Street Railway Journal

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Saratoga as a Convention City

The American Street Railway Association is making a change this year in the policy which it has followed for the last twenty-one years, or since its establishment, by meeting in a small city. Whether this policy will be followed in subsequent years is for the association to determine. We are not sure that a fixed policy to meet in Saratoga or some corresponding small city would be the wisest thing to do, but the association has made no mistake in deciding to try the plan this year. Saratoga has many advantages as a convention city. It is celebrated for its excellent hotel accommodations, is very central for the Eastern States, which furnish the bulk of the membership of the association, and a visit to it makes an attractive trip for all at any time of the year, but particularly during the first two weeks of September. The principal argument in favor of meeting in a large city is that the delegates have an opportunity during the time in which the association is not in session of inspecting local street railway operation, and thus gaining an idea of how others solve the problems in which they themselves are engaged for twelve months in the year. Saratoga itself cannot in one sense supply this opportunity. Nevertheless, although there is no local street railway system in Saratoga, there is much of electric railway interest to be seen in the immediate neighborhood. The city is on a spur of the Hudson Valley Railway Company, one of the longest interurban electric railways in the country, and within easy riding distance are the large water-power plants of Spier Falls and Mechanicsville, the works of the General Electric Company, at Schenectady, and the important chain of city and interurban railways connecting the Hudson River on the south and east with the extensive valley of the Mohawk River.

The Papers and Programme of the American Street Railway Association

The list of papers to be presented at the twenty-second annual meeting of the American Street Railway Association is a most interesting one, and the standing of the gentlemen who are to read the papers is sufficient guarantee that they will be up to the high standard which has been established in previous conventions of the association. All the important branches of electric railway operation are comprised in the programme which has been arranged by President Hutchins and Secretary Penington. They include a treatment of two legal topics, one paper on a subject connected with track construction, one on rolling stock, two papers relating to power station practice, and two which can be considered as of interest particularly to interurban railways. In addition, a report can also be expected from the standing committee on rules and one from the committee on standards. There is no one of these topics, except possibly on interurban railway work, which is not of very great interest to all street railway managers, and the growing number of interurban roads, as well as the especial value which papers on train orders and signalling and the transportation of freight and express possess, make a treatment of these topics of great interest. The meetings of the association are essentially experience meetings, and we sincerely trust that every delegate who attends the convention will do so with the express intention of contributing some results of his experience to the association on at least one of the topics which are to be discussed. If this plan is followed the success of the convention from a technical standpoint is assured.

Through the courtesy of the Hon. A. B. Colvin, president of the Hudson Valley Railway Company, and through that of the General Electric Company, three attractive excursions have been arranged during the three days of the convention. The excursions in the neighborhood of Saratoga are among the most enjoyable of any of the country, as the Saratoga region is not only very picturesque, but possess great historical interest. Within a few miles of Saratoga Springs have occurred many of the most deadly contested battles conducted during the French and Indian War and later during the War of the Revolution, while the pen of Cooper and other writers of fiction has lent a touch of romance to many of the scenes which lightens the more grisly aspect of actual warfare. With Lake George on the north, Saratoga Lake on the east, Schenectady on the south, and the manifold charms of Saratoga Springs themselves, the visitor to Saratoga will find much to occupy him whether he is in search of picturesque or historical scenes, the more practical achievements in electrical science of a later day, or desires to spend a few leisure hours in the many pleasures afforded in a typical American summer resort.

The Accountants' Convention

The programme of the Street Railway Accountants' Association meeting is, like those of past years, a very practical one. This has been one of the strong features of this association, and also one of the causes of its success, in that it has aimed at practical assistance toward solving live problems within its line of work.

The paper entitled "Freight and Express Accounts," by Irwin Fullerton, general auditor Detroit United Railway, is upon a subject that is holding the attention of all interurban companies, and many urban companies at this present time. Mr. Fullerton is located in a part of the country where this branch of electric railroading is at a high mark, and his paper will be of thorough interest. Added to this is the discussion which will follow from the accountants of other sections, so that the result should be for the betterment of this accounting. "Car Maintenance Records," by S. C. Stivers, who has just left the Jersey City, Hoboken & Paterson Street Railway, is of interest because a wide diversity exists in the treatment of the details of car maintenance, and this will probably result in more uniformity.

No title has been given to the "paper or address by a representative of the United States Census Bureau," but as the Census Bureau used the standard classification of the association, it no doubt will be along the lines of its experience with it. Anything its representative will say will be of value as throwing a side light upon the classification which has been so cordially received by electric railway interests.

The "Reportof the Committee on a Standard Form of Report for Electric Railways" is of great importance, because of the discussion which preceded its experimental approval last year. Since then it has been adopted by the National Association of Railroad Commissioners at their convention in Portland, Maine, in July of this year. The arguments against it at the Accountants' convention last year seem not to have developed strength, but it will probably be taken up in a thorough manner again.

Individual opinion is wide apart on the method of conductors' remittances, and, like so many of the subjects interesting to the operator, it has never been thoroughly discussed, therefore the paper by Frank R. Henry, auditor St. Louis Transit Company, entitled "The Advantages and Disadvantages of the Bag System as Compared with the Receiver System of Handling Conductors' Remittances," will open up a discussion that will, it is hoped, benefit this much vexed problem.

C. N. Duffy, secretary Chicago City Railway, and chairman of the committee which formulated the standard classification, is always interesting, therefore his comparison of the American standard with the proposed British municipal standard, should be interesting to our British friends as to us. While, of course, America is not called upon to discuss the proposed British standard, it can do no harm, and it may point out the desirability of international uniformity along the American line, as this paper showed in its editorial columns Aug. 1.

A new idea is to be tried in "Replies to Questions," which is to throw open a portion of each session to the asking and replying to any questions not provided for in the programme. This should be a popular feature, and we understand it is not necessary for the questioner to be present, but by writing the question the answers will be given in the verbatim report, which is always published immediately after the convention.

Taken as a whole, this programme is full of promise, and in the light of past performances by this association, it will be turned to account before the convention is over.

The Meeting of the American Railway Mechanical & Electrical Association

The Saratoga Convention will be noteworthy from the fact that at it will be held the first regular meeting of the American Railway Mechanical & Electrical Association, which convenes one day earlier than either of the two other associations, that is, the first meeting will be held at 10:30 a. m. on Tuesday, September 1. The papers to be read at the meeting have already been printed and distributed to the members, and present an array of interesting topics which should elicit an extended discussion. The association has a wide sphere of usefulness and can, by concerted effort, effect as important improvements in the mechanical side of street railway operation as has already been accomplished in accounting by the older Accountants' Association. When we consider the topics to be treated at the Saratoga meeting, which include two papers on repair shop practice, two on controlling mechanism, one on motors, and one on rolling stock, it will be seen that the four days selected by the association for its meeting this year are none too long to cover the field mapped out in the programme. We believe that the Saratoga meeting of this association will be the first one only of a most honorable and useful career, and one which will reflect great credit on the foresight of those who organized the association and those who have joined its membership.

The Electric Railways in the Hudson and Mohawk Valleys

Electric railways in the vicinity of Saratoga present many interesting features for the consideration of practical railway managers and engineers, for while the convention city itself has no distinctive street railway facilities whatever, and may be said to be almost entirely without a local service, it is connected with some of the most important properties of this class in the Empire State, all of which are easily accessible to it. The principal features of these enterprises are outlined and discussed in the series of articles on "Electric Railway Attractions of Saratoga and Vicinity," which form an important part of this issue. By reference to the map of the district, which accompanies these articles, it will be seen that there has been a remarkable growth of electric lines in the Hudson and Mohawk Valleys, centering at Albany and extending as far north as Warrensburg and south to Hudson.

The territory served by these electric lines had already enjoyed steam railroad service that was far superior to that of almost any other part of the country, but the abundant water-power available favored the cheap production of electric current, and ways and means were quickly devised for utilizing it. At the present time the water-power development is one of the largest and most important in the country, and just now its value is greatly enhanced because of the increasing cost of fuel. The magnitude of the transmission system, too, and the refinements that have been introduced add to the interest of this feature of the work. But while the water-power development has done much for this region, and is confidently expected to do still more, it has been found impracticable to discard steam power, and, as a matter of fact, one of the most important recent additions is a steam-driven interurban power plant, designed in accordance with the latest practice. This equipment furnishes power for the operation of the Fonda, Johnstown & Gloversville system, and is described in detail elsewhere. On the other hand the United Traction Company, the Hudson Valley Company and the Schenectady Railway Company are depending more and more on water-power, and the first-named company is even now preparing to dismantle its remaining steam plants. A comprehensive system of feeding the transmission lines upon which these railways depend has been worked out, and ultimately it is expected that provision will be made against every contingency that would necessitate a shut down or seriously cripple the service.

In other features of construction and equipment the properties of this section, although pioneers, rank high in comparison with similar enterprises. Bold engineering marked the laying out of many routes, and while this gave them an advantage as scenic railways it necessitated a high standard of track and line construction and the use of cars equipped with approved safety appliances. In spite of the fact that most of the present properties are made up of smaller roads, which were absorbed and welded together, they have been improved or rebuilt, so that they now form a very creditable system. High speed is maintained on all the interurban lines, and the suburban service has here reached a point that for cities of the size served is in a class distinctly its own.

From an operating point of view a better locality could not be found for holding a street railway convention, as every class of service—city, suburban and interurban, excursion and tourist traffic, freight and express business—are all to be found here. The natural center of this development is Albany, the capital city and most important electric railway point in that part of the State, and the predominating influence is the United Traction Company, which controls the transportation facilities of Albany, Troy, Cohoes, Watervliet and Rensselaer, and thus holds the key to the situation. This company has confined its operations to the local and suburban service of the cities it controls, and its policy is a guarantee of non-interference with the companies developing the interurban business. This has enabled the projectors of this class of road to develop new fields with confidence, and has, at the same time, assured them admittance to the "five cities," an important consideration in that section, especially for companies handling freight and express. This branch of the service has already been developed to a point where it is apparent that electric railways can handle it with profit. At the present time the steam and electric roads are working much more harmoniously than formerly, and in several cases they exchange traffic. This condition has not always prevailed, however, but the New York courts last year decided that electric railways could compel steam roads to permit the establishment of a physical connection between the systems and accept business involving transfers between their roads; in other words, the electric railway was recognized as a common carrier, and the steam road prevented from discriminating against it. The express companies find it to their advantage to recognize the electric lines and cater to them. Altogether, it will be seen, therefore, that street railway men visiting Saratoga will find much in the properties of that section to command their earnest attention.

Our Convention Issue

Following the series of articles in this issue on the electric railway system in the Hudson and Mohawk Valleys, we have attempted to outline briefly the standard practice of the largest cities in this country in track construction, overhead construction, power stations and rolling stock. In these chapters the methods followed in New York and Brooklyn have been omitted, as the practice in these cities was so fully discussed in our New York convention number published in October, 1901. We realize that outside of the fourteen or fifteen cities selected for this discussion on city practice, there is much that is of value and worthy of adoption. The space at our disposal, however, permitted us only to take up the practice of a certain limited number of cities, and the data from these have been grouped in a way which, so far as we know, has never been followed before. In other words, a comparison has been made at one time of the practice of the various companies considered, so that the differences between them can be readily understood. We cannot attempt here to discuss editorially all the topics treated in the several chapters, as in each subdivision of the subject a series of general conclusions has been appended in which a comparison is drawn of the plans followed. We believe, however, that the general trend of practice of the different companies whose methods are discussed in this series of articles will be found of practical value by constructing and operating engineers in all parts of the world.

Mr. Dawson's Article

We present in Mr. Dawson's able paper a very judicious *resume* of current international practice in power station operation. It is not strange that common necessities and requirements should have produced a certain unity of method, yet the divergencies from a common standard are conspicuous and instructive. In the general matter of power station design we feel that the influences now at work are likely to effect considerable changes in the next few years. Looking at the subject in its broad aspects, it is apparent that in the century now begun the fuel question is likely to take on a far more serious aspect than in the past, and that the engineer will find the necessity of economy in fuel ever more and more imperative. Up to the present the aim of, perhaps, the majority of improvements, has been the reduction of labor costs, with highly successful results, but at the present time there is every indication that the price of fuel is rising more rapidly than the price of labor, and that future efforts should be directed mainly at fuel economies. Moreover, nothing is more certain than that interest charges have entered in this country upon a downward gradient, so that capital investment is already far less of a burden than it was a decade since. The normal and proper tendency in station design would, therefore, appear to be the diminution of operating expense, both of fuel and labor, even at the cost of considerable increased investment. This is the more important since the depreciation charges on modern machinery are materially less than they were a few years ago, so that on the whole the fixed charges are diminishing while the fuel charge is increasing, and the labor charge is barely holding its own, and, perhaps, even has a downward tendency.

These conditions, while general all over the world, have affected the world gradually, and our own country only recently. In England the capital charges are low, and the labor charge, while less than here, is still materially greater than on the Continent. This condition has materially affected the design not only of power stations, but of the machinery installed in them. Some of the peculiarities of German practice, as instanced by Mr. Dawson, speak plainly on this point. High superheating of the steam has generally been regarded here, and in fact in England, as "too troublesome" or "too theoretical," or too something or other else, but in Germany they have neither spared the trouble nor the theory, and have reached in virtue of their labor some truly remarkable results. If the triple expansion engine was the thing that saved steam the triple expansion engine was the thing they wanted, and in it went, never mind if it was a trifle more complicated and required a little more care. And we are strongly of the opinion that the need of economy, together with the competition of the steam turbine, will compel the use of the triple expansion engine here. In stations large enough to insure a good load factor there is no valid objection to its use. In the same way the

Germans and Continental engineers generally like to connect all the auxiliaries possible to the main prime mover. This, to our eyes, seems clumsy and inconvenient, but it undeniably saves power over either steam or electric auxiliaries, and that is what counts in the long run under Continental conditions. Mr. Dawson very justly remarks that English and American engineers aim at simplicity in design, which is in itself a good thing; but there is a kind of simplicity which contents itself with being "just about as good," and there is still another kind which accomplishes, by means of a single intricate piece, what could be done as well by two simple pieces. Neither sort is especially commendable. We do not say these things in reproach, but as a reminder that our Teutonic friends are not so far behind us as we sometimes love to think.

We think that Mr. Dawson does not overestimate the importance of the steam turbine. This truly remarkable machine is forcing its way very rapidly. Its strongest points are its high rotative speed as applied to driving alternators, and its very uniform economy under widely varying loads. Both these advantages are somewhat reduced by the difficulty of designing direct-current dynamos for turbine speeds, and its consequent inapplicability to small and moderate-sized railway plants in which its uniform efficiency would be particularly available. Its best hold in large stations is its economy of space, which again is reduced in value by its special suitability to alternators which can readily be placed where saving in space counts for little. Of course, the adoption of alternating motors or a great improvement in the reduction of alternating to direct current would remove these disabilities and very greatly increase the use of the turbine. The gas engine as a prime mover is one of the most interesting of possibilities. It certainly is capable of greater economy than any steam engine has yet shown, but it is, nevertheless, not in a satisfactory state. That it will be greatly improved is certain, but whether it will soon compete with the steam engine is quite another matter. The same economic forces that tend to compel modifications of practice in the direction of fuel economy act as a direct stimulus to improvements in the gas engine, and the result may well be sensational. If the steam engine is to be our main reliance in the future, as in the past, we are inclined to think that improvement in furnaces is likely to lead to greater economies than improvements in any other single direction. One has only to look at a series of boiler tests to be impressed with the fact that proper burning of the fuel is the exception rather than the rule. The evaporative efficiency of a single type of boiler varies more than any other factor in power production, and this is a matter mainly depending on the design and operation of the furnace. One must watch the fuel from coal pocket to stack in order to insure proper economy in its use.

The Design of City Power Stations

The general theory of power house design applies to city stations as well as others, but in large urban systems certain conditions arise which greatly modify the factors which control location and design. These in chief are the cost of real estate, cost of water supply, and the great mass and density of the traffic. In the case of interurban roads or those in and about the smaller cities the cost of real estate is not a serious matter. It is a small fraction of the total investment and within the area near enough to the center of load to be considered it is fairly uniform. Likewise the water supply, especially for condensation, can generally be obtained quite easily from wells or streams anywhere within the area concerned. As to the traffic, it is usually such in amount and kind that it is hard to get a good load factor, and the output is likely to be greatly affected by temporary local conditions. In large urban stations real estate and water supply are serious matters. It is a tremendously costly matter, even if it would be permitted, to build the power station or stations at the point which economy of distribution would dictate, and even if it were feasible water supply might involve great expense for even a very inadequate supply. As a city gets bigger and bigger the number of sites available on the score of cost, water supply, and, for that matter, fuel supply, rapidly diminishes. As regards load conditions an urban system generally has a far better load factor than usual, and much greater uniformity of load factor with much less likelihood of relatively great and sudden disturbances. As an offset to this advantage the center of load on a large urban system fluctuates with almost tidal regularity, moving in and out from the geometrical center or back and forth with the diurnal movement of passengers. This fluctuation should be taken account of in the distribution system and implies increased feeder capacity.

