of a moving body doubles its momentum, but doubling the speed multiplies the momentum by four, that is by the square of the velocity. The speed factor is, therefore, the more difficult to deal with, and to stop within a given distance a correspondingly increased braking power must be applied. Under these conditions, it is not surprising that a pressing need has arisen for a power brake to apply to street cars.

Some forms of hand brake in common use upon various standard trucks, are so designed that they enable the motorman to handle his car with safety and without undue effort under ordinary conditions, but a clear advantage will be gained by providing him with means of stopping suddenly (in cases of emergency) without extra exertion, and relieving him at all times of the burden of applying his own muscular energy to the task of braking.

Air brakes have been applied to this work to some extent with good results, such equipments following the lines established by steam railroad practice, excepting that the pressure is generated from pumps driven by eccentrics on the axle. In this respect, of course, the system differs radically from steam practice. With the latter minimum and maximum pressure limits are secured by means of an automatic steam regulator upon the locomotive, which operates whether the train is in motion or at a standstill, starting the pumps when the pressure falls and stopping them again when it has been restored. The axle driven pump, on the other hand, depends upon the motion of the car for its operation, so that while the maximum pressure can be limited, the minimum cannot, as several applications of the brake may follow one another at such short intervals of *space* that the pressure absorbed in each application is more than that generated between stops.

It is evident that a continuation of this process may so reduce the pressure, that it will be inadequate for the proper control of the car, but such a condition is unusual. It may be guarded against in practice by the use of reservoirs as large as the limited space under the car will allow, and of sufficient capacity for a reasonable number of successive stops at short intervals, with an auxiliary hand brake (which should accompany any power brake that may be used) always available in case of emergency.

It seems probable, therefore, that the air brake will become the standard with all forms of mechanical traction, excepting electric, and it might include that also, if such cars had not in the motors an ample source of energy applicable to braking purposes, rendering additional apparatus superfluous.

It is, of course, commonly understood that dynamo-electric machines are convertible, i. e., a generator may be connected to an electric circuit and used as a motor, and an electric motor, if driven mechanically, will deliver electrical energy—in other words, become a generator. The armatures of motors, being geared to the main axles of an electric car, must always revolve while it is in motion, and if not in electrical connection with the line the motors are driven by the momentum of the car, and are capable of current generation. It is clear that the equipment of an electric car must of necessity embody this source of power, whether it is availed of or not, and that this power runs to waste when any other force whatsoever is used in braking. "Good engineering practice" (which means "greatest economy") is diametrically opposed to waste in any form. Therefore the use upon electric cars of any power brake other than electrical must be considered the opposite of good engineering practice, provided, of course, such brakes are practical and reliable.

The idea of applying electricity to braking purposes is not a novel one by any means, and a vast amount of study has been devoted to the problem. The results of this experimenting may be classed under three headings:

First.—Brakes operated by current taken from the overhead line.

Second.—Brakes operated by current taken from storage batteries upon the cars.

Third.—Brakes operated by current generated in the motors.

The first and second forms have little to recommend them, except that they relieve the motorman. A "trolley brake" (one taking power from the line) is unreliable, as the trolley may leave the wire at a critical moment, rendering the brakes inoperative, and a storage battery brake necessitates the addition to the car equipment of heavy and expensive apparatus.

These types are not, strictly speaking, electric brakes, as the rigging and shoes are the same as with ordinary hand brakes, some form of electro-magnet taking the place of other power in applying pull on the chain. As power brakes they should be classed with compressed air, and are subject to the serious objection already applied to air brakes in this connection, i. e., the waste resulting from the creation of additional power for braking, while that obtainable from the motors is left unused. In common with air brakes, they are also open to the criticism that in providing an auxiliary it is necessary either to duplicate the rigging and shoes (impracticable in a space already overcrowded) or to rely upon a reserve source of power only, trusting to one set of shoes and connecting mechanism. This criticism would also apply to brakes taking current from the motors when such current is used to excite an electro-magnet acting upon the ordinary brake rigging.

The underlying principle involved in the third form, i. e., converting the motors into generators, constitutes electric braking in its true sense, but here a further subdivision should be made distinguishing between the practice of stopping a car by short circuiting the motors, either directly or through resistances, and that of using magnetic friction plates controlled by current from the motors.

Most electric railway operators are familiar with the fact that the ordinary double motor equipment constitutes a practical emergency electric brake, which comes within this class and of which an alert motorman may avail himself to avert accident in case both the line power and the hand brakes have failed. To do this, the motors must be connected in parallel, and the reversing switch turned as if to run backwards. With rheostatic controllers, the motors being permanently connected in parallel, the operator need only throw the reversing handle, but with series parallel controllers which, at "off" position, open all the motor connections, it is necessary also to set the controller on one of the "parallel" notches. The motors now being in parallel oppose each other, and the voltage of one being under ordinary conditions higher than that of the other, overcomes it, and sets up a counter current reversing its field. This puts the motors in series instead of parallel, and as there is no resistance in circuit except the motor windings, a current is instantly built up which brings the car to a standstill just as an overloaded generator backs down its engine. If, at the outset, both motors should generate the same voltage, they would, being in parallel, exactly balance each other and no current would flow, and if the circuits included any poor contacts of high resistance the motors might not build up. As a matter of fact, however, it is practically impossible except by the most careful selection to find two motors that will balance without equalizing leads when running at the same speed, and it is assumed the wiring is in perfect condition.

Unless the connections were reversed this action could not take place as the motors must begin to generate upon the magnetism left in the field castings when the line current is withdrawn, and with the circuits unchanged the initial current generated, instead of building up this residual field, would oppose it and reduce it to zero. This rule applies, of course, whenever current is obtained from the motors.

By a slight modification of the regular connections the motors may be short circuited independently. This prevents balancing and as the full potential of each motor takes effect at once the danger of failure on account of high resistance connection is reduced. Moreover, if one motor is disabled the action of the other is not interferred with.

Although of value in case of emergency, such methods of stopping are a severe strain upon the equipment both mechanically and electrically and cannot be used regularly for braking. By completing the motor circuits through resistances the current may be regulated so that instead of acting as a sudden shock endangering the gears and insulation, the brake power can be applied more gradually and with less danger to the apparatus. With any short circuiting method, however, the magnetic drag upon the armatures due to their generator action furnishes the entire retarding force, none of which is applied directly at the car axle or wheels. The car pressing forward against the slackening speed of the armatures throws a strain upon the gears and pinions, and the motors are subjected to an unnecessarily heavy current.

The magnetic friction method is, therefore, to be preferred, as by its use all forces tending to propel the car are opposed directly and simultaneously, reducing all internal strains to a minimum, and bringing the vehicle to rest in the least possible time. The commercial form into which this type of brake seems to have resolved itself consists of a circular iron plate made fast to the axle and turning with it in a plane parallel to that of the wheel, together with an electro-magnet, also in the form of a disk, which is held so that it cannot revolve. This magnet when energized is brought into close contact with the axle disk, the resulting friction retarding the latter (and with it the car wheels), while at the same time the generator action going on in the motors tends to bring the armatures to rest.

This last consideration is of special importance, on account of the great momentum of a heavy armature rapidly revolving, and the difficulty of destroying this mechanically by a counter force applied at the wheel or axle, working upon the short leverage afforded by the radius of the pinion. The armature may be compared to the escapement wheel of a clock, being the most effective medium of control in stopping as well as starting, and it is only by making the attack here at its source that the inertia of the car can be met and overcome with maximum economy. In going thus directly to the root of the matter, an electric brake possesses peculiar advantages, which are especially emphasized when dealing with suburban or interurban service, where speeds of thirty to forty miles an hour are not uncommon. An inherent weakness in all brakes employing friction only as a means of stopping, is found in the fact that they are most effective at low speeds, their efficiency falling as the speed increases. At high velocities brake shoes practically lose their grip upon the wheels, and no pressure that can be applied will fully compensate for this. An electric brake on the contrary is most effective at highest speed, as the faster the armatures revolve the greater is the current generated.

In addition to the force applied to the armatures, and the mechanical friction between the disks, this form of brake embodies another retarding action, which at first sight is not apparent. This third factor is due to eddy currents set up in the axle plate, as it revolves in the field of force surrounding the magnet. These currents tend to retard the plate, just as the motor armatures are retarded, and the resultant braking effect, although entirely distinct from that due to friction, is added to it, entailing, however, no additional wear upon the disk surfaces. The working together of all these forces, distributed and applied where most effective, enables a motorman to bring his car quickly to rest. At the same time the whole arrangement is, to a certain extent, automatic in preventing internal strains, either mechanical or electrical.

An electric brake has still another advantage peculiar to itself which is perhaps the most important of all, when the car must be stopped within a minimum distance. It is a well established fact that a better grip upon the rails can be maintained by retarding the car wheels up to a limit just below the slipping point than by passing this point and "skidding" the wheels. Not only does skidding prevent effective braking, but it usually also results in flat wheels, as every railway operator can testify. It requires both skill and precaution on the part of the motor man at any time to bring a car to rest without slipping the wheels, and in cases of emergency, where an accident is threatened, his first impulse is to set the brakes to their full limit, which in ninety-nine cases out of one hundred means the slipping of the wheels. It would appear, therefore, that with friction brakes, the time when a quick stop is most necessary is the time the operator is least liable to effect it.

With an electric brake, on the other hand, the conditions are quite different, as a moment's study will show. As the braking force comes from the armatures, it is clear that if the car wheels stop turning, the current and with it the brake action ceases. The moment the wheels begin to turn, however, they are again retarded, and this goes on until the momentum of the car has been destroyed. The electric brake furnishes, therefore, with the best braking conditions, an automatic guard against flat wheels, an item which is of considerable importance in the maintenance of equipment.

It should be noted that, from the nature of its action as described, an electric brake will not hold a car on a grade. When this is necessary, the auxiliary brake must be used, but the car being stopped, very little brake pressure is required. As usually arranged, the electric brake connections are on the reverse side of the power cylinder in the controller, the handle being turned one way to apply power and the other to apply the brake, the same resistances being used in both cases. A combination of the regular and the auxiliary brakes can be made by extending the controller shaft through the platform and connecting it to the auxiliary rigging, so that after passing the various rheostatic steps, the handle may turn farther and set the brake shoes. This does not seem expedient, however, as with such an arrangement the brake shoes would probably be applied at every stop, and would often bind the wheels and cause slipping and flatting, which would not otherwise occur. With an entirely independent auxiliary handle, the operator would never apply the shoes, except when for any reason it became necessary to hold the wheels.

With the use of electric brakes a practical economy in operation, aside from the prevention of flat wheels, is found in the saving of wear and tear upon wheels and brake shoes. The latter will scarcely wear at all, being used ordinarily simply to prevent the wheels from turning after the car has stopped, and only acting as brakes in cases of emergency. The life of wheels is also materially increased by taking away the wear due to the grinding friction of peripheral brake shoes which in ordinary city service, where stops are frequent, probably amounts to far more than the rolling friction upon the rails. Against these savings must, of course, be charged the expense of maintaining whatever forms of friction plate may be used with the electric brake.

It would appear, in reviewing the special advantages which it possesses, its peculiar adaptability to the service required and the economy in its application, that the electric brake embodies the requisite practical and theoretical elements to meet the serious problem of power braking upon electric cars.

Rail Bonds.

From an electrical standpoint the efficiency of the return circuit on an electric railway is just as important as that of the overhead system, and at least as much care should be taken to secure resistance for the current in this part of its path. Looking at the question from a mechanical standpoint, the necessity for durable construction is even greater, as the connections are underground and hence cannot be easily inspected. While a defect on the overhead wires would be instantly detected, that on a bond or other part of the return system might, without the electrical tests, pass unnoticed except as indicated by an abnormal increase in the power required to operate the line.

After leaving the car wheels the return current will seek the negative pole of the dynamo by as many paths as may be open. It will not all pass by the circuit of best conductivity, but will divide itself among the different paths in inverse ratio to the resistance of each. That is, if of two paths, A and B, A has twice the conductivity of B, A will not carry all the current, but simply twice as much as B. The best method to reduce the total resistance of the return, and hence the power wasted between car wheel and generator, then, is to provide as many paths as possible and to make each of as high a conductivity as possible.

Acting upon this idea the early constructors of electric railways used devices of all kinds to improve grounds. But experience has shown that while ground plates may accomplish the result sought, the disadvantages of permitting the current to stray back on water pipes and other metal circuits under the ground more than counterbalance the advantages of improving the return in that way. Recent practice in cities is therefore in favor of confining the return current to the rails, while in suburban work grounds in streams or otherwise can be relied upon largely to supplement the return.

The return circuit can be largely confined to the rails without the adoption of any special method of insulating them but by providing such a good return that the resistance through any ground return will be so much greater than that by the artificial return that the fraction of current returning through the former can be practically neglected. The area of a sixty pound rail, for example, is about 5.89 sq. ins. and that of a ninety pound rail about 8.82 sq. ins. equaling, for a single track road with two rails, the carrying capacity respectively of copper rods with diameters respectively of about 1.12 ins. and 1.37 ins.

Taking the resistance of iron as six times that of copper the resistance of the ninety pound rails in a mile of track, if there was no extra resistance at the joints, would be about .016 ohms. Similarly the resistance with a sixty pound rail per mile of track would be .024 ohms. The loss in voltage from a current passing through a mile of track would be as follows:

	Single Track 60 lb. rail	Single Track 90 lb. rail	Double Track 90 lb. rail
50 amp	.12	.08	.04
100 amp.	.24	.16	.08
200 amp.	.48	.32	.16
1000 amp.	2.4	1.6	.8

The carrying capacity of steel without undue rise in temperature is sufficiently high, so that this element need not be considered with the currents mentioned.

From the figures given above it will be seen that for a light traffic, the only return needed will be to connect the rails with each other electrically and with the negative pole of the generator, assuming that the positive pole is connected with the line. Where the number of cars increases, return feeders must be used to reduce the potential drop, which increases directly with the amount of current. To be on the safe side also, cross bonds should be used at intervals to provide for a break in any bond. In the best practice, the rails of each track are cross bonded every three or four rail lengths, and the tracks of a double track road about as often, with the addition, often, of a supplementary wire. The advantage of the latter does not lie, as was once thought, in supplementing the carrying capacity of the rails, so much as in helping to bridge around any defective bond.

Modern practice is decidedly in favor of making the carrying capacity of the bonds nearly, if not quite, equal to that of the rails, and copper is almost universally used for this purpose on account of its greater conductivity.

The connection between the rail and the bond is an important point of consideration, since, to avoid electrolytic action between the two dissimilar metals, care must be taken to have it perfectly watertight. This is accomplished in most bonds by making a good mechanical joint, but the use of a waterproof paint at the joint has been followed with success upon a number of roads. Another point which theory would dictate is that, as the relative carrying capacity of copper to iron is about as 6 to 1, the area of contact at the joint should be six times that of the cross section of the bond. This is, of course, not necessary where galvanized iron bonds are used. The bond should also be longer than that of a straight line between its terminals to permit of the taking up of the expansion and contraction of the rail or the bond. They are usually ten inches longer than the channel plate and are bent about three inches from the end. It has been found in some cases desirable to have them annealed to prevent breaking in cold weather.

The proper location of the bond is another point upon which opinions differ. Bonds are usually made fast to the webs of the rails, and span the joint plates. They have, however, been also attached to the bases and trams of the rails. In both of the latter positions a shorter bond can be employed, with reduction in cost of copper. When attached to the base the inspection is difficult, however, while connection with the tram renders the top of the bond subject to vehicular wear. In any case the bond should be so placed that the paving blocks do not press against it, particularly at the point of contact with the rail and at bends. On some suburban roads it has been found desirable to place the bonds under the channel plates where they cannot easily be stolen, and in the interurban work of the future this may be an important consideration, as the amount of copper usually contained in a bond is sufficient to tempt persons to break them off.

The accompanying engravings show the principal bonds in use on American railways at present.

Fig. 1 is the West End bond, manufactured by A. & J. M. Anderson, and designed by R. C. Brown, former engineer of the West End Street Railway, of Boston. It consists, essentially, of a loop of No. 00 tinned copper wire. The wires are eighty inches in length, and each has sweated upon it where it passes through the web of the rail, and before its insertion in the rail, two soft steel, tinned, tapered sleeves one and a half inches in length. The rails are drilled just before bonding, and these sleeves are driven in by a sledge and follower. The ends of the wires are joined together by means of a tinned copper, slotted sleeve, four inches in length, into which they are inserted and sweated. In Boston two of these bonds are used at each joint. The use of steel against steel in the contact made by mechanical means is for the purpose of avoiding any possible electrolytic action at this point.

Fig. 2 is the Johnston bond, manufactured by John A. Roebling's Sons Company, and is in five parts, the bond proper and four brass nuts. Two of these are at each end of the bond, and one has a conical head to fit the hole drilled in the rail. The nuts are screwed tightly up, so that their flanges come against the web of the rail, and this fastening is reinforced by slightly upsetting the protruding end of the copper rod on the end nut after the whole is in place. After the bonds are installed the joints may be soldered, but in any case should be coated with suitable paint.

Fig. 3 illustrates the Chicago rail bond, manufactured by the Washburn & Moen Manufacturing Company. This bond is in three parts, the copper bond proper and two steel drift pins. The terminals of the bond are thimble shaped and pass through a hole in the rail, into which they should fit closely. The end is then expanded slightly, with a tapering punch driven into the hole in the terminal. This serves to secure the bond in the rail while the drift pin is driven home. This pin is one-sixteenth of an inch larger than the hole in the end of the bond into which it is driven, hence the terminal is expanded, and the contact between the iron and copper is so intimate that corrosion or electrolytic action cannot occur. An additional means of fastening the bond and increasing the surface of contact is by riveting the end of the tubular terminal, as shown in the engraving.

Fig. 4 illustrates a one-piece rail bond, manufactured by the Benedict & Burnham Manufacturing Company. This is of copper, with a shoulder to abut against the one side of the rail, and is connected to the rail itself by riveting. The special advantages claimed for this bond are that being all in one piece there is no danger of different parts becoming disjoined or of the bond itself becoming loose. Where this bond is connected to the tram of the rail the upper end of the hole is countersunk and the terminal of the bond expanded, presenting a flat surface to the wear of traffic. The shoulder and the head produced by riveting give an added surface of contact, reducing the resistance at the point of contact of the bond and rail. The bond has been widely adopted, its construction and method of application permitting a wide variety of choice in its use. It is the only one-piece rail bond in the market. The cross bonds are of the same construction as the rail bonds, but longer.

In Fig. 5 is shown a sample of a different class of bond. Here an ordinary wire is used as a bond, and this is held in place in the rail by a bonding cap. This is of steel, slotted with conical end and fits snugly over the end of the bonding wire. The bonding hole is drilled one thirty-second of an inch smaller than the outside diameter of the cap. It is driven into place by a hammer. The crimp extending the full length of the cap allows the shell to compress firmly over the wire and into the rail. The cap is manufactured by the Ohio Brass Company.

Fig. 6 illustrates another method of connecting the rails by a tinned copper wire, channel pins being used. These are of somewhat the same shape as the cap already described, but drop forged of copper with wider slot which extends the entire length of the pin. This allows the wire to pass through the pin, and if deemed advisable the wire can be carried around two or three times as shown in the cut, doubling or trebling the carrying capacity of the bond. This is the method of the General Electric Company.

Fig. 7 illustrates a bonding chuck manufactured by Stern & Silverman and used in Philadelphia. It is bored to fit the bond wire and one end is screwed into the rail, making a close electrical contact with bright surfaces. The other end tapers and is slotted, and after the bond wire has been slipped through the chuck the nut is screwed up, binding the surfaces closely together after which the joints are coated with insulating paint. This bonding chuck is of steel and permits the lacing of the bonding wire if desired, as shown in the engraving. .

Fig. 8 illustrates the King rail bond manufactured by Strieby & Foote. It is a copper rod with drop forged steel terminals fitted with a drop forged washer and lock nut, threaded right and left hand. The terminals have a side bearing surface of twelve times the cross section of the connecting line independent of the bolt inside the web. After channel plates are depended upon for connecting the rails, the device being a method of electrically connecting the rails with the plates. The bond is of two parts, a plastic or putty-like metal compound which makes contact between the rail and the channel plate and an elastic cork case to hold the plastic material in position as near the end of the rail as possible. The current passes from one rail through the bond to the fish or channel plate and then through the second bond from the plate to the next rail. The contact points, about two inches in diameter, on both rails and plate are treated with a solid alloy which silvers the surfaces and prevents them from rusting.

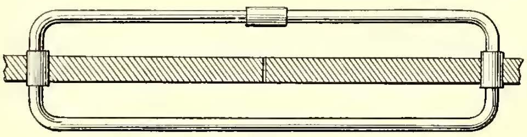


FIG. 1.—WEST END BOND.

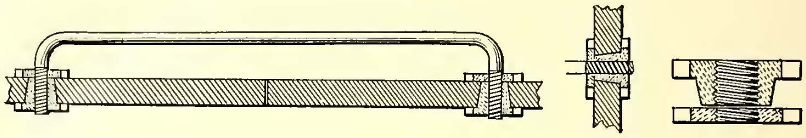


FIG. 2.—JOHNSTON BOND.

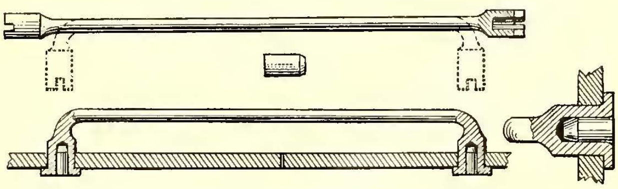


FIG. 3.—CHICAGO BOND.

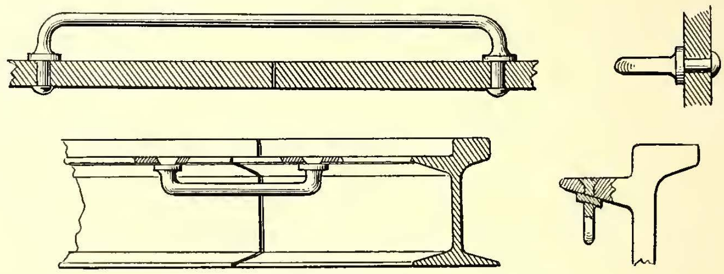


FIG- 4.—BENEDICT & BURNHAM BOND.

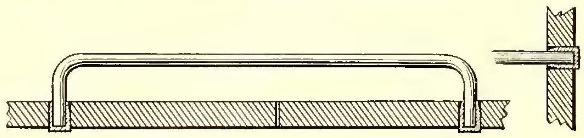


FIG. 5.—BONDING CAP.

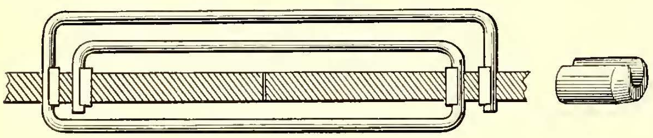


FIG. 6.—BONDING WITH CHANNEL PINS.

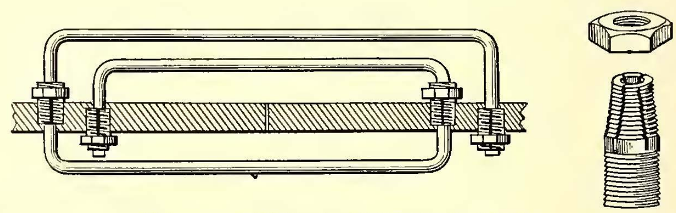


FIG. 7.—STERN & SILVERMAN BOND.

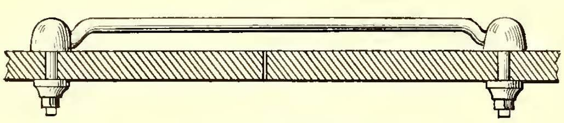


FIG. 8.—KING BOND.

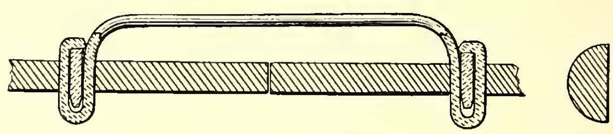


FIG. 9.—TECK BOND.

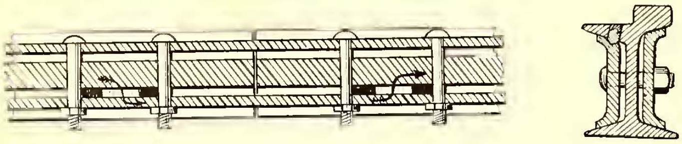


FIG. 11.

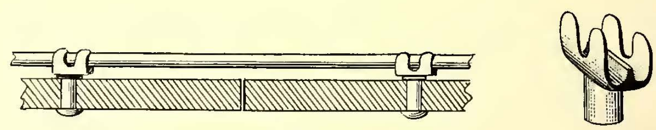


FIG. 12. GRAUTEN BOND.

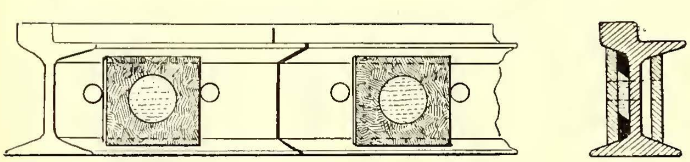


FIG. 10.—PLASTIC BOND.

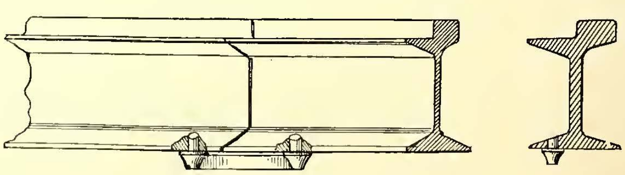


FIG. 13.—BRAZED BOND.

connection is made the terminals are painted with waterproof paint or coal tar. The bond is very easy to adjust and remove.

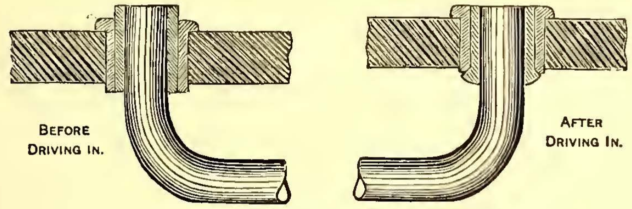
The Teck bond, manufactured by the Technic Electrical Works, is illustrated in Fig. 9. It is a copper wire of semi-circular section with its ends bent at right angles. The bent portion forms a slot through which a key or wedge is driven. The key is slightly larger than the slot, and its action is to force the copper over the edge of the holes into close contact with the rails. When this is done, the ends are so spread that the bond is practically riveted into place.

Fig. 10 illustrates a method of bonding in which the

The plastic material is the invention of Harold P. Brown and, it is claimed, has been in service for five years without change.

Fig. 11 illustrates a somewhat different method of using the same material without disturbing the paving. Near the end of the rail a hole is bored through the tram and extending partly into the channel plate. The drill with which this hole is bored carries with it as it enters the upper surface of the angle plate a burr forming a telescopic joint perfectly smooth on the inside. The drill is wet with a solution of soda and water instead of oil so as to prevent the trouble which follows the use of insulating fluid on a contact surface. The hole is then partly filled with plastic alloy. A plug of soft iron is then forced in as a stopper. For re-bonding T rails the hole is bored through the angle-plate into, but not through the base of the rail.

Fig. 12 illustrates the Grauten rail bond of the H. W. Johns Manufacturing Company. Ordinary wire is used for carrying the current and it is attached to the rail by the bonding device. This is a cup shaped hub with fingers which can be bent over after the wire is in place, and a shank nine-sixteenths to three-fourths of an inch in diameter. The whole is of composition metal, and its shank fits closely into the hole in the web of the rail when it is riveted in place. The bonding wire is soldered into the grooves. With this device a continuous supplementary can be used,



FIGS. 14 AND 15.—AMERICAN RAIL BOND SECTIONS.

or short wires as bonds as desired, or a continuous wire can be crossed from one rail to the other. Where a continuous wire is run on one side connectors similar to the cup portion of the bond are used for cross connections. The connectors can be put into the rail and riveted in place before the rails are laid, if desired.

Fig. 13 illustrates a type of bond used on the Detroit Railway, the invention of Wayne Choate. It consists of a number of copper strips or copper cable with cast copper terminals. The contact terminals have about eight times the cross section area of the bond. The bond is brazed to the base of the rail with hard spelter. The brazing is effected by a simple portable furnace using gasoline and taking from ten to fifteen minutes. An important advantage claimed for the bond is that it is practically impossible to break it off, making it not only indestructible, but difficult for thieves to carry it away.

Bonds of a similar appearance to that shown, but electrically welded to the rails have also been suggested. The inventors propose the use of a portable welding machine operated in case of an electric road by a motor, or in case

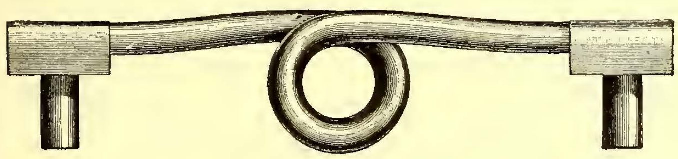


FIG. 16.—WIGHTMAN BOND.

of new construction by a gas engine or other portable power. A device of this kind is being put on the market by Rogers, Baldwin & Vickers.

Fig. 14 shows a bond manufactured by the American Electrical Works, the principle of its construction being to connect the bond to the rail by two bushings. The hole of the outside bushing and the outside of the inside bushing are both tapering, and after the bond wire is inserted in the rail the inside bushing is driven home. Its end is then turned over with a crescent shaped caulking tool, locking the bond into the rail.

Fig. 16 illustrates a bond manufactured by H. J. Wightman & Company. The bond has broad terminals to give large contact surface with the rail and is riveted through the web. It is looped to take up any expansion and contraction in bond or rail.

IT is stated that the operation of the Nantasket Beach division of the New York, New Haven & Hartford Railroad Company by electricity has been, on the whole, so successful that the company is satisfied as to the economy under the conditions presented and will equip the Dedham branch some time during the coming summer.

Some Results From Cast Welding Rail Joints.

The evidence as to the complete success of the cast welding process for rail joints is constantly strengthening, and has become nearly conclusive—as conclusive perhaps, as is possible in an experience of but two or three years. The process has now been thoroughly tested on a large scale through summer and winter, on several important roads. The West Chicago Street Railroad Company has placed between 9000 and 10,000 joints throughout its system, and its engineer, George Watson, reports that they have been found very satisfactory and have complied with all requirements. He states that cast welding is the only thing which he has yet found that will hold up the joints of a light girder rail.

M. K. Bowen, superintendent of the Chicago City Railway Company, has given the cast welding process most careful attention, having become interested in the results obtained from the use of these joints on about forty miles of track on the Chicago City system. He states personally and by letter that the joints have passed through both summer and winter service to the company's perfect satisfaction, and he believes that it is the only device by which a lasting and smooth riding track can be obtained. Mr. Bowen's wide experience as a practical engineer gives special value to his opinions of a matter of this kind.

On the West Chicago and Chicago City systems, out of 20,600 cast welded joints put in last year only 254 have broken. These were all broken in the first cold snap in November, and the breakage seems to have cleared out all imperfect joints and weak spots in the track, as since that time there have been practically no breaks, although the temperature variation has ranged from 8 degs. below zero to 50 degs. above zero. The West Chicago test has been particularly severe, from the fact that the joints were put in on old rail which was more or less rusty, so that the welds were undoubtedly somewhat less perfect.

C. G. Goodrich, vice-president of the Twin City Rapid Transit Company, of Minneapolis, reports that he is much pleased with the way in which the joints have stood the cold weather and temperatures which have gone as low as 24 degs. below zero. He thinks that the cast welding process has solved the joint question, and that his company will continue the work of putting it in as rapidly as possible this spring. Out of some 2000 joints put down on this road, only eleven have "drawn" and upon investigation it has been proven that in each case where a joint pulled apart, it was because of a poor weld, and the casting has been found full of blowholes.

The reports from St. Louis, where this weld was first tried, have been decidedly enthusiastic, and a large amount of new work will be taken up this spring.

