Street Railway Journal

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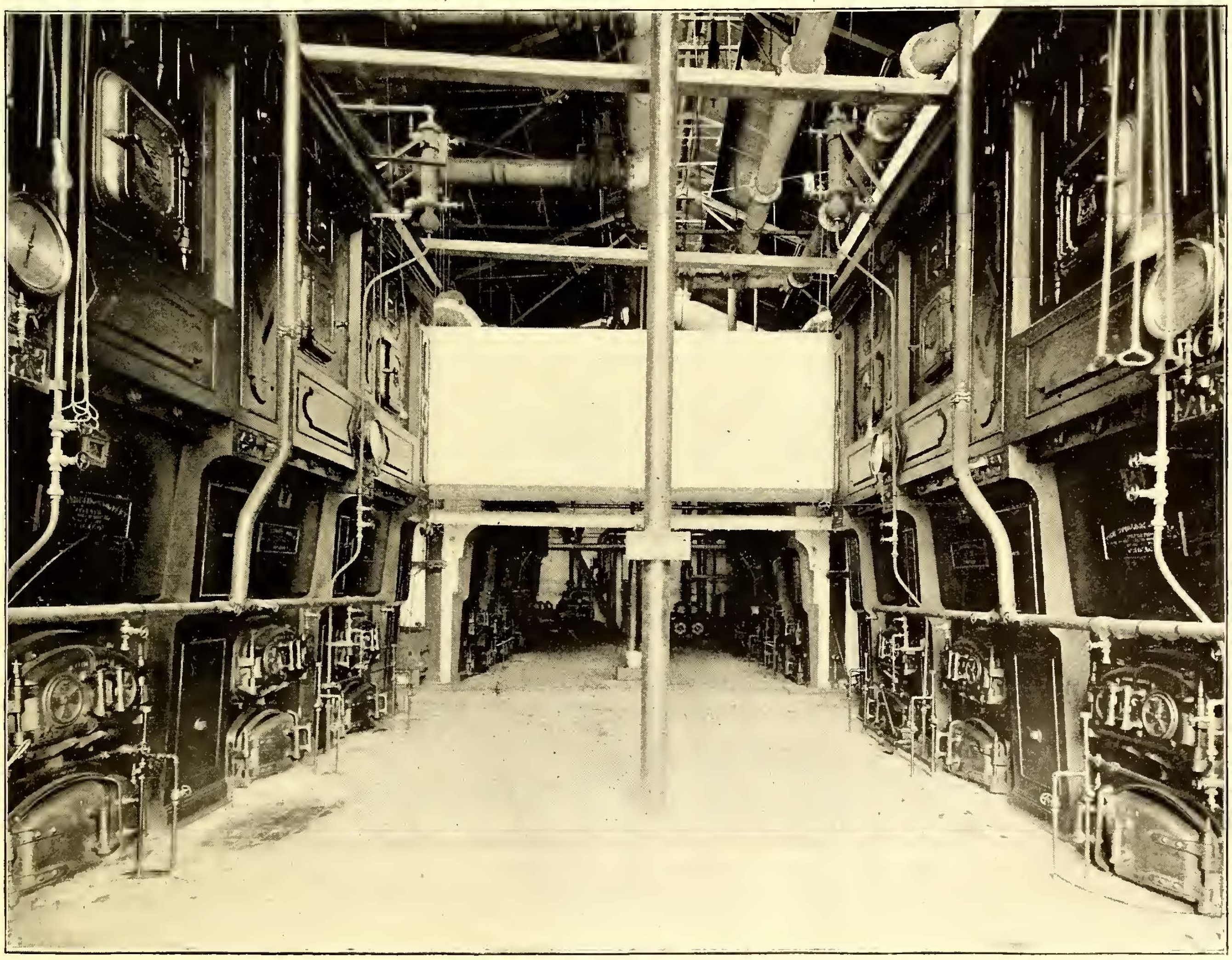
THE SYSTEM AND METHODS OF THE LOS ANGELES RAILWAY COMPANY

Los Angeles is the largest city in Southern California and the center of the rich farming and vineyard districts for which that part of the State is famous. Its climatic and productive advantages are so great that its growth, both in population and in building, has been phenomenal and almost continuous. The census of 1890 gave the city a population of 52,000 as against about 11,000 in 1880; while a census taken under a State law in 1897 shows a population of 108,000. This increase in population has been accompanied by development no less wonderful in other ways. The banking in 1887 was done by six institutions with a combined capital and reserve of $1,668,481, and a total of deposits of $7,647,009. In 1897 there were seventeen banks, with a capital and reserve of $4,843,180 and total deposits of $15,075,710.

The building permits for the year 1897 aggregate $2,481,685 and the class of structures erected would grace any city in the world. The business blocks are of modern, fireproof construction, six and eight stories in height, and the dwellings of a character which marks Los Angeles as one of the handsome residence cities in the country. The ease with which flowers and plants are grown in the semitropic climate gives a beauty of adornment to this portion of the city that is equaled probably nowhere else on the

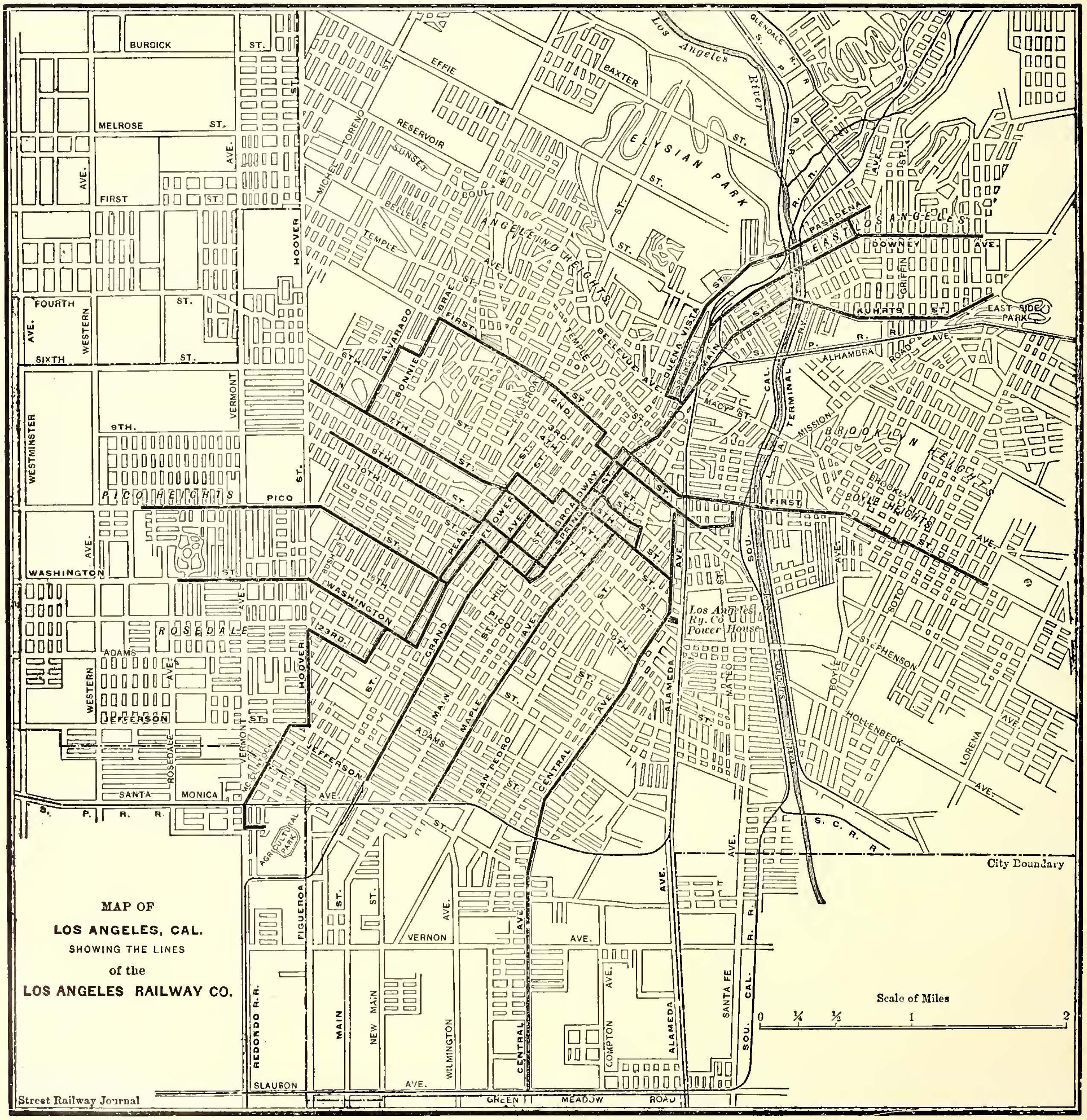


BOILER ROOM OF LOS ANGELES RAILWAY POWER STATION continent. The streets are paved with a natural gravel or macadam except in the business portion, where concrete and asphalt construction is used.

The street railway system, as is common with the rapidly growing cities of the West, has developed from a patchwork of small independent horse lines into the present well-equipped electric system. The process of this development involved the construction of an extensive system of cable railways, in the building of which money was not spared, but which ultimately proved to be a financial mistake. The causes that led up to this condition of affairs need not be discussed here. The facts are that in 1895 there were in operation in Los Angeles two parallel systems, one consisting of cable and horse cars, and the other of electric cars. The ownership of the two systems had been consolidated, but the business did not produce the revenue necessary to keep up the repairs and betterments required, and to carry on the expensive cable operation, the latter, under the peculiar local conditions existing, being excessive.

It was at this stage that the present company, the Los Angeles Railway Company, was organized, largely of the holders of the bonds of the existing companies. The property of the latter, horse, cable, and electric, was sold under the trust deed, and the whole purchased by the Los Angeles Railway Company.

The physical condition of the property was such that the new managers had a very complicated problem with which to deal. There were four power houses to operate. The rolling stock was in poor condition. The electric car equipment was an aggregation of Westinghouse gearless motors, Edison No. 6, Westinghouse No. 3, G. E. 800, Westinghouse No. 12 and Westinghouse No. 14, and all in bad order. The track conditions were also bad, as the rails were light and badly worn.



The problems presented were:

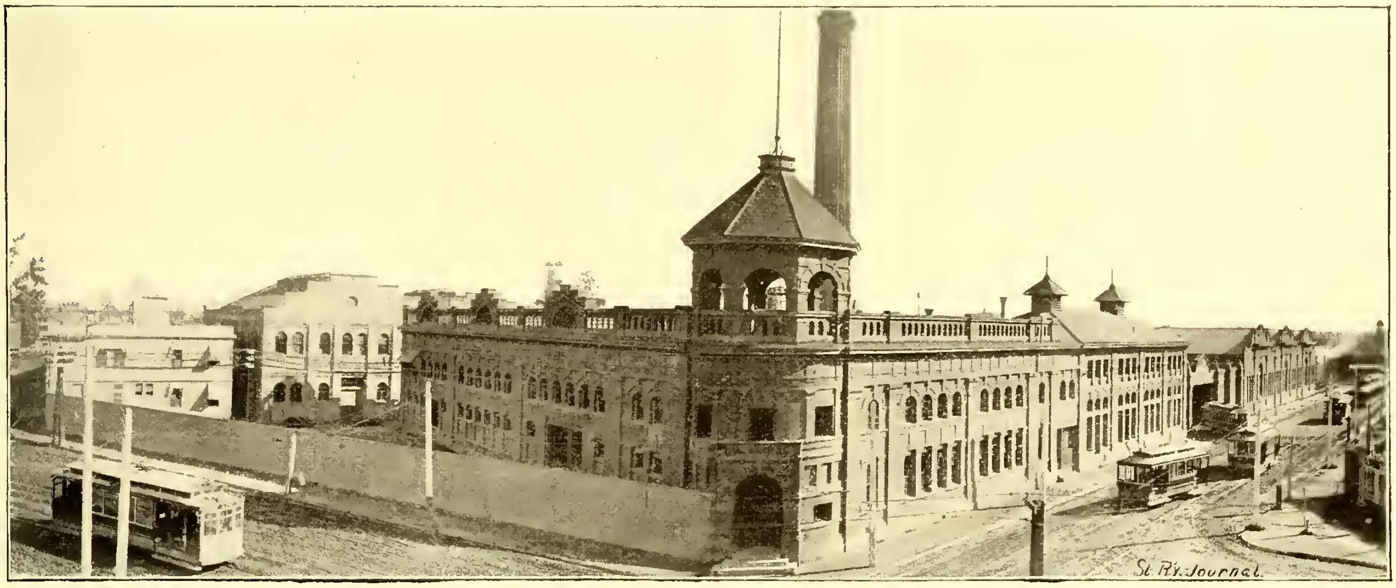
First—To keep up the operation of the present systems, and in doing this to do as little in the way of repairs as possible to portions of the plant that later on might be abandoned.

Second—To design a system of betterment, which, while utilizing as much of the existing plant as possible, would provide for its present and reasonable future needs, and which would carry out the plan, to which the company was already committed, of converting the whole system to electric power. This latter involved the change to the electric system of eighteen miles of horse lines and twenty-two miles of cable.

Third—The reorganization of the working force.

The actual possession of the property was turned over to the new management on March 24, 1895, but the legal title did not pass to the new company until July of the same year, so that nothing could be done which involved the incurring of financial liability before the latter date. The interval, however, was used to make a study of the plant as it then existed, and to formulate some general lines upon which to work.

Immediately upon the passing over of the title, active operations began, and by April 1 of the following year the whole system was electrified and being operated from one power station. This brings us to the plant as it now exists, which consists of twelve lines, aggregating seventy-four miles, over which are operated seventy-one cars. There are two other corporations controlled in the interests of the main company, and supplied with power from its station, which adds twelve miles to the above total and over which are operated ten cars.

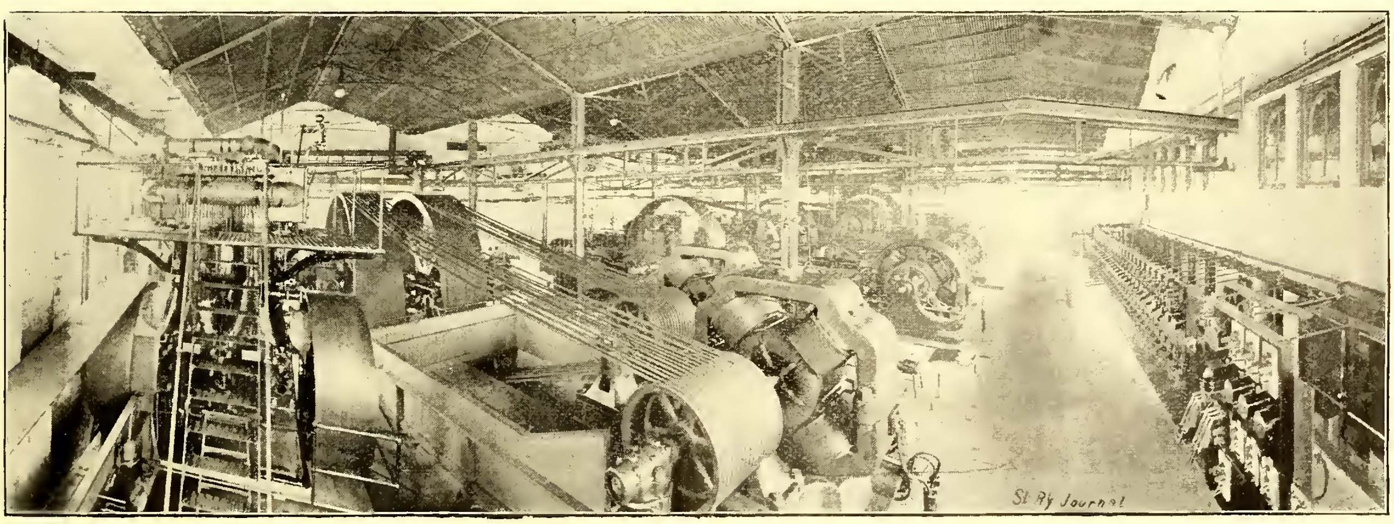


POWER STATION, CAR HOUSE AND REPAIR SHOPS

POWER STATIONS

The central power station and shops occupy an entire block. The buildings are of brick and iron and present a neat architectural appearance, while well adapted for their several uses.

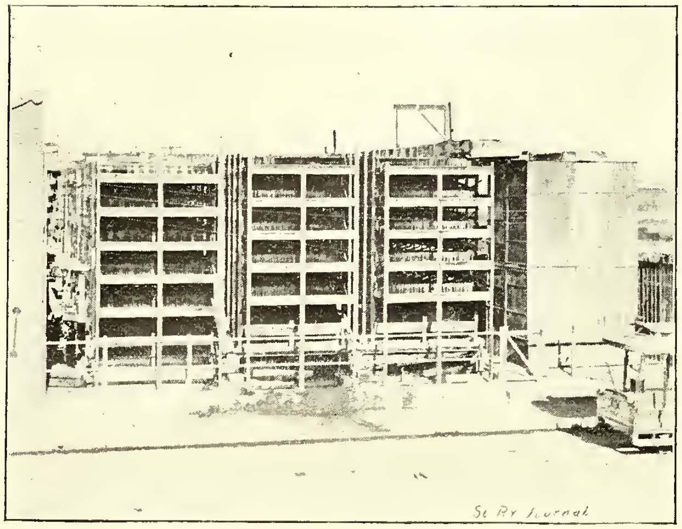
The steam equipment consists of five batteries of Stirling boilers, two boilers of 250 h.p. each constituting each battery. All the boilers are connected to a main steam pipe in such a manner that any one may be cut out of operation without interference with the others. The furnaces are fitted with grate bars and all the appliances for burning coal as well as false linings and bridge walls for the burning of crude petroleum which is the usual fuel. The oil is delivered to the station by a pipe line direct from the wells and is received in a thousand barrel tank, set in a concrete basin. The latter was built for confining



INTERIOR OF POWER STATION

the oil in case of the bursting of the tank. The thousand barrel tank delivers into three 200-barrel tanks, which are below the fireboxes of the boilers, and 250 ft. distant from them. This prevents any possibility of a flow of oil into the boiler room in case of accident.

The oil is heated in the tanks by steam pipes to a temperature of about 115 deg., and allowed to stand for four or five hours, so as to precipitate all water and foreign matter, which are pumped off from the bottom. The oil is then pumped to the boilers through a pipe line which has



END VIEW OF TRAY CONDENSERS

an overflow and check valve so arranged that only a certain pressure can be maintained on the system. The connecting pipes to the boilers are so arranged that there is a continuous flow and no dead ends, with the accompanying clogging up of pipes and unequal temperature of the fuel oil.

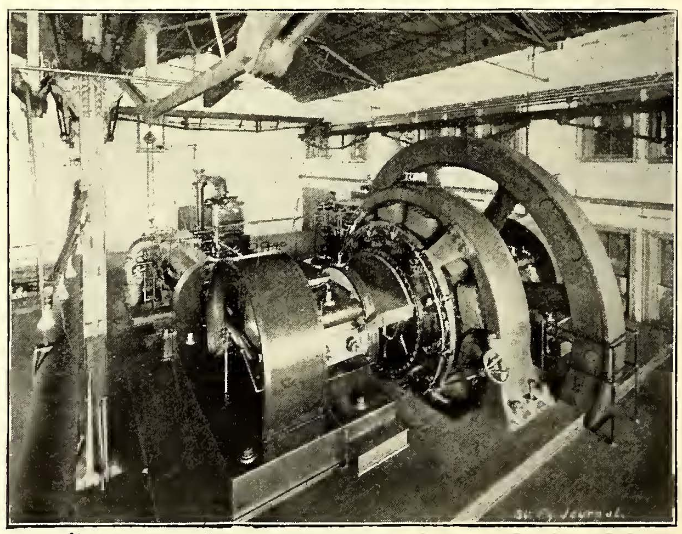
Oil for fuel is found in considerable quantities within the city limits, and costs, delivered at the power house, from 70 cents to $1.50 per barrel. The Los Angeles Railway Company has eight wells of its own, and produces from one-third to one-half of all the oil it consumes. This production would be increased up to the full amount were it not for the fact that the company has a very advantageous contract for a supply of power from a water company which is now constructing the works necessary to transmit a large supply of power to Los Angeles from mountain streams, about 70 miles distant. The output of the station during 1897 was 5,922,230 k.w. hours, to produce which 55,267 barrels of oil were burned. The production was, therefore, 107.15 k.w. hours per barrel of oil, and the evaporation 12.89 lbs. of water per pound of oil.

Water for boilers and for condensing is obtained from wells sunk on the property of the company from the irrigating ditches of the city. The feed-water used contains a considerable quantity of carbonate of lime and magnesia and other impurities which tend to form a flinty scale upon the boiler tubes. This has been successfully reduced by employing the boiler compound of the Dearborn Drug & Chemical Works. The method of applying this and cleaning the boiler tubes is as follows: All the water—cool, not hot—is first allowed to run out of the boiler. After this all the sediment that has settled in drums is taken out and weighed, so that accurate data is obtained on sediment taken from boilers. The tubes and drums are then washed out, after which cups fastened to chains are pulled through the tubes, taking out all the scale that has been loosened by the compound, or has formed during the run. Tubes that had barely 1 in. opening formerly have now $2\frac{3}{8}$ ins., and in many cases the scale has been removed down to the iron. The compound loosens the scale so that it can be readily removed.

The method of handling the compound is as follows: Taking as a standard the evaporation of 30 lbs. of water per hour to 1 h.p., pump in 2 lbs. every twelve hours to each 65 h.p. The compound is mixed with two parts water and put into the feed water by means of a $\frac{3}{8}$ in. pipe, the flow being regulated so that the above quantity is regularly mixed with the feed water. The arrangement is on the same principle as a sight feed lubricator, and is automatic in quantity fed. As the amount of water required in the boiler changes, the compound is reduced or increased in the same proportion.

For cooling the condensing water a system of cooling trays is used. The water from the condensers is pumped back and allowed to flow over the shallow trays in a thin film which at the end of each tray is broken into very small streams by passing through perforated boards, thus giving ample opportunity for the air to circulate. No artificial circulation is used on these trays, and a temperature of about 10 deg. above the atmosphere is obtained.

The engine equipment originally consisted of two 600 h.p. triple expansion Golden State engines—with a Thompson valve movement, and steam was used at a pressure of 185 lbs. A test of these engines demonstrated that for the conditions obtaining it would be desirable to reduce the pressure and to instal the proposed new equipment on a compound basis. One 800 h.p. cross compound Corliss engine, built originally by the Risdon Iron & Locomotive Works, was therefore taken from one of the old cable power houses and refitted for electrical work. A 250 h.p. vertical Ball engine was installed for the furnishing of current to such stationary motors as the company was serving with power, and an E. P. Allis cross compound 1,200 h.p. engine was put in place to carry the main load.



1200 H.P. DIRECT-CONNECTED UNIT

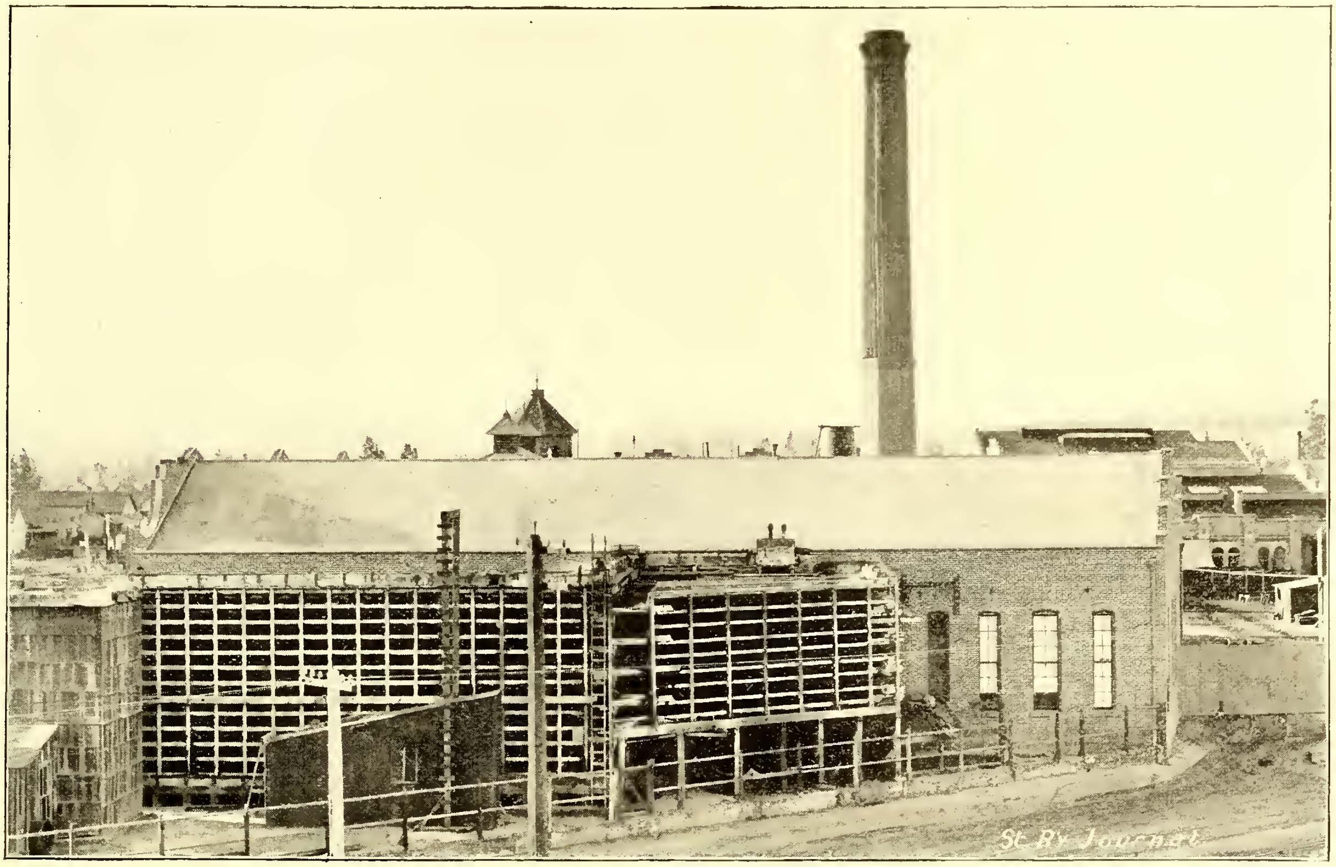
The generator equipment consists of one 400 k.w. Westinghouse railway generator, rope connected to one of the original 600 h.p. engines, and two 200 k.w. Westinghouse railway generators, also rope connected to the other 600 h.p. engine; two G. E. m.p. 270 k.w. railway generators are rope connected to the 800 h.p. Corliss engine, and one Edison 200 k.w. bi-polar generator is belt driven from the Ball engine. The 1200 E. P. Allis engine is direct connected to an 800 k.w. Walker generator.

The leads from all the machines are taken through underground conduits to a tunnel back of the switchboard and connected up with the board in such a manner as to give the greatest flexibility possible to the station.

The switchboard is of the most modern type, of the General Electric Company's construction, and consists of twenty-five feeder and seven generator panels and one main panel carrying the totalizing ammeter and watt meter. The board is of black slate and fitted with the most approved switches and safety and measuring devices, including a recording watt meter which registers the total output of the station. The feeder system is divided into twenty-five sections, and each is connected to a separate panel on the board.

The rails are laid with joints "butted," and a six hole angle bar fastening is used. The work of relaying is done in small sections, that is, one or two blocks at a time. The managers have not yet used the cast weld joint, but look favorably upon it.

Some interesting observations have been made by the company upon the amount of power required to propel cars over tracks of different character—these apply not only to its own road but to that of the Main Street and Agricultural Park Railroad Company, to whom the Los Angeles Railway Company sells power. The tracks of this road have also been laid recently with 60 lb. rails and well bonded, and the type of cars operated and their equipment is practically the same on both roads. The amount



SIDE VIEW OF POWER STATION, SHOWING TRAY CONDENSERS

As the company operates cars over several very sharp grades ranging from 9 to 14 per cent, and also supplies current to a large number of stationary motors, consisting mainly of elevators, the load might fairly be expected to show some very bad phases of variation. The diagram, on page 308, which is one of many and is fairly typical, shows on the contrary a fairly regular line. The calculated and the observed k.w. output also show a very close agreement.

TRACK CONSTRUCTION

The track, which was laid originally with the light rails in use a few years since, has been replaced in many places with the company's standard construction, a section of which is shown on page 308. The rail weighs 60 lbs. per yard, are 6 ins. deep and are laid in lengths of from 60 ft. to 64 ft. The managers of the Los Angeles Railway Company were the pioneers in the bringing of these long rails across the continent, and find no difficulty or additional expense in transportation. In a recent shipment of 500 tons only three rails had to be straightened.

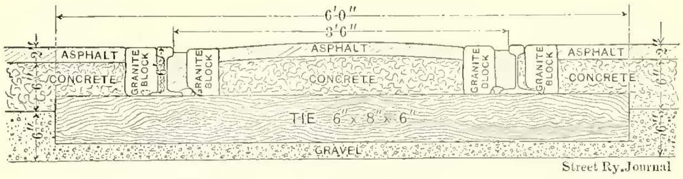
of power used, as registered by the recording watt meter, shows that the operation over the old tracks required 1.299 k.w. hours per car mile, while on the heavy and well constructed tracks but 9.39 k.w. hours are needed.

The company makes its own special work, and 60-lb. rails and heavy guards are used in its construction.

ROLLING STOCK

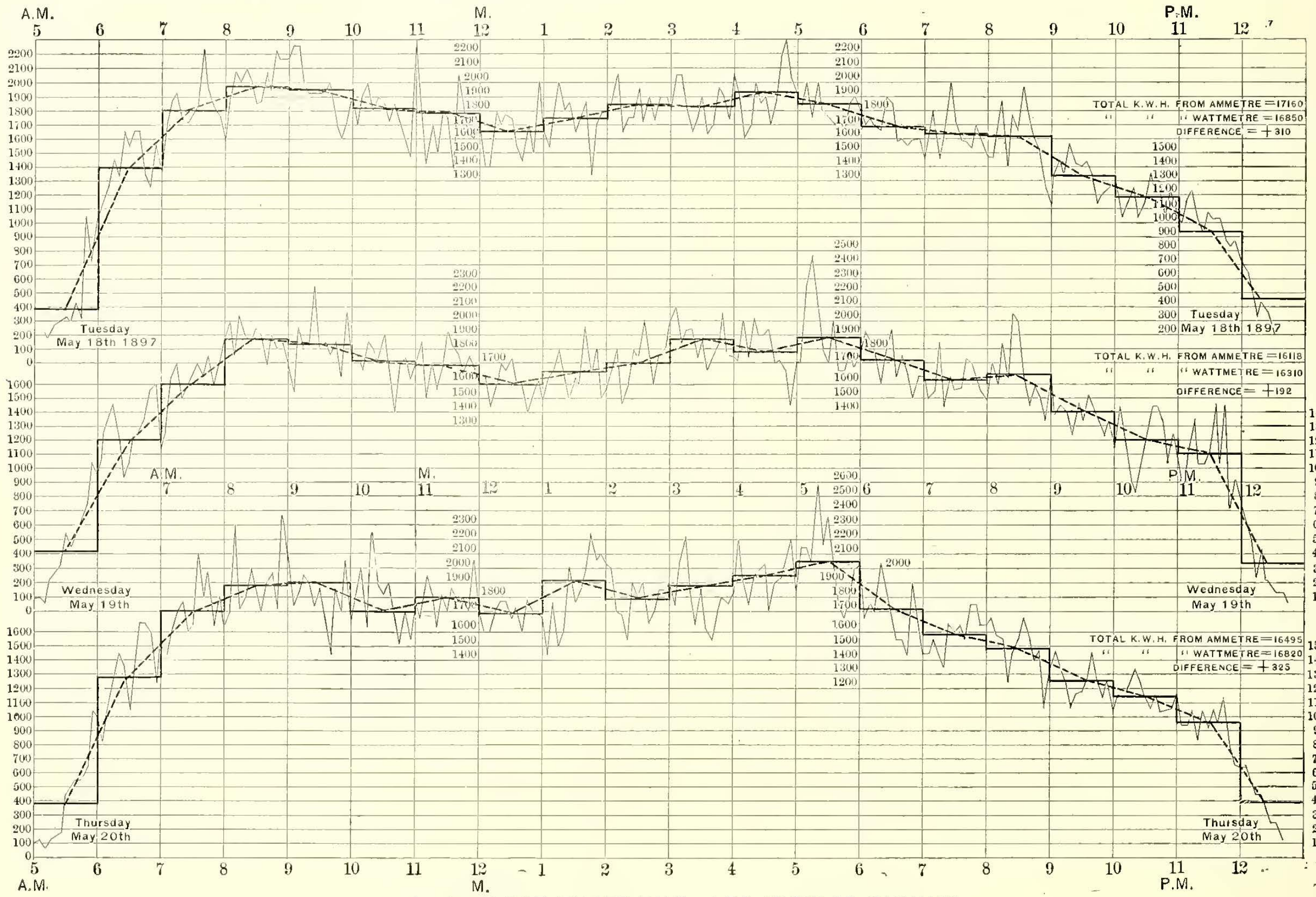
The rolling stock has been standardized to a 32 ft. double truck combination car, and a 26 ft. single truck combination car with 26 ft. open cars for rush business. The motors used are the G. E. 800 and the Westinghouse 12 A with series parallel controllers. Double equipments are used on nearly all cars.

The operation of all cars is controlled by a dispatcher—using a system of private telephones. Each conductor reports his arrival at a terminus and receives from the dispatcher his leaving time, and any special orders that the exigencies of the service may render desirable. In case of accident or delay, the conductor reports from some of the intermediate telephones and receives the necessary special instructions, the wrecking car or the emergency wagon is ordered out as the occasion requires, or a shop employee is notified to meet the car at some specified point and remedy any small defect. In this manner it has been found possible to keep the cars from coming into



SECTION OF T RAIL CONSTRUCTION IN PAVED STREETS

the shop for trivial repairs, and thus the car mileage per car is increased. This latter has been raised from 115 to 136 miles per day. One of the chief values of the dispatching system of operation is the promptness with which



LOAD LINE FOR THREE DAYS—LOS ANGELES RAILWAY

notice of accidents, delays and other emergencies are put before the superintendent, and the ease with which he can communicate with every car on the system.

CAR HOUSES AND REPAIR SHOPS

The company is still using the old car houses of the cable system. These are to be replaced, however, with finely designed modern structures of brick and iron, giving all the conveniences for quick and easy handling and cleaning of the cars of the various lines. The shop facilities are commodious—the machine tools being well adapted to their work. The great distance from the centers of manufacture and the consequent high freight rates make it incumbent upon this company to do more work than would fall to the shop of the ordinary Eastern road, which is close to the large manufacturing and supply centers.

One ingenious feature of the carpenter and paint shops is the use of small flat wheel dollies, or false trucks, which are run under a car body after it is lifted from the regular truck. By means of these the car bodies can be shifted into any place in the carpenter or paint shops without the use of tracks and the limitation as to space that tracks make in a shop. The floors of the shops are consequently built smooth and without tracks, and the car bodies can be set in almost any position and handled in and out with great facility. One track, however, is laid through all of the shops, so that cars can be run through from one to another in case of need.

A glance at the illustration of the storeroom will show that in this important department everything is kept in order and according to a system. The accounting methods are largely the standard street railway system, and all supplies purchased are charged into supplies account and charged out as used, on requisitions of the proper officers. The supply clerk's books show at all times just how much of a particular article is on hand, and if used where, when and by whose order.

ORGANIZATION AND RECORDS

The organization of the employees and official staff has been carried to a high degree of excellence. The table on the opposite page shows the scheme of organization. A system of daily reports is used, which, while avoiding duplication of information and unnecessary bookkeeping, so fit into each other that a complete history of the business and results is constantly being written. These reports lead up from the small detail of the time card of the mechanic to his foreman or the daily report of the conductor and motorman—through the master mechanic, executive engineer and electrician, civil engineer, superintendent and auditor, to the general manager, who, by means of the reports of these latter officials, is kept in daily touch with the whole operation.

DIAGRAM SHOWING ARRANGEMENT OF OFFICIAL STAFF OF THE LOS ANGELES RAILWAY CO.

- GENERAL MANAGER.
  - Auditor
    - Receiving Clerk
    - Register Clerk
    - Time Book Clerk
    - Voucher Clerk
    - Storekeeper
    - Ass't Storekeeper
    - Night Watchman
    - Porter
    - Stenographer
  - Executive Engineer and Electric'n
    - Master Mechanic
      - Foreman of Machine Shop
      - Machinists
      - Apprentices
      - Helpers
      - Blacksmiths
      - Helpers
      - Foreman of Car Shop
      - Carpenters
      - Foreman of Paint Shop
      - Painters
      - Car Washers
      - Foreman of Car Barn at Central Avenue—Day
      - Helpers
      - Foreman of Car Barn at Central Avenue—Night
      - Helpers
      - Car Inspector on Street
      - Foreman of Car Barn at Grand Av.—Day
      - Helpers
      - Foreman of Car Barn at Grand Av.—Night
      - Helpers
    - Ass't Engineer
    - Clerk & Draftsm'n
    - Time Keeper
    - Ass't Time Keep'r
    - Supt. Power Dept.
    - Ass't in Power Dept.
    - Supt. Line Dept.
      - Foreman
      - Linemen
      - Groundmen
      - Emergency Wagon
      - Line Inspector
    - Supt. Winding Room
      - Machinists
      - Winders
      - Helpers
    - Engineers
    - Oilers
    - Change Oilers and Laborers
    - Oil Tender and Strainer
    - Fuel Oil Houseman
    - Fireman
    - Boiler Washers
    - Pipe Fitters
    - Machinist and Change Engin'r
    - Dynamo Tenders
    - Engineer Oil Wells
  - Civil Engineer
    - Fieldmen
    - Road Master Div. No. 1
      - Section Foreman
      - Laborers
      - Section Foreman
      - Laborers
      - Section Foreman
      - Laborers
      - Teamsters
      - Switch Repairer
      - Oilers
    - Road Master Div. No. 2
      - Section Foreman
      - Laborers
      - Section Foreman
      - Laborers
      - Section Foreman
      - Laborers
      - Section Foreman
      - Laborers
      - Teamsters
      - Oilers
      - Watchman at 12th and Grand
      - Track Layer and Extraman
      - Special Work Construction Gang.
  - Superinten't
    - Division Forem'n Clerk
    - Division Forem'n
    - Chief Clerk
    - Dispatchers
    - Ass't to Division Foreman
    - Switchmen
    - Flagmen at Buena Vista St. Bridge
    - Trainmen
- ATTORNEY

In the general manager's office, the final results of the business and operations of the road are not only reported, but such of these results as are capable of tabulation and illustration by graphic charts are put into this form, so that the whole history of the road is always before him in a condensed form and convenient for study.

The chart case of this official is a novelty. It consists of a box about 2½ ft. square mounted on an adjustable drawing table stand. A roll of standard cross section paper millimeter scale is fixed to rollers set in each end of the box—thus allowing the paper to run back and forth over a board. The rollers are actuated from the outside by means of a small crank.

On this paper are charted by months, among other items of information:

1. Total half-fare passengers.
2. Total free passengers.
3. Total cash passengers.
4. Total passengers.
5. Cost of operating railroad per total passengers carried.
6. Receipts from passengers per total passengers carried.
7. Ratio of operating expenses to total receipts.
8. Total railroad operating cost.
9. Total operating cost.
10. Total passenger income.
12. Total receipts from sales of power.
12. Total receipts from sale of power.
13. Total cost of power sold.
14. Total cost of all power produced, including repairs.
15. Total k.w. hours of power sold.
16. Total k.w. hours for railroad and shops.
17. Total k.w. hours' output of station.
18. Cost per k.w. hours of total output.
19. Cost per k.w. hour of power sold, including solicitors and inspectors.
20. Total number barrels oil burned.
21. K.w. hours per barrel oil burned.
22. Total car miles.
23. Average number cars operated.
24. Daily average car miles per car.
25. Cost of railroad operation per car mile.
26. Receipts from passengers per car mile.
27. Daily average cost of operating per car.
28. Daily average receipts per car.
29. Damage account.
30. General office.
31. Repairs and maintenance of rolling stock.
32. Repairs and maintenance of way.
33. Cost of power, not including repairs.
34. Cost of transportation, wages, etc.
35. Total operating cost.
36. Daily average receipts per car for each of the twelve lines.

An inspection of this chart conveys a vivid idea to the mind of the railroad man of the effect of the work of the new management. Thus, the total outlay for repairs and maintenance, both rolling stock and way, has been reduced from about $12,000 per month to $6,000; the cost of rolling stock repairs alone from $6,000 to $2,800, and the cost for repairs and maintenance of way from $6,000 to $3,200.