When the small systems of a decade ago grew to formidable dimensions they rapidly outgrew their power stations, and in the press and hurry of increasing demands all sorts of makeshifts were indulged in to tide over the present emergency. These proved expensive, and have gradually been supplanted by stations laid out with reference to the demands of the system as a whole. As our data here presented show, there are two fairly distinct plans for supplying a great urban load. One is the system of distributed power stations, so thoroughly worked out in the practice of the Boston Elevated Railway Company, the other the central station idea, well exemplified in Baltimore and in several metropolitan instances. The former establishes several stations in the load district and feeding the railway system directly. The other establishes one immense station at some particularly favorable spot and transmits over a separate feeder system high-tension polyphase current to sub-stations with rotaries located at favorable points on the general network. The theoretical questions involved between the two plans are those touching, on the one hand, the cost of generating power in stations of different capacities and load factors, and on the other the cost of distributing and retransforming current in case a single generating plant is chosen. The costs here considered must be based not only on operating expenses, but on the total cost of the energy, including fixed charges, upkeep and depreciation. Most of the misunderstandings in the premises have come from the omission of these latter factors. Not only the relative but the absolute magnitudes of the various stations compared obviously enter the question, together with the magnitude and variations of the load factors. In due time experience will settle the question, but up to our present writing sufficiently complete data from the large central power stations are not at hand. Nothing final is yet known of their economy, and still less of the practical cost of taking their current, transmitting it to the sub-stations and reconverting it into direct current.

One thing, however, appears to us reasonably certain, that when a station gets so big that it should be subdivided and run in practically independent sections to insure safety against a general breakdown, a point has been reached at which there is very little hope of reaching an economy in generation much in excess of that which would be attempted by the sections run independently at separate points. Any material gain must be made in such case by the lessened cost of real estate and water and fuel haulage, and a possible gain in the steadiness of the load factor. As a matter of fact the load factor reached in the separate stations of the Boston system is so high as scarcely to warrant hope of much further gain, so that the question of economy simmers down to an equation between real estate and feeder copper. The greatest gain possible on the one-station plan is in increasing the number of feeding sub-stations, and the economies of this step have not yet been thoroughly discussed. A converting apparatus which does not require attention is greatly to be desired and would change the whole situation most radically. The advent of the steam turbine, on the other hand, lessens the space required for a station and makes it easier to establish separate feeding plants, although the unsuitability of the turbine for direct-current generation is a serious drawback. In a turbine-driven station the boiler space is the most considerable factor, and to keep this within limits a steeple construction of the boilers would seem logically to be the next step. Further economy in generation depends very much on increase in pressures, high superheating and the use of improved turbines and triple expansion engines. In large stations, with high and relatively steady load factors, triple expansion is worth while, and the higher the pressures go the more important is its advantage. Triple expansion is the logical step if the reciprocating engine is to hold its own against the increasing competition of the steam turbine.

The Functions of the Repair Shop

Mr. McCulloch's description of the equipment, operation and methods of the repair shop of the Chicago City Railway is one of the most valuable contributions to the literature of practical railroading that we have seen for some time. It is particularly useful to the railway fraternity on account of the details regarding costs, which throw much light on the vexed questions of maintenance and its cost. The Chicago City road is an excellent one from which to derive data, as it is large enough to justify the establishment of completely equipped repair shops without being so large as to lose its value as an example. It also includes both cable and electric equipments, so that not only does the report give some comparative data, but the shop itself was compelled to do a larger variety of work than would be usual. The first thing to be noted in the equipment of the plant is that no mistakes were made in half-doing it to save initial cost. It was constructed on the theory that such a shop must be able to compete in economy of operation with first-class establisments of far greater size. It must make castings as cheaply as a large foundry, and wind armatures at as low a price as the big electrical manufacturers. Therefore, it was fitted up with the latest forms of machine tools, electrically driven throughout, and was organized as carefully as if it were going into sharp competitive business quite on its own account. The result not only has justified this thoroughness of equipment, but is a lesson on the economy with which a small establishment can do work when well administered. There is no greater mistake than to think that all the advantages in cost lie with the large shop. On the contrary, in the very big establishments there is likely to be a vast amount of "lost motion" between ordering a thing and getting it done, all of which costs good money.

Very few persons outside of the executive departments of street railways have any adequate notion of the work that is cut out for the repair shop of any large street railway system. The Chicago City Railway operated in 1902, for which year the data are given, 527 motor equipments and 172 grip cars, making a total, including trailers, of about 900 to 1000 cars. It has a little over a hundred miles of double track, of which about 40 per cent is cable road and the rest electric. Yet on this system the repair shops required the services of from 300 to 350 men, including the repair force in the car houses, and the repair force including the car house crews, ran up a yearly pay roll of more than $350,000, to say nothing of materials used. This fact is respectfully commended to the non-technical reader who labors under the delusion that incidental expenses are moderate. To be sure, the repair shops in this case do no small amount of work which most repair shops do not attempt, but on the other hand the equipment is such as to tend toward reduction of labor costs. It is not so much, however, the total pay roll that is striking as the itemized report showing the distribution of repair costs. For instance, the average man does not realize at all the cost of maintaining a car equipment. Unless he is in the railway business he looks upon it rather lightly, and even if he knows something about it he is apt to be misled by glib recitals of percentages of depreciation and the small cost of repairs superinduced by "our latest type R. S. V. P. 4-11-44 equipment." The weary souls who stand over the system 24 hours per day to foot up the leering lines of the monthly expense list know better, but generally hold their peace. But here are some of the figures. The repairs and renewals on motors and the purely electrical equipment of the cars averaged $134.21 per motor car. This does not look much like the current estimates of depreciation, does it, long-suffering friend? And then there is to be added another cheerful item of $28 per equipment for inspection and ordinary supplies, bringing the total maintenance charge to $162.21 per car.

This result, it should be borne in mind, is from a good-sized road, well operated and successful, in which the very repair shop equipment we are considering has brought down the costs of work to a point very considerably below those which would commonly be charged for the same items. We would much like to see an equally rigid analysis of the maintenance charges on a road of only average size and under only ordinarily good management. The results would not be cheerful reading, but they would be a good lesson to the gibbering idiots who are chortling about 3-cent fares and figuring salesman's depreciations and repairs. The thorough organization and equipment of the repair shops under consideration have encouraged the undertaking of repairs and minor manufactures of a kind not usually attempted except in emergencies. Many roads do more or less at rewinding armatures and fields, but few go so far as to strip, retape and rewind the wire of burnt-out fields or to reforge old axles into guard irons and switch tongues, let alone manufacturing special track work for crossings. The costs given by Mr. McCulloch for armature and field winding on the various types of motors in common use are very instructive, and while a good many roads may find it difficult to duplicate them, others, which have the advantage of relatively low-priced labor, will find it quite possible to do so. It is always a nice question how far it pays to go into heavy repair work and minor manufacturing, and each road must settle the question for itself. The danger from an economic standpoint lies in the tendency of repairs to make repairs. Does, for example, a field rewound from scrap copper retaped stand up as well as a new field, and will a switch tongue forged from axle steel last like one made from special steel for the purpose? These are questions that must be answered by experience, and while the results in Chicago have apparently been good we should greatly dislike to guarantee similar satisfaction in the average repair shop. Nevertheless, the Chicago City Railway has set a pace that is stimulating.


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THE COMING CONVENTIONS

AMERICAN STREET RAILWAY ASSOCIATION

The meetings of the American Street Railway Association will be held in the ball room of the Grand Union Hotel, Saratoga Springs, on the afternoon of Wednesday, Sept. 2, and on the mornings of Thursday, Sept. 3 and 4. The programme of the Association is as follows:

Wednesday, Sept. 2, a. m. Registration.
2:00 p. m. First session.
Address of welcome, by Mayor Knapp.
President's address.
Report of the executive committee.
Report of the secretary-treasurer.
Presentation of papers.
8:00 p. m. Excursion to Saratoga Casino upon invitation of the Hudson Valley Railroad Company.

Thursday, Sept. 3.
10:00 a. m. Session.
Presentation and discussion of papers.
1:00 p. m. Excursion to the works of the General Electric Company at Schenectady, upon invitation of the General Electric Company.

Friday, Sept. 4.
10:00 a. m. Session.
Election of officers and any unfinished business.
1:00 p. m. Excursion to Lake George on train drawn by electric locomotive, upon invitation of the Hudson Valley Railroad Company.
8:00 p. m. Banquet in the ball room of the Grand Union Hotel.

The titles of the papers to be presented are announced as follows:

"The Right of Way," by Herbert H. Vreeland, of New York.

"Comparative Merits of Single and Double Truck Cars for City Service," by John I. Beggs, of Milwaukee.

"The Manufacture and Distribution of Alternating Currents for City Systems," by Richard McCulloch, of Chicago.

"Freight and Express on Electric Railways," by J. B. McClary," of Birmingham.

"Train Orders and Train Signals on Interurban Roads," by T. E. Mitten, of Buffalo.

"The Evils of Maintenance and Champerty in Personal Injury Cases," by Michael Brennan, of Detroit.

"Electrically Welded Joints," by William Pestell, formerly of Worcester, and now of J. G. White & Co.

"Steam Turbines," by W. L. R. Emmett, of the General Electric Company, Schenectady.

THE STREET RAILWAY ACCOUNTANTS OF AMERICA

The meetings of this association will be held in one of the club rooms at the end of the court piazza of the Grand Union Hotel. The entrance will be found very near the headquarters of the Street Railway Journal. The following programme has been adopted for the Saratoga meeting:

Wednesday, Sept. 2, 1903.—In Convention Hall, Grand Union Hotel. 10 a. m., sharp.
Annual address of the president.
Annual report of the executive committee.
Annual report of the secretary-treasurer.
Paper: "Freight and Express Accounts," by Irwin Fullerton, general auditor, Detroit United Railway, Detroit, Mich.
Appointment of convention committee on nominations.
Appointment of convention committee on resolutions.
Replies to questions.

Thursday, Sept. 3, 1903.—10 a. m., sharp.
Paper: "Car Maintenance Records," by S. C. Stivers, New Jersey & Hudson River Railway, Edgewater, N. J.
Paper or address by a representative of the United States Census Bureau.
Report of the committee on a standard form of report for electric railways. Chariman, William F. Ham, comptroller Washington Railway & Electric Company, Washington, D. C.
Replies to questions.

Friday, Sept. 4, 1903.—10 a. m., sharp.
Paper: "Advantages and Disadvantages of Bag or Envelope Receiver System of Conductors' Deposits," by F. R. Henry, auditor St. Louis Transit Company, St. Louis, Mo.
"Comparison of the Municipal Tramways Association of Great Britain, Proposed Standard Classification and Form of Report with the American Standard," by C. N. Duffy, secretary Chicago City Railway, Chicago, Ill., chairman committee on standard classification.
Report of committee on resolutions.
Report of committee on nominations.
Election and installations of officers.
Adjournment.

THE AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION

The convention of this Association commences one day earlier than that of the American Street Railway Association, or of the Accountants' Association. The meetings of the Association will be held in one of the club rooms of the Grand Union Hotel, very near the meeting halls of the other two associations, and the first meeting will be held on Tuesday, Sept. 1, 10:30 a. m. An address of welcome will be extended by Hon. Edgar T. Brackett, State Senator of New York State.

The meetings on Sept. 2, 3 and 4 will be called to order at 10:00 a. m. The papers to be read are as follows:

"Shop Kinks," by H. H. Adams, of Baltimore.

"Type-M Control," by W. O. Mundy, of St. Louis.

"Improvements in Street Car Motors," by E. W. Olds, of Milwaukee.

"Care and Maintenance of Car Bodies," by C. F. Baker, of Boston.

"Shop Practice," by Alfred Green, of Rochester.

"The Use and Abuse of Controlling Mechanism," by D. F. Carver, of Jersey City.

ELECTRIC RAILWAY ATTRACTIONS AT SARATOGA AND VICINITY

ELECTRIC railway operators who go to the Saratoga Convention carrying with them the impression that there is little of interest to be seen or heard aside from the exhibits of manufacturers and the sessions of the conventions, will be agreeably disappointed. Within a radius of 50 miles of Saratoga at points accessible by electric travel, are no less than seven systems, each of which affords interesting features in operation and construction. In fact, it would be difficult to find in the entire country a district offering so great a variety of methods as the roads of this section.

Most of the systems in this territory depend upon water-power for operating their plants. This method of generating current, which, by reason of the gradual advancing cost of coal, is bound to receive increasing attention in the future, has reached a high stage of development in this valley, and because of the great variety of these water plants, as well as the magnitude of some of them, the live railway operator will find plenty of opportunity of making a study of this feature under the most favorable circumstances.

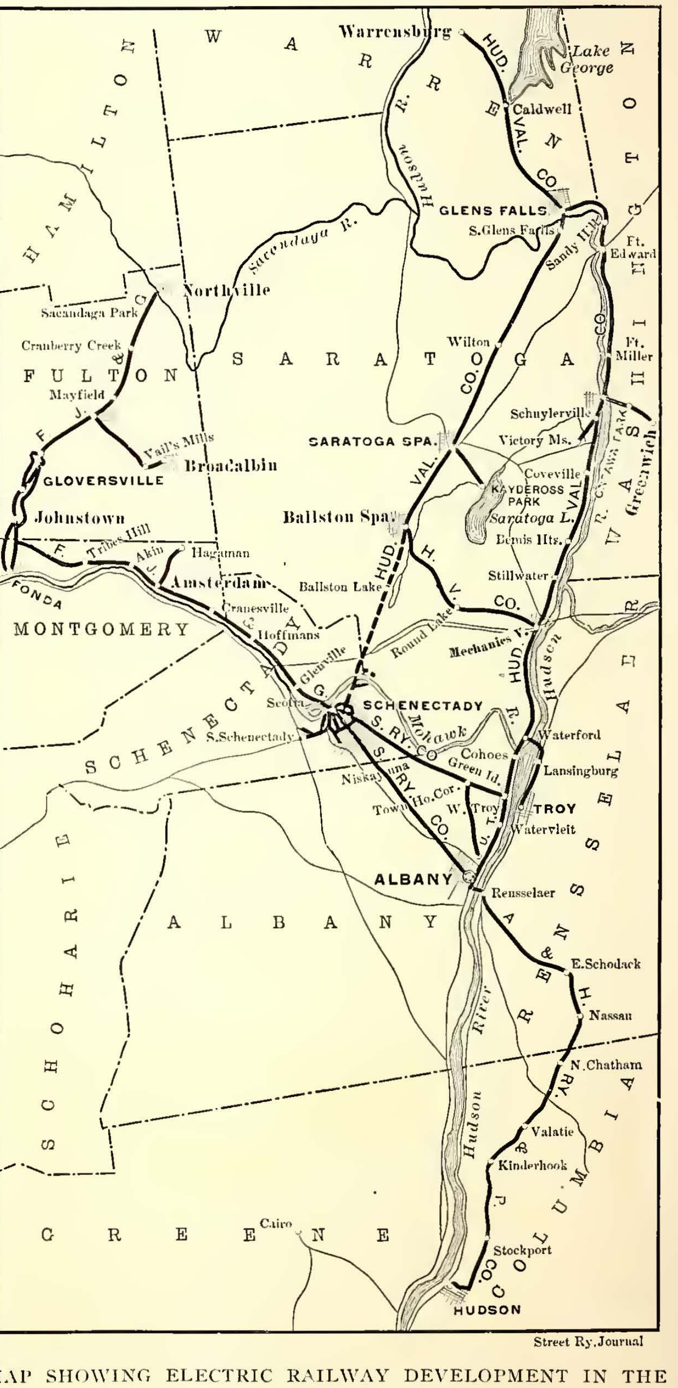
Methods of transmitting and handling current after it has been generated have also received careful attention. In fact, some of the most interesting transmission lines in the country are located in this portion of the Hudson Valley, and not only are these lines remarkable for their length, but for the methods of utilizing and distributing the power. The number of water-power plants, and the great demand for current at widely separated points, have encouraged engineers to work out novel and interesting methods of sectionalizing and grouping the circuits, so that current may be taken from different plants and delivered at various points, thus insuring the consumers protection against breakdown at generating stations and on transmission lines, and at the same time permitting of greater flexibility in the amount of current that may be utilized at any given time or point.

The development of these water-powers and transmission lines has also resulted in the designing of a number of unusually large sub-stations for utilizing and handling the power. Some of these sub-stations supply current for manufacturing purposes, for arc lighting, and for incandescent lighting, as well as for electric railway operation, and in several instances the four varieties of equipment are installed under one roof, forming a complex and interesting layout.