Theoretically as well as practically, the cast welding process should be highly economical and most perfectly serve its purpose. The outfit required is small, compact and inexpensive, as compared with the electric welding process; and if, as is claimed, complete union of the metals in the joint and rail can be secured, the strength of the joint can hardly fail to be enormous.

In the East, the Falk Company is putting down joints on the lines of the Consolidated Traction Company, of Newark, and of the Union Railway Company, of Providence, and in the South, on the Citizens' Street Railroad Company, of Memphis.

A GREAT deal is occasionally said about the importance of standard wheel sections. This sounds well, but must not be accepted without consideration. There are many different forms of rail in use, not a few of which are prescribed by law. Some roads have a grooved rail in the city, conforming to city ordinances, while in the suburbs or the country they run over T rail. One road running out of the city of Washington has a T rail in its suburban section, while within the city its wheels must run in a one-inch groove. Inside the city limits this road conforms to the ordinary rates of speed, while outside it makes nearly forty miles an hour. Under such widely varying conditions, a standard form of wheel is out of the question.

SCIENCE · ENGINEERING · INVENTION

M. DELAISE has been awarded a franchise for the installation of an extensive electric railway system in Algiers.

THE Metropolitan Railway Company of Kansas City is contemplating the operation of its cable drums by electric motors.

THE flywheel governor of an automatic cut-off engine in the power house of the Traction Company, in Scranton, Pa., broke down recently. The press reports say that the springs were stretched too far by the flying outward of the governor balls, when a heavy load on the engine was suddenly taken off. A dozen pieces of the governor flew in all directions, one of them going through the floor like a cannon ball. Such an accident is very unusual, but its possibility suggests an examination of the construction of flywheel governors, to learn what is likely to happen to them in the event of suddenly throwing off a heavy load.

ACCORDING to a foreign exchange the official statistics for thirty-two lines representing 90 p. c. of British railroad systems show that ths proportion of employes receiving a salary of less than $5 per week is 42 p. c. in England, more than 50 p. c. in Scotland and 78 p. c. in Ireland. In the latter country two-thirds of these employes earn only from $2.50 to $4 per week while in England and Scotland, the greater number of them are paid from $4 to $5 per week. On the other hand, if we consider the proportion of employes earning more than $10 per week, the proportion is more than 4 p. c. in England, less than 1½ p. c. in Scotland and a little more than 2 p. c. in Ireland.

THE new Boston subway is to be divided for ventilating purposes into sections of 600 ft., and each section is to have a fan of sufficient power, when run at moderate speed, to remove the total air contents of the section every ten minutes and at maximum speed every seven minutes. The corresponding rates of flow of the air currents will be sixty feet and eighty-six feet a minute. Twelve fans may be used if found necessary and the usual volume of air to be removed will be from 12,000,000 to 18,000,000 cu. ft. an hour. For the two track sections the fans will be seven feet in diameter, and for the four track sections eight feet and will be driven by electric motors, the power required being estimated to be about the same as that of a single car. The air will be expelled through specially provided chambers and vent shafts placed at one end of the tunnel.

A RECENT list published in one of the French electrical papers of the central stations for the distribution of electricity in France, Jan. 1, 1896, shows the total number of stations, Paris excepted, is 438. The following table gives the motive power of 378 of these stations, the total number of which information could be secured :

Motive Power.	Number of Stations.	Horse Power.
Hydraulic	182	11,665
Hydraulic and steam	48	7,422
Steam	128	26,802
Low grade of gas	6	206
Illuminating gas	13	1,605
Petroleum	1	12
Total	378	47,712

IN an article by M. E. Cadiat in the *Portefeuille Economique des Machines* the following coal consumption figures are given :

On the storage battery line at Paris from St. Denis to Madeleine and from the Opera to Neuilly the car mileage averaged 1,376 miles per day, the cars having room for fifty passengers. Six thousand five hundred horse power hours were used or 4.72 h. p. hours per car mile, and the coal consumption was 2.75 lbs. per h. p. hour and 12.98 lbs. per car mile. On the trolley cars at Marseilles during the first four weeks of operation 38,953 car miles were run with an average coal consumption of 7.73 lbs. per car mile including car and power station lights. At Havre during October and November the trolley system required from 1.75 to 2 h. p. hours to develop a kilowatt hour, 1.28 k. w. hours per car mile were consumed and the coal consumption was 6.72 lbs. per car mile. These cars also have room for fifty passengers. The compressed air motor cars at Nogent-sur-Marne, carrying fifty passengers required about sixty-six pounds of steam per car mile, which it, is stated, can be generated in the best French boilers with from 4.8 lbs. to 5.5 lbs. of coal.

A New Form of Radiation.

Several weeks ago the scientific world was startled by the announcement of the discovery by Dr. Wilhelm Konrad Röntgen, of Berlin, of what appears to be an entirely new form of light rays—a discovery which, it is believed, will be of the utmost value in helping to solve some of the problems concerning the ether and the vibratory theory of light and heat which have hitherto baffled physicists. A brief description of Dr. Röntgen's experiments as described in his preliminary communication to the Wurtzberg Physical Institute entitled "A New Form of Radiation" will be of interest to engineers, as there are possibilities of important practical applications in engineering processes.

If the current from an induction coil be passed through a Crookes' tube certain light effects will be observed at both positive and negative terminals of the tube. The "cathode rays," so called, emitted from the negative terminal are known to have peculiar properties differing from direct or "incident light" in many respects, and it is believed that these differences are due to peculiarities in the etheric vibration.

The Röntgen "X rays" (apparently so called in advance of further researches which will determine their character so that a more definite name may be applied) are not cathode rays, but are generated at the spot where the cathode rays impinge upon the walls of the Crookes' tube. In Dr. Röntgen's primary experiment he found that these rays would pass through a "somewhat closely fitting mantle of thin black cardboard," covering the Crookes' tube so as to cause fluorescence on a paper screen washed on one side with a fluorescent chemical compound, whether the paper side or the treated side of the screen were turned to the Crookes' tube. This showed at once, of course, that these X rays must have the property of penetrating cardboard and paper—substances hitherto supposed to be opaque.

Experiments were then conducted with other opaque and translucent bodies with the result of proving that these rays actually have the power of penetrating or passing through many such substances where ordinary light is absorbed or reflected, and among the most interesting of Dr. Röntgen's researches are those where photographs have been taken, by means of these X rays, of the contents of closed boxes. The flesh of the hand has proven translucent to X rays, so that the bones can be seen and photographed through the fleshy covering. Platinum .2 m. m. thick is transparent, together with silver and copper plates decidedly thicker. Lead .5 m. m. thick is practically opaque, and, from the results with all the substances experimented upon, Dr. Röntgen concludes that the relative transparency of different substances of the same thickness is dependent upon their relative densities, no other properties being in the least comparable with this.

Dr. Röntgen has not yet proved experimentally that the X rays are able to cause thermal effects, but believes this to be nearly certain. He finds that the X rays cannot be concentrated by lenses, nor can they be refracted to any extent, so far as at present determined. One essential difference between the X rays and the cathode rays is that the latter are deflected by magnetic influence while the former are not.

Dr. Röntgen decides that these X rays cannot be the ultra violet rays of the spectrum, upon which much research has been expended, but he believes that they are due to longitudinal vibrations in the ether, although he announces this as a "suspicion" merely and not as a definite conclusion, since his experiments have not yet been carried to such a point as would warrant him in forming an irrevocable opinion on this point.

As before stated, the announcement of this great discovery has set scientists to work to develop its practical features. There seems to be an almost immediate use of the discovery in medical science. It may be possible, for example, to locate bullets in a person's body, or to study the operation of the internal processes from actual sight or by means of special photographic methods. It has been suggested, also, that the presence of defects in castings and constructive material might be determined by these rays, but no such conclusions are warranted by the experiments so far carried on, since the latter seem to prove that comparatively thin sheets of metal are practically opaque even to the X rays. It is impossible to predict, however, what may be accomplished in the development of this entirely new branch of physical science, and certainly its interest to those studying the purely physical theory of etheric vibration must be exceedingly great.

The Serpollet Steam Motor.

Steam dummies or motor cars have been regarded, on the whole, with much greater favor in Europe for highway lines than in this country, and are at present being employed in many places in which in this country electric power would be used. One of the forms which is attracting considerable attention from European engineers at present and which is in use on several Paris lines, as well as in Hâvre, Tours and elsewhere, is the Serpollet.

The novel features of the motor lie principally in the method of generating the steam and were described in a recent paper read by M. Lesourd before the French Society of Civil Engineers. The boiler tubes are of steel and in place of being cylindrical, as shown in Fig. 1, were originally flattened as in Fig. 2. The later forms of

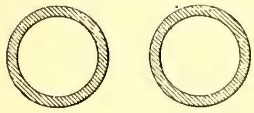


FIG. 1.

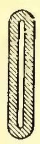


FIG. 2.

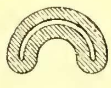


FIG. 3.

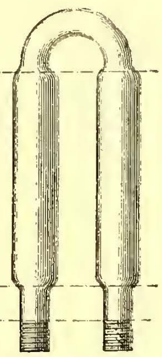


FIG. 4.

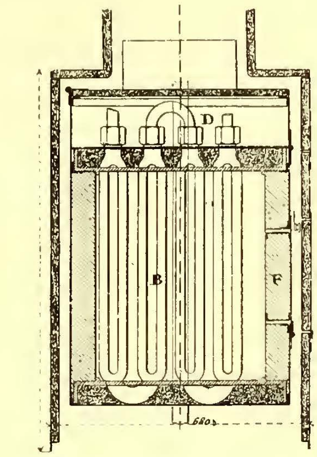


FIG. 5.—CROSS SECTION ON C D.

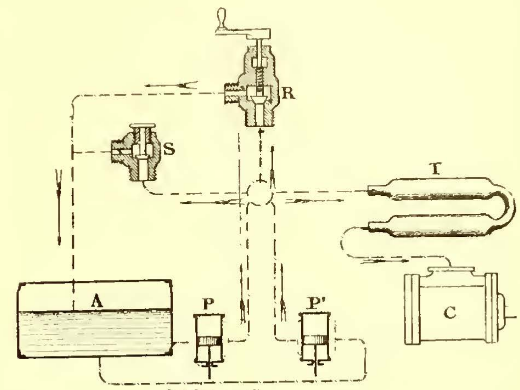


FIG. 7.—DIAGRAM OF CONNECTIONS.

tubes, however, are stamped to present in cross section the form of a U as shown in Fig. 3. At the ends, however, the tubes are circular in section and are connected in pairs as shown in Fig. 4, which constitutes one element of the Serpollet boiler. The space within the tube in which the water and steam circulate is variable between .4 in. and 1.2 ins. according to the position which the tubes occupy in the boiler, the tubes having the largest spaces being naturally those farthest from the point where the water is fed into the boiler. It is easy to see that the form of the tubes presents the maximum resistance possible to deformation as well in one direction as in another.

In tramway work the tubes are of two kinds and arranged in two ways, as shown in Fig. 6, part being horizontal and part vertical.

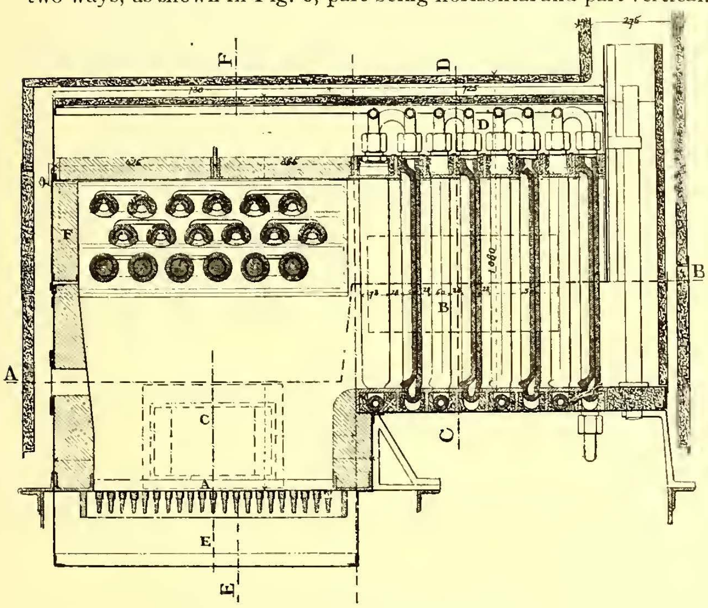


FIG. 6.—LONGITUDINAL SECTION.

The first row above the furnace into which the water is injected are circular in section and horizontal. Above these are U shaped horizontal tubes, and beyond these U shaped vertical tubes. The connections between the elementary steel tubes are made by joints which are always kept out of the action of the heat and are developed in a material which is a non-conductor of heat. The draught is stimulated by means of the exhaust which discharges at the base of the stack, as shown in Fig. 6. The stack is itself surrounded by a false concentric stack which assists to draw air through the double envelope surrounding the boiler and thus diminishes the radiation.

The first application of the Serpollet motor for tramways was made in December, 1893. It was put in operation on the lines of the Paris Tramway Company (Department of the Seine). The engine, which had two cylinders, 5.9 ins. $\times$ 5.9 ins. was carried under one of the platforms and connected to one axle by chain gearing. The car weighed, empty and without steam apparatus, 7700 lbs. All the apparatus necessary for propulsion, including the supply of coal and water, weighed 3300 lbs.; entire car with forty passengers weighed 17,160 lbs.

Coke is used to avoid smoke. The consumption of coke averages about 4.4 lbs. per mile. On the St. Etienne line with a car earrying twenty passengers opeaating on a line 600 yds. long, where there is a constant grade of 3.7 per cent, the consumption of coke averages from 6.5 to 7.1 lbs. per mile. The boiler is usually carried on the front platform.

The method of feeding the injection water is quite ingenious, and is shown in Fig. 7. Upon starting the feedwater is injected into the boiler by a pump, P', which is operated by hand and which pumps directly into the boiler, T. As soon as steam is generated the pump, P, which is operated by an eccentric, feeds into the boiler. This water is always injected in an amount greater than that necessary for the production of steam demanded by the engine. The changes of speed are produced by means of the regulator, R, operated by hand, and which communicates with the reservoir, A. When this cock, R, is completely closed, the water passes into the boiler with the full pressure of injection, and, consequently, the maximum of pressure is secured, as when mounting the steepest grades. When, on the other hand, the plug is raised to a greater or less degree, a part of the water passes back into the reservoir, and only that part goes into the boiler which is required for the work. It thus follows that, by a simple movement of this cock, the entire mechanical regulation of the apparatus is secured.

If a sudden stop is desired it is only necessary to open the cock, R, wide, when not only the injection water from P, but as well all the water and steam in the boiler is emptied into the reservoir, A, reduc-

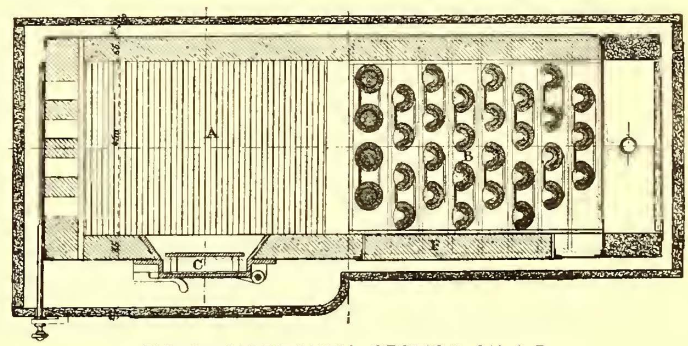


FIG. 8.—HORIZONTAL SECTION ON A B.

ing the pressure on the engine cylinders to zero. This action, accompanied by application of the brakes, makes a stop in the shortest possible time.

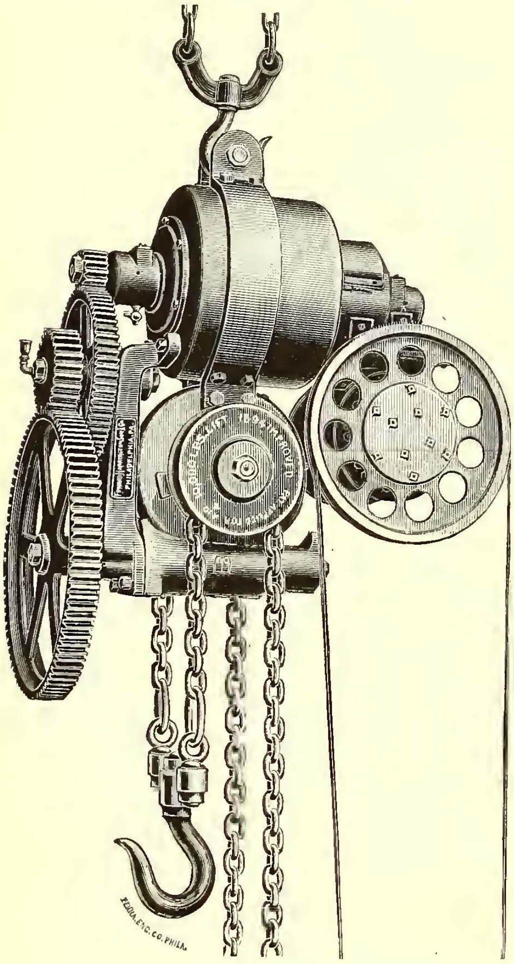
A safety cock, which is automatic and opens at a pressure of forty-four pounds, is provided in S. When the pressure in the boiler exceeds this limit, this cock opens automatically and allows a part of the water to return into the reservoir, A, when the pressure in the boiler is immediately reduced.

An important question in this type of boiler is, of course, the durability and life of the tubes, occasioned by the action of the fire, to which the rows closest to the furnace are particularly subjected. This, it is claimed, is largely in the hands of the motorman, who, by closing his draughts during prolonged stops, can add materially to the life of the tubes.

K. M. DOUGLASS, general manager and purchasing agent of the Schuylkill Valley Traction Company, writes us that his company contemplates extending its lines about fifteen miles this year.

Hoist and Electric Motor Combined.

The combined electric motor and hoist illustrated herewith is manufactured by E. Harrington, Son & Company and promises to find an extensive use in electric railway repair shops. With this combination there is an important saving of time and labor required to lift heavy castings and convey them from one point to another. Ten thousand pounds can be lifted with ease, with a gain of 3 to 1 in labor and 5 to 1 in time; that is, 10,000 lbs. can



ELECTRIC HOIST.

be raised at a maximum speed of 5½ ft. and lowered at the rate of ten feet per minute. Smaller loads can be raised faster.

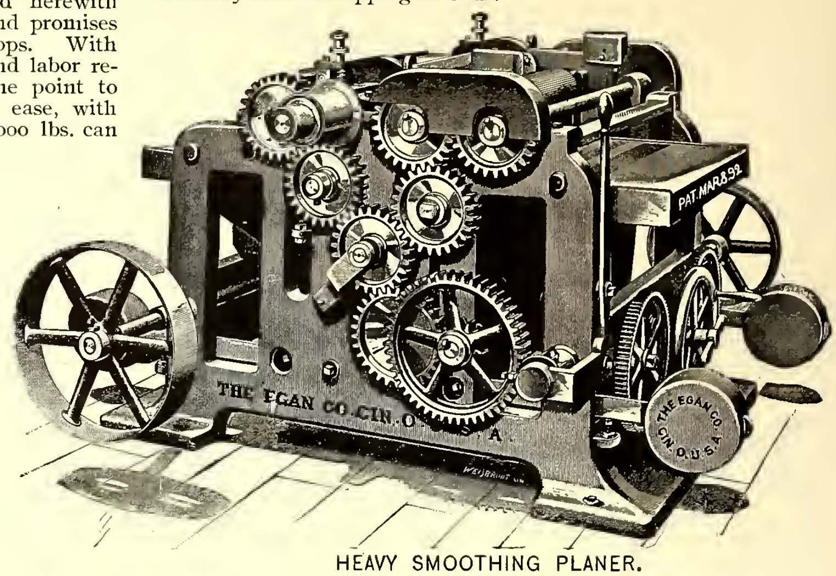
By means of a controller operated by the rope shown at the right in the cut, the operater can vary the speed as he may desire within these limits. By this controller also, the action of the motor is started, reversed or stopped.

The motor shown in the cut is of the Story make. It is compact in form, multipolar, iron clad, and not affected by surrounding machinery. It is entirely enclosed, making it dustproof, fireproof and moistureproof.

Extra Heavy Smoothing Planer.

The desire to produce something better in the way of a hardwood planer than has heretofore been built, has resulted in the introduction by the Egan Company of the machine shown in the accompanying engraving.

The machine is built in four sizes, 24 ins., 25 ins., 26 ins. and 30 ins. wide. The frame is cored and substantially braced, making it very stiff and suitable for a machine of this class. The table is dovetailed in the frame and raises and lowers on very long inclines by means of two screws operated by a hand wheel convenient to the operator. This means of adjusting the bed is claimed to be the best, as it makes it solid and free from vibration, and gives it support beneath. The feed is four powerfully geared rolls of large diameter, the upper front fluted roll being geared at both ends so as to give a parallel lift to the roll, and thereby allow two strips of any kind of stock to be fed through the machine and making it impossible for them to lift out of gear when making a heavy cut. The rolls are weighted on an improved principle, the weights being adjustable to give more or less pressure, as desired. There are two speeds to the feed, and the machine, it is claimed, will do smoother work at its fastest feed than has heretofore been attained on any smoothing planer at a much slower speed. The cylinder is four sided, so as to use either two or four knives as may be desired, is double belted and the feed is run directly from it. There are pressure bars on each side of the cylinder arranged on a new principle and working to the circle of the head, thereby preventing all tearing out of wavy grained or knotty stuff or clipping of ends.

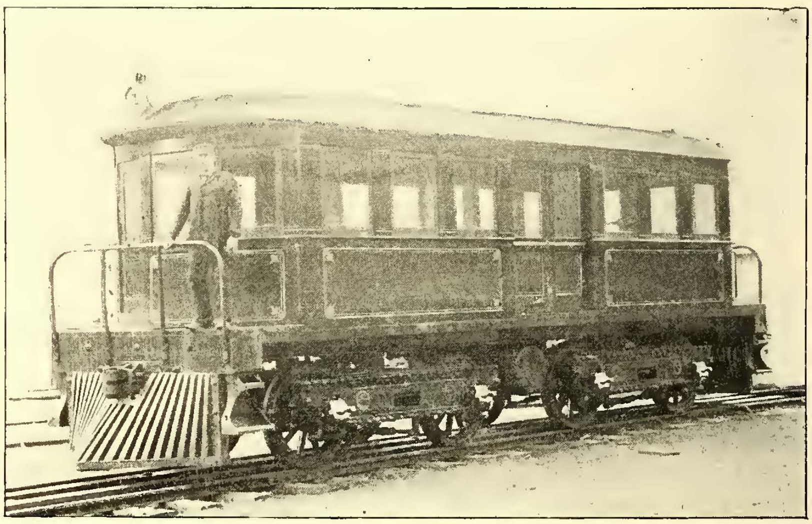


HEAVY SMOOTHING PLANER.

One of the greatest advantages of this machine, especially in the wide sizes, is that the stock can be run diagonally under the cylinder. This, it is claimed, is better than running a cylinder in a diagonal position, as it permits the use of straight belts.

Electric Locomotive.

The Westinghouse Electric & Manufacturing Company has re-



NEW ELECTRIC LOCOMOTIVE.

ceived the first electric locomotive manufactured under the arrangement entered into some time ago with the Baldwin Locomotive Works. In appearance the locomotive is much different from the steam locomotive, and it also shows radical departures in construction from every electric locomotive hitherto manufactured. It is thirty-eight feet long and nine feet across. All the operating parts of the locomotive have been placed on the truck and the body of the car will only contain the controlling apparatus, and can be utilized as a receptacle for such appliances as are usually carried by any train. It may also be used as a freight or baggage car.

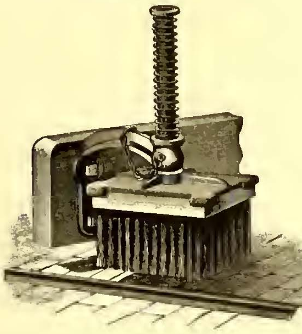
One of the characteristic features of the locomotive is the truck, which has eight wheels and is constructed in a very substantial manner. The wheels are forty-two inches in diameter. There will be four motors of 200 h. p. each connected to the axles of the locomotives. Thus the entire weight of the locomotive will be placed upon the truck, thereby becoming available for adhesion.

The locomotive completely equipped will weigh 160,000 lbs. The motors will be geared, which method has been decided upon so as to enable the company to use more efficient and durable motors and also greatly reduce the cost of the locomotive. The motors have been geared to produce a speed of seventy-five miles an hour, although it may reach 125 miles an hour, if it were demanded.

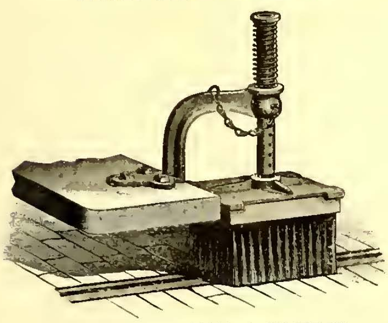
Other locomotives are being built. All will be equipped with air brakes, which will be operated in the usual manner by an air pump which is underneath the car, and which will be driven by an electric motor. The locomotives will be designed so as to be utilized with any method of electric traction. They can be used with the trolley system, the third rail system, the electro-magnetic system or with the Tesla polyphase system.

Adjustable Track Brush Holder.

A track brush is a valuable adjunct to the usual equipment on street railway cars for removing snow and dirt from the rail, and in some cases is the only means employed to do this work. In the adjustable track brush holder shown herewith and supplied by the



TRACK BRUSH RAISED.



TRACK BRUSH LOWERED.

Ohio Brass Company, the manufacturers have a new and simple device for this service. It is so easily handled that the motorman can offer no excuse for allowing the track broom to remain in service longer than is absolutely necessary, which of course results in a large saving in the wear of the steel wires, or not using them when necessity demands it. Views of the holder are given on this page. It is adapted for V shaped, upright, flat guard boards.

An important feature of the track brush holder is that the coiled spring is always in compression. If the cotter pin be removed from the pipe standard through any means, the spring will lift the track broom clear of the rail and entirely out of the way of danger. The broom in this case simply fails to perform its work, and this, it is thought, is superior to the forms of holders in which any slight trouble with the working parts results in the track broom being thrown down on the rail. Another point claimed for the holder is the wide range and, at the same time, the nicety of adjustment which can be given to the track broom. The holes which are drilled in the pipe standard are set closely together, allowing the broom to be set so that the wires will merely touch lightly the top of the rail or bear down upon it the full limit of their elasticity.

The steel wire track brooms manufactured by the Ohio Brass Company have gained a very considerable reputation on account of their lasting qualities. This is due to their being made with a carefully selected quality of steel wire, which is of great elasticity, but of sufficient stiffness to meet the necessary requirements. These wires are securely seated in a heavy hard wood block which makes a strong and substantial brush for the severest kind of service.

A NEW fender for cable and electric cars has been brought out by Rafael Mayolini, of New York City. The object of the inventor has been to provide a fender which could be readily transferred from end to end of the car, and which is so constructed in two spring sections that these may be curved, brought together and locked, so as to completely guard the front of the car. As at present constructed, the fender extends from one side of the dashboard of the car dash around the bumper to the other side of the dash, in the form of a bow. It is of either sheet steel or very tough wood, the latter beingpreferable on account of its lightness, but either one being sufficiently flexible to provide a yielding surface in front of the car. The surface of the fender extends from side to side of the car, at a distance of about twenty-four inches in front of the center of the dash, and stands about 4½ ft. high. It is easily transferred from one end of the car to the other, by simply unlocking it at the center and lifting each half from the steel fastenings provided for it at the side of the dash.

Car for Transporting Cables.

E. P. Frederick, superintendent of the Broderick & Bascom Rope Company, presented in a recent issue of the *Engineering Record* some particulars of a truck which has given the best results of any method employed by that company for transporting cables in city streets.

It has been in use for about four years, and during that time has been improved and special appliances added to facilitate handling and minimize labor and time as experience has dictated. A most

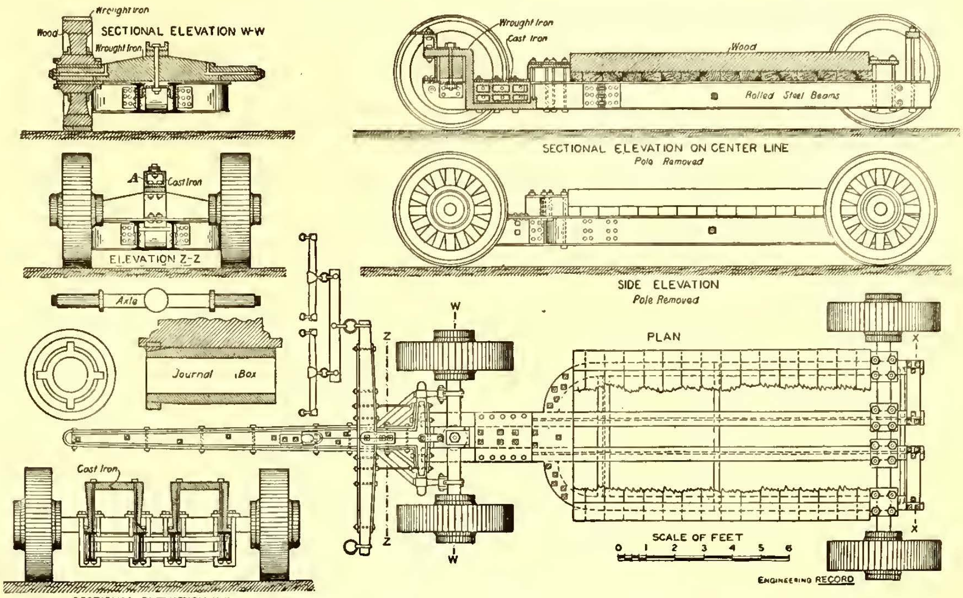


FIG. 1.—CAR FOR TRANSPORTING CABLES.

notable improvement to the wagon has been that of a frame to carry two thirty-two ton hydraulic jacks ready at any moment and under every condition to be put in position by means of levers, and at once be started to work to lift the wagon from any hole or soft spot in the street in a very few minutes. A reference to Fig. 3, which is a rear view of the wagon, will clearly show the manner of working the jacks.

The length of wagon between axles is fifteen feet, the front

FIG. 2.—SIDE VIEW OF CABLE TRANSPORTATION CAR.

axle journal being five inches diameter, and that of the rear axle six inches. The journal part of the axle has one inch diameter holes, bored back beyond the collar, making them self-oiling, as enough oil is stored in the oil chamber at the time of starting to last the entire trip. At no time have the journals or boxes become heated. The wheels are wooden, fifty inches in diameter, with a twelve inch tire, one inch thick. In addition to the regular felloe, there is an auxiliary one, so that in case the tire should become loose it would be unnecessary to recut the tire and reweld it. All that would be necessary would be to take off the auxiliary felloe and put on a new one of increased diameter, to fit that of the loose tire. The original boxes were of cast iron, three-quarters of an inch thick, and were found to be too light, becoming loose and breaking with the first heavy load. They were replaced with boxes one and three-quarters inches thick, and pressed into the hubs under a pressure of twenty-five tons, and covered with white lead and canvas ducking at the time of being pressed into their places. Since then they have given no trouble, being apparently as solid as if they were a part of the wheel itself. The holes in the boxes are bored to equal diameter clear through, there being no taper, either in boxes or axles, and while it may be disputed by authorities, it is Mr. Frederick's opinion that to this fact is due, in a great measure, its light draft and remarkable easy running qualities. The fact is that the only trouble to contend with in hauling a cable is to stop it at the point desired, it being necessary to use considerable judgment to gauge the distance the wagon will run of its own momentum, after the signal to stop has been given. The entire height of the wagon from the ground is twenty-five inches. The rear part of the I beams is bolted to the lower part of the rear axles, and held in position by U bolts, as shown in the engraving. The two central I beams run to and underneath the front axle, extending beyond sufficiently to allow a heavy rectangular piece of wrought iron, A, three inches thick by nine inches wide, to straddle the axle and rest on the top. This is secured firmly to the central I beams on both sides of the axle, thus allowing the whole weight to rest upon the top of the axle, instead of being suspended from the axle, as is usual with low wagons. The tongue is of the usual style, strongly made and heavily banded on all sides, throughout its entire length, with iron.