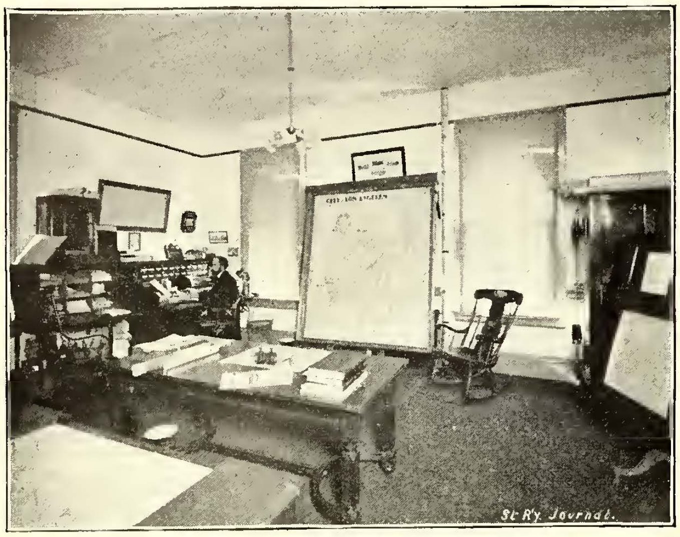
The cost of power per k.w. hour has been reduced from a trifle less than 2 cents to 1.09 cents; this latter with a fuel that costs the equivalent of coal at $4.50 per ton.

The effect of continuous work on the boilers and the use of proper compounds to reduce the formation of scale is shown by a reduction in the number of barrels of oil burned from 5500 to 4500 per month, though the output in kilowatts of the station has at the same time increased from 385,000 to 560,000 per month. Another demonstration of the same fact is shown in the increase of the number of k.w. hours per barrel of oil burned from 78 in June, 1896, to 125 in January, 1898.

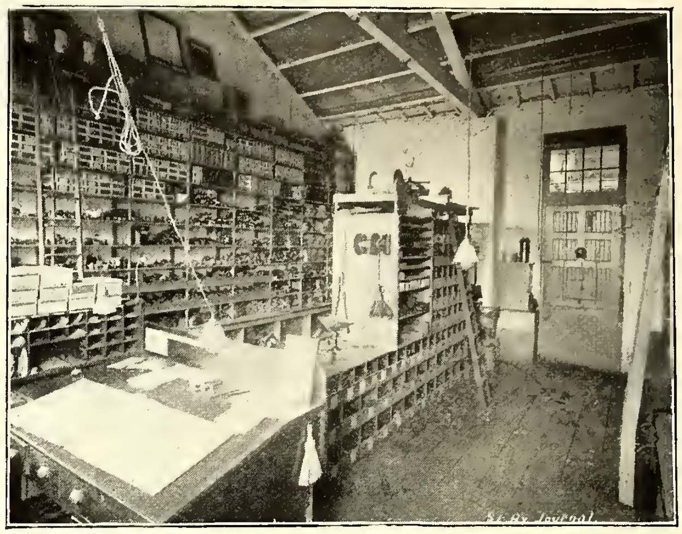
The line showing the daily average number of car miles traveled per car is an excellent index of the result of improved track and equipment conditions and of the efficacy of the dispatcher system, as in the months following its introduction there is a sharp and sustained increase.

The cost of railroad operating per car mile is always an interesting detail, and the chart shows this line to drop from 15 cents to 11.02 cents.

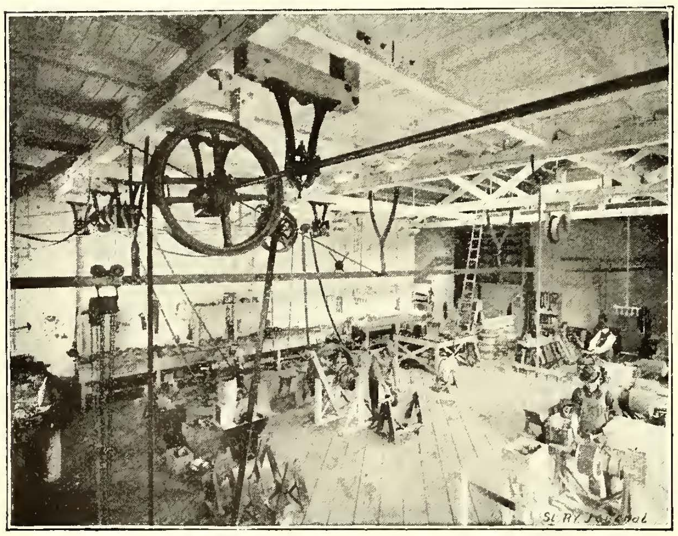
The wages of motormen and conductors is 20 cents



GENERAL MANAGER'S OFFICE

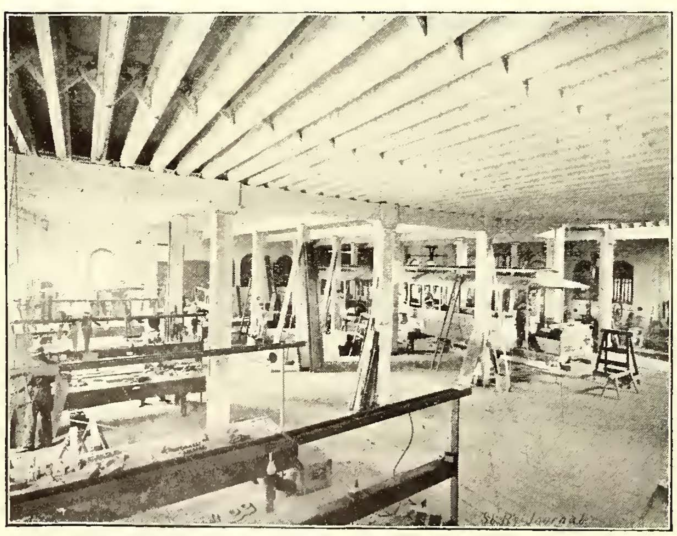


STORE ROOM

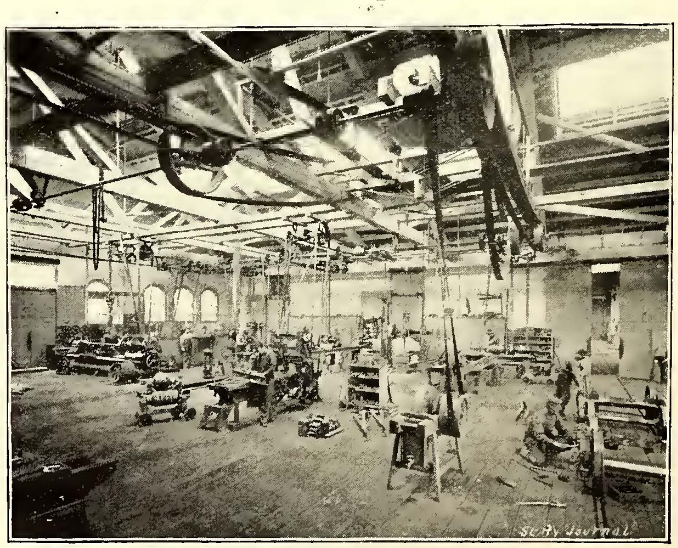


WINDING ROOM

PAINT SHOP



CARPENTER SHOP



MACHINE SHOP

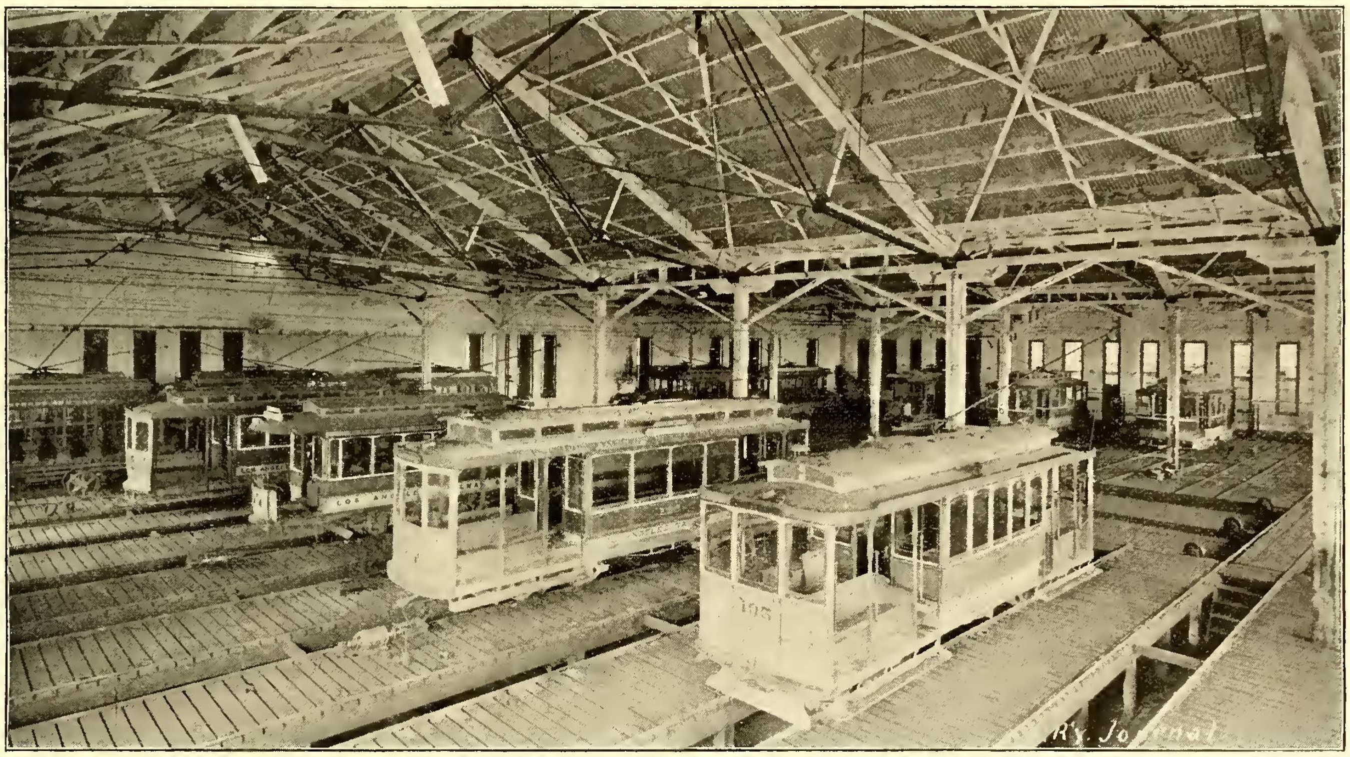
per hour; mechanics vary from 20 to 35 cents per hour, and laborers are paid $1.75 per day.

OPERATION

The cars are operated from 5 o'clock A. M. to 12 o'clock P. M., though the matter of continuing the operation an hour later is now under consideration by the management. Trailers are used in times of extraordinary traffic. The demands in this particular are exceedingly heavy, as the locations of the different pleasure grounds are at the ends of various lines. The annual festival of a week's duration, which is usually held in April or May of each year, presents at times some serious problems in bunched up loads.

A contract has been entered into with the Government for the transporting of the mails in closed pouches from the main to the branch post-offices. The geographical relation of the different stations and the railway lines makes it possible to give an excellent service in this particular.

The transfer system is exceedingly generous and produces excellent results in increasing the traffic. It is quite a problem to work out a system which will at once accommodate the public and be fair to the street railway, but this seems to have been done, and the system adopted prevents fraud almost to a certainty. Each transfer has its series and serial number and can be traced continuously from its issuance to a particular conductor in the morning to its return by him unissued or by some other conductor canceled. Transfers are not rung up on the fare register—but are turned in at central points on the line each trip. Boxes are provided for this purpose.



INTERIOR OF CAR HOUSE

At the end of a run the conductor makes up his report and cash tag and places the latter, together with his cash, in a small canvas bag, numbered, and drops it into a chute leading into an ingeniously arranged safe in the main office, so that the counting of the cash is all done in daylight and at one time. This arrangement has been found to economize the time of one clerk or receiver.

The fire brigade is a thing in which the men take a deep interest. All the shop and powerhouse employees are formed into a fire brigade, and the readiness with which they respond to drill alarms shows that good results may be expected in the event of actual fire.

PERSONNEL

No account of the Los Angeles Railway Company would be complete without some mention of the men who have made it what it is. First among these should be mentioned Gen. M. H. Sherman and E. P. Clark, who were the originators of the first considerable electric system in Los Angeles. They labored long and patiently under adverse conditions and laid the foundation for the present system. When the reorganization took place, Thos. Brown of San Francisco was elected president, and he has been a powerful factor in the company's affairs. Although a man of large responsibilities and with constant demands upon his attention, he has devoted time and labor without stint to the business of the company. In this he has been greatly aided by the other directors, all of whom are trained in the conduct of large enterprises. J. T. Burke, who has been secretary since the reorganization, has proved himself thoroughly equipped for that important office. He is also the secretary of the State Association of Street Railways.

The work of reconstruction and reorganization of working force was intrusted to Fred W. Wood of Los Angeles. The board of directors, understanding the value of concentrated power, have wisely given him great latitude of judgment in his position, and have contented themselves with laying out the broad lines of policy upon which they wished the business conducted, charging their general manager with the details. Mr. Wood has been a resident of Los Angeles for over twenty years, and has literally grown up with the city. A civil and mechanical engineer by profession, he has added to his acquirements a thorough knowledge of business by years of active work. A student by inclination, he has in the intervals of a busy life read law and been admitted to the bar of the Supreme Court of the State of California. For ten years he was the president and manager of the Temple Street cable road in Los Angeles. He is also a member of the American Society of Mechanical Engineers and the Technical Society of the Pacific Coast, and has contributed valuable papers on the subject of street railways to American and English technical publications.

Messrs. Hasson and Hunt, electrical and mechanical engineers of San Francisco, were retained as consulting engineers. They are both men of large experience, being ex-naval officers, and thoroughly equipped for the work. Mr. Hunt was on the ground for a year and a half, in active charge of the designing and erection of new machinery.

Lincoln Nissly for two years has occupied the position of engineer and electrician.

In the final adjustment of forces, Geo. E. Talcott, who had been connected with the Newark, N. J., street railway system as electrician and consulting engineer, and who has been identified with the development of electric light and electric railway matters from their first practical installation down to the present, was given the position of executive engineer and electrician. The scope of his department is such as to bring all mechanical and electrical matters under one head.

G. E. Pillsbury, a civil engineer of wide experience, is in charge of the track department, both as to maintenance and construction.

The accounting is under the supervision of C. A. Henderson, whose many years of training in this department with Eastern roads has made him well fitted for such duties.

The superintendent, John J. Akin, has been with the company since the time of the building of the cable road system and has held this position through all the successive changes.

John Fowler, the master mechanic, is a thorough machinist. He acquired his training in the Southern Pacific shops and was subsequently for ten years superintendent of the Temple Street Cable Railway.

It is worthy of note that the conductors and motormen of the Los Angeles Railway are of an exceptionally high class. Their intelligence and courtesy is a frequent source of comment among street railroad men who visit in the city.

Power Consumption in Rapid Transit Service

By A. H. Armstrong.

Perhaps no subject is attracting such widespread attention and is being so much discussed as the application of electricity as a motive power in the rapid transit problem. The ability of the electric motor to quickly accelerate with a minimum loss a heavy train weighing 100 tons or more, has entitled it to the most careful consideration when determining the motive power for roads of this character. Rapid transit service is here meant to embrace roads operating heavy trains at a high average speed over distances of 6,000 feet or less between stops. For distances much greater than 6,000 feet between stops, the conditions governing the operation of the trains will be different and the problem requires a different treatment, unless the average speed increases proportionally with the length of run between stops.

Rapid transit service is especially severe in its demands upon the motive power owing to the continual starting and stopping, leaving but little time for the train to run at a constant speed. Hence it is immediately evident that for such service the conditions governing fractional speed running of the motors should be most carefully studied in order to minimize the losses during acceleration.

Aside from the kind of motive power used, the mechanical problem of train acceleration and braking, offers a wide field for further investigation. To cover a given distance in a given time with a certain train starting from rest, does not by any means imply a certain fixed amount of energy expended. The maximum speed reached and the energy consumed will both be found to be variables depending upon the rate of acceleration and braking effort used.

Train friction is also variable, being expressed as a function of the speed, but in this discussion will be treated as a constant quantity throughout the run as the requirements of ordinary rapid transit work do not usually call for higher maximum speeds than 25 to 30 miles per hour where the error introduced in assuming a constant train friction at all speeds can be neglected. From experimental runs train friction has been found to vary from 23 lbs. per ton for a single motor car of 25 tons down to 13 lbs. per ton for a trailer, so that an assumed value of 20 lbs. per ton for a train, consisting of motor car and trailers, will be found to be conservative. Train friction is here meant to include all friction losses of the driving parts, gears, etc., in addition to the rolling friction of the train.

Assuming a train to cover a distance of 5,280 ft. and come to rest in 140 seconds from time of starting, a set of curves as in Fig. 1 can be plotted, showing the relation between speed-time and distance-time. This distance of 5,280 ft. is somewhat above that encountered in the majority of rapid transit, and much higher than the length of run in elevated roads, but has been chosen for sake of simplicity as giving one stop per mile to form a basis of comparison for other roads giving a larger number of stops per mile. A method of reducing the following values to agree with any number of stops per mile is discussed later.

Referring again to Fig. 1, the power is applied for sixty-four seconds at a constant rate of 80 lbs. per ton when deducting 20 lbs. per ton train friction leaves a net accelerating force of 60 lbs. per ton. At the end of sixty-four seconds the train has reached a maximum velocity of 41.4 miles per hour, and is allowed to coast with a retarding force of 20 lbs. per ton for 59.3 seconds when brakes are applied at the rate of 150 lbs. per ton braking effort. A braking effort of 150 lbs. per ton is chosen as fairly representing average current practice in service of this character calling for a rapid slowing down of the train at stops, and in order to simplify the problem the brakes are assumed to be applied uniformly throughout the time braking takes place. The distance traveled at any time is shown by the distance-time curve representing three tangent parabolas described by the uniform forces of 60, 20 and 150 lbs. per ton, respectively.

Having thus described in detail a representative acceleration curve, it is evident that by accelerating with a lower rate than 60 lbs. per ton net, the length of time for coasting would be reduced with a constant braking effort until a limit is reached when brakes must be applied as soon as power is shut off. Also it is evident that by increasing the rate of accelerating above 60 lbs. per ton net and keeping the same braking effort of 150 lbs. per ton, the length of time the train will coast will be increased being a maximum when the accelerating rate becomes infinite, that is when the train starts with a certain initial velocity.

Such varying rates of acceleration are shown in Fig. 2, where the train covers a distance of 5,280 ft. in 140 seconds as in Fig. 1, the accelerating rates varying from 63.4 lbs. per ton (including 20 lbs. friction) as a minimum to infinity as a maximum rate. This accelerating rate of 63.4 lbs. (43.4 lbs. net) is thus the least constant rate that the train could be accelerated to enable it to cover the distance of 5,280 ft. in 140 seconds and the maximum speed reached, 5.13 miles per hour, is the highest speed possible with the given conditions of braking. The maximum speed reached is shown to decrease rapidly with the increasing rate of acceleration, until an accelerating rate of 120 lbs. per ton is reached, after which it increases slightly with still higher rates of acceleration. With a train friction greater than 20 lbs. per ton, this inerease in maximum speed required with very high rates of acceleration, is shown much more pronounced, so that it is not true as generally assumed that for a given set of conditions the maximum speed reached is a minimum with an infinite rate of acceleration, but this minimum value is reached with some finite rate beyond which it would increase.

Having thus determined the limiting rates within which the train can be so accelerated that it can cover 5,280 ft. in 140 seconds with the braking effort of 150 lbs. per ton constant in all cases, it becomes of interest to find the amount of energy expended with each rate of acceleration. The total energy required to bring a train up to a eertain speed is the sum of the energy required to accelerate the mass and that required to overcome train friction up to the point of shutting off power,

$$E = \frac{m V^2}{2} + f s$$

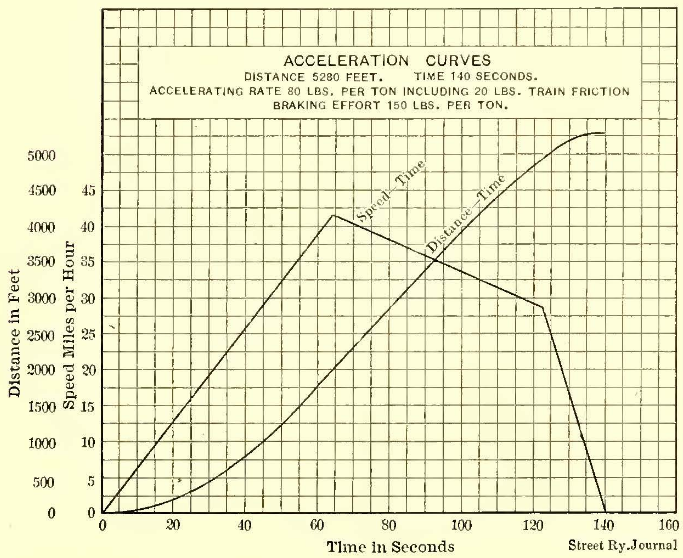


FIG. 1

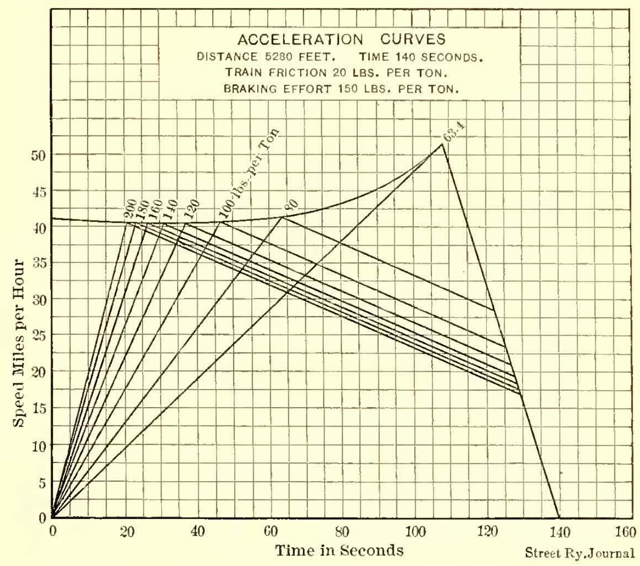


FIG. 2

where f is train friction, in this case assumed to be 20 lbs. per ton, and s is distance traveled up to point of shutting off power. It is obvious that stated generally the less the maximum velocity the smaller is the amount of energy expended for the same conditions governing coasting and braking, and hence the quicker rate of acceleration demands less total energy output of the motive power, although the rate of expending this energy is much greater.

This decrease of energy eonsumption with increased rate of acceleration is clearly brought out in Fig. 3, where energy eonsumed is for sake of convenience reduced from foot-pounds to the electrical term of watt-hours-per-ton-mile. From the curve it is seen that there is a certain maximum amount of energy that can be expended with given eonditions of train friction and braking effort, this maximum amount of energy corresponding to the minimum rate of acceleration, that is continuing up to the moment of applying the brakes and leaving no time whatever for eoasting. Hence this method of acceleration is highly inefficient, and considering only the amount of work to be done, the more rapid the rate the less energy required to move a train a fixed distance in a given length of time.

A popular error exists in assuming that the amount of energy needed to overcome train friction being a fixed quantity for a given length of run, the efficiency of the run, that is the relative amount of energy input to the train, can be expressed by the maximum speed reached, the lower the maximum speed the less the total energy required. The fallacy of this reasoning is shown by an inspection of curves in (Fig. 4) illustrating a run of 5,280 ft. with an acceleration of 80 lbs. per ton and 150 lbs. braking effort. Train friction is assumed constant at all speeds at 20 lbs. per ton, and it is understood that accelerating rates as given always include this train friction.

Curve "A" shows the acceleration to be carried on at a constant rate up to a speed of 41.4 miles per hour when power is shut off and coasting commences. Curve "B" carries the acceleration up to a speed of only 35 miles per hour, which speed is maintained constant until braking takes place, by supplying the train with just sufficient energy to overcome train friction. Of the two runs the coasting method requires the higher maximum speed, but still the total amount of energy expended per ton weight of train is only 146,200 ft. lbs., as compared with 162,000 ft. lbs., with the method using constant current input at full speed and hence lower maximum speed. The reason for this lower energy input is evident by a comparison of the speeds at which brakes are applied, the higher speed at braking, indicating a less efficient run, as the energy consumed in braking is wasted as heat in the brake shoes. Where the train is allowed to coast, the train friction reduces the maximum speed attained, so that when brakes are applied part of the braking has already been effected during coasting, and hence less heat must be wasted at the brake shoes to bring the train to rest. The most efficient run possible is obviously that one in which the train friction constitutes the entire braking effort and the train is allowed to coast the entire distance, reaching zero speed at the end of the specified time, and hence allowing no energy to be lost in the brake shoes.

All previous curves have been shown with the train coasting after full speed is reached as this represents the most efficient method of acceleration, and further curves will be plotted on the same basis.

Referring again to curves in Fig. 2, it is evident that similar curves can be plotted for a train covering 5,280 ft. in any other time than 140 seconds, and in Fig. 5 is such a set of eurves showing maximum speeds reached with any rate of acceleration from the minimum possible to infinity, train friction being assumed as 20 lbs. per ton as before and braking effort 150 lbs. per ton. The least time in which a train can cover a given distance with a given braking effort is when brakes are applied at moment of starting, the train accelerating with an infinite velocity, that is, starting with a definite initial velocity. Such a minimum time is found from curves in

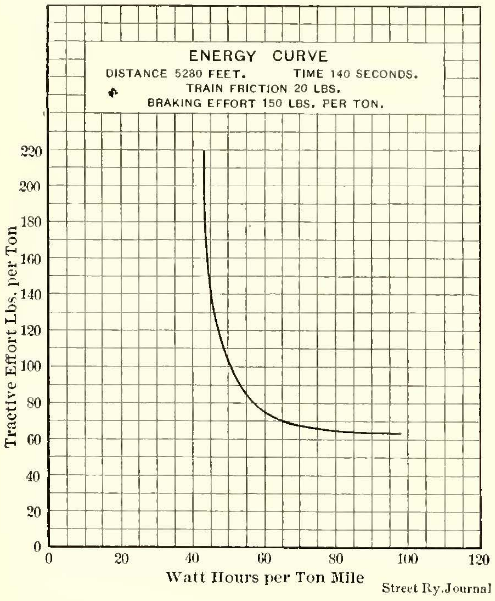


FIG. 3

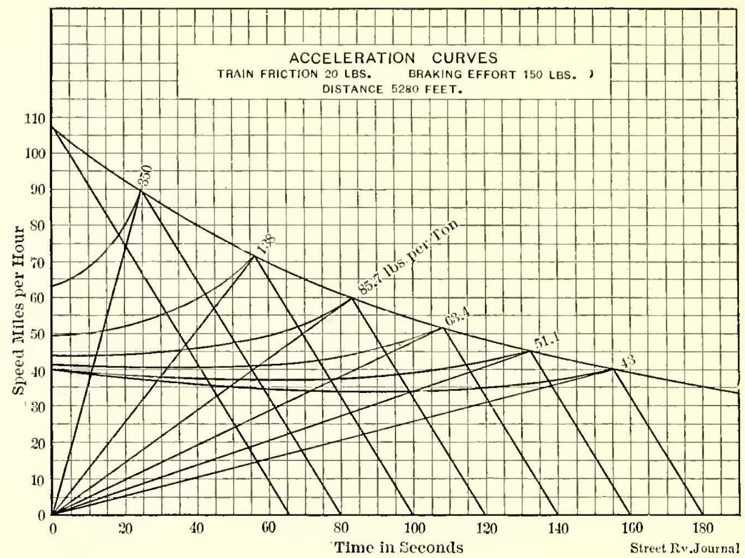


FIG. 5

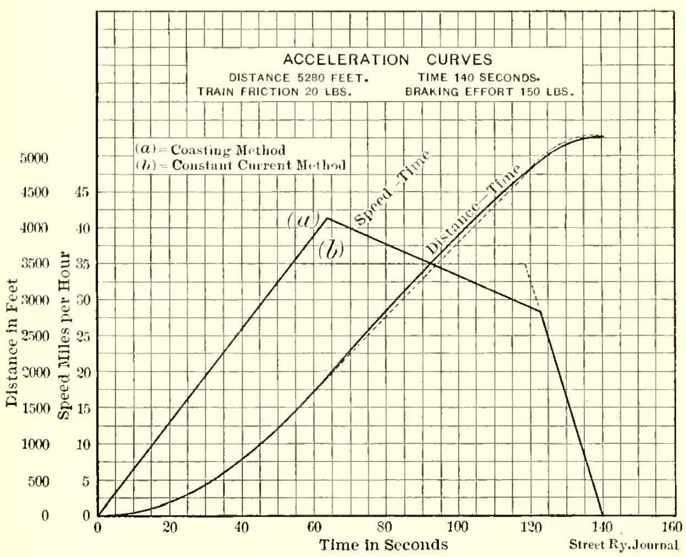


FIG. 4

Fig. 5 to be 66 seconds, which represents an average speed of 54.6 miles per hour, which is the highest speed a train could make, theoretically stopping every mile with a braking effort of 150 lbs. per ton.

The maximum time consumed in running 5,280 ft. is obviously infinity with a tractive effort equal to train friction 20 lbs. per ton, and the maximum speed reached would be zero.

To avoid confusion only the minimum rates of acceleration, including 20 lbs. per ton train friction, are shown in Fig. 5, and the limiting values of maximum speeds for all other rates, thus affording a means of ascertaining the maximum speed reached for any rate of acceleration and any length of time for completing a run of 5,280 ft. with the assumed constants of train friction and braking effort.

As the relative speed when brakes are applied is a measure of the energy input for a given run, the run ending with the lowest speed on the braking line is evidently the one requiring the least energy input, and this least speed occurs when a train coasts the entire distance with a retarding force equal to train friction and ends at zero speed in the specified time, hence the longer the coasting the less the energy required to propel a train with a given number of stops per mile.

The relative amount of energy required for the different rates of acceleration is better shown on curves in Fig. 6, giving the energy consumed in accelerating a train with any rate making any speed over a distance of 5,280 ft., the speed given being the average speed while train is in motion and tractive effort, including 20 lbs. train friction. An inspection of curves shows that the least energy that can be expended is 40 watt hours per ton mile, and this is the amount of energy expended in moving a train at any speed with a tractive effort equaling a train friction of 20 lbs. per ton. The benefit of a rapid rate of acceleration for the higher speeds is here shown very clearly, and the curves bring out most forcibly the poor economy resulting from having the rate of acceleration and schedule speed so proportioned that power must be applied up to the moment of applying brakes, that is at the minimum rate and allowing no time for coasting. For instance, with an average speed of 25 miles per hour while train is in motion, the least tractive effort possible is 61 lbs. per ton, requiring an energy output of the motive power of 94 watt hours per ton mile, while if the accelerating rate had been increased to 80 lbs. per ton the average energy consumption would have been decreased to 54 watt hours per ton mile, a reduction of 42½ per cent in station capacity required, if electric motors are used.

This brings up another point to be considered and that is that although the average amount of energy required for a given run decreases with the rate of acceleration, the rate of input increases, necessitating a larger outlay in line copper and occasioning a greater fluctuation in the load on the generating station if the number of trains operating is small. Hence while an increased rate of acceleration reduces the average generator load, it may increase the cost of line copper in much greater proportion and indeed may be carried to the extreme where either line loss or interest on copper investment would offset the gain in reducing average train energy consumed. The importance of carefully considering each individual case is thus evident in order to operate a given road for the minimum expense.

All previous curves have dealt with a train making but one stop per mile, and this was done for sake of simplicity as although most rapid transit roads and all elevated or underground roads have a larger number of stops than this, it is very simple to reduce the results obtained to agree with any number of stops per mile. Curves in Fig. 6 give speeds in miles per hour as the average speed while train is in motion and do not include length of time at stops, hence for comparison all runs should be reduced to average speed while train is in motion. The watt hours per ton mile are the same for average or schedule speed as the time lost in stopping does not affect it. By referring again to the acceleration curves, the area inclosed by the speed as ordinates and time as abscissae represents the energy expended for a given run and this area is proportional to the distance between stops provided the runs are entirely similar, that is the rate of acceleration, train friction and braking effort are the same. Such a comparison is shown in Fig. 7, where two runs are shown, (a) covering a distance of 5,280 ft. in 140 seconds; that is, with one stop per mile, and (b) covering a distance of 1,320 ft. or four stops per mile. Here as shown the speed of 60 miles per hour with minimum accelerating rate of 85.7 lbs. per ton. (See Fig. 5). As accelerating with the minimum rate is highly inefficient, a higher rate is advisable, say 120 lbs. per ton, where maximum speed reached is 46½ miles per hour and energy 65 watt hours per ton mile. These values reduced by means of the ratio 1.625 found above gives 28.6 miles per hour maximum speed reached with 120 lbs. per ton tractive effort and requiring an energy expenditure of 65 watt hours per ton mile as the constants of a train making 16.25 miles per hour schedule speed with ten seconds stops over average distances of 2,000 feet between stops.

All values of watt hours per ton mile given on curve sheets are net, that is they represent only the actual energy consumed in accelerating the train and overcoming train friction and hence representing the useful output of the motive power. The efficiency of the motors and their method of control entail additional losses which it is not the intention of the present article to discuss, so that the energy values given do not represent station capacity of generating apparatus until the efficiency of acceleration,

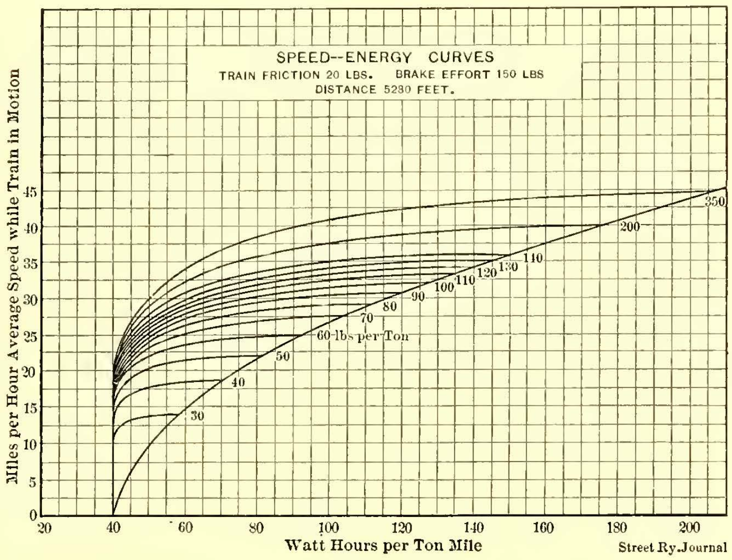


FIG. 6

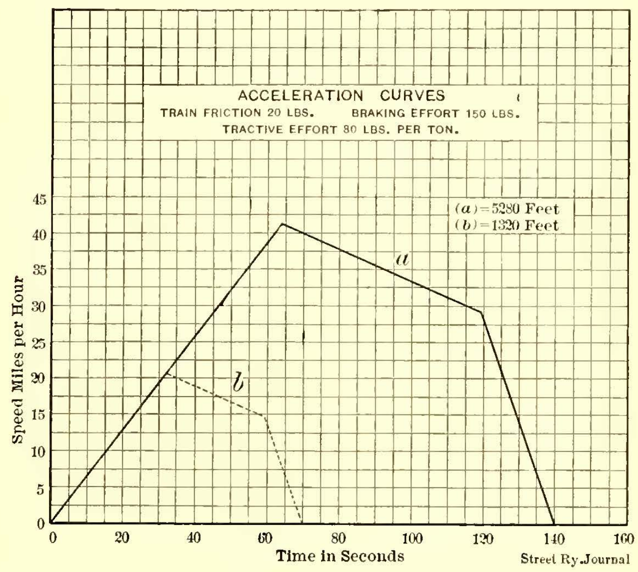


FIG. 7

area inclosed by "a" is four times "b," and maximum speed reached and duration of run in seconds are both double.

Thus a ready means is provided for ascertaining the energy required and maximum speeds reached for any number of stops per mile and average speed while train is in motion. Having plotted complete sets of curves for one stop per mile for all conditions of accelerating and coasting, any similar run may be reduced in the inverse ration of $\sqrt{n}$ the square root of number of stops per mile

$$x = \frac{a}{\sqrt{n}}$$

where x may be the maximum speed reached, length of time power is applied, duration of run in seconds, etc., depending upon the value of "a" taken. For example, a road is operating a train with stops every 2,000 feet, and it is desired to maintain a schedule speed of 16.25 miles per hour including ten seconds stops, wanted the tractive effort, maximum speed reached, and average energy output of the motors. Deducting the time lost in stopping, the average speed is 18½ miles per hour and the time train is in motion between stations is 73.8 seconds. Comparing with stops one mile apart, the square root of ratio of distances traveled is 1.625, and hence this calls for a run of 120 seconds, with one stop per mile and maximum that is the ratio of useful output of motors to train input, is determined for the case in hand. While a discussion of the electric motor and its method of control may modify the advantages of rapid acceleration as for instance as cited above when the rate of acceleration is pushed so high as to necessitate a lavish expenditure for line copper, it will still be found that the problem of economic handling of rapid transit service lies in the proper proportioning of rate of acceleration and braking effort to schedule speed.

On straight line work, where the trolley wire is flexibly supported in the center of the track, there seems to be little wear on the wire from the trolley wheel, except in the cases of very heavy traffic. On one of the roads in Dallas, Tex., the original trolley wire, a copper No. 4, B. W. G., is still in use after eight years' service, and promises to last a long time yet. The same road has been using for about four years on a section about 1½ miles in length a 5-16 in. galvanized steel trolley wire, and reports it still in good condition. Though, of course, a much poorer conductor than copper, the trolley wheel seems to obtain current from it as well as from a copper wire.

Electric Railway Motors

By George T. Hanchett.

IX. Field Coil Construction and Arrangement.

Railway motor field coils are now almost universally of the mummified or taped type. The principal reason for this is on account of the greater weight and bulk of coils employing spools of any form, and, in railway motor design, space and weight are most jealously allotted to the various parts. The greater expense of supporting spools is a further consideration.

In winding a mummified coil, a wooden form of the type shown in Fig. 1 is generally used. It is intended to be screwed to the face plate of a lathe or winding machine, and the same bolts that hold it thereto also secure it together. The nut ends of the bolts are placed on the outer side for convenience in removing the flange, C, to free the finished coil. To facilitate this latter operation the wooden core should be given a slight taper.

In order to retain its form when taken from the reel such a coil must have stout tape wound into its turns at intervals to hold it together. To do this a strip of tape is wound in between the layers and lapped over the first few turns of the next layer, as shown in Fig. 2. As the wire on most railway motor field coils is quite heavy, considerable of this taping must be done on every layer. Two sets of tapes must be carried up, the one binding the layers that the other omits. As the wire is wound it should be carefully inspected for breaks in the insulation, and where these are found they should be carefully wrapped with cotton yarn, or, better still, covered with cloth or varnished paper, as shown in Fig. 3. The paper is looped about the wire over the bare spot and the adjacent turns hold it in place. To secure the first and last wires so that they will not unwind, they should be tied with strong cord, as shown in Fig. 4, several cords being caught under the next to last turn and the ends firmly knotted together when the winding is complete.

It is common practice to solder flexible leads on to the ends of a field coil and depend on them for permanency. Too often such leads are used as convenient handles in moving the coils and are broken off short or the winding otherwise damaged. This difficulty is obviated by the use of a terminal of the type shown in Fig. 5. It is of cast brass, and its application will be readily understood. The end of the winding is securely soldered into the socket provided for it and the protruding terminal is drilled and tapped to secure a wire, as shown. The heavy taping which the coil ultimately receives firmly secures this plate from moving. The waterproof qualities of the winding will be improved by using wire that has been run through hot paraffine before winding.

The completed coil should be served with two layers of strong cotton tape. Adhesive tape should not be used, as it is not strong enough to be drawn tightly and always contains a certain amount of moisture. After the first layer of tape is tightly wound on, the coil should be painted with P. & B., and while it is still sticky another layer of tape should be put on, the winder being careful to lap the joints of the first layer. After two more coats of P. & B. have been applied the coil is ready for baking. If no convenient means are at hand for doing this the coils may be connected in series and enough current passed through them to heat them. If the pressure at hand is 500 volts, as is usually the case, the more coils that are connected in series the less outside resistance will be necessary. The outside resistance may be a few old rheostats. A good method is to provide an asbestos lined box and place the coils and car rheostats therein. In this way the heating effect of all of the current will be utilized. The heat which the coils receive from the current they carry is the best which can be applied, and will bake the coil more quickly and thoroughly than in any other way. In applying current to field coils for this purpose it should be remembered that railway motor field coils are not as a rule designed to carry their full load current continuously, for advantage is taken of the fact that in practice the current is of an intermittent nature. They are, therefore, made smaller and lighter than would be permissible if the full load was steadily maintained. On interurban motors the field coils are made heavier for obvious reasons. The fastening of the field coils to the motor case is accomplished at present in several ways. It is highly important that this be securely done, because the vibration of the motor is sure to chafe a hole in the insulation of the field coil if there is the least play, that is in the case modern field coils, which have no spools. With field coils wound on brass spools it is simply a matter of screwing the spools to the case.

The almost universally used method is to secure the coil by clamping it with a casting held by one or more screws. The Westinghouse method shown in Fig. 6 is an example of this. The clamping casting is a rectangular frame, and four bolts secure it to the case, passing through the latter and being secured by nuts on the other side. In this case the clamp, beside holding the field in place, affords a substantial protection for the coil, in fact as good protection as if it were wound on a spool.