One of the electric railway systems in this district has adopted the method of generating direct current by means of water-wheels and then transforming and transmitting the current at high potential through the use of inverted rotaries. The reasons for utilizing this seemingly roundabout method and the advantages claimed for it are detailed in the succeeding pages.

While water-powers form the principal source of supply in this district, there are also several large and well-equipped steam-power stations, and one of these in particular, which is described in detail, may be commended to the attention of visitors as one of the largest up-to-date interurban power plants in the country.

From the standpoint of roadbed construction the electric roads of Eastern New York show many features of superiority over the general run of lines in other portions of the country. Several of these lines lay in the route of that growing system of electric roads which enthusiasts hope will some day afford unbroken electric travel from New York to Chicago. At any rate, it is evident that the builders have had in mind the possibility that some day they may be called upon



MAP SHOWING ELECTRIC RAILWAY DEVELOPMENT IN THE HUDSON VALLEY

to take care of through high-speed traffic, for while the topography of the country has made it difficult at present, the grades have been brought down to a very low standard. There are numerous extensive cuts and fills, many of the former being through solid rock, and double-track lines are the rule rather than the exception. There are a number of note-

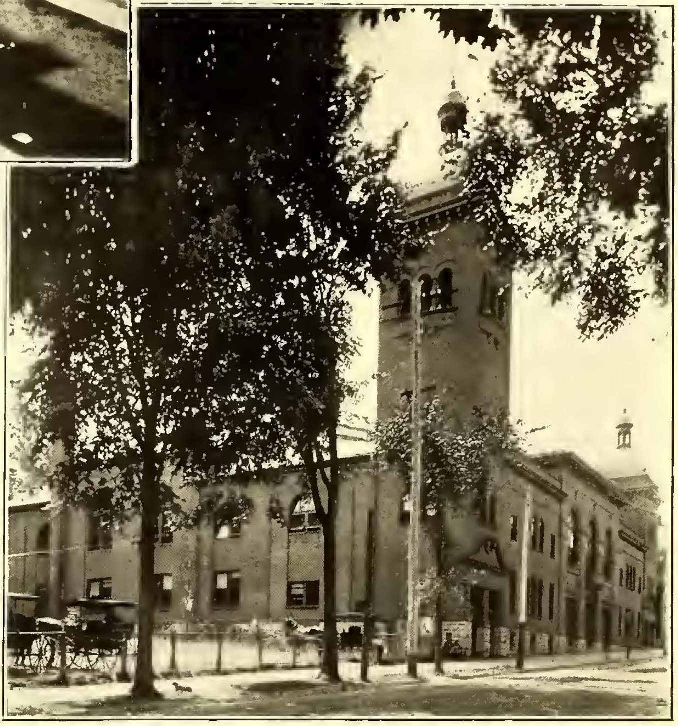
TYPICAL SCENE ON BROADWAY, SARATOGA

worthy steel bridges, and the construction of concrete bridges and crossings has been brought to a high stage of perfection.

The cities and towns are larger and closer together in this district, than they are in the newer western portions of the country, and the headway of the interurban roads is more frequent than on the majority of the best-known lines of the Central West. Half-hourly headway is the usual rule, while some of the roads give fifteen-minute headway over portions of their lines. High-speed is the rule on nearly all the lines in this district. In the matter of rolling stock, as a rule, they compare favorably with modern interurbans elsewhere, and, in some instances, they present the latest and highest examples of the car-builder's art.

The city, as well as the interurban lines of the district, are developing the package express business, but as a rule they are handling freight only as a secondary consideration. The rates for express matter are considerably higher than those received by the majority of the roads that are developing this business in the Middle West. Some of the lines carry on a very profitable exchange of freight and express with the Hudson River steamboat lines, an example which could be followed to advantage in other portions of the country.

In the development of summer traffic the Eastern New York roads can furnish many valuable suggestions. The remarkable scenic beauties of the Mohawk and Hudson valleys give a natural impetus to summer traffic, and this has been stimulated by the establishment of summer parks, and the practice adopted by three of the roads in the erection, at points of natural attraction, of the large summer hotels which are operated by the companies themselves.



CONVENTION HALL

GRAND UNION COURT

THE HUDSON VALLEY RAILWAY

The only electric railway line at present operating into Saratoga is that of the Hudson Valley Railway Company, but it is expected that by the latter part of the year, the Schenectady Railway will gain admission to the city under a traffic arrangement with the Hudson Valley Company from Ballston.

GRAND UNION HOTEL PARK

The Hudson Valley Railway Company was formed in 1901 through the consolidation of the Stillwater & Mechanicsville Street Railway Company, the Greenwich & Schuylerville Electric Railway Company, the Saratoga Traction Company, the Saratoga Northern Railway, the Glens Falls, Sandy Hill & Fort Edward Railway, and the Warren County Railway. These were short lines built by independent interests and merged into the present company by a group of capitalists known as the Powers-Colvin syndicate. Connecting links were built, so that the line now extends from Waterford to Warrensburg, a distance of about 60 miles, with a branch line leaving the main line at Mechanicsville, and running by way of Ballston and Saratoga, and connecting with the main line at South Glens Falls. This system has a spur from Saratoga to Saratoga Lake, and there is also a spur from the main line at Thompson to Greenwich. The section between Saratoga and Glens Falls has only been completed a short time, and it is practically an air line of 18 miles. The total system, including second track and sidings, aggregates 127.73 miles, of which about 88 miles is on private right of way.

HISTORICAL POINTS AND SCENIC ATTRACTIONS

The frequent waterfalls in the Hudson River afford cheap power, which has been taken advantage of by numerous manufacturing establishments, and the valley itself supports a large farming population, thus presenting a very good average per mile. But it is from the summer traffic that the system receives its heaviest returns. There are few portions of this country where nature and history have combined in providing so much to please and interest humanity as in the portion of the Hudson Valley traversed by this road. The noble Hudson, famous thrughout its entire length for beautiful scenery, is less placid in these parts than in the portion below Albany, and is dotted with numerous islands, and interrupted at frequent intervals by the dams and waterfalls, which turn the wheels of many industries and add to the attractiveness of the scenery. It might be mentioned incidentally that the Hudson Valley Company controls a number of these water-powers, some of which are developed and others retained for future requirements. The main line of the system furnishes an almost uninterrupted view of the Hudson for nearly 50 miles, and twice it crosses the river on expensive bridges.

On either side a range of mountains follows the wide valley, and at intervals on the main line one can catch glimpses of the Green Mountains in Vermont, 30 miles or 40 miles distant, while on the Saratoga division, and approaching the northern terminus, may be seen the forest-covered peaks of the Adirondacks. The Saratoga division passes in close proximity to Mount McGregor, famous as a mountain health resort, and as the spot where President U. S. Grant breathed his last. Lake George, near the northern terminus, has been described by many writers as the most beautiful lake in America. The southern end of the lake was selected by the company as the site for its chief summer resort.

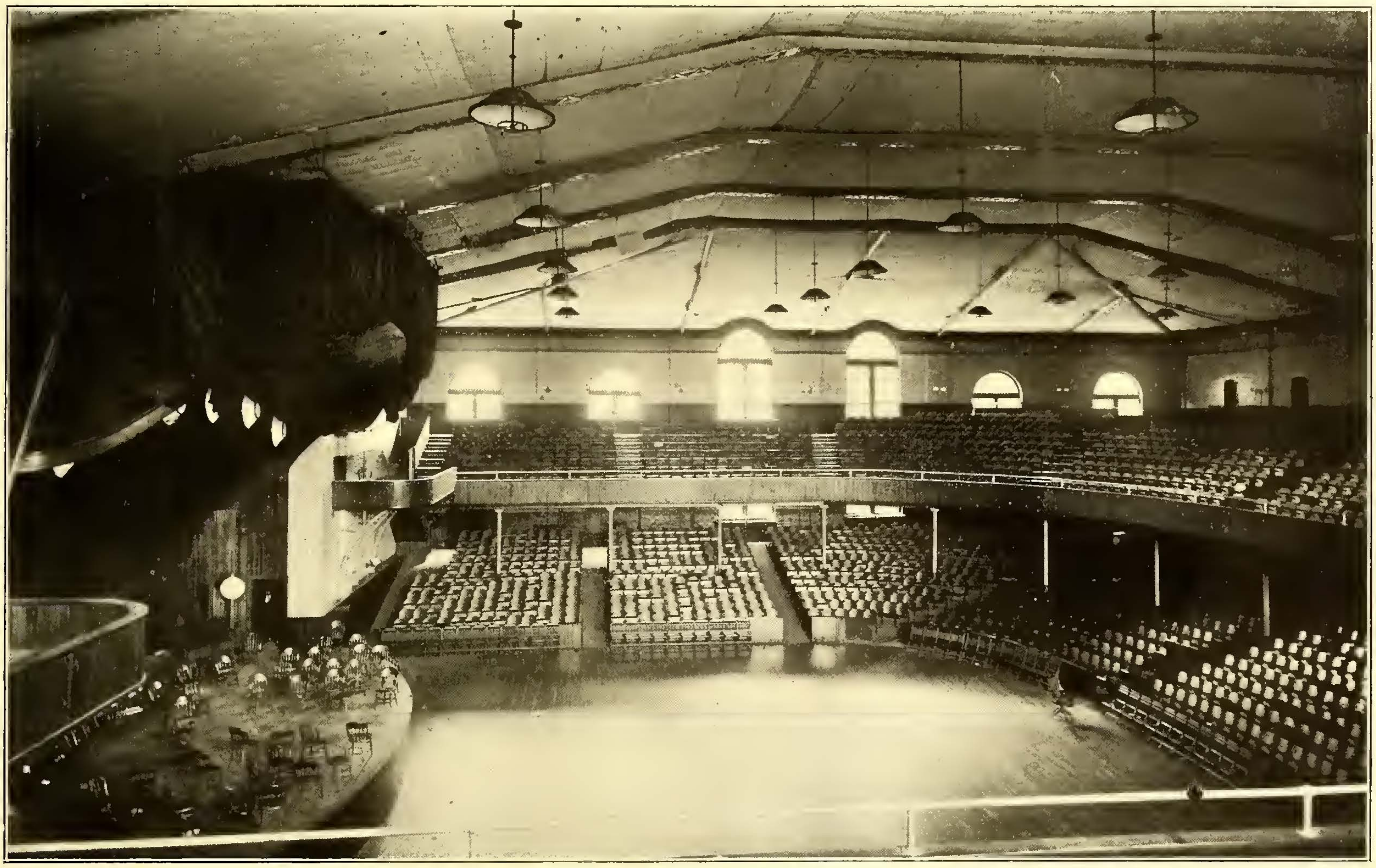
CONGRESS PARK

Many and varied are the historic attractions of this portion of the valley. Every hill and vale in the entire district has been the scene of warfare, first, between the early settlers and the Indians; later, between the French and Indians on one side and the colonials and the English on the other, and still later, between the veterans of George III. and the Revolutionary heroes.

Waterford, at the southern terminus of the company's property, is famous as the center of the knit goods trade. Tradition says that this was the northern point reached by Henry Hudson, when, in 1610, the "Half Moon" crept up the Hudson. A short distance south of Mechanicsville is the power station of the Hudson River Power Transmission Company, which supplies power to a number of electric roads and plants in this district. Here also are grouped a number of important manufacturing industries, which derive their power from the river. Stillwater, a few miles north on the main line, was settled in 1690, and has several manufacturing plants. The town was the base for the American army during its campaign against Burgoyne. Several battles were fought in that section, and all over a wide district are battlefield tablets marking the graves of English or American soldiers.

Schuylerville is rich in its historic interests. It was settled in 1690 by the illustrious Schuyler family, and a short distance from the village is to be seen the old Schuyler mansion, erected by soldiers of the American army shortly after the surrender of Burgoyne. To the west of the village is the famous Saratoga battle monument, marking the scene of the great American victory of Saratoga. Near Moses' Kill the line crosses a fine concrete bridge, and a short distance from this point there is one of the most beautiful views in the entire valley. Fort Edward is the site of several famous fortresses in colonial and revolutionary days. Near the center of the town is a memorial erected to Jane McCrea, the "maiden martyr" of the Revolution, who was murdered there by Burgoyne's Indians. Near Sandy Hill are the car houses, shops and largest steam power stations of the Hudson Valley Company. Here, also are several large factories driven by water-power.

Glens Falls, a live city of 20,000 inhabitants, and the headquarters of the system, is famous for its beautiful waterfalls and the paper manufacturing industry which this water-power has made possible. A few miles north of Glens Falls the road almost loses itself in the forests at the base of French Mountain, historic in French and Indian warfare. Near Caldwell are the ruins of Fort William Henry, and not far distant are those of Fort George. At Warrensburg, the northern terminus of the line, are a number of large mills. The town is almost surrounded by hills and mountains.



INTERIOR OF "CONVENTION HALL," SARATOGA, WHERE THE STATE POLITICAL CONVENTIONS ARE HELD

SARATOGA

The branch line to Saratoga leaves the main line at Mechanicsville, passing Willow, Glen, Round Lake and Ballston. In the early part of the last century, the latter was a famous watering-place, and there are a number of ancient hotels, which in the twenties were the Mecca for gay society. But the mineral springs which made the place famous have failed, and it has now settled down to a quiet manufacturing town.

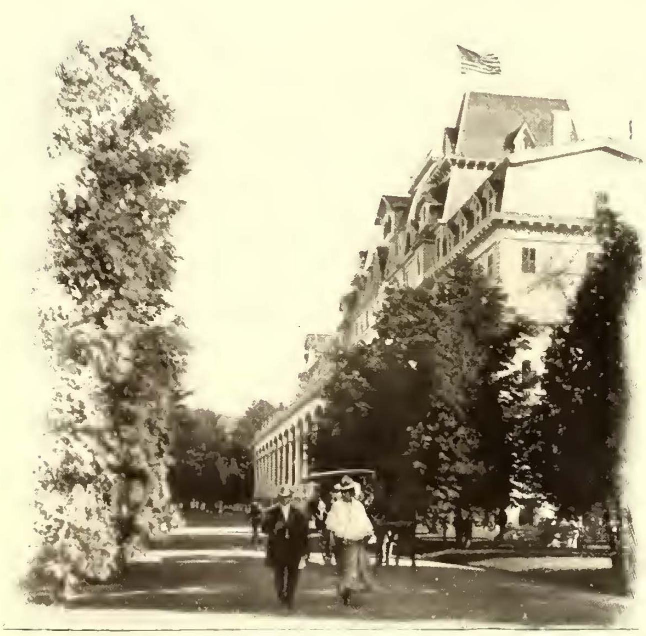
The fame of Saratoga is too well known to require detailing. The entire district bubbles with mineral springs, the waters of which have acquired a national reputation. As a center for fashionable summer life, Saratoga has long rivaled Newport. The huge hotels which line Broadway accommodate many thousands of guests, and by reason of this fact, Saratoga has of late years acquired a widespread reputation as a convention city. Convention Hall, Saratoga, has been the scene of hundreds of political, fraternal and trade conventions. Saratoga Lake, 3 miles from the city, is the site of Kaydeross Park, one of the several resorts owned by the company.

OPERATION

The Hudson Valley Railway does not pass through Saratoga, as the citizens are unwilling that famous Broadway shall be

TROLLEY LINE CROSSING SCHROON RIVER AT WARRENSBURG

traversed or even crossed by an electric road. The southern division terminates in the neat terminal station on Broadway opposite Congress Park and within a few steps of the Congress Hall and Grand Union Hotels. The northern portion of the Saratoga division ends on a street parallel to Broadway about four blocks from the terminal station. The company has not given up hopes of operating cars through the city, and expects



FORT WILLIAM HENRY HOTEL AT LAKE GEORGE

soon to complete arrangements whereby the two sections of the Saratoga division will be connected.

At present the system is operated in three divisions. One division extends from Troy; that city is entered over the tracks of the United Traction Company. The line extends to Fort Edward, including the southern portion of the main line and the Greenwich branch. A second division comprises the southern portion of the Saratoga branch, and includes the spur line to Saratoga Lake. The third division includes the northern portion of the Saratoga branch and that portion of the main line extending from Fort Edward to Warrensburg. Cars alternate out of Troy on half-hourly headway, one car going to Saratoga and the next going through on the main line to Fort Edward. The car to Saratoga connects in that place with a car on the northern portion of the Saratoga branch, and this car operates through Glens Falls to Warrensburg. City cars operate between Glens Falls, Sandy Hill and Fort Edward on 7½-minute to 15-minute headway, and these cars transfer the through passengers from the main line to the cars which go to Warrensburg. Cars on the Greenwich branch operate south to Schuylerville on the hourly headway, so that there is half-hourly service through Schuyler to Thomson Junction. Between Saratoga and Ballston, and between Saratoga and Saratoga Lake, there is 15-minute headway.