The arrangements for attaching horses are such that, no matter how heavy the load or the number of horses, the direct strain on the

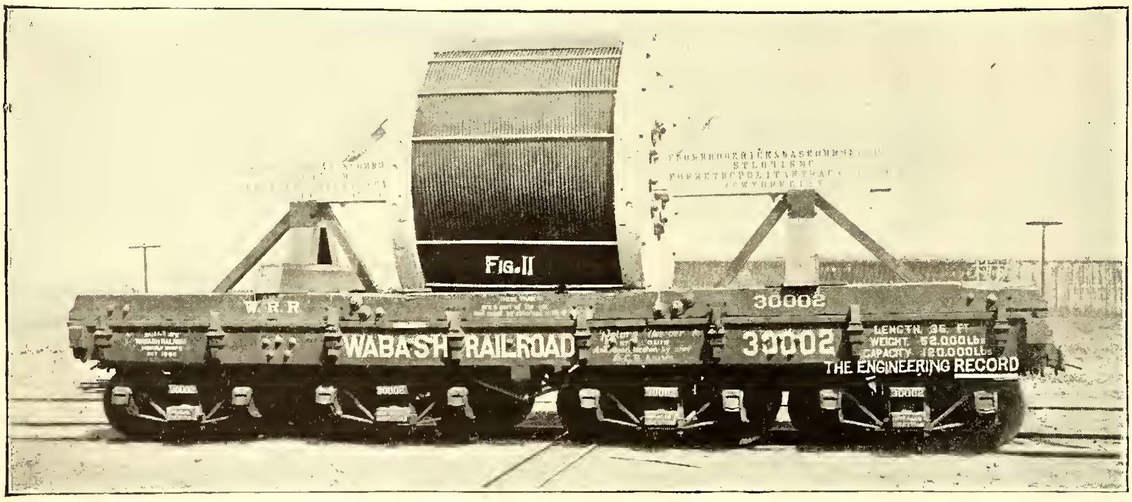


FIG. 4.—RAILROAD CABLE TRANSPORTATION CAR.

tongue is never greater than would be exerted by eight horses. When attaching the horses, the method of procedure is to use sections of wire ropes, thirteen feet long, of varying sizes, attached together with shackles suited to the size of the ropes. The first,

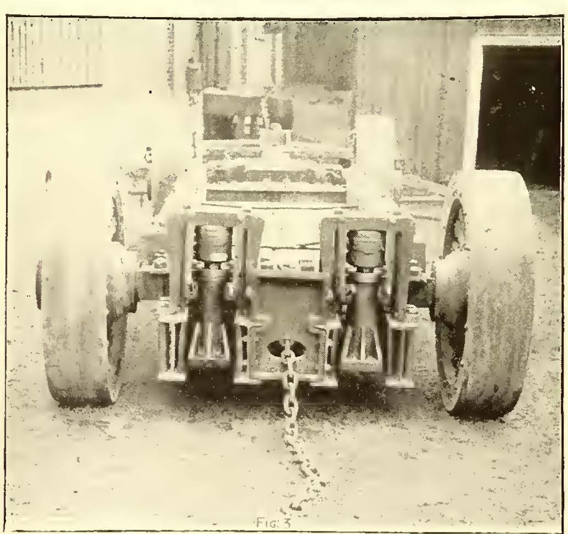


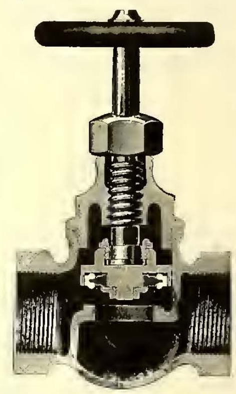
FIG. 3.—END VIEW OF CAR.

or tongue rope, is attached directly to the central I beam, and running under and beyond the tongue. This rope is one and five-sixteenths inches diameter, and is then attached to a one and a quarter inch diameter rope which is in turn attached to one a size smaller; this is continued until it reaches three-quarters of an inch diameter. Where there are forty to fifty horses, this is of considerable importance, as it lightens the load on the horses to a very large extent, and enables them to exert a greater force on the load. On the first heavy cable handled, a very heavy chain was used, but was soon discarded, on account of its cumbrous weight and liability to breaking, which was a frequent occurrence, and was displaced by the much stronger, lighter and easily handled wire ropes. At each thirteen foot section of wire rope there is a foretree or piece of hickory timber, of sufficient length and strength so as to attach two sets of double trees, in which are placed four horses, thus making the string of horses four deep throughout the entire length. The capacity of the wagon is 160,000 lbs. and its weight is 13,500 lbs. When empty it is easily handled by four horses on level streets.

Fig. 4 illustrates a car built by the Broderick & Bascom Rope Company for the Wabash Railroad for transporting cables. The car has a capacity of 150,000 lbs. The number of wheels is sixteen, on four trucks, the length of car thirty-four feet, and it has heretofore carried for the Broderick & Bascom Rope Company two spools of cable for Cleveland, O., weighing 140,000 lbs. To prevent too much deflection on account of the extremely heavy weight in the center of the car, a 12 in $\times$ 12 in. timber was placed through the center of the spool. This was used as a principal for a truss and was built up in that manner, extending beyond the spool so as to rest on the center of the trucks, bringing the weight to bear on four different points of the car, making an equal distribution of the load. The amount of deflection in the center of the car on the timbers was less than ⅝ in., the amount of compression on car springs being 1¼ in.

A New Improvement Upon Old Valves.

Renewable disk valves are not popular with all engineers, but the trouble has been perhaps with the disks and not with the principle. The valves have the advantage that they can be repaired at a nominal ex-



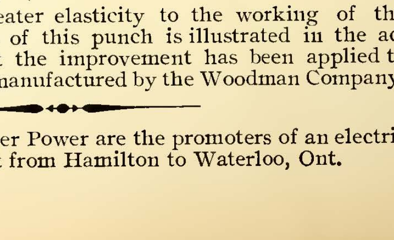
SECTION OF DISK VALVE.

pense, and will last longer than the ordinary valve. The material of which the disk is made is an important point. Valve bonnets must of necessity be screwed on tight. Taking off and replacing the bonnet time and again stretches the metal, and before long the threads around the bonnet begin to leak badly.

The Crane Company which has had long experience in valve manufacture has experimented in the use of some metallic composition for the disk. These experiments have been carried on for some three years with such satisfactory results that a year ago the valves were placed on the market. The bonnets of the valves are made very heavy, the seats wide and strong and there is provision for repacking the stuffing boxes while the steam is on the line. The renewable metal disks have proved satisfactory, lasting much longer than any vulcanized rubber disk tried.

New Ticket Punch.

The R. Woodman Manufacturing & Supply Company has recently brought out a new style of transfer ticket punch which promises to meet with general adoption. The Woodman ticket punch is most favorably regarded by the trade and over 3000 are in use on the West End Railway of Boston. It has also been adopted by the Detroit Citizens' Street Railway Company, the different lines in Baltimore and by other companies in other cities.



NEW TICKET PUNCH.

The improvement lies mainly in the use of an elliptic spring in place of a circular spring giving greater elasticity to the working of the device. One of the forms of this punch is illustrated in the accompanying engraving, but the improvement has been applied to the various styles and sizes manufactured by the Woodman Company.

DR. BURNS and Engineer Power are the promoters of an electric railway proposed to be built from Hamilton to Waterloo, Ont.

The Fitchburg Engine.

The Fitchburg Steam Engine Company has long enjoyed the name of being independent in the design and development of its engines, bound by no tradition simply because it was old, rejecting nothing simply because it was new and different from others.

The design of the main bed is unusually heavy and stiff, the metal being carefully disposed to resist all strains, the crosshead and connecting rod ends originally patented by the company have been extensively copied by leading builders. The guides bored concentrically with center of cylinder, first done by the company twenty-five years ago, are now quite generally used. The piston valve and many other devices have also been largely copied. In the valve motion, the company stands alone. This device, of which cut is shown, drives piston valves, mention of which has heretofore been made, but of special and patented design. The valves have no loose packing rings, to unequally wear the seats and to get leaky, but are in this respect the same as solid valves. Though taut they are expansible their whole length and can be kept steamtight by an hour's attention of the engineer once a year and are guaranteed for twenty years in this respect.

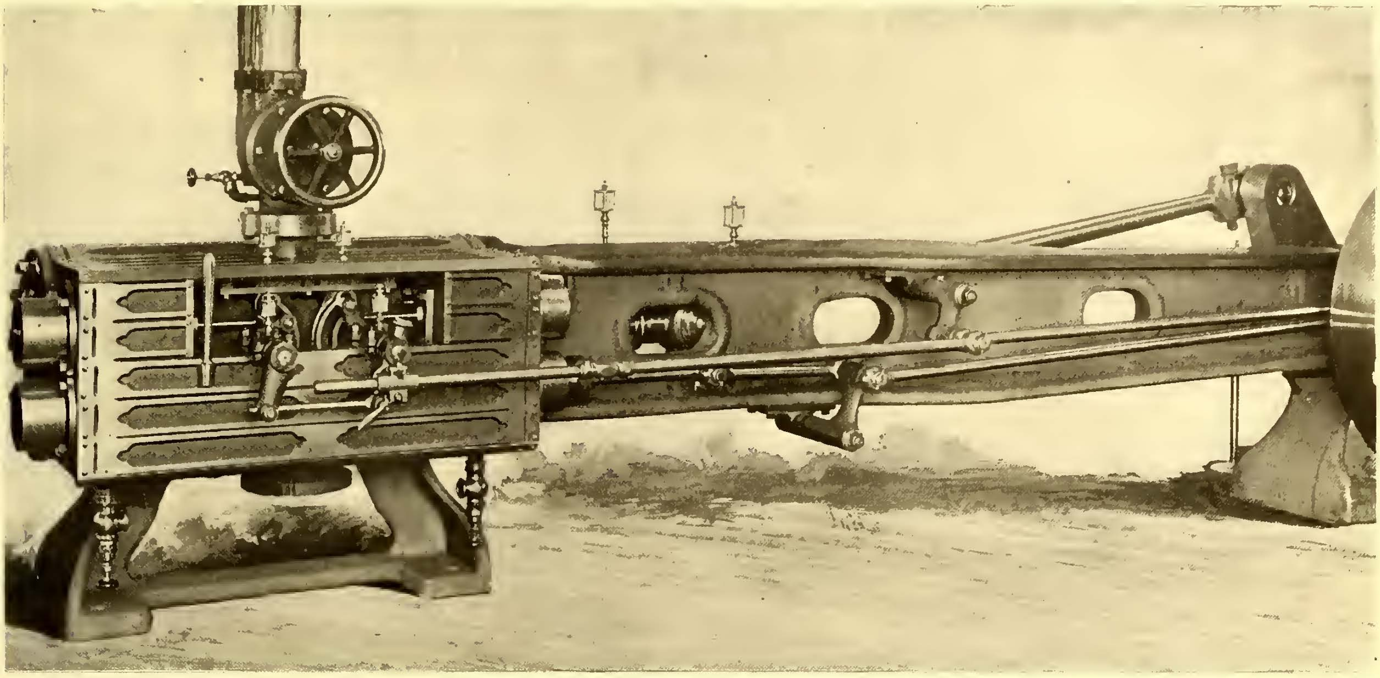
They are also double ported, giving twice the usual admission of steam with a given opening, and as they are brought close to the bore of the cylinder the clearance is reduced to a minimum. The steam valves are connected by short rods of small diameter directly to cams outside the stuffing boxes. These cams are moved by hardened steel rollers upon steel pins in cranks so keyed upon thin actuating shafts with relation to the cranks driven by the eccentric, as to get the Corliss wrist plate action in opening the valves. The crank moving the valve has its longest leverage while the actuating crank has its shortest, giving twice the quickness and extent of opening that the usual direct connection would give. The path in the cam is so made that for more than half the travel of its actuating pin and roller, it receives no movement. It is then started very softly, increasing easily until the lap of the valve has been traversed and its edge has reached the edge of the port. It is then suddenly thrown open, giving full port area, and is as suddenly closed for cut-off of steam, traveling only as far as the lap and width of port. It then remains quiet during the remainder of the engine's revolution while the opposite valve is being moved in its turn.

The work of moving the valves is practically nothing as they are perfectly balanced and their motion is so small the governor has no duty except to regulate the speed of engine. There are no dash pots, and the governor has to move but a very short distance to make a difference from three-fourths cut-off to no admission of steam. The control is therefore absolute. The engines are guaranteed to control within 1½ p. c. under a change of load from 5 p. c. of rating to 20 p. c. beyond rating, whether thrown on or off, and no matter how abruptly. The engine is especially adapted for rolling mill and electric railway work because of this absolute control and of the great strength of the special engines which are put in for such work.

This cam valve motion makes it possible for the governor to respond instantly and at any speed, slow or fast.

It can be run from 200 revolutions down to sixty. The exhaust valves are moved directly by a separate eccentric and are adjustable independently to any degree of exhaust.

Any power from 1000 h. p. down, compound condensing or otherwise, can be furnished by the manufactures.



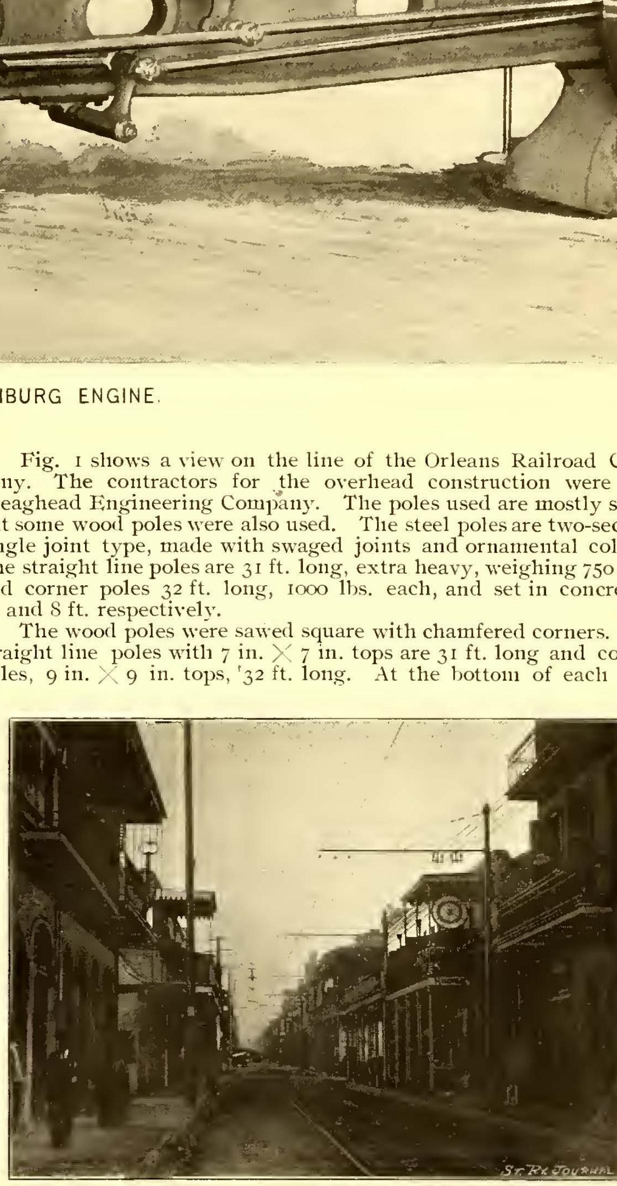
VALVE GEAR OF FITCHBURG ENGINE.

Overhead Construction in New Orleans.

The accompanying engravings show views of some recent overhead construction in New Orleans. The peculiar local conditions in this city arising from the surface level being lower than the Mississippi River produce a subsoil thoroughly saturated with water. The dry surface soil is only about two or three feet deep, and after digging through this water is reached in quantities.

Fig. 1 shows a view on the line of the Orleans Railroad Company. The contractors for the overhead construction were the Creaghead Engineering Company. The poles used are mostly steel, but some wood poles were also used. The steel poles are two-section single joint type, made with swaged joints and ornamental collars. The straight line poles are 31 ft. long, extra heavy, weighing 750 lbs., and corner poles 32 ft. long, 1000 lbs. each, and set in concrete 7 ft. and 8 ft. respectively.

The wood poles were sawed square with chamfered corners. The straight line poles with 7 in. × 7 in. tops are 31 ft. long and corner poles, 9 in. × 9 in. tops, 32 ft. long. At the bottom of each pole hole was placed a large cypress block, 3 ins. thick, onto which the pole was set. After pumping out the water from the hole, the concrete, made of sharp sand, broken stone and imported cement, was put in in courses and thoroughly tamped with heavy bars.



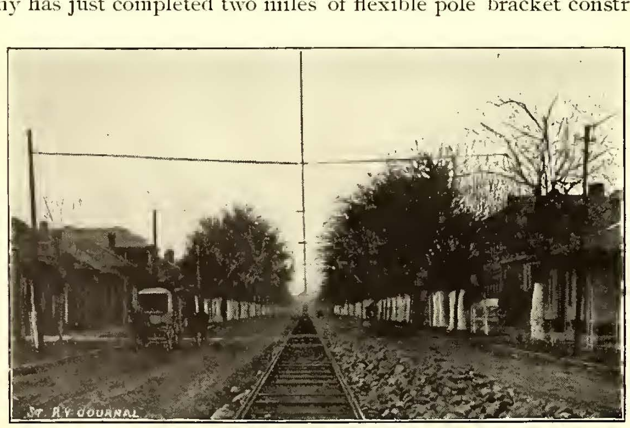
BOURBON STREET, NEW ORLEANS.

By referring to the illustrations, numerous sheds and balconies will be noticed. These balconies, especially the "double-deckers," seriously obstructed the work of erecting heavy poles. It was necessary in a great many cases to cut through these balconies to secure the proper location of poles.

On the Orleans Railroad the specifications required double insulation throughout. In the span wire construction on iron poles, a pole clamp and insulated turnbuckle was attached to each pole for the support and adjustment of the span wire. At feeder spans a double insulated turnbuckle was used at each end. This feeder span was a heavy insulated steel cable soldered to the feeder wire at one end and to a solid bronze ball in the center of the span. This bronze ball is made the same shape as the line insulators and connects to trolley ear by heavy stud bolt, thus completing feeder connection with the trolley wire. On the wood pole construction, a galvanized eye bolt with a Bourbon No. 2 strain insulator is used on each pole to support the feeder span wire. The road is divided into sections by means of section insulators and a system of feeders reaches each division.

The system is protected throughout by means of Wurts lightning arresters, and there was no difficulty in securing a wet ground connection for them in New Orleans soil.

It is interesting to note that the St. Charles Street Railway Company has just completed two miles of flexible pole bracket construction on its lines. The brackets are of the Creaghead flexible type 13⅓ ft. long. The feeders are supported from this bracket by means of feeder hangers which are attached to the brackets. Each hanger is double for the support of two feeder lines.

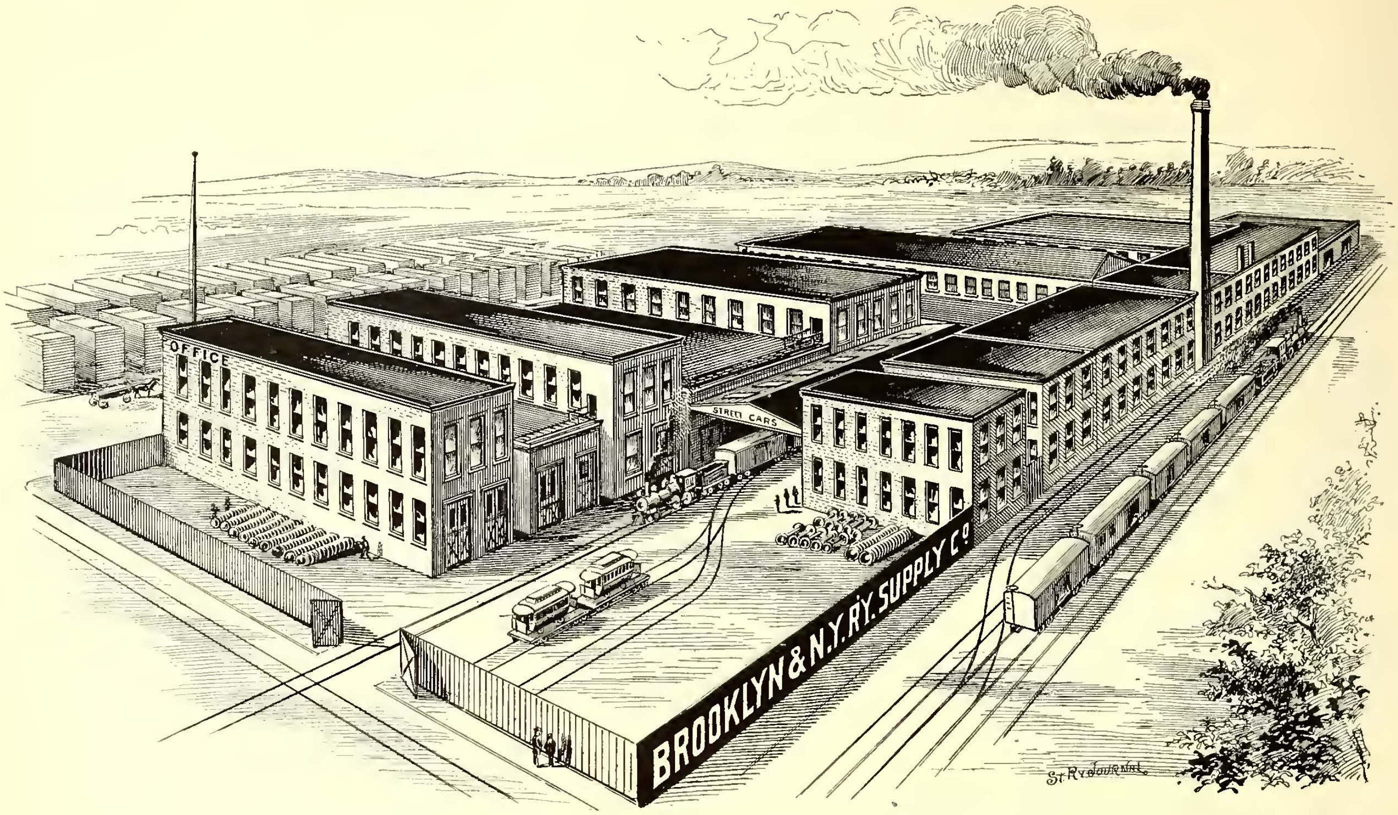


URSULINES STREET, NEW ORLEANS.

THOMAS F. RYAN, of the Metropolitan Traction Company, of New York, Samuel Thomas, Henry H. Rogers, Charles R. Flint and G. B. M. Harvey are at the head of an enterprise which is to form a continuous electric railway system from St. George, S. I., to Point Pleasant, N. J. New lines will be built to connect existing roads. Among the companies whose tracks will be used are the Staten Island Electric Railroad Company, the Consolidated Traction Company, of Jersey City, and the Atlantic Coast Railway Company, of Asbury Park.

The Works of the Brooklyn & New York Railway Supply Company.

Announcement was made in our January issue of the organization of a new company, the Brooklyn & New York Railway Supply Company, for the manufacture of street railway cars, trimmings, supply parts, etc. As will be remembered, the new company has been formed by uniting the business of James A. Trimble, of New York, and that of the Lewis & Fowler Manufacturing Company, late of Brooklyn, N. Y. The company has recently secured at Elizabeth, N. J., the extensive car shops originally built for the J. W. Fowler Car Company. The office of the company is already fully established at Elizabeth, but manufacture is being carried on at the former works of Mr. Trimble, at East Twenty-eighth Street, New York, and at the Lewis & Fowler works, Brooklyn. The machinery is being moved to Elizabeth as rapidly as possible, and the company expects soon to be able to do all manufacturing at its Elizabeth factory.



THE WORKS OF THE BROOKLYN & NEW YORK RAILWAY SUPPLY CO.

The facilities here for the receipt of supplies and distribution of manufactured products are of the best, as the works are close to the main Western trunk lines, and a branch extends into the factory. It has a large supply of air seasoned lumber on hand, and with the long experience in car construction enjoyed by the managers a prosperous future seems opening to the company.

The factory, which is shown in the accompanying engraving, is entirely of brick and comprises eleven distinct buildings, with a total floor space of 100,000 sq. ft. The buildings are arranged somewhat in the form of the letter U and there is a covered passageway between the two wings, as shown. Here the completed cars are loaded on to flats by block and tackle and carried away by rail.

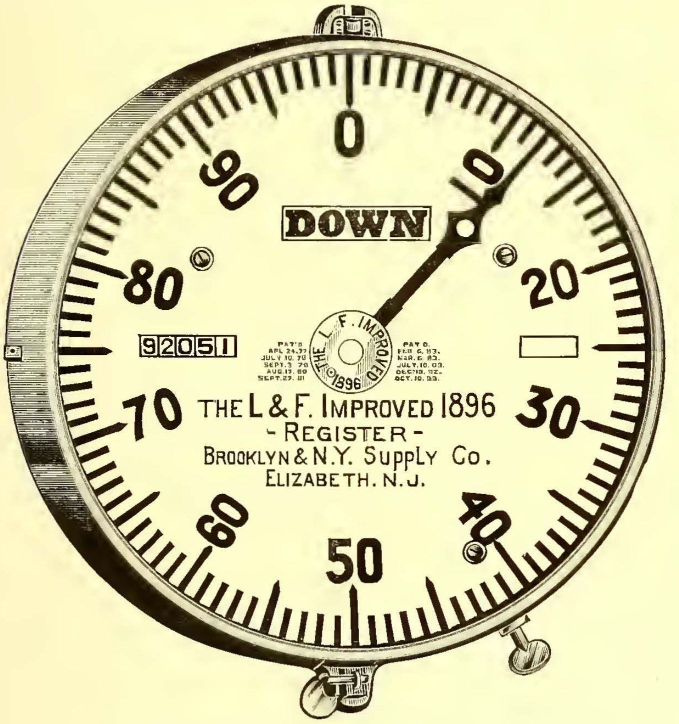
The arrangement of the works is such that the movement of the material used in the construction of the cars is constantly in one direction. The fuel and lumber are taken in at the northwestern end of the building, shown in the engraving at the extreme right hand corner. Here are two kiln dry rooms with concrete floors, having a total capacity of 60,000 ft. of lumber each. The process of drying and seasoning is aided by a draft of hot air supplied by a Sturtevant blower fan which keeps a continuous current of hot air passing through the rooms.

Next to the lumber room is the mill room and cabinet shop, and adjoining these the body shop and brass foundry. Adjoining the brass foundry on one side of the passageway is the machine shop and next to this the blacksmith's shop. On the other side of the covered passageway from these shops are the trimming shops, paint shop, varnish shop, finishing house and pit house.

An extensive part of the new work of the company will be the manufacture of registers. The company owns the old patents of the Lewis & Fowler Manufacturing Company, and will manufacture the L. & F. improved register here. This register is in use on some 700 different roads and is so well known as to require no extended description at this time. The Brooklyn & New York Railway Supply Company will maintain the high standard in construction which has always been a characteristic of this register, together with the other features which have given it a well earned eminence. In the 1896 style the register is arranged to totalize to 100,000, making it absolutely impossible for a conductor to ring it around. The totalizer has also been changed in form somewhat and is shown now by numerals. The small totalizing dial which was formerly used has been abandoned. The new style of totalizer can be added to old machines if desired.

The personnel of the Brooklyn & New York Railway Supply Company is a strong one and includes the following well known names: President, J. A. Trimble; secretary W. L. Brownell; treasurer, C. L. Cannnan, Jr.; manager of track and foundry department, W. C. Wood; special sales agent, Frank A. Morrell.

These gentlemen need no introduction to the trade, as all are veterans in the manufacture of street railway supplies. It is the

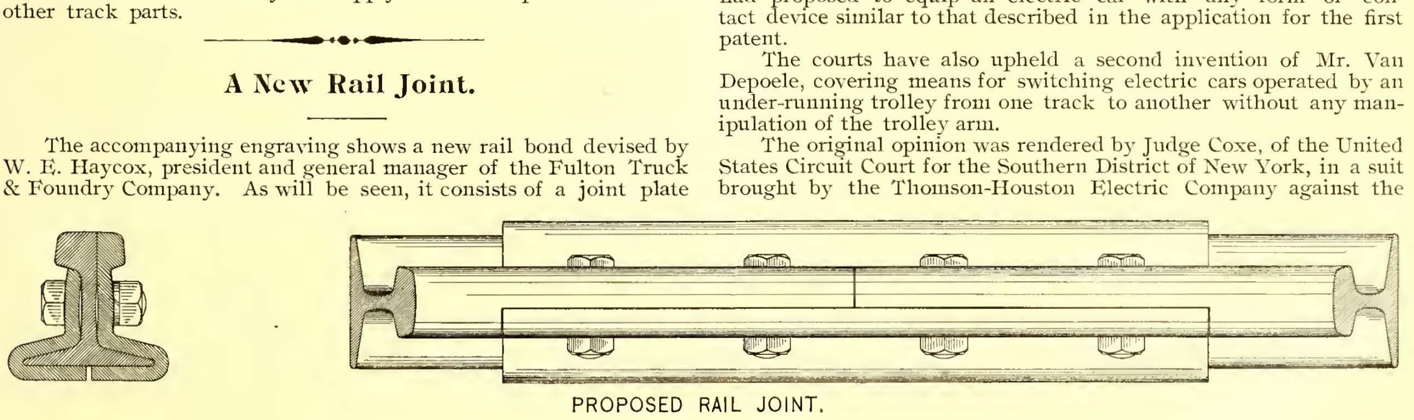


THE L. & F. 1896 IMPROVED REGISTER.

intention of the company to continue at its works at Elizabeth the extensive business in car trimmings which has been enjoyed by the two establishments united in this company, and to furnish all the different wood and metal parts needed in car repairs. In the department of new cars the works will have a capacity of some 1500 cars per year and all work will be done under the personal supervision of Mr. Trimble, which is a guarantee of the best possible construction. Mr. Trimble has been before the street railway public for many years as a practical car builder and the cars of his make have achieved an excellent reputation for durability and good workmanship. A large supply of timber will be kept on land owned by the company adjoining the works, and this will insure the supply of perfectly seasoned wood. The department of track construction has not yet been fully organized, but it is expected that the company will soon be able to announce that it is ready to supply cast steel special work and other track parts.

A New Rail Joint.

The accompanying engraving shows a new rail bond devised by W. E. Haycox, president and general manager of the Fulton Truck & Foundry Company. As will be seen, it consists of a joint plate



PROPOSED RAIL JOINT.

which requires the milling out of the head of the rail on the outside for a distance of nine inches on either side of the joint. The wearing surface here is furnished by the end of the joint plate which is brought up flush with the top of the rail. A wheel passing over the joint cannot cause the hammer blow as it travels on the joint plate when crossing the joint. In no place is there a complete break in the rail.

Recent Orders for Trucks.

It is substantial evidence of the success of the Peckham "Extra Long" extension trucks that they should have been adopted as standard on so many of the great street railway systems of the East, and the large order for 400 trucks just given by the Union Traction Company, of Philadelphia, has been particularly pleasing to the company, because it was placed only after a most severe and thorough trial of the 639 trucks previously ordered by the People's Traction Company, which is now consolidated with the Union Traction Company. The books of the People's Traction Company, when examined by the new management, are said to have shown a remarkably low depreciation account, and the easy riding qualities of the truck are so pronounced that the judgment of the new officers was in favor of the extension contract above noted, which was given on Feb. 7.

The Steinway Railway Company, of Long Island City, has also found the Peckham "Extra Long" trucks satisfactory, as is proven by an order placed on Feb. 21 for one hundred additional trucks. The original trucks ordered by this company, one hundred in number, have now been in service for over a year, and President McCabe bears testimony to their excellent qualities.