The field coils of the smaller sizes of the Walker motor are held in pairs by castings shaped as shown in Fig. 7.

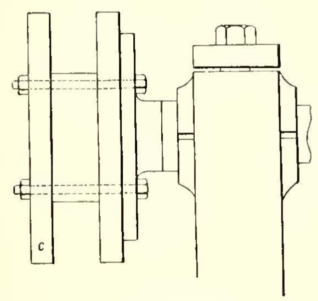


FIG. 1.—FORM FOR WINDING FIELD BOBBIN

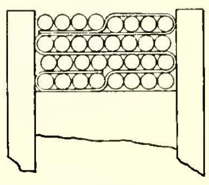


FIG. 2.—METHOD OF INSULATING

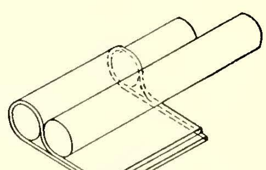


FIG. 3.—REINFORCING INSULATION

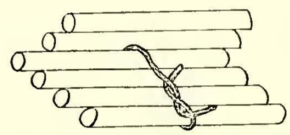


FIG. 4.—SECURING THE LAST TURN

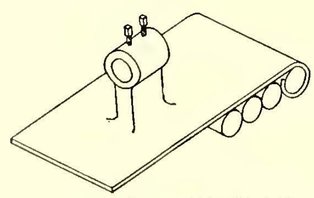


FIG. 5.—TERMINAL PLATE

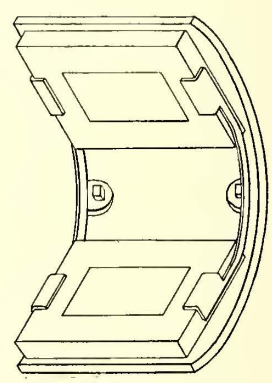


FIG. 7.—WALKER CLAMP FOR FIELD COILS

While this method does not protect the coil as fully as the one just recited, it has the advantage that only four bolts are necessary to hold in all four field coils, and hence they are very easily removed. These bolts have no nuts, but are threaded into the case.

Wherever the pole piece is bolted on to the case a pole shoe is almost always used to reduce the reluctance of the air gap, and this pole shoe is employed to retain a clamping collar which confines the field coil. The later motors of the Walker and General Electric companies have employed laminated poles bolted on the case on account of the increased efficiency afforded by this practice.

Railway motor field coils are always connected in series, even in the largest sizes. The principal reason for this is the certainty of obtaining equal magnetization for all the pole pieces. It is easily possible to wind each pole with an exactly equal number of turns, and if this is done they will, if connected in series, carry the same current regardless of resistance, and hence will have the same ampere turns. If they are connected in multiple, to have equal magnetizing power they must have equal resistance and the same number of turns, a condition impossible to obtain, owing to difference in tightness of winding and variation in conductive qualities of copper. Parallel connection would be a great advantage if equal magnetization could be attained, for it reduces the size of the wire necessary and in the heavier motors, as for instance the Walker No. 25, where the field wire is No. 0000 B. & S., this is no small consideration, for such heavy wires are very difficult to wind.

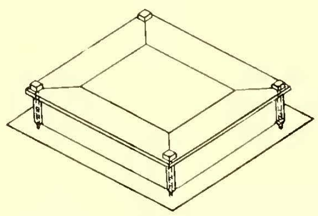


FIG. 6—WESTINGHOUSE CLAMP FOR FIELD COILS

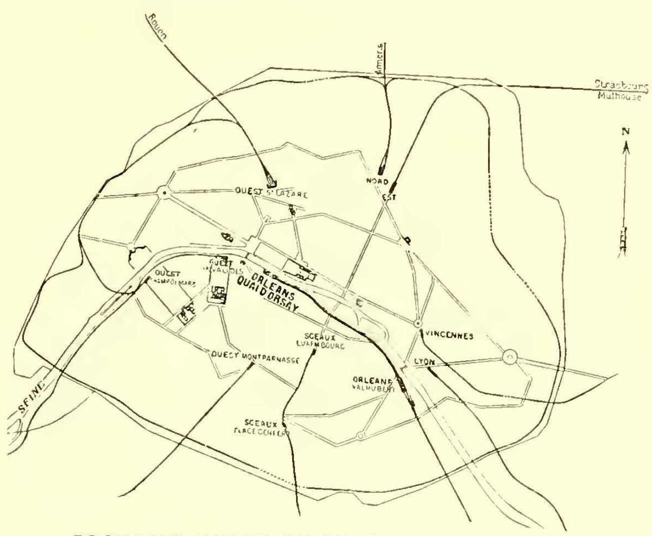
Heavy Electric Railroading Proposed in France

An enterprise involving the expenditure of not less than forty million francs, or eight million dollars, and the creation of a road about 2½ miles long, partly under ground, to be operated exclusively by electricity, is about to be undertaken in the city of Paris by the Orleans Railroad. The main terminal of this railroad, which operates about 4300 miles of track in the West and Southwest of France, is at the Place Valhubert, near the Pont d'Austerlitz, in the extreme east of Paris. The traveling population of Paris does not live in the eastern part of the city, but in the western, in which direction the city is steadily growing, and access to the present Orleans station in most cases involves carriage transportation. The Orleans Company has, therefore, decided to prolong its line into the very heart of Paris, and for this purpose has secured a right of way underground to a point on the left bank of the Seine, opposite the Garden of the Tuilleries, where it will erect a terminal station.

The new road will have two tracks and will drop from the Valhubert station on a grade of 1.1 per cent toward the Seine. Here the river banks are in two stories, an upper quay or roadway, and a lower quay, used as a dock or wharf cor canal boats. A belt 9 meters wide has been secured on this lower quay, and the line will follow this in the open for 650 meters. It will be an underground road beneath the upper quay for the remainder of the distance until it reaches the terminus under the Cour des Comptes. Openings in the wall side of the quay facing the river will afford light and ventilation. The rail level is about that of the normal height of the water—any seepage water in times of flood will be gathered in a sump and drained out.

About half way between the Place Valhubert and the Quai d'Orsay a station will be built, known as the Station du Pont St. Michel. The Quai d'Orsay station—the terminal station, will have fifteen tracks, any one of which can be used for arriving or departing trains. According to the present plans, the three tracks nearest the river will be used for side tracks, the next four tracks for the long-distance departing trains, the next two for arriving long-departing suburban trains, the next two for arriving long-distance trains, the next two for arriving and departing suburban trains and the last two for station service.

The platforms of the Pont St. Michel station will be 230 meters long. Those of the Quai d'Orsay station, 185 to 240 meters long and 6 to 7 meters wide. A number of elevators will be installed to facilitate movement of passengers and baggage. The rail level is 25 ft. below the street level, and the company has not been obliged to purchase the title to the surface, the structure overhead being carried by a metal roof construction guaranteed by the company. The building above the station will probably be occupied by a large hotel, and will, of course, be in harmony with the buildings in its vicinity.



PROPOSED ROUTE OF ORLEANS RAILROAD—PARIS

A short distance west of this station is the terminal station of the Ouest Railroad at the Invalides, and still further west is the small station of the Champ de Mars, the former a part of the main line of the Ouest Railroad, the latter an off-shoot from the Ceinture or Belt Line which encircles Paris. These stations will probably eventually be joined to the Quai d'Orsay station of the Orleans road, thus uniting the Ouest, Ceinture and Orleans systems.

In driving the underground tunnel the Orleans Railroad will operate without interference whatsoever with the street traffic. The earth overhead will be supported by a metal shield pushed forward by hydraulic presses and followed closely by the masonry. The method is similar to that employed in building the great sewer recently laid down in Paris.

The operation of this underground road, as at present contemplated, is to be carried on by means of electric locomotives driven by continuous current at a pressure of between 500 and 700 volts, using the third rail system of contact. In asking for estimates, however, the company has requested bidders to submit plans also for the use of systems of generation and distribution other than that just mentioned. The locomotives are to be eight in number, all alike, and able to haul a train of 250 French tons in seven minutes between the stations of the Quai d'Orsay and the Pont d'Austerlitz without stopping at the intermediate station of the Pont St. Michel. This means a speed of 45 miles an hour. The locomotives should not only be able to haul a train of the weight mentioned on a grade of 11 mm. and on curves of 200 meters radius, but it should also be able to haul trains as heavy as 300 tons at a slower speed. The locomotives must be built to move in either direction, at the same speed, and be of a length to allow them to be turned on turntables 6 m. 20 c.m. in diameter. They are to be equipped with motor-driven air pump and air brakes.

The electric generating station will be placed at the western end of the Valhubert station departing platform, taking the place of certain waiting rooms. The equipment is to be of sufficient capacity to allow of the simultaneous movement of four 200-ton trains, exclusive of the locomotive, upon the line—one starting from the Austerlitz station, one from the Quai d'Orsay station, the third climbing the grade of 11 mm. and the fourth running between the Pont St. Michel and the present main station. Furthermore, the generating plant must include sufficient lighting capacity for three stations already mentioned and the tunnel, as well as for the station and shops at Ivry. The current is to be taken by the locomotives from an insulated third rail at the side of the track in the stations and between the tracks over the rest of the line, due provision being made for all switches and cross-overs.

In order that a better knowledge of the operation of electricity in heavy traction service might be gained than was possible in Europe, the Orleans Company recently sent over to America a corps of engineers to investigate the different electric railway installations of this type in this country. The party was headed by M. E. Solacroup, Assistant Chief Engineer of Material and Traction, and M. Sabouret, Chief Engineer of the Central Service. The other members were Messrs. Liberty, Fremenville and Walton. Their inquiries were conducted very quietly, but during their short stay they were able to visit almost every installation of special interest to them in the United States.

The investigation was begun at Hoboken, where an electric locomotive is hauling all the freight service between the Transatlantic docks there and the West Shore and Erie Railroads. From there they visited Baltimore, to inspect the great electric locomotives which operate the entire traffic of the B. & O. Railroad through the Belt Line tunnel in that city. From Baltimore they went to Chicago, for the purpose of observing the operation of the electric elevated railroads, and, returning East, passed through Cleveland, Niagara Falls and Buffalo, where they had an opportunity of studying the employment of the electric car in high speed interurban service.

From Buffalo they traveled to Boston, where they were met by C. P. Clark, President of the New York, New Haven & Hartford Railroad, and Colonel N. H. Heft, Chief Electrician of the same road. They traveled over the Nantasket Beach Branch of the New Haven system between East Weymouth and Hull and inspected the power house. Returning, they visited the third rail electric system between Berlin and Hartford, Conn., opened for traffic last summer, and rode on the 30-ton electric locomotive operating between factories at New Haven and the Cedar Hill Junction.

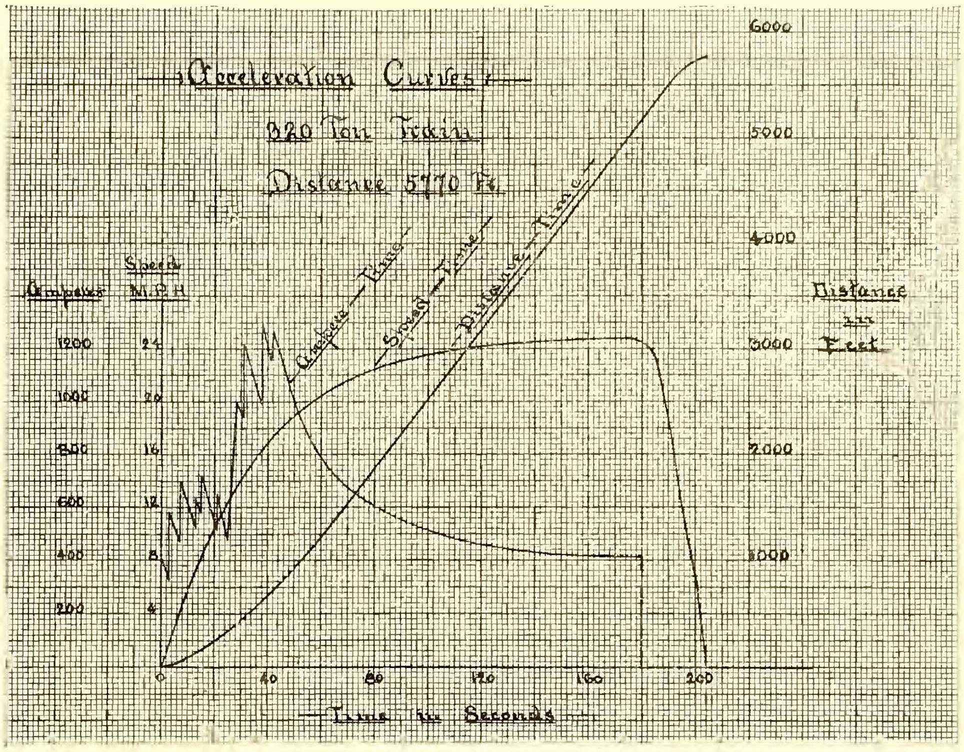
FRENCH ENGINEERS AT SCHENECTADY

A special test was arranged for their benefit at Schenectady on the experimental two-mile track of the General Electric Company, the conditions of the track and load being, as far as possible, similar to those which will obtain on the line in Paris. A length of track was marked off 1.11 of a mile long, by two white flags, corresponding to the distance between the Quai d'Orsay and the Pont St. Michel stations, the most difficult portion of the proposed Orleans extension. According to the time schedule arranged for the operation of the road this distance should be covered in three minutes and fifty seconds. A train was made up of a motor car of the Nantasket Beach pattern, equipped with four G. E. 55-175 h.p. motors as locomotives, several New York Central coaches and seven flat cars loaded with pig iron, making a total train load of 320 tons, including the motor car, which weighed 45 tons. The run between the flags, including starting and stopping, was made easily in three minutes and twenty-five seconds, giving a margin of not less than twenty-five seconds to the good. The diagram on this page shows the acceleration curves of this run.

The question of rendering the third rail innocuous after the passage of the train having been brought up, the General Electric Company arranged an exhibition of its method of effecting this result. A section of the third rail was measured off and divided into sections, in lengths varying from 30 ft. to 500 ft. Connections were made between these and a system of automatic switches, and the conditions of the General Electric system of surface contact, almost exactly reproduced. By this system the arrangement of circuits is such that sections into which the rail is divided may be of any length, from that of a few feet to any number of miles, that is, any section of the conductor rail will be alive only when the train itself is running over that section. The instant the train passes to the succeeding section, that which it has just left becomes dead and absolutely innocuous. The use of this system also renders it possible to "section" the conducting rail at stations, leaving it continuously alive at all intermediate points. The switch cutting the dead section into circuit is closed as the contact shoe of the train comes into contact with the conductor, energizing it, and is automatically opened as the train passes to the next dead section.

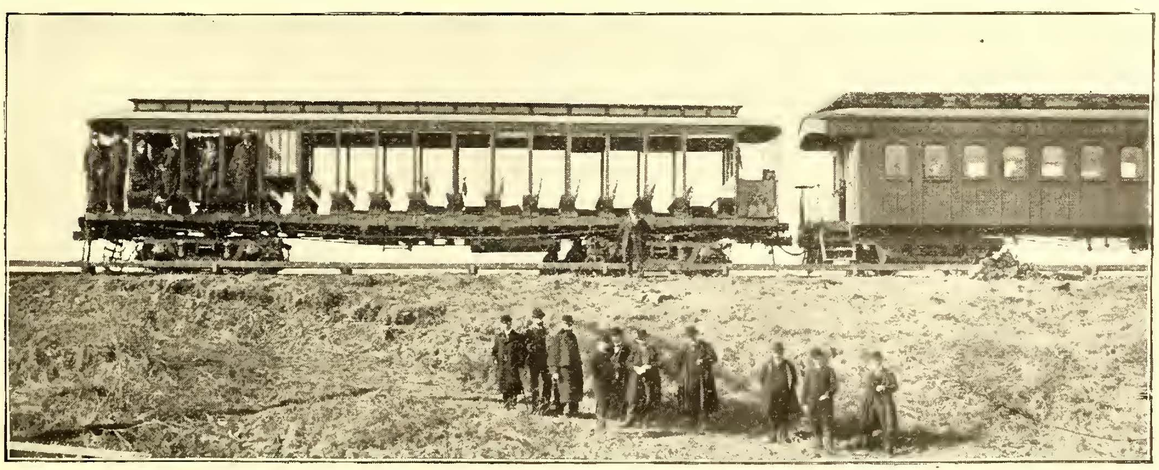
The motor car was run over that part of the track beside which the third rail was sectioned, and as a visual means of indicating that the third rail was alive a number of incandescent lamps on the top of the boxes containing the switches were conducted to the conductor. As the car reached the sections and rendered them alive, the lamps lighted up, being extinguished as the contact shoes passed over the dividing lines between the different sections.

These tests formed the subject of the concluding investigations of the French engineers in this country. A few days before their departure a dinner was tendered to them at Delmonico's, at which many prominent railroad engineers and electricians were present to meet them. They admitted having received many new ideas during their stay, and return to France convinced of the use and possibilities of electricity as a motive power, especially in the field of heavy traction.



CURVE DIAGRAMS OF SCHENECTADY TEST

The snow fall was exceptionally heavy in Montreal last winter, and, according to the records of the Government observatory, was heavier than any since the establishment of that institution. The aggregate fall for the winter was over 14 ft. 6 ins. on the level, the greater portion falling between Jan. 22 and Feb. 23. In spite of this fact, the service of the Montreal Street Railway Company was at no time seriously interrupted.



INSPECTING THE THIRD RAIL SYSTEM

LETTERS AND HINTS FROM PRACTICAL MEN.

Pressing Wheels on Axles

St. Louis Car Wheel Company,
St. Louis, Mo., May 5, 1898.

Editors Street Railway Journal :

The communication of G. Leverich on page 190 of the April number of "The Street Railway Journal" opens a subject that should interest every street railway company. Having had no experience in fitting steel wheels on axles, I do not consider myself competent to discuss his article in that respect, but in fitting chilled wheels on both iron and steel axles, and in fitting steam car wheels and axles, I have had considerable experience. As a result I have about reached the conclusion that formulae and standards are not of much practical benefit in every day work, for we sometimes have soft axles and wheels, at other times a hard axle with a soft wheel, again a soft axle and a hard wheel, and still again both axle and wheel are hard. In such cases the wheel fitter must vary his sizes of bore and fit to suit the density and hardness or softness of the material he has in hand, for with soft wheels and axles the difference in diameter of wheel and axle must be greater than with either of the other conditions to insure the wheels remaining fixed on the axle when in use. While Mr. Leverich's formula may be correct for steel wheels and axles of a known strength and density, he does not advance any information as to what pressure is required to force the wheel to its seat on the axle. This seems to me to be important, as it is the only means that we have of determining the accuracy of fit and whether the wheel will remain where it is placed.

Alex Magee.

Lobdell Car Wheel Company,
Wilmington, Del., April 23, 1898.

Editors Street Railway Journal :

I have read with interest the article entitled "Pressing Wheels and Axles" in the April issue of the "Street Railway Journal." While the deduction of Mr. Leverich may be technically correct, it seems to me that the practical application of his theory would be attended with some delay and difficulty. I think there has been very little trouble in well regulated wheel and axle shops with burst wheels, and the practical experience of such shops is sufficient to provide for the proper and expeditious fitting of wheels on axles, whether steel or iron. Unless the limit of compression and elasticity of each axle and wheels used is accurately known, I do not see how Mr. Leverich's theory can be put into practical application.

Wm. W. Lobdell,
President.

Railways in the Argentina.

New York, May 19, 1898.

Editors Street Railway Journal:

The May number of the "Journal" publishes an article from the pen of the United States Consul at Montevideo, Uruguay, giving some of the railway conditions of that city, and his statement that electricity would doubtless be used were it not for the high price of coal and the extreme cheapness and hardiness of the horses. The writer of this letter made a complete survey of one of the prinipal lines in Montevideo less than a year ago, and found that the same roads could be operated electrically, even with coal at $8 gold per ton, cheaper than it is now done by horses, and the receipts would be much greater. The operating expenses per car mile on this road for the past year, taken from the company's own annual report, was $.0917, whereas the same system reconstructed could be operated for $.072, and give a much better and cleaner service, doing the same work with two-thirds the number of cars.

Coal is dear in these countries, but even then the roads can be operated as cheaply, or very nearly so, as they can at home. In the first place, labor is much cheaper, and the weather conditions are perfect the whole year around for street railway work. A double equipment of cars is not necessary, as open cars can be used ten months of the year, and frequently during the winter. Snow is unknown, so they require neither sweepers or snow plows. Horses are not taken care of as they are in this country. Their very cheapness forbids the spending of money necessary to give them proper medical attention when they need it. The average street car horse does not give a five-year service in South American countries, and in Montevideo especially, as it is a very hilly city, and the tracks are not by any means in good condition. There is a splendid, and as yet unoccupied, field for the street railway investor in the capital of Uruguay.

F. A. Wardlaw.

Cost of Feed-Water

Brooklyn, N. Y., May 13, 1898.

Editors Street Railway Journal :

Frequently, when figuring the cost of steam power in central and in isolated stations, very little account is made of the cost of feed water, both of the cost of the water itself, and the additional cost of putting it into the boiler. In this city the cost of water is about 15 cents per 1000 galls., or, say, $11\frac{1}{4}$ cents per 100 cu. ft. In a power-house developing 1000 h. p. at an expenditure of about 20 lbs. of water per h. p. hour, there will be the neat little quantity of 146,000,000 lbs. per year, assuming that the consumption averages 20 lbs. for 20 hours per day, 365 days in the year, would amount to 19,518,000 gallons of water per year, costing the neat little sum of $29,277.00 per year!

"But," says the critic, "the condensing engine saves about all that expense by using the same water over and over again, therefore that item of expense doesn't count." To a certain extent this criticism is true, but a great many power stations are operated condensing, yet the feed water is not used but once, on account of the grease which plays havoc with the boilers. But, supposing that about all the water is saved and used again and again, there is the cost of putting the feed water into the boiler, something that remains the same, no matter whether fresh water is used or the same supply is used over again.

The average pressure carried in modern power station boilers may be taken at 160 lbs. per in. gage pressure. This amounts to a static pressure of 2.3 ft. of vertical height to the pound, making the pressure equal to a vertical height of 368 ft. In other words, the power required to feed the boilers during one year's time will be that of 146,000,000 lbs. raised 368 ft. high, or 53,728,000,000 foot-pounds, about 1,628,121 h. p.-hours during the year. This amounts to about 223 h. p. per hour, or nearly one-fourth of the whole amount of power developed.

It will readily be seen that with this great and what may in one sense be called "useless" consumption of power, it is of great value that the method of transmitting this amount of power, from the boiler to the feed-water, is of vital importance. The engineer may calculate for himself the cost of feeding the boilers by any one of the various methods in use, bearing in mind that for a direct connected pump the amount of coal per h. p. required to put in the feed-water is the same as required by the engine, about $1\frac{3}{4}$ lbs. With the common steam pump at least 50 and perhaps 60 lbs. of water per h. p. will be required, bringing the necessary coal consumption up to 4 1-6 lbs. per developed h. p.

With the injector there will be a consumption of about 100 lbs. of water per h. p. developed in handling the feed-water, equal to 8 1-3 lbs. of coal. The ratios of cost are then: $1\frac{3}{4}$, 4 1-6 and 8 1-3 lbs. of coal per h. p. for the 223 h. p. required per hour. Let each engineer figure out for himself the cost of boiler feeding by the three methods, and see how long he can afford to use an injector or a steam pump for boiler feeding.

Electrically-driven pumps, such as are being placed in the new Union Edison Station, in Brooklyn, probably have an efficiency per coal burned of about 2 1-3 lbs. of coal per h. p.-hour, while belt-driven pumps range at about 1.95, or 2 lbs. of coal per net h. p. Some of these things are well worth taking into account when planning changes or new work, with a view toward cutting down running expenses in the power station.

JAMES FRANCIS.

Railway Shop Kinks

By B. F. FELLS

The overhead drill shown in Fig. 1 will be found very useful in repair work and can be made by any mechanic at small cost. The drill bracket is pivoted, and can be swung to any position over the work. First, the wood hanger (H) is bolted to the ceiling of the shop, and an arm (J) bolted to this and braced with an iron strap (I). A pivoted bearing step (A) is now screwed to the ceiling and the shaft (B) put up, to which shaft is keyed the pulley (C) and the bevel gear (D). A steel step (F) for the shaft (B) also serves as a bearing for the end of

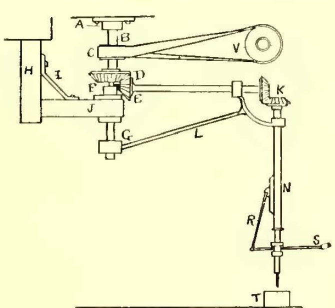


Fig. 1
OVERHEAD DRILL

the shaft (U). A shaft which is set-screwed in the piece (J) provides support for the brace (L), the connection being at (G). The pulley (V) drives the shaft (B), thus giving motion to the gear (E), and power is thus transmitted to the gears (K) and the drill shaft (D), the latter turning in the shell (N). The collar (P) is part of the drill, and the handle (S) is connected with this and to the arm (R), so that the machinist can raise and lower the drill as required by the work in hand. The work to be drilled is placed at (T). As the drill mechanism is pivoted at (J) it may be moved about in a radius of 8 ft., the drill running all the while.

REMOVING BROKEN SCREW STUBS.

When a screw is broken off at the bearing, turn out a slot with a cutting wheel (A), as indicated in Fig. 2, after which the point of a rounded screw-driver (B) may be inserted into the slot, as shown in Fig. 3, and the screw turned out. Hardened cutting wheels, which work with a hand bit stock and made expressly for this work, may be bought at any hardware store, but it may be necessary to retemper them after using for awhile. There are always pieces of small work requiring hardening, and the process may be given. The pieces to be hardened are packed in layers with the carbon in small iron pots, and must be so distributed that each piece will be covered with the carbon on all sides. When this is finished the pots are securely covered, and sealed absolutely air-tight,

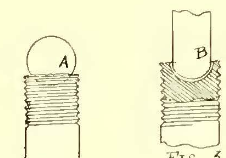


Fig. 2 Fig. 3
REMOVING BROKEN SCREW STUBS

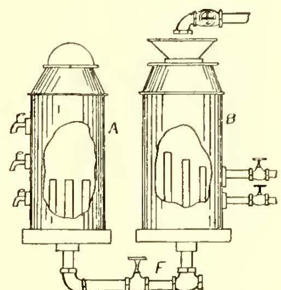


Fig. 4
OIL SAVING DEVICE

and placed in the hardening furnace, where they are submitted to an intense heat for one whole day, after which they are taken out red hot and dumped in a solution to cool. The pieces are then spread out in pans and allowed to remain in a very hot room over night to dry, after which, on the following day, they are cleaned and inspected preparatory to tempering.

TO SAVE OIL.

The next device, Fig. 4, is for saving oil, and as the shop plumber can make the two cylinders of zinc and fit the parts cheaply, it will pay to have one of these filterers of oil. A steam coil is put in at the bottom of cylinder B, and steam connected by means of the pipes. A wrought iron pipe is then fixed at (F) and six smaller brass pipes joined to it and passed up into the cylinders, three on each side, as shown. The dirty oil is run into the side containing the steam coil and immediately becomes hot, and the dirt is precipitated to the bottom. The heated oil passes through the tubes to the other side and rises drop by drop through water, on the surface of which it collects, thoroughly cleansed and ready for use, and can be conveniently drawn off by faucets.

SOFT MALLET.

There are various forms of soft mallets available for shop work, but I have found the one shown in Fig. 5 the most effective. The handle is hardwood, over the end of

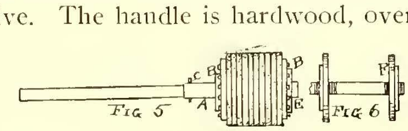


Fig. 5 Fig. 6
SOFT MALLET

which is put a piece of pipe (A) about 5 ins. long and cut with a thread, so as to screw on flanges (B) (B). The latter can be cut from sheet iron or brass and strengthened with shoulders. A pin (C) will hold in the wood handle. A nut, (E), can be used to tighten the outer flange. Fig. 6 shows the arrangement without the leather packing. The leather is cut from sole and makes a good, soft mallet, that will not nick.

Making the Return Circuit

At a meeting of the Institution of Electrical Engineers (British), held at London, April 28, the following papers were read:

EARTH RETURNS FOR ELECTRIC TRAMWAYS.

By H. F. Parshall.

Considering the small difference of potential at which electrolytic action may take place, a consideration of primary importance in electric tramway systems in which the rails are used as return conductors, is in reference to the rate of fall of potential, and the difference of potential between the rails and the general mass of earth, the magnitude of which may vary according to such local conditions as the locality of gas and water pipes, the conductivity of the earth between the rails and such pipes, and the conductivity of the pipes themselves.

The exposed surface for leakage of the track is very great; thus in the ordinary four-track tramway system there is some 50,000 feet per route mile. With so great a surface, and with, as is generally the case, considerable conductivity of the concrete and earth, a large fraction of the current may be diverted from the rails, even in short lines, and with a maximum drop as small as that specified by the Board of Trade. Thus, in tests recently carried out in a line some 8 miles long, it was found, by cutting the track at the middle of the line and inserting an ampere-meter, that some 60 per cent. of the current was returning through the earth itself. Tests made as to the conductivity of the earth return showed as a whole that it was about one and a half times that of the rails, bonds, and fish-plates, which would indicate that on an average about 33 per cent of the current was leaving the rails. In other words, the voltage drop in the earth return was but two-thirds of what it would have been had the current been wholly in the rails.

In laying the rails, therefore, it seems desirable to adopt such methods of construction as will, to a considerable extent, insulate the rails from the adjacent mass of earth. The conductivity of the earth is considerable, and with differences of potential up to the limit established by the Board of Trade is so great that, in the cases I have examined, stray currents are not diverted from the mass of earth by gas and water pipes. I have made tests by cutting the rails and measuring the currents at different points, and, so far as could be determined, the neighboring gas and water pipes were not traversed by the current. In one special case two lines of the tramway formed two sides of an acute angle triangle, and a very large water main formed the third side, and, even though some 50 per cent of the current did not come back through the rails, the tests showed beyond doubt that there was no current whatsoever coming across the third side of the triangle through the water pipe. Of course, with the small difference of potential common in practice in this country, the C. E. M. F. of polarization which accompanies currents flowing between conductors when electrolysis takes place is an important element in determining the law of current-flow.

The tests carried out by the writer have in every case shown that the joint conductivity of the rail and the earth is considerably greater than that of the rails themselves. For this reason there exists the necessity of determining the conductivity of the rails, fish-plates, and bonds, before the track is laid in the earth, so that after a roadway is completed the measured drop may be taken as an indication of what percentage of current is straying from the rails; further, so that tests made from time to time may indicate the general condition of the bonding.

In general it is desirable that the earth return be isolated to the greatest degree practicable from any other metallic conductors liable to be affected by electrolysis. In some cases, however, where the drop in the earth return has been comparatively great, attempts have been made to prevent electrolysis by bonding the rails to the adjacent gas and water pipes. The results have been more or less satisfactory. It is obvious that, if the rails and adjacent gas and water pipes can be kept at the same potential, electrolytic action can be effectively prevented. Considering, however, the very considerable conductivity of the earth, it would seem doubtful whether such bonding would prove effective with any considerable drop in the rails, since in this case stray currents would flow from one part of the system to another, and at such a difference of potential as would cause electrolysis.

In the case of lead-sheathed cables running parallel to earth returns of tramways the results have been entirely satisfactory, and are conclusive, since, in the absence of bonding, the lead sheathing was rapidly eaten away. This instance, however, is not to be relied upon as an indication that it would be safe to carry out the same process in dealing with gas and water pipes. The lead sheathing is homogeneous, of comparatively high resistance, and with small surface exposed to the earth, whereas the reverse holds true with gas and water pipes as ordinarily laid down. I have no doubt that there are cases in which effective bonding of the rails adjacent to conductors might give entirely satisfactory results, but I should hesitate to make any general recommendation to this effect, since in very many cases a result directly opposite might be obtained.

There is such a difference in soils—first, as to corrosive properties; second, as to electrical conductivity—that a general rule which would prevent electrolysis in every case would be unnecessarily severe, and in many cases prohibitive. It is obvious that, where currents stray generally into the earth so as to enter metallic conductors, the difference of potential should not be allowed to exceed that at which electrolysis begins, plus the drop in the earth itself.

In a given system of distribution the controllable features in the earth return are practically limited to the method of jointing the cross sections of the rails, and the chemical composition of the rails.

The chemical composition of the rails cannot be altered greatly, since rails low in carbon, but of high electrical conductivity, are found to wear away so rapidly that high carbon rails are a practical necessity.

The cross section of the rail in practice is largely determined from mechanical considerations, and in the best practice rails of from 80 to 100 lbs. per running yard are used. The method of making rail joints is practically, then, the only factor controlling the resistance of the rail return that is susceptible to wide variation in practice.

The electric welding of the rail joints has been tried in the United States, but thus far the results have not been such as to encourage the manufacturers to advance the use of the system, or the tramway companies to adopt it. The joints in electrical tramway work are equally objectionable from either a mechanical or electrical point of view, so that a system of perfectly welded rails would meet with general favor. In practice the effect of temperature in causing expansion and contraction has been noticeable in long lengths of welded rails, but the effects thereof have not been of such a serious nature as might be expected from the range of temperature. From the reports I have at hand it appears that there were unexpected results of the welding process that made themselves evident in the course of time.

First, the electrical conductivity of the welded section was less than that of a solid rail.

Second, the portions of each rail near the weld were so softened as to wear away unevenly.

Another unexpected result was that, owing to the sudden increase and decrease in temperature, the rail took a very high temper at the weld, so that its power to withstand shock was decreased.

To the writer's mind it is not improbable that these mechanical difficulties could be overcome. Welding apparatus of sufficient capacity, however, is costly, and it is frequently difficult to arrange for the amount of power required; so far, therefore, the process has not been employed in this country.

Another method of somewhat the same nature as the process of welding is that known as the "cast weld," or the "Falk joint." This joint is made by pouring molten metal into a metal mould clamped round the rail joint. The surfaces of the cast metal that come in contact with the mould and with the rail joint are chilled, and are thus prevented from forming a perfect weld. I believe it has been asserted that a weld is effected. It seems, however, extremely doubtful, since without the use of a flux a weld is almost impossible between cold wrought steel and molten iron. The rail expands after the metal is poured around it, and remains expanded until after the cast iron has set, and finally resumes its former size. This affords a slight clearance for expansion and contraction, and accounts for the mechanical success of the joint, which, carefully applied, makes when new a perfect mechanical track; although, in the writer's mind, the difference of resilience between the part surrounding the casting and the remaining part of the track may eventually cause uneven wearing away of the rail.

The clearance above spoken of undoubtedly admits a certain amount of moisture, so that by the formation of oxide the resistance of the joint increases in the course of time. From the results of tests which I have at hand, it also appears that the electrical resistance of this joint, even when new, varies considerably; so that, considering the low voltage restrictions in this country, it should be used in connection with an efficient form of bond. Owing to the rigidity of the joint, however, copper bonds will undoubtedly be found more durable in conjunction with it than with a fish-plate form of joint.

Bonds.

The bonds generally used up to this time are of the pressure-contact type, and in making any general statements this is naturally assumed as the basis. In the discussion of a paper read some time ago before this Institution, the writer pointed out that, according to experience with pressure contacts in central station work, 100 amps. per square inch had been found the limit in best central station practice; and that, considering the trying conditions to which bonds are subjected in the earth, one-half of this value would more likely be satisfactory. In actual practice I have found it advisable to work to a still lower limit, and in most of the systems which I have designed the current-density at surface of contacts does not exceed 25 amps. per square inch. Experience shows this limit a safe one, and that the contact resistance is negligible as compared with the resistance of the rails.

Considering the complicated phenomena accompanying a junction of copper and iron, in respect to the difference of potential caused by the contact of dissimilar metals, and the effect due to a current passing between dissimilar metals, it seems in the normal case that all E.M.F.'s would balance each other, since in the case of the current keeping uniformly through the rails the E.M.F.'s at the positive ends of a bond are balanced, and in the case of one end of a bond losing its contact the additional resistance would be greatly in excess of the unbalanced contact E.M.F.

The design of a copper bond should be largely in reference to the permanency of the contact surface. If there is any working between the surfaces, sooner or later there will be a film of oxide, so that the value of the contact is destroyed. The working of the surfaces may be caused by heating from excessive current-density, or by lack of flexibility in the bond. Numerous types have been forthcoming. Many of the bonds brought forward during the last two or three years have been designed with a recognition of the importance of greatly increasing the area of the contact surface, as compared with the cross section of the body of the bond itself.

It is beyond the scope of this paper to discuss all the different types of bonds that have been brought forward from time to time. Samples of many of the different types are exhibited. The copper bonds that the writer has tested, since they have been more generally used in this country, are either of the "Chicago," "Crown" or "Columbia" type, samples of which are before you.

Flexible bonds are found desirable for use where the mechanical conditions are such that short bonds can be used, in which case the added resistance of the bonds to the track can be made as low as 5 per cent, or less. Bonds of this type have been frequently used in the United States, and with good results when the ends are made of drop forged copper. When, however, the ends have been made of cast copper, and cast on to the conductors, the results are not generally satisfactory. The resistance of cast copper is so much greater than that of drawn copper that it is not best suited for use in bonds. Further, the union between cast copper and drawn copper wires is imperfect, so that the electrical resistance is much higher than between two pieces of pure copper fused together.

The remaining type of bond that I propose to discuss is that known as the "plastic" bond, which was invented by Mr. Edison several years ago. From the results obtained from a line bonded over five years ago, it appears that this plastic alloy, which consists of mercury and other ingredients, as to the nature of which I am uninformed, is much more permanent than might be expected from its mechanical nature. The bond is placed between the fishplate and the rail, in a cork receptacle, which is compressed to about half its thickness when the fish-plate is drawn up tightly.

The amount of copper required materially to increase the conductivity of well-bonded rails is so great that in ordinary practice auxiliary track feeders are not commercially practicable, unless they be connected in circuit with a source of E.M.F. to compensate from the drop in the feeder, so that this may exceed that in the track return.

I believe Major Cardew was the first to suggest employing E.M.F.'s in feeders to compensate for the drop therein. In the arrangement, however, of the earth return as originally devised by him, it was necessary to use generators of different E.M.F.'s in the generating station. I have used in my work a generator that is separately excited through a coil in series with the trolley feeder, so that the voltage generated by the armature is directly proportional to the current-output, provided the field magnet is not saturated. The armature is in series with an insulated feeder connected with the rail at whatever point is necessary to take off current. The results in practice are most satisfactory. It has been found that the machine works perfectly automatically, and limits the voltage drop in the earth return to any desired amount by an adjustment of a rheostat in parallel with the field-magnet coil. Fig. 1 gives a diagrammatic representation of the system.

In a system that I have recently designed to carry some 250 cars, I propose to employ several earth generators feeding in from several points in the system. Pairs of test wires are run back to the station from various points, one of the test wires being connected to the track return, and the other to adjacent earth plates. The earth generators in the station will be adjusted from time to time, according to the difference of potential between the earth plates and the earth return. As far as possible the adjustments will be made so that the two are kept generally over the system at the same voltage. Whatever difference of potential there is between the two will be such that the earth return is, in general, positive to the neighboring water or other pipes, since in this case whatever electrolysis takes place will be in the track return itself.

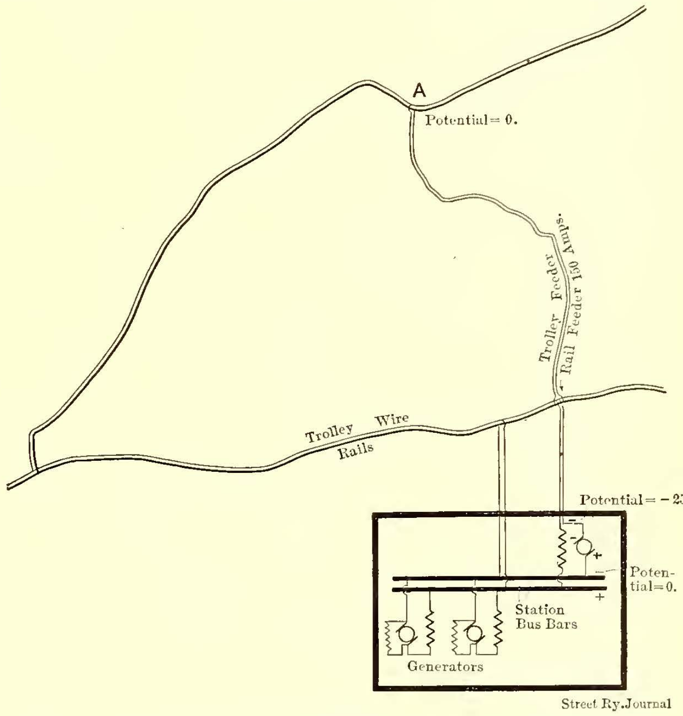


FIG. 1.—ARRANGEMENT OF FEEDERS FOR RETURN BOOSTER SERVICE

Steel Rails.

The percentages of carbon, manganese, etc., in steel rails have varied considerably at different times; and there are, even now, wide variations in the practice of different companies and in different countries.