EXCURSION AND FREIGHT BUSINESS

The company pays particular attention to special excursion business, and for this service furnishes either an open car seating ninety passengers, or a parlor car seating twenty-five passengers, and furnished with refrigerator, tables for serving lunch, etc. An extra charge of $10 is made for the latter car. The charge for a special car from Waterford to Warrensburg is $92, and a charge of $5 and $10,

TROLLEY LINE NEAR MT. M'GREGOR

respectively, is made for cars run into Troy and Albany. If desired, special cars are run in trains drawn by an electric locomotive.

The company has a traffic arrangement with the United

FORT WILLIAM HENRY DOCK

Traction Company to run its cars through to the center of Albany, but at present this is not done.

Formerly the company operated an express business over the entire system, but at present this is not in effect. Freight cars from steam roads are handled over portions of the system between Mechanicsville and Glens Falls. These are handled for the factories along the line, and switching charges are made. The only portion of the system over which regular express business is conducted is between Greenwich and Schuylerville. Two cars per day are operated over this portion. The reason for the partial abandonment of this important branch of the business is the loss sustained by the company in the recent strike, when the road was practically tied-up for nearly two months. Before the strike, plans had been made to rebuild and improve the system in many ways, but the loss occasioned by these labor troubles has prevented the execution of many of the projects.

INTERURBAN SERVICE

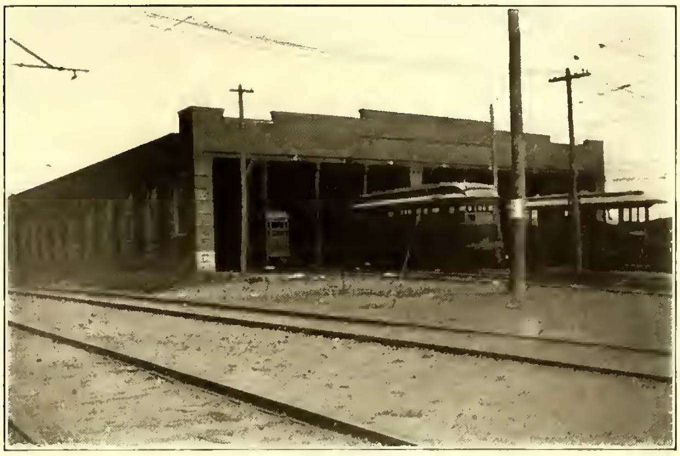
For interurban service there are sixteen 42-ft. closed cars, thirty-two 42-ft., 15-bench open cars, and five thirteen-bench open cars; also about fifty smaller single-truck cars for use on the city lines. For express service there are eight 40-ft. express cars, while for handling freight and construction trains two electric locomotives of standard type are equipped with four 75-hp motors. Among other rolling stock are six snow plows of the nose type, and one rotary snow plow; 20 hand cars, 10 push cars, one rail-laying car, and one gasoline inspection car. All the cars were made by J. M. Jones' Sons, of West Troy, N. Y. The interurban cars are equipped with four 50-hp Westinghouse motors and have the Westinghouse automatic air equipment.

The interurban cars have Ohmer fair registers. The present system of selling tickets is somewhat complicated, in view of the fact that cars do not run from one terminus to the other. Tickets are sold only from point to point, and the conductor takes up a coupon for each portion of the trip as it is covered. The conductor must turn in a coupon for each division of the line for which a passenger is carried, and each coupon is marked with a value for the accounting department. Mileage books containing $10 worth of coupons are sold for $7.50. Weekly limited tickets for twelve round-trip rides are sold between any two points for one-half of the regular fair. Between Glens Falls, Sandy Hill and Fort Edward tickets are sold at the rate of 33 for $1.00, each ticket being good for a five-cent fare. These books are limited to three months.

POWER EQUIPMENT

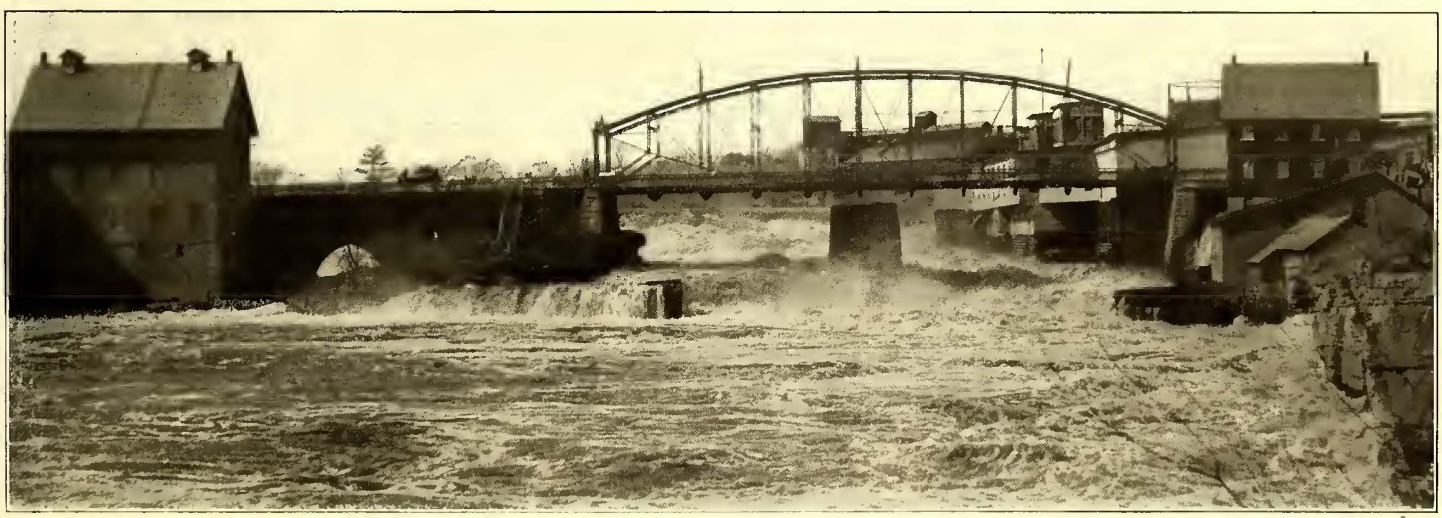
The present power equipment of the Hudson Valley Company is a heterogeneous mixture of old and new, combining, as it does, the equipment of the consolidated roads. At present there are five power stations in operation, four of which are combined water and steam plants. There are also six sub-stations.

Early in the fall of 1902 it was decided to build a large dam on the Hudson River, or purchase power from the Hudson River Water-Power Company. With this in view, and knowing it would be impossible to secure quick deliveries on apparatus suitable for this kind of work, the railway company



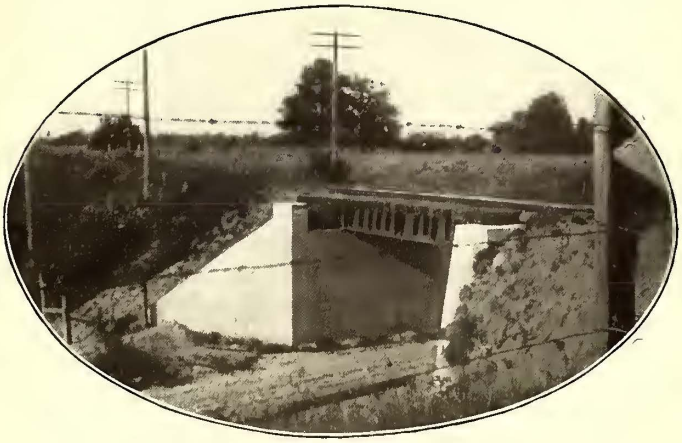
FORT EDWARD CAR HOUSE

ordered eight 300-kw 40-cycle Westinghouse rotary converters, but, owing to labor troubles, it was decided to purchase power temporarily from the Hudson River Power Company and not make any effort to establish a water-power plant at that time. Shortly after this, it became apparent that the Hudson River Water-Power Company would not be able to furnish all the power required by the Hudson Valley Company for the present summer, and these negotiations had to be abandoned. This left the Hudson Valley Railway Company with eight complete sub-station outfits, but with no available power to drive them. These conditions resulted in the employment of the rotaries as auxiliaries, and the development of the present system.



TROLLEY CROSSING AT GLENS FALLS

One 300-kw 40-cycle rotary was installed at Warrensburg. It was belted to a 400-hp water-wheel, and separately excited, making a double-current generator, from which direct current was supplied to that end of the line, while alternating-current was furnished through step-up transformers at 22,000 volts to Lake George, a distance of 7½ miles. Lowering transformers and a rotary converter were employed to change it to direct-current at 600 volts, at which it was sent out on the line at that point, thus taking care of about 16 miles of railway line. The same general plan was followed in utilizing rotaries at the steam plant in the Queensbury power house, supplying alternat-



STEEL AND CONCRETE CROSSING

ing current at 22,000 volts to the sub-stations at Wilton, a distance of 11 miles in one direction, and Moses Kill, a distance of 14 miles in the opposite direction.

At the Saratoga plant, one of the 300-kw rotaries was belted to a 500-hp engine, using a separate exciter, the same as at Warrensburg. While it is not claimed that this is the most efficient way of operating a road, it has been found to increase greatly the flexibility of the system and show the advantages of using rotary converters as auxiliaries. In fact there are few water-power plants even of the most modern types that do not shut down for occasional short periods, causing great inconvenience to the public and a considerable loss to the company.

The largest steam station is at Queensburg, near Fort Edward. It has a total output of about 1200 hp. The largest unit is an 800-hp Allis tandem compound engine, direct-connected to a 550-kw multipolar 600-volt direct-current generator. It is this machine that supplies direct current to two inverted Westinghouse rotaries of 300-kw capacity. Current from these is stepped up to 22,000 volts, through banks of single-phase oil-cooled transformers, and it then passes over a three-phase transmission

TYPICAL CONCRETE BRIDGE

line to the Wilton sub-station. The remaining machines at Queensburg include a 400-hp Bates straight line engine, belted to a 300-kw generator, and a Lake Erie cross-compound 300-hp engine direct-connected to a 200-kw generator. Steam is supplied by four 250-hp and two 200-hp water-tube boilers, all hand fired. The two largest engines operate condensing, and there are Blake condensers of sufficient capacity to take care of them. There is also installed in this station a booster set in connection with a storage battery which operates in multiple with the line, and takes the peak of the load in this vicinity. The battery is of the Chloride make, has 276 cells, and supplies 400 amps. for three hours.

The switchboard in this station has twelve panels—two alternating current and two direct current panels in connection with the rotaries, four generator panels, one booster panel, and three feeder panels. The instruments are of Westinghouse type, with the exception of a total Weston ammeter and a total Thompson recording wattmeter. The outgoing high-tension lines have long-arm, high-tension circuit breakers, and Westinghouse low-equivalent lightning arresters.

At Saratoga there is an 800-hp steam station. The equipment comprises one 500-hp cross-compound Armington & Sims engine, belted to one 250-kw General Electric generator; also, one 300-hp cross-compound Ball engine, belted to two 100-kw General Electric generators. It is proposed to change this arrangement somewhat and have a 300-kw

STEEL BRIDGE CROSSING HUDSON RIVER

rotary converter, belted to one of the engines, and operated as an alterating-current direct-connected generator, supplying high-tension alternating current to the rotaries at the Round Lake sub-station.

At Stillwater, where there is an 8-ft. fall in the river, there are three 200-hp water-wheels, and a 300-hp engine, the water-wheels being connected by a clutch to a shaft through the center of the house. Belted to the shaft are two 200-kw generators. Steam for the engine is supplied by two 200-hp Franklin boilers.

At Warrensburg, where there is a 13-ft. fall in the river, there is another combined steam and water plant. The water-wheels supply 400 hp, which is conveyed by belt from a shaft to a 300-kw Westinghouse converter, at present used to supply direct current, but to be used later as an alternating-current direct-connected generator to supply alternating current to the sub-station at Caldwell.

At Middle Falls, on the Greenwich spur, there is a 300-hp water-wheel belted to a 200-kw Westinghouse generator, and a 250-hp Knowlson & Kelley engine belted to a 200-kw Westinghouse generator. These supply direct current in their district.

TRANSMISSION

At present there are installed 52 miles of wire for the three-phase transmission system, and it is the intention ultimately to string high-tension lines over the entire system, connecting up all power stations and sub-stations. The company proposes to purchase sufficient current from the Mechanicsville water-power station of the Hudson River Power Company to operate the sub-station near the southern terminus of the line, and arrangements will be made so that, should occasion require it, the Mechanicsville plant could supply power for any of the other sub-stations on the system, of which six are now under construction.

The ultimate plan of operation, however, provides for the utilization of an undeveloped water-power located 3 miles beyond Warrensburg, the northern terminus of the road. The company controls this water-power, and it is believed that with proper equipment about 3000 hp may be developed. It is probable that these plans will be carried out during the coming year, when the value of this rather complex system of operation will be tested. At present the load for the system under average service is about 1200 hp, while the maximum load is about double that. The large water-power plant could be depended upon to take care of the average load, while the smaller water plants would be arranged to take care of the peaks. The smaller water plants would serve as a duplicate, while the steam equipment would form a second reserve. With the Mechanicsville plant offering still another source of supply, it will be seen that there will be practically no possibility of any portion of the system being tied up.

LINE AND TRACK

Owing to the fact that much of the system is very old, portions of the track and overhead are not up-to-date, but on the recently constructed section, between Saratoga and Fort Edward, an 80-lb. rail has been used. This is laid on good standard ties, and figure 8 copper bonds under fish-plates are used. The trolley wire is double 000 figure 8, with side-arm bracket pole construction. The greater portion of the line is ballasted with cinders, there are a number of quiet heavy cuts and fills, and the average grade on the entire system is quite low. A number of highways are crossed by concrete culverts, and there are two concrete arch bridges of very fine appearance. Passing over the Hudson near Thompson, the line crosses a 900-ft. railway bridge. The girders are of timber, braced with steel, and the bridge forms a notable piece of engineering, in that the girders for the twenty spans were built on shore, and then dropped into place upon the stone piers, by means of a steam derrick car. This bridge is illustrated herewith.

PARKS AND LAKE RESORTS

The park properties of the company are as follows: Kaydeross Park, on the shores of Saratoga Lake, comprises about 50 acres of land, well laid out, on a high tableland or bluff overlooking the lake, which stretches away for miles in either direction, thus affording beautiful views and excellent boating facilities. The grounds are attractive, and there are, besides a substantial dwelling-house and office, a large casino, a most excellent and unusually attractive summer theater, a number of booths for refreshments, a boat-house and other buildings.

Ondawa Park is located at Big Falls, on the Greenwich branch, and consists of about 27 acres of woodland, well laid out, on the shores of the Battenkill River, which at this point forces its way through a narrow defile in the rocks, which rise perpendicularly on either side to a height of more than 100 ft. The spot is very picturesque. The cliffs on both sides of the stream are covered with trees and ferns, the river rushes down this channel a raging torrent, and all lovers of nature in her wildest aspects are bound to be attracted here.

IN KAYDEROSS PARK, NEAR SARATOGA

At the southerly end of Lake George is located Fort William Henry Hotel and Park. This property comprises 30 acres of land, a large four-story hotel, capable of accommodating 800 guests (its piazza commanding a fine view of the lake, is 825 ft. long, and 24 ft. wide), a large, new casino, with stage, boat-house and steamboat wharf. The grounds around the hotel are beautifully laid out, and include the site of Fort William Henry, of historic fame.

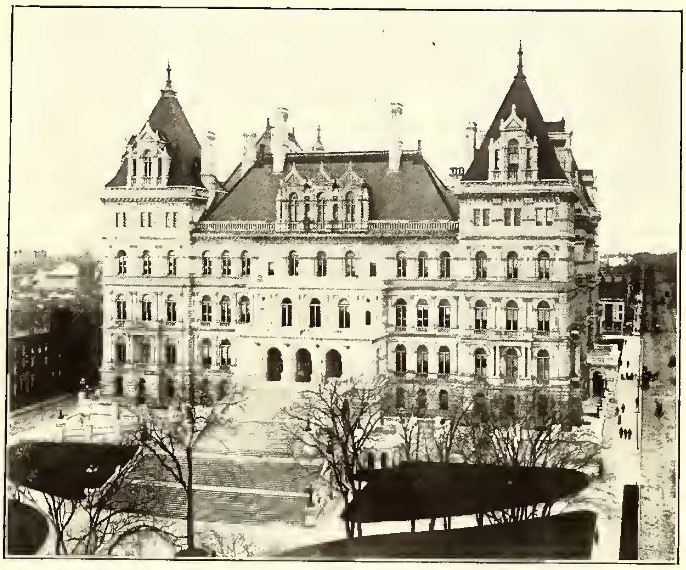
ORGANIZATION

The Hudson Valley Railway Company has an authorized capital stock of $3,000,000, of which $2,272,000 has been issued. The total bond issue is $4,000,000, of which $3,000,000 has been issued. The balance sheet, dated June 30, 1902, showed the cost of road and equipment to be $5,744,057, and other permanent investments of $844,960. This does not include the Saratoga-Glens Falls line, which was recently completed.