Among other orders recently received by the New England office are a fourth order from the Lynn & Boston Railroad Company, a fourth order from the Braintree & Weymouth Street Railway Company, second orders from the Gloucester Street Railway Company, the Gloucester, Essex & Beverly Street Railway Company, the Athol & Orange Street Railway Company and the Greenfield & Turners' Falls Street Railway Company; and original orders from the Ashville, Hopkinton & Framingham Street Railway Company and the Hingham Street Railway Company.

The New York office has received an extension order for 100 trucks from the Baltimore City Passenger Railway Company and others.

Altogether over 4000 of the Peckham "Extra Long" trucks are in use on large electric and cable roads in New York City, Brooklyn, Jersey City, Long Island City, Staten Island, Boston, Philadelphia, Baltimore, Washington, Richmond and San Francisco.

There have recently been some changes in the personnel of the Peckham Company. W. H. Wilkinson, who has been for some years in charge of the Kingston factory has retired, and W. E. Cooke, who has been for a long while the company's chief engineer has been made its general manager, with headquarters at Kingston. Mr. Cooke will have immediate charge of the factory and of the general business of the company under Mr. Peckham's direction.

Recent Electric Railway Patent Litigation.

Several recent decisions by the courts in patent litigation are of general interest to street railway managers, inasmuch as a number of patents which seem to be fundamental in character have been sustained and the decision of the lower courts confirmed on appeal. The most important patent which has been passed upon for many years is patent No. 495,443, originally issued on Apr. 11, 1893, to Chas. J. Van Depoele, and now owned by the General Electric Company. The owners claim that it covers broadly the under-running trolley, as distinguished from the original form of trolley, which consisted of a small truck running on the top of the wires. The suit for infringement of this patent, instituted against a company in Connecticut, was vigorously contested, and has resulted in a victory for the patent in the United States Circuit Court, for the District of Connecticut. The court held that the device is of great utility in the art of electric railroading and that it has superseded every other known apparatus. The experts for the defendant admit that they do not know that anyone other than Van Depoele, prior to September, 1885, when he put the apparatus into practical operation, had proposed to equip an electric car with any form of contact device similar to that described in the application for the first patent.

The courts have also upheld a second invention of Mr. Van Depoele, covering means for switching electric cars operated by an under-running trolley from one track to another without any manipulation of the trolley arm.

The original opinion was rendered by Judge Coxe, of the United States Circuit Court for the Southern District of New York, in a suit brought by the Thomson-Houston Electric Company against the Elmira & Horseheads Railway Company, of Elmira, N. Y. An appeal was taken by the defendant to the Circuit Court of Appeals, and the latter has filed an opinion sustaining a number of claims of the most important character. After this latter decision, the defendant applied to the Supreme Court of the United States, for a writ of certiorari, which has been denied, and a final injunction has been issued.

STREET · RAILWAY · NEWS

San Francisco Notes.

The Market Street Railway Company began running its Second Street electric line from Folsom to Market Feb. 3, transferring at Folsom to the new Bryant-Braunan Street line. Feb. 6 the "Hollis franchise" electric line was started, completing the crosstown line, via Fillmore Street, from the bay shore near the Golden Gate to the bay shore near the Union Iron Works—a distance of 5½ miles. Feb. 14 the Oak Street double track cable road, changed to a single track electric line, was operated for the first time, and the cars, instead of climbing a 12 p. c. grade, begin climbing a 5 p. c. grade and then a series of ½ and 1 p. c. grades, returning down the 12 p. c. grade.

The Sutro road opened on Feb. 1 as scheduled. It is generally conceded that there is room for such a road in the territory traversed, and its business has been excellent from the start.

When the Metropolitan Railway Company was absorbed into the Market Street Company its lines were remodeled to suit the lines already in the combination. Some of the streets containing the steepest grades were abandoned altogether, as was a portion at the outer end. The result of this action was a suit by the property owners, Jan. 22, to have the whole Metropolitan Company's franchise forfeited on the ground that the stipulation that cars should be run at least once every fifteen minutes the full length of the line had been violated. The railway company's answer to this move was an application to the Board of Supervisors for a new franchise over such portions of the old Metropolitan Company's routes as it has found it profitable to operate.

In San Francisco all lines lead to the "Ferry" landing at the foot of Market Street. Realizing this the local postmaster has begun a campaign for the distribution of all mail from the ferry landing by mail cars. A promise has already been secured from the Harbor Commissioners for the necessary room in the new Union depot at the ferry. Permission from the authorities at Washington and the co-operation of the street railway companies have yet to be obtained, but the postmaster confidently expects to gain them both soou and go ahead with his plans.

California is famed for her balmy climate where street railway men have no thunderstorms in summer nor snow and ice in winter to contend with. "There are others," however, besides lightning and snow. The topography of San Francisco includes many steep hills and down their sides rush destructive torrents of water during the heavy rainstorms that occur occasionally in the winter. This water carries down large quantities of detritus that quickly cover the rails in low places. While the downpour lasts the most that can be done is to divert the stream by bags of sand which are dumped at proper points by the employes. When the rain stops, shovels and horse scrapers quickly clear the way.

An opportunity for comparing the vulnerability and flexibility of the cable and trolley systems was afforded during the storm of Jan. 17. During the hour of heaviest rainfall, important cable roads aggregating over seven miles in length of double track were temporaily stopped on account of an overflow or blockade at a single intersecting street of each line, whereas the electric lines, when blockaded, operated on both sides of the break.

The East Oakland electric railroad has been in the hands of a receiver for some time. The income and outgo accounts ran so close a race that it was decided to handicap the outgo by shutting down the power plant and operating the generators from the power house of the Piedmont Company. The fact that the distance was too great with that arrangement for the feeders then in use and that it was undesirable and inconvenient to invest in large quanities of copper wire at that time led to the adoption of the three wire system on the six miles of East Oakland lines. This method of running is reported to be operating very satisfactorily. It saved something over $4000 worth of copper, and the line loss was reduced from a probable 40 p. c. with the old feeders to about 10 p. c. at present.

In San Francisco, Oakland and vicinity the house movers have successfully maintained that a permit to move a house permitted the removal of the house without regard to the inconvenience or injury of interfering property such as wires, poles, etc. They did their moving at night when passing through railway and electric light wires, but insisted that the companies take down and replace their own wires. In Alameda on Jan. 22 the City Recorder rendered judgment for the plaintiff with damages at $40, in the case of the Alameda & Oakland Electric Railway against a house mover who blocked the company's tracks with a house which he was moving from five to nine o'clock one Sunday morning and in addition cut the company's wires. The company claimed $10 for fares lost by the delay and $30 for replacing a pole and repairing the wires. The Court's decision declared illegal an ordinance requiring street car roads to remove poles and wires at their own expense for the benefit of house movers. He considers the ordinance in the nature of an attempt to violate the city's contract with the railway company in granting a franchise. This decision, small in amount though it is, has been hailed with delight by all local electric street railway men.

Annual Meeting of the Texas Street Railway Association.

The second annual meeting of the Texas Street Railway Association will be held at Galveston, March 18. The Association invites manufacturers of electrical apparatus and their representatives to be present at the meetings of the Association and space will be provided for exhibits if any desire to show their appliances. Applications for space should be made to J. K. Urie, care of Galveston Street Railway Company.

News Notes.

Ashland, Pa.—The Ashland, Centralia & Locust Gap Electric Railway Company has applied for a charter to build an electric railway between the above named towns. The officers are: President, A. L. Laubenstein; treasurer, James A. McCarthy; secretary, Thomas Pepper.

Bonham, Tex.—The Bonham Electric Light & Power Company has been organized to build an electric light plant and electric railway in Bonham. Capital stock, $25,000.

Brockton, Mass.—The Brockton Street Railway Company has asked permission to extend its line to Bridgewater. H. B. Rogers, 104 Ames Bldg., Boston, is purchasing agent.

Chicago, Ill.—The Chicago City Railway Company will equip thirty-nine miles of its lines with electricity in the spring, and will issue capital stock sufficient for all improvements to be made. R. L. Garth, 2,020 State Street, Chicago, is purchasing agent.

C. S. Leeds, of the Suburban Railroad Company, Chicago, writes us that his company has constructed part of its road, has let contracts for part of the machinery, and has prepared specifications and plans for about twenty-five miles of track, including bridges, viaducts, overhead work, etc., also for cars, motors and generators. Contractors desiring to present bids should address C. S. Leeds, 100 Washington Street, Chicago.

Cleveland, O.—The Cleveland Electric Railway Company has been granted franchises for extensions to its lines. J. J. Stanley is general superintendent of the company.

Colorado Springs, Col.—The Colorado Springs & Cripple Creek Short Line Railway Company, has been incorporated by Wm. R. Benzie, Jas. A. McCormick, Quincy E. Hicks, Lynn S. Atkinson, and Francis L. Burton, of Colorado Springs, to build an electric railway from Colorado Springs to Cripple Creek. Capital stock $1,000,000.

Dallas, Tex.—The property and franchises of the Queen City Railway Company have been sold to John Davenport, of Boston, Mass., for $1,000,000.

Fulton, N. Y.—The Fulton & Oswego Falls Street Railway Company has applied for a franchise in the village of Fulton.

Kingston, N. Y.—The Kingston & Lake Katrine Railroad Company has been incorporated by Richard Lelahon, J. F. Dwyer, W. J. Turck, Jr., J. S. Winne, C. W. Crispell, J. W. Lasker and C. W. Keefe, of Kingston; D. H. Kennelly, of New York, and H. W. Martin, of Bennington, Vt., to build and operate a street railway in Ulster County. Capital stock, $100,000.

Knoxville, Tenn.—The Citizens' Street Railway Company, will construct a large new power house, and it will be supplied with Corliss engines and the very best electrical equipment. W. G. McAdoo is president of the company.

Long Island City, N. Y.—The Steinway Railway Company will erect a new plant and supply depot to cost $75,000.

Louisville, Ky.—The Louisville Railway Company, is in the market for twenty to twenty-five. S. R. G. 30 Motors.

Lowell, Mass.—The Lowell & Suburban Railway Company is considering the extension of its line to Centralville Hill.

Middletown, Conn.—The Middletown Street Railway Company, will extend its line to Gildersleeve's and Glastonbury in the spring. E. W. Gross is superintendent and general manager.

Middleboro, Mass.—The Middleboro & Lakeville Street Railway Company has been incorporated. Capital stock, $100,000.

Mt. Vernon, N. Y.—The North Mount Vernon Railway Company has obtained all of its franchises and work will probably be begun in a short time.

Norfolk, Va.—The Norfolk Street Railroad Company has applied for permission to extend its lines. W. M. Rosborough, 835 Church Street, Norfolk, is general manager.

THE Norfolk & Ocean View Railroad Company has applied for permission to extend its lines to Willoughby Spit. F. R. Owen is purchasing agent and superintendent.

Oswego, N. Y.—The Oswego Street Railway Company will erect a large power house on the banks of the Oswego Canal. Water power will be utilized in generating the electricity, but a steam plant will be put in as an auxiliary.

Portland, Me.—The Portland Extension Railroad Company has been incorporated by William G. Davis, William R. Wood and Chas. F. Libby, of Portland; Edward A. Newman, of Deering, and William A. Wheeler, of Brooklyn, N. Y., to build and operate an electric railway from Westbrook to Gorham. Capital stock, $50,000.

Quincy, Ill.—J. C. Hubinger, of Keokuk is the promoter of an electric railway to be built from Quincy to Niota, a distance of sixty miles.

Rochester, N. Y.—The Rochester Railway Company has asked for permission to extend its lines. F. O. Rusling, 267 State Street, Rochester, is general manager.

St. Louis, Mo.—The Union Car Company has been incorporated by H. W. Rocklage, Ernest Overbeck and H. P. Wehrenbreckt, of St. Louis, to build, buy and sell street and railroad cars. Capital stock, $50,000.

San Antonio, Tex.—W. H. Weiss, president of the San Antonio Street Railway Company writes us that they are in the market for an Edison No. 32,500 volt railway generator with complete station equipment, an M. P. 80 Thompson-Houston generator with complete station equipment, and one Armington & Sims engine, compound condensing, with double-disk crank, cylinder to be 10½ x 16½ x 12 in. stroke, with fly-wheels to serve as driving pulleys, 58 in. diameter x 14½ in. face, and to develop one hundred horse power when running at 300 revolutions per minute, condensing. They are to be second-hand, but in first class, serviceable condition.

San Francisco, Cal.—The Continental Motor & Traction Company has been incorporated by W. J. Bowie, C. I. Ives, W. R. Hooper, Phillip LaMontague and W. R. Snedberg, of San Francisco, to construct, manufacture and deal in inventions and patents relating to electricity, steam or compressed air, and to construct electric railways. Capital stock, $1,000,000.

Seattle, Wash.—The Seattle Consolidated Street Railway Company has been granted a fifty year franchise for extensions to its lines. S. L. Shuffleton, 200 Pike Street, Seattle, is purchasing agent and general manager of the company.

South Hadley Falls, Mass.—Charles S. Boynton is interested in an electric railway from South Hadley Falls to Holyoke.

Thompsonville, Conn.—The Thompsonville & Enfield Street Railroad Company has asked for permission to extend its proposed line to Springfield, Mass. Among those interested are C. H. Briscoe, Geo. B. Fowler, L. A. Upson and J. W. Johnson.

Topeka, Kan.—The Comstock Motor Company has been incorporated by G. J. Mulvane and D. W. Mulvane. Capital stock, $100,000.

Washington, D. C.—The Georgetown & Tenalleytown Railway Company is negotiating with the Tenalleytown & Rockville Railway Company for the purchase of the property and franchises of that company.

Car Equipment Notes.

The Milwaukee Street Railway Company has contracted with the Brill Company for twenty motor cars for delivery on Apr. 1. These cars will be 25 ft. 6 ins. in length of body with five foot platforms. The length of car over all will be thirty-eight feet. The width at the belt rail will be 8 ft. 2 ins., and the height inside from floor to roof 8 ft. 3 ins. There will be twin doors opening as wide as possible. There will be a center aisle through the car twenty-two inches wide, on each side of which will be seven cross seats and two longitudinal seats, one at each end, thirty-two inches long, accommodating two persons each. The total seating accommodations will thus be thirty-six. This arrangement of the seats will provide what is practically a commodious vestibule just inside the doors. There will be nine "split oval" windows, the upper part remaining fixed while the lower sash drops below the window sill. Movable vestibules will be placed on both ends of the car. The trucks will be of the Brill maximum traction type, and the brake rods will be fitted with a wheel and handle. Push buttons will be on every side post for the use of passengers. The inside finish will be of light cherry and mahogany, the ceiling of three-ply veneered bird's eye maple or quartered oak, the trimmings of bronze and all fittings of the best. The electrical equipment will consist of two G. E. 1000 motors, with type K 2 controller. These cars will go on the National Avenue line for operation both in summer and winter.

The Jackson & Sharp Company, of Wilmington, Del., is building thirty-seven cars for the City & Suburban Railway Company, of Baltimore, Md. The company is also building thirty open cars for Braintree, North Adams, New Haven and other New England roads, together with four passenger and two combination cars for the Saginaw (Mich.) and Bay City interurban railway. These are of standard pattern presenting no special features. They are very handsomely finished both within and without.

The Paterson (N. J.) Railway Company is getting from the Jackson & Sharp Company ten long double truck open cars of new design, for summer use. These cars have many novelties of detail and the finish and ornamentation is more elaborate than anything that seems to have been previously attempted. While considerable attention has been paid to the decorations of the roof it has also been made exceedingly strong and stiff. The sills are double plated with iron to their full depth and are of the strongest possible character. The use of iron on the sill of the long car is becoming generally recognized as a necessity, and in this case the double thickness of metal used will make trussing practically unnecessary.

These cars have a very strong partition at the ends, furnished with the usual windows. The panels of this end framing are practically mortised into the posts and are glued and pinned in place. The panels for the side posts are bolted through the sill, making an unusually secure fastening. This adds strength at a point where it is much needed.

The Jackson & Sharp Company is also building a number of fine closed cars for the Oakland (Cal.) Railway and a number of narrow gauge cars for a South-American steam railroad. The interesting feature of these cars is that they are to be shipped entire, the company for whom they are designed having reached the conclusion that the durability of the car would be sufficiently increased to pay for the very large increase in freight. The company has just delivered a number of very handsome cars to the Wilmington City road. These cars were quite a revelation to the Wilmington people. They are handsomely upholstered, hair cushions being used on the seats. The finish is oak and the trimmings are bronze. The brilliant lighting, cheerful appearance, ease of riding and beauty of the design have attracted general commendation and attention.

The Brill Company is building 150 cars for the Nassau Electric Railway Company, of Brooklyn. They are 30 ft. 4 ins. over platforms, and 7 ft. 4 ins. wide over posts. They have six reversible back cross seats, and two stationary seats at each end. They are mounted on single DuPont trucks with Steel electric motors and are provided with Millen brakes. The wheel base is 7 ft. 6 ins.

The company is also building seventy-six cars for the Broadway road. They are 22 ft. long with platforms 4 ft. 3 ins. wide, and the width of the car over the posts is 7 ft. They are mounted on a Peckham "Extra Long" extension truck. They have Gold heaters, Millen brakes and are finished and painted in the standard style of the Broadway road.

The company also has an order for the Cape Town Tramway Syndicate of South Africa for a number of double deck cars of novel pattern. There are three different styles. The general pattern of these cars is as follows: length over body, 14 ft. 6 ins., width 7 ft. 6 ins., height to top of canopy, 15 ft. 2½ ins. These cars seat twenty on each deck. The top seats are across the car and have reversible backs, while the lower seats are longitudinal. There is a stairway at each end which makes a 6 ft. platform necessary. These cars are mounted on Brill No. 21 C trucks with G. E. 800 motors. Eight of the cars are 17 ft. long and have cross seats on both upper and lower decks seating forty-eight. The remaining cars, two in number, are 22 ft. long over body and seat twenty-six people on the upper deck and thirty-two on the lower. These two cars have Eureka trucks, and Westinghouse No. 38 motors. In addition to their being double decked and having two stairways, the small head room strikes one strangely. There are no ventilators nor raised roof windows, and the clear space in the center of the car between the floor and the roof is only 6 ft. 1½ ins.

The Brill Company is also building six motor and eight trail cars for the Washington, Alexandria & Mount Vernon Railway. These cars are 30 ft. long with 4 ft. 6 in. platforms and are 8 ft. wide. They have cross seats and can accommodate forty-two passengers. They are furnished with water coolers and one toilet room. The seats are the Hale & Kilburn "Walkover" pattern. There are two G. E. 2000 motors, one to each of the two Eureka trucks. The driving wheels (Whitney) are 36 ins. in diameter. The controller is of special manufacture and unusual size. The resistances occupy a space under the car 68 ins. × 78 ins. ten inches in depth and appear to the eye almost a solid block of metal. Electric signal bells are provided at each seat. The Standard air-brake is used. The piston speed of the pump is reduced two to one the pump being driven directly from the idle axle. The brakes can be put on from either platform. In connection with the air supply is a special signal whistle. In the end of each platform there is a sliding door so that there can be easy communication between the cars of the train, a necessary feature where trailers are used. The eight trailers are of the same size and seating capacity as the motor cars. In fact they are duplicates of them except so far as the driving mechanism is concerned. Both trailers and motor cars are provided with double and folding doors at the side of the vestibule of a neat and very compact pattern.

Cable Records in Melbourne.

The accompanying table shows the life of a number of ropes which have recently been installed on the lines of the Melbourne Tramway & Omnibus Company of Melbourne, Australia, by Thomas & William Smith, the English cable manufacturers.

NAME OF SECTION.	LENGTH OF ROPE. Feet.	LIFE IN DAYS.	TOTAL MILES RUN.
Richmond City	24,990	751	121,520
& Suburban.	14,210		
St. Kilda Suburban.	29,749	770	149,646
St. Kilda Esplanade	24,600	665	119,331
St. Kilda City	24,139	1,043	187,813
Chapel Street &	21,740		
Toorak Suburban. . . .	14,875		
Brunswick City	16,758	808	162,827
Johnston Street City	18,455	744	130,130
& Suburban	14,465		
Port Melbourne . . . . . . (still working.)	16,794	795	139,125

It is the practice in Melbourne as soon as a new cable shows signs of breaking up on a city section, where it gets very severe work, to remove it to a suburban section, where the traffic is not so heavy, and in this way its life is considerably prolonged. Another practice which undoubtedly has contributed to the length of life of the cables is that they are carefully inspected every night, broken wires are nipped off, and entire strands sometimes hundreds of feet in length are put in where required. In this way, while the cost of repairing reaches a considerable amount in the course of a year, it is thought that longer lives are obtained from the cables than where a less careful system of inspection is used, and that an important economy is effected. As an instance of the excellence of the splicing in Melbourne, it may be stated that the cable now running in the Port Melbourne section ran for over two years before the original splice had to be renewed, and then it was only cut out and respliced because the cable had stretched to the end of the race.

In the list given above it will be noticed that in some cases the cables have been worked entirely in one section, whereas on others they have been removed to suburban sections to complete their lives. The life and mileage of each cable refers to the life on the different sections on which the cable was at work.

A Large Consolidation in Prospect.

It is probable that there will shortly be a general consolidation of many of the street railway systems of New Jersey, including the Consolidated Traction Company, the Elizabeth Street Railway Company, the Paterson lines, the Trenton lines, the North Bergen Traction Company, the Camden corporations, the New Brunswick lines and the lines in Orange. This will bring about a system which will furnish a complete network of the lines between Jersey City and Philadelphia, and thus a long intended plan will be carried out.

Why Lightning Arresters Do Not Always Protect.

Even with the best of insulation a lightning arrester does not always protect. The reason for this is not obvious. That which we see and call a lightning flash is not a simple passage from a cloud to the earth; it is a vibration. The lightning oscillates back and forth. Electric oscillations, or waves, interfere with one another much as water waves do. If a trough of water be raised at one end and then quickly lowered, the water in the trough will quietly surge back and forth. If the end of the trough be raised a second time a new system of surging may be started in such a manner that the two will interfere with each other and cause splashing at certain points where crests of the two systems combine to form higher crests. Calm or smooth surfaces will be noticed at points where a crest of one system has been neutralized by a trough of the other system.

In electric wires we have somewhat analagous conditions during thunderstorms. The calm places and splashing places are very close together, so that a lightning arrester, for aught we know, may be connected at a calm place or at a splashing place. If at the former, no discharge will take place at the arrester and the apparatus is liable to become damaged. If at the latter, however, a discharge will take place and the apparatus will be protected. But these splashing places are constantly shifting their positions. How, then, is a lightning arrester to be properly located? Answer.—By connecting such a number of lightning arresters along the line that several of them are likely to be found at splashing places. The writer recommends four to the mile of wire, but this is by no means to be taken as an invariable rule; much depends upon the local conditions, the character of the soil with reference to ground connections and liability of lightning to strike, the grade of insulation to be protected, the voltage of the circuit, which latter governs the safe spark gap length which may be employed, and the surroundings with reference to telegraph and telephone wires. In general, thickly settled districts tend to decrease the number of lightning arresters which may be required.—A. Jay Wurts, in *Cassier's Magazine.*

Standard Rules for Construction.

The committee of the National Electric Light Association, which has in charge the formation of a joint committee composed of the various electrical, insurance and allied interests for codifying a standard set of rules for electrical construction, announces that the following organizations will be represented on the committee:

National Electric Light Association, by William J. Hammer, chairman committee on standardizing rules.

American Street Railway Association, by John A. Seely, consulting electrical engineer.

American Institute of Electrical Engineers, by Prof. Francis B. Crocker, of Columbia College.

National Board of Fire Underwriters, by William H. Merrill, chief electrician, Chicago, Ill.

Western Union Telegraph Company, by A. S. Brown, chief electrician, New York.

Postal Telegraph Company, by Francis W. Jones, chief electrician, New York.

American Institute of Architects, by Alfred Stone, secretary, Providence, R. I.

National Association of Fire Engineers, by Capt. William Brophy, electrical expert of the Commisioner of Wires Department, Boston, Mass.

American Bell Telephone Company, by C. J. H. Woodbury, of the engineering staff, Boston, Mass.

General Electric Company, by Lieut. S. D. Greene, general manager sales department, New York.

Westinghouse Electric Manufacturing Company, by Charles F. Scott, electrician, Pittsburgh, Pa.

The delegates above named will meet in joint conference on Mar. 18, and will undertake at once an exhaustive examination of the various rules that have been promulgated by the different electrical and insurance interests, and will attempt to form a new code which will contain the best rules brought together from all sources. The new code will be submitted by the delegates to each of the bodies which they represent for final approval, but until such approval none of the organizations will, of course, be definitely committed to the action of the joint committee.

The American Society of Mechanical Engineers has kindly offered the committee the use of its headquarters at No. 12 West Thirty-first Street for its deliberations on Mar. 18 and 19.

Much credit should be given to Messrs. Hammer, Ayer, Smith, Leslie and Brophy, the special committee of the National Electric Light Association, who have undertaken the formation of this joint committee, for their untiring efforts in impressing the importance of the subject upon the different organizations to be represented.

Recent Decisions by the New York Railroad Commissioners.

The Board of Railroad Commissioners of New York have recently made important decisions which will act to prevent the construction of competing street railway lines. Under a recent amendment to the railroad law, all street railway corporations in New York State are obliged to apply to the Board of Railroad Commissioners for a certificate stating that they have complied with the requirements of that section and that public convenience and necessity require the construction of the projected railroad.

The first case was an application from the Kings, Queens & Suffolk Railroad Company for the desired certificate. The projected line was to extend from the eastern boundary of the city of Brooklyn to the village of Far Rockaway. It was brought out in the testimony offered to the Commissioners that the projectors did not have a clear idea as to the exact route of the road or the exact points of its termini. Moreover it was proven that the road would simply duplicate existing facilities, and it was not proven that the present facilities (furnished by the Long Island Railroad Company) were inadequate for the needs of the people. It was also offered in evidence that some of the promoters of the enterprise had a personal feeling against the Long Island Railroad. The Board based its decision against the company on the above facts, and also upon the engineering features proposed, which included the use of bicycle cars "not more than one-fourth to one-third of the weight of ordinary passenger coaches," and a speed "sixty miles an hour or greater, as circumstances may demand. The cars can be run as fast around curves as on the straight line, which alone will effect a considerable saving in time."

The second application to the Board was much more important in character, as it involved the construction of about sixty-six miles of new street railway line in the city of Buffalo, in opposition to the Buffalo Street Railway Company. In this case all the preliminary work had been done, and franchises obtained from the Mayor and Council of Buffalo, so that the permission of the Railroad Commissioners was the last requirement before commencing construction. The Board went very thoroughly into the various problems involved, giving particular attention to the existing facilities and the probable future requirements of Buffalo. It complimented the present system, stating that its history was in many respects "that of a vigorous enterprise, intelligently conducted and seeking to meet the public needs as the city's rapid growth has brought them forward." In evidence of this it was shown that in the last five years the track mileage has increased from 64 to 143, and the car mileage from 3,201,-292 to 7,686,150, or at the rate of 156 p. c. The number of cars operated increased from 93 to 301 and have been greatly improved. It was also shown that during the year ending June 30, 1895, 12,000,000 out of the 45,000,000 of people carried were transferred, so that the average fare received from each passenger is but 3.53 cents. Affidavits were submitted by Thos. H. McLean, general manager of the Citizens' Street Railroad Company, of Indianapolis; Chas. E. Sergeant, general manager, and Richard Hapgood, roadmaster, of the West End Street Railway Company, of Boston; M. S. Robinson, general manager of the Fort Wayne (Ind.) Electric Railway Company; E. C. Foster, general manager of the Lynn & Boston Railroad Company, and a large number of other experts to the effect that public convenience and necessity do not require the construction of the new company's lines.

In rendering its decision, the Board made a careful analysis of the proposed routes and a discussion of their individual merits. Several were considered as desirable, but many others as neither necessary nor desirable for various reasons, and the final conclusion was that the applicant did not show public need for the construction of such a substantial part of the proposed railroad as would warrant affirmative action by the Board.

Trade Catalogues.

The Superiority of Electric Storage Traction. Published by Stern & Silverman, Philadelphia, Pa.

This is one of the handsomest catalogues which has ever come to our office, and indicates the determination of the manufacturers of electric storage apparatus to push their products vigorously. Views are given of the apparatus supplied for use on the Fourth Avenue Railway of New York, together with engravings of several trolley lines installed by Stern & Silverman.

Catalogue No. 20. Modern Methods of Mining and Handling Coal, Minerals, etc. Published by the Link Belt Engineering Company.

This company has recently absorbed the business of the Independent Electric Company and is now making extensive applications of electric motors to machinery for the mining and handling of coal. In the latter applications our readers are most interested and the catalogue gives views and descriptions of the horizontal conveyors and buckets manufactured by the company. These have been adopted by a number of railway companies. The catalogue is well illustrated.

Electric Power Pumps manufactured by the Knowles Steam Pump Works, of New York.

The first combinations of electric motors with machinery were made by the electric manufacturing companies, but it is a striking testimonial to the extent to which electric motors are now used in industrial trades that the largest manufacturers of machine tools, pumps and other appliances adapted to be driven by electric power are constructing apparatus especially fitted for electric motors. The catalogue of the Knowles Steam Pump Works is an example of this and it shows a large number of types of pumps fitted with different kinds of motors. Some of these will undoubtedly find general adoption around electric railway power stations, car houses, repair shops, and other points where electric power is available and to general industrial use. The catalogue is well illustrated.

Personals.

Mr. Stanley E. Russell, representative of the Q. & C. Company, at Atlanta, Ga., died Feb. 13, of pneumonia.

Mr. M. G. Starrett, who has been for a long time the chief engineer of the Brooklyn Heights Railroad Company, has accepted the position of assistant chief engineer of the Metropolitan Street Railway Company, of New York.

Mr. Frank H. Ball has retired from the Ball & Wood Company, and has assumed charge of the American Engine Company, at Bound Brook, N. J. Mr. Ball is one of the most level headed steam engineers in the country, and his services will be of great value in his new connection.

Mr. S. L. Nicholson has severed his connection with James W. Boyd & Sons in order to become connected with the Cutter Electric & Manufacturing Company, of Philadelphia. Mr. Nicholson will handle the company's circuit breakers in Eastern Pennsylvania and Southern New Jersey.

Mr. Frank A. Morrell who has recently represented the New Haven Car Register Company and was formerly identified with the Lewis & Fowler Manufacturing Company has recently made a business connection with the Brooklyn & New York Railway Supply Company. Mr. Morrell is well and favorably known to the trade.

Mr. James B. Hanna, secretary and treasurer of the Cleveland City Railway Company, was married on Feb. 26 to Miss Harriett Lucilé Beggs, of Cleveland, at the residence of the bride's sister, Mrs. Frederick N. Reed. Mr. Hanna's many friends, among whom we feel proud to include ourselves, offer him their heartiest congratulations.

Mr. M. H. Clark, who has recently been elected treasurer of the Clarksville (Tenn.) Street Railway Company, was the last acting secretary of the Treasury of the Confederate Government, and paid out to the disbanded Confederate army the silver and gold bullion and coin in pro rata installments after the surrender of Pres. Jefferson Davis.

Mr. J. L. McLean has recently been appointed superintendent of the operating department of the Los Angeles Railway Company, of Los Angeles, Cal. He was formerly chief dispatcher of the Denver Consolidated Tramway Company, and while in that city devoted considerable attention to a method of dispatching cars by telephone, which has been described in this paper. The system has also been adopted by the Los Angeles Railway Company, and the City & Suburban Railway Company, of Portland, Ore. Mr. McLean was born in Missouri, in 1870. In January, 1891, he was appointed to the dispatching office of the Denver Tramway Company, and in the following year, the chief dispatcher of this company. In 1894, he organized in New York the American Car Dispatching Company, of which he is vice-president and general manager.

J. L. McLEAN.

C. H. ZEHNDER.

Mr. C. H. Zehnder has recently been elected president of the Dickson Manufacturing Company, of Scranton, Pa. This company, as stated elsewhere, is about to extend its works and become a large manufacturer of engines and boilers and will as well add a switch and frog department to its works. Mr. Zehnder is president of the Jackson & Woodin Manufacturing Company, of Berwick, Pa., but will resign that office to take up his new work. He has been president of the Jackson & Woodin Manufacturing Company, for the last three years and has held many positions with the company during the seventeen years in which he has been in its employ. During Mr. Zehnder's connection with the company its business has increased greatly both in volume and variety of products. The Dickson Manufacturing Company is well and favorably known as a builder of locomotives, mining machinery, and stationary engines, and under Mr. Zehnder's management, it is safe to predict for the company a continued and increasing success.