It may be said that English rails some years back would commonly contain the following:

Carbon	0.25 to 0.35
Manganese	0.8 to 1.0
Silicon	0.05
Phosphorus	0.06
Sulphur	0.06

Of late years the percentage of carbon has increased. One large railway company specifies:

Carbon	0.4 to 0.5
Manganese	0.95 to 0.85
Silicon	0.10 to 0.06
Phosphorus	0.10 to 0.08
Sulphur	0.08

In American practice the carbon runs still higher, as will be seen from the following:

Carbon	0.45 to 0.55
Manganese	0.8 to 1.0
Silicon	0.10 to 0.15
Phosphorus	0.06
Sulphur	0.06

In France yet higher percentages of carbon have been tried, running up to nearly 1 per cent.

The results are shown in the following table—trials of some sample sections of steel rail of varying compositions which were furnished for testing purposes:

Carbon.	Manganese.	Silicon	Phosphorus.	Sulphur.	Resistance compared with Copper at 20° C.	Resistance of 1 Mile 1 sq. in. Sectional Area at 20° C.
0.378	0.550	0.181	0.040	0.041	10.8	0.468
0.446	0.568	0.188	0.046	0.044	11.1	0.482
0.536	0.592	0.201	0.051	0.059	11.3	0.490
0.568	0.608	0.204	0.053	0.061	11.4	0.495
0.588	0.632	0.214	0.056	0.065	11.5	0.499
0.610	0.650	0.220	0.062	0.071	12.1	0.560

Eight 76-lb track rails, tested in place after 2½ years' use, gave the following results:

	Resistance compared with Copper 20° C.	Resistance of 1 Mile 1 sq. in. Sectional Area at 20° C.
Test No. 1	11.3	0.490
Test No. 2	10.3	0.447
Test No. 3	10.1	0.438
Test No. 4	10.7	0.464
Test No. 5	9.65	0.419
Test No. 6	10.07	0.437
Test No. 7	10.25	0.445
Test No. 8	10.50	0.455
Average	10.4	0.45

Two old 65-lb. rails, much worn, tested in place:

	Resistance compared with Copper 20° C.	Resistance of 1 Mile 1 sq. in. Sectional Area at 20° C.
Test No. 1	11.7	0.508
Test No. 2	12.3	0.534
Average	12.0	0.52

High values would be expected owing to the wearing of the rail, which is not allowed for in the calculations.

Two new 90-lb. rails, tested in place:

	Resistance compared with Copper 20° C.	Resistance of 1 Mile 1 sq. in. Sectional Area at 20° C.
Test No. 1	10.6	0.460
Test No. 2	10.4	0.451
Average	10.5	0.455
A 66½-lb. rail not laid	10.0	0.434

Bonds.

The current flows across the joints partly through the fish-plates and partly through the bonds. The resistance of the fish-plates is a variable quantity, but all tests on rails in use have shown that they contribute considerably to the conductivity of the joint.

For the bonds themselves the following tests have been made:

(1) Conductivity tests on bond copper.

(2) Resistance due to contacts.

(3) Resistance due to current "gathering" from other sections of rail to enter the bond terminal.

1. For conductivity the Chicago bonds in the different tests have shown practically 100 per cent of the conductivity of pure copper. A flexible Crown bond showed only 93 per cent conductivity. The Columbia bonds in the cases tried showed about 90 per cent conductivity.

2. Resistance Due to Contacts.—Measured from the potential difference between two points very close together, one on the bond terminal, the other on the steel. Experiment showed the following results:

——	Test.	Resistance per Bond (2 Terminals.)	Resistance of 176 Joints, or per Mile with 30-ft. Rails.	——
		Ohms.	Ohms.	
Chicago Bonds	1	0.00000197	0.000347	Bond and hole very clean.
⅞-in terminals in ½-in. web. 1.37 sq. in. contact area.				
" " "	2	0.0000215	0.000379	" "
" " "	3	0.0000025	0.000440	Bond not cleaned; hole freshly reamed, but oily.
" " "	4	0 0000080	0.00141	Bonding not supervised.
Crown Bonds	5	0.0000080 0.0000028		" "
⅞-in. terminals in 7/16-in. web. 1.2 sq in. contact area..				
Total		0.0000108	0.00190	
Crown Flexible Bond	6	0.0000422		Bonding not supervised; bonds afterwards found to have been put in rusty hole.
⅞-in. terminals in 7/16-in. web. 1.2 sq. in. contact area.		0.0000518		
Total		0.0000910	0.0165	
Columbia Bond In ⅞-in. hole in ½-in. web. 1.37 sq. in. contact area.	10	0.0000072	0.00127	Hole clean; bond untouched.
" " "	12	0.0000095	0.00167	" "
" " "	13	0.0000077	0.00136	Hole 4 days old; bond untouched.

Tests 4, 5 and 6 show that want of care in bonding may lead to serious increase in contact resistance.

From the tests made it may be said generally that bonds properly applied—that is, clean bonds in bright reamed holes, put in with a proper fit with a drift driven square—have practically negligible contact resistance. Experiments showed that with at least 100 amperes per square inch the drop in the contact surface was inappreciable compared with that in the bond and in the rail. The same was found true with bonds—samples of which are exhibited—that have been in use for over two years, when the current-density has been limited as stated. Experiments on this point have been carried out to a considerable extent, since it has been frequently stated that the contact resistance is a very appreciable factor, and that it can be greatly lessened by amalgamating the surfaces. This will not be the case except when there is carelessness in putting the bonds in place.

3. Gathering.—The current may be supposed to flow uniformly through the rail at all parts, a foot or so from the ends or from bonds. At a bond, however, it has to gather, and it is scarcely to be expected that, say, 16 ins. of rail terminating at a bond should show the same resistance as 16 ins. in the middle of the rail.

Tests on a bar of steel 3 ins. x ½ in. showed "gathering" at the two bond terminals added resistance equivalent to a total of about 1 inch of the bars.

Tests on an 83-lb. rail showed "gathering" resistance equivalent to 3.4 ins. of rail at each contact, or a total of 6.8 ins. per joint.

Joints.

The conductance of the joints depends, as stated, on both bonds and fish-plates.

The first have been discussed already.

The second have a very appreciable effect, even with rails that have been in use for some time.

The following table shows the results of a number of tests made partly in the laboratory and partly on track in use:

Laboratory Tests.	Additional Resistance due to Joint.		
	Ohms.	Inches of Rail.	Resistance of 176 Joints per Mile, or with 30-ft. Rails.
83-lb. rail; six tests; no bonds, fish-plates uncleaned, and not fully tight	0.0000095 to 0.000081	10 to 87	0.0017 to 0.0143
Average	0.000039	34	0.0068
Single 0000; 30-in. bond only (calculated).	0.000101	109	0.0178
83-lb. rail, with one 30-in. Crown 0000 bond, plates well tightened.	0.0000024	3	0.0004
Same with fish-plate removed. ..	0 000106	114	0.0187
This bond had too great contact resistance. See Contact Test No. 5.			
Tests on Rails in Use.			
76-lb. rail; one 30-in. 0000 Chicago bond and fish-plates.	0.0000307 to 0.0000622	32 to 65	0.0054 to 0.011
Four tests made without disturbing track, average	0.000043	45	0.0076
76-lb. rail as above (track 2½ years old); four tests.	0.0000275 to 0.0000843	28 to 80	0 0048 to 0.0148
Average	0.000046	48	0 0081
Single 30-in. 0000 Chicago bond only (calculated)	0.000103	1 4	0.0181
Old 65-lb. rail; one 30-in. 0000 Chicago bond, fish-plates not tight..	0 000069	57	0.0121
Above with fish-plates removed ..	0.000090	74	0.0158
Above with fish-plates replaced and well tightened.	0.0000473	39	0.0083
New 90-lb.; two 32-in. 000 Chicago bonds and plastic to one fish-plate	0.0000081 0.0000040	10 5	0 0143 0.0071
Average	0 0000060	7½	0.0105
Fish-plate added to conductivity.			

The above values show that the contacts had not deteriorated in any way in the two and a half years of use. Some of the rails were very old, but the fish-plates, which were not fully tight, showed bright patches of metal at places of contact with rail. On replacing plate and re-bonding, the joint was equivalent to 39 ins. of rail. A second rail tested without fish-plate showed also no deterioration of the bonding.

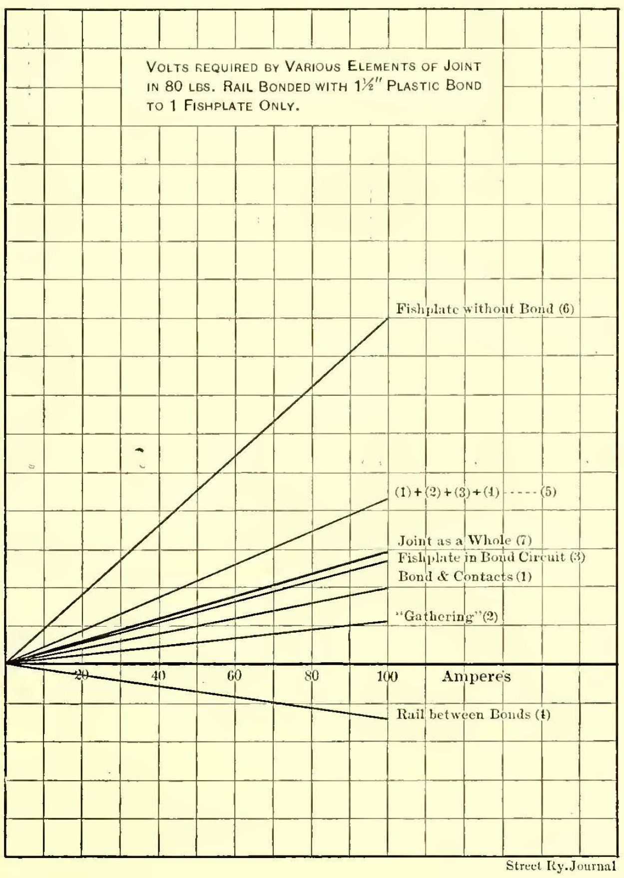
Some 66½-lb. rail laid on another line recently bonded showed joint resistances equivalent to 9½ ins. to 28 ins. in four different cases.

Plastic Bonds.

1½-in. hole in the cork receptacle between fish-plate and rail filled with plastic material.

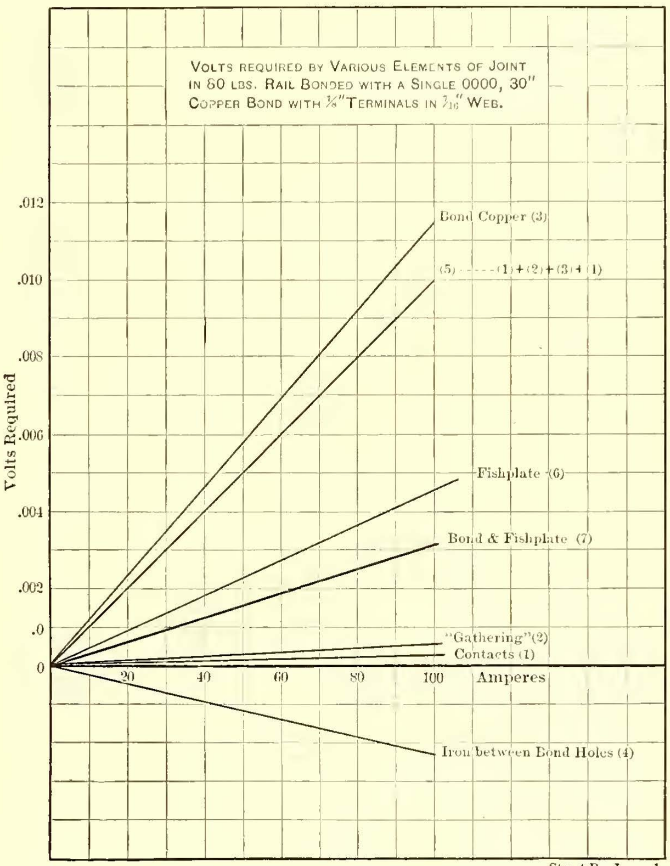
————	Increased Resistance due to Joint.	Inches of Rail.	Increased Resistance of 176 Joints, or per Mile with 30-ft. Rails.
	Ohms.		
83-lb. rail bonded to one plate only; both plates separated by paper from rail....	0.0000213	24	0.00375
Do.; but bonded to both fish-plates; plates not very tight..................	0.0000126	14	0.00222
Do.; plates a little tighter	0.0000122	14	0.00217
Do.; plates very tight; brown paper still between plates and rails....	0.0000117	13	0.00206
Do.; brown paper removed; plates tightened very hard up......	0.0000083	9	0.00146

of 30-150 amps. was passed through the latter. A standard resistance of 0.0000398 was placed in the same circuit, and the fall of the potential across this compared with that across the two points on the rail. The places at which current was led in and out of the rail were always at some distance from the points between which the potential difference was taken. Where measurements were made upon the actual track, current was supplied from an accumulator placed upon a car brought up to the spot. Current was led from this to a point in the middle of the rail to be tested, and was led out some 5 or 6 ft. on the other side of a rail joint. The fall of potential was then measured between two points inside those by which the current was led into the rail, and also between two points on the same rail outside the places at which current was led into it. The standard resistance was included in the circuit, and comparisons taken with this at each stage. From these two measurements the resistance of the rail could be calculated as long as no cross bonds occurred upon the part of the track actually under test. To measure the resistance of the joints, a joint was included between the two points of which the potential difference was taken, and this compared with the potential difference between two points at a similar distance apart on the continuous rail. It was found extremely important



Volts required by various elements of joint in 80-lb. rail bonded with 1½-in. plastic bond to one fish-plate only.

FIG. 2



Volts required by various elements of joint in 80-lb. rail bonded with a single 30-in. 00000 copper bond, with ⅞-in. terminal in 7-16-in. web.

FIG. 3

From the above, it seems safe to take the resistance through fish-plates as equivalent to some extra 50 ins. of rail, and to take this resistance as in parallel with the copper or plastic bonds used in addition. Curves can then be constructed for any particular system of bonding similar to those of Fig. 3, which gives P. D. for the various elements of a joint of 80-lb. rail bonded with a single 0000 B. & S. copper bond 30 ins. long with ⅞-in. terminals. The contact and gathering resistances are added to the bond copper resistance, and the resistance of the iron between the bond holes deducted. This gives curve No. 5. The resistance so found is taken as in parallel with the fish-plates, resistance and curve (7) calculated for the whole joint. The volts so found must be multiplied by the number of joints per mile, and added to the volts required to drive the current through a mile of jointless rail.

Apparatus Employed in Testing.

All resistances were found by measuring the potential difference between two points on the rails when a constant current

in some cases to reverse the current both in the rail and the potentiometer, since with the small potential difference measured thermo-electric effects were very liable to disturb the results.

In certain experiments a current was passed into the rails at one end of the track, and taken out at the other. The current in the rails at intermediate points could be measured by taking the difference of potential between two points on the same metals which had been tested for resistance as above. This had, of course, to be done for all four lines of the double track. The volts used to drive current through the whole length of track were measured by making use of the test wires. The potentiometer was employed for this purpose also, and the results may be taken as correct, within the limits of correctness of calibration of the instrument itself, which was supplied by Elliott Brothers.

Immediately following Mr. Parshall's paper Major P. Cardew, of the Royal Engineers and Engineering Adviser to the Board of Trade, read two short papers, one by himself and one by A. P. Trotter.

NOTES ON ELECTRIC TRAMWAYS.

By Major P. Cardew, R. E., and A. P. Trotter, Members.

The accompanying note, on return feeders for electric tramways, has been forwarded to me by A. P. Trotter; and, as it contains a neat graphical method for determining the fall of potential in the return with uniform distribution of current, and the proper points of application of return feeders, I think it may prove interesting in connection with Mr. Parshall's paper.

As Mr. Trotter alludes to previous suggestions of my own on this subject, I also forward a note which was prepared by me in May, 1894, and sent to the South Staffordshire Tramways Company, advocating the automatic regulation of this fall of potential.

P. CARDEW.

NOTE ON RETURN FEEDERS FOR ELECTRIC TRAMWAYS.

By A. P. Trotter.

While great ingenuity has been expended in designing bonds for electric tramway rails, and while these bonds, assisted in some cases by bare copper conductors laid between or near the rails, form a considerable item in the cost of building a line, little attention has been paid to the use of return feeders. The use of return conductors provided with a small dynamo was suggested by Major P. Cardew several years ago, and it has been independently proposed by G. Kapp. The system has been in use for some time in Geneva, and has recently been applied with success to the extension of the Bristol tramways.

The best mode of arranging such return conductors does not appear to have been described, and the present communication is intended to afford an opportunity for discussing it.

Assume a tramway line with passing places, five miles long, and ten cars running. The most even distribution will, of course, be when they are equidistant, and a less even distribution is not likely to occur than when all the cars are in pairs at passing places. Let each car take 20 amps., and let the resistance of the bonded rails be 1/20 ohm per mile. When the cars are evenly distributed, half a mile apart, the rail resistance between each pair is 1/40 ohm, and with 20 amps. the drop on half a mile of rails is ½ volt.

The series is as follows:

Cars	1	2	3	4	5	6	7	8	9	10	Works.
Volts	0	½	1½	3	5	7½	10½	14	18	22½	27½

The first car is supposed to be at the extreme end of the line. The case is an extreme, but not an imaginary one. The large total fall of 27½ volts over five miles should, of course, be reduced in the first instance by more ample bonding, but the example serves the better to illustrate the problem.

When the cars are all passing, in pairs, at a mile apart, the drop due to 40 amps. over one mile is 2 volts. The diagram shows the distribution for these two cases; the line A B showing the fall of volts for 10 cars evenly spaced half a mile apart, and the curve C B the fall for cars in pairs a mile apart. Mathematically, the point A is the origin of the curve, to which the line A B is an approximation; but, as it is not intended to treat the problem mathematically, the point A is for convenience placed at the top right-hand corner.

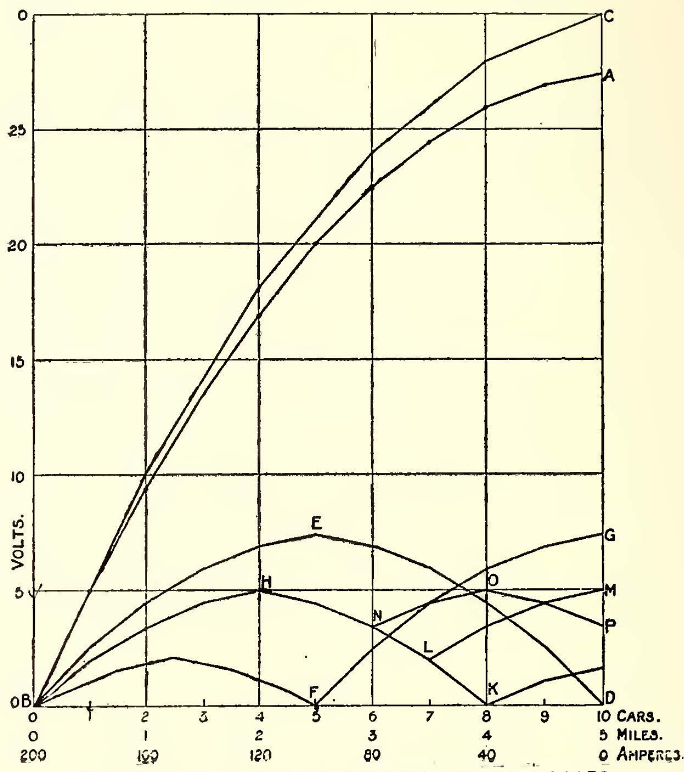
The volts in the two cases differ so little, compared with the fluctuations of energy on an electric tramway, that this question of distribution of the cars will not be referred to again, but the line A B will be considered as typical.

The return feeder method by which this fall of volts may be reduced consists in connecting a feeder to some point on the rails, and tapping off some of the return current. The conductivity of the feeder is not relied upon for this, but a dynamo, acting as a negative "booster," may be said to suck the current back. By this means the point at which the feeder taps the rails may be brought down to zero-potential, or might be made negative to the generating dynamo.

Disregarding the two latter conditions, a simple plan would be to run a feeder the whole length of the line, and to reduce the volts to zero at the far end of the line, D. The distribution is then symmetrical; half of the current goes to the generator dynamo and half to the return feeder. To draw the curve of distribution, cut out a piece of card to the shape of the curve of volts A B, and, fitting the vertical axis to the ordinate 5, place it so that it passes through the point D. Turn the card over and complete the curve through A in the same way. The maximum volts, at the point E, are 7½.

But there is no occasion to reduce the volts at the end of the line to zero, and there is evidently a maximum expenditure of copper and of energy in the feeder. The middle point of the line is evidently not the best point to tap, for the volts would be distributed as shown by the line B F G, which may be easily drawn by means of the template. Here the maximum is, as before, 7½, and the volts near the works are unnecessarily low, viz., 2 volts at 1¼ miles out. It is clear from the line B F G that the feeder would draw off three-fourths of the total current. It would be still worse to tap the rails at the point at which the volts rise to one-half the maximum, viz., at about 1½ miles from the works.

Starting now in a different manner, let it be given that the maximum volts are not under ordinary circumstances to exceed five, allowing a margin of two below the Board of Trade limit. Draw the line B H by means of the template, and fitting the template so that its axis is vertical, that the top touches the line



METHOD OF PLOTTING RETURN FEEDER LOSSES

of 5 volts at the point H, and that it passes through the point B. Turn it over and draw the line H K. But as it is not necessary, from the "undertakers'" point of view, to reduce the volts to zero at the point K, set the template again, allowing 5 volts at the end of the rails at the point M, and, drawing the line backwards, it is found to intersect the line H K at L. The volts at this point are two, and this is the best that can be done with a single return feeder. This feeder will be 3½ miles long, and will draw off 0.65 of the current.

NOTE ON ELECTRIC TRAMWAYS.

By Major P. Cardew, R. E.

It is, I believe, generally admitted that where the rails are used for the collection and partial transmission of the return current, the best means of preventing injurious action on pipes is to minimize the difference produced by the current between the potential of the uninsulated return at different points, and between any part of such return and the earth. On account of the resistance offered by all conductors to the current, the transmission of a current by means of a conductor causes a fall of potential throughout the length of the conductor, the difference of potential being greatest between the ends of the conductor.

This is the case whether the whole current is transmitted throughout the length of the conductor, or is fed in (as in the case of a tramway line) at different points along the length, provided that the direction of the current throughout the length of the conductor is the same, which must be the case when this conductor forms the only path for the current back to the generating machine.

But if additional conductors are used to take current from the main conductor, which receives the current distributed along its length back to the generator, the greatest difference of potential in this main conductor may no longer exist between the ends of the conductor, and the amount of this difference may be greatly reduced. The extent of the reduction will depend upon the position of the junctions effected and the resistance in the auxiliary conductors.

If we assume, for example, in auxiliary conductors, all of equal resistance, connected to the main conductor at equal distance throughout its length, and one from the extreme end of the main conductor of twice the resistance of the others, a resistance equal to this last being interposed between the generator and the near end of the main conductor, then with a uniform distribution of current all the points of junction will be at the same potential, and the extreme difference of potential between any points of the main conductor will be reduced to $\frac{1}{4(n+1)}$ of what it would be without these auxiliary conductors or feeders.

Thus with one feeder to the distant end alone the fall of potential in the main conductor can be reduced to one-fourth, and with a feeder to the center as well, to one-sixteenth, of that due to the same distributed current without feeders; and it will be seen

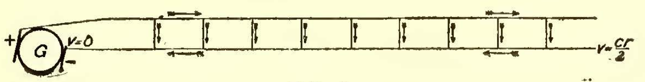


FIG. 1

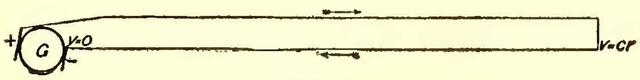


FIG. 2

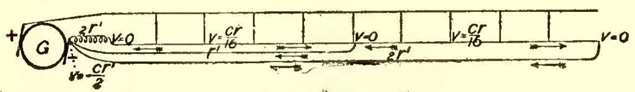


FIG. 3

Note.—In the above figures v indicates potential with regard to earth.

that under such conditions the variation of potential in the main conductor can be reduced to any required limit.

But, unless these feeders are of very large cross-section and conductivity compared with that of the main conductor, there will still be a considerable fall of potential in them, and in consequence a considerable difference of potential between the main conductor and the terminal of the generator to which it is connected by means of the feeders.

In place of adjusting the resistances of all feeders to equality, varying E.M.F.'s may be introduced into each feeder, proportionate to its resistance, and thus the potential of all feeding points may be kept the same as that of the terminal of the generator if desired.

In considering the application of the feeding arrangements described above to the special case of minimizing the leakage to earth from the rails of a tramway used as a return circuit, it must be borne in mind that, although the load under normal conditions may be fairly uniformly distributed, yet the exigencies of traffic may require far more current to be supplied to one section of the line than its proper share, other sections at the same time being lightly loaded.

The position and slope of the various gradients on the line also considerably affect the distribution of current in the rails. The number of cars at work, and therefore the total load, also generally varies during each day's running, and from day to day.

The disposition shown in Fig. 4 can be adapted to meet the special requirements; but unless the auxiliary E.M.F.'s are continually adjusted to the variations of load, both as regards amount and distribution, the arrangement must be defective at times.

In order to provide auxiliary E.M.F.'s for the efficient working of the feeders to the return, automatically adjusted to the requirements, I would suggest the following arrangement:

Let the tramway be divided into several sections according to its length and the amount of traffic gradients, etc.

Let there be two insulated feeders for each such section—one for the line, and one for the return, the latter being connected to an uninsulated conductor, as provided in Regulation 4.

Let the currents in these feeders pass through a "motor generator" at the generating station, the "field magnets" of which are excited by the current to line alone, while the armature is wound with two circuits—one for each current, so as to oppose each other—the circuit through which the current to line passes being made slightly the more powerful. The motor generator will then revolve as urged by the line current, and will generate an auxiliary E.M.F. for the return current.

The generator for each feeding circuit should be of rather higher E.M.F.'s than that supplying the near end of the line and return; but, as the extra volts will be taken by the motor generator in the station, there will be no need to exceed the limit allowed by the Board of Trade on the line outside.

The expense involved may probably prevent the adoption of any such system in its entirety at present, but it possesses the advantage that it can be adapted to existing tramways, and a pair of feeders run to any part where the difference of potential from earth of the rails is found to be excessive.

Such an arrangement with one pair of feeders is sketched in Fig. 5.

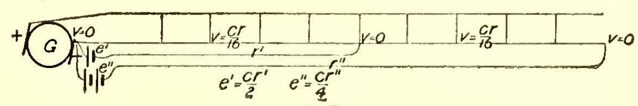


FIG. 4

Note.—v indicates potential with regard to earth; e′ and e″, auxiliary e.m.f.s.

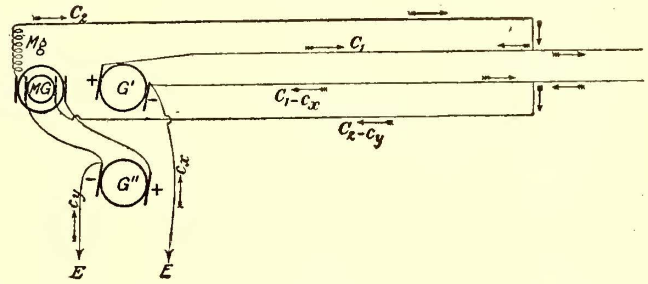


FIG. 5

G′ = generator; G″ = auxiliary generator; MG = motor generator; Mg = magnetizing coils of motor generator.

DISCUSSION.

The discussion which followed these papers was opened by Mr. Gadsby (London), who from experience in a hot climate considered lead sheathed cables laid direct in the ground for feeders unsatisfactory. He thought a cast weld joint with copper bond would be the most suitable for general use. In order to obtain greater powers of resistance to ordinary wear and tear, by the presence of a larger percentage of carbon, he advocated rails with a steel head separate from and bolted to an iron (or steel) body of lower percentage of carbon, but of higher conductivity. He considered the drop at Dover—which he stated was 5 to 6 volts—to be due to the small section of cable connecting the generator and the rails—a distance of 400 yards.

Mr. Murphy (Dublin) advocated cast weld joints bonded. He had tried a separate steel head to rails and had found it in practice most unsatisfactory. The head always worked loose and set up vibration and loss of power, however tightly bolted down.

Mr. Lauson remarked that at Dover the drop was really due to a large water pipe, laid almost alongside the rails for a considerable distance, and was not as suggested by the first speaker.

Professors Ayrton and Perry (London) advocated an insulated system throughout for both feeder and return.

Dr. Sylvanus Thompson (London) thought a plastic bond would eat away the contacts. The thermo-electric properties, due to a joint of copper and iron and owing to the joint not being absolutely perfect, would account for variation of apparent resistance, when the current flowed in different directions. With regard to the gathering of the current at the bonds, the increase of resistance was due to the reduction of the effective cross-section of rail through which the current flowed. He suggested that when two bonds were used, holes should be drilled as near as possible to the ends of the rails consistent with the mechanical strength of the rail and the flexibility of the bond.

Mr. Worthingham (Manchester) stated that the insulated return could not be used on account of difficulties of working and installing. He asked what sized hole should be punched or drilled in a stock of rails to allow for reaming out when wanted for use, to permit the use of certain sized bonds.

Mr. Wood (Bristol) found that a booster in circuit showed a drop of 3 volts, when cut out of circuit a drop of 8 volts.

Mr. Swan, president of the institution and one of the earliest inventors in incandescent lighting, dealt with electrolysis and suggested that pipes should be maintained at the same potential as the rails.

Mr. Parshall, in reply, adhered to his opinion as stated in his paper.

Major Cardew thought that the pipes should be connected to the negative pole of the generator.

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We regret to find that an article last month upon "The Situation in Boston," in which the endeavor was made to point out and discuss in a largely impersonal way the novel and interesting conditions found in the ownership of both surface and elevated railway systems by the same corporations, has been interpreted in Boston finanacial circles as a criticism of the Boston Elevated Railway Company and its propositions to the public. We were very far from intending such criticism, our belief being that that company's plans are conceived in entire good faith and will surely effect a solution of the extremely difficult problem of municipal transportation in Boston. All who understand Boston's topography know how difficult it is, and always increasingly must be, to force into or through its highly congested "old city" the cars of the multitude of suburban lines which connect an immense outside residential area with this business center. To students of the science of street railroading nothing is more self-evident than that all forms of transportation facilities, underground, surface or elevated, which can possibly find place in this congested area, will soon be taxed to the utmost and—in the general influence on earnings, gross and net—will inevitably pay upon almost any required investment. The management of the West End Street Railway Company and of the Boston Elevated Railway Company, together with the State engineers of Massachusetts, have shown consummate ability, energy and breadth of vision during the past ten years, in deciding upon, and putting into immediate execution, the great engineering plans which have resulted (1) in the concentration of the termini of eleven railroad systems into two "Union Stations," (2) in the construction of what is probably the largest, finest and—even in its as yet unfinished state—most popular subway in the world, and (3) in the proposition, now decided upon, to build an elevated railway system connecting the two Union Stations with each other and with the subway, while bringing relief also to the dense lines of daily traffic to and through Charlestown on the north, South Boston on the south, and Cambridge on the west. The Boston transportation system as a whole will undoubtedly gain greatly in earnings from these new elevated lines, the people will be benefited by increased rapid transit, and—since it is more facilities which are required, and not merely a redistribution of business—it is not probable that the surface traffic under the elevated will permanently diminish in amount. The management of the Boston Elevated Railway Company may be trusted to carry through this elevated railway project and to operate both surface and elevated systems on the broadest lines, not only because such a policy means relief to the people and improvement in traffic conditions, but also because the public will surely respond most generously to the added facilities given.

The paper by Mr. Parshall, published elsewhere in this issue, on the method of reducing the drop on a railway return circuit by the use of return boosters, will prove of interest, not only to European railway managers, who are usually compelled by law to limit the loss on their return circuits to a certain amount, but to American readers as well, to whom this problem is often a very serious one. Mr. Parshall has undoubtedly made a more extended application of this method to railway service than any one else, so that his testimony as to the efficiency of the system in doing the work for which it is intended, is valuable, and in certain respects the system seems more desirable than that of "pumping out" the current from the water pipes by means of a return booster, a method which has been tried in certain systems in this country. While the power consumed by the return booster method is naturally more than if the current is returned to the station by feeders only without the addition of the return generator, it has advantages which are readily appreciated in reducing the potential of different parts of the track. The results of Mr. Parshall's tests on bonds which show the losses at the "gathering in" points and at other portions of the bond connections are also valuable, as is as well his testimony that there is no oxidization at the points where the bonds are connected to the rail, when the bonds are carefully installed.

Of what advantage will it be to me? is the question that is very naturally asked by every one to whom the suggestion is made of joining a given association or becoming identified with a certain movement,—as, for example, uniting with the Street Railway Accountants' Association. The selfish principle in human nature is quick to manifest itself, and therefore there is the instant demand for a statement of the prospective profits. Nor do we hold that in any business matter it should be otherwise. No one is in business except for business reasons, and accordingly no one should devote either his time or his money to anything that will not produce a satisfactory return. Membership in the Street Railway Accountants' Association, however, is of companies rather than of individuals, and therefore the question is a company question. Membership is taken in the name of the company and at the expense of the company, although it is the company's auditor or chief accountant that is the immediate beneficiary. The question to answer, then, is this: Of what benefit is it to a street railway company to have membership in the Acountants' Association? Many of the advantages following from membership in the organization are so obvious that to state them in detail would be very much like producing a catalogue with which every one is already acquainted. Let us see, therefore, if it is not possible to get before the reader some of the benefits of membership that are not so commonplace as to be included in that conception of the organization with which every one may be supposed to be familiar. Co-operative effort is the order of the day in all directions. Comparatively little progress is made in the arts, in mechanics, or in science by men working alone and apart from their fellows. The rapid advancement of the age, wherever it is observed, will be found, upon investigation, to be due to each operator and each investigator profiting to a certain extent at least by what his fellows have done and are doing. Progress is just as possible and just as necessary in the realm of accounting as it is in any other branch of business administration, and it is governed by the same general laws. All the reasons, therefore, that prevail for men of like pursuits to join together for advancing their common calling, are in force with respect to street railway accounting. Street railway companies who are members reap the advantage of having more efficient accounting departments than would otherwise be possible.

The objects of the Street Railway Accountants' Association are such as have been cordially indorsed by every broad-minded street railway manager and official to whose attention they have been brought. No one has objected to them or opposed them. Accounting is recognized by all as being the vital element of business. Without accounting, no enterprise attempts to go forward, and the better the accounting is, the surer the enterprise is of success. The more efficiently the accounting system of a street railway company is administered, the less risk there is to the investor. Therefore, the more the Accountants' Association does to secure uniformity of method and to promote general efficiency of work, the better it will be for the industry.

What has been accomplished to date by the Accountants' Association is a standardizing of construction, equipment and operating accounts. While this is extremely important, it is only a beginning. Still other undertakings are before it, and one after another all of them will be as thoroughly completed as has been the initial effort. Every company, therefore, should be represented in the work for mercenary reasons, for the pecuniary advantages it will reap from the results a strong organization can attain. A number of very prominent street railway corporations are apparently holding aloof from this movement. They are, we think, apathetic rather than antagonistic, for they have never advanced any reasons against the association. Some of them explain that they are too busy in their own affairs to give attention to anything else. Their argument, in a few instances, is that, having secured the highest accounting talent that is available, there is no need of attempting to improve upon their methods. Having in use the very best that is to be found anywhere, there is no reason why they should contribute to a fund of information from which all in the association may draw. They claim that they would be contributing without the chance of securing in return anything of value. Such arguments are untenable in the light of all experience in street railway administration. Certainly such arguments do not prevail with respect to the efficient and useful organizations of which their electricians, their mechanical engineers and various other talented employees are members, and, therefore, they ought not to prevail with respect to the position in which their accountants are placed. These men are certainly entitled to as liberal consideration as any others of corresponding rank. However great the accomplishments of a given accountant of a street railway company, and however broad his experience may be, he will always gain by contact with other accountants, even though they are his inferiors. No one knows it all. However special the accounting system of any company may be, still advantages will flow from an acquaintance with what others are doing and from a frank exchange of experience with the managing accountants of other companies.

The World's Manufacturing Facilities for Electric Railway Apparatus

In considering the enormous market for apparatus and material afforded by the thousand or more cities of all countries in and between which electric railways are built, building or yet to be built, it will be interesting to survey the manufacturing world in order to learn what preparation has so far been made for supplying this demand as it increases and becomes more urgent. It is entirely true that in certain countries electric railway development is to some extent hampered at the present moment by the impossibility of obtaining dynamos, motors and other material of the kind wanted in the time required, and purchasers have either to wait or to buy types against which, for one reason or another, they have a prejudice.

There are only five countries of the world in which electric railway apparatus is at present manufactured to any extent, these countries being the United States, Great Britain, Germany, Belgium and Switzerland. In Austria-Hungary are found one or two large establishments for the manufacture of electric lighting apparatus, but in these little attention has so far been given to railway work. France has no large purely French house in this line, though branches and agency connections of American and German manufacturers exist and practically control the very large French market for this kind of material.

Switzerland is placed among the manufacturing countries by virtue of a single large establishment, and Belgium because of certain branch factories of German houses. Speaking generally, however, it may be said that the only electric railway dynamos and motors in existence are of American, British, German and Swiss makes.

There are five important manufacturing companies in the United States, which have probably turned out in the aggregate up to date not less than 75,000 railway motors and 500,000 k.w. in railway generators. These establishments have been developed under pressure of orders to their present ample facilities, and, being equipped with machine tools for every detail of construction and with raw material in unlimited quantities at unprecedentedly low figures, it is but simple truth to say that American competition in this particular branch of work—even apart from questions of merit—is most to be feared by other manufacturing nations.

Great Britain possesses, we believe, but two establishments actually manufacturing railway dynamos and motors. Their total output to date is quite insignificant, and it is probably true that not 200 British-built motors are now in operation at home and abroad. British energy, usually so potent in the search for new opportunities of profit making, has seemingly almost wholly overlooked this field until too late for taking advantage of its best opportunities. Moreover, even now, strange to say, the possibilities are understood by but few, and to but slight extent, and apparently little effort is being made by British manufacturers to extend their facilities or meet the conditions imposed. The recent engineering strike is responsible for many things deplorable to Great Britain's well wishers—among others, for an accumulation of orders so great that many of the larger manufacturers are unable to guarantee deliveries short of eight, twelve, or even, in some cases, eighteen months. This has proven a golden opportunity for competition in both home and foreign markets, and by the time this unusual congestion is relieved, American and German machinery of all kinds will be firmly seated "on trial" in places where, under normal conditions, British machinery would have gone.

British manufacturers seem to regard this present congestion of orders as but a temporary matter, and, curiously enough, they appear to be making no provision for remedying it by increasing their factory facilities or reorganizing their present ones to secure a greater output. Moreover, the power of the trades unions in Great Britain is such that, unless the most drastic changes are made in the methods of handling labor, British manufacturers will be hopelessly handicapped, certainly in the particular branch of work under discussion.

To-day, the principal electric railway equipment business in Great Britain and in foreign countries financially dependent upon London, is done by companies and individuals representing American manufacturing concerns, and controlling their British patents.

In Germany, is and will be found competition of the sharpest and most intelligent kind. The German manufacturer is bright, pushing, capable and far-sighted. With interests and connections all over the world, and with unlimited capital at low rates of interest available for operations at home, there has been during the past few years a development of national enterprise worthy of the highest admiration.

There are three large electric railway manufacturing establishments in Germany, which are purely German in all respects, and a fourth which is German in ownership, but is operating under American patents and methods. All are financially strong, having the support of powerful syndicates which have, by their purchases of tramways and tramway concessions, furnished a large market for the apparatus made by their manufacturing associates. Germany itself is very much alive to the financial and popular advantages of electric railroads at home and abroad, and, as a consequence, manufacturing is done on a scale which, if not yet equal to that in the United States, is still sufficient in magnitude to make it possible, in connection with the much lower wages of labor, to quote fairly low prices in outside markets in competition with American goods. German factories in this line have been recently built, and are laid out with great economy of space and with a view to minimum cost of handling. American machine tools have been freely purchased for their equipment, and the idea is to spare no effort to "get the business." In those countries such as Austria and France, where extreme Chauvinist sentiments are held, the Germans establish branch factories and selling agencies. Altogether, there is no question that the German manufacturer is a foeman worthy of American steel, and many a page from his experience may be taken with advantage by American manufacturers.

In the field of electric railway supplies other than dynamos and motors, there is and will be the keenest kind of competition for the world's markets. Steel rails and structural iron will be furnished by America, Great Britain, Germany and, to some extent, France. Here, America's competition will probably, in the long run, drive out all others on account of cheapness of raw material, efficiency of labor and magnitude of operations. It is significant that even to-day American iron is going to Great Britain, Germany, France, Russia and the Orient in immense quantities. The overhead material and rail bonds for electric railways in Europe are manufactured almost entirely in America, though Germany is beginning to take an interest in this important branch of the general subject. Great Britain, Germany and America will compete for the world's trade in engines, but unless the first two countries profit by American dearly bought experience, American engines will drive all others from competition, except when freights and tariff cut a too important figure. Car bodies are difficult and costly to transport, and will probably be built locally to a large extent, even at a considerable difference in cost, but choice of models and quality of woods will have in intelligent markets a potent influence on contracts, and even now there seems to be a movement in Great Britain to buy cars in America. Trucks have long been an international commodity, and will continue to be. Germany is building its own trucks, to a large extent, but Great Britain very few.