The officers of the company are A. B. Colvin, president; John W. Herbert, first vice-president; George Greene, second vice-president; Peter McCarthy, chairman of executive committee; Frank W. Cowles, treasurer; Hermon E. Smith, general passenger agent; J. A. Kellogg, secretary; J. B. Ingersoll, superintendent of power and lines.

UNITED TRACTION SYSTEM OF ALBANY

The hub of all interurban roads in Eastern New York is Albany, the capital of the Empire State, famous as a city of wealth and homes, and for the magnificent State building which crowns the crest of a hill a short distance from the business center. The United Traction Company, which controls the



STATE HOUSE

city systems of Albany, Troy and the surrounding group of cities, has been particularly liberal in its treatment of interurban roads, and has offered them every inducement to enter the capital city under traffic arrangement. It is the fixed policy of the company to develop its present territory, and to make no extensions outside the cities it controls, preferring to leave the interurban business to those who make a specialty of that work. In consequence, the building of interurbans has gone on with the assurance that the city company will not encroach upon newly developed fields. Traffic arrangements are maintained with the Hudson Valley Railway Company for entering Albany, the Albany & Hudson Railroad Company in Albany, the Schenectady Railway Company in Albany and Troy, and the Troy & New England Railway in Troy. The cars of the Fonda, Johnstown & Gloversville Railway will shortly enter Albany under an arrangement with the Schenectady Company. These traffic arrangements are uniform, the city company taking one-half of the city fares collected by the interurbans. These receipts last year amounted to about $100,000. For permitting the express cars of the interurban roads to run over its tracks, the city company receives 25 cents per car-mile.

The United Traction Company was formed Dec. 30, 1899, through the consolidation of the Albany Railway (chartered in 1863), the Watervliet Turnpike & Horse Railway, and the Troy City Railway. It operates under lease the Troy & Lansingburg Railway, the Troy & Cohoes Railway, the Lansingburg & Cohoes Railway, and the Waterford & Cohoes Railway. The towns touched and their population are as follows: Albany, 94,191; Troy, 60,651; Cohoes, 23,910; Watervliet, 14,321; Rensselaer, 7,466, and Waterford, 3,146. The cities are grouped on either side of the Hudson within a radius of 12 miles, and the system is operated in two departments, under division superintendents having headquarters in Albany and Troy respectively.

NO TRANSFERS

From a financial standpoint the position of the company is an enviable one. All of its grants are perpetual, having been obtained before the days when people professed to believe that electric roads could be operated profitably on a basis of twenty-five-year franchises, 3-cent fares and universal transfers. The company sells no tickets and receives a straight 5-cent fare for all city passengers. It is claimed positively that free transportation is given to no one, except to employees in uniform and wearing a badge. In Albany no transfers are issued, but in Troy transfers are given at certain points under the franchise of the old Troy Company. The officials of the United Traction Company have deep-rooted ideas on the subject of transfers. It is claimed that electric roads operating in cities of from 75,000 to 100,000 inhabitants cannot give transfers and make money, and in support of this position, it is claimed that the United is the only railway in a second-class city in New York State that pays dividends. Before the consolidation the company paid as high as 12 per cent dividends, and is now paying 5 per cent.

To obviate the necessity of transfers the lines in Albany are operated on an interchangeable system, by which a passenger can secure a car from one portion of the city to any other portion of the city within fifteen minutes. The leading north and south lines alternate as follows, each on a fifteen-minute headway: North Albany to Pine Hills; North Albany to West Albany; South End to Pine Hills; South End to West Albany. From the railway station in the center of the city cars operate on a seven and one-half-minute headway to Pine Hills, West Albany and Delaware Avenue. Cars operate directly through the business section on a five-minute headway to Troy. This

STATE STREET HILL, 10 PER CENT GRADE APPROACHING CAPITOL

arrangement gives a two and one-half-minute headway for considerable distance on Broadway, on Washington Street, and on South Pearl Street. From Albany to Cohoes there is a ten-minute headway; Rensselaer to Troy, ten-minute headway, and Kenwood to Troy, ten-minute headway. At night there is a twenty-minute headway on all city lines, and half-hourly on the Albany-Troy line. In all, the company operates 83 miles of track, and with regular summer headway has 150 cars in service. Rates of fare are as follows: Albany to Troy, 10 cents; Albany to Watervliet, 8 cents; Albany to Rensselaer, 6 cents; Rensselaer to Troy, 11 cents; Albany to Cohoes, 15 cents.

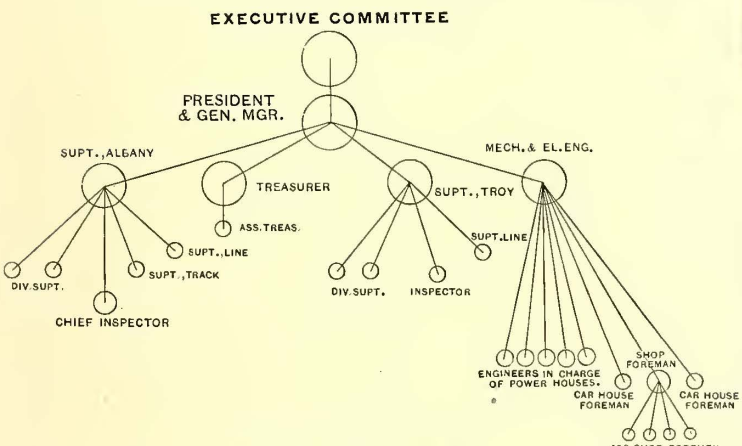
National fare registers are used on all city cars, while on the interurbans the conductors punch different colored slips.

DISCIPLINE

The United Company maintains a very rigid system of inspection. The force of inspectors includes forty-five men, on an average of about one to every five cars operated. They board cars at frequent intervals, inspect fare registers and slips, and report any infraction of rules on the part of motormen and conductors. They go at once to the scene of accidents, and secure all evidence and statements required. The system is covered by private telephones and inspectors have keys to boxes, giving them instant communication with the division superintendent. Inspectors make reports each evening to the chief inspectors, one for each division, who in turn make written extract reports to the division superintendents.

Two years ago the United Company went through an exceedingly hard-fought strike with its motormen and conductors. The matter was finally compromised, and the company reserved the right to employ non-union as well as union men.

At the present time the employees seem well satisfied and



ORGANIZATION CHART

Street Ry. Journal

good discipline is maintained. The men are uniformly courteous and careful in operating cars, and accidents have been reduced to a minimum. Carelessness by a conductor or motorman is reprimanded by the division superintendent, and only in extreme cases is a man sent to the general manager. In all hearings before the latter stenographic notes are retained for reference. For missing a car without an excuse the man is assigned to the last extra for a week.

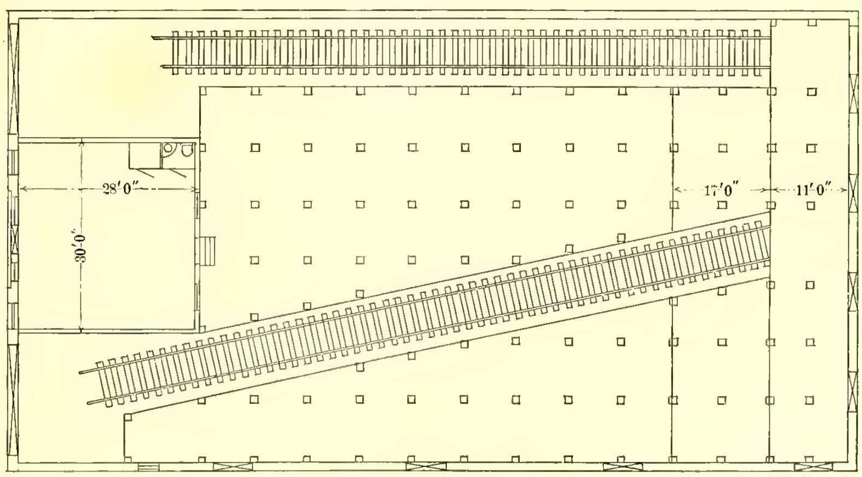
Collision with another car or with a wagon is considered cause for immediate discharge. Runs are apportioned in strict order of seniority. There are four classes of runs: (1) Regular men, who work ten hours, with one and one-half hours relief. (2) Short-run men who work from 8 a. m. to 8 p. m., with one and one-half hours relief. (3) Relief men, who take the relief runs and the night runs. (4) Trippers, who run from 12 p. m. to 2 p. m., 5 p. m. to 7 p. m., and 11 p. m. to 12:30 p. m. The trippers also handle the Sunday traffic. The peculiarity of the "rush hours" in Albany is that at no time in the morning is the traffic especially heavy. It is not a manufacturing city, and the travel to work strikes about an even average from 6 a. m. to 10 a. m. Many people go home at noon, and the theater traffic is also very heavy. At the largest theaters the company maintains sidings, and there are numerous extra cars to all parts of the city, as well as to the surrounding towns. In Troy, which is essentially a manufacturing city, the peak in the morning is very pronounced, and, on the other hand, the theater load is not very heavy.

EXPRESS AND FREIGHT

The Albany company was one of the first in the country to appreciate the advantages to be derived from handling express. Its express system was placed in operation in September, 1894, and it has made steady gains until it has become a very important factor in the gross business. This branch is conducted

STOCK ROOM AT NORTH ALBANY SHOP

as a separate institution under a manager, who reports directly to the general manager. The operation of cars, of course, comes under the operating department of the road, and it might be mentioned incidentally that the express runs are considered the most desirable by the men. The regular schedule calls for five round trips per day between Albany and Troy, three between Albany, Cohoes and Waterford, and three between Albany and Watervliet. The company maintains stations in all towns and has five delivery wagons in Albany, four in Troy, three in Cohoes, and one in Watervliet. There are three classes of business: Express, which includes delivery and collection; second-class express, which includes wagon service at one end, and freight, which includes no wagon service. There is no guaranteed time of delivery for freight, and the greater

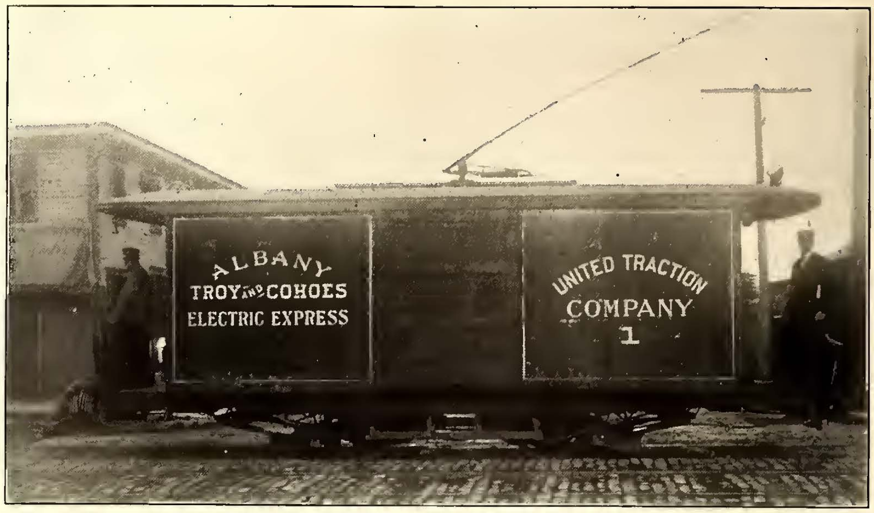


Street Ry. Journal

PLAN OF DIVISION STREET FREIGHT HOUSE AT TROY

portion of this class consists of rags from the knitting and collar mills at Troy and Cohoes. A large amount of business is forwarded from the Hudson River boat lines throughout the territory covered by the company. A large amount of business also comes from the Boston & Maine Railway, which touches

Troy, but not Albany. Express cars earn on an average 75 cents per car-mile, and the cost to operate is about 65 cents per car-mile, the long lay-overs being accountable for the high cost of operation. The earnings from passenger cars are 20 cents to 22 cents per car-mile, while the cost of operation is only from 12 cents to 13 cents. The express cars are all of the single-truck type, and have a capacity of about 10 tons each.

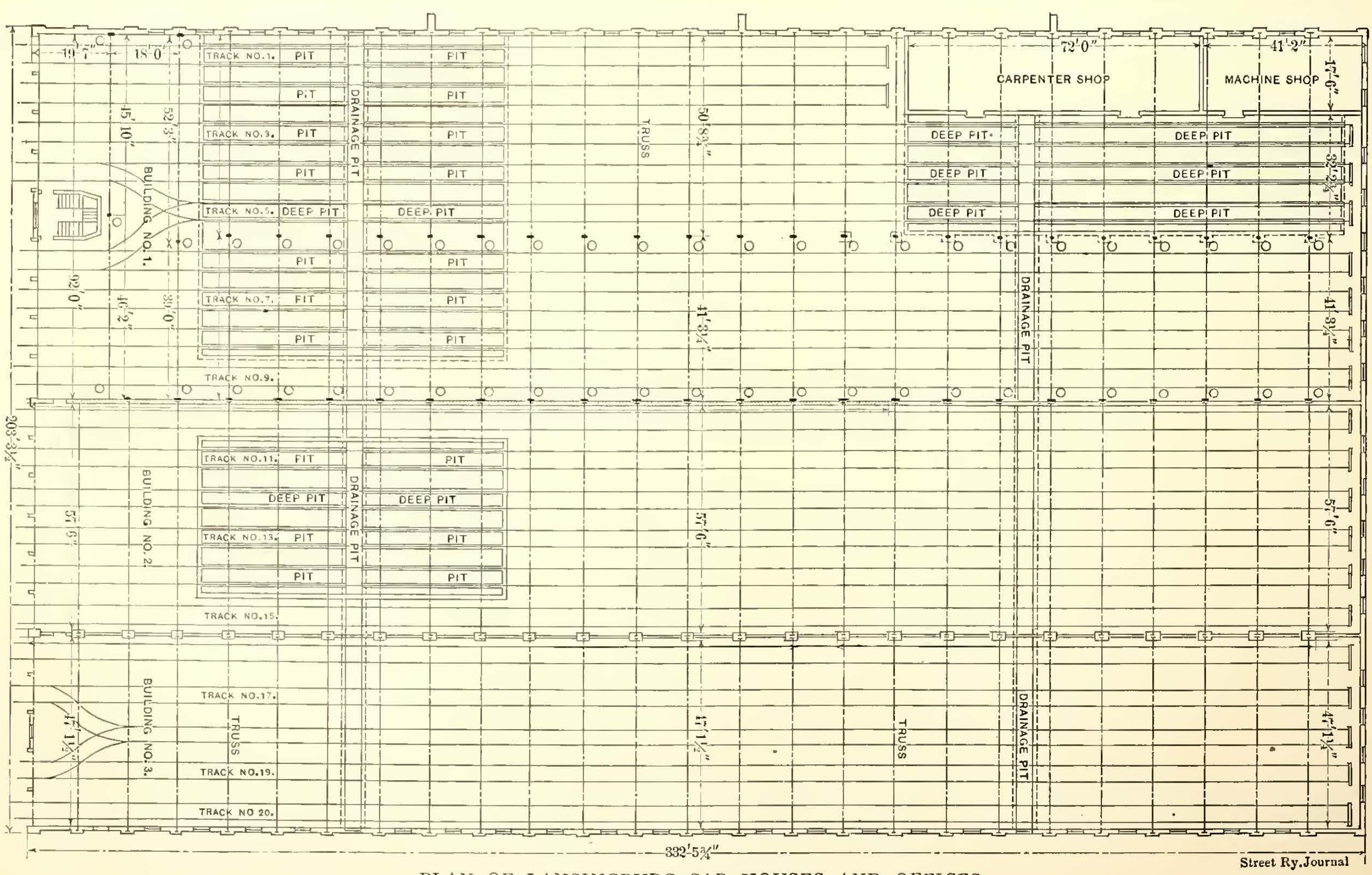


EXPRESS CAR

ROLLING STOCK

The management of the company is a strong believer in the use of single-truck cars. It is claimed that frequent headway with small cars gives better service than longer cars on less frequent headway, and, furthermore, that during the rush hours the crowds can be handled with greater rapidity with the small cars than with large ones, since passengers can get in and out quicker. It is claimed also that the liability of accidents is considerably less with the small car, since the conductor has less to attend to. It would be difficult to find a company where the rolling stock is more uniform. Most of the cars on the system were built by J. M. Jones' Sons, of West Troy, and Taylor single trucks, Westinghouse 12-A motors with K-10 controllers are standard. There are 193 box cars with 18-ft. to 20-ft. bodies, 158 nine-bench open cars, 6 express cars, 12 snow-plows, 6 sweepers and 12 service cars. Providence fenders are used on both ends, and one of the most stringent rules for motormen is that they shall test the fenders by "tripping" them at the end of each run. For winter service between Albany and Troy the company has purchased eleven 38-ft. double-truck cars, built by the J. G. Brill Company, and ten more of these have been ordered. These were purchased in answer to a demand for smoker facilities, and to compete with the service of steam roads between the two cities. These cars have a peculiar seating arrangement, with four cross-seats at either end of the passenger compartment, and longitudinal


INTERIOR INTERURBAN CAR



PLAN OF LANSINGBURG CAR HOUSES AND OFFICES seats occupying the remaining space on both sides. At one end of the car, partitioned off as in Pullman sleeping car, is a smoking compartment with seats around the sides. By this arrangement ladies may enter from either end without submitting to the annoyance of tobacco smoke. A cheap and convenient method has been adopted for preventing passengers from getting on or off open cars on the wrong side when on double track. A twine netting is strung over the entire side of the car and is buttoned at each end and to the center post. It

Weber joints, staggered. Double 0000 Crown bonds are used under the joints. For a stretch of 5 miles, between Troy and Albany, a 70-lb. A. S. C. E. T-rail is used. A very large proportion of the system is double track, and cross suspension overhead is used. In the country 35-ft. octagon wood poles are used, while the city poles are about evenly divided between three-leaf tubes and built-up channel iron with lattice work. Trolley wire is all 00.