Mr. Thomas H. McLean, of Indianapolis, has resigned his position as general manager of the Citizens' Street Railway Company of that city. During Mr. McLean's connection with the company which has extended over a period of two years and a half, the company has been largely reorganized and the lines equipped with electric power. In this work Mr McLean has had opportunity to show his high executive ability. During this time, owing largely to the improvements introduced by him as a manager, the stock rose from 12 to the neighborhood of 58, three months ago. Though firm in his dealings with the labor element, Mr. McLean won general popularity of both employes and public by his fair treatment of all and the general admiration felt for him has been strikingly evinced since the announcement of his resignation, by the general feeling of regret and most complimentary notices in the local press. Mr. McLean does not disclose his future plans, but it is safe to say that he will remain in the street railway business with which he has been connected for the greater part of his life.

Annual Meeting of the Standard Underground Cable Company.

The annual meeting of the stockholders of this company was held on January 28, 1896. Nearly seven-eighths of the capital stock was represented either in person or by proxy. The following gentlemen (all of Pittsburg) were re-elected as directors for the ensuing year: George Westinghouse, Jr., president Westinghouse Electric & Manufacturing Company; Robert Pitcairn, general agent and superintendent Pennsylvania Railroad Company; Mark W. Watson, president Exchange National Bank; J. W. Dalzell, vice-president Exchange National Bank; Geo. B. Hill, president Pittsburg, Allegheny & Manchester Passenger Railway Company; John B. Jackson, president Fidelity Title & Trust Company; James H. Willock, president Second National Bank; John Moorhead, Jr., iron manufacturer; Joseph W. Marsh.

The report of the board of directors showed a total business of nearly $1,000,000 for the year 1895. During the year three quarterly dividends of one and a half per cent each, and one of two per cent were declared, and the remainder of the earnings were carried into surplus account, which now stands at $446,869, notwithstanding the fact that at the beginning of the year 1895, $100,000 was charged off on patent account and $47,000 on account of bad debts, doubtful assets, etc., arising in the first twelve years of the company's existence.

The company has been discounting its bills since March last, and closed the year with no debt of any kind, except for current bills. Accounts receivable amount to over $100,000.

New plant and machinery was purchased during the year, at a cost of between $50,000 and $60,000 and paid for out of current funds.

The newly elected board of directors met on February 1, and elected the former officers as follows: Geo. Westinghouse, Jr., president; Joseph W. Marsh, vice-president and general manager; F. A. Rinehart, secretary and treasurer; P. H. W. Smith, assistant manager; C. M. Hagen, auditor; W. A. Conner, general superintendent manufacturing department, and Henry W. Fisher, electrician and chemist.

EQUIPMENT NOTES.

The C. J. Field Company, of New York, has moved its office to the Taylor Building, 39 Cortlandt Street, New York.

R. A. Humphrys, of Philadelphia, has recently published a new sample book of car curtains which he manufactures. The catalogue shows the leading styles for 1896.

The Joseph Dixon Crucible Company, of Jersey City, N. J., has published an important set of rules giving directions for the use of plumbago crucibles. The directions are prepared by John A. Walker, of Jersey City, vice-president of the Dixon Company.

The Steinway Railway Company, of Long Island City, has purchased 100 St. Louis open cars, 100 Peckham trucks and two 800 G. E. motors for its summer traffic, which is expected to be very large. The new car house and shops will be commenced at once.

R. W. Hildreth & Company, engineers, of New York, write us that owing to the death of Russell W. Hildreth, the firm consists now of Percy S. Hildreth and Alfred Liebmann. The business of the firm will be as heretofore, that of civil and constructing engineers.

H. W. Weller, of Boston, Mass., sales agent of the Campbell & Zell Company, of Baltimore, Md., has recently closed a contract for boilers with the New London Street Railway Company, of New London, Conn., for an equipment of Zell improved safety boilers. The amount ordered is 500 h. p. and the order was given only after a very careful investigation of various boilers in the market.

The Harrison Safety Boiler Works, of Philadelphia, have been awarded the contract for the feedwater heaters and purifiers for the Columbia & Maryland Railway (the new electric line between Washington and Baltimore, now in the course of construction), with power houses at Ilchester and Paint Branch, 3000 h. p. each. The advisory engineer for this company is Prof. R. H. Carpenter, of Cornell University.

The Geo. F. Blake Mfg. Company, of New York, supplied the complete outfit of pumps, including the independent air pumps, for the main condensers for the new Plant steamer "La Grande Duchesse" and the U. S. gunboat "Helena" which were launched Jan. 30 at the Newport News Ship Building & Dry Dock Company, Newport News, Va. The air pumps are of the Blake vertical twin system such as are used on the Cramp cruisers and other vessels.

The R. D. Nuttall Company, of Allegheny, Pa., as our readers well know, is doing a large business in gears and other electrical supplies, but it may surprise many to learn that the company is turning out in other lines some of the finest machine work in the country. Owing to the company's excellent machine equipment, it is now manufacturing sewing machines, geometrical lathes, etc., which have a standing in these lines equal to the company's reputation in the electrical trade.

The Mica Insulator Company, of New York, writes us that its foreign business has grown largely during the last six months, and that the increase in business has compelled the company to add to its facilities for manufacturing its well known insulation, micanite. The company has also made additions to its factory in London. European manufacturers of electrical machinery are using micanite largely in the construction of their various designs of apparatus, and the company is to be congratulated upon the success with which its insulation has met with in foreign countries.

Hoefgen, Moxham & Company, of New York, have just closed arrangements by which they become Eastern agents for the Edge Moor Iron Company, of Edge Moor, Del. The boilers of this company are attracting considerable attention at present on account of their many excellent features, and will continue to be made in the first class manner which has given to the Edge Moor Iron Company, its high reputation. An order for a large amount of high grade steel suspension wire, which will be used by the Penn Bridge Company, in bridge construction, has recently been closed by Hoefgen, Moxham & Company. The wire will be made by the Washburn & Moen Manufacturing Company.

The Fiberite Company, of Mechanicville, N. Y., is enjoying an excellent business. a fact which gives evidence of the growing popularity of the Medbery overhead material for railway use and also of other specialties made by that company. The contracts already secured have made it necessary to make up an unusually large stock. The sales of Medbery station switches are increasing daily. These are made with the careful attention to all details necessary for a reliable switch, and are now recognized as a standard article by the trade in general. The branch offices of the company in New York and Chicago carry full lines of all material made by the Fiberite Company, and are prepared to make immediate shipments from stock.

H. E. Collins & Company, Pittsburgh, Pa., sole sales agents for the Cahall vertical water tube boiler, manufactured by the Aultman & Taylor Machinery Company, Mansfield, O., report the following recent sales of Cahall boilers. National Chemical Company, Cleveland, O., 150 h. p., Republic Iron Works, Pittsburgh (4th order), 250 h. p., Municipal Electric Lighting Plant, London, O., 250 h. p., Voight Brewing Company, Detroit, Mich., 500 h. p., Michigan Alkali Company, Wyandotte, Mich. (4th order), 300 h. p., Jefferson Coal Company, Coal Glen, Pa., 500 h. p., Ohio Iron Company, Zanesville, O., 500 h. p. The boilers for the Republic Iron Works are for the utilization of waste heats from heating furnaces; those for the Ohio Iron Company, are for blast furnace gas and the balance of the orders mentioned are for boilers of the direct coal fired type.

Alfred Box & Company, of Philadelphia, manufacturers of the well known hoisting machinery, have recently published a handsome catalogue descriptive of their hoists, traveling cranes, hand and power jib cranes and electric cranes. The high standard of work of Alfred Box & Company has brought to them a large amount of trade, and an evidence of the high reputation of their appliances is shown by the fact that the United States Government has adopted them and that they are now in use in the ships of the new navy, to the exclusion of all others. The firm has also received orders for cranes from foreign governments. The cranes are in general use in electric railway power stations and repair shops and are of all types and capacity. The catalogue is handsomely printed and forms very interesting reading. The mechanical stoker and radial drills of the company are also illustrated and described.

The Dickson Manufacturing Company, of Scranton, Pa.,under the new management of C. H. Zehnder, the recently elected president of the company, proposes to make extensive additions to its works and facilities for manufacture, especially in the line of engines and boilers for electric and street railway plants. The company will build the very heaviest machinery and will erect and equip a boiler shop on the most modern plan with the view of handling very cheaply and making the heaviest boilers. The locomotive department of the company will be extended, and in addition the company will establish a switch and frog department which will manufacture special work for steam and electric railways. The new secretary and treasurer of the company, L. F. Bower, will have charge of the office force and accounting department. He is young and energetic and it is safe to predict that the company will rapidly forge ahead in its chosen field.

McIntosh, Seymour & Company, of Auburn, N. Y., write us that they have orders from the Columbian & Maryland Railway Company, for eight engines of 1000 h. p. each, that will couple direct to 700 k. w. Westinghouse generators. This firm is also making two 1200 h. p. 800 k. w. direct coupled engines for the City & Suburban Railway Company, of Baltimore, Md., making six for that Company, two 1200 h. p. 800 k. w. direct coupled for the Cincinnati Street Railway Company, making fourteen which have been sold that company, two 1200 h. p. engines for the Municipal Electric Light Company, of Brooklyn, N. Y., and one 1000 h. p. cross compound vertical engine for the Atlantic Mills of Lawrence, Mass. The above are the company's sales for slow speed engines since Jan. 1, 1896. The company is also making a 700 h. p. three cylinder, three crank vertical engine direct connected to two 200 k. w. dynamos for Buenos Ayres, Argentine Republic. The company has also on hand orders for a large number of high speed engines.

The New Haven Car Register Company, of New Haven, Conn., manufacturer of the famous New Haven fare registers reports that it has been awarded the highest medal and diploma given for fare registers at the recent Cotton States & International Exposition at Atlanta, where the company made a very fine exhibit of single, double and triple registers. This company also received the highest award at the Columbian Exposition, and has been very successful in anticipating the requirements in its line. Its registers have been adopted by many of the leading street railroads of the country and attract attention at once by their very rich and elegant appearance, and win friends everywhere by their completeness and durability. The double and triple registers made by this company are rapidly becoming very popular for the registration of different classes of fares, or fares and transfers. The managers of street railways are rapidly coming to realize the necessity of registering transfers separately from the cash fares, and the double register made by this company accomplishes this in the most complete manner.

The New York Car Wheel Works, of Buffalo, N. Y., is reported as doing a large business in cold rolled axles for street railway service. Nine thousand and over of these axles have been placed in service, and the company writes us that it has as yet to hear of a case of breakage among the entire quantity. The axles are guaranteed true to diameter to .003 in., and are of a low phosphorous and low carbon stock. This is of high tensile strength, about 62,000 to 68,000 per square inch, and is so ductile that it is not liable to break. The company claims that it has at various times tested axles sent to it, picked out of the regular stock, and has been able to bend a number of them nearly double without breaking or even cracking. The company has also tested the elasticity and transverse strength of a number of bars 3⅜ ins. in diameter by 6½ ft., or slightly less, in length, by placing them in a hydraulic press in such a manner that the two ends only were supported, and the pressure transmitted to the exact center of the axle by a piece of 3⅜ ins. steel cut to fit the circumference of the axle. The average of these tests has been as follows, viz: the axles would commence to bend at 13½ tons, and the pressure would increase to about 20 tons, where it would remain until the axle broke. In a number of cases the pressure was run in these tests up to 20 tons. After removing the pressure the axle sprang back nearly straight.

The Berlin Iron Bridge Company, of East Berlin, Conn., has just completed a very successful year. The shipments have been the largest in the history of the company and are represented by over $1,500,000 worth of business. At the annual meeting of the stockholders, which was held at the office of the company Jan. 30, the following directors were elected: Chas. M. Jarvis, Burr K. Field, Geo. H. Sage, H. H. Peck of Waterbury, S. H. Wilcox of Brooklyn, N. Y., J. W. Burr and F. L. Wilcox. At the meeting of the directors the following officers were elected: President and chief engineer, Chas. M. Jarvis; vice-president, B. K. Field; secretary, Geo. H. Sage; treasurer, F. L. Wilcox; manager of highway bridge department, D. E. Bradley; assistant to the president, E. W. Stearns. The company has just completed for the Ansonia Brass & Copper Company, of Ansonia, Conn., a new boiler house 65 ft. × 142 ft. The side walls are of brick and the roof is entirely of steel, covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated steel. The company has recently been awarded a contract for a steel floor to be placed in one of the buildings of the Alexander Smith's Sons' carpet factory, at Yonkers, N. Y., and has also been given the contract for furnishing the iron work for Meara Brothers' new block, at Torrington, Conn. This block is three stories high and the girders are placed in the ceiling of the first floor and made sufficiently strong to support the two upper floors.

WESTERN NOTES.

The Moses P. Johnson Machinery Company, of St. Louis, has been appointed agent in St. Louis for the Walker Company, of Cleveland.

The Wells & French Company, of Chicago, has received a contract from the Chicago City Railway Company for seventy open motor cars, and from the Akron & Cuyahoga Falls Rapid Transit Company an order for fourteen open motor cars.

The Mason Electric Equipment Company, Chicago agents for the Fiberite Company, has just completed a shipment to the far West of a large quantity of the Medbery overhead material. This order is said to be one of the largest ever given out in this country.

J. H. McGill has been appointed Chicago representative of the Ohio Brass Company, of Mansfield, O. Mr. McGill will have his headquarters at Room 1533 Monadnock Block, where he will be ready to receive any visitors who may be interested in overhead appliances and the other specialties of the company which he represents.

The Partridge Carbon Company, of Sandusky, O., writes us that it is enjoying an excellent busines, and that the demand for the company's product is constantly increasing. The company has secured the excellent reputation which it holds through careful attention to the details of manufacture, and its products are most favorably regarded in the field.

M. B. Austin, who represents in Chicago both the Safety Insulated Wire & Cable Company and Haynes, Booth & Hayden, has removed his office to 1129 and 1130 the Monadnock Building. Mr. Austin reports continued good business in both lines, and it certainly reflects well to his credit that the business of the office has increased with every month since the opening of the Chicago agency about eighteen months ago.

The Standard Railway Supply Company, of Chicago, is an entirely distinct company, our readers need hardly be reminded, from the Standard Electric Company of that city, whose failure was announced last month. The Standard Railway Supply Company, we understand, is doing an excellent business, and the popular president of the company, Garson Myers, reports the outlook for the coming year as most encouraging.

The Egan Company, of Cincinnati, O., manufacturer of wood working machinery of every description, has just gotten out a large poster illustrating a great variety of wood working machines, tools and appliances, manufactured by this company, a majority of which would be found useful in street railway car and repair shops. This company's business has grown rapidly in the past few years, and it now claims to have the most extensive and best equipped plant in America, if not in the world, for the manufacture of wood working machinery, and can on very short notice fully equip a car or repair shop.

The Fitzgerald-Van Dorn Compa y, of Chicago, has just issued a very complete and interesting pamphlet, fully illustrating and describing in detail the various patterns of couplers and accessories manufactured by it. The Van Dorn coupler is strictly up to date. It is automatic and is machine fitted so as to make a perfectly tight coupling, thus completely overcoming jerking where trailers are hauled. It is the standard on several of the most important street railway systems in this country, and also on the Metropolitan and Lake Street Elevated lines, Chicago, it being the only automatic coupler adapted to this work. The company reports its business as rapidly increasing.

The Trump Manufacturing Company, of Springfield, O., has been awarded the contract for the erection of twelve water wheels, aggregating 2000 h. p., for the People's Power Company, at Rock Island, Ill. These wheels are to be placed at the dam opposite the Rock Island Arsenal and will drive electric generators for supplying the power for the Moline Central Street Railway. The plant is to be equipped with the new Trump model wheel which is claimed to be the most powerful turbine in the market, it having tight fitting gates that work with such remarkable ease as to make it especially desirable where a governor is required, as is the case where the power is to be used for street railway work.

Max A. Berg has resigned the management of the Chicago office of the Ohio Brass Company to accept a more responsible position with that company at its works at Mansfield, O. Mr. Berg was formerly manager of the electric railway department of the Electrical Supply Company which afterwards changed to the Ansonia Electric Company. After the failure of the latter company he filled a similar position with the Wallace Electric Company, Chicago. Mr. Berg has made a great many warm friends both in and out of the business, all of whom wish him continued success. The Chicago office of the Ohio Brass Company will be continued at 1129 and 1130 the Monadnock, under the management of J. H. McGill, who is well known to the electrical trade.

The Commutator Company, of Minneapolis, E. F. Keister, manager, is placing on the market a commutator segment manufactured by a process of drawing which is entirely new and original with this company. The company has built special machinery for this particular work, and the product is a metal of perfect homogeneity and extremely low and uniform resistance. These segments are finished on the inside and bevels to standard gauges, thus doing away with any lathe or other machine work, a point that will be greatly appreciated by any one in repairing commutators, as it saves labor and first cost and enables one to do the work anywhere. Mr. Keister has had several years' practical experience in electric railway work and fully understands the requirements in this line.

The Ohio Brass Company, of Mansfield, O., is meeting with excellent results in the sale of its motor bearings. These are of genuine bell metal which have gained an excellent reputation from two causes; one is due to the peculiar quality of the metal used in their composition, and the other arises from the superior manner in which the castings are machined and finished. The selection on the company's part of the various materials and the proportions used was only arrived at after an extended and thorough investigation, and the company claims to have been successful in securing a metal that combines great wearing qualities with a minimum amount of friction. Smoothness in finish and accuracy of fit, for the bearings, are obtained by the employment of skilled mechanics and the use of special machines and tools adapted for this class of work, for the company realizes how carefully these points should be looked after, and that it is the combination of these several features that makes the genuine bell metal bearings the most satisfactory and economical ones to use.

Gleyre Brothers, of St. Louis, manufacturers of the Trendley brake, say that the outlook for 1896 is most encouraging. Inquiries are constantly increasing in number from all parts of the country, and there is also a very noticeable increase in European correspondence on the subject. Messrs Gleyre Brothers believe that it is only necessary for the street railway men to become thoroughly familiar with the Trendley brake to insure its adoption. They have filled a great many trial orders, the reports from which are very gratifying, and promise a good business this spring. They have been giving more time and money to making practical tests and exhibits than in urging sales, believing that the future business in the street railway field would fully justify this plan. The manufacturers claim for this brake twelve times the power of the ordinary hand brake, and yet so simple in construction and management that any man can handle it either for an ordinary service stop or as an emergency brake after ordinary instruction. It is further claimed that the Trendley brake attachment can be easily applied to any car, is comparatively inexpensive and will meet all of the requirements that can be demanded of a first class brake.

The Leschen-Macomber-Whyte Company, has just been incorporated and has opened an office and warehouse at Nos. 19 and 21 S. Canal Street. Henry Leschen, who is president of the new concern, is a St. Louis wire rope manufacturer. Mr. Macomber has heretofore been the Chicago representative of the A. Leschen & Sons Rope Company, and Mr. Whyte has been identified with the electrical and wire rope business for the past eight years, and has an extensive acquaintance with the electric, street railway and lighting field. The Leschen-Macomber-Whyte Company will carry a complete stock of wire rope and fittings, also manilla and the celebrated "Hercules" and flattened strand wire rope and black manilla transmission rope. The company also represents, in Chicago and vicinity, the Charles Scott Spring Company, makers of spiral and elliptic springs for street railway trucks and machinery purposes; Badger Manufacturing Company, overhead line material; Fletcher Manufacturing Company, electric light and railway specialties Bradford Belting Company, "Monarch" insulating paint. It also handles insulated copper wire, rubber insulated wire, galvanized steel strand, rail bonds, etc. The young men are hustlers, and no doubt will make a success of their enterprise.

List of Street Railway Patents.

U. S. PATENTS ISSUED JANUARY 28, 1896, TO FEBRUARY 18, 1896, INCLUSIVE.

JAN. 28.

CAR FENDER.—Chas. M. Wilcox, Newark, N. J. No. 553,549.

ELECTRIC RAILWAY CONDUIT.—A. Beck, Atlanta, Ga. No. 553,552.
Has a series of metallic frames provided with slots or openings in their tops, bars secured to the frames, a plate rigidly secured to the top of the frames upon one side of the slot and plates removably applied to the top of the frame upon the opposite side of the slot.

FENDER FOR CARS.—R. C. McGuire, Pittsburgh, Pa. No. 553,591.

UNDERGROUND TROLLEY SYSTEM.—N. H. Anspach, Chicago, Ill. No. 553,635.
A slotted conduit, a housing in the conduit formed with a diaphragm base resilient sides supported on the diaphragm and a metal presser bar supported underneath the conduit slot, for engagement by the trolley, by said sides to form the cover of the housing, and a service conductor inclosed in the housing and extending into proximity to contact with said bar by pressing the latter against said service conductor.

STREET CAR FENDER.—H. L. Bedford, Bailey, Tenn. No. 553,664.

ELECTRIC RAILWAY SYSTEM.—J. F. Page, Chewacla, Ala. No. 553,736.
Consists of a feed wire having a series of branches each including two contact points, a contact plate movably mounted on the track adjacent to each of said branches and adapted when moved to connect with one of said contact points and means actuated by said contact plate for closing the circuit between said contact points.

FENDER FOR CARS.—J. B. Kendall, Washington, D. C. No. 553,754.

TRACK STRUCTURE.—V. Angerer, Philadelphia, Pa. No. 553,771.
Consists of the main rail, the wing or crossing rail or rails, a bracket formed integral with one of said rails and an inclosing box formed on the bracket.

ELECTRIC RAILWAY.—M. L. Wood, U. S. Navy. No. 553,799.

FEB. 4.

TRACK CLEANER.—J. Baringer, Akron, O. No. 553,823.

BRAKE HANDLE.—C. H. Gaffney, Gloucester, Mass. No. 553,848.
Consists of a brake shaft having a rachet wheel secured to it and an annular groove on one side of said ratchet wheel combined with a sleeve pivoted on said ratchet wheel and a yielding pawl rod engaging the latter and adapted to enter the annular groove when the handle is oscillated.

CAR FENDER.—T. F. Gardner, Pittston, Pa. No. 553,849.
Consists of a scoop, an apron extending beneath the scoop, a guide bar attached to the front edge of said apron, means for guiding said guide bar to cause it to travel upward, a movable platform and connections between the platform and guide bar for operating the latter.

CAR BRAKE.—W. Robinson, Boston, Mass. No. 553,871.

AUTOMATIC GRIPPING DEVICE FOR INCLINED RAILWAYS.—O. W. Smith, Duluth, Minn. No. 553,942.
A safety grip consisting of gripping cams formed with grooves in their opposing faces, and intermeshing teeth on their edges whereby the cams are moved in unison.

CAR BRAKE.—W. S. Whitney, Glens Falls, N. Y. No. 553,973.

ELECTRIC RAILWAY.—F. C. Esmond, Brooklyn, N. Y. No. 553,979.
Consists of a case for magnetic circuit closing devices, consisting of a base of insulating material located, when the case is in position for use below the street level, and a dome shaped top of conducting material connected to such base and projecting above the street level.

ELECTRIC RAILWAY.—F. C. Esmond, Brooklyn, N. Y. No. 553,980.

CIRCUIT CONTROLLING DEVICE FOR ELECTRIC RAILWAY SYSTEMS. —F. C. Esmond, Brooklyn, N. Y. No. 553,981.

COMBINED CAR BRAKE AND FENDER.—A. K. Bonta, Hoboken, N. J. No. 554,018.
A car fender movable toward and away from the roadbed, in combination with an electromotive device adapted to move the same and a source of electricity carried by the car and supplying current to said electromotive device.

CAR FENDER.—W. H. Heydrick, Philadelphia, Pa. No. 554,064.

UNDERGROUND SYSTEM FOR ELECTRIC RAILWAYS.—W. P. Allen, Chicago, Ill. No. 554,102.
A normally charged electrical conductor, and a normally insulated resilient metallic tube for enclosing the same, said tube being closed at each end, and means for bringing said flexible metallic tube in contact with said electrical conductor.

ELECTRIC CONDUCTOR AND CONTACT DEVICE THEREFOR.—W. P. Allen, Chicago, Ill. No. 554,103.

CAR BRAKE.—P. Erb, Lancaster, Pa. No. 554,113.

CAR FENDER.—J. F. Girtler, Brooklyn, N. Y. No. 554,119.

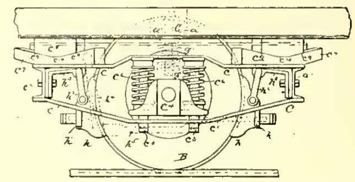
CAR FENDER.—L. E. Sicard, New Orleans, La. No. 554,149.

CAR FENDER.—C. Welsh, Ilchester, Md. No. 554,158.
Consists of a stationary front frame, a main and supplemental wheel guards, and a spring impact member adapted to drop the wheel guards at one time.

CAR FENDER AND BRAKE.—G. W. Beard, Baltimore, Md. No. 554,167.
A frame movable vertically and provided with brake shoes arranged to bind between the wheels and rails and a fender pivoted to said frame.

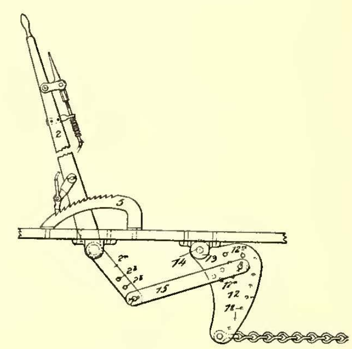
FEB. 11.

CAR TRUCK.—J. A. Brill, Philadelphia, Pa. No. 554,233.
A combination of truck bearings and car rub plates, the bearings having aligned and oppositely and upwardly inclined contact surfaces merging one into the other, and the rub plates having similarly disposed but downwardly inclined surfaces superposed on the bearings and secured to the car body, and a spring co-acting with said rub plates and bearings, and adapted to be compressed thereby when the car body is moved out of line with the truck.



PAT. NO. 554,233.

DIFFERENTIAL BRAKE LEVER.—J. A. Brill, Philadelphia, Pa. No. 554,234.
A primary lever having a long and short arm, a link connected with the short arm, and an oscillating lever to which the link is pivotally connected at a point at one side of a line drawn through the pivot of said lever and the resistance end thereof.



PAT. NO. 554,234.

PLATFORM CONSTRUCTION FOR STREET OR OTHER CARS.—J. A. Brill, Philadelphia, Pa. No. 554,235.
Consists of platform knees, a crown piece secured tranversely to the platform knees to the rear of their outer ends and a buffer secured to the extended ends of the platform knees, "end on."

TROLLEY AND SWITCH FOR ELECTRIC RAILWAYS.—L. L. Stimpson, Boston. No. 554,350.
A trolley pole sustained approximately in a vertical line by cords or tow lines extending from the top thereof to the ends of the car on which it is placed.

SLOT IRON FOR STREET RAILWAY CONDUITS.—W. H. Holden, Chicago, Ill. No. 554,445.

UNDERGROUND CONDUIT FOR ELECTRIC RAILWAYS.—W. S. Merkle, St. Louis, Mo. No. 554,450.

CAR FENDER.—H. Schweers, New York, N. Y. No. 554,462.

CAR FENDER.—W. D. Gold, Philadelphia, Pa. No. 554,487.

CAR BRAKE.—A. H. Fox, Baltimore, Md. No. 554,507.

FEB. 18.

TROLLEY SUPPORT.—F. E. Homer, Cleveland, O. No. 554,694.
Consists of a sleeve socket, a base frame, equalizing chain loops secured at their extremities to the upper and lower portions of the socket. and coiled springs secured at their outer ends to the base plate, and at their inner extremities to said chain loops.

CAR FENDER.—W. H. Leavitt, Hingham, Mass. No. 554,883.

RAIL BOND FOR ELECTIC RAILWAYS.—S. Nikloff, Worcester, Mass. No. 554,949.
Comprises an outer cylinder joined at one end with an inner cylinder axially concentric and parallel therewith, and having an annular intervening space for the reception of a tubular key or expander.

We will send copies of specifications and drawings complete of any of the above patents to any address upon receipt of twenty-five cents. Give date and number of patent desired. THE STREET RAILWAY PUBLISHING COMPANY, HAVEMEYER BUILDING, NEW YORK.

FINANCE

Studies of the Comparative Economy of Horse and Electric Traction.

By Edward E. Higgins.

First Paper.—The West End Street Railway System of Boston.

After eight years' experience in electric railroading with the overhead wire system—a system which has been eminently successful from an engineering standpoint, even in its early and crude forms—it ought to be at last possible to draw some rough conclusions from actual operating reports of the true financial relations between electric and horse traction in many individual cases. It is not possible, however, to generalize much in this direction—to say, for example, that an electric railroad can be operated at any given percentage of the gross receipts, or that there is any certain increase in gross receipts, reduction in operating expenses, or returns upon capital investment brought about by the adoption of electricity by a horse road, which can be predicted in definite percentages. All kinds of local conditions enter into the problem. The operating expenses of an electric road range from eight cents per car mile to thirty cents per car mile, depending on complicated influences, the most important of which is, perhaps, the average speed of the cars and the mileage per car day.

I propose to discuss in these papers the actual operating statistics of several street railway systems large and small. In all cases I shall try to find from actual experience answers to the following question:

What would be the comparative cost, at present prices, of building and equipping (a) an electric railway system, and (b) a horse railway system to occupy the same routes and to run the same number of car miles per annum as is now done by the electric system in the several cities, and what would be the comparative gross receipts, the earnings from operation and the net returns upon the relative capital investments?

TABLE I.

Statistics of Actual and Assumed Mileage, Equipment and Operation of the West End Street Railway Company.

ITEM.	HORSES.		ELECTRICITY.	
	Actual—1889.	Assumed 1896.	Actual—1895.	Assumed 1896.
	Mls. track 253 Car miles. 16,573,831	Mls. track 275 Car miles. 22,180,125	Mls. track 275 Car miles. 22,180,125	Mls. track 275 Car miles. 22,180,125
Miles track owned	236.58	275	263.27	275
Miles track operated	253.20	275	274.83	275
Miles (track) overhead construction.	31.30	—	248.15	275
Closed cars—horse	913	1280	371	—
Closed cars—electric	43	—	873	918
Open cars—horse	881	1185	170	—
Open cars—electric	4	—	841	886
Horses	7728	10,350	857	—
Electric motor cars	—	—	2108	2000
Power station plant—horse power.	—	—	—	25,000
Car miles run	16,573,831	22,180,125	22,180,125	22,180,125
Passengers carried	104,243,150	135,465,000	155,231,506	155,231,506
Receipts per passenger	$.04961	.04912	.04912	.04912
Receipts per car mile	.312	.300	.344	.344
Passenger receipts	5,171,975	6,654,038	7,624,277	7,624,277

I shall first discuss one of the largest street railway properties in the world, that of the West End Street Railway Company of Boston, Mass. This company operates 275 miles of track laid in 150 miles of street in the city and suburbs of Boston. Nearly all of this track is through paved streets, less than ten miles being unpaved. On Sept. 30, 1895, 248 miles were completely equipped with, and in operation by the overhead electric system and 9.5 miles were partially equipped. The remaining mileage, consisting chiefly of lines where, for one reason and another, there will be some delay in equipping with the electric system, is now in operation by horses.

During the year ending Sept. 30, 1895, the company ran 22,180,125 car miles, carried 155,231,506 revenue passengers, and earned $7,624,277, an average of $.04912 per passenger and $.344 per car mile. Of the total car mileage 95.13 p. c. was made by electric cars and 4.87 p. c. by horse cars, and of the total passenger receipts 96.2 p. c. were from electric cars and 3.8 p. c. from horse cars. These figures show that this system may be considered, for present purposes, to be completely equipped by electricity.