In this general discussion of the world's manufacturing facilities we have tried to state the simple facts, found to be such by the closest observation of recent history and contracts. No one country is going to do all the electric railway business of the world, and while we are always glad of national success, we are prepared to no less cordially recognize good work done in other countries in a field of effort where America is recognized as being until now pre-eminent.

Electricity on the Chicago South Side Elevated

For the purpose of inviting increased traffic and reducing operating expenses, the stockholders of the South Side Elevated Railroad, in June, 1897, decided to issue $1,500,000 of 4½ per cent. ten-year bonds to provide for equipping the road with electricity. Actual work began in the fall of 1897, with Sargent & Lundy as engineers and the Electrical Installation Company in charge of converting the cars and putting the track into condition electrically. After satisfactory tests (see "Street Railway Journal," August, '97,) Frank J. Sprague's "multiple unit system" of equipment was adopted. In a general way this means that each car of a train is equipped with motors and controlling apparatus as if it were to run separately. When the train is made up, however, all the cars are operated by one motorman. The motor controller for each car, located just under the platform hood, is itself operated by a pilot motor, and the motorman governs the pilot motor circuit only, leaving the acceleration of the train to be taken care of automatically. This provides that the motor controllers for each car move in synchronism and that the work of drawing the train is distributed equally among the several motors. Since the weight of each car in the train becomes available for tractive purposes the rate of train acceleration is limited only at that point where a higher rate would be uncomfortable to the passengers.

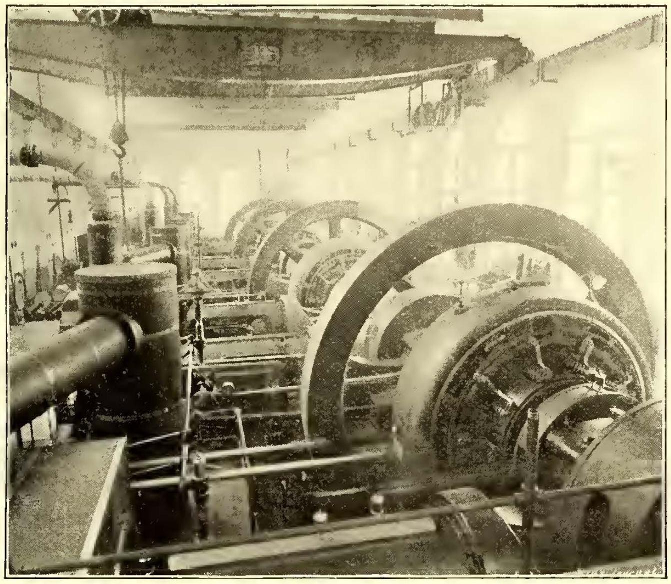


FIG. 1.—INTERIOR OF STATION

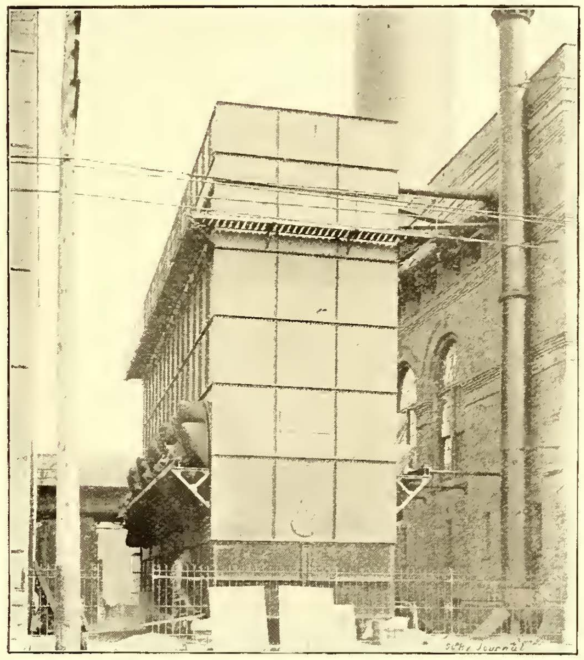


FIG. 2.—COOLING TOWER

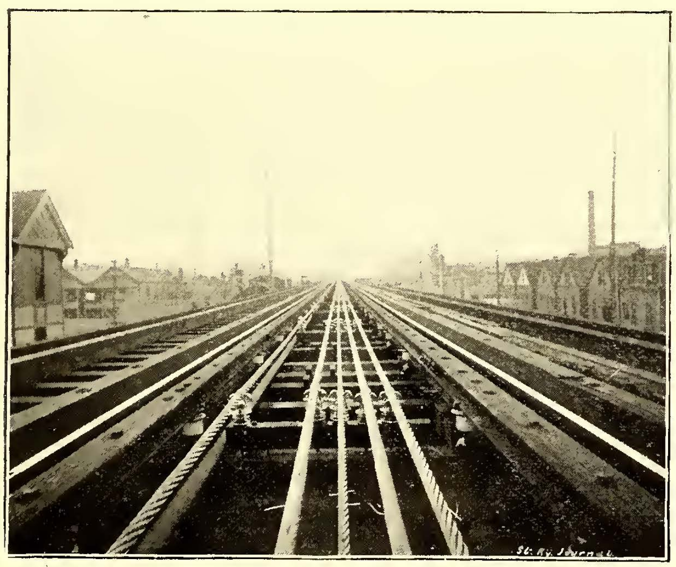


FIG. 3.—VIEW OF TRACK, SHOWING CABLES

FIG. 4.—METHOD OF DRILLING RAILS

The first electrical trains were started about a month ago, and the newly equipped cars are being added as rapidly as made ready. About one-third of the equipment is now in operation by electricity. At the start some trouble was experienced with minor details, but the trains are now running without interruption, and the advantages of smoothness and increased acceleration over steam operation are very evident. As soon as the steam trains are out of the way it is expected to materially decrease the running time from the city to Stony Island Avenue, the end of the road.

The site selected for the power house is at State and Fortieth streets, near the center of current distribution for the line. It is of brick, 200 ft. x 112 ft. The engine and boiler rooms are 59 ft. and 49 ft. wide respectively, and run the full length of the building. The steel stack is 200 ft. high, 19 ft. in diameter at the bottom and 13¾ ft. at the top. The steel plates vary in thickness from ½ to ¼ in. and the brick lining from 9 to 4½ ins.

The engine room contains four 1200 h.p. Allis engines, with space for installing a fifth. They are horizontal, cross-compound with cylinders 26x54x48 ins. and designed to run at 80 revolutions per minute. The generators are 800 k.w. Westinghouse, direct connected. Three Blake pumps supply the boilers, and the exhaust from these is utilized in a Warren Webster feed water heater.

A Reynolds condenser is connected to each engine, the water being supplied from a cooling tower (Fig. 2), manufactured by the Wheeler Condenser & Engineering Company. After passing the condensers a 20 in. pipe returns the water to the cooling tower. This is 64 ft. long, 34 ft. high and 16½ ft. wide, located just outside the building. The hot water is thrown on to wire screens hanging vertically in the tower, and trickling down over these is in contact with an air blast created by ten fans, each 10 ft. in diameter. The fan shafts, of which there are five, pass through the power house wall and are direct connected to C. & C. 18 h.p. motors. The capacity of the tower is 5000 gals. of water per minute, reducing the temperature approximately from 140° to 90° F.

The boiler room is equipped with eight 600 h.p. Babcock & Wilcox water tube boilers, and automatic chain grate stokers, made by the same company. The fittings and valves were supplied by the Crane Company. The main steam headers are 12 in. in diameter and are joined to the engines and boilers by 8 in. pipes.

From the Lake Shore Railroad a switch brings the coal cars directly into and over a large hopper, discharging into a crusher driven by an electric motor. After crushing, the coal is carried by Mead conveyors to the storage bins above the boilers; before reaching the furnaces it passes through an automatic weighing machine; a separate meter also measures the water fed to each boiler; these devices will greatly facilitate the keeping of station records.

The feed water taken from the hot wells after passing the heater goes through a Green's fuel economizer of 832 tubes, which, owing to the limited space, is placed over the boilers.

The station switchboard is of white marble fitted with General Electric switches and circuit breakers and Weston voltmeters and ammeters. There are in all ten panels, one each for the generators; one main panel for the entire station output; one for the station itself, and one for each two of the eight feeders.

For the north end of the road there are three feeders, two of 1,000,000 c.m. and one of 500,000 c.m.; for the south end are two of 1,500,000 c.m., two of 1,000,000 and one of 500,000. The cables were drawn into position on the structure with a locomotive. They are supported on standard cross arms and glass insulators.

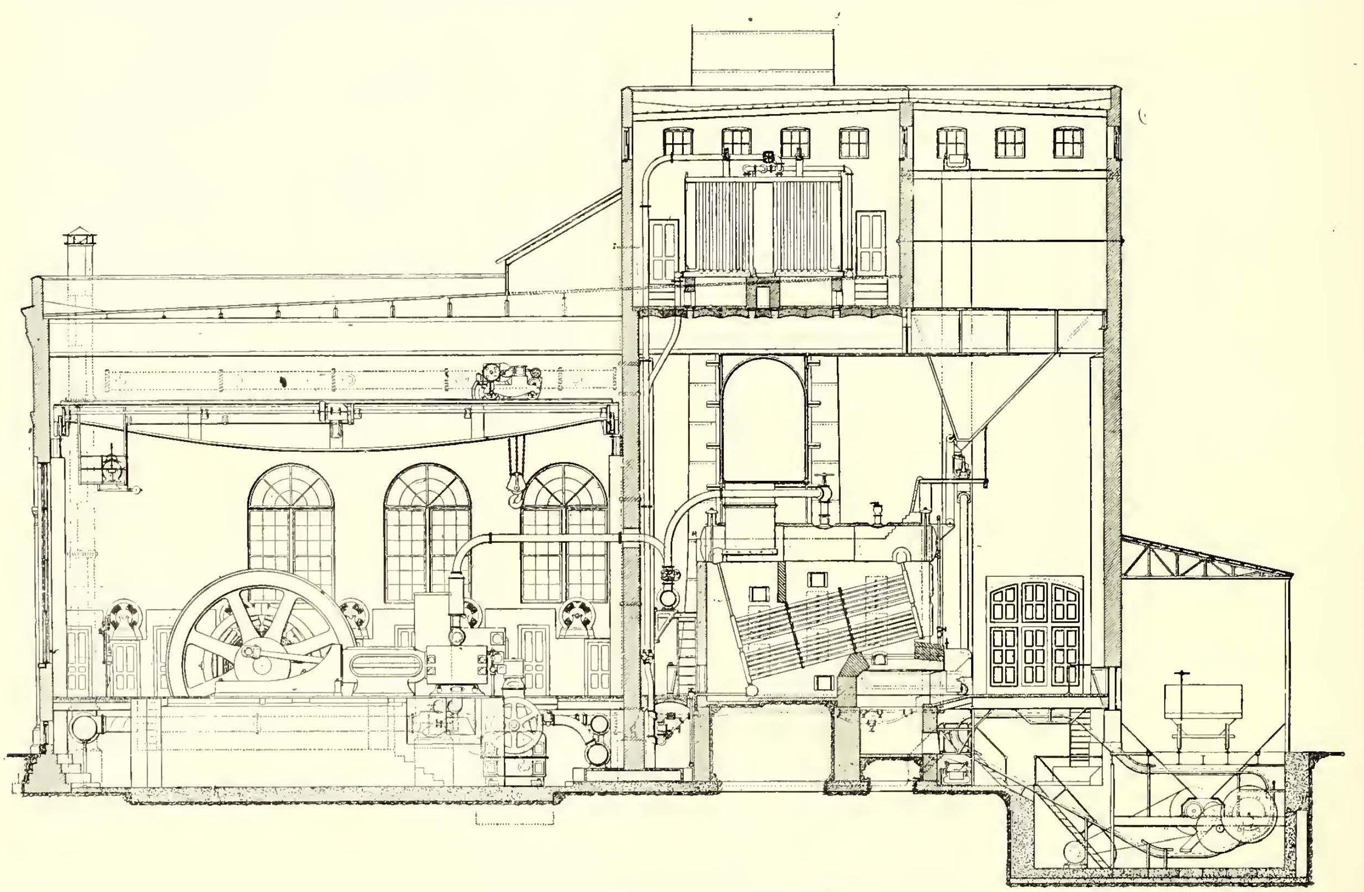


FIG. 5.—SECTION OF STATION

Atkinson and Columbia 0000 rail bonds are used; the track is also cross bonded and bonded to the structure. In drilling the bond holes the work was greatly facilitated by the use of electrical drills (Fig. 4) designed by the Electrical Installation Company.

The third rail is a 40-lb. T rail in 60-ft. sections, carried on standard third rail insulators made by the General Electric Company. The third rail is divided into as many electrical sections as there are stations on the line. Each section is connected to the feeder through a circuit breaker, thus a ground at any point will cut out only a very short part of the line.

It is stated that the property and franchises of the Electric Railway Light & Power Company, of Sedalia, Mo., have been sold to an Eastern syndicate for $350,000. F. W. Childs, of New York, has been appointed general manager.

Employment Bureau of the Brooklyn Heights Railroad

By H. Milton Kennedy.

The employment bureau of a street railway company is relatively of more importance, as bearing upon the discipline of the crews operating the cars, than is generally regarded. Upon the careful selection of these men at the outset, to a great extent, depends the future behavior as to honesty, sobriety, discipline, caution against accidents and politeness to passengers.

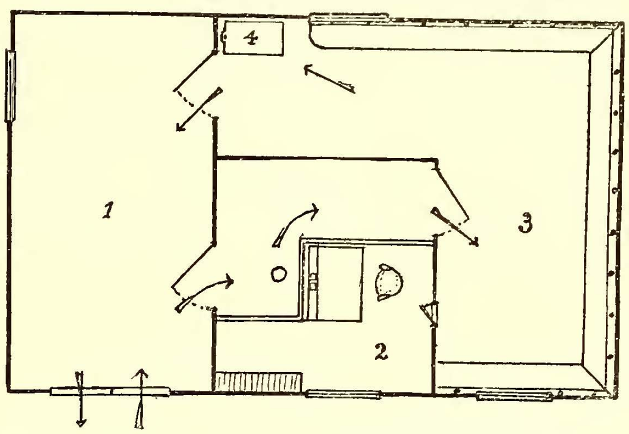
This subject has been of much concern to the Brooklyn Heights Railroad Company, owing to the annoyance occasioned by the numerous applicants who were constantly calling at the company's building containing the main executive and operating offices. Besides these drawbacks, those who were interviewed for employment had to be questioned in the presence of all others in the same room. This sacrificed the advantage to be gained by going into the details of a case according to the circumstances, and of the applicant being ignorant of the questions that were to be asked him. Upon the General Passenger Agent assuming charge of this department, under instructions from the General Superintendent, the first of March, this year, in addition to previous duties, the subject of suitable quarters was immediately taken up. It was desirable to have such quarters away from the building, and yet not to have them at any one of the depots, among the men. Fortunately, the original offices of the Brooklyn Heights Railroad, in the power house for the Montague street cable line, were available, and with slight alterations made to suit the purpose admirably. It was announced that hereafter all applicants for employment would be received at the new address, 40 State street, so that the relief at the main offices from applicants, politicians and old employees with "a friend" was immediate.

The modus operandi under the new system is this: The "recruits" gather in the waiting room, or, if in large numbers, as at this season of the year, are formed in line on the sidewalk, as approaching a theatre box office. One of the assistants of the department keeps this line in order, weeding out those who are unqualified on general appearance and allowing the head of the column to enter the Superintendent's office, one at a time.

Here they are questioned in general as to their identity, experience, vocation and qualifications, both mentally and physically. If O. K. thus far, they are given an application blank which requires their record for the last five years, with names and addresses of employers, whether or not they have ever been employed by any other railroad company or by this company, whether or not they are members of any secret organization or unions, whether they have ever been rejected by a surety company, and other minor questions. This blank is filled out in the next room, provided for this purpose, and then their height, weight and general identification is noted thereon. Then they pass out until they are sent for, if ever. Their references of past or present employers are next written to, and if satisfactory the applicant is notified to call at a given time and date. He is then scrutinized again, with his application paper at hand, to see if he is the original first applicant, and questioned as to the names and occupations given thereon, to make doubly sure in case the identification might tally, and yet be another person. If the applicant is to be a conductor, he is given an order for cap and uniform and told when to report; if a prospective motorman, he is given a note to the company's doctor for a general physical examination and test of eyesight. If he returns with the doctor's certificate, he is then given a line to the electrical instructor and "school" car. Here he is sent through the company's shops and instructed as to the mechanical construction of motors and controllers and the electrical operation of a trolley car. On the school car, which is run over a suburban route, he is taught the proper handling of a car, and vigilance on the road.

If competent, he is returned to the employment bureau with a voucher, where he is then given an order for a uniform and requested to report ready for duty. After conductors and motormen are thus ready for assignment they are "looked over" once more to guard against infringements of substitutions, and after a brief, courteous talk, taking the men in groups, they are assigned to one of the five divisions. The conductors are furnished with badge and punch, on which they deposit $1 each, and required to fill out a bond for $150, the premium of which is $1 annually, arranged by this company with a surety company.

The little talk which is given the new appointees before going to their depots is believed to have a good effect. Briefly they are advised:



1.—Waiting room. 2.—Superintendent's office. 3.—Applications filled out. 4.—Height, weight and identification taken.

OFFICE ARRANGEMENT—EMPLOYMENT BUREAU, BROOKLYN, HEIGHTS RAILROAD

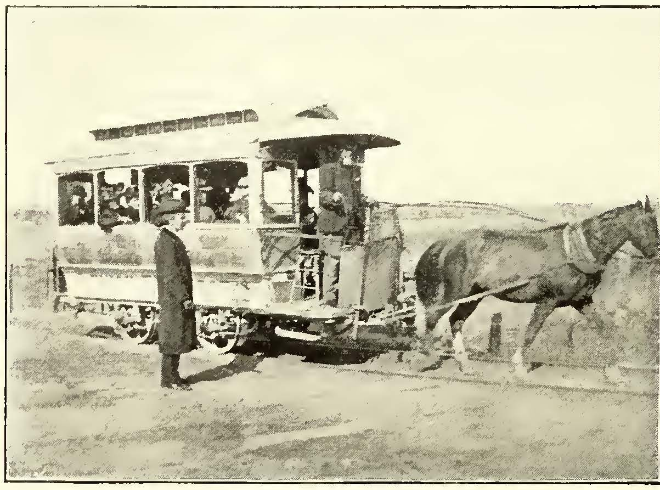
Conductors should not talk back to passengers when addressed in a manner that natural impulse would prompt them to resent. If asked for their badge number, politely give it, and if any trouble arises, their chance to defend themselves is before their Division Superintendent. Treat passengers with the same courtesy that would be shown by the proprietors of a store; in the latter place they would be dealt with considerately, so that they would return—the same policy should be followed on a street railroad. Guard in every way against accidents, and use care in reporting all that happens, getting names of witnesses, etc. Obey the discipline of the road and follow instructions. As to sobriety and honesty, if the positions are valued or reputation regarded use care not to violate either. Men who frequent saloons are dismissed. A vigilant detective service is kept over the road, and of course honest men have nothing to fear from this, but if any are dishonestly inclined, they had better tackle a money drawer or a bank, for the "game" here would be too small to warrant the attempt.

Motormen are also instructed as to sobriety, discipline and accidents. In addition, they are told that "Caution" with a capital "C" is to be their watchword at all times.

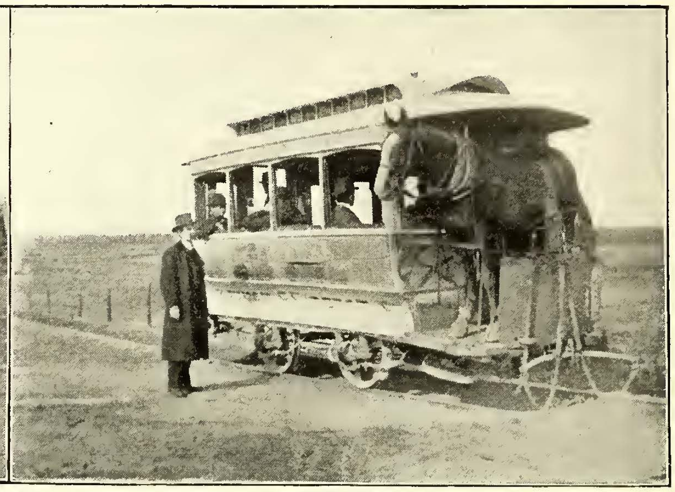
No excuse for collisions is regarded as valid, and the oft misused "slippery rail" and "sand box wouldn't work" will not be accepted. They are also reminded that cars are run "to carry passengers" and not for the convenience of motormen, therefore watch for patrons. The delivery of a guide book of the Brooklyn Heights Railroad system, with map, and a book of rules, completes their journey through the Employment Bureau, with a "wish for success."

A Novel Gravity Road in Denver, Colorado

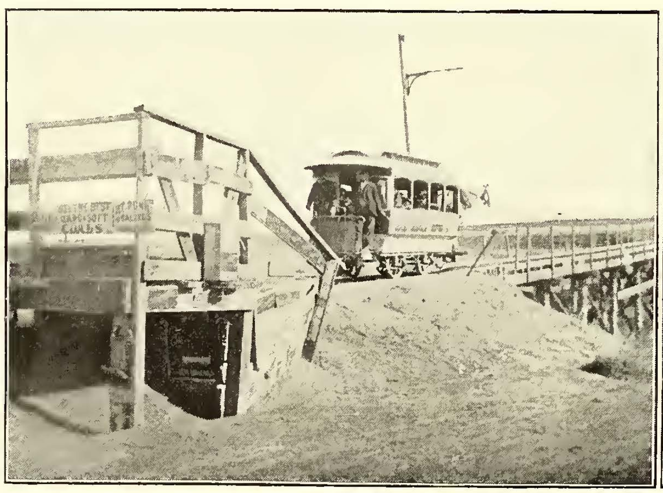
The accompanying illustrations show a rather novel and amusing method of transportation on one of the suburban



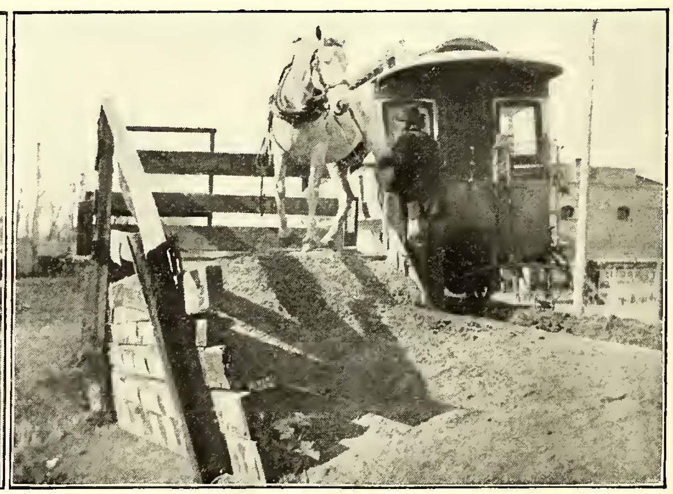
ASCENDING THE GRADE



LOADING THE MOTIVE POWER



NEAR THE FOOT OF THE GRADE



UNLOADING AT THE FOOT

lines in Denver. As will be seen, the horse pulls the car up the hill and then rides down on the rear platform.

A short description of this line was published in the "Street Railway Journal" about three years ago, at which time a different system was employed. At that time a special truck for the accommodation of the horse was attached to the car and drawn after it.

The grade averages $3\frac{1}{2}$ per cent, and this is sufficient to return the car, the horse and the passengers to the foot of the hill entirely by gravity. The line is about one mile in length. The company owns one car and five horses, and the daily mileage is about forty. The horse is able to draw the car up the grade at an average speed of about $2\frac{1}{2}$ miles per hour, and the car descends by gravity at a rate of about 15 miles per hour.

Recent Improvements in Memphis

In 1895 the Memphis Street Railway Company acquired from the city a fifty-year franchise and the right to purchase all the street railway properties in the city and county. Since that time the purchases have been completed and the entire street railway system of the city is now owned by the Memphis Street Railway Company. During this time the tracks of nearly the entire system have been relaid. On paved streets 80-lb. Johnson rail has been used, and on macadam, gravel and suburban streets 75-lb. "T" rail has been laid. All the rail in paved streets has been in 60-ft. lengths, and cast welded with the Falk joint. No bonds are used with the Falk joint, as none, it is thought, are required, but with T rails the Atkinson bond is used under the fish plates. In connection with the city the company has laid a number of miles of brick pavement, using what is known as the Tennessee Paving Brick Company's paving brick, which is proving quite durable and very satisfactory.

The company operates from sixty to ninety cars. On its suburban lines the G. E. 1000 motors and double truck cars are used, but the major part of the equipment consists of G. E. 800 motors, although the company is still using quite a number of the early Edison motors, with rewound fields.

The Peekskill Traction Company, of Peekskill, N. Y., has been granted a franchise to build an electric railway in Peekskill.

Accounts of Materials in Store—III.

BY A. O. KITTREDGE, F. I. A.

In establishing a store system, whether it be done upon an elaborate plan with a central warehouse and regular storekeepers, or upon a more economical basis with different classes of stores kept in different places and in the charge of various employes as nominal custodians, one or two fundamental rules should be laid down at the outset to be adhered to without change or variation.

First, the accounts with stores in the main books should be arranged to agree with the system that it is desired to enforce. At this point the accountant has the choice of methods in several particulars. He may have a single account with stores, which is to be debited with all goods, materials and supplies that are received taken at cost value, and credited with the same goods as delivered, likewise taken at cost value; or he may have a group of accounts, each separate account of which shall represent an important article or class of material or supplies, and the total constitute stores in general. For example, there may be an account with coal, another account with lubricating oil, still another with each of the several more important items, and finally a sundries or miscellaneous account, in which are summarized the multitude of odds and ends which go to make up the assortment of materials and supplies necessary to the operation of any street railway system. Or the stores account, so far as the books are concerned, may be subdivided with respect to the location of the stores. If, instead of one central warehouse the stores are variously distributed in the shops and car barns of the company, then it may be advantageous to open up an account with each of these store stations. Or a combination of these two plans is possible. Leading materials and supplies like coal may be specialized in separate accounts, while sundry materials are gathered in accounts corresponding to the location of the supplies.

Dr. Any Individual Material or Supply.	Cr.
Amount received taken at cost value.	Amount delivered on requisition taken at cost.
Dr. Balance = Cost value of amount on hand.	

FORMULA OF A MATERIAL OR SUPPLY ACCOUNT.

Whether a single account or several accounts are preferred, the general method is the same. Each account is to be opened with the inventory of the materials on hand which it stands for, taken at fair value at the date of opening. It is to be debited from time to time with the new materials or supplies bought, taken at actual cost, delivered. The invoice files in the office should be arranged upon such a plan that reference from ledger account to invoice, or from ledger account to a general inventory book, is possible in a way to show instantly whenever required the cost of any given article or any given lot with which stores has been charged.

Dr. Stores (Collectively).	Cr.
Materials and supplies taken at their cost value.	Materials and supplies delivered on requisitions taken at cost.
Dr. Balance = Cost value of materials and supplies remaining on hand.	

FORMULA OF A SINGLE ACCOUNT WITH STORES, OR OF A GENERAL ACCOUNT REPRESENTING THE AGGREGATE OF DETAIL ACCOUNTS.

Another of the fundamental rules to be laid down in inaugurating a system of store accounts is that no material from any storehouse, no matter what the nature of the custodianship may be, shall be delivered save upon a proper requisition signed by some one authorized to sign requisitions, as, for example, the superintendent or a foreman. And, in turn, no materials shall be allowed to leave the depository save there be left behind a receipt for the same, signed by the one who personally takes the material. There are two distinct functions in what is here described: The requisition may be signed by one who never sees the articles themselves. He intrusts the order on the warehouse keeper to an assistant or a subordinate. This is step number one. Whoever receives the goods or supplies therefore should be responsible for proper delivery in the interest of the use to which they are to be put. He it should be therefore who signs the receipt. This is step number two.

Both requisitions for materials and the receipt for the material taken should be so numbered or otherwise designated in connection with proper stubs that auditing or

Requisition For Materials or Supplies in Store: No.........				**Receipt** For Articles as noted:			**Extensions** To be Made in Office.	
Date.	Quantity.	Kind and Description.	To be used in	Date.	Quantity.	Kind and Description.	Cost.	Amount.
(Signed) .... Superintendent.				Signed) .... Foreman.				

GENERAL FORM OF REQUISITION FOR STORES, WITH RECEIPT AND SPACE FOR OFFICE EXTENSIONS.

checking back may be comparatively simple. Requisition and receipt may be in a single blank, and, further, this blank may be advantageously extended so as to include columns for the necessary office extensions.

Materials ordered out of stores by the superintendent or other authorized person are designated by quantities and kinds, without reference, so far as the form is concerned, to prices. The delivery by the warehouseman to workman or foreman is likewise by quantity and kind without regard to prices. When these requisitions reach the office of the accountant, however, cost prices are to be inserted, and for this purpose the columns at the right of the blank shown herewith will be found extremely convenient.

In describing forms convenient for use in connection with stores there is the necessity of confining the specification to generalities. Each individual case in practice requires some peculiar adaptation of or addition to the form, and therefore to attempt to enter into fine details in description would only be to court various difficulties in the way of explanation.

The suggestion has been made of a stub for keeping a record of the requisitions issued. It will be found economical in many cases to substitute for the stub a carbon copy to be retained in the requisition book. This plan successfully overcomes the danger of requisitions being raised between the time they leave the person signing them and the time the materials are delivered to the man sent for them. There may be good reasons also for the storekeeper retaining a copy of the requisition, in which case it may be made out in triplicate by the carbon process, one copy remaining in the requisition book as a record of what has been ordered out; another copy remaining with the storekeeper as a record of what he has delivered, while the original goes, in due course, to the office, and there receives the extensions at cost prices. It forms the basis of credit to stores account, or to some subdivision of stores account, and also of the debit to the proper construction, equipment or repair account, as the case may be.

The Standard System of Street Railway Accounting

As the date of the third convention of the Street Railway Accountants' Association approaches interest naturally centers in what is being done by the permanent committee appointed at Niagara Falls upon a "Standard System of Street Railway Accounting, covering the classification of operating expenses, classification of construction and equipment accounts, and form of annual report." The work of this committee up to the beginning of the present year and that of its predecessor has been almost entirely theoretical. On the first of January, however, a considerable number of the street railway companies represented by membership in the National Association put into practical operation the classification recommended by this committee, and which received the indorsement of the last convention of the association. Since that date the several members of the committee have been studiously watching the operation of the system under practical conditions in various directions, and therefore a part of their report at the next convention promises to be of a decidedly practical character. In addition to what the committee may have to report officially concerning the operation of the system, there will be reports, it is fair to expect, from those accountants outside of the committee who have employed the system during the present year. These reports, no doubt, will be confirmatory of what the committee may offer.

In addition to this practical work, in which the members of the committee have been specially engaged the past few months, there has been undertaken a careful inquiry concerning the opinion in which the standard system is held by those members of the association who have not yet put it to a practical test. The object in view has been to call out, if possible, objections and criticisms, in order that the committee may be in shape to make their forthcoming report more comprehensive than would otherwise be possible. The secretary of the association, at the suggestion of the chairman of the committee, issued a circular letter some time since to all the members of the association, asking if they had put the standard system into use, or if they contemplated doing so; and soliciting criticisms concerning the system, or any suggestions which they had to offer with regard to it. The replies to this circular were promptly returned by the members, and in the interval have been very carefully examined by different members of the committee. In the main, as we are informed, the answers are to the effect that the system recommended by the convention conforms very closely in its general features to those already in use, and therefore that in all its leading features it is satisfactory. A few members have suggested minor modifications which they think would be improvements, and these will undoubtedly be included in the report of the committee at the coming convention in a way to bring them up for general discussion.

The fact that the committee is pursuing its course very quietly, and that the work that has been accomplished since the last convention has been done without special publicity, is no indication that progress is not being made. By the very nature of the case, the undertaking of this committee cannot be pushed beyond a certain rate of speed and accomplish good results.

Car Mileage Records

A valued correspondent of the Journal suggests as a subject of discussion in these columns methods of arriving at correct results in individual car mileage records. He declares that while this is not strictly a question of accounts as usually handled by the auditing department of a street railway, it is of great importance in a variety of matters in which street railway accountants are interested, particularly in repair shop statistics. What he would like to see, and we cordially endorse his suggestion, is a general discussion of this matter in our columns, through which, no doubt, revelations of interest to all and of very great advantage to many of our readers will result.

The subject is one in which individual preferences and original plan largely predominate, and we venture at the outset to say that there are perhaps no two street railway companies in the whole land maintaining car mileage records, that pursue exactly the same plan, unless, indeed, one has been copied from the other. Can we not have a discussion of this subject in the way in which our correspondent suggests? Those accountants who have the inclination to do so are invited to prepare for these columns articles describing their methods, including illustrations of forms. Those who have not the time and inclination to send in articles in shape for publication are invited to write us informally, describing their methods in as much detail as they see fit, leaving to us the matter of arranging their manuscript for publication. We should like to hear from a very large number of accountants upon this interesting and very important subject. If we can secure a general expression from our readers the good results suggested by this correspondent are sure to follow.

LEGAL NOTES AND COMMENTS*

EDITED BY J. ASPINWALL HODGE, JR., AND ROBT. H. ERNEST, OF THE NEW YORK BAR.

Contribution in Collision Cases

Suits for negligence growing out of collisions between the cars of street railway lines are becoming numerous. This is largely owing to the adoption of new forms of propulsion, which not only increase the speed, but those controlling the cars bring the body of the vehicles at crossings much nearer together, because of the absence of horses, and greater risks are taken than were possible before.

On the other hand, complications arising out of the presence of two possible defendants in the action resulting from a collision do not occur as often as they otherwise would because of the tendency that exists to consolidation between the street car lines of our various large cities, where accidents are most frequent.

But there still remains a very large number of cases which are constantly before our courts, wherein the plaintiff sues two joint *tort-feasors*, and hence the doctrine of contribution between them can be frequently evoked, and sometimes merits more careful consideration than it receives.

It is not an infrequent thing to see the attorney for a plaintiff, present his case in court, before a jury, by merely putting in evidence the fact of the collision and the amount of injuries his client has suffered, and then leave the fight between the counsel of the two railroad companies, and so the issue has merely turned upon the question as to whether both or only one of the railroad companies is liable; and, if but one, which one.

Such a contingency is one which makes things extremely easy for the plaintiff and very difficult for the defendants. The degree of negligence on the part of the two defendants, the jury are told, has nothing to do with the question, if they were both negligent in any degree; and of course the tendency is to lay the blame upon both parties. Then, because it is assumed that both corporations jointly contribute to pay the judgment there is a tendency to award higher damages than would be awarded were there but one defendant. The defendants are at a further disadvantage because each of the defendants has to oppose two counsel, the counsel of his co-defendant and the counsel of the plaintiff, both of whom unite in denouncing its alleged negligent conduct.

But the special subject under consideration is the right of one of the co-defendants, who has settled with the plaintiff, or against whom a judgment has been recovered, whether a joint or single judgment, to enforce contribution against his co-defendant. In the ordinary negligence case, where but a small sum is involved, the question would not ordinarily be raised between the loss departments of two metropolitan railway systems, but where a large judgment is recovered, the question must arise and be decided.

The general rule of course is well known that no right of contribution exists between wrongdoers, but there is an exception to this rule which has received a considerable amount of attention from some of our courts, and especially in Massachusetts.

In an English case (*Pearson* v. *Skelton, 1 M. W., 504*), a stage proprietor had been sued for the negligence of a driver, and he had paid a judgment which had been recovered against him. He, thereupon, sought contribution from one who was a co-proprietor with him in the business, and it was held that the rule that no contribution exists between *tort-feasors* did not apply to the case, since the defendant was only a *tort-feasor* by a fiction of law, the court holding that the rule that no right of contribution between wrongdoers is wholly confined to cases where there is a presumption, at least, that the party knew that he was committing a wrongful act and did it voluntarily.

This rule was followed in Pennsylvania, where it was held that where a pedestrian recovered damages in an action for negligence against one of two counties, both of which were obligated to keep a bridge in repair which had fallen down, injuring the plaintiff, that the county against whom the judgment was rendered might recover contribution from the other. (*Armstrong County* v. *Clarion County, 66 Pa. St., 218.*)

One of the tests as to whether contribution can be had is a careful examination of the facts to discover whether, as a Connecticut judge has put it, we can find "personal participation, personal culpability and personal knowledge. If you do not find these circumstances, but perceive only a liability in the eye of the law growing out of a mere relation to the perpetrator of the wrong, the maxim of law that there is no contribution among wrongdoers is not to be applied." (*Bailey* v. *Bussing, 20 Conn., 455.*)

Sometimes an exception to the rule prohibiting contribution between wrongdoers is stated by asserting that the joint *tort-feasors* must be in *pari delicto*, if the rule is to be enforced. But, it will be seen that the exception, however worded, is in most cases covered by the remarks of the Connecticut judge, which have just been quoted.

The rule, or this exception to the rule, has been applied in the following Massachusetts cases: *Gray* v. *Boston Gas Co, 114 Mass, 149; Westfield* v. *Mayo, 122, Mass., 100; Churchill* v *Holt, 127 Mass., 165; Lowell* v. *Boston, 23 Pick, 24; Jacobs* v. *Pollard, 10 Cush, 287.*

Applying these principles to a case where a collision has occurred between two street railways, through the joint negligence of the employees of both companies, and where an injured passenger has collected compensation from one of the companies, whether before or after judgment, there would seem to be a good cause of action by the company paying the compensation against the other company.

It might possibly be otherwise if the collision was caused, not by the negligence of the employees, but by deficient or improper rules enacted by the company, or even by the carelessness of the company in not providing proper and efficient brakes or motors, tracks or switches.

In these latter instances it might be held that the negligence was brought so near to the corporation itself that it might be considered to be the wrongdoer itself, rather than a wrongdoer by presumption, made so by the imputed negligence of a subordinate employee.

The question does not seem as yet to have been squarely raised in the appellate courts, but the subject is one full of interest to lawyers and street railway companies.

We shall discuss in a later issue the result, in collision cases, of a settlement with, or release of, one of the railroad companies, upon a suit afterward brought to trial against the other company. H.

* Communications relating to this department may be addressed to the editors, Johnston Building, 30 Broad Street, New York.

LIABILITY FOR NEGLIGENCE.

GEORGIA.—1. In an action against a street railroad company by a minor to recover damages for personal injuries sustained by being run over by a moving car, when it appeared by the evidence for the plaintiff that there was a pile of lumber in the street on one side of and near the railroad track, not placed there by the defendant, behind which the plaintiff and other boys were playing, and as the car approached the end of such pile of lumber the plaintiff suddenly ran on the track immediately in front of or against the front part of the moving car, and was struck and injured, and when it further appeared by the same evidence that the line of track in the approach to and at the place where the accident occurred was open to the view of the motorman and free from obstruction, that the car was not being run at a reckless and unusual rate of speed, and that the plaintiff could not have been seen from the car until he came on or within 30 ins. of the track, and that as soon as plaintiff came on or near the track the brakes were applied and every effort made to stop the car, it was not error to grant a nonsuit.

2. It affirmatively appearing that the motorman could not have seen the plaintiff in the street before he appeared on or near the track or knew he was there, and there being no proof that such place was used by children in playing, or that there was anything to put the motorman on notice that persons were accustomed to be behind the pile of lumber, or that on this particular occasion children were in fact playing about and behind the same, his failure to sound the gong on approaching such pile of lumber was not negligent relatively to one who ran out suddenly in front of a moving car or against it, so as to authorize the latter to recover for injuries so sustained, when no negligence on the part of the motorman is shown in his efforts to stop the car and prevent the injuries when the person first came on or near the track, but, on the contrary, it affirmatively appeared that the brakes were promptly applied and the car stopped as soon as possible. (a) This is true, even though the person injured be a minor of tender years.—(Perry v. Macon Con. St. R. Co., 29 S. E. Rep., 304.)

KENTUCKY.—1. Plaintiff, while on the right side of the track, was struck by the middle part of a street car going in the same direction. He did not hear the sound of the gong, but his witnesses, who were further away, heard it, and saw the headlight of the car. The accident occurred at 8 o'clock in the evening, but the street was lighted by electricity, so that one could see very well. The plaintiff was never on the car track at all. Held, insufficient to submit the question of negligence to the jury.

2. In order to have the question of negligence submitted to the jury, negligence, or circumstances from which it may be inferred, must be shown.—(Gordon v. Louisville Ry. Co., 44 S. W. Rep., 972.)