CAR HOUSES AND REPAIR SHOPS

At North Albany there are two car houses which hold 150 cars; at Quail Street, Albany, a house for 100 cars; Albia, near Troy, 50 cars, and Lansingburg, 250 cars. All of the houses are provided with pits equipped with 2-ton hydraulic pit jacks. Light repairs are done at all the houses, and they have blacksmith shops and light machine tools. All pits are covered by 10-ton cranes, manufactured by Pawling & Harnischfeger Com-

C. H. 600 4-22-'03 No 2835

UNITED TRACTION CO.

DAILY REPORT OF CARS REPAIRED

CAR HOUSE Date

Car Open No.	Car Box No.	Account No.	MATERIAL

REPORT FOR LEGAL DEPARTMENT

No. 3100-12-22-03-C.M

LOCATION	TROUBLE	INSPECTED BY	REPAIRED BY	DATE REPAIRED
Car Body				
Windows				
Steps				
Gates				
Grab Handles				
Doors				
Foot Gongs				
Signal Bells				
Fenders				
Heaters				
Lighting Circuit				
Push Button Circuit				
Trolley Circuit				
Diverters				
Motor Switches				
Fuse Box				
Controllers				
Controller Cable				
Hand Brakes				
Air Brakes				
Emergency Brakes				
Motors				
Trucks				
Wheels				
Axles				
Gears				
Pinions				
Scrapers				
Draw Bars				

Conductor No. *Driver No.*

Car No. *Run No.* *Line* *Time Out* *Time In* *Date.*

Mileage

FORM T. 5M-6-15-'01.

United Traction Company .... Car House

DAILY REPORT OF FOREMAN TO MASTER MECHANIC

....190

No. Repair Men on duty—day,

No. Repair Men on duty—night,

Total Cars on hand at 6 P. M., No. Cars O. K. not in service,

CARS IN BAD ORDER AT 6 P. M.

CAR NO.	TROUBLE	CAR NO.	TROUBLE

CARS PULLED IN SINCE LAST REPORT

CAR NO.	TROUBLE	CAR NO.	TROUBLE

Remarks:

FORMS OF REPORT ON ROLLING STOCK

can be removed and placed on the opposite side in a very few seconds. It is claimed to be an improvement over the removable guard rail, since it covers the entire side of the car, and if a passenger leans out and forces it beyond its natural tension he does so at his own risk.

Four emergency stations are maintained; two in Albany, which have two tower wagons each, one in Lansingburg and one in Troy, with one wagon each. They have the appearance and equipment of fire department houses. Harnesses are suspended and horses and men are drilled daily. There are fire alarms in the houses, and the wagons respond to alarms from certain boxes. They are equipped with hose bridges and all necessary tools and material. Houses are connected with the private telephone system, which has fifteen boxes in different parts of the railway system.

LINE AND TRACK CONSTRUCTION

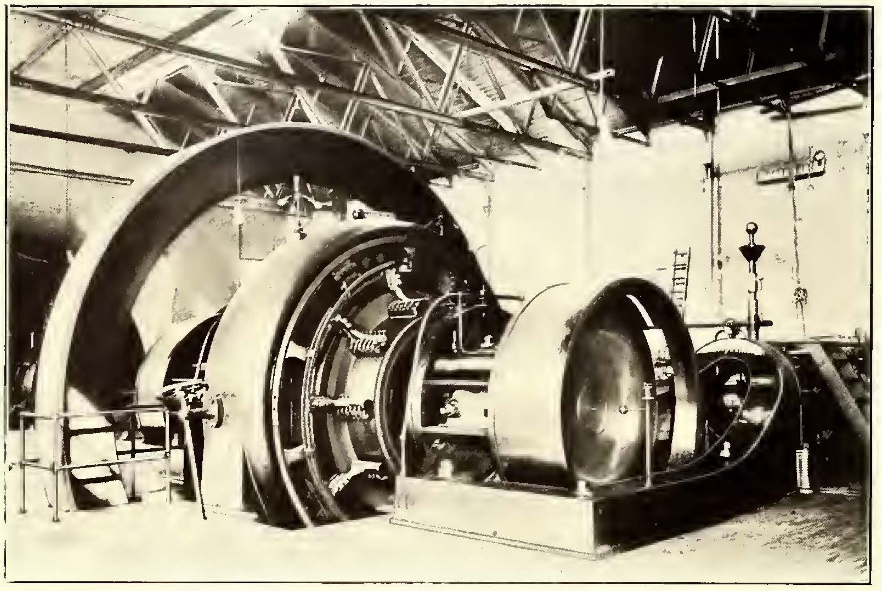
For city track the latest adopted standard rail is a 9-in. girder, Pennsylvania Steel No. 200, laid with Continuous or

pany, of Milwaukee, the company having recently purchased a number of these cranes for repair shops, car houses and substations. All car houses have quarters for the convenience of the men, provided with reading tables, wash rooms, etc.

The main repair shop, with offices of the electrical and mechanical engineer and the master mechanic, are at North Albany, where two old car houses are utilized. The equipment is very complete but is of the usual order. In the rear is a paint shop recently erected. This is 100 ft. wide by 50 ft. deep, and is provided with a transfer table in front so that cars can be placed without the use of special work. The building is conveniently arranged and well lighted. In another building, 60 ft. x 75 ft., lately erected, is the general stock room for supplies of all kinds. The storekeeper and assistants have a well arranged office. In the storeroom proper all small material is arranged in compartments which are properly tagged, and a record of everything is kept by card system. Material is checked off on the card system as it is given out. All requests for material are by requisition from foremen of departments, and charges are made to the several departments on daily charge sheets. Supply sheets are entered in a loose leaf ledger.

RECORDS AND REPORTS

The foreman of each department makes a daily report to the master mechanic of all material used and the details of all work done on a form similar to that reproduced herewith. The mechanical engineer keeps a card system record of each car, the date and character of all repairs and the time in service. The average mileage of cars in service is 200 miles per day. Trolley wheels average about 6000 miles. Rawhide pinions average sixty days.



800-KW GENERATOR IN SOUTH PEARL STREET STATION, ALBANY

The company has a very practical and comprehensive system of reports and records. Some of the forms employed in the car house, repair shops, power stations and legal department are herewith reproduced. They are self-explanatory, and are so simple that no difficulty is experienced by employees of all grades in filling in the desired information.

POWER HOUSE UNITED TRACTION CO.

DAILY REPORT.

Form B B. 1M 1-5-03. No 3197 — 24 HOURS ENDING ______ 1903

	Dis-abled	In and Ready	Max.	Min	Mean	REMARKS
Engines						
Boilers						
Steam Pressure						
Vacuum						
Temperature of feed water						
Coal Consumed						
Generators						
Converters						
Voltage						
Amperes						
Total E. H. P.						
Av. E. H. P. converters in service						
Av E. H. P. special feed						

ENG. OIL ______ CYL. OIL ______ LBS. WASTE ______

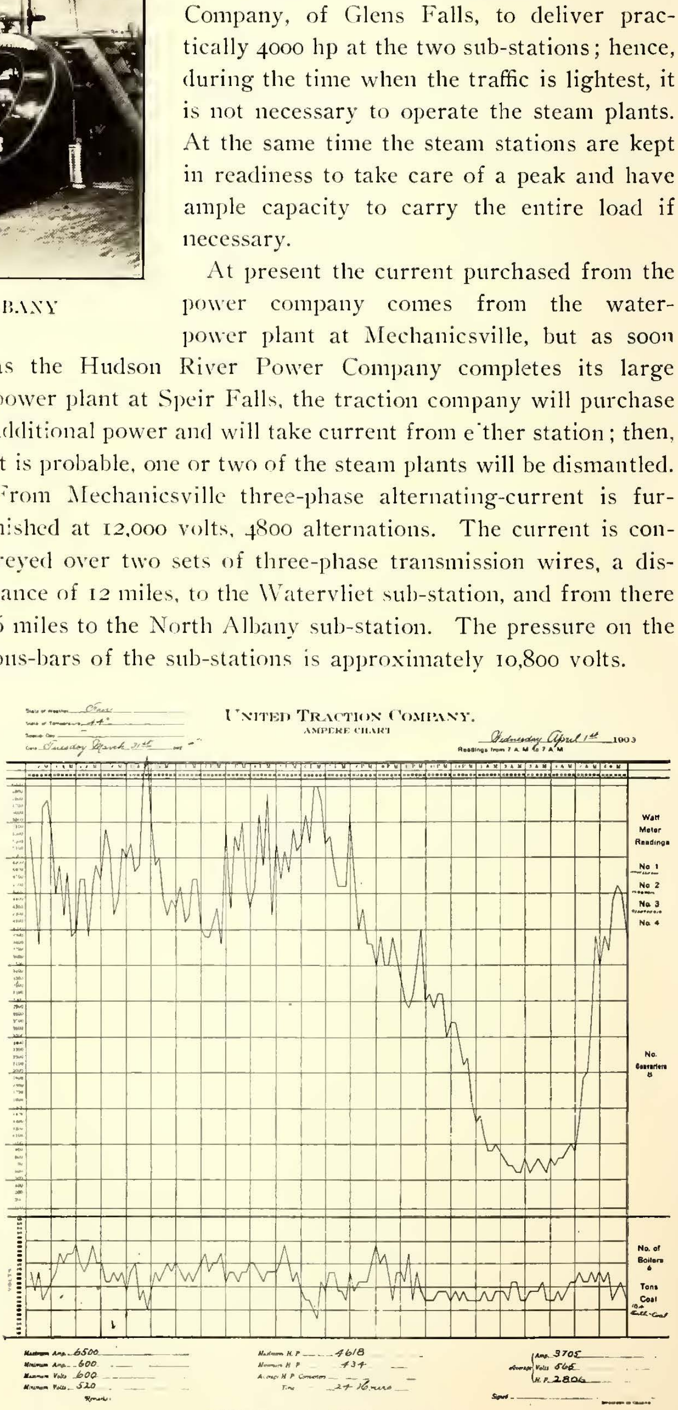
GENERAL

FORM USED FOR POWER HOUSE REPORT

POWER EQUIPMENT

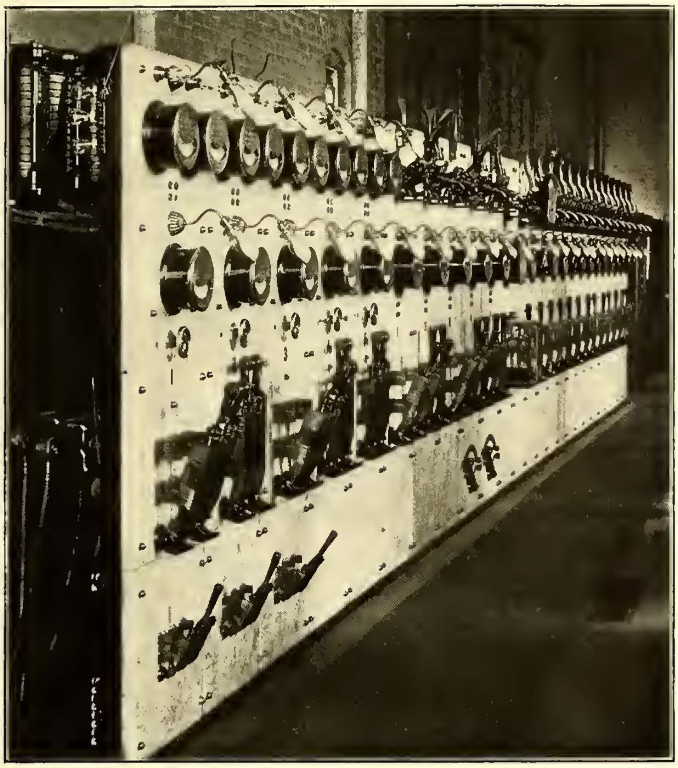
The company has three steam power stations and two rotary sub-stations. One of the stations is located on South Pearl Street, Albany, the second at Division Street, Troy, and the third at Lansingburg. The larger sub-station is located in Watervliet, and the other at the North Albany shops. During the season when the traffic is heaviest their peak requires a current capacity of about 8000 amps. at 550 volts, or equal to nearly 6000 ehp. The average load is about 5600 amps. At the present time the company has a contract with the Hudson River Power Company, of Glens Falls, to deliver practically 4000 hp at the two sub-stations; hence, during the time when the traffic is lightest, it is not necessary to operate the steam plants. At the same time the steam stations are kept in readiness to take care of a peak and have ample capacity to carry the entire load if necessary.

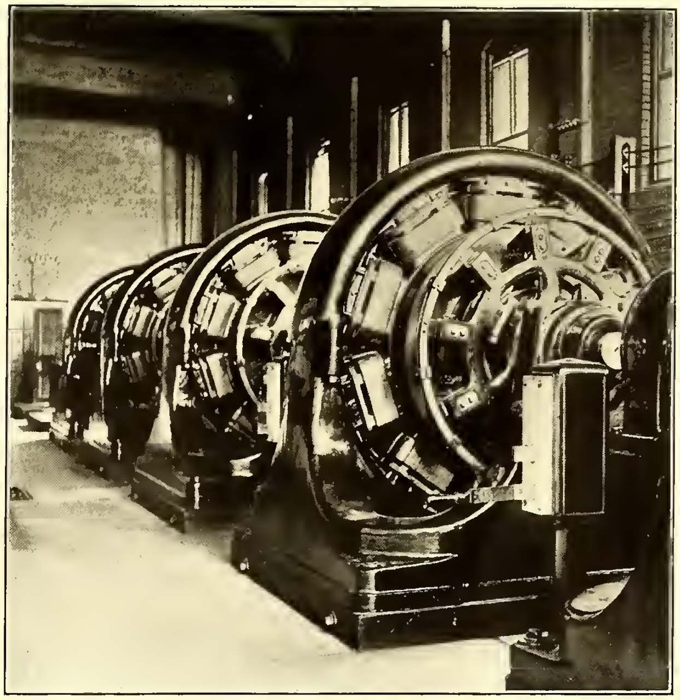
At present the current purchased from the power company comes from the water-power plant at Mechanicsville, but as soon as the Hudson River Power Company completes its large power plant at Speir Falls, the traction company will purchase additional power and will take current from either station; then, it is probable, one or two of the steam plants will be dismantled. From Mechanicsville three-phase alternating-current is furnished at 12,000 volts, 4800 alternations. The current is conveyed over two sets of three-phase transmission wires, a distance of 12 miles, to the Watervliet sub-station, and from there 6 miles to the North Albany sub-station. The pressure on the bus-bars of the sub-stations is approximately 10,800 volts.



TYPICAL DAILY CHART

The Watervliet sub-station is 85 ft. x 30 ft., and 25 ft. high, and is of the most modern fireproof construction, with heavy walls built of hard brick. A 10-ton crane covers the house. The main flooring is concrete. The rotaries are five in number, 375 kw each, of the compound-wound Westinghouse three-phase, 40-cycle type. Three of these rotaries have induction starting motors, mounted upon an extension base attached to the main rotary frame at the alternating current end, the motor secondaries being pressed directly upon the extended end of the shaft of the rotary armature. The other two rotaries are without starting motors, being started and brought up to synchronous speed by applying direct current taken from the other rotaries to their direct-current end, running then as direct-motors. The voltage at the direct-current end of these





25-PANEL SWITCHBOARD AND ROTARY CONVERTERS AT WATERVLIET SUB-STATION

rotaries varies from 550 to 600. Each rotary is mounted upon a substantial brick foundation, covered with well-seasoned and treated planking, and securely fastened with holding-down bolts running up through holes in the rotary base frame. There is a cable duct 4 ft. sq. running the entire length of the building under all rotaries and between the side walls of their foundation.