On Sept. 30, 1889, the company operated its cars over 253 miles of track, of which 31 miles were in operation partly by horses and partly by electricity, and the remainder by horses only. The car mileage during the year ending Sept. 30, 1889, was 16,573,831, the passengers carried were 104,243,150, and the passenger receipts were $5,171,975, an average of $.04961 per passenger and $.312 per car mile. It will thus be seen that this system was, in 1889, operated practically as a horse railway.

In order to get a clear understanding of the problem as stated above and the course of reasoning involved in its solution let us assume that the streets of Boston are entirely free from street railway tracks, and that the question is "By which motive power, horse or overhead electric, can a street railway company proposing to build 275 miles of track through 150 miles of street, and to operate 22,180,125 car miles per annum, derive the greatest percentage return upon the relative investments?"

In Table I, will be found the data and assumptions bearing upon the problem, the figures in the column marked "Actual" being taken from the company's reports, and those in the column marked "Assumed" being obtained in the manner to be explained. In Table II, is found my estimate of the relative investments required for the construction of the horse and the electric road, the way in which these items are obtained being also explained in the following discussion.

Roadbed.—One of the best standard forms of electric railway roadbed construction to-day is a ninety pound rail section with thirty-six inch, twelve bolt joint plates. Such a construction can probably be laid down to-day upon a contract of this size for about $15,000 per mile, this price including the cost of taking up and relaying pavement, together with special work, electric rail bonding, etc. In fact, it could ordinarily be done for less money than this, but it happens that there is an enormous amount of special work in Boston due to the crooked and irregular streets and complicated crossings, switches and turnouts. The cost of new pavement is not, and should not be included in the above figure, since this is, properly speaking, a burden on franchises and not a necessary construction item. In order to make this figure perfectly safe, the sum of $2500 per mile

TABLE II.

Comparative Investments Required for Building and Equipping a 275 Mile Street Railway System in Boston, Mass., for Operation by Horses and by Electricity.

	HORSES.		ELECTRICITY.	
	Actual—1889.	Est'd.—1896.	Actual—1895.	Est'd.—1896.
	Miles track 236 Car miles 16,573,831	Mls track 275 Car miles 22,180,185	Miles track 275 Car miles 22,180,185	Mls track 275 Car miles 22,180,185
Roadbed	5,091,696	3,988,000	5,952,893	4,812,000
Overhead electric construction	—	—	1,620,908	1,500,000
Real estate	} 4,843,373	3,000,000	4,659,573	2,500,000
Stables, car houses and shops		2,000,000	1,660,895	1,661,000
Power station buildings	—	—	} 3,276,315	1,000,000
" " equipment	—	—		2,000,000
Cars and equipment	1,551,397	2,169,000	5,253,797	3,263,000
Horses	1,035,552	1,035,000	—	—
General equipment	388,588	400,000	500,876	501,000
Total	12,910,606	12,592,000	22,925,257	17,237,000

may be added for bridging and various engineering difficulties connected with roadbed, the sum total becoming therefore $17,500 per mile, or $4,812,500 for the entire roadbed. The actual cost of roadbed (263 miles owned), as appearing in the balance sheet of the West End Company on Sept. 30, 1895, was $5,952,893, which undoubtedly includes a certain amount of duplication of work due to the equipment of the horse road by electricity, and also represents the higher prices for rails of years ago.

The rails necessary for horse traction may properly be considerably lighter than those for electric traction, a good standard of construction being a sixty-five pound girder rail, with twenty-four inch joint plates, spiked to stringers, which are in turn fastened to ties spaced three feet apart. Such a construction would, of course, be far superior to the old horse railway types generally used, but would cost little more per mile at present prices than formerly, and would be more economical in the end. The special work would be somewhat less expensive than with electric traction and no bonding of rails would be required, but the saving in such a horse railway roadbed over the electric railway roadbed would hardly amount to $2500 per mile, since the labor items would be practically the same, and the cost of the wooden substructure would go far to balance the saving of forty to fifty tons of iron per mile, and the cheaper special work. I have assumed, however, in order to make every fair allowance, that a horse railway roadbed would cost only $12,500 per mile plus about $2000 per mile for bridging and engineering difficulties. The total cost for the 275 miles in the system would therefore be $3,987,500. This figure compares with a balance sheet item on Sept. 30, 1889 (for 237 miles of track owned), of $4,679,096 plus $412,601 charged separately to "construction electric road". The difference is considerable, but this balance sheet item is of little value as a check because it is made up of items taken from the books of the five or six companies which were consolidated with the West End Company in 1888, and probably represents a price somewhat larger than that necessary for duplicating the construction even at that time.

Overhead Electric Construction.—The balance sheet figure on Sept. 30, 1895, for the entire overhead electric equipment of the West End road was $1,620,908. A large part of this construction was made at a time of higher prices for copper, for line appliances and for engineering and other labor. If the work were to be repeated to-day the cost would undoubtedly be much less. On the other hand the company has built several miles of underground conduit (forty-one miles of feeder ducts), the cost of which has been large and has been charged wholly to operating expenses, whereas a portion of this charge at least might have been conservatively carried to investment account. It is impossible to do more than to form a rough guess as to the cost of duplicating at present prices the overhead and underground construction in the best possible manner, without going into elaborate calculations as to the amount of feed wire capacity necessary for the distribution of electricity over the entire city. If, however, we assume a cost of $8000 per mile of street or $1,200,000 in toto for the overhead conrtruction, and if we add an arbitrary sum of $300,000 for underground conduit work required in the business heart of the city, we should probably have a fair approximation to the total present cost of an excellent distributing system. This item, therefore, appears in the estimates as $1,500,000.

Real Estate and Buildings.—The real estate account in the balance sheet for Sept. 30, 1889, was $4,843,373, this figure including buildings. The real estate account in the balance sheet for Sept. 30, 1895, was $4,659,573. This latter figure did not include power station buildings, car houses or shops, but was apparently for land alone.

Here, again, there is no possibility of analyzing figures or of making other than merely arbitrary changes. The company has always been far sighted enough, undoubtedly, to purchase land considerably in advance of its immediate requirements. It would, probably, be fair to assume that the cost of the land absolutely necessary for the operation of a horse road, as specified, would not exceed $2,500,000, and that the cost of the land necessary for the smaller building capacity of an electric road would not exceed the same amount in spite of the fact that high priced land for the power station is usually required. If the West End Company were to re-equip its road it would hardly build an enormous station in the heart of the city, but would have four or five stations placed in different parts of the city on cheaper land. This, together with the sales of unnecessary land, would materially reduce the enormous figure of $4,659,573.

I have assumed that the cost of car houses and shops given in the balance sheet of 1895 is reasonable, although it probably represents a slightly larger sum than the cost of duplication to-day, because of the changes which have been made to adapt old car houses to electric service. I have estimated the cost of power station buildings in several parts of the city at $1,000,000, a sum much larger, of course, than that required for the construction of a single large station. The cost of stables, car houses and all other buildings necessary for the operation of a horse railway would certainly not be less than $2,500,000, which figure, together with the value of land, corresponds very well with the item of $4,843,373 for "real estate and buildings" in the balance sheet for 1889.

Equipment.—The actual equipment of the road in 1889 and 1895 may be seen in Table I. This equipment covered, of course, spare cars, and, probably, was all needed, inasmuch as the peculiar conditions of Boston, where there are so many different routes, nearly all passing through three or four streets in the business heart of the city, make it impossible to paint all cars alike and, therefore, reduce the number of spare cars to a minimum.

Now, 956 closed cars and 885 open cars were apparently necessary in 1889 for the operation of 16,573,831 car miles. It is, therefore, reasonable to presume that if this service should be increased to 22,180,125 car miles without change of motive power, a proportionately large number of cars would be required. This may not be exactly true, but it is a near enough approximation for the purpose, and the only one which we can form, based on the actual experience of this particular road. I have assumed, therefore, that 1280 closed cars and 1185 open cars would be required in equipping the 275 mile horse system for the larger annual car mileage.

By inspecting the equipment figures for 1895 it appears probable that the number of horse cars in actual service will not exceed forty-five closed and forty-five open, this figure being based on the number of horses owned by the company, a large number of which are undoubtedly necessary for truckage. I have, therefore, assumed that the necessary electric car equipment will be 918 closed and 886 open cars.

In 1889, the company owned 7728 horses. I assume that they will require a proportionally larger number, viz., 10,350, to give the larger car mileage.

In 1895, the company owned 2108 electric motors. Some of these are of the earlier types, are not as powerful as the later, and cannot be used to the same advantage. It is probable that a much less number than 2000 will be necessary for giving the required service, but I have assumed this figure.

It is probable that a 25,000 h. p. station plant, placed at perhaps five centers of distribution throughout the city would operate the entire system on the heaviest traffic days of the year. The equipment in 1895 was about 20,000 h. p.

The following average prices are assumed for the equipment:

Closed cars and trucks for electric service (about 50 p. c. are "long," or "double truck" cars.)	$1500
Open cars and trucks for electric service	1000
Closed cars and trucks for horse service	1000
Open cars and trucks for horse service	750
Twenty-five horse power motors, equipment and labor	500
Horses, present (low) prices	100
Station plant per horse power, including boilers, engines, dynamos and all accessory appliances	80

The above prices are fairly close and are based on large orders. They provide for the most perfect equipment possible to obtain at the present time. Some comment is necessary on the individual items in the investment account. It will be seen that the balance sheet item in 1895, for cars and equipment is $5,253,797, as against my estimate of $3,263,000, a difference of nearly $2,000,000. The explanation of this is that the West End Company purchased a very large proportion of its equipment in the days of high prices—prices which averaged perhaps 25 p. c. greater on car bodies and trucks, and 200, 300 or even 400 p. c. greater on electric equipment. The balance sheet items for power station equipment and buildings was, in 1895, $3,276,315, while the estimated cost for the equipment alone is $2,000,000. The last named figure is large—larger than would be found in an actual purchase to-day—but it means slow speed direct connected engine dynamos at prices per horse power approximating, perhaps, those which the West End Company had to pay for a high speed, belted, generating plant of small units.

General Equipment.—This item, in 1889, appears in the balance sheet as $388,588. With a modern road equipped in the best possible manner it would, probably, be somewhat higher, and I have assumed $400,000. In 1895 this item appears as $500,876 (including horses), and I have assumed this figure as being reasonable.

The estimated cost of construction and equipment of a horse and electric road built in Boston in 1896 appears, therefore, in detail in the second and fourth columns of Table II, the first and third columns giving the actual balance sheet assets of 1889 and 1895, which will be useful for comparisons. If my figures are correct, a 275 mile horse railway equipped in such a way as to operate about 22,000,000 car miles should cost, in Boston, about $12,592,000, while an electric road of the same length and for the same service would cost about $17,237,000.

We are now prepared to take up a discussion of the comparative expenses of the 275 mile system equipped for operation by horses and by electricity. In the first column of Table III will be found the actual expenses of the West End Company in 1889, operating 253 miles of track almost entirely by horses. In the second column will be found the actual expenses for 1895, in which year the company operated 275 miles of track substantially as an electric railway. In the third and fourth columns will be found my estimates of the probable cost of operating a 275 mile road laid out as hereinbefore specified, if all the equipment is of the best as provided for in the estimates of cost.

The West End Company is being run to-day with great attention to detail, and upon an exceedingly economical basis. It is believed that there are very few wastes in the system and that the interests of the stockholders are being cared for most thoroughly. The expenses for 1895 are probably as low, in all administrative items, as it would be possible to make them for the best interests of the system. The year ending Sept. 30, 1889, was a good average year for the West End Company, although the consolidation had been but recently effected.

The changes brought about in these figures by assuming the road and equipment to be perfectly new, of the latest and most modern type of to-day and operated under present conditions will now be taken up in detail.

General Expenses.—The salaries of general officers and clerks and the general office expenses and supplies may be assumed to be the same for our "perfect electric road" as the actual figures for 1895, and there will be no serious mistake to assume also that these are proper and reasonable charges for the horse railway. The number of general employes and the grade of intelligence required is dependent more upon the car mileage run than upon the kind of motive power adopted.

The legal expenses, injuries and damages may also be assumed to be the same for an electric road as the figures for 1895. Injuries and damages are apparently taken care of on the West End road by accident insurance, as this item of $240,000 appears in several of the recent annual reports. There is no reason to suppose that there will be any large increase per car mile in years to come. In 1889, the figure corresponding to these two items amounted to $.00944 per car mile, and, as it is not probable that they would increase exactly in proportion to the total car mileage, I have assumed that for our new horse road the legal expenses will be $.002 and injuries and damages $.007 per car mile. Of course the liability to accident is somewhat greater with the more rapidly moving electric cars than it is with the horse cars, although not proportionally so, since an electric car can be more readily controlled by reversal and other means than a horse car.

I have assumed insurance for the electric road at the same figure per car mile as is found in the operating reports of 1889 and 1895.

For the horse railway this item would increase with the amount of equipment and housing capacity for horses and cars, and therefore is roughly proportional to the car mileage.

The item "other general expenses" in column C includes various expenses such as those for inspectors, transfer agents, advertising etc., which are frequently charged to transportation expenses, and as there is no corresponding item under general expenses in the horse railway figures for 1889, I have preferred to add this sum ($240,015) to "other transportation expenses" ($174,768) and include it in the general division of "transportation expenses" instead of "general expenses".

of 1000 to 1500 h. p. The conditions under which its stations have been operating, however, are such as to be much less economical than what would be the case with new stations, and from all the experience which has been gained on other roads, and taking into account the large proportion of long double truck cars owned by the company, it seems probable that $.015 per car mile would cover the current expenses of well designed power stations of large size including fuel, water and labor, exclusive of repairs and renewals.

The item of superintendence and general expenses, found in the horse railway report for 1889, amounted at that time to $.01135 per car mile. It will probably not increase in proportion to the car mileage, and I have assumed that it does not amount to over $.01 per car mile, or $221,801 in toto.

TABLE III.

COMPARATIVE OPERATING EXPENSES OF A STREET RAILWAY SYSTEM IN BOSTON, MASS., EQUIPPED FOR OPERATION BY HORSES AND BY ELECTRICITY.

	Accounts.	Actual Operating Expenses.				Estimated Operating Expenses.			
		1889.		1895.		Horse.		Electric.	
		Total	Per Car Mile.	Total	Per Car Mile	Total	Per Car Mile	Total	Per Car Mile
		A	B	C	D	E	F	G	H
	GENERAL EXPENSES.								
1	Salaries of general officers and clerks.	} 187,941	.01134	127,700	.00576	127,700	.00576	127,700	.00576
2	General office expenses and supplies.			67,880	.00306	67,880	.00306	67,880	.00306
3	Legal expenses.	} 156,537	.00944	65,313	.00294	44,360	.00200	65,313	.00294
4	Injuries and damages.			240,000	.01082	155,261	.00700	240,000	.01082
5	Insurance.	35,754	.00216	62,053	.00280	47,909	.00216	62,053	.00280
6	Other general expenses			240,015	.01082				
7	Total	380,232	.02295	802,961	.03620	443,110	.01998	562,946	.02538
	TRANSPORTATION EXPENSES.								
8	Provender	588,773	.03553	62,833	.00283	554,503	.02500		
9	Electro-motive power.	*31,602	.00191	403,403	.01819			332,702	.01500
10	Wages.			2,191,754	.09883			2,191,754	.09883
11	Superintendence and general expenses.	188,042	.01135			221,801	.01000		
12	Stable service	464,876	.02806			684,475	.03086		
13	Stable and station supplies and expenses.	93,301	.00563			124,874	.00563		
14	Car service and expenses	1,441,374	.08695			2,121,528	.09565		
15	Trackage rights			2,693	.00012			2,693	.00012
16	Rentals of buildings and other property	22,488	.00135	28,363	.00128	22,488	.00101	28,363	.00128
17	Other transportation expenses.			174,768	.00788			414,783	.01870
18	Total.	2,830,456	.17079	2,863,814	.12912	3,729,669	.16815	2,970,295	.13393
	MAINTENANCE OF ROADWAY AND BUILDINGS.								
19	Repairs of roadway and track	} 234,789	.01417	} 692,051	.03120	68,750	.00310	137,500	.00620
20	Renewals of " " "					251,400	.01133	306,000	.01380
21	Repairs of overhead electric construction.			} 225,017	.01015			75,000	.00338
22	Renewals of " " "							52,130	.00235
23	Repairs and renewals of buildings.	66,299	.00400	50,989	.00230	62,500	.00281	66,525	.00300
24	Repairs of power station equipment							10,000	.00045
25	Renewals of " " "							6,050	.00027
26	Removal of snow and ice	9,273	.00056	46,002	.00207	60,000	.00271	40,000	.00180
27	Total	310,361	.01873	1,014,059	.04572	442,650	.01995	693,205	.03125
	MAINTENANCE OF EQUIPMENT.								
28	Repairs of car bodies and trucks.	} 259,638	.01567	623,450	.02811	221,801	.01000	277,252	.01250
29	Renewals of " " "					65,600	.00296	179,900	.00811
30	Repairs of electric car equipment							110.900	.00500
31	Renewals of " " "							79,500	.00358
32	Maintenance of tools and machinery.	7,854	.00047						
33	Harness, horse shoeing and veterinary care.	167,123	.01009	27,647	.00124	223,797	.01009		
34	Renewals of horses	143,355	.00866	92,073	.00415	166,351	.00750		
35	Total	577,970	.03489	743,170	.03350	677,549	.03055	647,552	.02919
36	Total operating expenses	4,099,019	.24737	5,424,004	.24455	5,292,978	.23864	4,873,998	.21975

* Including maintenance of motors and line.

The total general expenses made up in this way are therefore seen to be $443,110, or $.01998 per car mile for the horse railway, and $562,946, or $.02538 per car mile for the electric railway, a difference of $119,836, or $.0054 per car mile in favor of the horse railway.

Transportation Expenses.—The cost of provender was, in 1889, $.03553 per car mile. There has since been, however, a heavy reduction in prices for all kinds of grain, and it seems probable that the comparative cost of provender at present would not exceed $.025 per car mile. This would amount to $554,503 for the new horse railway.

The power station equipment originally put in by the West End Company consisted of a large number of small generators ranging from 80 h. p. to 500 h. p. A few of these are still in operation, but the company has been gradually installing larger machines until now it has a few 2000 h. p. direct connected units and several others

In considering the items for stable service and car service and expenses, a peculiar condition confronts us as requiring special reasoning. The introduction of electrically propelled cars has raised the standard of intelligence required of street railway employes, and has raised their daily wages from ten to twenty per cent. This has established new wage standards for street railway employes, so that it would probably be impossible to secure to-day a large body of men to handle a horse railway for the same wages as were offered in 1889. If, therefore, we are to deal with the exact problems presented in building a horse railway of to-day, as has been done in other items throughout, we must take this fact into account, and I have assumed that the items of stable service and of car service and expenses are increased 10 p. c. per car mile, which is about half the actual increase on the West End road.

Stable and station supplies and expenses I have assumed at the same figure per car mile as in 1889. The other items in transportation expenses are self-explanatory.

The total estimated transportation expenses for the new horse road therefore become $3,729,669, an average of $.16815 per car mile, while the total transportation expenses for the electric road become $2,970,295, equal to $.13393 per car mile.

In dealing with the estimates for maintenance we will have to break away somewhat more from the established figures in 1889 and 1895 than is necessary in dealing with general expenses and transportation, for the reason that the cost of depreciation and renewals has not yet been established on the West End road, certainly for the electric system and probably also for the horse railway system, although the figures of 1889 undoubtedly include, to a large extent, renewals as well as current repairs. The actual figures in both years will be valuable, however, as a check upon the estimates which I shall make on an entirely different basis.

Maintenance of Roadway and Buildings.—An entirely new roadbed laid with sixty-five and ninety pound rails with long channel bar or cast welded joints and rails butted close together ought to last an average of ten years time in Boston before being taken up and replaced by new rail. There are certain heavily worked sections, amounting to perhaps ten or fifteen miles of track in all, which will not last as long as this—perhaps even no longer than five years—as over 2000 cars per day pass over these joints. The proportion of special work, too, is, as above stated, larger in Boston than in most cities. The roadbed as a whole ought, however, to have a life of ten years.

For the first year or two after such a roadbed is put in, the current repairs will be little or nothing. It is hoped that these deep girder rails in electric service will make low joints nearly impossible, but we cannot be sure of this in view of the fact that electric motor cars in the past have had such a serious effect upon the rail joints. It will be, I think, fairly safe to assume that the annual charge for ordinary repairs only during the life of a roadbed will not exceed $250 per mile of track for the horse railway system in Boston, and $500 per mile of track for the electric railway system. These figures are all placed in the estimates.

In estimating the renewal account, I have assumed a salvage of $1000 per mile at the end of the ten years' life, and have also assumed that the charges for engineering difficulties will not have to be repeated. I have therefore amortized at 5 p. c. compound interest the sum of $11,500 per mile of track for the horse road, and $14,000 per mile of track for the electric road, and find that the annual charge to renewal account should be $251,400 in the first case and $306,000 in the second.

The combination of these two items for the horse railway system compares very well with the actual figures in 1889, bearing in mind, of course, the fact that the roadbed of that day was far inferior to that proposed to be laid down. The combination of the electric estimates is considerably smaller than the actual figures for 1895. This is entirely explainable. The roadbed of the West End Company is to-day in a most heterogeneous condition. There are many different types of rail sections and joints, and comparatively little of the deep girder construction, although the company is now gradually converting its mileage to this standard. The fact that it is charging the cost of such construction to operating expenses, joined to the heavy cost of current repairs on defective track, brings the "repair account" up to the heavy total of over $2500 per mile of track. If this road were completely laid with the heavy rail, I think the above estimates would be possible.

An entirely new overhead electric construction put up in the best possible manner with modern appliances, ought to last for at least fifteen years without complete renewal, and to have a salvage of 25 p. c. at the end of that time, this salvage being chiefly in copper. During that life the sum of $500 per mile of street ought to cover the current repairs. I therefore assume $75,000 as the annual repair account, and $52,130 as the annual renewal account. The last named figure at 5 p. c. compound interest will amount in fifteen years to $1,125,000.

The sum charged to this account in 1895 is much greater than this, due in part to the imperfection of the appliances originally used, and in part to the fact that the cost of 2.24 miles of underground feeder conduits has been charged to operating expenses instead of to construction account. In 1894 the cost of repairs of electric line construction amounted to only $87,442.

I have assumed that the life of well constructed brick buildings will be fifty years, and the current repairs during that life will be 2 p. c. per annum—this for both horse and electric roads. The combined repair and renewal account will therefore amount to practically 2½ p. c. upon the original cost, or $62,500 and $66,525 respectively.

The life of the steam plant in the power station will probably be not less than fifteen years, and of the electric plant not less than twenty-five years. As the cost per horse power of the steam plant will be not far different from that of the electric plant we may assume a general average life of twenty years for the power station plant. During this time the current repairs ought not to average more than 5 p. c.

The item of removal of snow and ice is variable, depending, of course, upon climatic conditions in different years. After inspection of such of the West End figures as are available, I have estimated the average cost of removal from year to year at $60,000 per annum for the horse road, and $40,000 per annum for the electric road, the latter figure being less, inasmuch as by the use of mechanical power instead of horse power for operating plows, etc., the cost is materially reduced.

The total account for maintenance of roadway and buildings thus comes to $442,650 or $.01995 per car mile for the horse road, and $693,205 or $.03125 per car mile for the electric road.

Maintenance of Equipment.—The ordinary current repairs of car bodies and trucks with a traffic similar to that of the West End Company ought not to exceed $.01 for horse cars, and $.0125 for electric cars. This latter figure amounts to about $150 per annum for each closed electric car, and $100 per annum for each open car, and leaves a sufficient amount for repairs on plows, scrapers and other vehicles. This ought easily to cover the cost of varnishing once or twice a year, painting once in two years, and repairs due to accidents and all other causes affecting car bodies and trucks exclusive of motors.

We may assume with entire safety that the life of a well built horse car will be twenty years, and an electric car and truck ten years. The renewal account therefore becomes $65,600 and $179,900 respectively.

The combined repairs and renewals for the horse railway correspond fairly well with the figures for 1889, when it is considered that much of the equipment taken over by the West End Company at the time of its consolidation was doubtless in poor condition and required considerable work to bring it up to the standard. The actual figures for 1895, amounting to $.02811 per car mile, are abnormally high, due doubtless, to the large amount of reconstruction of cars necessary to adapt them to electric service, this cost being conservatively charged to operating expenses.

The electric motors of to-day are so well built and so cheap that the cost of repairs to the electric car equipment should not exceed $.005 per car mile for the life of the motor, and the latter should be at least ten years. In fact to assume a cost of $.0175 for the current repairs of a complete electric car is to assume a figure considerably above what is being achieved by not a few large electric railways operating under conditions approximately as severe as those in Boston. It is probable, however, that the lower figures would increase somewhat from year to year so that the sum taken will represent perhaps a fair average.

The cost of harness, horseshoeing and veterinary care will probably be slightly greater per car mile than was the case in 1889, on account of the increase in cost of labor. I have assumed it, however, to be the same, namely, $.01009, or $223,797 in toto.

I have estimated the cost of renewals of horses at $.0075 per car mile instead of $.00866 in 1889 on account of the lower prices for horses to-day.

The totals for maintenance of equipment become therefore $677,549, or $.03055 per car mile for the horse road, and $647,552, or $.02919 per car mile for the electric road.

The total estimated operating expenses amount to $5,292,978 or $.23864 per car mile for the horse railway, and $4,873,998 or $.21975 per car mile for the electric railway.

TABLE IV.

GROSS RECEIPTS AND CAR MILEAGE OF THE WEST END SYSTEM OF BOSTON FOR ELEVEN YEARS.

	Gross Receipts.	% inc.	Car Miles.	% inc.	G. R. per C. M.
1885	$4,039,741		14,411,110		$ .280
1886	4,440,481	9.9	15,105,161	4.8	.294
1887	4,665,020	5.1	14,703,251	2.7*	.319
1888	4,887,737	4.8	15,415,802	4.8	.317
1889	5,249,903	7.4	16,573,831	7.5	.327
1890	5,780,083	10.1	17,665,360	6.6	.327
1891	5,968,984	3.3	17,462,572	1.1*	.342
1892	6,317,205	5.8	17,498,660	0.2	.361
1893	6,692,578	5.9	18,669,809	6.7	.359
1894	6,823,879	2.0	19,240,486	3.1	.355
1895	7,624,277	11.7	22,180,125	15.3	.344

*Decrease.

It will thus be seen that there is a direct saving by electric motive power over horse power of $418,980 or $.01889 per car mile in the operation of 22,180,125 car miles over a 275 mile system. It will not be fair however to assume that this is the only advantage obtained by the use of electricity. Horse cars cannot possibly run so fast as electric cars and cannot possibly, therefore, attract as many passengers as the latter, since speed in transit is a most important consideration in competition with other transportation agencies. The horse railways will not earn so much per car mile as the electric roads, with the same car mileage, and the next question for consideration is therefore

What is a reasonable estimate of the gross receipts of a horse railway system operating 22,180,125 car miles in Boston?

Some light is thrown upon this question by a comparison of the figures in Table IV, which shows the gross receipts and car mileage for the West End system in 1888 and thereafter, and for the constituent companies for several years prior to 1888. It will be seen that the gross receipts per car mile for the old horse railway system ranged from $.280 to $.319 between the years 1885 and 1888, and that in 1889 and thereafter the effect of the added speeds of electric traction began to be more and more apparent. The gross receipts per car mile reached a maximum in 1892 at $.361, when the service in car miles actually showed a decrease from the previous year, while the traffic increased. The gross receipts per car mile have since been steadily decreasing, and in 1895 are but $.349. This has come about through an increase of 15.3 p. c. in the car mileage for 1895 over 1894, and an increase of 13.5 p. c. in gross receipts.

Now, a horse railway system in Boston operating 22,180,125 miles over existing routes and under present competitive conditions would not earn anything like $.349 per car mile, even if such a service could be given, which is probably impossible on account of the congested condition of Washington and Tremont Streets even with the easily handled and less numerous electric cars. It is probable that the gross receipts would drop to $.27 or $.28 per car mile, but in order to make all possible allowances in favor of horse traction I will assume $.30 per car mile as a possible figure.

The comparative operating statement of the two systems would therefore stand as follows:

	Horse Railway System.	Electric Railway System.
Gross receipts	$6,654,038	$7,624,277
Operating expenses	5,292,978	4,873,998
Earnings from operation	$1,361,060	$2,750,279
Deductions from income.		
Taxes	237,500	325.300
Net income	$1,123,560	$2,424,979

I have assumed the actual taxes for 1895 for the electric road, and for convenience in calculation I have assumed that the taxes for the horse road would be less in direct proportion to the two investment accounts. This is, of course, only a rough approximation, but it is sufficiently favorable to the horse system inasmuch as the land and buildings account would be somewhat greater with a horse road than with an electric, and it is this class of property that has to stand the large part of the burden of taxation.

Finally, then, as a result of all our discussion, we find that the electric system should earn $2,424,979 net, equivalent to 14.07 p. c. on the necessary investment of $17,237,000, while the horse railway system will earn $1,123,560 net, equivalent to 8.9 p. c. upon its total investment of $12,592,000.

It should be noted, in conclusion, that this result is brought about in a city where it is very difficult to obtain the full advantage of electric traction for the reasons which have been set forth. In Dr. Bell's article in the STREET RAILWAY JOURNAL for February, 1896, it was shown that the increase in schedule speeds in all except the outlying suburbs of Boston has been slight. As a matter of fact, the daily mileage of the horse cars on the old Boston system was about sixty to sixty-five, and this has been increased to only eighty to eighty-five miles with the electric system. If it were possible to raise this average speed to even one hundred miles, as is done in most other cities, the operating expenses per car mile would be cut down very materially and there would be a large increase in net earnings. This small mileage per car day is really the cause of the large operating expenses per car mile in Boston which have excited so much comment in various slight discussions of the cost of electric traction.

Annual Report of the Twin City Rapid Transit Company of Minneapolis, Minn.

The annual report of this company is always looked for with much interest, as its results are presented in a clear and distinct way, and one adapted for accurate comparisons. The following is an abstract of the latest report.

OPERATION.

Year ending December 31,	1893.	1894.	1895.
Receipts from passengers	$2,164,925	$1,981,706	$1,964,773
" " other sources	24,232	21,973	24,031
" total	2,189,157	2,003,678	1,988,803
General operating expenses	1,264,408	890,031	846,892
Other " "	145,824	154,516	132,593
Surplus earnings	$778,925	$959,131	$1,009,319
Deductions from earnings.			
Interest on funded debt	604,939	660,300	649,753
" " floating debt	6,551	25,722	52,015
Taxes	51,144	52,939	49,071
Net income	$116,291	$220,170	$258,479

GENERAL OPERATING EXPENSES IN DETAIL.

	1893.	1894.	1895.
General expense	$ 94,281	$ 61,162	$ 56,934
Maintenance of equipment	180,831	103,350	81,816
" " way and structure	98,931	66,607	58,069
Conductors' and motormen's wages	452,687	369,598	378,256
Inspectors' and transfer agents' wages	27,252	14,300	8,859
Conducting transportation, miscellaneous	144,518	90,639	87,131
Cost of maintaining power stations	229,358	161,375	154,104
Machine shop expense	36,550	23,000	21,722
	$1,264,408	$890,031	$846,892

CONDUCTING TRANSPORTATION IN DETAIL.

	1893.	1894.	1895.
Miscellaneous car expense	$32,917	$23,129	$23,076
Station expense, labor, etc.	78,297	45,653	44,388
Fuel for cars and stations	15,910	9,692	8,952
Electric lighting "supplies"	1,190	969	383
Oil and waste for cars	3,550	2,200	2,172
Electric supplies for cars	3,739	3,150	3,362
Stationery and printing for stations	2,301	1,826	1,863
Transfers and transfer supplies	3,118	3,493	2,936
Strike, additional expense	3,496	528	
	$144,518	$90,639	$87,131

INTERURBAN LINE.