MICHIGAN.—A car of a street car company was left by employes unguarded at a point on its tracks, where it had been left before, and where the employes knew children played upon it. The car was not blocked, or, if so, not so blocked that it could not be moved by the children playing about it. Held, not to show negligence of street car company rendering it liable for injury to a child moving it backward and forward upon the track.—(Kaumeier v. City Elec. Ry. Co., 74 N. W. Rep., 481.)

MICHIGAN.—1. An instruction, "If you believe plaintiff's side of the case and the plaintiff's witnesses, then the plaintiff has made out a case," is erroneous, when many of the facts testified to by plaintiff's witnesses might be true, and yet the defendant not be liable.

2. In an action against a street railroad company for personal injuries to a boy, defendant's request that if the boy had been warned repeatedly by his father of the danger of crossing the car tracks without looking, and the boy appreciated their danger, then their verdict must be for defendant, was modified by the court by adding: "That is, if he was a grown person, * * * or had the intelligence of a grown person fully." Held, erroneous, as it was only necessary for the boy to have had sufficient intelligence to appreciate the danger and take precautions.

3. Where there was no evidence to show that the position of a boy on the track of defendant company was discovered in time to avoid injury, a charge leaving it to the jury whether it was possible, by diligence, to stop the car after the boy came on the track, is erroneous, as being misleading.

4. Where the plaintiff's testimony showed, in an action against a street railroad company for personal injuries, that the boy injured was of sufficient intelligence to appreciate danger, and that, if he had looked in the direction of the car which struck him, he would have seen it coming, and avoided the accident, the action cannot be maintained.—(Henderson v. Detroit Citizens' St. Ry. Co., 74 N. W. Rep., 525.)

NEW JERSEY.—The reply: "I charge to this extent: He ought to be able to see far enough up the track to see that he has the right of way; and he has the right of way if he can get upon the track before the car would reach that point if going at a reasonable rate of speed,"—given on a request to charge that a driver of a vehicle, when approaching a street railway at a place where his view is impeded by other vehicles, ought to wait until his view is no longer thus impeded before going on the track—correctly states the law; its meaning being that a driver under such circumstances ought to reach a point so near the railway that he could see without impediment far enough up the track to form a judgment whether he could drive on the track before the approaching car, running at a reasonable speed, would reach that place, and, if he could, he had the right of way.—(New Jersey Elec. Ry. Co. v. Miller, 36 Atl. Rep., 885.)

See dissenting opinion, 39 Atl. Rep., 885.

NEW JERSEY.—A child, about two years and nine months old, attempted to cross a public street in which a line of trolley cars was operated. There was a car then coming toward the child. From the evidence the jury could infer that, although its power was off, the car was running at great speed, occasioned by a down grade and its very crowded condition, and that, when the motorman saw the child start to cross he did not apply the brakes or attempt to retard the speed of the car until the child fell upon the track. It was run over before the car stopped. The trial judge was requested to charge that, in regulating the speed of the car, the motorman was not bound to allow for the possibility that a child of that age might undertake to cross and fall upon the track so as to be unable to get off before being run over. The request was given with the qualification that the rate of speed of the car was otherwise reasonable. By this qualification, and by other parts of the charge, it appears that the case was tried on the theory that, if the car was run at reasonable speed, the motorman was not bound to take into consideration the possibility of the fall of a child of that age in crossing, while, if running at an unreasonable rate of speed, he was bound to that duty. Upon the charge the verdict must be taken to have determined that the car was run at an unreasonable rate of speed, and that the liability of defendant was thus made out. Held, that defendant has no ground of complaint thereon. But in declaring this conclusion it is not intended to indicate an opinion that a motorman, running his car in a public street, is not bound to consider the apparent condition of persons attempting to cross the street, and, if they appear to be infants of tender age, or crippled, decrepit, or drunken persons, to regulate the speed of the car as reasonable prudence would require, considering their right to cross the street, and such risks as might naturally result from their apparent condition.—(Murray v. Paterson Ry. Co., 39 Atl. Rep., 648.)

NEW YORK.—An action against a street car company cannot be maintained where plaintiff could prove nothing except that he believed that he was struck by one of the horses of the car, but how or by whose fault he was unable to make clear.—(Boetgen v. N. Y. & H. R. Co., 5 N. Y. Supp., 331.)

NEW YORK.—While the established principles are not to be relaxed, which impose the obligation upon street railway companies, whose cars are propelled rapidly through crowded city streets, of having their cars under such control, and to run them at such speed, as to enable pedestrians who are crossing prudently to do so with complete safety, yet pedestrians are not absolved from observing at least some slight care and caution so as to avoid being injured.

2. Same—Contributory Negligence.—A foot passenger, while passing over a city avenue at a street crossing, kept his eyes fixed on the ground, and gave no evidence of looking or listening for the approach of a car on the tracks of defendant's street railway, until, having reached the further rail, and when a car was within five feet of him, he was roused from his lethargy, and then, in his hesitation to act in the sudden emergency, was unable to extricate himself, and was struck by the car. Held, on the facts, that there was a failure to establish absence of contributory negligence.—(Martin v. Third Ave. R. Co., 50 N. Y. Supp., 284.)

NEW YORK.—At the trial of an action to recover damages for personal injuries, plaintiff's medical expert witness testified that he had never seen plaintiff prior to examining him, three days after the accident, and that his opinion of the permanent character of the injuries was based solely upon the history of the case as given by the plaintiff. No testimony whatever was offered touching such history. He was then asked, under appropriate objections, which were overruled, whether, speaking with reasonable certainty, the injuries would, in his opinion, be permanent, and answered, "They will." Held, that the ruling was improper, within the authorities requiring the witness to communicate to the jury the facts upon which his opinion is founded.—(McCabe v. Third Ave. R. Co., 50 N. Y. Supp., 34.)

Exhibits at the Electrical Exhibition.

The second annual exhibition of electrical and kindred industries was held at Madison Square Garden, New York City, from May 2 to May 31, 1898. The attendance was excellent during the show, although it would probably have been much larger if there had not been so many rainy days. Great interest was aroused throughout the country in this exhibition, and delegations were sent from many cities to visit it. The many exhibits were attractively arranged, and a good idea of the general appearance of the hall can be secured from the accompanying illustrations.

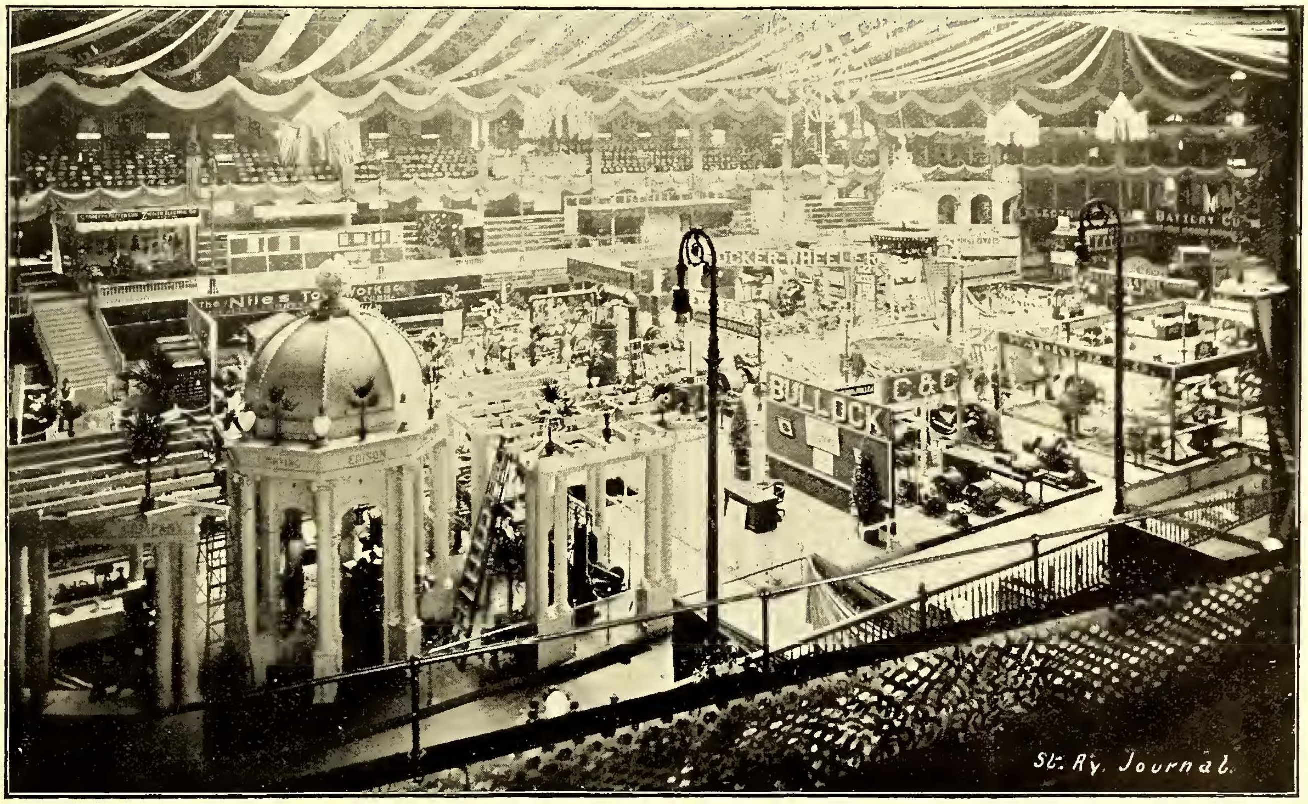
Manufacturers of street railway apparatus were very well represented, and among the latter may be mentioned the following as particularly worthy of note:

The John Stephenson Company, Limited, of New York City, exhibited a full-sized car of the type now operating on Madison avenue, New York City. The car was taken from actual service in order to be shown at the exposition, and was therefore fully equipped in every detail. The car was shown in operation on the new Walker electric conduit system. The Stephenson Company also exhibited a miniature model of the standard Broadway car complete in every detail and built to scale. This model attracted considerable attention, particularly from the general public.

The Gold Car Heating Company of New York City exhibited several samples of its different types of electric heaters for street railway cars, elevated cars, houses, boats, buildings, etc. This company has recently designed a new case for its heaters, intended particularly for use on southern roads. The Gold portable heaters for houses and steamships attracted considerable attention. The exhibit was in charge of Frederic Weston.

The Fischer Foundry and Machine Company of Pittsburg, Pa., through its New York agents, Porter & Remsen, showed one 125 h.p. Fischer tandem compound four-valve automatic high-speed self-oiling engine, direct connected to a 75 k.w. Onondaga direct-connected generator. The engine and dynamo furnished a large number of the lights in the exhibition hall. The company thinks that the self-oiling feature of these engines is entirely new, and satisfactorily solves the problem of engine lubrication. The engine exhibited was fitted with a Wright's governor. The exhibition was in charge of T. H. Hadley.

The Heywood Brothers & Wakefield Company of New York City, Boston and Wakefield, Mass., had a small booth, where its time recorders for employees were shown. These recorders are new in their line, and the strong points claimed for them are simplicity in construction, simplicity in operation and legibility of record. They are particularly well adapted for use in street railway repair shops, car barns, etc., and in any place where it is necessary to keep the time of several employees.



INTERIOR VIEW OF ELECTRICAL EXHIBITION

Adam Cook's Sons, of New York City, exhibited a full line of the well-known Albany compounds, including cylinder oil, machinery oil, dynamo oil, etc., and the Albany grease. The Albany grease was used on most of the engines and dynamos throughout the exhibition hall. Albert J. Squire had charge of this exhibit.

The John A. Roebling's Sons Company of Trenton, N. J., had a very pretty booth divided into two rooms. One room was fitted up very tastefully as a reception room, and the other contained an interesting exhibit of the Roebling wires and cables for electrical purposes and lead-encased cables for underground and submarine work. Among the many interesting things shown in the exhibition room proper were a number of samples of special shapes of trolley wires, including "Figure 8," wire, etc., several sections of the Atlantic cable laid for the Commercial Cable Company in 1894, samples of the "Flexible" rail bond and the Columbia rail bond, and a section of the three-conductor thirty-mile telephone cable, which the Roebling Company has just furnished to the Western Union Telegraph Company, and which is to be laid across Puget Sound. The Roebling Company also showed a number of its feeder cables in connection with the working model of the Walker conduit system.

The Consolidated Car Fender Company, of Providence, R. I., had two full-sized Providence fenders in place on the ends of the Madison avenue car, shown in connection with the Walker conduit exhibit. This company also had two miniature models of its fenders on the small model of the standard Broadway car shown by the John Stephenson Company, Limited. G. H. Hale was in charge of the company's exhibit.

The Consolidated Car Heating Company of Albany, N. Y., showed six of its heaters in the car used in connection with the exhibit of the Walker conduit system. These heaters were installed as if for regular service, with the temperature-regulating switches, etc.

The Johnson Company of Lorain, Ohio, furnished the rails for the model of the Madison avenue conduit system.

Henry R. Worthington, Incorporated, of New York City, had a large and prominent space on the main aisle of the exhibition hall, well filled with the Worthington electric pumps for house, tank, elevated service, mine service, fire protection, water works supply, etc., and switches, controllers and automatic rheostats for controlling the same. A fine collection of drawings, showing in detal the various pumps made by the company, was also shown. This firm is calling particular attention to its new pattern boiler feed pumps, one of which was shown in its exhibit. All of the pipe connections in this pump are flayed, and the pump is so designed that the exhaust pipe may run either above or below the pump, as desired, and in parallel with the steam pipe. There was also shown in the exhibit a 5-in. x 7-in. x 3-in. vertical triplex pump, of the company's "Steeple" pattern, connected by one reduction of gears to a general electric motor. These pumps are designed for water pressure of 150 lbs., and are fitted with differential plungers. The exhibit was in charge of F. W. Jones, Jr., G. M. Maynard and E. R. Howell.

The Onondaga Dynamo Company, whose works are at Sycamore, N. Y., had on exhibition one 75 k.w. multipolar generator directly connected to a Fischer engine, and several Onondaga dynamos. The exhibit was in charge of the New York agents, Fairchild & Sumner.

The Niles Tool Works Company, of Hamilton, Ohio, displayed a full line of the Niles machine tools. These tools include boring machines, mills and lathes of various sizes, some designed to be worked by foot power, some by steam power and some by direct connection with electric motors. This company also exhibited a number of its all-wrought steel pulleys, for which a number of advantages are claimed. These pulleys are lighter than iron, and even lighter than some types of wooden pulleys. F. E. Woodward was in charge of the all-wrought steel pulley department and Walter M. Wood had charge of the machine tool department.

The Samson Cordage Works of Boston, Mass., showed samples of its "Spot Cord" and "Massachusetts" arc lamp and trolley cord and bell cords of various colors.

The Electric Launch Company, of Morris Heights, New York City, had a new type of electric launch exhibited in connection with the display of the Electric Storage Battery Company. This launch was 25 ft. long and was equipped with chloride accumulators. All of the motor power in these launches is concealed beneath the floor, leaving the maximum amount of room for passengers.

The New York Car Wheel Works of Buffalo, N. Y., had on exhibition several samples of their standard wheels, including one pair of 33-in. wheels, 360 lbs., for use with Brill trucks; one pair of 30-in. wheels for Bemis trucks, and one pair of 33-in. wheels, 380 lbs., for Peckham trucks. In addition to these, a pair of wheels was shown which had been designed expressly for interurban work, where high speeds are required. J. A. Granger had charge of the exhibit, assisted by C. L. Jackson.

Elmer P. Morris, manufacturers' agent, of New York City, made an attractive display of the various electric railway supplies for which he is the agent. For the Card Electric Company of Mansfield, Ohio, he exhibited a 3-h.p. motor, type E; a 12½-k.w. type E, generator, and a 25 h.p., type S, motor, all designed for 110 volts. In addition to these he showed several types of Card automatic circuit-breakers. He also exhibited two switchboards fully equipped with the different types of electrical instruments manufactured by the Keystone Electrical Instrument Company of Philadelphia, Pa. These included a full line of volt and ampere meters and jack-knife switches. For the Simonds Manufacturing Company he displayed a number of steel gears and pinions, which were all sold during the exhibition. For the Forest City Electric Works of Cleveland, Ohio, he exhibited rail bonds and commutator bars. For the Warren Electric and Specialty Company of Warren, Ohio, he exhibited a number of different styles of incandescent lamps, including miniature lamps in all the standard sizes. In addition to this Mr. Morris showed samples of the following specialties: Insulating soldering paste of the Highland Electro-Chemical Manufacturing Company of Connellsville, Pa.; oil filters of the Kosmic Oil Filter Company of Easton, Pa.; the Sinclair automatic car coupler; lightning arresters of the Garton-Daniels Electric Company, of Keokuk, Ia.; trolley poles of the Pittsburgh Steel Trolley Pole Company, and overhead line material of the Electric Railway Equipment Company of Cincinnati, Ohio.

Broomell, Schmidt & Co., Limited, of York, Pa., manufacturers of the American fuel economizer, induced draft fans, steel tanks, stacks, etc., sugar refining and special machinery, exhibited one of their American economizers in the generating department. The machine equipped was one of this company's improved style "B," with forced water circulating device. The claims made for this economizer are that it will save from 10 to 25 per cent of the coal bill, if properly installed, the amount of saving depending upon the temperature of the waste heat gases that leave the boiler setting and enter the economizer; also upon the temperature of water with which the economizer is supplied. The higher the temperature of gases and the lower the temperature of water entering the economizer the greater will be the saving.

The Diesel Motor Company of New York City had in operation a 20 h.p. Diesel motor, coupled directly by a rigid coupling to the armature shaft of a C. & C. generator. This motor was not built for electrical work, being an ordinary 20 h.p. stationary motor, intended to run machinery by belt drive. It runs at 170 r.p.m., is a single-cylinder motor, and, like all internal combustible motors, works on the four-stroke cycle. Time was not available to change the gearing for higher speed, and the directors of the Diesel Motor Company therefore decided to try the experiment of coupling it directly to an electric light generator. The results obtained were all that could be desired, the motor carrying its load of lights with less than 1½ per cent. of variation.

The H. B. Camp Company of Aultman, Ohio, displayed several samples of its vitrified clay conduit and porcelain-lined, steel-armored insulating conduit. This company also showed in connection with the Madison Avenue electric railway exhibit its clay conduit as it appears in actual use.

The Harrison Safety Boiler Works of Philadelphia, Pa., had in operation one 6-in. horizontal Cochrane steam separator, high-pressure pattern; one 6-in. vertical Cochrane steam separator, models of separators and one 350 h.p. standard Cochrane feed water heater and purifier.

The American Engine Company, of Bound Brook, N. J., exhibited one 35 h.p. American-Ball engine, directly connected to one of its own 25 k.w. generators; also one of its own 5 h.p. multipolar motors. This engine and generator supplied a number of the lights in the exhibition hall. The engine was equipped with the new American-Ball governor. Joseph Inglesbe had charge of this exhibit.

The Kosmic Oil Filter Company of Easton, Pa., showed two of its standard oil filters. One of these filters was in operation and filtered all of the oil used in the exhibition hall. The other filter was left so it could be easily inspected by visitors. In this filter clarification takes place from below upward and not by filtration from above downward. All water is removed from the impure oil before filtration. The filtering material is a preparation of cork.

The Kensington Engine Works, Limited, of Philadelphia, Pa., showed in operation the Beeckman system of automatic undergrate mechanical draft, as applied to two 250 h.p. Babcock & Wilcox boilers, working with 175 lbs. pressure. In this system of mechanical draft the speed of the fan, and therefore the draft pressure is controlled by the steam pressure in the boiler, the engine which drives the fan slowing down to minimum speed when the pressure reaches the desired point. When the steam pressure falls a pound or a pound and a half the speed of the fan engine increases and blows the fire, thus responding very quickly to the demand of the boilers for more steam. The advantages claimed for this system are increased economy, increased efficiency and reduction in cost of repairs. In addition, this system enables the poorest grades of coal to be used with good results.

The Babcock & Wilcox Company of New York City installed in the generating department of the exhibition two boilers of 265 h.p., each complete, forged steel construction, built for 200 lbs. working pressure. These boilers furnished steam for the use of exhibitors in the hall. They were a part of a plant of 16,000 h.p. recently sold to the Metropolitan Street Railway Company of New York City for its new Ninety-sixth street power-house, and were furnished by the Babcock & Wilcox Company by special permission from the Metropolitan Street Railway Company. The Babcock & Wilcox Company also exhibited one of its forged steel headers for high-pressure work; also one of its forged steel cross boxes. These headers and cross boxes are new departures, and several advantages are claimed for them.

The Armington & Sims Company of Providence, R. I., showed in operation a 13 in. x 12 in. A. & S. engine, directly connected to a Walker generator. This engine furnished a number of lights for the exhibition hall.

The Edison Electric Illuminating Company of New York City, occupied a large space at the right of the main entrance, divided into three sections. In the first section were shown the applications of electricity to industrial and household purposes. In the second section were shown different types of arc and incandescent lamps. The third section was devoted to power, showing the advantages of direct connection. In this section were shown a printing press, book-binding machinery, direct-acting pumps, apparatus for ventilation, lathes, drills, etc. A new refrigerating plant, operated by a motor, showing the actual freezing of water, and an electric forge for welding and other purposes, were also shown.

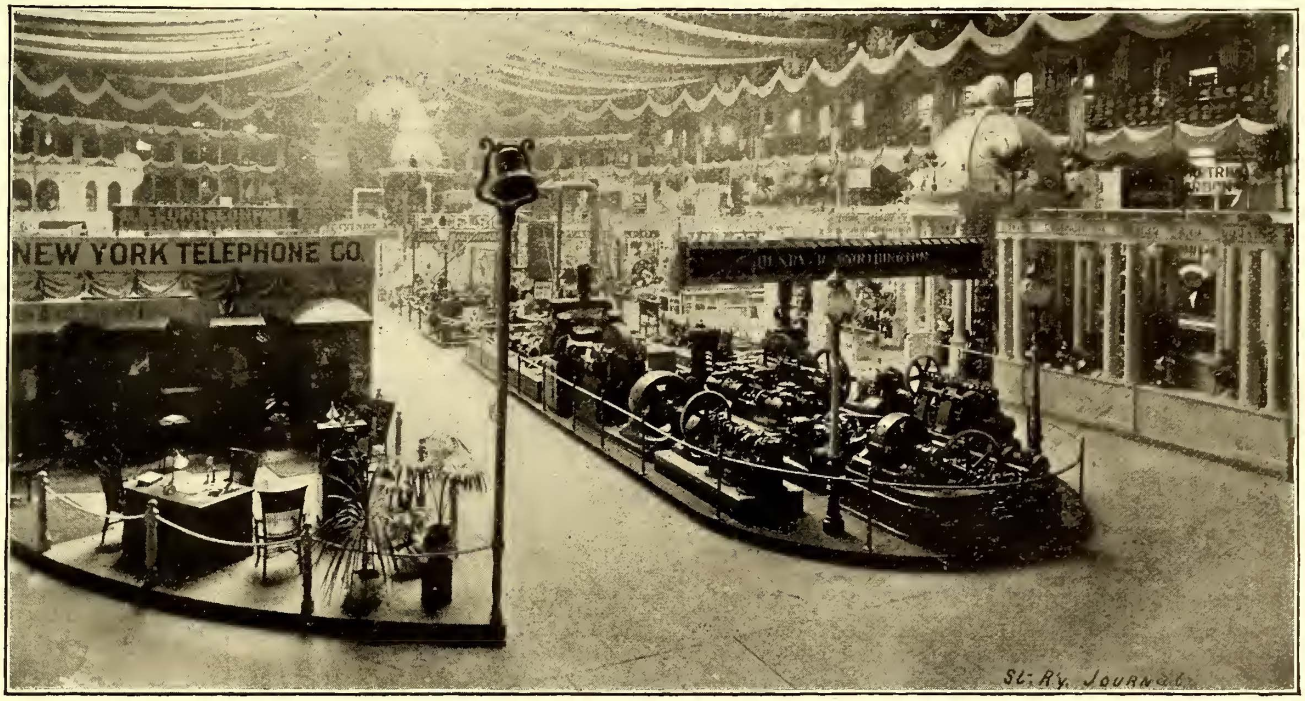
The Electric Vehicle Company of New York City had on exhibition several electric cabs and other electrically propelled vehicles, which attracted considerable attention from all visitors.

The Fuel Economizer Company of Matteawan, N. Y., exhibited one of its Green's 150-h.p. fuel economizers. The economizer was shown unpainted in order to demonstrate the quality of casting and good workmanship in the same. This company also showed its circulating device, with automatic arrangement of valves for blowing off, which is very simple, having few parts to get out of order. A sample of the sectional asbestos, which this company is using for the front of its economizer, was also shown. The piece of asbestos shown is the same grade that this company is going to use in the Cincinnati Edison Electric Station and the Milwaukee Electric Railway and Light Company's new power station, for which plants orders have recently been received for Green economizers. The Fuel Economizer Company also reports a number of recent sales to collieries, for which class of service these economizers are particularly well adapted.

The Monarch Manufacturing Company of New York City had space in the generating department, where actual demonstrations of the efficiency of the Monarch engine stop and automatic speed limit were given. These two appliances were quite fully described in the last issue of the "Street Railway Journal." This company's space was almost constantly filled with an interested crowd of gentlemen, many of them owners of steam plants of various kinds

exhibition a swing bolster swivel truck, type 14B with 4 ft. wheel base. This truck was one of an order for forty now being built for Buenos Ayres, Argentine Republic. This company also had on exhibition three handsome aluminium models of its No. 14 swivel truck, No. 14 A swing bolster truck and No. 14 D swing bolster maximum traction truck. A "Metropolitan Special" Peckham truck was also shown in operation under a Stephenson car on the section of Walker conduit electric railway, and in the Walker Company's space were shown one Peckham Excelsior 7B truck and a maximum traction swing bolster truck, type 14D, with Walker motors mounted. There was also shown a model of Peckham's Broadway truck under the miniature Stephenson car at the main entrance.

The Partridge Carbon Company of Sandusky, Ohio, through its New York agents, Wood, Shaw & Co., made a very attractive display of the well-known Partridge motor, dynamo and generator brushes. The brushes shown were all of the standard sizes and shapes for the principal makes of dynamos, generators and motors. These goods are very extensively used, and the claims of the manufacturers that there are no bettter brushes than the Partridge brush made at the present time are well supported. This company has recently placed on the market a new electric light carbon for enclosed arc lamps, which is arousing considerable attention and interest among electrical men. It is stated that the



VIEW OF ELECTRICAL EXHIBITION FROM MAIN ENTRANCE

in and near New York, who were greatly pleased at the practical demonstrations given of the ease and rapidity with which an engine could be stopped with the Monarch safety device by simply pressing a push button from any part of the engine room.

The Electric Storage Battery Company of Philadelphia, Pa., had its space well occupied with storage batteries of various styles. One battery of giant accumulators was particularly noticeable. These accumulators are of a type used in Chicago, and in the Brooklyn Edison illuminating station. Some of the cells can give 2000 amps. for one hour and the others 6000 amps. for one hour. This company also showed batteries for welding and electrotyping and samples of special large cells. A large X-ray machine giving a spark nearly twelve inches long, was shown in operation, and attracted a great deal of attention on account of the interesting experiments which were carried on each evening.

The Sprague Electric Company of New York City had one of the most extensive exhibits in the show, and in addition showed samples of its different apparatus throughout the hall in exhibits of other companies. Among the apparatus shown may be mentioned electric elevators for house and other purposes, Lundell dynamos and motors, exhaust fan outfits, dental outfits, Lundell-Quimby pumping outfits, printing press outfits, organ-blowing devices, cab motors and controllers, fan motors, interior conduit wiring material, etc.

The Peckham Motor Truck and Wheel Company of Kingston, N. Y., occupied a space on one of the main aisles, where it had on

American carbons previously in use for this purpose are objectionable on account of the excessive dust deposits they cause on the inner globe, which necessarily reduces the quantity of effective light. J. S. Partridge, president of the Partridge Carbon Company, has been working for several years in an endeavor to solve the problem, and the new electric light carbon is the result of his experiments. He has succeeded in producing a carbon that he claims to be in every respect equal to the imported carbons and far superior to American goods heretofore produced. Extensive tests of these carbons have been made by several different companies, and the results are exceedingly gratifying to the manufacturers. Mr. Partridge had charge of the exhibit at the electrical show.

The Weston Electrical Instrument Company of Newark, N. J., in addition to the various types of its electrical instruments, which were shown on the different switchboards in operation throughout the exhibition, had a space where a full line of its instruments was displayed. These instruments included electrical measuring instruments for portable, stationary and laboratory use, volt meters, ampere meters, watt meters, etc.

The Adams-Bagnall Electric Company, of Cleveland, Ohio, exhibited enclosed and open arc lamps for all kinds of circuits. This company is one of the few manufacturers making a lamp designed for an electric railway circuit.

The Berlin Iron Bridge Company of East Berlin, Conn., through its New York office, arranged one of the most attractive exhibits in the building line at the exhibition. This company built a complete roof, composed of its patent anti-condensation fireproof lining, showing the pleasing and satisfactory result this lining gives on a power house or any other building in which condensation or dripping from the corrugated iron roof covering is apt to occur. This roofing consists of two layers of special corrugated paper laid immediately under the corrugated iron. To protect this paper from fire two layers of asbestos paper are placed below it on the inside. In both cases the top layer of paper and the asbestos paper are well lapped and laid with broken joints. To support both the top layer of paper and the asbestos from sagging between the purlines, or points of support, and to hold them tightly against the corrugated iron covering, one course of galvanized wire is used, this latter being tightly stretched over the purlines.

The J. G. White Company, of New York City, installed the subway in connection with the Walker electric conduit exhibit. The subway showed a section of 6-duct and 9-duct vitrified clay conduits, as they would appear when installed for actual operation. The principle feature of this installation was that one section of the clay conduits was left entirely unsupported by concrete, and yet was strong enough to support a weight of something over one ton. The 18-in. sections of the conduit were laid as brick is laid, with broken joints.

The American Electric Heating Corporation, of Boston, Mass., arranged an exhibit that was particularly attractive, especially from a popular point of view. In addition to its well known types of car heaters this company presented a large variety of other heating devices for domestic and manufacturing uses. Electric cooking apparatus, stoves, ovens, flat irons, tailors' irons, hatters' irons, glue pots, bicycle tire vulcanizers, etc., were shown, many of them in actual operation, and crowds gathered to examine them and to eat the biscuits and drink the tea which were freely served to all who cared to partake.

The McGuire Manufacturing Company, of Chicago, Ill., exhibited a McGuire truck of the Metropolitan Elevated type, in connection with the Walker exhibit.

The Standard Air Brake Company, of New York City, had one of its motor compressors in operation in connection with the exhibit of the Excelsior Electric Company.

The Walker Company displayed an extensive exhibit in a large space near the center of the main floor. In one corner was a No. 20 L equipment mounted on a truck. This is the type of equipment that is to be supplied to fill the Brooklyn L contract. Immediately adjacent to this was another truck, on which was mounted one of the Walker No. 3 equipments. This truck was blocked from the floor, leaving the motors free to operate. A solenoid blow-out controller was employed to distribute the current to these motors and the case of the controller was removed to show how effectively this device blows out the arc. This controller was industriously manipulated both by visitors and representatives of the Walker Company, and though some of the contacts had to break considerable current, there was not the faintest trace that they had ever seen service. On an adjacent table were displayed a number of parts which showed to very good advantage the substantial construction of the type S controller. A 50-k.w. Walker alternator of the revolving field type completed the list of heavy machinery exhibited. Another interesting addition to the exhibition was the new Walker intergrating ammeter. It is claimed that this is the only direct reading ammeter on the market which is adapted for continuous currents and registers ampere hours. Two powerful permanent magnets are provided which influence the thin copper disk rotating between them. On the surface of this disk are mounted three coils, each having a common connection in the disk itself, and presenting their free ends to a long three-part commutator of small diameter. On this commutator rest three broad copper brushes. The contact that the brush makes with the commutator, while extremely persistent, is surprisingly light. The friction is negligible. James S. Anthony was in charge of the exhibit.

SPECIAL EXHIBITS.

S. H. Short, vice-president of the Walker Company of Cleveland, Ohio, made a personal exhibit of a pioneer electric street-car motor, with underneath contact, used in Denver, Col., in 1885.

The Moore vacuum tube system of lighting was shown in operation in connection with a prettily designed chapel. This system of lighting is the invention of D. MacFarlan Moore, and has now been brought to an advanced state of perfection. The color of the light is such that it is invisible in daylight, thus proving the similarity of the two, and the temperature of the tubes is that of the room; that is, it is practically light without heat. The current for this exhibit was taken from the street mains of the Edison Electric Illuminating Company.

A model of a third-rail electric system for interurban work was shown in actual operation and aroused considerable curiosity. This model exhibited the operation of the third-rail system as in use by the New York, New Haven and Hartford Railroad Company on its branch line between Berlin, New Britain and Hartford. The model was nearly 60 ft. in length. It was furnished by H. V. Parsell, Jr. Several details of apparatus as used in the actual working of the road were also shown through the courtesy of Col. N. H. Heft, in charge of the electrical department of the N. Y., N. H. & H. R. R. Co., at New Haven, Conn.

New Route to Coney Island

The Sea Beach Railroad, formerly operated as a steam line between Bay Ridge Dock (Sixty-fifth Street) and Coney Island connecting with New York City via a ferry line from Bay Ridge to foot of Whitehall Street, has been purchased by the Brooklyn Heights Railroad Company, which operates the largest street railway system in Brooklyn. The road, which formerly ran through the tunnel under the tracks of the Brooklyn Heights Railroad Company at Third Avenue and Sixty-fifth Street, has been connected at that point by an incline curve walled in masonry. The dock property at Sixty-fifth Street has been overhauled, and it is the purpose of the company to put this terminal in first-class shape and ready for summer business. Arrangements are now being made with the Staten Island Rapid Transit Company to operate the ferry line between South Ferry, New York, and this point, and the question of reducing the rate, which had formerly been a 10-cent rate, is now being considered. In this case the trip from South Ferry to Coney Island will be absolutely the shortest route to that world-wide famous resort, consuming only forty minutes of time, including a delightful sail down the harbor and a quick country trip by rail, as against sixty minutes by any other route. The management of the Brooklyn Heights Railroad have promised, in the event of the rate being reduced to 5 cents by the ferry company, to establish new lines direct from Sixty-fifth Street dock through the Bay Ridge, Fort Hamilton, Dyker Meadow, Bath Beach, Bensonhurst and Ulmer Park territory, giving the regular commuters of that section a decided advantage over their present method of transportation to business. In addition to the regular ferry business from New York arriving at this dock from the special excursion steamers from Newark, New Brunswick, Perth Amboy and South Amboy and points up the Hudson and up the Sound touching here throughout the season with passengers for Coney Island. From the dock to Coney Island the roadbed has been resurfaced and thoroughly repaired with new ties and a new T rail and equipped with the overhead trolley system of electrical propulsion. One hundred and fifty new open cars of the largest double truck type have recently been purchased from the John Stephenson Company to aid in handling this traffic more conveniently and expediently. With the new connections via Brooklyn Bridge to Park Row, New York, giving through service to Coney Island, and by its liberal transfer system from all parts of Brooklyn, people of all classes can now reach the shores of the Atlantic from greater distances and more cheaply than ever before. The new terminal at Coney Island, which has been laid out on a large area of ground adjoining the Sea Beach Palace, has been especially arranged with a view of handling large crowds with as little confusion as possible under such circumstances. There are loops arranged to handle the general business at Brooklyn and New York, straight spurs of track with long landings where trains of any length can be made up for special excursions for New York patrons going via Bay Ridge ferry. Shade trees have been set out and a lawn grown, which, with park benches, make a very presentable terminal. The line was opened on May 20 by a special party made up of officials of the company and representative New York newspaper men. Three of the special cars of the company were taken to Park Row, New York, and the trip to Coney Island was made in fifty-five minutes, somewhat more than the regular running time when the line is in operation. After a stroll through the Bowery the return was made direct to Bay Ridge and thence by boat to New York. On the return lunch was served on board the buffet parlor cars, and the party was taken by special steamer from Bay Ridge to New York.

Two Westinghouse 12-A 25-h.p. motors were placed on the heavy Taunton snow plows of the Milford, Holliston and Springfield (Mass.) Railway early in the winter. The superintendent of the railway, G. B. Larrabee, reports that during a very severe winter, in which the heaviest storms were encountered that have occurred for several years, the motors never caused a stoppage nor were guilty of a burn-out. During the heaviest storm the motors were only normally warm. These motors were of the ordinary standard Westinghouse type.

NEWS OF THE MONTH

The Chester Traction Company of Chester, Pa., has recently devised a set of questions which must be answered by the person endorsing an applicant for work with the company. Among the questions are the following: "Can you vouch for the applicant's honesty and truthfulness? What is his reputation in the community? Is he industrious and reliable? Does he use intoxicants? Has he ever tended bar? Is he loud mouthed or profane? Has he ever been placed under arrest? What do you know of his associates? Can you recommend him as worthy of the confidence of this company and one to whom the care and welfare of its patrons may be safely entrusted?

The Bergen County Traction Company of Fort Lee, N. J., has under consideration the advisability of equipping its cars with a device for carrying bicycles.

The Lewiston & Auburn Electric Railway Company has purchased a number of interesting animals which were used at the Sportsmen's show in Boston. The collection includes jackals, deer, moose and prairie dogs, and will be placed in the company's street railway park.

The Omaha Street Railway Company of Omaha, Neb., is making a number of changes and additions to its plant in order to be prepared to handle the large crowds that are expected at the coming exhibition to be held in that city. Six new boilers and new engines and generators are being installed in the power house.

The Chicago City Railway Company, of Chicago, Ill., is to equip its cars with a new sign for designating the different routes. The signs will be made of white celluloid, painted with black letters, and will be set in small frames on the decks of the cars. The signs are so arranged that the light from the inside of the car will shine through them at night.

The Exeter Street Railway Company of Exeter, N. H., has decided to build a casino at the terminus of its line. The building will be 210 ft. x 110 ft., practically three stories in height, and of pleasing design. It will contain a theatre with seating capacity of 1,000, a dancing hall that will seat 300, 85 bath dressing rooms, four bowling alleys, a billiard hall, bicycle check room, etc. It is expected to have the casino completed by July 1.

The first international electric railway to be operated on the Canadian border will probably cross to New York State over the new steel arch bridge now being built over the Niagara gorge at Niagara Falls to replace the upper suspension bridge. It will be built by the Niagara Falls Park and River Railway Company, which company has secured a lease of the electric road rights across the new steel arch, and will run its cars across the bridge to the New York State side.

The Union Traction Company of Philadelphia, Pa., has recently issued an exceedingly attractive souvenir of Willow Grove Park, one of the most popular resorts in the vicinity of that city. The book is explanatory of the very many and varied attractions of this park and is handsomely illustrated.

Every car on the Paterson (N. J.) Street Railway that left the shed recently was decorated with American flags at each end. Several patriotic motormen and conductors had already arrayed their cars with the national emblem, and then the railway company took the matter in hand and supplied flags for all the cars.

The Fair Haven & Westville Street Railway Company of New Haven, Conn., has begun a crusade against the offensive habit of expectorating on the floors of its cars. Conductors have been provided with little printed slips, and whenever a passenger is detected in violation of the rule the conductor quietly hands him one of the slips. The slip reads as follows: "Passengers are respectfully requested to refrain from expectorating on the floor of the car." It is thought that this method will be more effective than the usual placard, as it calls the attention of the offender more forcibly to the regulation.

The Cataract Power & Conduit Company of Buffalo, N. Y., has recently published the schedule of rates of charges for electric power which it has adopted. These rates have been decided upon after receiving the opinion of several electrical experts and after careful investigation. It is the company's aim to furnish to all who may desire to use electric power in Buffalo and vicinity, the advantages of cheap power supplied under a definite and absolutely invariable schedule of eharges, so adjusted as to impose upon eaeh user a charge equitably proportioned to the service rendered, and to secure to the city of Buffalo as a whole the full advantages which should result from her proximity to the great water power at Niagara Falls. The charge for power will depend upon the actual amount used, as determined by standard metres installed by the conduit company upon the premises of the consumer. These meters record the number of electrical units which are actually taken by the eonsumer. The standard electrical unit of power is the kilowatt hour, equivalent to about 1 1-3 h. p. hours, the charge for power to be determined by the record of the meter and by calculation upon the following schedule:

No. of units. Rate per unit.

Not exceeding 1,000.......... $.0200

Exceeding.	But not Exceeding.	.0200 for 1,000 units, and for the excess...$.0150
1,000	2,000	.0150 " 2,000 " " " ... .0120
2,000	3,000	.0120 " 3,000 " " " ... .0100
3,000	5,000	.0100 " 5,000 " " " . . .0080
5,000	10,000	.0080 " 10,000 " " " ... .0075
10,000	20,000	.0075 " 20,000 " " " ... .0070
20,000	40,000	.0070 " 40,000 " " " ... .0066
40,000	80,000	.0066 " 80,000 " " " ... .0061
80,000		

The first funeral ever held on the lines of the street railway company in Oswego, N. Y., occurred on May 11. The casket was carried from the house to a funeral car, and then the mourners and friends boarded three other cars in waiting. The funeral procession moved slowly over the railway line to a point near St. Paul's Church, to which the attendants walked from the cars. After the church service the cars were again boarded and proceeded to St. Paul's Cemetery. It is thought that the funeral car will become a regular feature of the railway service.