There are fifteen 150-kw Westinghouse oil-cooled transformers installed along the west side of this station. These are divided into five groups, and supply current to rotaries. The transformers lower the voltage from 10,800 volts to 370 volts. They are mounted upon a platform back of and within 2 ft. of the rotaries. Beneath this platform is a 4-ft. duct, the brick walls of which form the foundations for the transformers. Across the top of the foundations forming this platform are laid heavy planks, which are 14 ins. above the floor.

The low-tension switchboard is installed along the east wall of the station. The board is of blue Vermont marble slabs, and the apparatus is finished in bronze and black enamel. There are five alternating-current rotary panels, five direct-current rotary panels, one station instrument panel and fourteen feeder circuit panels. Three of the five rotary panels have one three-pole main knife switch, three 1200 ammeters, one three-pole induction motor starting switch, one synchronizing outfit and receptacle for voltmeter plugs. The two other panels are similar except that they have no motor-starting switches. Two of the five direct-current rotary panels have two single-pole main knife switches, one 1200-amp. direct-current ammeter, one 1500-amp. Westinghouse brush-type circuit breaker, one direct-current rotary starting rheostat, one field rheostat and one set of voltmeter receptacles. The three remaining direct-current rotary panels are the same as the others except that they have no rotary starting rheostats. The station instrument panel has mounted upon it one 700-volt Weston standard voltmeter, one 5000-amp. Weston ammeter, and one 5000-amp. Thomson recording wattmeter. On each of the feeder panels are one single-pole main switch, one 1200-amp. ammeter, and one 1500-amp. Westinghouse-Brush-type circuit breaker. A single-pole equalizing knife switch is mounted upon a pedestal on the main floor and located between each two rotaries.

The high-tension switchboard was built by the General Electric Company, and consists of eight blue Vermont marble panels, and is also located along the east wall of the station. Each of five panels has one 12,000-volt, three-phase oil-break switch of 25-amp. capacity, and three high-tension fuse blocks separated by marble barriers. These panels are used to cut the current in or out of the high-tension side of the transformers; one panel being used for each group of transformers. The fourth panel has a 12,000-volt, three-phase oil-break switch, one 12,000-volt Thomson voltmeter, and one high-tension ammeter. One of the two remaining panels has one 12,000-volt oil switch, one 12,000-volt ammeter, one power factor meter and one Bristol recording ammeter. Two panels are used to control the incoming lines and the current to the five transformer controlling panels. The third remaining panel has mounted on it one 12,000-volt oil switch, which is used to control the lines to the North Albany sub-station.

The high-tension wires are brought into the northeast corner of the station and down to the main switchboard. The high-tension transformer feeders are carried from the switchboard around the north and west walls of the station, being properly spaced and mounted upon suitable insulators, each consecutive three wires running to their respective group of transformers. From the low-tension side of each group of transformers three heavy feeders are carried down outside of transformer tanks and into the cable duct beneath the platform, then running into a cross duct, which leads into a cable duct underneath the low-tension switchboard; they are then carried up

VIEW OF NORTH ALBANY SUB-STATION

to the alternating-current rotary panel used to control that particular rotary which this group of transformers is to serve. Three low-tension leads are then brought down from this panel and carried back through the cross duct into the main rotary cable duct and up to the brush holders on the alternating-current end of the rotary.

From the direct-current end of the rotaries heavy cables are carried down through the cable duct across to the direct-current rotary controlling panels, and from there the current is conveyed over solid copper bus-bars on the back of the board to the various direct-current feeder panels. From the feeder panels the current is conveyed to the trolley feeders over heavy cables.

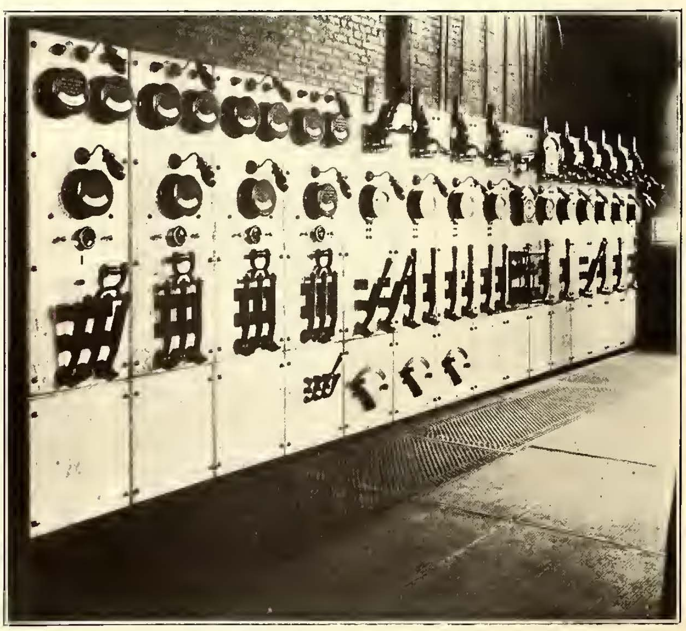
In the roof of this station are installed five 36-in. Globe ventilators. These are not only used to maintain proper circulation of air through the main building, but also force a circulation of air through the cable ducts beneath the floor, thus providing against undue heating of cables. An air compressor outfit is used for cleaning and cooling the electrical equipment.

Plans are being made to install at Watervliet a 500-kw rotary converter with the necessary transformers and switching apparatus. The switchboard will also be arranged to control the new lines which will come from Speir Falls, and arrangements will be made so that it will be possible to carry the full load from either set of transmission lines.

The North Albany sub-station is similar to the Watervliet sub-station except that at the present time it is smaller. At present it contains four 375-kw Westinghouse rotaries and twelve 150-kw Westinghouse transformers. The low-tension switchboard was built by the Westinghouse Company, and has four alternating-current rotary panels, four direct-current rotary panels, one station panel and six feeder panels. The high-tension board was built by the General Electric Company and has two main feeder panels and four transformer controlling panels. The other details are similar to those at Watervliet. Eventually, however, the North Albany station will be the larger, as there will be installed shortly two 500-kw rotaries and the other necessary equipment, also a differential booster set, which will handle current from a Chloride type-G battery outfit of 264 cells, supplying 1360 amps. in ordinary regulation. The low-tension switchboard will be extended to control the booster and battery and a number of new direct-current feeder circuits, while the high-tension board will have installed on it switches for controlling the new incoming lines from Speir Falls.

An interesting feature in connection with these sub-stations is that in event of an accident to the Mechanicsville plant or transmission lines the company would then start its South Pearl Street generators and deliver 550 volts direct-current to the North Albany sub-station, where it would invert the rotaries, supplying the direct current to the direct-current end of the machines, running them as shunt motors (by shunting the series field windings), and deliver alternating current to the rotaries at Watervliet.

The South Pearl Street steam station is of modern construction with heavy walls of fire-brick. The dimensions are 171 ft. x 117 ft., and 36 ft. high. It has a corrugated iron roof, constructed upon structural steel work. The following apparatus is installed in this station: One 800-kw Westinghouse 550-volt, direct-current compound-wound multipolar railway generator; 1000-hp steam engine, running at 80 r. p. m.; one direct-connected 800-kw, 550-volt direct-current compound-wound multipolar railway generator, running at 80 r. p. m.; two 550-hp General Electric 550-volt compound-wound



15-PANEL SWITCHBOARD IN NORTH ALBANY SUB-STATION

multipolar direct-current generators, belted to a 500-hp engine. There are one 500-hp, three 250-hp and six 125-hp Babcock & Wilcox boilers, operating at 125 lbs. steam pressure. The switchboard consists of four generator panels and eight feeder panels, all of which are constructed of white marble.

The Division Street station, Troy, is 110 ft. long by 110 ft. wide and 30 ft. high. The equipment consists of one 800-kw

Westinghouse 550-volt direct-current compound-wound, multipolar railway generator, directly connected to a Knowlson & Kelley cross-compound 1000-hp engine, running at 80 r. p. m.; two 175-hp General Electric, 550-volt, direct-connected compound-wound multipolar railway generators, belted to a 350-hp Greene simple engine, and two 200-hp Thomson-Houston 550-volt direct-current compound-wound bipolar railway generators, belted to a 350-hp Greene simple engine. The steam is furnished by two 175-hp Babcock & Wilcox boilers, one 375-hp Stirling boiler, three 200-hp Manning boilers, and two 150-hp tubular boilers. The board is Westinghouse make, constructed of white marble slabs, and consists of five generator panels, seven feeder circuit panels and one station panel.

The Lansingburg steam plant has one 350-hp Greene engine, belted to three 80-kw Edison generators, and two 150-hp Knowlson & Kelley engines, each belted to two 80-kw Edison generators.

In the steam plants the company uses buckwheat hard coal at $2.70 per ton.

MANAGEMENT

The United Traction Company has an authorized capital stock of $5,000,000, of which $4,999,950 has been issued. The funded debt is $5,350,800, of which $4,241,000 has been issued. The financial statement for the year ended June 30, 1903, is as follows:

	1903	Increase
Gross earnings	$429,950	$50,570
Operating expenses	316,081	61,004
Net earnings	$113,869	*10,434
Total income	$115,443	*$10,434
Fixed charges	76,916	3,340
Surplus	$38,527	*$13,774
Net income for year	248,319	45,274

*Decrease.

The growth of the business since the electrical system was installed has been remarkable. In 1889, the last year of horse operation, the number of passengers carried was 4,047,000. In 1896 the figure reached 9,500,000, while for 1900 it was about 16,000,000. During this entire period there was no material growth in the city of Albany and only 2½ miles of additional track was constructed.

It is worthy of record here that this company was one of the pioneer electric railway concerns of the country to engage in the handling of express, and that the thoroughness with which it engaged in this branch had much to do with the ultimate success which rewarded its efforts. It has afforded the interurban lines entering its territory exceptional facilities for developing this branch of their service likewise. It was also one of the first companies, in the pioneer days, to adopt electricity, and the consequent litigation with the telephone interests and the decision in favor of the railway went a long way toward establishing the legal status of the overhead system.

The officers and directors of the United Traction Company at the present time are as follows:

Robert C. Pruyn, chairman board of directors; John W. McNamara, president; Francis N. Mann, Jr., vice-president; Charles G. Cleminshaw, secretary; James McCredie, treasurer. The directors are: A. Bleecker Banks, Anthony N. Brady, Thomas Breslin, Charles Cleminshaw, Albert Hessberg, George P. Ide, William Kemp, Francis N. Mann, Jr., James H. Manning, William McEwan, John W. McNamara, James O'Neil, Robert C. Pruyn, William Shaw, William J. Walker.

SUMMER ROAD FOR TROY

The Troy & New England Railway operates from Albia, 3 miles from Troy, to Averil Park, a distance of 8¾ miles. The towns on the line are Wyantskill, with a population of 300; Snider's Corner, 200; West Sand Lake, 800; Averil Park, 1400. The line is built on private right of way, 40 ft. wide, and extends across the country. The road was designed essentially for summer traffic, but there is a considerable farming population along the road. The line follows the Wyantskill Creek, and crosses it fourteen times on timber trestles. The scenery in the valley is quite beautiful, making it an ideal summer ride. The company owns and operates Averil Park, which is a very popular summer resort, and is provided with a large pavilion and numerous other attractions. These features were described in the Street Railway Journal of June 1, 1901. The line

TERMINAL STATION, TROY & NEW ENGLAND RAILWAY

affords the only connection to Burdon Lake, East Sand Lake, Glass House Lake and Crooked Lake, which are favorite fishing and hunting resorts for thousands of people.

The company has a traffic arrangement with the United Traction Company by which it is permitted to enter the center of Troy, but at the present time the cars operate only to the terminal station, illustrated herewith, located at Albia. Cars connect with the Albia line of the Troy system. During the summer the cars run on half-hourly headway, and on hourly headway in winter. There is very heavy special excursion traffic during the summer months. The company handles considerable express business for the summer resorts and farms along the route, but this branch of the business is somewhat handicapped because of the fact that cars are unable to operate into the center of Troy, being prevented by the very steep hill; hence, it is necessary to haul the goods by wagon into Troy.

The rolling stock includes 5 open motor cars and 4 open trailers, built by the American Car Company, and 4 closed motor cars, built by the Jackson & Sharp Company, all single truck cars. They are equipped with two 40-hp motors. A portion of these cars are equipped with Diamond trucks, while several others have new equalizing trucks, built by the Powell & Turner Truck Company, of Troy. The trucks are built with an extended frame, by means of which weight is evenly distributed, doing away with a large amount of rocking. The track is laid with 60-lb. T-rail, and a concealed bond is used under angle plates. The nuts on the plates are locked with a patent nut lock, consisting of a flat strap hooked at either end of the plate and fastened in the center with cotter pins. Originally the track was bonded with outside bonds, but one day last winter it was discovered that the power was insufficient, and an investigation showed that a band of industrious copper thieves had cut out practically every bond on the line, and had also carried off 2 miles of trolley wire; hence, the company's belief in the concealed bond.

The power house for the line is located at Wyantskill Creek, at the center of the road. The building is 40 ft. x 60 ft., divided in the center. In the boiler room are three 175-hp Manning tubular boilers, a Deane jet condenser, two Deane boiler-feed pumps and a Metropolitan injector. In the engine room two 250-hp Westinghouse compound engines are belted to 225-kw compound-wound generators, operating at 290 r. p. m. The engines operate condensing, and the condensation is returned to the boilers by a loop system and Stratton separators. Connected to the engines are Spencer automatic damper regulators. At the side of the engine room is a five-panel Westinghouse board. There are two line panels, a station panel and two generator panels. The station panel has a volt motor and a total ammeter. The entire equipment was installed in 1895 by Westinghouse, Church, Kerr & Company.

The experience of this company in the handling of freight and express is different from that of the other roads in this neighborhood, due largely to special conditions. It is the only one of the lines in this locality which has not found its freight service profitable. The express business is continued, however, more as an accommodation to the patrons of the line than through any direct profit accruing from this branch of the service. One freight car is run daily between Albia and Averill Park, in each direction. This car is of the same general type as the smaller of the Hudson Valley express cars, and measures 27 ft. inside. The Troy & New England Company was one of the earliest in the field, having maintained its express service for nearly seven years, but usually with trailer cars. Its rates were 10 cents a hundred for light freight, and $1.50 per ton for heavy. The teamsters who collect and deliver were paid by the 100 lbs., and the management, owing to the natural disadvantages with which the line is confronted, says that there is no money in freight, under the present conditions. The Troy & New England Railroad Company has a capital stock of $350,000, and a funded debt of $183,800. During 1902 the road carried 264,255 passengers with a total car mileage of 159,348, and receipts per car-mile were $0.166, while operating expenses per car-mile were $0.103. The following figures of operation are for the year ending June 30:

	1899.	1900.	1901.	1902.
Receipts from passengers...	$[illegible]2,[illegible]79	$26,368	$27,382	$26,236
" " other sources.	1,987	4[illegible]0	400	220
" total.............	34,666	26,768	27,782	26,456
Operating expenses.........	20,107	14,488	15,740	16 458
Earnings from operation....	14,559	12,280	12,042	9,998
Deductions from earnings.				
Interest	9,663	9,584	9,584	9,548
Taxes..................	659	723	631	617
Net income..............	4,237	1,973	1,826	*166
Total surplus account.......	5,232	7,205	9,031	8,865

* Deficit.

The officers of the company are Edward F. Murray, president; Rice C. Bull, secretary and treasurer; A. W. Bentley, superintendent.