The following reference is make to the operation of the interurban line between St. Paul and Minneapolis:

"In 1891 the gross receipts were $252,079 the operating expenses were $111,058 and the surplus earnings $141,021. In 1895 the gross receipts were $362,637, the operating expenses $120,209 and the surplus earnings $242,428. The percentage of operating expenses to gross earnings in 1891 was 44,06 p. c. and in 1895, 33.15 p. c. The gross earnings per car mile run in 1892 were 26.72 cents, in 1895, 32.42 cents. The cost of operating per car mile run in 1892 was 11.83 cents, in 1895, 10.75 cents."

In the report the reason for the substantial reductions in the different items of operating expenses is explained in the following manner:

The decrease of general expenses comes about through a reduction in salaries and the effecting of economies through the consolidation of the two systems under one management, together with a large difference in the cost of removing snow and ice, these items being in 1893, over $22,000, in 1894, less than one-half this figure and in 1895, less than one-quarter.

In explaining the reduction in the "Cost of Maintenance and Equipment" the following figures are given:

	1893.	1894.	1895.
Repairs to motors	$105,021	$66,055	$48,527
" " car bodies	75,810	37,295	33,288
Total	$180,831	$103,350	$81,816

"In the latter part of 1892 and during 1893 we began the modification of our entire motor equipment in order to simplify the operation, increase the efficiency and reduce the cost of maintenance. This cost of modification accounts for the large amount charged to repairs of motors in 1893.

"The reduction of 1895 over that of 1894 is legitimate, due to the economy resulting from the simplification of construction and a reduction in the cost of labor and price of material.

"In 1893 we spent $75,810 in repairs to car bodies. A large part of this was the expense of the reconstruction of our horse cars, increasing their length and adapting them to electrical use."

The report states that the decrease in the maintenance of way and structure of 1894 over 1893 is the result of a new rail joint construction begun in 1892 and continued vigorously through 1893. It was a special joint put in the track where the traffic was the heaviest, and the results have been most satisfactory, lessening the expense not only of track, but also of rolling stock maintenance.

The reduction of "Wages of Inspectors and Transfer Agents" is stated to be due to the abolishing of transfer agents and the placing of transfers in the hands of conductors.

"The decrease in the two items 'Miscellaneous Car Expenses' and 'Station Expenses, Labor, etc.,' is due primarily to a reduction in forces employed, wages paid, consolidation and rearrangement of the methods of station operation and a general reduction in the cost of material used." The cost of "Maintaining Power Station" in 1893 is stated to be abnormally high as compared with 1894, due to the greater cost of fuel and the necessity of operating two stations, one with high speed engines during the overhauling of station No. 1. The entire Minneapolis system is now operated from one station.

"The saving in the machine shop expenses follows as a natural result of the above economies."

It will thus be seen that the above reductions are the results of improved methods of electrical construction and operation resulting in legitimate economies in all departments.

Statement by the Metropolitan Traction Company, of New York.

President H. H. Vreeland has recently made a statement to the stockholders of the Metropolitan Traction Company, regarding the results of operation so far achieved, and with the idea of enabling them to form a partial judgment as to the probable future value of the property.

The system of the company as now constituted consists of 25.34 miles of cable track, 6.78 miles of undergound conduit track and 131.38 miles of horse railway track, the total mileage (single track basis) being 163.5 miles. Of this mileage 46.93 miles, including the Broadway Railway and its extensions are owned, in fee; 24.12 miles are held under lease with the additional security that two-thirds of the stock of the subordinate companies is owned by the Traction Company; and 92.45 miles are held under long leases, in no instance less than ninety-nine years. In other words, nearly one-half of the system is practically owned in fee.

(*Continued on page 212.*)

STOCK AND BOND QUOTATIONS.

Notice.—These quotations are carefully revised from month to month by local bankers and brokers, and closely represent the market value of the different securities as tested by individual sales. Few of these, however, are actually quoted on city exchanges, and accuracy in the range of prices cannot, therefore, be vouched for.

Securities.—Active securities only are quoted in these tables, and the bond issues described do not necessarily constitute the entire funded indebtedness of the different properties. For a full and detailed description of all the securities, see American Street Railway Investments, published annually on March 15th.

Abbreviations.—The following abbreviations are used: M. mortgage; Gen. M. general mortgage; Cons. M. consolidated mortgage; deb. debentures; convert. convertible; in esc. in escrow; g. gold; guar. guaranteed; bds. bonds; int. interest; + in addition; auth. authorized; incl. including; cert. indebt. certificates of indebtedness; in tr. in trust; n nominal.

Company. STOCKS AND BONDS	Issued.	Due.	Quotations. 1896. High.	Low.	Feb. High.	Low.	Closing
ALBANY, N. Y.*—Local quotations to Feb. 11.							
Albany Ry. Co., Stock 100	1,250,000	....	136½	135½	135½	135½	135½
Cons. M. 5% bds. (incl. $112,000 in esc.).	500,000	1930	109	105½	....	....	....
Deb. 6% (convert.) bds	200,000	1901	....	....	....	....	....
Wat. T'p'ke & R.R. Co.'s 2d M. 6% bds.	150,000	1919	113½	111	....	....	....
Wat. Turnpike & R. R. Co., Stock. 100	240,000	......	....	....	....	....	....
1st M. 6% bds. (int. guar. by Alb'y Ry.	350,000	1919	114	113½	....	....	....
BALTIMORE, MD.*—Local quotations to Feb. 17.							
Baltimore Traction Co., Stock 25	5,750,000	......	19½	16¾	18½	17	18
1st M. 5% bds	1,500,000	1929	112½	110½	112½	112½	....
No. Balt. Div. 1st M 5% bds	1,750,000	1942	110½	107½	109	108	. .
Ext. and Imp. 6% bds	1,250,000	1901	105½	105	105½	105½	....
City & Suburban Ry. Co., Stock 50	4,000,000	......	50	46	48	46	....
Gen. M. 5% g. bds	3,000,000	1922	112	109½	110	109¾	....
Baltimore City Pass. Ry. Co., Stock 25	2,500,000	......	72	67½	69	68	....
1st. M. 5% g. bds	2,000,000	1911	115	114	115	114	....
Central Pass. Ry. Co., Stock 50	300,000	......	72½	68	....	....	...
Cons. M. 5% bds. (+ $151,000 in esc.)..	549,000	1932	112	111	112	111	....
1st M. 6% bds	151,000	1912	110	110	....	....	....
BOSTON, MASS.*—Local quotations to Feb. 17.							
West End St. Ry. Co., Stock, common 50	9,085,000	......	69¼	64	69¼	64½	68½ b
preferred 8%. 50	6,400,000	......	90	88	90	88	89¾ b
Deb. 5% g. bds	3,000,000	1902	105	103	105	104½	105 b
Deb. 4½% g. bds	2,000,000	1914	105¼	104	104½	104	....
North Shore Traction Co., Stock. common 100	4,000,000	......	....	....	....	....	....
preferred 6%. 100	2,000,000	......	83	80	....	....	....
Lynn & Boston R.R. Co.'s 1st Cons. M. 5% g. bds. (+ $1,677,000 in esc)	3,702,000	1924	....	....	....	....	....
BROOKLYN, N. Y.*—New York quotations to Feb. 21.							
Long Island Traction Co., Stock 100	30,000,000	......	22	11	22	18	21½
Coll. Tr. 6% g. notes	2,500,000	1895-7	96	96	96	96	96
Brooklyn Heights R. R. Co.							
1st M. 5% bds	250,000	1941	....	....	....	....	....
Brooklyn City R. R. Co., Stock 10	12,000,000	......	172	159	172	168	172
1st Cons. M. 5% bds	6,000,000	1941	113	109	113	111½	113
Brooklyn, Q. Co. & Sub. R. R. Co.							
1st M. 5% g. bds. (+ $350,000 in esc.)...	3,150,000	1941	102	98	102	99½	100
1st Cons. M. 5% g. bds	2,500,000	1941	80	80	80	80	80
Brooklyn Traction Co. Stock. common 100	6,000,000	......	11	7	11	8	11
preferred 6% 100	3,000,000	......	54	48	54	49	53
Atlantic Ave. R. R. Co.							
Gen. M. 5% bds	759,000	1909	107½	107	107½	107½	107½
Cons. M. 5% bds. (+ $1,034,000 in esc.)..	1,966,000	1931	108	105	108	105½	106
Imp. M. 5% g. bds	1,500,000	1934	82½	71	82½	71	80
B'kl'n, Bath & W. E. R. R. Co.							
Gen. M. 5% bds. (+ $552,000 in esc.)...	448,000	1933	85	85	85	85	85
Coney Isl. & B'kl'n R.R. Co., Stock 100	1,000,000	......	....	....	....	....	....
1st M. 5% bds	300,000	1904	....	....	....	....	....
Cert. Indebt. 6%	200,000	1910	....	....	....	....	....
B'kl'n City & Newt'n R.R.Co. Stock 100	1,000,000	......	....	....	....	....	155 b
1st Cons. 5% bds	1,900,000	1939	111	109	111	109	111
BUFFALO, N. Y.*—New York quotations to Feb. 21.							
Buffalo Ry. Co., Stock 100	5,370,500	......	80	68	78	68	71½
1st Cons. M. 5% bds. (+ $1,457,000 in esc.)	3,543,000	1931	106	100	105½	102	105
Crosstown St. Ry. Co.'s 1st M. 5% bds.	2,200,000	1932	104	100	103½	101	103
CHARLESTON, S. C.*—Local quotations to Feb. 15.							
Enterprise St. R. R. Co., Stock 25	250,000	......	....	....	....	....	6
1st M. 5% bds.	50,000	1906	....	....	....	....	101
Charleston City Ry. Co., Stock 50	100,000	......	....	....	....	....	70
1st M. 6% bds	100,000	1915	....	....	....	....	112
CHICAGO, ILL.*—Local quotations to Feb. 21.							
Chicago & So. Side R. T. R. R. Co. Stock 100	7,500,000	......	7	4½	7	4½	4⅞
1st M. 5% bds	7,500,000	1929	60	59	60	59	59
Exten. 5% bds	3,000,000	1933	42	37	38	37	38
Chicago City Ry. Co., Stock 100	9,000,000	......	315	275	295	275	288
1st M. 4½% bds	4,619,500	60 d.	100½	100	100	100	100
Lake St. Elev. R.R., Stock 100	10,000,000	......	24¾	18½	23½	20	21⅞

Company. STOCKS AND BONDS.	Issued.	Due.	Quotations. 1896. High.	Low.	Feb. High.	Low.	Closing
CHICAGO, ILL.—Continued.							
Met. W. S. Elevated Ry., Stock 100	11,500,000	......	47	12½	14½	12½	14½
1st M. 5% bds	12,500,000	1942	68	65	67	67	67
North Chicago St. R. R. Co., Stock. 100	5,500,000	......	308½	248½	254½	245	248½
1st M. 5% bds	2,413,000	1906	104	104	104	104	104
Cert. Indebt. 6%	500,000	1911	....	....	....	....	....
No. Chi. Cy. Ry. Co.'s 1st M. 6% bds...	500,000	1900	....	....	....	....	....
" " " " " 2nd M. 4½% bds..	1,850,000	1927	....	....	....	....	....
" " " " " Deb. 6% bds......	550,000		102½	98	102½	98	102½
North Chicago City Ry. Co., Guar. Stock 100	500,000	......	....	....	....	...	...
West Chicago St. R. R. Co., Stock 100	13,189,000	......	114	100	109¾	105	105
1st M. 5% bds	4,100,000	1928	102	100	102	102	102
W.C S.R.R.Tunnel Co.'s 1st M. 5% bds.	1,500,000	1909	....	....	....	....	...
Deb. 6% bds	4,000,000	....	100	97	98½	97½	98
Chi. W. Div. Ry. Co.'s 1st M. 4½% bds.	4,040,000	1932	101	101	....	....	....
Chi. Pass. Ry. Co.'s 1st M. 6% bds.....	400,000	1905	109	108	....	....	....
" " " " Cons. M. 6% bds...	600,000	1929	....	....	....	....	....
Chicago W. Div. Ry. Co., Guar. Stock 100	1,250,000	....	600	600	....	...	....
CINCINNATI, O.*—Local quotations to Feb. 15.							
Cincinnati St. Ry. Co., Stock 50	11,000,000	....	112¾	111½	112¾	112	112¼
1st M. 7% bds	50,000	1896	....	....	....	....	....
1st M. 4% ext'n'd bds	100,000	....	....	....	....	....	....
" " 5% "	150,000	....	....	....	....	....	....
Mt. Adams & Eden Park Inclined Ry., Stock 50	2,500,000	....	112	109	109¾	109	109¾
1st M. 6% bds	50,000	1900	....	....	.. .	....	....
" " 6% "	100,000	1905	....	....	....	....	....
Cons. M. 5% bds	531,000	1906	....	....	....	....	....
Cincinnati, Newport & Covington St. Ry. Co., Stock 100	3,000,000	....	36¼	34	36½	35	36¾
Cons. M. 5% g. bds.(incl. $500,000 in esc.)	3,000,000	1922	98¾	97	98¾	98	98
So. Cov. & Cin. St. Ry. Co 1st M. 6% bds.	250,000	1912	....	....	....	...	....
" " " " " " " 2nd Cons. M. 6% g. bds. (incl. $250,000 in esc.).....	400,000	1932	....	....	....	. .	....
COLUMBUS, O.*—New York quotations to Feb. 21.							
Columbus St. Ry. Co., Stock 100	3,000,000	....	50½	44½	50½	44½	50
Cons. M. 5% g. bds.(incl. $780,000 in esc).	3,000,000	1932	100	93½	98	93½	97½
Crosstown St. Ry. Co.'s 1st. M. 5% g. bds. ($90,000 in esc.)	500,000	1933	95	90	....	....	95 b
COVINGTON, KY.*—(See Cincinnati.)							
DETROIT, MICH.*—Local quotations to Feb. 13.							
Detroit Citizens' St. Ry. Co., Stock. 100	1,250,000	....	100	100	100	100	100
1st M. 6% b is. (+$1,150,000 in esc)	1,150,000	....	100	100	100	100	100
Fort Wayn & Belle Isle Ry. Co., Stock 100	250,000	....	250	225	250	225	225
1st M. 6% g. bds. ($60,000 in tr.)	340,000	....	100	100	100	100	100
Wyandotte & Detroit River Ry. Co., Stock 100	200,000	....	110	100	110	100	100
Rapid Ry. Co., Stock	250,000	....	110	100	....	....	....
1st M. 5% bds	300,000	....	96	93	....	....	....
The Detroit Ry., Stock	1,000,000	....	....	....	....	....	....
1st M. 5% bds	1,800,000	1925	....	....	....	....	....
HARTFORD, CONN.*—See New Haven.							
HOBOKEN, N. J.*—See Newark.							
HOLYOKE, MASS.*—Local quotations to Feb. 13.							
Holyoke St. Ry. Co., Stock 100	250,000	....	210	200	200	....	200
Springfield St. Ry. Co., Stock 100	1,000,000	....	215	205	205	....	205
Northampton St. Ry. Co., Stock 100	225,000	....	195	185	185	...	185
INDIANAPOLIS, IND.*—New York quotations to Feb. 21.							
Citizens' St. R. R. Co., Stock 100	5,000,000	....	40	26	30½	26	30
Cons. M. 5% g. bds. (incl. $1,000,000 in esc.)	4,000,000	1933	90	81	86	81	85
JERSEY CITY, N. J.*—See Newark.							
LOUISVILLE, KY.*—Local and New York quotations to Feb. 21.							
Louisville Ry. Co., Stock, common 100	4,000,000	....	51½	46	51½	46	51
preferred 5% 100	2,000,000	. . .	101	95	110	99	100
Cons. M. 5% g. bds. (incl. $1,263,000 in esc.)	6,000,000	1930	109	105	108¾	106	108¼

*For detailed description of these and other securities issued, see **AMERICAN STREET RAILWAY INVESTMENTS**, a supplement to the **STREET RAILWAY JOURNAL**, published annually on March 15th.

Company. STOCKS AND BONDS.	Issued.	Due.	1896. High.	1896. Low.	Feb. High.	Feb. Low.	Feb. Closing
LYNN, MASS.*—See Boston.							
MINNEAPOLIS, MINN.*—New York quotations to Feb. 21.							
Twin City Rapid Transit Co. Stock. {com.. 100	15,000,000	....	25	25	25	25	25
{pref.7%	1,500,000	....	100	100	100	100	100
Minn. St. Ry. Co.'s Cons. M. 5% g. bds. (+ $960,000 in esc.)	4,040,000	1919	98	93	98	93	96
St. Paul City Ry. Co.'s Cab. Cons. 5% g. bds. (incl. $680,000 in esc.)	4,298,000	1937	93	85	88	85	86¾
St. Paul City Ry. Co.'s Deb. 6% g. bds.	1,000,000	1900	....	....	....	....	....
MONTREAL, CAN.*—Local quotations to Feb. 12.							
Montreal St. Ry. Co., Stock 50	4,000,000	....	226	206½	219	206½	219
1st M. 5% bds	300,000	1908	....	....	....	....	....
2nd M. 4½% bds	700,000	1922	....	....	....	....	....
NEW ALBANY, IND.*—See Louisville.							
NEWARK, N. J.*—New York and Philadelphia quotations to Feb. 21.							
Consolidated Traction Co., of N. J., Stock 100	15,000,000	....	25	22	25	22	22
1st M. 5% g. bds	11,711,000	1933	85	78¾	84	79	82¾
North Hudson Co. Ry. Co., Stock 25	1,000,000	....	....	....	....	....	....
Cons. M. 5% bds. (incl. $620,000 in esc.)	3,000,000	1928	....	....	....	....	....
2nd M. 5% bds	350,000	1928	....	....	....	....	....
Deb. 6% bds	500,000	1902	....	....	....	....	....
NEW HAVEN, CONN.*—Local quotations to Feb. 11.							
Fairhaven & Westville R. R. Co., Stock 25	600,000	....	53	53	53	53	53
Winchester Ave. R. R. Co., Stock 25	400 000	....	....	....	....	....	....
1st M. 5% g. bds	500,000	1912	102½	102	102	102	102½
Deb. 6% bds	100,000	1909	101	100	100	100	100
New Haven St. Ry. Co., 1st M. 5% bds.	600,000	1913	102	102	102	102	102
Hartford St. Ry. Co., Stock 100	200,000	....	219	215	215	215	215
H'd & W'th's'fl'd H. R. R. Co.'s deb. 5% bds	1,344,000	....	102	101	102	102	103
NEW ORLEANS, LA.*—New York quotations to Feb. 21.							
New Orleans Traction Co., Stock, {common.. 100	5,000,000	....	20	15¾	18	16	17
{pref. 6%.. 100	2,500,000	....	70	62¾	68	62¾	63½
N. O. City & Lake R. R. Co.'s 1st M. 5% g. bds. ($423,500 in esc.)	3,000,000	1943	102	99	102	100	100
Crescent City R. R. Co.'s Cons. M. 5% g. bds	2,350,000	1943	95	90	93	90	92
New Orleans & Carrollton R. R. Co., Stock 100	1,200,000	....	127	123	127	124	127
1st M. 6% bds	250,000	{1897 1906}	....	....	....	....	....
2d M. bds	350,000	{1905 1907}	....	....	....	....	....
Canal & Claiborne R. R. Co., Stock 40	240,000	....	48	46	47	46	46 b
1st M. 6% bds	150,000	1912	....	....	....	....	102 b
Orleans R. R. Co., Stock 50	185,000	....	46	44	46	45	44½
1st M. bds	18,000	....	114	111	112½	111	112½
St. Charles St. R. R. Co., Stock 50	594,350	....	68	63	67	63	64
1st M. 6% bds	150,000	1912	....	....	....	....	....
NEWPORT, R. I.*—See Providence.							
NEW YORK, N. Y.*—Local quotations to Feb. 21.							
Metropolitan Traction Co., Stock 100	30,000,000	....	108½	92	108⅜	102	106
Metropolitan St. Ry. Co., Stock 100	13,500,000	....	....	....	....	....	....
B'y. Surf. R. R. Co.'s 1st M. 5% bds	1,125,000	1924	114	112	114	112	113
" " " " 2nd M. 5% bds	1,000,000	1905	105	102	105	103	104½
So. Ferry R. R. Co., 1st. M. 5% bds	350,000	1919	107½	106	107½	106	106½
Lex. Ave. & P. F. Ry. Co.'s 1st M. 5% bds.	500,000	....	114	110	114	110	113¾
Broadway & Seventh Ave. R. R. Co., Guar Stock 100	2,100,000	....	197	190	195	190	192
Cons. M. 5% g. bds. (+ $4,850,000 in esc.)	7,650,000	1943	116	114	116	114	114
1st M. 5% bds	1,500,000	1904	107½	107	107½	107	107½
2nd M. 5% bds	500,000	1914	111	110	111	110	110½
Sixth Ave. R. R. Co., Guar. Stock 100	2,000,000	....	220	195	200	195	200
Ninth Avenue R. R. Co., Guar. Stock 100	800,000	....	....	....	....	....	160 b
Twenty-third St. Ry. Co., Guar. Stock 100	600,000	....	308	305	306	305	305 b
1st M. 6% bds	250,000	1909	115	115	115	115	115
Deb. 5% bds	150,000	1906	104	102	103	103	103
B'y. Surf. R. R. Co.'s 1st M. 5% bds	375,000	1924	114	112	114	112	113
42nd St. & G'd. St. Ferry R. R. Co., Guar. Stock 100	748,000	....	315	310	315	310	315
1st M. 6% bds	236,000	1909	116	116	116	116	116
Cent. Pk., No. & E. Riv. R. R. Co., Guar. Stock 100	1,800,000	....	165	160	165	160	164
Cons. M. 7% bds	1,200,000	1902	115	113	115	114	114
Bl'cker St. & Fulton Ferry R. R. Co. 100	900,000	....	30⅜	29½	30⅜	29½	30
1st M. 7% bds	700,000	1900	111	109	111	109	110
Third Avenue R. R. Co., Stock 100	9,000,000	....	186	172	186	175	182
1st M. 5% g. bds	5,000,000	1937	121	116	120	116	119
Second Avenue R. R. Co., Stock 100	1,862,000	....	165	150	163	154	160
Cons. M. 5% bds	1,600,000	1909	108¾	107⅛	108¾	107½	108½
Deb. 5% bds	300,000	1909	104	102	104	102	103
Eighth Avenue R. R. Co., Stock 100	1,000,000	....	360	333	345	333	340

Company. STOCKS AND BONDS.	Issued.	Due.	1896. High.	1896. Low.	Feb. High.	Feb. Low.	Feb. Closing
NEW YORK—Continued.							
Cert. Ind'bt. 6%	1,000,000	1914	110⅛	110	110⅛	110½	110⅛
42nd St., M. & St. N. Ave. Ry. Co., Stock 100	2,500,000	....	68	57	64	57	61
1st. M. 6% bds	1,200,000	1910	117	113	116	114	116
2nd M. inc. 6% bds	1,500,000	1915	71	65	71	68½	70
Dry Dock, E. B'y. & Battery R. R. Co., Stock 100	1,200,000	....	172	163	172	163	170
Gen. M. 5% g. bds	885,000	1932	114	113	114	113	114
Cert. ind'bt 5% 100	1,100,000	1914	103	100	103	100	102¾
Central Crosstown R. R. Co., Stock 100	600,000	....	200	190	195	190	195
1st M. 6% bds	250,000	1922	120	118	120	118	118
Christopher & 10th St. R. R. Co., Guar. Stock 100	650,000	....	155	150	155	155	155
Union Ry. Co., Stock 100	2,000,000	....	104	95	104	96⅜	101
1st M. 5% bds	2,000,000	1942	105	100	103	100	103
Westchester Elec. R. R. Co.'s 1st M. 5% bds	500,000	1943	100	99	100	100	100
NORTHAMPTON, MASS.*—See Holyoke.							
PATERSON, N. J.*—New York and Philadelphia quotations to Feb. 21.							
Paterson Ry. Co., Stock 100	1,250,000	....	28	22	28	25	28
Cons. M. 6% bds. (inc. $250,000 in esc.)	1,250,000	1931	100	94	100	98¾	99
PHILADELPHIA, PA.*—Local quotations to Feb. 18.							
Union Traction Co., Stock	....	....	....	....	12	10	....
Philadelphia Traction Co., Stock 50	15,000 000	....	71⅝	62	71⅝	65⅛	....
Coll. Tr. 4% g. bds	1,053,000	1917	....	....	....	....	....
Continental Pass. Ry. Co., Guar. Stock 50	1,000,000	....	129	128⅜	129	128½	....
1st M. 6% bds	350,000	1909	....	....	....	....	....
Empire Passenger Ry. Co, Stock 50	600,000	....	152	150	152	150	....
1st M. 7% bds	200,000	1900	....	....	....	....	....
Phila. City Pass. Ry. Co., Stock 50	475,000	....	176	170	174	170	....
1st M. 5% bds	200,000	1910	....	....	....	....	....
Phila. & G'ys Ferry Pass. Ry. Co., Guar. Stock 50	308,750	....	85	83	85	83	...
Ridge Ave. Pass. Ry. Co. Guar. Stock 50	420,000	....	250	240	250	240	...
13th & 15th Sts., Pass. Ry. Co., Guar. Stock 50	334,529	....	233	223¾	233	232	...
1st M. 7% bds	100,000	1903	....	....	....	....	...
Union Pass. Ry. Co., Guar. Stock 50	925,000	....	205	201	205	201	....
1st M. 5% bds	500,000	1911	....	....	....	....	....
2nd M. 5% bds	250,000	1910	....	....	....	....	....
W. Phila. Pass. Ry. Co., Guar. Stock 50	750,000	....	225	222	225	222	....
1st M. 6% g. bds	246,000	1906	....	....	....	....	....
2nd M. 5% bds	750,000	1926	....	....	....	....	....
Frankford & S'thw'k P. C. Pass. R. R. Co., Guar. Stock 50	1,875,000	....	325	320	325	320	....
Lombard & So. St. P. R. R. Co.'s 1st M. 5% bds	150,000	1901	92	90	92	90	....
West End P. Ry. Co.'s 1st M. 7% bds	132,100	1905	....	....	....	....	....
Citizens' Pass. Ry. Co., Guar. Stock 50	192,500	....	280	271	271	....	....
2nd & 3rd Sts. Ry. Co., Guar. Stock 50	848,160	....	227	225	227	225	....
Lehigh Ave. Ry. Co., Stock 50	599,950	....	52	51	52	51	....
People's Pass. Ry. Co., Stock {common 25	740,000	....	....	....	....	....	....
{preferred 25	277,402	1905	....	....	....	....	....
1st M. 7% bds	219,000	1905	....	....	....	....	....
Cons. M. 5% bds	246,000	1912			....	....	....
Germantown Pass. Ry. Co., Guar. Stock 50	572,800	....	130	120	130	120	...
Green & Coates Sts. P. P. Ry. Co., Guar. Stock 50	500,000	....	131	127	131	130	....
1st M. 6% bds	100,000	1898	....	....	....	....	....
Hest'v'e, Mantua & F'r'm't P. R. R. Co., Stock 50	2,500,000	....	49⅜	46	49⅜	46	....
PITTSBURGH, PA.*—Local quotations to Feb. 18.							
Citizens' Traction Co., Stock 50	3,000,000	....	56¼	55	56¼	56	....
1st M. 5% bds	1,250,000	1927	....	....	....	....	....
Pittsburgh Traction Co., Stock 50	2,500,000	....	....	....	....	....	....
1st M. 5% bds	750,000	1927	....	....	....	....	....
Duquesne Traction Co., Stock 50	3,000,000	....	34⅛	32⅞	34⅛	33	34½b
1st M. 5% bds	1,500,000	1930	102½	102¼	....	....	103 a
P'b'gh, Allegheny & Manch'r Tr. Co., Stock 50	3,000 000	....	38⅜	38⅛	....	....	39a
Gen. M. 5% bds	1,500,000	1931	106	106	106	106	106 b
P'b'gh Union P. Ry. Co.'s 1st. M. 5% bds.	100,000	1901	....	....	....	....	....
Federal St. & P. V. R. R. Co., Stock 25	1,400,000	....	19⅝	18⅞	19	18⅞	....
Gen. M. 5% bds.. (new)	1,250,000	1931	102¼	102¼	....	....	102 b
P'b'gh & Birmingham Tr. Co., Stock 50	3,000,000	....	16¾	15½	16¾	15½	....
Gen. M. 5% g. bds	1,500,000	1929	97½	96	97¼	96	96a
Central Traction Co., Stock 50	1,500,000	....	27	26	26	26	26b
1st M. 5% bds	375,000	1929	....	....	....	....	....
P'b'gh & West End P. Ry. Co., Stock 50	1,500,000	....	....	....	....	....	50a
1st. M. 5% bds	450,000	1922	....	....	....	....	....
PROVIDENCE, R. I.*—Local quotations to Feb. 13.							
United Traction & Electric Co., Stock 100	8,000,000	....	50	50	50	50	50
1st M. 5% g. bds	8,000,000	1933	100	100	100	100	100
Newport St. Ry. Co. 1st M. 5% bds	50,000	1910	100	95	100	95	95

*For detailed description of these and other securities issued, see **AMERICAN STREET RAILWAY INVESTMENTS**, a supplement to the **STREET RAILWAY JOURNAL**, published annually on March 15th

Company. STOCKS AND BONDS.	Issued.	Due.	Quotations. 1896. High.	1896. Low.	Feb. High.	Feb. Low.	Closing
ROCHESTER, N. Y.*—New York quotations to Feb. 21.							
Rochester Ry. Co., Stock............ 100	5,000,000	....	32	27	....	....	....
Cons. M. 5% g. bds. (incl. $1,000,000 in esc.)............	3,000,000	1930	106	100	103	100	103
2nd M. 5% g bds. (incl. $750,000 in esc.)	1,500,000	1933	85	85	....	....	85b
ST. LOUIS, MO.*—Local quotations to Feb. 14.							
St. Louis R. R. Co., Stock............ 100	2,000,000	....	144	135	138	135	138
1st M. 5% bds............	2,000,000	1900 } 1910 }	100	99	100	99	99
Citizens' Ry. Co., Stock............ 100	1,500,000	....	92	75	80	75	75
1st M. 6% bds............	1,500,000	1907	107	106½	107	106½	107
Cass Ave. & Fair Grounds Ry. Co., Stock............ 100	2,000,000	....	60	55	60	55	55
1st M. 5% bds............	1,911,000	1912	99	98½	99	98½	98½
Union Depot R. R. Co., Stock........ 100	4,000,000	....	160	160	160	160	160
Cons. M. 6% g. bds............	1,150,000	1918	110	109	110	109	109½
Benton. Bellef'ne Ry. Co.'s 1st M. 6% bds............	300,000	1896 } 1911 }	101	100	101	100	100½
Mound City R. R. Co.'s 1st M. 6% bds.	400,000	1900 } 1910 }	104	103	103½	103	103
Jefferson Ave. Ry. Co., Stock........ 100	112,000	....	....	....	....	....	....
1st M. 5% bds............	250,000	....	101	100	101	100	101
Missouri R. R. Co., Stock............ 100	2,300,000	....	208	205	205	205	205
1st M. 6% bds............	500,000	1907	101	100	101	100	100
Lindell Ry. Co., Stock............ 100	2,500,000	....	140	134	140	135	137
1st M. 5% bds............	1,500,000	1911	104½	104	104½	104	104
St. Louis & Suburban Ry. Co., Stock 100	2,500,000	....	35½	32	35½	32	33½
1st M. 5% bds. (incl. $600,000 in esc.)..	2,000,000	1921	96	94½	96	94½	94¾
Inc. 6% bds............	300,000	....	....	....	....	....	....
People's R. R. Co., Stock............ 50	1,000,000	....	22	10	22	20	20
1st M. 6% bds............	125,000	1892 } 1902 }	101	100	101	100	100
2nd M. 7% bds............	75,000	1902	101	100	101	100	100
Cons. M. 6% bds. (incl. $200,000 in esc.)	1,000,000	1899 } 1904 }	75	75	75	75	75
Fourth St. & Arsenal Ry. Co., Stock 50	150,000	....	20	18	20	18	18
1st M. 6% bds............	50,000	1898 } 1903 }	100	100	100	100	100
Southern Electric Ry. Co., Stock { common..... 100	700,000	....	42	40	42	40	40
{ preferred 6% 100	800,000	....	85	84	85	84	84
Cons. M. 6% bds (incl. $200,000 in esc.)	500,000	1909	107	107	107	107	107
St. L. & E. St. L. E. R. Co., Stock.. 100	250,000	....	....	....	....	....	...
1st. M. 6% bds............	75,000	1905	102½	102	102½	102	102
Baden & St. Louis R. R., Stock..... 100	50,000	....	....	....	....	....	....
1st M. 6% bds............	250,000	1913	100	99	100	99	100
SAN FRANCISCO, CAL.*—Local quotations to Feb. 15.							
Market Street Ry. Co., Stock........ 100	18,616,782	....	45¼	44	45¼	44	45
M'ket St. Cable Co.'s 1st M. 6% bds....	3,000,000	1913	123	121	123	121	123
Omnibus Cable Co.'s 1st M. 6% bds....	2,000,000	1918	119¼	119	119¼	119	119¼
Park & Ocean R. R. Co.'s 1st M. 6% bds.	250,000	1914	....	....	....	....	....
Park & Cliff House R. R. Co.'s 1st M. 6% bds............	350,000	1913	103	102½	103	103	103
Powell St. R. R. Co.'s 1st M. 6% bds...	700,000	1912	....	....	....	....	. . .
Ferries & Cliff House Ry. Co.'s 1st M. 6% bds............	650,000	1914	....	....	....	....	....
Geary St., P'k & O. R. R. Co., Stock 100	1,000,000	....	....	....	....	....	60
1st M. 5% bds............	671,000	1921	106	101	....	...	104
Cal. St. Cable R. R. Co., Stock..... 100	1,000,000	....	....	....	....	....	106
1st M. 5% g. bds............	900,000	1915	109⅞	109¾	109⅞	109¾	109⅞
Sutter Street Ry. Co., Stock....... 100	2,000,000	....	....	....	....	....	....
1st M. 5% g. bds............	900,000	1918	109¼	109¼	109¼	109¼	109¼
Presidio & Ferries R. R. Co., Stock 100	1,000,000	....	7½	7½	....	....	....
Oakland, S. L. & Haywards Ry. Co. Stock............ 100	1,000,000	....	....	....	....	....	....
SPRINGFIELD, MASS.*—(See Holyoke.)							
TORONTO, ONT.*—Local quotations to Feb. 12.							
Toronto Ry. Co., Stock............ 100	6,000,000	....	77	66½	76⅜	70¼	....
WASHINGTON, D. C.*—Local quotations to Feb. 17.							
Capital Traction Co.	2,000,000	....	77¼	75	....	....	....
Metropolitan R. R. Co, Stock....... 50	750,000	....	100¼	97	100¼	99	100½
Coll. Tr 6% conv. bds..	500,000	1901	114	110	113½	112	114
Belt Ry. Co., Stock............ 50	500,000	....	15	15	15	15	15
Cons. M. 6% bds. (inc. $50,000 in esc.)..	500,000	1921	84	80	82	80	81
Eckington & Soldiers' Home Ry. Co., Stock............ 50	352,000	....	17	14	17	14	17
1st M. 6% bds............	200,000	1896 } 1911 }	101	100	101	100	101
G'getown & Ten'town Ry. Co., Stock 50	200,000	....	17	14	14	14	14
Columbia Ry. Co............. 50	400,000	....	58	50	58	55	60
1st M. 6% bds............	500,000	1914	113½	112½	113½	113	114
WORCESTER, MASS.*—New York quotations to Feb. 21.							
Worcester Traction Co., Stock { common.. 100	3,000,000	....	15½	12	15½	12	15½
{ pref. 6%... 100	2,000,000	....	88½	80	88	84	86½
Worcester Cons. St. R. R. Co........		....	....	....	....	....	....
1st. M. 5% bds............	150,000	....	100	100	100	100	100
Deb. 5% g. bds............	500,000	....	99	99	99	99	99

* See foot note on preceding pages.