The motormen and conductors of the Brooklyn Heights Railroad Company have been supplied with new blue uniforms and hats with gold braid. This company has also adopted the "service stripes" system for its employes.

It is stated that the Detroit Railway Company has been compelled to reduce the wages of all employees on its lines from 21 cents an hour to 18 cents, on account of the reduction in the gross receipts of the company during the past year. A strike is threatened.

Electricity as Applied to Heavy Electric Railroading

An interesting lecture with this title was presented May 26 in the auditorium at the Electrical Exhibition, by S. H. Short, of the Walker Company. Mr. Short carefully reviewed the results which have been secured in heavy railroad work by electricity as a motive power, and the reasons for its substitution for steam in different localities. The subject of the application of electricity to elevated railways, to which Mr. Short has during the last two or three years paid a great deal of attention, was thoroughly discussed, and some particulars were given of the motor recently designed by him for use on the lines of the Brooklyn Elevated Railroad Company. This motor was illustrated and described in a recent issue of the "Street Railway Journal," and has shown in practice to have an efficiency of 92 per cent.

Mr. Short is a leading authority on the subject covered by the lecture, and the New York Electrical Society, under whose auspices the lectures were held, was especially fortunate in securing his services for the occasion. An interesting commentary on the advance made in the design of electric apparatus was afforded at the Exhibition by the fact that in one part of the building in which the lecture was given was shown as an exhibit of the first experiments in electric railroading, one of the cars built and operated by Mr. Short in 1885. The lecture was largely attended and illustrated by many stereopticon views.

International News Notes

The Borough Engineer (Mr. James Bower), of Gateshead (Eng.), has issued a report with a map, showing the streets through which the British Electric Traction Company has offered to lay lines in addition to those now worked by steam traction, and also the suggestions of the members of the committee appointed to consider the question.

At Aberdeen (Scotland) the progress of the Tramways Bill, promoted by the Town Council, excites no little interest. The preamble of the bill has been passed. The only opposition from the citizens was caused by a clause throwing any deficiency of income arising from the undertaking onto the city rate; and this seems to be fizzling out.

Constantinople will have to do without electric traction yet awhile, as the Sultan refuses to permit its employment by the City Tramways Company.

The Government has approved of Johannesburg Tram Company extending its service to the suburbs, and has made arrangements by which the company will convey mails from the suburbs to the central post office.

At Birmingham (Eng.) the question of halfpenny stages is raised, but unless electric traction is permitted by the Corporation instead of the present steam haulage, the Tramways Company does not see its way to making the desired change. The company has paid 5 per cent dividend and carried £33,773 to reserve, as the result of last year's working.

The question of tramways still absorbs the attention of the Bristol (Eng.) Corporation, which, before giving permission to the Tramways Company to extend its system, wishes to fix a date for the purchase of the whole undertaking, instead of having to buy portions of the line at different times, as it would have to do as the matter now stands. A draft agreement has been drawn up and will be submitted to the Council, fixing the date at which the corporation may first exercise its power of purchasing the whole of the company's undertaking at seventeen years from the first of May, 1898, or at subsequent periods of seven years from that date. The introduction of the overhead trolley system is also authorized. It is to be hoped that the Council will adopt this agreement, as the subject has been debated for two years.

The Great Cema Tramway (Wales).—The unopposed bill for the construction of a tramway from Llandudno up the Great Cema came recently before the Earl of Morley, chairman of committees of the House of Lords. The line will be about a mile in length. It starts in Church Walks, Llandudno, and goes for half a mile along the public road to the iron gate, and thence over private land to a point close to the old telegraph house. The cost, including purchase of land, is estimated at £20,000, and the share capital authorized by the bill is £25,000. The plans have been prepared by A. E. Taylor, of Chester, and the preamble was proved by W. Johnson, solicitor to the company. Clauses to give effect to an agreement with Lord Mostyn, whereby the lord withdrew his opposition, were submitted. The bill passed the Lords, and on April 5 complied with standing orders, and was sent for second reading in the House of Commons.

Cable Trams for Leith.—A scheme is before the Town Council. Mr. Colam, C. E., who was called in to advise, has submitted a report on the construction and equipment of the necessary works. The total cost of the conversion of the tramway lines and their equipment, with all necessary pits and machinery, is estimated at about £45,000—that is, assuming that new rails and granite sets would be required throughout.

At Liverpool great interest is manifested in the new electric tram system now under discussion. The work will be commenced shortly, but so far the only contracts given have been for bonding, poles and overhead wire, which have been placed with Robert W. Blackwell, London and Liverpool.

Plymouth (Eng.) has in prospect a partial provision of electric tramways on the overhead system. The Mayor has just laid the foundation stone of the municipal station, from which electric energy will be furnished both for lighting and traction. The Corporation hopes some day to take over the tramways; meawhile it wants the company to pay a percentage of profits as "way-leave." Seventeen years hence is when the Corporation can buy the system, but the company says it cannot pay way-leave unless it gets a longer lease.

The Vienna Tramway Company's business, which two years ago was a source of anxiety, has been prudently transferred to the syndicate of the German Bank. Recently the shares have fluctuated considerably, but Dr. Luegar has returned, and it must soon be known what solution of the tramway question Vienna will adopt. Electric traction is seriously contemplated. Doubtless this is due to the large expansion in working expenses, mainly due to shorter hours of work and increased wages. It is estimated that the provisional expenditure in connection with the substitution of electric for horse traction will amount to 600,000 florins.

The Costa Rica Electric Light & Traction Company has been formed with a capital of £260,000, composed of £130,000 in ordinary shares of £1 each, all of which are taken by vendor, and £130,000 in 5 per cent first debentures issued in bonds of £50 and £100 each, at 90 per cent. The brokers are Messrs. Leonard, Clow & Company, London.

At last the Bristol Corporation has decided, by 36 votes to 30, to allow the extensions and electrical power bills to proceed and have withdrawn their opposition, excepting as to the proposed fares. The tramways company is content to run the risk of Parliament increasing instead of reducing the fares. There is a provision by which the Board of Trade can revise tramway fares if the dividends rise above a certain limit. Bristol can confidently expect a fairly complete system of electric trams within about two years' time. The company has purchased extensive premises and orders for the plant, etc., will be placed forthwith.

A Handsome Catalogue

The Johnson Company, of Lorain, O., has recently published its catalogue for 1898, entitled Catalogue No. 11. It contains sections of the company's standard types of rails, fine half tone views of its different forms of special work and special appliances, such as transfer tables, derailing switches, etc. Views are also given of the Dupont truck. The catalogue is very handsomely printed.

The Coming Electric Light Convention

The National Electric Light Association will hold its twenty-first annual convention at Chicago, Ill., during June 7, 8 and 9, 1898. The membership of this association includes the leaders in the central station field and the attendance at the convention comprises, in addition, a full representation of the manufacturing and supply interests, as well as a large number of engineers and electricians, attracted by the programme of technical papers. These papers will be unusually interesting this year, and very valuable discussions are expected. An exhibition of electric light apparatus will also be held.

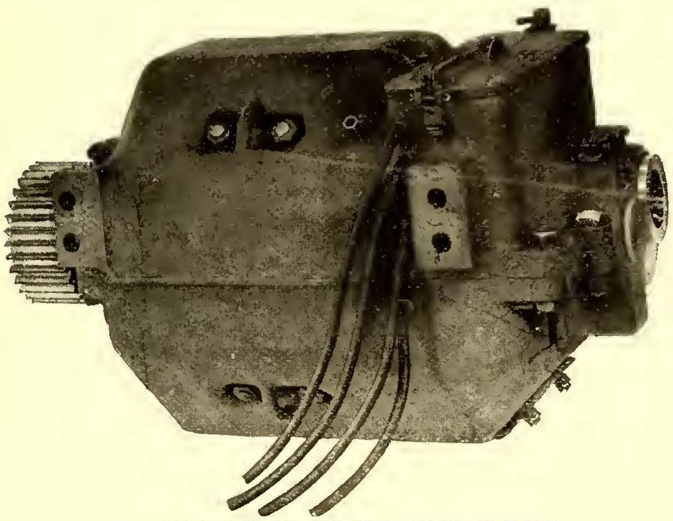
Change in the Time of Meeting of Pennsylvania Street Railway Association

The American Street Railway Association having selected September 7 and 9 as the time for its annual meeting, which would be the regular time for the convention of the Pennsylvania Street Railway Association, the latter association, in order to avoid a conflict in dates, has changed the time for its meeting to October 19 and 20.

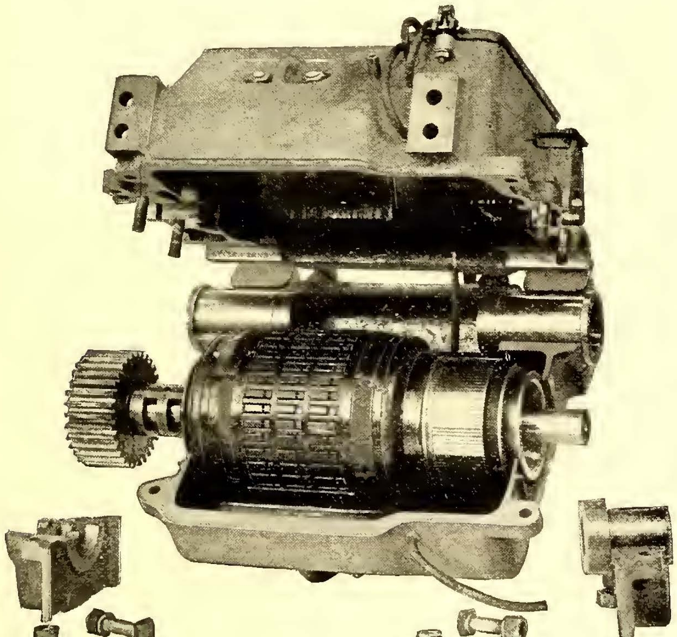
The G. E. 51-B. Motor

The General Electric Company announces the development of a railway motor especially adapted for medium heavy railway work, under the designation of the G. E. 51-B. It is the outcome of a series of exhaustive tests on cars and locomotives with heavy trains propelled by electric motors on steam train schedules, and the complete and reliable data thus obtained has been used to determine the best form of construction necessary to meet the requirements.

This motor has been especially designed for high speed suburban and elevated railway work. It has a capacity of 80 h.p. based on a rating of 75 deg. C. rise in temperature of the windings above that of the surrounding atmosphere after one hour's run at rated load. A double G. E. 51-B motor equipment, with the gear ratio of 2.27 will pro-el a loaded 20-ton car at a maximum speed of 26 miles an hour on a level track. Higher or lower gear ratios may be used for different speeds; that is, with the speed reduced one-half, the motors will handle a car or train twice the weight.



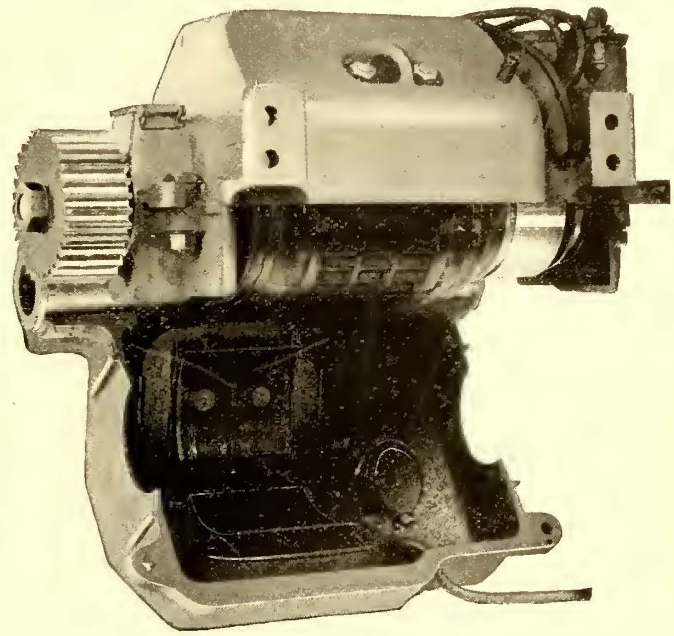
FRONT VIEW OF MOTOR—CASE CLOSED



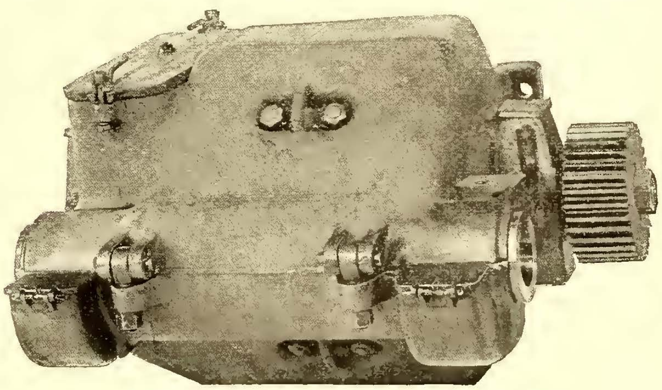
MOTOR WITH ARMATURE DROPPED FOR REMOVING

The frame of this motor is of cast steel made in two bowl-shaped halves bolted together. It completely protects the working parts of the motor from mechanical injury and the action of water or dust. The upper casting has a large opening to allow of the inspection of the commutator and brush holders, and the replacement of the brushes. This is covered with a dust-proof cover plate, easily removed by turning a cam-locking device. A hand hole, also fitted with a weather-proof cover plate, let into the lower frame at the commutator end, facilitates the removal of any foreign substance in the bottom of the motor.

The motor has four laminated pole pieces with projections supporting the coils which are slipped over them. They are secured by bolts passing through the frame and fastened with nuts on the outside. The bearings have been given ample proportions to insure good lubrication and long life. The upper support of the linings of the armature bearing is part of the upper half of the motor frame; the lower support is a cap bolted to the upper support. The armature can thus be held in the upper half of the motor, while the lower half only is lowered. To remove the armature it may be lowered with the lower half. The cored recess between the inner ends of the lining and the motor frame is occupied by a combination thrust collar and oil guard, an open space at the bottom being left to give free outlet to oil or grease. With this construction it is impossible for oil or grease to work its way into the motor or come into contact with the windings. The upper supports of the linings are provided with large grease boxes, and the lower are cored, leaving a recess for the oil. Felt wicks or wipers come in contact with the shaft through openings in the lining, and convey a continuous supply of oil to it. The linings of the armature bearings are cylindrical in form, made of cast iron and babbitted, and are held in place by dowels in the lower support. The axle-bearing linings are held in place by the upper and lower halves of the frame, extending back and enveloping the car axle. They are made of composite-bearing metal lubricated by oily waste held in an oil well and pressed against the outside of the axle by a leaf spring. The dimensions of the armature bearing are, commutator end, 6¾ ins. x 3 ins.; pinion end, 9½ ins. x 3¼ ins. The axle bearings are 9 ins. long, with diameter corresponding to the size of the axle.



MOTOR WITH LOWER HALF OF CASE DROPPED FOR INSPECTING



REAR VIEW OF MOTOR—CASE CLOSED

The field coils are of copper ribbon wound on metal spools and insulated between turns with asbestos. The coils are thoroughly insulated from the spools with specially prepared mica, canvas cloth and press board. After the windings are in place the canvas is brought over and sewed, completely inclosing and protecting the coil. The whole is then given a heavy coating of weather-proof insulating compound. For convenience in car wiring, and to facilitate opening of the motors, the connections between the upper and lower fields are made on the outside of the motor, and both field and armature leads are brought out at the front.

The armature is of the iron-clad, hollow-core type 16 ins. in diameter and 10½ ins. long. The core is built up of well-annealed laminations provided with ventilating ducts, as in the armature of the G. E. railway generators, the laminations being assembled directly on the shaft and not on a separate spider. The core has thirty-seven slots, each slot containing three insulated coils laid together in one compact unit. This gives the armature thirty-seven sets of coils with 111 leads, corresponding to the number of bars in the commutator. All coils are formed and insulated before application to the core, the small number facilitating repairs, while the method of grouping them permits the use of substantial insulation. This is of the highest grade, and shipment of armatures poorly insulated is prevented by giving each a thorough test with 2500 volts alternating.

The pinion is made of cast steel with machine-cut teeth, and bored for a taper fit on the armature shaft. Both gears and pinions are made at the General Electric Company's gear plant at Lynn.

The commutator is 11⅝ ins. in diameter, with 111 segments built up with alternating layers of mica insulation and securely clamped on a malleable iron shell. The segments are of the best hard-drawn copper 6⅛ ins. long with a wearing depth of 1 in. The mica cone insulations used in assembling the commutator are built up and compressed into moulds, making them hard and compact, and the mica between the segments is especially selected with a view of giving it a degree of hardness that will make it wear evenly with the copper segments. To insure perfect insulation, every commutator is tested with 500 volts direct current between adjacent segments, and 5000 volts alternating between the segments and the shell.

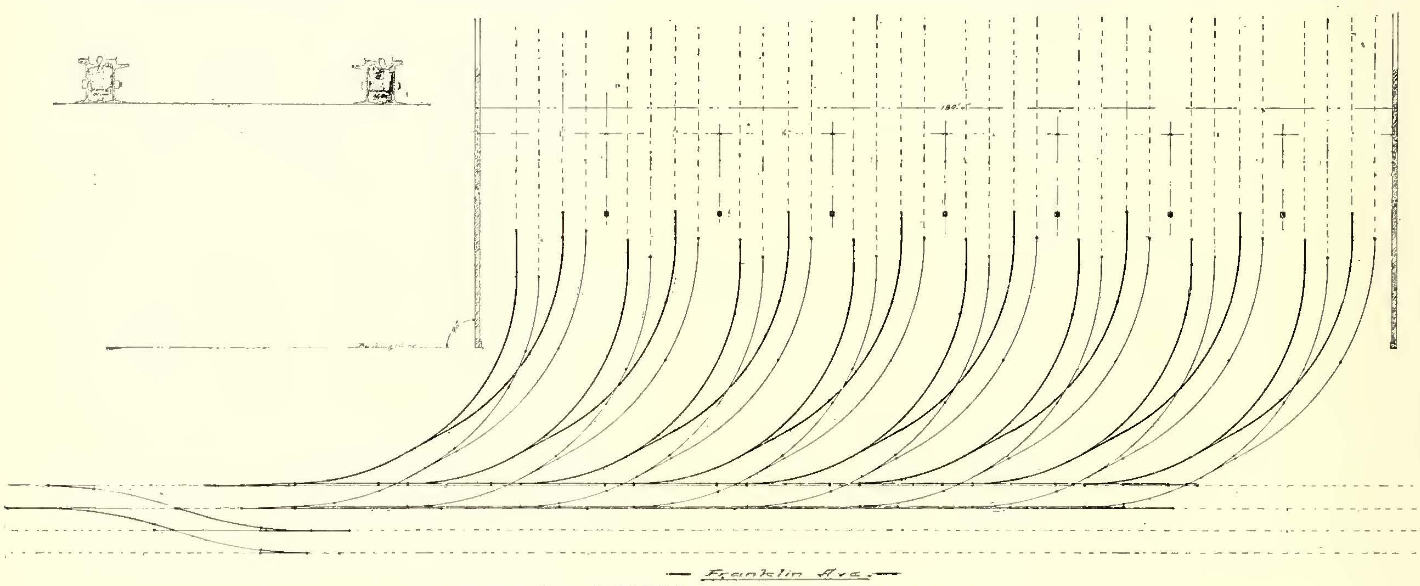
The brush holders are of cast brass, and each is arranged to hold two carbon brushes which slide in finished ways and are pressed against the commutator by independent pressure fingers, giving a uniform pressure throughout the whole working length of the brushes. The brush holders are off-set ¼ in. to prevent the wearing of grooves in the commutator, and are clamped to a well-seasoned hard-wood yoke filled with moisture-proof compound bolted to the top magnet frame and easily removable through the opening over the commutator.

Mounted on 33-in. wheels the clearance between the bottom of the frame and rails is 3 ins. That between the bottom of the gear case and rail is 4 ins.

A Large Piece of Special Work

An interesting piece of special work has recently been laid by the Coney Island & Brooklyn Railroad Company, of Brooklyn, N. Y., at the entrance to its Franklin Avenue car house on Franklin Avenue, near Bergen Street. It was the desire of the company to have the main line unbroken except at one switch, so that the track has been gauntleted for sixteen curves leading into the car house. A plan of the whole work, as well as a section of the main track and the auxiliary track, are shown in the accompanying engraving. The two tracks are firmly bolted together every 4 ft. with cast iron fillers or spacing blocks, which bind the two rails together, and the rails are spiked on the outside. The frogs crossing the main track are elevated on a curve sufficient to allow the cars to pass over the main track while running on the curve, thus giving the continuous service required on the main track.

This piece of special work was supplied by the New York Switch and Crossing Company, of Hoboken, N. J., and is made throughout of 9-in. rail with chrome steel centers, and bound together with cast iron. It is the intention of the railway company to continue this system of curves shown to the extent of six more. To allow for this extension, the last switch, mate and frog are so arranged that the additional curves can be placed in position without removing any of the present work.



LARGE PIECE OF SPECIAL WORK—BROOKLYN, N. Y.

Correspondence School of Electrical Instruction

The Electrical Engineer Institute of Correspondence has recently been incorporated, with Joseph Wetzler as president, T. Commerford Martin as vice-president, and H. A. Strauss as secretary and general manager, to give instruction in electrical engineering by correspondence. The school has an excellent corps of instructors and is organized to teach all branches of electrical engineering to those whose time and circumstances will not permit their attendance at a regular university. The school will be under the immediate direction of the publishers of the "Electrical Engineer," which is sufficient guarantee of the thoroughness and desirability of the instruction given.

Electric Railway at Algiers

A new electric railway at Algiers, installed by the French Thomson-Houston Company, was put in operation during April. The system has a length of 7.3 k.ms., and extends through the main portions of the city. The line has a number of steep grades and sharp curves. There are eighteen single-deck motor cars, with forty places each—ten first-class and ten second-class within the car and twenty on the platforms. The cars are equipped with General Electric No. 53 motors. The gage is 1.055 m.

The power station has a capacity of 700 h.p., and contains three tubular boilers, with 213 sq.m. of heating surface, and each able to produce 2500 k.g. of steam per hour. The engines are of the Creusot-Corliss type. They run condensing, have a capacity of 350 h.p. each, and operate at 65 r.p.m. They are two in number and each is belted to a 200 k.w. M. P. generator.

A car on the electric line of the Seattle (Wash.) & Rainey Beach Railway was held up on the night of April 30 by three masked men, and the crew and sixteen passengers were relieved of about $150 in cash and six or seven watches.

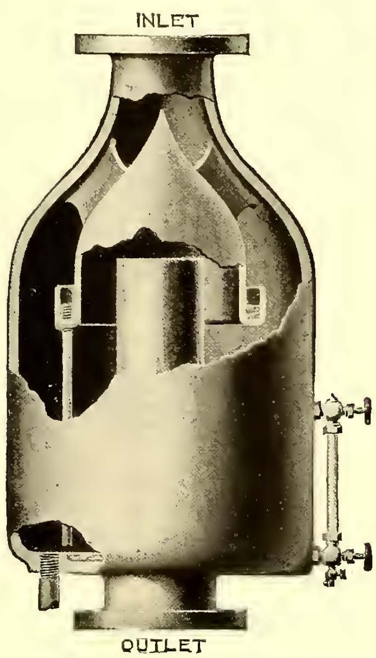
New Steam Separators

The Hoppes Manufacturing Company, of Springfield, O., has placed upon the market a new separator having several points of interest. As shown in the accompanying cuts, these separators are made for either vertical or horizontal pipes, and the principle employed in each is essentially the same.

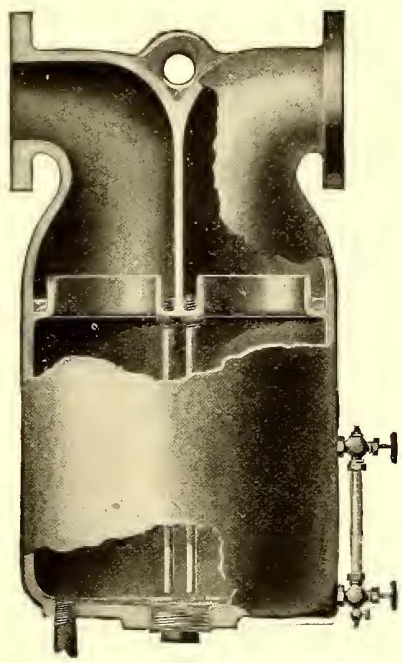
The object of the designer of this separator has been to secure as great efficiency as possible in the separation of the entrained water from the steam with the least possible obstruction to the flow. With this object in view, an effort has been made to keep the interior of the separator as smooth as possible, and all sharp corners or depending ledges have been avoided, as these not only add friction, but, worst of all, the entrainment would be blown from them by the force of the current sprayed into the steam and add saturation.

As will be seen, the steam inlet gradually enlarges into a steam chamber of ten times the area of the pipe, and is then gradually reduced to the original area. No baffle plates or other obstructions are employed and the steam is not required to take on any centrifugal, zigzag or other tortuous motions in its passage through the separator.

The principal feature of this separator, however, is the interception of the entrainment by gutters which are kept partially filled with water. It has been found that by keeping these gutters or



VERTICAL TYPE OF SEPARATOR


HORIZONTAL TYPE OF SEPARATOR

channels thus partially filled all the entrained water or oil is effectually cut off, the channels being arranged to guard both the inlet and outlet. The excess entrainment caught by the gutters is carried to the bottom of the separator by a small pipe or pipes, as shown in the cut.

In the vertical separator the steam enters at the top, and all the entrainment following the interior surface will pass along the surface to the bottom of the separator and be intercepted by the water at the bottom. The water or oil in the steam which is not following the surface will strike the exterior of the cone in the top and spreading over its surfaces will be caught by the gutter at the bottom of the cone and be carried to the bottom of the separator by a pipe provided for that purpose. In the horizontal type the steam may enter at either side, both being alike. As the steam enters it passes one of the gutters, and as it ascends on the other side it passes the other. All entrainment is caught by the gutters and carried to the bottom of the separator, from which it is trapped in the usual manner. This company also manufactures separators and receivers of large dimensions built on the same plan as the separator. It also manufactures oil eliminators and grease extractors for exhaust steam. All separators for pipes above 8 ins. are made from flange steel, as are also the combined separators and receivers.

The postal authorities have decided to use the Haverhill & Amesbury Street Railroad to carry the United States mails between Haverhill and Salisbury Beach.

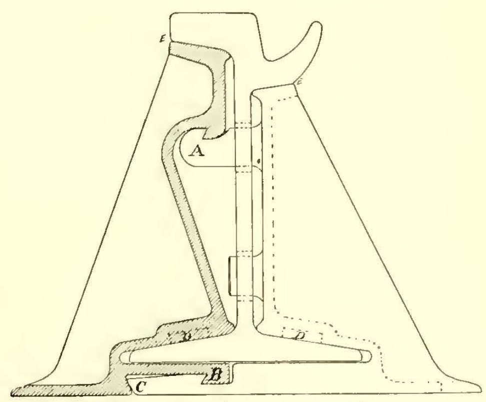
The American Railjoint

For years past railroads have been looking for something in the way of a joint that would dispense with the use of bolts, nuts, etc. This has been the case more particularly with the street railway systems of the country. About six years ago the joints now manufactured by the American Rail-Joint & Manufacturing Company were first introduced on the Toledo street railway system, and they have been in constant use there ever since, giving good satisfaction. They are also in use in other Western cities. During the past winter some improvements have been made in the joint, which are illustrated in the accompanying engraving, which represents a joint on a 9-in. girder rail.

These joints are made of the highest grade of malleable iron, and are of two parts only, which are driven up and locked together on what is known as the wedge principle. A and B represent the locking device, the taper being ⅜ in. to the foot. This enables the joint to clamp the rail both at the top and bottom very firmly, and practically does away with all friction. At E the plates are ground so as to make a perfect fit to the ball of the rail.

These joints are usually 8 ins. or 10 ins. in length, but can of course be made any length desired. In width they are always double the width of the base of the rail. This feature, it is claimed, is not found in any other joint made. The joints are made with or without chairs and to fit any description of rail.

A new feature which has been introduced this season is the bonding of the joint, as shown at D. The joint is cored to admit of a bar of copper 4 ins. in length, 1 in. wide and ¼ in. thick on both sides of the base of the rail. These bars of copper have a contact of 4 ins. x 2 ins. on each end of the rail, being of about the carrying capacity of three ordinary No. 0000 copper bonds. The cost of these bonds is about 10 cents per joint, weighing as they do only about 2-3 lb. to the joint. This bond has been reported upon favorably by a number of electric railway



NEW TYPE OF RAIL JOINT

engineers and is being put in on several roads. The copper, when in the joint, is entirely surrounded by the malleable iron, and no water or moisture of any kind can get to it.

Electric Locomotive Truck

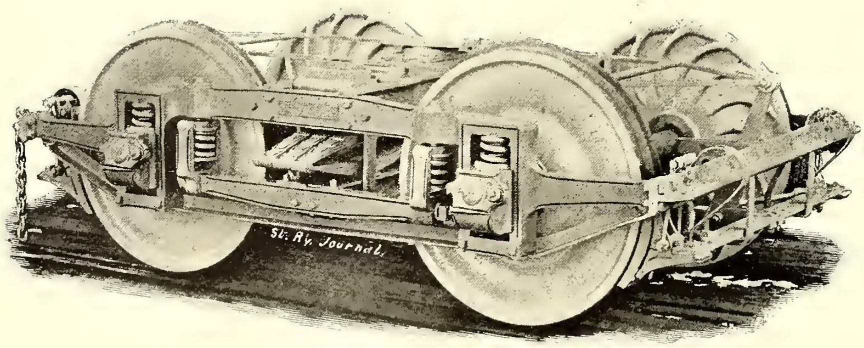
The Paris, Lyons & Mediterranean Railroad, one of the important trunk lines of France, has recently had built a double truck trunk line electric car for experimental purposes in connection with the proposed electric equipment of part of the line of that company. The car weighs complete about 96,000 lbs., and will be furnished with sufficient power to draw several other cars in a train. The car body is being built in France, and only a few details are at hand in regard to it. The floor frame is of channel bars. It is 36 ft. 9 ins. long and 6 ft. 9 ins. wide. The channels are about 10 ins. deep. The car will be mounted on a pair of Brill perfect trucks, No. 27. Owing to the fact that the car will be required to draw a number of other cars, the work put upon these trucks will be of two kinds. The first is that of the locomotive. The second is that of a railway carriage.

To meet the requirements of the locomotive alone the trucks are built in the most substantial manner. The side frames, which also form the jaws for the journal boxes, are massive forgings nearly as large as the bars of a locomotive frame. They are deeper but not as thick, and are handsome pieces of blacksmith's work.

The end pieces of the frame are T-irons carried by palms worked upon the side pieces. The seat in these palms are finished and the holes are reamed for taper bolts. Locomotive practice is followed in constructing these trucks, and wherever bolts are used they are made taper and the holes are reamed. The swing bolster is held between a pair of angle iron transoms which are bolted to the side frames of the truck. The ends of the angle are cut out and bent so as to form brackets for the purpose. The wheels are of unusual size, being 45 ins. in diameter. They are of cast iron and are mounted upon axles 7 ft. 6 ins. long and 5 ins. in diameter at the wheel fit. The journals are 4¼ by 8 ins.

Each truck is furnished with a pair of 150-h.p. motors, thus giving the car 600 h.p., quite as much as an ordinary locomotive, and from a practical point much more, since its method of application is much more advantageous. The trucks weigh 11,080 lbs. each; the motors 10,000 lbs. per pair, and the car body 24,000 lbs. This brings the weight without passengers up to a little more than 66,000 lbs. Lead or iron ballast will be used to get the required load of 96,000 lbs.

As the car will carry passengers, ease of riding was considered of the utmost importance. In the production of an easy riding carriage the initial step was the introduction of journal springs over the boxes. The first advantage of this is the reduction of the weight not carried by springs, which now consists of wheels, axles and boxes only. The heavy equalizer, instead of resting directly on the boxes, is carried by the open links, in which another set of springs are introduced. The latter have the same capacity as those on the journal boxes and have a double function, cushioning the equalizing movement where the wheel rises and cushioning the swing motion when the truck moves sidewise. This prevents that sudden unpleasant jerk always felt when the ordinary truck enters a curve even at a slow speed.



ELECTRIC LOCOMOTIVE TRUCK

The equalizing bar forms a part of the swing motion and is firmly attached at its center to the spring plank. The links by which it is carried are attached to the wheel piece a short distance from the centers of the journal boxes. The hanging of these links is peculiar. It consists of a large bar carrying a spring seat upon the lower end, while the upper post terminates in a square head under which a ball or hemisphere is finished forming with a hemispherical cup in the solid frame a ball and socket joint. The hole beneath is made sufficiently large to allow the bar the required swing. This construction gives an extra long link, as no room is taken up by the hinge.

Upon the spring plank there are two sets of triple elliptics. Quadruple springs would have been preferable, but in this case the contract limited the wheel base to 6 ft., and there was only room for the triple springs. The construction gives a vertical elasticity at least one-third greater than that obtained with the M. C. B. standard four-wheel truck with the same load carrying power.

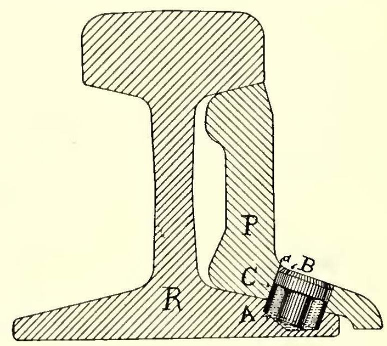
Stated another way, it means that a wheel must rise 50 per cent higher or fall 50 per cent lower in order to move the body of the car the same distance as in the ordinary passenger truck.

The steadiness of these trucks under the action of the brakes is a valuable feature which railroad men will appreciate. On account of the changed relationships between the bearing points, and the suspension of the equalizers at the ends with the weight actually central, these trucks do not tilt under the action of the brakes, no matter how hard they may be applied. The brake rigging is, of course, much less sensitive to wear than in the common truck. This feature also under some circumstances reduces the liability to skidding.

As shown in the engraving, this truck is substantially the form of "Perfect" truck which the Brill Company recommend for passenger service on steam roads. It is fitted with the M. C. B. standard box and in other respects would conform to the standard. The brake rigging is nearly the same as that used on heavy steam car work. The brake beam in this case is a heavy flat bar, trussed for strength, but the brake hangers, springs, straps, etc., are like those used on steam road trucks. It should be noted that the double brake rod shown in the cut is a feature introduced for the purpose of clearing the motors, which come up very high. The brake levers could not be inclined because the French guard rails are high and fill the whole space between the rails except a small opening in the center, which was the only place for the lower rod. By using pipe the double rod was made quite light.

New Plastic Rail Bond

A new type of the "Plastic" rail bond for rebonding old T or girder rails has recently been devised by Harold P. Brown, of New York. This bond is easily applied and will not break nor corrode. It is also well adapted for new rails whose section is not suitable for the standard "Plastic" bond. The bond is installed in the following manner: Near the end of each rail, a hole ⅝ to ⅞ ins. in diameter is bored diagonally downward through the bottom of the angle plate, and into but not through the base of the rail. The drill designed for this purpose has a point with a very obtuse angle, and as it penetrates the lower surface of the plate it carries down a burr into the upper surface of the rail. As the hole progresses in depth, a part of this burr is crowded back into the layer of rust between the two steel surfaces, forming a telescope joint which is perfectly smooth on the inside.



NEW PLASTIC RAIL BOND

The drill is wet with a solution of soda and water instead of oil, so as to prevent the trouble which sometimes follows the use of an insulating fluid on a metal contact surface. The hole is amalgamated by wetting the surfaces, dropping in a small piece of the Edison solid alloy, and rubbing it around with a pointed piece of hard wood. This instantly makes a layer of bright silvering, which will not rust, nor will it permit the steel below it to rust.

To further seal the crack between the angle plate and the rail, an amalgamated copper tube is driven in. The hole is then partly filled with the plastic alloy, which adheres to the silvered surface of the steel and forms a conducting path of very low resistance between the rail and the angle plate. An amalgamated copper plug, T shaped in section, seals the hole and completes the circuit between the rail and angle plate by dipping into the plastic alloy. The angle plate may move ⅛ of an inch in any direction without shearing the lower end of plug, and merely bends the top of the copper tube without breaking it. Even if the tube should be broken and a portion of the plastic alloy escape, there would be enough held in the hole in rail base to maintain a perfect contact. The plug has a filler near the top, into which a part of the surface of the rail is forced by a hammer blow on a blunt chisel.

It is stated that a complete joint formed by one pair of ⅝ in. holes in the angle plate has four times the conductivity of a No. 0000 copper bond. With one pair of ⅞ in. holes, the conductivity is said to be double that of the ⅝ in. hole. As the plastic alloy remains soft, no harm can result from the slight motion of rail and angle plate as cars pass over. For rebonding girder rails with angle plates that are wide on top, the hole is bored through the tram of the rail into the top of the angle plate. The details of the new bond are well shown in the accompanying illustration.

The San Mateo Electric Railway of San Mateo, Cal., has announced the winners in its semi-annual merit contest. Five motormen received $10 apiece and five conductors $5 apiece.

New Geared Air Brake.

The Standard Air Brake Company has been working for some time past on an improved axle-driven air brake for street cars, the chief feature of which is that the compressor is in operation only such a part of the time as is required for actual compression. The system maintains the air pressure required and automatically causes the air compressor to start and stop when the minimum or maximum pressure is reached.

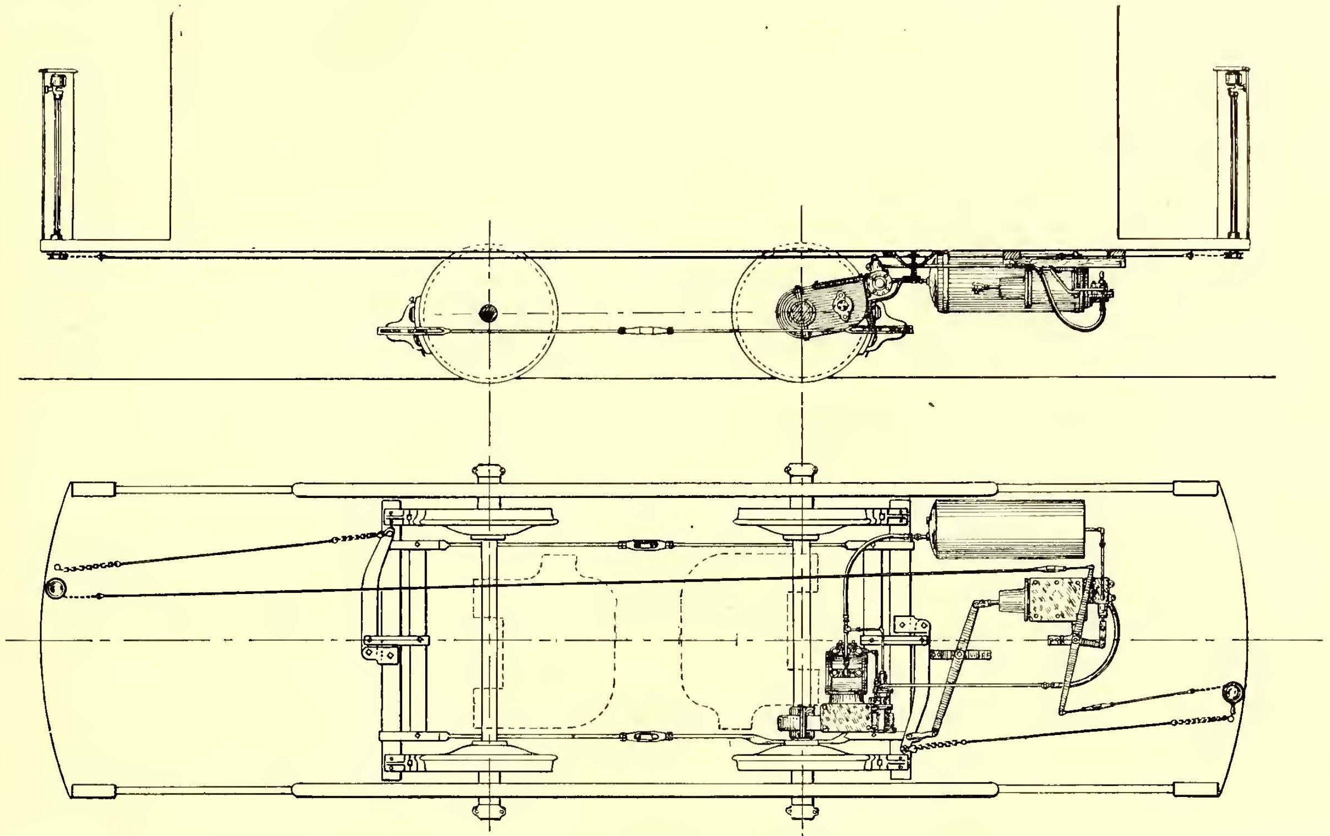


FIG. 1.—PLAN AND SIDE ELEVATION OF AIR BRAKE EQUIPMENT

The driving mechanism consists of a split gear fastened to the car axle. This gear is in mesh with another gear, which runs free on the pump shaft and also forms one member of a friction clutch. The latter consists of a series of plates, half of which, being the drivers, rotate with the clutch gear, but are free on the shaft, while the other half, placed alternately between the drivers, rotate with the pump shaft. When the pressure is applied the plates are forced together, causing the pump shaft to rotate, but without starting shock. The pressure is applied by the governor by means of a shipper, yoke and collar on the shaft. The casing is dust-proof, and contains all the above driving parts except the pump and governor, which are rigidly bolted to it. All parts run in oil.

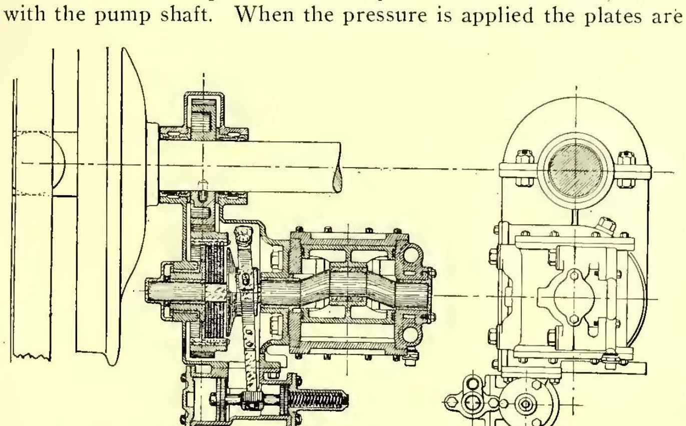


FIG. 2.—SECTION AND SIDE ELEVATION OF PUMP

The pump, Fig. 2, is double acting, having a piston cast hollow and in one piece, within which is the crank, crank brass and ways. The bearings, subject to the thrust of the piston, are inside and quite beyond the reach of dust to cut them out. The suction and discharge valves are in the cylinder body and have removable seats to facilitate repairs. The suction and discharge ports are cored to one inlet and one outlet respectively, making only one connection for the suction and one for the discharge. This construction renders the pump easy of access, as no pipe connections have to be disturbed in examining or cleaning. Under the suction valves are means for lifting them by exhaust air just before the operating mechanism throws the clutch into engagement, thus relieving the latter at that instant of any load, so the strain on the clutch when thrown in contact is practically nothing.

The governor, Fig. 3, consists of two cylinders of different diameter in one casting, fitted with two pistons, the larger piston and cylinder being twice the area of the smaller. In the center is attached the shipping lever for operating the clutch.

Above, and bolted to the larger cylinder, is the valve chamber of the governor proper, which controls the air to the larger cylinder of the operator. Within the valve chamber is a brass slide valve attached to a hollow valve stem, one end of which is a piston, against which the air pressure in the chamber acts in overcoming the pressure of spring within the hollow valve stem.

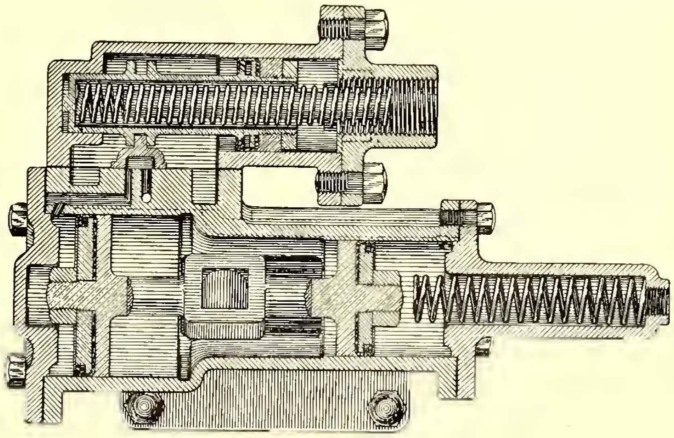


FIG. 3.—GOVERNOR

The air pressure is always in the smaller cylinder, which holds the clutch in contact, and is also at all times in the valve chamber acting on the piston against the spring. When the air pressure reaches a predetermined maximum pressure it overcomes the resistance of the spring and moves the hollow valve stem, which draws with it the slide valve, opening a port which permits the air from the valve chamber to enter the larger cylinder, which, being twice the area of the smaller one, forces the shipping lever in the opposite direction, consequently disengaging the friction clutch, and the pump remains at rest. When the air pressure drops to a predetermined minimum pressure the air in the valve chamber or the governor has not pressure enough on the piston

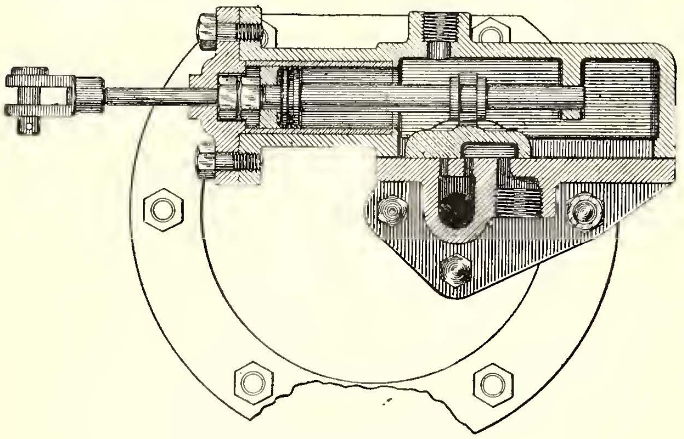


FIG. 4.—OPERATING VALVE

on the hollow valve stem to resist the force of the spring, consequently it moves back in the opposite direction, drawing the slide valve with it until it opens the port from the large cylinder to the exhaust. The air pressure which held the clutch out of engagement is released, and since the air pressure is always on the smaller cylinder this throws the clutch into engagement again, through the shipper lever, and the pump recharges the reservoir to maximum pressure.

The reservoir is of the cold weld type, of a suitable size to fulfill the requirements of the service. The brake cylinder is the ordinary hollow spindle type, attached to the floating lever. The leverages on a car are not changed, and the hand brake can be used just the same as though no air brake were on the car.

The operating valve is bolted to the brake cylinder head, which obviates all piping for this purpose. Formerly it was the custom to place an operating valve on each platform, which required two lines of pipe the whole length of the car. In the present method not only is the expense less, but the danger from leaky pipe connections is entirely obviated. There are three ports under the slide valve, a small port for service stops, a large port for emergency application of the brakes and an exhaust port. The exhaust from the brake cylinder therefore performs two functions.

The platform equipment consists of a ¾-in. cold-rolled iron staff, within a piece of 1-in. iron pipe, supported by the dashrail, in a convenient place and height for the motorman. On top is a pressure gage and immediately under it is the handle by which the motorman manipulates the operating valve. This handle moves altogether through an arc of 180 degrees, and the movement is conveyed to the operating valves by means of a rod, chain and bell-crank lever under the floor of the car. By a movement of 90 deg. the service port is opened, 170 deg. emergency.

Special attention is called to the fact that the compressor is in operation only a very small percentage of the car mileage. In Jersey City and Brooklyn, while in the city limits, it is in operation less than one-quarter of the time. A good idea of the time the compressor is in operation in interurban traffic is given on the Consolidated Traction Company's line between Jersey City and Newark, known as the "Plank Road." Between the two cities, a distance of about five miles, very few stops are made, about six, so that in 25,000 ft. the compressor is in operation a distance not exceeding 400 ft.

Patent Decision on Motor Suspension

A decision was rendered last month in the United States Circuit Court of Appeals for the Second Circuit in the case of the Sprague Electric Railway & Motor Company vs. the Union Railway Company and Walker Company. The appeal was from a decree of the Circuit Court for the Southern District of New York, which adjudged that the defendants had infringed claims 2, 6 and 9 of letters patent No. 324,892, dated Aug. 25, 1885, and issued to Frank J. Sprague for an improved electric railway motor. The three claims which it was claimed had been infringed are as follows:

2. The combination of a wheeled vehicle and an electro-dynamic motor mounted upon and propelling the same, the field-magnet of said motor being sleeved upon an axle of the vehicle at one end, and supported by flexible connections from the body of the vehicle at the other end, substantially as set forth.

6. The combination, with a wheeled vehicle, supported upon its axles by springs, of an electro-dynamic motor flexibly supported from such vehicle, and centered upon the driving-axle thereof, substantially as set forth.

9. The combination, with a wheeled vehicle, of an electro-dynamic motor centered upon the driving-axle thereof at one end, a spring-support for that end of the motor from the truck or body of vehicle, and relieving axle wholly or partly of dead-weight, and a spring support for the other end of motor from the truck or body of vehicle, substantially as set forth.

The opinion which was rendered by Judge Shipman was that the first two claims were infringed by the defendants, but that the last was not infringed.

Patent Decision on Controllers

Judge Townsend, in the Circuit Court for the District of Connecticut, rendered a decision last month in the case of the Electric Car Company of America vs. The Hartford and West Hartford Railroad Company et al., infringement being alleged of patent No. 393,323. The owners of this patent are the General Electric Company. The patent in question covers not the broad subject of series parallel control, but, in changing the circuit connections of the controlling switch, the automatic introduction into the circuit of "dead" auxiliary resistances. Then when the new connection has been effected, the gradual and automatic cutting out the resistance. The function of this resistance is to reduce the current flowing so that at the time of making a change in the motor connections the current is small compared with what it would be if these resistances were not inserted.

Of the several claims in the patent upon which suit was brought seven were declared not infringed and two as infringed.

Electric Railway Equipment in Mexico and Lisbon

W. B. Rommel, engineer of Wernher, Beit & Company, of London, has been spending a short time in New York during the past month, perfecting plans for the electrical equipment of a section of the street railway system of Mexico, which is owned by the company of which he is the engineer. This is the system of which H. P. Bradford was recently appointed general manager to take the place of T. H. McLean, who has recently resigned.

The amount of track to be equipped at present is 26 miles, extending over about 15 miles of road. The line is the most important of those owned by the company, and extends to San Angel, through Mixcoac, Tacubaya and Chepultepec to the center of the City of Mexico, whence it extends on the other side of the city to Guadalupe. The portion of the line within the city limits for about 8¾ miles of track will be relaid with 85 lb., 7 in., three-quarter grooved rail, mounted on creosoted wood ties. Outside the city the present T rail construction will be used for the present. The company will equip thirty-five motor cars and an equal number of trail cars, of which twenty-eight of each will be used in regular service and the rest kept for reserve. The motor cars will have an 18 ft. body length, will be mounted on single trucks and will carry first class passengers. The trail cars will be used for carrying second class passengers.

The company will erect a power station at a point near the middle of the line and about the center of the entire system, so that it will be a desirable point for power distribution, when the present animal power has been superseded by electric motors. The details of the station equipment had not been decided upon at the time of going to press, with the exception of the engines, which will be of the McIntosh & Seymour type. They will be two in number, cross compound, condensing, running at 100 r.p.m., and each will be directly connected to a 425 k.w. generator. The station will be built to accommodate the other units as soon as they are needed.

On account of the high price of coal in the City of Mexico, arrangements have been made for equipping one of the boilers with a furnace capable of burning peat, which exists in large quantities near the city. If this proves to be a desirable and economical fuel, the furnaces under the other boilers will be changed from coal burning to peat burning.

Wernher, Beit & Company, besides their large holdings in Transvaal mining properties, have also important tramway interests, and control a number of lines besides those in the City of Mexico, notably the tramway systems of Lisbon, Portugal, Cape Town, South Africa, and Port Elizabeth, South Africa. The two latter lines are electrically equipped, and were described in the April issue of the "Street Railway Journal." The Lisbon system is still operated by mule power, but its electrical equipment is contemplated during the early future.

Personal

MR. J. B. SPEED has resigned his office as President of the Louisville Railway Company, of Louisville, Ky.

MR. EMERSON McMILLIN has resigned the Presidency of the Columbus (O.) Street Railway Company.

MR. H. H. HILBORN has been appointed manager of the Berlin & Waterloo Street Railway Company, of Waterloo, Ont.

MR. W. B. POTTER, chief engineer of the General Electric Company, sailed for Europe last month on the steamer Campania.

MR. CHARLES H. STOLL, formerly president of the Passenger & Belt Railway Company, of Lexington, Ky., has resigned his position and will move to New York.

MR. H. F. PARSHALL, consulting engineer, of London, England, is about to take a much needed vacation for a month or so. He will probably go to Scotland or Switzerland.

MR. T. M. STEGER, until recently president of the Nashville Street Railway Company, has resigned that position and will be succeeded by Mr. L. D. Tyson, formerly vice-president of the company.

MR. GEORGE S. WHIPP, formerly with the Lewis & Fowler Manufacturing Company, and recently engaged as an independent contractor, has now connected himself with the Cambria Iron Company, and will make his headquarters in New York.

MR. CHARLES Y. FLANDERS, who is very well known among street railway men, has associated himself with the St. Louis Car Company, of St. Louis, Mo. Mr. Flanders was formerly connected with Morris Tasker & Company, of Philadelphia, Pa., and he takes with him the best wishes of his friends.

MR. E. R. RICHARDS, First Lieutenant First Infantry, N. G. of Missouri, the representative of the J. A. Fay & Egan Company in St. Louis, having been called out with his regiment, Mr. John B. Temple has been sent from Cincinnati to take his place, and Mr. Phillip J. Fraker has been called from Buffalo to Cincinnati to take the place vacated by Mr. Temple.

MR. F. O. RUSLING, formerly manager of the Rochester Railway Company, and previously superintendent of the Buffalo Railway Company, has been appointed General Manager of the Chicago & Milwaukee Electric Street Railway Company, operating between Evanston, Ill., and Waukegan. Mr. Rusling was recently offered the position of manager of the Port Elizabeth Electric Railway Company, of Port Elizabeth, South Africa, but in its place accepted the position which he now holds.

MR. FRANK D. RUSSELL has recently accepted the position of vice-president of the Rochester Car Wheel Works. Mr. Russell is very well known throughout street railway circles, and his many friends will hear with pleasure of his advancement. He is well acquainted with the needs of electric railways, having had both a theoretical and practical training; he was for a number of years connected with the John Stephenson Company, Ltd., of New York, and was also for some time associated with the "Street Railway Journal."

MR. SIDNEY WEBB, one of the leading progressive members of the London County Council, has been in America for some weeks, partly for rest and recuperation and partly with the intention of studying local and municipal government, and street railway results applicable to the tramway situation in London. Mr. Webb is widely known in Great Britain both as a speaker and a writer, and was accompanied by his equally well-known wife (formerly Miss Beatrice Potter), whose literary and other work is well known on both sides of the Atlantic.

MR. T. J. MINARY, general manager of the Louisville Railway Company, will hereafter fill the office of president of that company, as well as general manager. Mr. Minary was born at Versailles, Ky., in 1850, and moved to Louisville in 1869. In 1872 he was chosen secretary of the Central Passenger Railway Company, and four years later was made general manager. In this position he displayed great executive ability, and on the consolidation of the five companies into the Louisville Railway Company, owning and operating all the street railway lines in that city, he was chosen general manager of the new company. Mr. Minary's many friends in the street railway field extend to him their hearty congratulations on his advancement.

Obituary

MR. CHARLES B. PRATT, President of the Worcester (Mass.) Consolidated Street Railway Company, died at his home on May 10, 1898. Mr. Pratt was born in Lancaster, Mass., in 1824, and has been prominent in Massachusetts political and commercial circles for many years. For three years, from 1877 to 1879, he was Mayor of Worcester. He was President of the First National Insurance Company, a director in the First National Bank and for many years was president of the Worcester Agricultural Society. He had been a member of both branches of the Worcester City Council and of both branches of the Legislature.

AMONG THE MANUFACTURERS

D. W. PHELAN, of New York City, is supplying all the poles for the Green County Traction Company, of Coxsackie, N. Y.

FORD, BACON & DAVIS, the firm of engineers, have moved their New York office from the St. Paul Building to 149 Broadway.

ROBERT A. KEASBEY, manufacturer of the well known Magnesia sectional covering, has recently moved his place of business to 83 Warren Street, New York.

THE PAIGE IRON WORKS, of Chicago, have been running for two months day and night, work not being discontinued from 7 o'clock Monday morning until 5 o'clock Saturday evening.

PATTERSON, GOTTFRIED & HUNTER, Limited, of New York City, dealers in machinery, metals, hardware tools and supplies, are sending to the trade an attractive poster calling attention to their goods.

THE AMERICAN ELECTRICAL WORKS, of Providence, R. I., manufacturers of bare and insulated electric wires, are sending to their friends a souvenir of Memorial Day in the shape of a handsome steel plate engraving of Abraham Lincoln.

FORÈE BAIN, of Chicago, Ill., is sending to his friends a little book of useful information. Mr. Bain is a consulting engineer and registered solicitor of patents, and is well known in electric railway circles. He has his offices in the Monadnock Block.

THE CAHALL SALES DEPARTMENT, of Pittsburgh, Pa., has received an order from the Lorain Wheel Company of Lorain, O., for 10,500 h.p., three tube boilers of the Cahall make. Two thousand five hundred h.p. of these boilers will be equipped with the Cahall chain grate stoker.

CRANE COMPANY of Chicago, through its representative, G. A. Hurd, has recently secured orders for high-pressure valves, extra heavy pipe valves and fittings from the North American Chemical Company at Bay City, Mich., and the Mattheissen & Hegler Zinc Company, La Salle, Ill.

THE STILLWELL-BIERCE & SMITH-VAILE COMPANY have moved their New York office to 141 Broadway, room 909, where all callers will receive a cordial welcome, and where full information concerning the well known products of this company will be cheerfully given.

THE JOSEPH DIXON CRUCIBLE COMPANY, of Jersey City, N. J., is making a graphite that is particularly well adapted to the lubrication of gas engine cylinders. This graphite has been in use for some time in the shops of the Pennsylvania Railroad Company, at Sharon, Pa., and the officers in charge are very high in their praise of it.

THE HOPPES MANUFACTURING COMPANY, of Springfield, O., announces that its new catalogue describing the Hoppes separators and oil eliminators is almost ready for distribution. These separators are described in another column of this issue, and the catalogue will undoubtedly be of great interest to steam users everywhere.

THE COMMUTATOR COMPANY, of Minneapolis, Minn., has been compelled to enlarge its plant to over double its former capacity within the past six months, owing to its increase of business. This company has also made several changes and improvements in its processes, and if there is anything wanted made of copper the company is prepared to furnish it.

THE DEARBORN DRUG & CHEMICAL WORKS, of Chicago, Ill., has recently issued a series of small pamphlets descriptive of the oils, lubricants and compounds which it supplies. These pamphlets are unusually artistic and contain a great deal of very interesting and valuable reading matter on the subject of oils, greases, vegetable compounds, etc.

LITTLEFIELD & MEYSENBURG, of Chicago, Ill., in addition to handling rails, special work, etc., for the Johnson Company, have taken the agency for this company's steel motors, and have added to their selling force William D. Ray, formerly superintendent of the New Whatcomb (Wash.) Street Railway, and author of "Practical Application of Dynamo Electric Machinery," etc.

FRANK C. PATTEN, of Sycamore, Ill., owner and manager of the Poorman's Axle Grease Company, of that city, is making a specialty of high grade grease for the use of electric railway companies, and will send samples free of charge to any railway. Mr. Patten claims a number of strong features for this grease and is receiving a number of fine testimonials from users of it.

THE W. T. VAN DORN COMPANY of Chicago reports good orders from the West Chicago Street Railway Company, the Kings County Elevated of Brooklyn, N. Y.; Glasgow Street Railway, Glasgow, Scotland, and sixty-two car orders from Omaha Street Railway, Omaha, Neb. Mr. Van Dorn says that he has booked a large number of foreign orders to be shipped later in the season.

WILLIAM S. TURNER, electrical and mechanical engineer, of New York City, has moved his office from No. 1 Nassau Street to the Washington Life Building, 141 Broadway, New York. Mr. Turner makes a specialty of furnishing specifications, plans, estimates, tests, reports, etc., on electric traction plants, electric lighting plants, power transmission plants and installations of steam engineering of every kind.

THE WESTERN ELECTRIC COMPANY, of Chicago, Ill., has issued its catalogue of electric light supplies for the season of 1898. This catalogue makes a volume of considerable size, containing 555 pages, and is substantially bound in cloth covers. It contains price lists and illustrations of nearly every appliance which is required in a power station or on the line. A complete index adds greatly to the volume of the catalogue.

THE GENERAL ELECTRIC COMPANY has issued a very artistic catalogue giving descriptive details and prices of the G. E. lightning arresters. The pamphlet gives first, the essential points which are necessary in any lightning arrester, and then describes in detail the many different types of station and line lightning arresters which the General Electric Company manufactures. On the fly leaf of the pamphlet is a very fine half tone reproduction of a flash of lightning.

THE WILLIAMS RAIL JOINT COMPANY of Chicago, Ill., is equipping a Southern road with its truss rail joint, and has made the first shipment of 300 on an order for 1000 joints. This order was secured as a result of the use of sample joints by the purchasing company. Trial joints are in use on a number of other roads and are giving good satisfaction, proving to be all that is claimed for them. This joint was described in the "Street Railway Journal" for August, 1897.

WINTHROP G. NORRIS & COMPANY, of Boston, Mass., have taken the contract to build and equip the Fitchburg & Suburban Street Railway, which will run from Fitchburg to Leominster, Mass., a distance of five miles. It is expected this road will be in operation by July 1, 1898. This company is also engaged upon drawing up plans for the power station of the Clinton & Worcester Railway, of Clinton, Mass. This road is also expected to be in operation within a short time.

STONE & WEBSTER, of Boston, have recently made arrangements with S. Homer Woodbridge, by which his business of heating, ventilating and sanitary engineering will hereafter be intimately associated with their own electrical engineering work. This arrangement has been made in order that this firm may be able to make the entire installation of mechanical, electrical and sanitary apparatus for a building. Mr. Woodbridge's office will be with Stone & Webster, at 4 Postoffice Square, Boston.

DAVID C. SANFORD, of Bridgeport, Conn., is making a specialty of supplying solid babbitt bearings. In these bearings, the composition is so proportioned that the greatest degree of hardness is secured without the loss of strength and toughness, which are so essential to withstand the many severe shocks motors are subject to. These bearings have a number of advantages, one feature that is particularly worthy of note being the oil ways, which are all cast in and are much truer and cleaner than they can be cut with a drift.

THE RIDGELY & JOHNSON TOOL COMPANY, of Springfield, Ill., manufacturers of valveless pneumatic tools for riveting, chipping, beading flues, cutting staybolts, chipping iron and steel castings, stone cutting, carving and lettering, etc., has published a new catalogue describing these different tools. This company makes a specialty of supplying high grade pneumatic hammers of any size desired. The catalogue contains many views of the Ridgely & Johnson tools and shows the method of applying them in actual work.

THE FOSTER ENGINEERING COMPANY, of Newark, N. J., is sending to its friends and customers its new catalogue describing the Foster pressure regulator pump, speed governor pump regulator, and the different types of valves which it manufactures, including an automatic safety top valve damper regulator, relief valve inside boiler check and other high grade specialties for steam, water, gas or air. The catalogue contains a number of very clear drawings and diagrams showing in detail the construction of these different appliances.

THE B. F. STURTEVANT COMPANY, Boston, Mass., has issued its catalogue No. 103 showing many views of the Sturtevant engines for electric lighting and street railway plants, and general high grade work. This company has devoted itself exclusively for many years to the careful designing and developing of an extensive line of small compact and high grade engines to fulfil all requirements. That it has succeeded in this work, the company claims, is proven by the fact that over 6000 of its engines of various types have been sold since it entered the field.

THE ALLEN & MORRISON BRAKE SHOE COMPANY of Chicago on April 6 placed test shoes on the Metropolitan Street Railway of Kansas City. On May 10, after running 35 days, full time, an examination showed only ⅛ in. wear, indicating that the life of the shoes will be six months for that service. Sixty day tests on a steam road show the shoes one-half worn out and still good for six to eight weeks more. Shoes are now in service on the Baltimore & Ohio and Northern Michigan railroads, and on cars of the Wagner Car Company. Further tests will be reported in these columns.

THE JACKSON & SHARP COMPANY, of Wilmington, Del., has recently received an order for a number of open and closed cars from the Pensacola (Fla.) Electric Terminal Railway Company, and has shipped two 39-ft. double truck closed car bodies for suburban service to the Rochester Railway Company, Rochester, N. Y. In addition to these orders this company has also shipped cars to Asheville, N. C.; Harrisburg, Pa., a number of very handsome closed cars to the Newport Street Railway, Newport, R. I., and to the Black River Traction Company, Watertown, N. Y.

THE CENTRAL ELECTRIC COMPANY, of Chicago, in removing to its new quarters, 264-266-268-270 Fifth Avenue, is much more conveniently located than before, especially as regards shipping facilities. In the new location the company has more than 23,000 sq. ft. of floor space, and by means of careful arrangement the capacity of this space is almost doubled. The company is issuing a very neat folder to the trade, which gives a complete list of the ships of the United States and Spanish navies, date when built, displacement, indicated horse power, armament and speed. This information will be of interest especially at this time, and will gladly be sent on application.

THE W. R. GARTON COMPANY, of Chicago, has recently moved into the Ashland Block, where it has secured handsome and commodious quarters. This company has now completed arrangements for a very full set of agencies so that now it is able to supply almost everything which street railway companies require in the operation of their lines. Among the manufacturers for whom Mr. Garton will act as representative are the Duquesne Forge Company, of Rankin Station, Pa., manufacturers of forged steel gears and pinions, and the Central Union Brass Company, of St. Louis, the well known producer of overhead materials, car trimmings, bearings, etc.

WILLIAM H. CAMPBELL, of New York City, makes a specialty of street railway transfer tickets and punches. The Campbell transfer ticket is printed on excellent paper of various colors, and they are furnished in books, pads or packages, numbered or unnumbered, as desired. They are also made in several different styles both for conductors and transfer agents, adding or eliminating any special features as required. The larger or conductors' form may be printed so as to be good at all or every point on the line for several days in the year. The smaller one or transfer agents' ticket is good at one point only and for the day printed thereon. It is claimed that these forms are no infringement of any existing patent.

JOHN A. ROEBLING'S SONS COMPANY, of Trenton, N. J., has recently supplied to the Western Union Telegraph Company a cable for the transmission of telegraphic messages beneath the waters of Puget Sound between Port Angeles and Victoria. The most notable fact about the cable is its great length, being 29 miles long, with but a single splice. The entire cable weighs 421,080 lbs., and was manufactured at about the rate of one mile a day. This is one of the longest cables ever manufactured, and it reflects great credit upon the Roebling Company that not a single flaw was detected in it when completed. This company is also now at work on several submarine cables for the United States Government which will be used in harbor defenses.

THE CHRISTENSEN ENGINEERING COMPANY, of Milwaukee, Wis., has recently completed arrangements with R. W. Blackwell, of London, for handling its apparatus in the United Kingdom. The liveliest interest has been expressed abroad in the apparatus of this company, and its managers realize the necessity of furnishing facilities for supplying the orders which must come from European tramway companies. The company believes in supplying all railway companies using its brakes with very clear instructions, which can be given to the motormen to enable them to fully understand the construction and operation of its apparatus. It has therefore prepared a number of catalogues which make the handling of its apparatus by the motormen very easy.

EUGENE MUNSELL & COMPANY and the Mica Insulator Company, of New York and Chicago, have completed arrangements with the George Worthington Company, of Cleveland, whereby the latter company will handle both "Mica" and "Micanite." Its territory includes the city of Cleveland and some eight or ten of the adjoining counties. A large stock of India and amber "Mica," in the sheet and segments for railway motors, as well as "Micanite" plate, segments, rings, cloth, paper, etc., will be carried by the George Worthington Company to supply the electrical trade in its section. This is an important step in the right direction, and the trade in Cleveland and vicinity will appreciate the fact that this stock has been placed in the hands of so large a company, which has excellent facilities for making prompt delivery.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, of Pittsburg, Pa., is to supply the electrical apparatus for the new plant of the Detroit, Ypsilanti & Ann Arbor Railway Company, consisting of four 300-h.p. generators, three booster switchboards and ten car equipments, including forty 50-h.p. motors. The Westinghouse Company is also to furnish the apparatus for the new equipment of the Lewiston (Maine), Brunswick & Bath Railroad. Generators to supply alternating and direct currents simultaneously are to be located at Brunswick, Maine, the initial installation being 1000 h.p. Direct current is to be used at the sections of railroad in and about Brunswick, and alternating current is stepped up to 10,000 volts and transmitted to sub-stations at Lewiston, Bath and Lishen Falls. Here Westinghouse rotaries transform it to supply different trolley feeders.

THE W. R. GARTON COMPANY, of Chicago, which concern succeeds W. R. Garton of Chicago, is doing a splendid business. As an example, within the last thirty days it has several times turned over a goodly sized stock of various materials. This company has a very large line of specialties, and is representing some of the best concerns in the country. Its line is so complete that it is prepared to furnish materials to railway, electric light and power companies upon demand. This company has also been very successful in the closing of some very good yearly contracts for Raster carbon rheostats, and has also received some very goodly sized orders for Keystone instruments. It has been equally successful in the placing of some good contracts for Garton arresters. It has been permitted thus far in the short space of time it has been in the business to send some large orders to nearly every manufacturer whom it represents, and it is about closing some very nice contracts for specialties, which promises great things for the future. This company also has an excellent line of overhead materials, manufactured by the Central Union Brass Company. M. M. Wood, who originated the materials sold by one or two of the largest concerns in the country, has developed a very unique line of overhead material for the Central Union Brass Company.

THE SPRAGUE ELECTRIC COMPANY, of New York City, is running its works at Thirty-fourth Street, New York, day and night upon contracts for interior conduit and Lundell power motors for the United States Government. The interior conduit manufactured by the Sprague Company is now the standard of the United States Government, and it is used not only upon a large number of war ships and cruisers, but upon many of the improvised cruisers recently called into service for scouts, torpedo boats and coast defence ships. The Sprague Company is also filling a number of orders for the Sprague elevator for the Government printing office at Washington. This is a duplicate order, and was given after a severe test of the elevator already installed. The Sprague Company is also filling a number of large orders from foreign countries, including a large number of Lundell fan motors for India and Japan, and a number of electric motors which will drive by direct connection several machines in a well known electrotyping and stereotyping plant in Berlin, Germany.

THE AMERICAN BRAKE SHOE COMPANY, of Chicago, Ill., is now the owner of the Diamond S. brake shoe patents, and has been incorporated for the purpose of maintaining a careful inspection of the product of all the licensees under the Diamond S. patents, for the purpose of insuring uniformity throughout the entire country, and of securing to the railroad companies using these shoes a continuance of the good results obtained from the Diamond S. shoes manufactured by the Sargent Company. It is also intended to provide inspection of brake shoes in service for the purpose of giving the railroad companies the benefit of the services of experts in this branch of railroad equipment. Many inquiries as to the Diamond S. shoe from parts of the country remote from Chicago have been received by the Sargent Company. The following licensees are now prepared to fill orders, and the American Brake Shoe Company is in a position to guarantee that their product will be of uniform excellence. The licensees are: The Sargent Company, offices: Old Colony Building, Chicago, Ill.; Security Building, St. Louis, Mo.; Endicott Arcade, St. Paul, Minn.; 537 Mission street, San Francisco, Cal. The Ramapo Iron Works, offices: Hillburn, N. Y.; Havemeyer Bldg., New York, N. Y.; Parker & Topping, offices: Endicott Arcade, St. Paul, Minn., Albina Foundry, Portland, Ore. Central Brake Shoe Company, offices: Ellicott Square, Buffalo, N. Y.; Havemeyer Bldg., New York, N. Y.

THE HAZELTON BOILER COMPANY, of New York, which is the sole proprietor and manufacturer of the Hazelton or porcupine boiler, has orders from the following concerns: Goodyear's India Rubber Glove Manufacturing Company, Naugatuck, Conn., two boilers (third and fourth orders); the New York Mutual Gas Light Company, New York City, two boilers (eighth and ninth orders); the People's Gas Improvement Company, Trenton, N. J., two boilers; the South Middlesex Street Railway Company, South Framingham, Mass., one boiler (third order); A. H. & C. B. Alling, woolen manufacturers, Derby, Conn., one boiler; the Greenfield Electric Light & Power Company, Greenfield, Mass., one boiler (second order); the Brooklyn Union Gas Company, Brooklyn, N. Y., two boilers (eighth and ninth orders); and three boilers for M. Guggenheim's Sons for their smelting works at Monterey, Mexico. Nearly all of the above boilers will be equipped with a very complete brick-lined steel jacket, with square furnace and square-grate surface, lately introduced to public use by the Hazelton Boiler Company. This steel jacket with square furnace forms a unique and very neat setting; and the firing front is embellished by an entablature or cornice, with fluted castiron pilasters, rendering the general effect of the entire structure very attractive. A battery of these boilers, placed side by side, presents one continuous firing front the entire length of the battery, and is a most convenient arrangement for firing and cleaning, while it is claimed more horse power of this type of boiler can be placed upon the same ground area than would be possible with any other kind of boiler. The Hazelton Boiler Company carries a considerable stock of large boilers, in units of 200, 250 and 300 h.p., which it is constantly adding to, as the three sizes named are most popular with its customers. The intelligent steam user of the present day finds that the best boiler, even though its initial price may be somewhat higher than that of the ordinary boiler, in the end always proves the best purchase. The Hazelton boiler, after a test of nearly eighteen years, has made an enviable record, and commands the highest approval of its many users.

New Publications

Directory of Directors in New York City. 600 pages. Price, $3.00. Published by the Audit Company, New York.

This directory gives the names and addresses of directors as well as the names of the companies with which they are connected and bears evidence of having been most carefully compiled.

Fatigue of Metal in Wrought Iron and Steel Forgings, by H. F. J. Porter, of the Bethlehem Iron Company, South Bethlehem, Pa. 55 pages. Illustrated.

In this pamphlet, Mr. Porter gives a great deal of very instructive and interesting information concerning the fatigue of metal in wrought iron and steel forgings, and in the comparative properties of these metals, especially their ability to resist repeated stresses.

Announcement for the Summer Quarter of the West Virginia University, Morgantown, W. Va. Published by the West Virginia University. 35 pages.

This pamphlet gives a full description of the different courses which are provided at this University. This college offers facilities for carrying on educational and scientific work without interruption, as all of the departments are open during the summer. Regular practical work is provided in drawing room, field practice, mechanical shops and scientific and engineering laboratories.

Gas, Gasoline and Oil Engines. By Gardner D. Hiscox, M. E. Second edition. 384 pages. Illustrated. Price, $2.50. Published by Norman W. Henley & Company, New York.

The success of the first edition of this book was so great that the publishers now announce a second edition. The style throughout is clear and concise and the illustrations ample. For certain classes of small electric roads the gas engine undoubtedly has economical advantages over a steam engine and has been used abroad for this purpose to a considerable extent. Mr. Hiscox's work is, therefore, a valuable one for consideration by those proposing stations of this character.

Announcement of Course of Instruction in the Summer School for Teachers and Advance Students at Cornell University.

This is a pamphlet giving the full course of studies in the course of instruction for teachers and advance students in the summer school at Cornell University. Particular attention is called to the course in mechanical drawing and designing and the course in experimental engineering. The first is under the tuition of J. S. Reid, and the second under J. B. Preston. The drawing class includes instruction in mechanical drawing, elementary designing, kinematic drawing and machine designing. The experimental engineering course includes thorough instruction in laboratory work, where materials are tested for tension, compression, torsion, etc. Tests of hydraulic motors, water motors, inductors, boilers, pumps, air compressors, etc., are made.

Les Tramways, les Chemins de Fer sur Routes, les Automobiles et les Chemins de Fer de Montagne à Crémaillère . By E. Seravon. Fourth edition completely revised by H. de Graffigny and J. B. Dumas. 567 pages. Illustrated. Price, $6. Published by E. Bernard & Cie., Paris.

As its title indicates, the field covered by this work is an exceedingly broad one. It is perhaps not surprising, therefore, that more space should not be devoted to the overhead trolley system, though 35 pages seem rather a small allowance in a book of this size for what Americans look upon as the most important method of propulsion now in use for street railway service. Most of the practice described is that of Europe, though space is given to some operating figures of the West End Street Railway Company of Boston, and some estimates of the cost of electric railway construction and operation by General Haupt, of Philadelphia. Two or three types of electric motors are discussed, but none of the modern forms of electric trucks are illustrated. The chapters on stored steam and the Serpollet motors are very complete. The work also contains in full the French laws on the subject of the establishment of tramway and railway lines.

Trade Catalogues

Useful Information for Practical People. Published by Forée Bain, of Chicago.

Lightning Arresters. Published by the General Electric Company, of Schenectady, N. Y. 30 pages. Illustrated.

Pneumatic Hammers. Published by the Ridgely & Johnson Tool Company, Springfield, Ill. 24 pages. Illustrated.

The Sturtevant Engine. Published by B. F. Sturtevant Company, Boston, Mass. 45 pages. Illustrated.

"The Foster." Published by Foster Engineering Company, of Newark, N. J. 64 pages. Illustrated.

Catalogues. Published by the Dearborn Drug & Chemical Works, Chicago, Ill.

Electric Light Supply Catalogue. Published by the Western Electric Company, of Chicago, Ill. Bound in cloth. 555 pages.

List of Street Railway Patents Issued

U. S. PATENTS ISSUED FROM APRIL 19, 1898, TO MAY 17, 1898 INCLUSIVE.

April 19.

Car Truck.—Jacob Mendel, Nyack, N. Y. No. 602,462.

Electric Contact Shoe.—Wm. M. Brown, Johnstown, Pa. No. 602,495.

A continuous contact member in combination with a contiuous elastic member secured thereto.

Electric Railway.—Hosea W. Libbey, Boston, Mass. No. 602,584.

Convertible Street Railway Car.—Geo. Moore, Boston, Mass. No. 602,604.

Consists of grooved frames and sliding shutters to convert car from a closed to an open car.

April 26.

Trolley.—James E. Wells, Syracuse, N. Y. No. 602,923.

Electric Railway.— Chas. F. Haltmann and Chas. Bergman, Pittsburgh, Pa. No. 603,060.

Relates to the construction and arrangement of contact boxes in road bed.

Car Ventilator.—Jacob Norling and Chas. E. Johnson, Chicago, Ill. No. 603,115.

May 3.

Steam Propelled Car.—Albert J. Pitkin, Schenectady, N. Y. No. 603,284.

Combines a steam boiler and engine with car, and mechanism for driving the car from the engine.

Car Fender.—John I. Newburg, Vicksburg, Miss. No. 603,339.

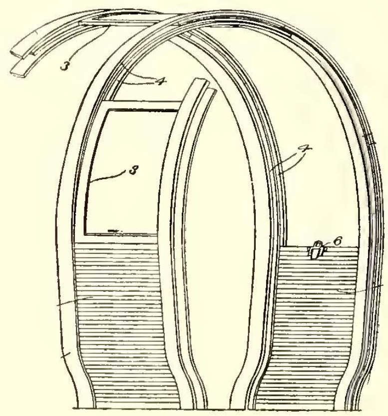
Railway Switch.—Wm. C. Ayers, Plymouth, N. C. No. 603,392.

Car Brake.—Augustus H. Bostley, South Williamsport, Pa. No. 603,439.

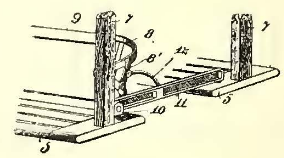
May 10.

Door Guard for Cars.—John B. Burton, Boston, Mass. No. 603,620.

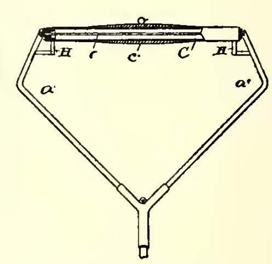
Consists in providing yielding means at the front edge of door to prevent injury to hands in closing door.



PAT. NO. 602,604



PAT. NO. 604,225



PAT. NO. 604,196

Electric Railway.—Eben C. Crocker and Edwin C. Howe, Bridgeport, Conn. No. 603,625.

Combined Truck and Wheel Brake.—Fred W. Wohlenberg, Chicago, Ill. No. 603,716.

Consists in mechanism for applying brake shoes to both the wheel and track simultaneously.

Car Fender.—E. M. Johnson, Brooklyn, N. Y. No. 603,728.

Car Fender.—Isaac Macowsky, New York, N. Y. No. 603,912.

May 17.

Car Fender.—James E. A. Walker, Walkerton, Canada. No. 604,097.

Car Fender.—Joseph Leightham, Reading, Pa. No. 604,171.

Trolley for Electric Railways.—Sidney H. Short, Cleveland, Ohio. No. 604,196.

In an electric railway, the combination of a motor car, and an overhead conductor, with a trolley-arm mounted on the car by means which permit the vertical movement but prevent the lateral movement of the upper end of the trolley arm, a horizontal cylindrical roller mounted on the upper end of said trolley-arm, and a convex sleeve secured upon said roller between its ends.

Gate for Cars.—Henry W. Brett, Moston, Mass. No. 604,225.

A gate attached to two adjacent seats, and adapted to be operated by turning over the seat-back.

We will send copies of specifications and drawings complete of any of the above patents to any address upon receipt of fifteen cents. Give date and number of patent desired. The Street Railway Publishing Company, Havemeyer Building, New York.