New York and Philadelphia quotations of Brooklyn, Buffalo, Columbus, Indianapolis, Louisville, New Orleans, New York City, Paterson, Rochester and Worcester. Securities furnished by Gustavus Maas, 26 Broad Street, New York.

(*Continued from page 209.*)

For the nine months ending Dec. 31, during which time partial benefits have been derived from the roads operated by mechanical traction, the net earnings of the company have been on a rising average, and during the last quarter, with the Lexington Avenue cable road in operation only one-half of the time and over only a portion of the route, the net earnings applicable to the payment of dividends have been at the rate of about 6 p. c. Of these net earnings over 73 p. c. have come from the mileage now operated by mechanical traction. "That is, with four-fifths of the mileage of the system still operated by horses, and therefore undeveloped, the net earnings of the one-fifth thus far improved have been so large as to carry the entire investment."

It is stated that the cost of operating the entire system by horses was formerly 70 p. c. of the gross receipts. The substitution of mechanical traction upon 20 miles out of 122 miles, reduced the cost of operation of the entire system to 54.39 p. c. The cost of operating the Broadway road was reduced from 66 p. c. to 38 p. c. by the substitution of mechanical traction for horses.

The results of operation for the last nine months are as follows:

Gross receipts	$5,320,257
Operating expenses.	2,714,927
Earnings from operation	$2,605,330
Other income from dividends and rentals	242,394
Total income.	$2,847,724
Fixed charges	1,707,882
Net income	$1,139,842
Dividends (5 p. c. per annum)	1,038,738
Surplus	$101,104

The Traction Company has no bonded indebtedness. The total outstanding bonded indebtedness of the subordinate companies is $22,436,000, against which is owned real estate to the value of $10,000,000. The franchises of the company are perpetual.

Annual Report of the Massachusetts Railroad Commissioners.

Part II of the Twenty-seventh Annual Report of the Massachusetts Railroad Commissioners dealing with street railroads has been given out and its principal totals are as follows:

ASSETS AND LIABILITIES.

	1894.	1895.
Capital stock	$26,971,275	$27,906,685
Funded debt and mortgages	19,188,000	22,915,300
Unfunded debt		1,100,188
Cost of road and equipment	49,815,693	52,529,948
OPERATING STATISTICS.		
Gross receipts	$11,236,428	$13,246,371
Operating expenses	7,729,059	9,088,086
Earnings from operation	$ 3,507,369	$ 4,158,286
Deductions from earnings		
Taxes	418,999	488,138
Interest	1,149,587	1,313,891
Rentals	126,115	98,902
Net income	$ 1,812,668	$ 2,257,355
Dividends	1,610,886	1,606,196
Surplus	$ 201,782	$ 651,160
Per cent O. E. to total receipts	69.51	68.93
Fatal accidents	29	25
Other accidents	1312	1482

The growth of business in the Commonwealth was almost phenomenal, over 260,000,000 passengers being carried during the past year as against about 220,500,000 in the previous year—a larger increase than in any two preceding years combined. Nearly one-half of this increase was made by the lines of the West End Street Railway Company alone.

Important Consolidation in Brooklyn.

The announcement was made on February 27, that the Atlantic Avenue Railroad Company will be leased by the Brooklyn Traction Company (owners of its stock) to the Nassau Electric Railroad Company for 999 years, the lessee to assume all the fixed charges of the Atlantic Avenue Company; to expend $500,000 in improving the system; and to pay the Brooklyn Traction Company a rental of $150,000 during the first year and $180,000 thereafter. It is proposed to form a new company as a successor to the Brooklyn Traction Company with a capital stock of $4,500,000. Of this amount the present preferred stockholders will receive share for share, and the common stockholders one share of the new stock for each four shares surrendered, provided however that they subscribe at par for $468,000 of the general mortgage bonds of the Brooklyn, Bath & West End Railroad Company, now held in the treasury of the Atlantic Avenue Company. The stockholders of the new company will receive an annual dividend of 4 p. c. after the first year.

TABLE OF OPERATING STATISTICS.

Notice.—These statistics are carefully revised from month to month, upon information received from the companies direct, or from official sources. The table should be used in connection with our Financial Supplement, "American Street Railway Investments," which contains the annual operating reports to the ends of the various financial years.

Abbreviations.—The following abbreviations are used: * Including taxes. d. deficiency. m. months.

Company.	Period.	Gross Receipts.	Operating Expenses.	Earnings from Operation.	Fixed Charges.	Net Income.
AUGUSTA, Me.						
Augusta, Hallowell & Gardiner R. R. Co...	12 m. June '94	28,307	25,641	12,665	9,894*	2,771
	12 " " '95	40,520	24,324	16,196	9,848*	6,349
ALBANY, N. Y.						
The Albany Ry..........	3 m., Dec. '94	122,382	85,240	37,142	22,579*	14,564
	3 " " '95	132,407	83,928	48,479	21,457*	27,022
	12 " " '94	461,918	298,972	162,947	92,592*	70,354
	12 " " '95	522,276	314,319	207,957	88,657*	119,300
ALTOONA, PA.						
The Altoona & Logan Valley Elec. Ry. Co..	12 m. Dec. '94	73 128	33,217	39,911	32,248*	7,663
	12 " " '95	83,292	41,158	42,135	33,564*	8,570
City Pass. Ry. Co. of Altoona..............	12 m. Dec. '94	50,303	40,302	10,000	4,300*	5,700
	12 " " '95	56 527	46,146	10,381	4,051*	6,330
BALTIMORE, MD.						
Baltimore Traction Co....................	12 m., Dec. '94	1,012,319	623,010	389,279	359,243*	30,037
	12 " " '95	1,179,191	639,707	539,485	413,097*	126,387
City & Suburban Ry. Co....................	12 " June '94	605,123	409,363	195,760		
	12 " " '95	751,720	546 970	204,750		
BATH, ME.						
Bath St. Ry. Co........	12 m. June '94	16,300	12,862	3,438	2,500	938
	12 " " '95	21,703	14,698	7,005	3,400	3,605
BAY CITY, MICH						
Bay City Cons. Ry. Co.	12 m. Dec. '94	83,450	52,011	31,439	30,000	1,439
	12 " " '95	88,658	58,517	30,141	30,000	141
BIDDEFORD, ME.						
Biddeford & Saco R R Co....................	12 m. June '94	24,219	14,813	9,406	6,391*	3,016
	12 " " '95	24,287	12,186	12,101	5,915*	6,186
BINGHAMTON, N. Y.						
Binghamton R. R. Co..	12 m. Jan. '95	121,969	69,581	52 388	30,152*	22,237
	12 " " '96	128,972	73,345	55,628	35,459*	20,169
BOSTON, MASS.						
West End St. Ry. Co...	12 m., Sept. '94	6,823,879	4807,083	2 016,796	725,064*	1291,732
	12 " " '95	7,746,171	5633,163	2,113,008	746,963*	1366,044
Lynn & Boston R. R. Co. / North Shore Traction Co.	12 m. Sept. '94	1,238,410	746,304	492,106	379,029*	113,077
	12 " " '95	1,381,389	784,392	596,997	391,681*	205,316
	1 " Dec. '94	92,183	64,030	28,153		
	1 " " '95	98,982	70,024	28,958		
	2 " " '94	286,538	195,901	90,637		
	2 " " '95	304,353	206,266	98,087		
BRIDGEPORT, CONN.						
Bridgeport Traction Co	12 m. Dec. '94	144,447				
	12 " " '95	298,883	151,697*	147,186	75,000	72,186
	1 " Jan. '95	18,775	13,401	5,374		
	1 " " '96	21,896	18,172	8,724		
BROCKTON, MASS.						
Brockton St. Ry. Co..	1 m., Dec, '94	18,236	10,725	7,511		
	1 " " '95	21,929	13,214	7,815		
	12 " " '94	225,614	144,547	81,067		
	12 " " '95	273,383	171,576	101,807		
BROOKLYN, N. Y.						
Brooklyn Elev. R.R. Co	12 m., Dec. '94	1,730,848	1041,095	689,754	831,093*	d 141339
	12 " " '95	2,082,937	1158,219	924,718	859,447*	65,271
Atlantic Ave. R. R. Co.	12 m., Dec. '94	1,011,258	615,863	395,395	265,118	130,277
	12 " " '95	891,940	706,900	185,040	302,918	d 117877
Brooklyn, Bath & West End R. R. Co.........	12 m June '94	111,605	86,717	24,888	39,718*	d14,830
	12 " " 95	130,928	79,394	51,535	61,150*	d9,616
Brooklyn City & Newtown R. R. Co......	12 m., Dec. '94	595,449	346,285	249,164	120,632*	128,532
	12 " " '95	598,691	372,554	226,137	127,647*	98,489
Brooklyn, Queens Co. & Sub. R. R. Co....	12 m., June '94	543,413	427,101	116,312	169,225*	d52,913
	12 " " '95	625,537	415,255	210,282	339,068	d 128786
	6 m., Dec. '94	348,969	213,351	135,618	167,644*	d32,026
	6 " " '95	362,162	230,425	131,737	169,134	d37,396
Brooklyn Heights R.R. Co......................	12 m., Dec. '94	3,509 016	2143,567	1,365,448	1468,553	d 103105
	12 " " '95	4,076,117	2682,614	1,393,504	2102,061	d 706758
Coney Island & Brooklyn R. R. Co.........	3 m., Sept. '94	115 805	62,260	53,545		
	3 " " '95	134,760	61,766	72,994		
	9 " " '94	252,546	162,528	90,018		
	9 " " '95	310,386	182,429	127,957		
BUFFALO, N. Y.						
Buffalo Ry. Co..........	12 m., Dec. '94	1,536,284	856,631	679,653	468,917*	210,736
	12 " " '95	1,714,163	877,123	837,040		
CHICAGO, ILL.						
Chicago City Ry. Co...	12 m., Dec '94.	4,264,618	2838,684*	1,425,934	207,878	1218,057
	12 " " '95	4,476,824	2807,726	1,669,098	300,389	1368,709
Chicago General Ry. Co	12 m., Dec, '95	82,082	64,334	17,748		
Lake St. Elev. Ry. Co..	3 m., Dec. '94	131,898				
	3 " " '95	156,767	90,160	66,627		
	12 " " '94	428,095	290,090	138,005		
	12 " " '95	517,301	319,606	197,695		
No. Chicago R. R. Co...	12 m., Dec. '94	2,565,618	1347,326	1,218,292	465,648	752,644
	12 " " '95	2,780,487	1311,607	1,468,880	471,251	997,629
West Chicago R. R. Co	12 m., Dec. '94	4,181,237	2518,627	1,662,610	859,471	803,139
	12 " " '95	4,201,477	2267,195	1,934,282	902,016	1032,266
Chicago & So. Side R. T. Co....................	1 m., Jan. '95	63,354	51,016	12,338		
	1 " " '96	65,871	43,039	22,832		
CINCINNATI, O.						
Cinn. Newport & Cov. Ry. Co...............	12 m., Dec. '94	497,950	370,606	127,344		
	12 " " '95	624,034	418,710	205 324		
CLEVELAND, O.						
Cleveland Elec. Ry. Co........................	1 m., June '94	148,812	101,455	47,357		
	1 " " '95	135,063	76,870	58,193		
	6 " " '94	607,577	407,254	200,323		
	6 " " '95	691,197	457,424	233,773		
COLUMBUS, O.						
Columbus St. Ry. Co...	12 m., Dec., '94	566,811	269,362	297,449	176,648	120,801
	12 " " '95	629,995	311,594	318,401	183,506	134,895
	1 m., Jan '95	45,645	24,482	21,163		
	1 " " '96	51,423	27,040	24,383		
DENVER, COL.						
Denver Cons. Tramway Co........................	12 m., Dec. '94	753,483	445,684	307,798	244,172*	63,625
	12 " " '95	716,039	441,283	274,756		
DETROIT, MICH.						
Ft. Wayne & Belle Isle St. Ry. Co......	6 m., June '95	116,945				
Citizens' St. Ry. Co...	6 " " '95	386,575				
Rapid Ry. Co..........	5½ m., Dec. '95	30,356	15,586	14,770	6,875	7,895
FALL RIVER, MASS.						
Globe St. Ry. Co........	12 m., Sept. '94	248,106	147,352	100,754	75,284	25,470
	12 " " '95	269,786	159,090	110,696	76,479	34,217
FINDLAY, O.						
Findlay St. Ry. Co......	12 m., Dec. '95	29,798	20,308	9,490	7,415	2,075
FITCHBURG, MASS.						
Fitchburg & Leominster St. Ry. Co........	12 m., Sept. '94	89,260	61,416	27,845	7,209	20,636
	12 " " '95	110,275	74,103	36,172	7,017	29,155
GALVESTON, TEX.						
Galveston City R. R. Co........................	12 m. Dec. '94	199,132	131,407*	67,726	50,000	17,726
	12 " " '95	216,271	141,080	75,191		
GIRARDVILLE, PA.						
Schuylkill Traction Co.	12 m. Sept. '94	88,288	56,564	31,724	25,000	6,724
	12 " " '95	90,981	52,851	38,130	29,770*	8,360
	3 m., Dec. '94	22,410	14,492	7,918		
	3 " " '95	23,994	14,155	9,839		
GLENS FALLS, N. Y.						
Glens Falls, Sandy Hill & Ft. Edward St. Ry. Co........................	12 m., June '94	43,206	33,414	9,792	9,538*	253
	12 " " '95	50,173	33,793	16,380	9,579*	6,801
GREAT FALLS, MONT.						
Great Falls St. Ry. Co	12 m., Dec. '94	26,431	24,905*	1,526		
	12 " " '95	26,650	28 126	d 1,476		
HAZLETON, PA.						
Lehigh Traction Co..	1 m., Dec., '94	10,067				
	1 " " '95	10,546				
	12 " " '94	97,202	50,605	46,597		
	12 " " '95	119,588	67,979	51,609	39,297	12,312
HOLYOKE, MASS.						
Holyoke St. Ry. Co.....	12 m., Sept. '94	75,427	48,546	26,881	3 524*	23,356
	12 " " '95	112,547	69,627	42,920	20,058*	22,862
HOUSTON, TEX.						
Houston City St. Ry....	12 m., Oct. '95	222,808	149,205	73,603	70,204*	3,399
JAMESTOWN, N. Y.						
Jamestown St. Ry. Co.	3 " Sept. '94	34,461	18,023	16,439	4,929*	11,510
	3 " " '95	39,411	19,439	19,972	6,871*	13,101
	9 " " '94	68,412	47,621	20,791	14 724*	6,057
	9 " " '95	74,092	51,630	22,462	15,989*	6,473
JOHNSTOWN, PA.						
Johnstown Pass. Ry. Co	12 m. June '94	90,197	50,626	39,571	19,028	20,543
	12 " " '95	94,926	52,009	42,917	19,844	23,073
KANSAS CITY, MO.						
Metropolitan St. Ry. Co	1 m., Dec. '94	138,325	84,916	53,409		
	1 " " '95	140,797	84,088	56,709	74,500	d 17,791
	7 " " '94	1,058,315	644,686	413,630		
	7 " " '95	1,088,928	616,201	472,727	279,497	193,230
KINGSTON, N. Y.						
Kingston City R. R. Co........................	12 m. June '94	46 467	29,038	17,430	9,398*	8,032
	12 " " '95	50,230	31,404	18,826	9,576*	9,249
LAWRENCE, MASS.						
Lowell, Lawrence & Haverhill St. Ry. Co	12 m., Sept. '95	269,740	205,816	63,924	73,423*	d 8,498
	12 " " '95	403,530	262,935	140,595	84,081*	56,514
LEBANON, PA.						
Lebanon & Annville St Ry. Co.................	12 m., June '94	39,903	30,005	9,898	6,341*	3,557
	12 " " '95	42,963	27,534	15,429	8,137*	7,292
LONG ISL. CITY, N. Y.						
Steinway Ry. Co. of Long Island City......	12 m., Dec. '94	215,135	114,127	101,008	85,044*	15,964
	12 " " '95	304,103	169,115	134,988	106,834*	28,154
LORAIN, O.						
Lorain St. Ry..........	1 m., Nov. '95	6,032	4,829	1,203		
	11 " " '95	74,468	40,733	33,735		
LOUISVILLE, Ky.						
Louisville Ry. Co.......	1 m., Sept. '94	105,026	56,438	48,588		
	1 " " '95	158,725	66,308	92,416		
	9 " " '94	875,604	471,747	403,857		
	9 " " '95	966,698	498,198	468,500		
LOWELL, MASS.						
Lowell & Suburban St. Ry. Co..................	12 m. Sept. '94	277,029	179,409	97,620	66,624*	30,995
	12 " " '95	329,817	199,346	130,471	66,575*	63,896
MACON, GA.						
Macon Cons. St. Ry. Co.	12 m., Dec, '95	69,190	44,529	24,661	16,711*	7,951
MANCHESTER, N. H.						
Manchester St. Ry. Co	12 m., June '94	81,627	76,906*	4,721	3,302	1,419
	12 " " '95	82,923	87,594	d 4,670		

Company.	Period.	Gross Receipts.	Operating Expenses.	Earnings from Operation.	Fixed Charges.	Net Income.
MARSHALLTOWN, IA. Marshalltown Light, Power & Ry. Co.	12 m., Dec.'94	38,758	24,190*	14,568	7,650	6,918
	12 " " '95	40.757	24,307*	16,450	7,500	8,950
MINNEAPOLIS, MINN. Twin City R. T. Co.	12 m., Dec '94	2 003,679	1,044,548	959,131	738,961*	220,170
	12 " " '95	1,988,803	979,485	1,009,319	750,839*	258,479
MONTGOMERY, ALA. Montgomery St. Ry. Co	1 m., Dec. '94	3,623	2,237	1,386		
	1 " " '95	4,383	1,957	2,426		
	12 " " '94	35,216	21,724	13,492		
	12 " " '95	50,645	27,915	22,730		
MONTREAL, CAN. Montreal St. Ry. Co.	12 m, Sept.'94	897,838	628,454	269,384	55,363*	214,021
	12 " " '95	1,102,778	652,812	449,966	98,617	351,349
	1 " Jan. '95	73,910				
	1 " " '96	95,057				
	4 " " '95	316,869				
	4 " " '96	485,457				
NEW BEDFORD, MASS. Union St. Ry. Co.	1 m., Dec. '94	13,381				
	1 " " '95	16,008				
NEWBURGH, N. Y. Newburgh Elec. Ry. Co.	1 m., Nov.'94	3,594	3,142	452		
	1 " " '95	5,818	3,956	1,862		
	5 " " '94	36,388	17,268	19,120		
	5 " " '95	52,737	25,360	27,377		
NEWBURYPORT, MASS. Haverhill & Amesbury St. Ry. Co.	12 m., Sept.'94	98,346	58,061	40,284	27,664*	12,621
	12 " " '95	104,853	65,936	38,917	28,223*	10,694
NEW HAVEN, CONN. New Haven St. Ry. Co	12 m., Dec.'94	126,183	69,517	56,666		
	12 " " '95	198,719	124,454	74,265		
New Haven & Centreville St. Ry. Co.	1 m., Dec.'94	2,742				
	1 " " '95	4,909				
West Shore Ry. Co.	1 " " '94	336				
	1 " " '95	334				
NEW LONDON, CONN. New London St. Ry. Co.	12 m, Sept.'94	49,899	29,150	20,749	6,423*	14,826
	12 " " '95	51,759	30,230	21,528	7,650*	13,878
NEW ORLEANS, LA. New Orleans Traction Co.	12 m., Sept.'94	951,528	620,508	331,020		
	12 " " '95	1,327,756	752,158	575,598		
	1 m., Dec. '94	100 066	50,658	49,408		
	1 " " 95	121,373	64,487	56,836		
NEWTON, MASS. Newton & Boston St. Ry. Co.	12 m., Sept.'94	33,478	25,262	8,216	7,677*	539
	12 " " '95	32,297	24,685	7,613	7,108*	504
Newtonville & Watertown St. Ry. Co.	12 m., Sept.'95	7,580	6,599	981	809*	172
NEW YORK, N. Y., Third Ave. R. R. Co.	12 m., Dec.'94	2,178,336	1,177,344	1,000,991	341,083*	659,909
	12 " " '95	2,355,154	1,456 782	1,198,372	828,917*	869,454
Metropolitan St. Ry. Co.	3 m., Dec. '95	1,990,079	956,265	1,033,814	595,560	438,254
	9 " " '95	5,562,651	2,714,927	2,847,724	1,707,882	1,139.842
Manhattan Ry. Co.	3 m., Sept,'94	2,083,310	1,250,635	832,675	660,228	172 447
	3 " " '95	2,148,530	1,319,129	829,401	766,790	62,611
	9 " " '94	7,371,408	4,089,329	3,282,079	1,960,568	1,321,511
	9 " " '95	7,167,493	4,125,757	3,041,736	2,141,776	899,960
Second Avenue R.R. Co	12 m., June'94	1,018,133	794,765	223,368	131,885*	91,483
	12 " " '95	957,463	734,915	222,548	129,428*	93,120
D. D., E. B. & Bat'y R. R. Co.	12 m., June'94	655,558	464,068	191,490	175,894	15,596
	12 " " '95	730,033	532,245	197,788	136,093	61,695
New York & Harlem R. R. Co.	3 m., Sept. '95	197,628	136,712	60,916	10,100	50,816
42d St., Man & St. N. Ave. R. R. Co.	3 m., Sept. '94	165,855	132,388	33,467	30,717*	2,750
	3 " " '95	161,121	133,972	27,149	30,700*	d 3,551
	6 " " '94	337,756	261 020	76,736	61,405*	15,331
	6 " " '95	326,773	265.914	60,859	61,400*	d 541
Union Ry. Co.	3 m., Sept. '94	136,588	67.172	69,416	37,674	31,742
	3 " " '95	136,125	74,570	61,555	32,427	29,128
	9 " " '94	364,974	189,974	175,000	118,165	56,835
	9 " " '95	345,292	198,225	147,067	95,323	51,744
Westchester Elec. R.R. Co.	3 m., Sept. '94	28,655	20.588	8,067	6,957	1,110
	3 " " '95	38,512	22,818	15,694	7,428	8,266
	6 " " '95	68,738	42,331	26,407	14,818	11,589
NORRISTOWN, PA. Schuylkill Val. Trac. Co	1 m., Dec.'94	3,165				
	1 " " '95	4,120				
NO. ABINGTON, MASS. Rockland & Abington St. Ry. Co.	12 m., Sept.'94	52,762	38,836	13,926	5,282*	8,644
	12 " " '95	67,815	49,759	18,056	6,008*	12,048
NORTHAMPT'N, MASS. Northampton St Ry. Co	12 m., Sept.'94	50,090	28,904	21,186	2,375*	18,811
	12 " " '95	83,504	46,240	37,264	3,131*	34,133
NORWALK, CONN. Norwalk Tramway Co.	12 m., Sept.'95	43,315	29,858	13,457		
NORWICH, CONN. Norwich St. Ry. Co.	12 m, Sept.'94	80,069	50,693	29,376	16,035*	13,341
	12 " " '95	85,210	53,454	31,756	17,400*	14,356

Company.	Period.	Gross Receipts.	Operating Expenses.	Earnings from Operation.	Fixed Charges.	Net Income
OAKLAND, CAL., Central Av. Ry. Co.	12 m., Oct. '94	32.668	26.781	5,887	1,852	4,035
	12 " " '95	30,808	26,148	4,660	3,785	875
Oakland Consol. St. Ry. Co.	12 m., Dec.'94	129,351	95 821	33,530	31,139*	2,390
	12 " " '95	125,485	94,115	31,370	25,140	6 230
ORANGE, N. J. Suburban Traction Co.	12 m., Dec.'94	42,502	42,938*	d 431		
	12 " " '95	52,000	56,000	d 4,000		
PATERSON, N. J., Paterson Ry. Co.	12 m., Dec.'94	243,921	157,520	86,401	88,597	2,196*
	12 " " '95	298,689	174,619	124,070	97,264	26,806
PHILADELPHIA, PA., People's Traction Co.	12 m., June'94	1,044,159	673,479	370 680		
	12 " " '95	1,660,676	829,815	830,861		
Hestonville M. & F. P. Ry. Co.	12 m., Dec.'94	286,021	315,762	207.450	97,966	109,485
	12 " " '95	523,212				
Electric Traction Co.	12 m. June'94	1,900 606	1,120.026	780,580		
	12 " " '95	2,151,853	1,241,584	910,269		
PORT HURON, MICH. City Elec. Ry. Co.	12 m., Dec.'94	46,702	32,585	14,117		
	12 " " '95	52,848	34,771	18,076	......	
POUGHKEEPSIE, N. Y., Poughkeepsie City & Wappinger's Falls E. R. Co.	12 m., Dec. '95	93.557	60,257	33,300		
ROCHESTER, N. Y., Rochester Ry. Co.	12 m., Dec.'94	782,520	448,304	334,216	269,045*	65,171
	12 " " '95	862,916	510,943	351,973		
SAGINAW, MICH., Union Ry. Co.	1 m., Dec. '95	9,827	5,819	4,008		
	12 " " '95	127,617	68,957	58 660		
ST. LOUIS, MO., National Ry. Co.	12 m., Dec.'94	1,353,136	776,582	576,554	337,684	238,870
	12 " " '95	1,403,957	821,315	582,642	366,587	216,055
SARATOGA, N. Y., Union Elec. Ry. Co. of Saratoga	1 m., Sept. '95	11,554	6,301	5,253		
	9 " " '95	99,578	52.703	46,875		
SCRANTON, PA., Scranton Trac. Co.	12 m., June,'94	247,768	140,080	107,688	105,796*	1,892
	12 " " '95	270,700	142,278	128.422	119,858*	8,564
	1 m., Jan '95	19,505	14,197	5,308		
	1 " " '96	25,485	13,702	11,783		
	7 " " '95	157,421	95,159	62,263		
	7 " " '96	191,016	94,676	99.339		
SEATTLE, WASH., West St. & No. End Elec. Ry. Co.	12 m., Dec.'95	29,737	15,031	14,706		
SPRINGFIELD, MASS. Springfield St. Ry. Co.	12 m. Sept.'94	373,903	252,269	121,634	18,210*	103,424
	12 " " '95	442,006	277,156	164,850	30,637*	134,213
SYRACUSE, N. Y., Syracuse Cons. St. Ry. Co.	12 m., Dec.'95	245,805	145,934	99,870	93,965*	5,905
TRENTON, N. J. Trenton Pass. Ry. Co.	12 m., Dec. '94	198,681				1,129
	12 " " '95	222.761				1,771
TORONTO, ONT., Toronto St. Ry. Co.	12 m., Dec.'94	958.371	517,708	440.663		
	12 " " '95	992,801	489,915	502,886		
TROY, N. Y., Troy City Ry. Co.	12 m, Dec.'94	432.596	212,407	220,189	130,474	89,705
	12 " " '95	490,489	242,775	247,714	126,116*	121.598
UTICA, N. Y. Utica Belt Line St. R.R.	3 m., Dec. '94	37,388	28,953	8,435		
	3 " " '95	41,112	28,995	12,117	10,220	1,897
WASHINGTON, D. C. Capital Traction Co.	12 m., Dec. '95	1 063.776	634,013	429,754		
WATERBURY, CONN., Waterbury Trac. Co.	1 m., Dec. '94	16,561	11.880	10.909		
	1 " " '95	22,789	142,073*	105,657		
	12 " " '95	247,730				
WHEELING, W. VA. Wheeling Ry. Co.	12 m., Dec '94	133,517	119,378	14,139		
	12 " " '95	150,094	88,552	61,542	32,248*	29,294
WILKESBARRE, PA., Wilkes Barre & Wyoming Val. Trac. Co.	12 m., Dec. '94	400,143	196.824	203,319	122,607*	80,711
	12 " " '95	451,941	209,600	242,341	134,215*	108,127
WILLIAMSPORT, PA. Williamsport Pass. Ry. Co	12 m., June'94	64,863	49,646	15,217	10,256	4,962
	12 " " '95	66,845	52,459	14,386	9,691	4,695
WORCESTER, MASS., Worcester Cons. St. Ry. Co.	12 m., Sept.'94	355,000	284,215	70,785	45,479	25,306
	12 " " '95	420,498	309,787	110,711	51,778	58,933
	3 " " '94	94.782	69,869	24 913		
	3 " " '95	116,683	83,021	33,662		