FONDA, JOHNSTOWN AND GLOVERSVILLE SYSTEM

The Fonda, Johnstown & Gloversville Railway is unique in that it combines both steam and electric operation, but each is entirely distinct, and over a short stretch of country the electric railway is in competition with the steam line. The foundation of this system dates back to January, 1867, when the Fonda & Gloversville Railway, a steam road, was placed in operation. This line was designed to connect the prosperous city of Gloversville with the main line of the New York Central & Hudson River Valley at Fonda, a distance of 10 miles. In 1881 the company purchased at a receiver's sale, the Gloversville & Northern Railway, which extended from Gloversville north to Northville, a distance of 16 miles. These two sections, with the steam branch line recently built, have since been operated as a steam road. In 1893 the Cayadutta Electric Railway was completed between Fonda, Johnstown and Gloversville, paralleling the lower portion of the electric road. About the same time the Johnstown, Gloversville & Kingsboro Horse Railway Company, connecting Gloversville and Johnstown, was equipped with electricity. In 1894 the steam road acquired, under 999-year leases, the property of both companies, and, in 1900, purchased the capital stock of the Amsterdam Street Railway Company, which included four city lines in Amsterdam, together with the city lighting plant, which was operated under a separate name. The Amsterdam line was at once extended, a distance of 13 miles, to connect with the line at Johnstown, and work was started on an extension to Schenectady, a distance of 16 miles. This line has just been completed. The company also completed a spur line from Amsterdam north to Hagaman, and a steam spur line to Broadalbin. On Jan. 1, 1903, all the lines mentioned were merged into the Fonda, Johnstown & Gloversville Railroad Company. The charter of the steam company gives it the right to use a variety of power, but the charters of the old electric roads do not permit steam trains to run over their tracks. In consequence it is possible for electric cars to operate over steam tracks, and this fact has been taken advantage of, and between Johnstown and Gloversville, at the present time, the north-bound through interurban cars operate over tracks on the steam right of way.

The total mileage of steam road, including sidings, is 37.4. From Gloversville to Schenectady is 32.7 miles, all double track. Branch lines from the main line aggregate 8 miles, the local lines from Gloversville to Johnstown, 4 miles, and the city lines operate 7.2 miles. The total system is 124.1 miles of single track on 94.4 miles of road. Of this 71.7 miles are on private right of way, and the balance on streets and highways.

The Fonda, Johnstown & Gloversville Railroad Company has a capital stock of $2,500,000. The authorized bond issue is $7,000,000, of which $5,000,000 has been issued. The company owns the capital stock of the Edison Electric Light & Power Company, of Amsterdam, which operates the lighting and power system in Amsterdam, and the Coal Company of Fulton County, which conducts an extensive wholesale and retail coal business. The company has coal yards in Fonda, Johnstown, Summersville, Fultonville and other towns. At Gloversville, the company has a storage house, having a capacity of 30,000 tons. This connection is a very good one for the railway company, since by purchasing in large quantities it is enabled to secure cheap fuel for locomotives and its power plant.

EQUIPMENT

The steam road has twelve locomotives, twenty-four passenger coaches, six baggage and combination coaches, and ten flat cars. A portion of the equipment has been purchased recently, which tends to refute the general supposition that the steam road is to be changed over to electricity. The road has exclusive freight connection with Johnstown and Gloversville. Gloversville has a population of 20,000, and is famous for its glove industry. During the winter months a large amount of lumber is shipped from the northern end of the road. The company operates five passenger trains per day from Fonda to Gloversville, and three of these go through to the northern terminus. A very large proportion of the passenger business of the road is summer excursion traffic. The company maintains a fine park near the northern terminus. At Northville the road connects with stage lines to Lake Pleasant, and to points in the Adirondack Mountains. The traffic to these points is very heavy, and the only reason that the roadway is not extended is the fact that the laws of New York have reserved this district as a forest preserve, and railroads are not permitted to extend through it. Numerous excursions are operated from Troy, Albany, Utica and other points on the New York Central, the coaches being taken through by the locomotives of the Fonda, Johnstown & Gloversville on a pro-rata basis. The company gives a 15-minute electric service between Gloversville and Johnstown, while from Gloversville to Fonda there are cars which connect with all New York Central trains. These cars go over the old horse line route, and do not interfere with the speed of the interurban cars. In Gloversville the company operates a city belt line on 10-minute headway, while in Amsterdam there are 8 miles of city lines operated under a 10-minute headway.

TRIBE'S HILL VIADUCT

STEAM AND ELECTRIC LINES ENTERING GLOVERSVILLE ON SAME RIGHT OF WAY

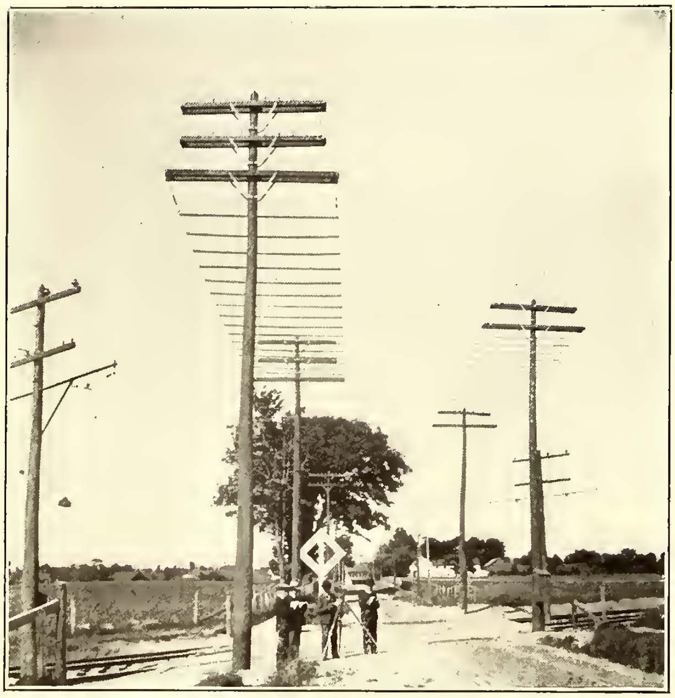
The through interurban cars from Gloversville to Schenectady operate at present at hourly headway, but half-hourly service will soon be instituted. The company is expecting the delivery of a number of high-speed cars, and these will be operated through to the center of Albany under the traffic arrangement with the Schenectady Railway Company. The cars leaving Gloversville on the even hour will stop only at certain points, and it is expected they will make the run into Albany, 49½ miles, in two hours and forty-five minutes. While on the Schenectady line they will run as second sections to the Schenectady limited cars, and will make no stops between Schenectady and Albany. The half-hourly cars from Gloversville to Schenectady will be arranged to carry baggage. Between Johnstown and Gloversville the company operates its through cars in but one direction over the single-track sections in these cities. The north-bound cars operate over a track on the steam right of way, while the south-bound cars go over the old Cayadutta line through the main streets of the cities and over a private right of way between them. The two routes are only a short distance apart.

LINE VIEW NEAR JOHNSTOWN, SHOWING TRACK AND OVERHEAD CONSTRUCTION

TRACK AND LINE CONSTRUCTION

By this arrangement the entire interurban system is practically all double-track, the portion between Johnstown and Schenectady being entirely so. The maximum grade between

Amsterdam and Johnstown is 1½ per cent, and between Amsterdam and Schenectady 1 per cent, while the maximum curvature is 8 degs. To accomplish this, it was necessary to do a large amount of cutting and filling. There is one fill of 33,000 yards, and one cut of 97,000 yards. A considerable portion of the road is built on a bluff high above the four tracks



PROTECTING WIRES AT RAILROAD CROSSING

of the New York Central Railroad, which it closely parallels, and a large amount of rock cutting was necessary. In one place there was a cut of 19,000 yards, through solid rock. The right of way is from 66 ft. to 150 ft. wide, and the roadbed is graded 30 ft. wide, on a level, and 26 ft. wide on fills. The track is laid with 80-lb. A. S. C. E. section. Weber 4-bolt, 22-in. joints are used, under which are placed 0000 Crown bonds, furnished by the American Steel & Wire Company.

ROCK CUT AT HOFFMANS

On city streets, cross-suspension overhead is used, but the interurban portion is all single and double bracket construction. Poles are 35 ft. tall, with butts 7 ft. below surface. A filling of charcoal is placed below the pole, and at the base of the pole is a copper plate 24 ins. x 24 ins. x 1½ ins., to which are soldered the cross-bonds from the rails of either track. The trolley lines are 13 ft. between centers and 000 trolley wire is used. There are two cross-arms, the lower one carrying the telephone, signal and direct-current feeders, and the upper carrying high-tension lines. The engineer adopted the plan of using four high-tension lines over the entire system, the fourth line being for emergency. High-tension lines are 0000 bare copper, and the installators are Locke No. 1000, chocolate color, 7 ins. wide. Grade crossings were eliminated wherever possible by building concrete crossings. There are a number of these along the line, all showing first-class construction. The composition used in preparing concrete is: One part Portland cement, three of sand and five of broken stone.

The system is ballasted throughout with very coarse gravel, which is obtained from three almost inexhaustible gravel banks on the company's line. The gravel is handled in dump bottom cars, and hauled by small steam locomotives, six of which were purchased for this purpose from the Manhattan Elevated Company, of New York.

At Tribe's Hill, a short distance from the power house, the company was obliged to erect a large steel viaduct. This is 617 ft. long and 76 ft. above the stream. It consists of a series of deck plate girders, the main girders being 30 ft. long, and 6 ft. wide. The tracks are laid on 13-ft. centers, and the bridge was designed to carry two Consolidated locomotives, followed by a moving load of 4000 lbs. per lineal foot. The structure cost about $50,000.

ROLLING STOCK

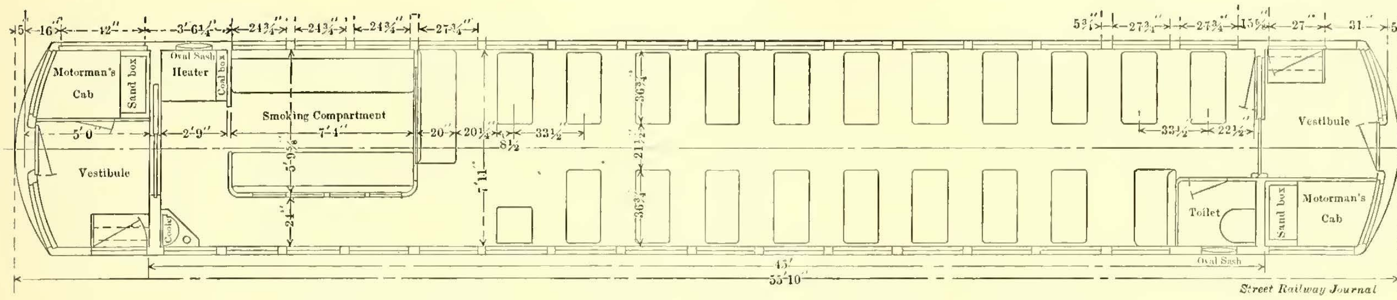
The rolling stock of the road is of several types and makes, as is usual with consolidated properties, but the latest cars are of modern design. Four 35-ft. cars have side seats, Westinghouse air brakes, No. 56 Westinghouse motors, K-10 controllers, and Taylor double trucks. Six 29-ft. closed cars were built by

VIEW ON ROAD TO HOFFMANS

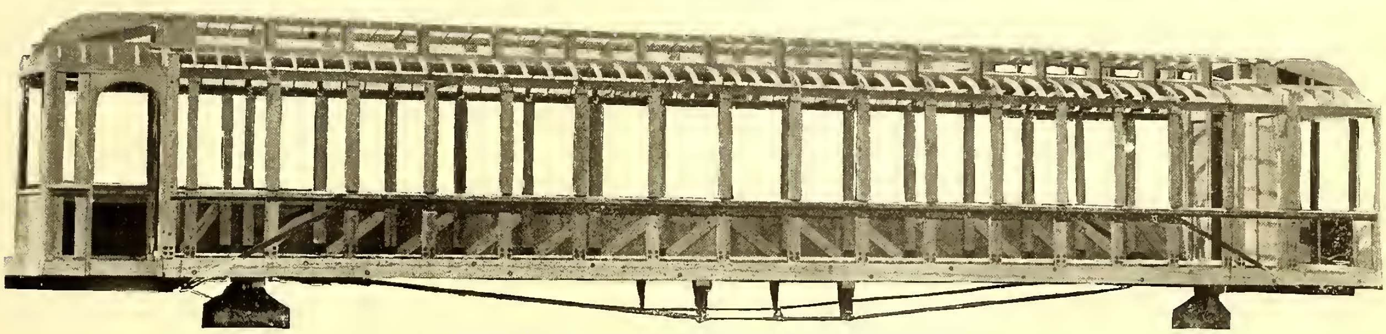
the J. G. Brill Company. They are mounted on McGuire single trucks, two General Electric No. 1200 motors, and Westinghouse K-10 controllers. Four 44-ft. fifteen-bench open cars, built by J. M. Jones' Sons, have Taylor double trucks, Standard traction air brakes, four General Electric 67-motors, and K-14 controllers. Five 30-ft. cars, built by Jackson & Sharp, have side seats, Taylor single trucks, Westinghouse magnetic brakes and hand wheels, and Westinghouse electric heaters. Eight 47-ft. interurban cars, built by the St. Louis Car Company, have St. Louis walkover seats, Peter Smith water heaters, and St. Louis arc headlights, St. Louis B-49 double trucks, Christensen air brakes, four General Electric 57 motors, K-14 General Electric controllers. Four of these cars have baggage and smoking compartments. These cars are 9 ft. wide, and will be used for the local through service. Other rolling stock includes five 32-ft. ten-bench open trailers, built by the Ellis Car Company; three eight-bench open motor cars, built by Lewis & Fowler; twelve ten-bench open cars, built by J. M. Jones' Sons; two McGuire double-truck sweepers, one Pollard snow-plow; one Stephenson snow-plow, and two Wason double-truck snow-plows.

For the high-speed limited service between Gloversville and Albany the company is expecting an early delivery of six very fine cars, built by the St. Louis Car Company. The total length over the bumper is 54 ft. 5 ins., length of body 45 ft., height from underside of sill 9 ft. 6½ inches, width 8 ft. 7½ ins. The special feature of the cars is the fact that the floor frame is entirely of steel. The main sills consist of 10-in. channels, built together with malleable separators, 3 ft. apart, and at the end of all transverse beams. The separators are inserted so that the riveting of the work will be entirely independent of the woodwork, and that no loosening of joints will occur by the shrinkage of any timber put on the car. The outside channels are rounded at the corners, forming the end of the sills. The transverse beams consist of 10-in. I-beams, secured to the main sills with angles and plates, while the main platform is framed with 6-in. channels, constructed in the same manner as the main sill. The bolsters are built up from 8-in. 24½-lb. channels, and are reinforced with 1-in. x 7½-in. plates. The cars have steel bumpers, arranged with spring resistances, capable of withstanding a blow of 150,000 lbs. Couplers are M. C. B. The features of the body construction are: Each post is fastened to steel sills by steel angles, and a ⅞-in. rod passes through it; this rod extends to top of cant rail and passes through the foot of steel carlins; carlins are also fastened or bolted to the cant rail, which is reinforced by a steel plate extending around entire car, thus making a steel skeleton framing, as well as a steel bottom. An important point about this construction is that all steel connections are on steel, making the framework absolutely independent.

These cars have a smoking compartment in the rear, which is separated from the passenger compartment, the arrangement being similar to that of a smoker in a Pullman car. High-back, reversible seats, finished in plush, with roll head rests and foot rests, have been adopted. Car bodies are mounted on extra M. C. B. trucks furnished by the Taylor Electric Truck Company, of Troy, N. Y. They have a wheel base of 6 ft. and are arranged to receive two General Electric No. 73-C motors on each truck, four to the car, arranged with the M. C. B. swing bolster mounted on triple elliptical springs. The jaws and journal boxes are of the M. C. B. standard type. The trucks are equipped with steel-tired wheels and Mansell retaining rings, 33 ins. in diameter with 3-in. tread and ¾-in. flange, and the axles are of 5 ins. diameter. The General Electric type-M control system is used. One of these cars will be exhibited at Saratoga by the St. Louis Company, and arrangements will be made to take a party from Saratoga through to Gloversville.



STEEL BOTTOM FRAME FOR 45-FT. MOTOR CAR FOR INTERURBAN SERVICE


FRAMEWORK FOR NEW STANDARD INTERURBAN

CAR HOUSE AND SHOPS

At Amsterdam the company has a car house, 200 ft. x 50 ft., having five tracks. This is to be doubled in capacity very soon. It has 280 ft. of pit, and inspecting and light repairs for the eastern division of the electric line are done here. The headquarters of the eastern division are located in an adjoining building, which is also arranged for stock and supply house for this division. At Gloversville the company has a car house, 200 ft. x 75 ft., with six tracks. The company is well equipped to take care of repair work of all kinds, since it has quite a complete locomotive repair shop at Gloversville. This includes a machine shop, 60 ft. x 180 ft., equipped with all necessary tools for repairing locomotives, a blacksmith shop, 50 ft. x 75 ft., and a car shop, paint shop and woodworking shop, 50 ft. x 150 ft. The latter house is equipped with woodworking tools, suitable for repairing and rebuilding cars. The company is now rebuilding several of its interurban cars, placing smoking and baggage compartments in them. This shop is equipped for armature winding. The company has a foundry which answers all its requirements for brass and iron castings. Despite the completeness of this layout the company is planning to erect at Gloversville a special repair shop, which will be equipped and used exclusively for the electrical division of the system.

MAIN POWER HOUSE AT TRIBE'S HILL

MAIN POWER HOUSE

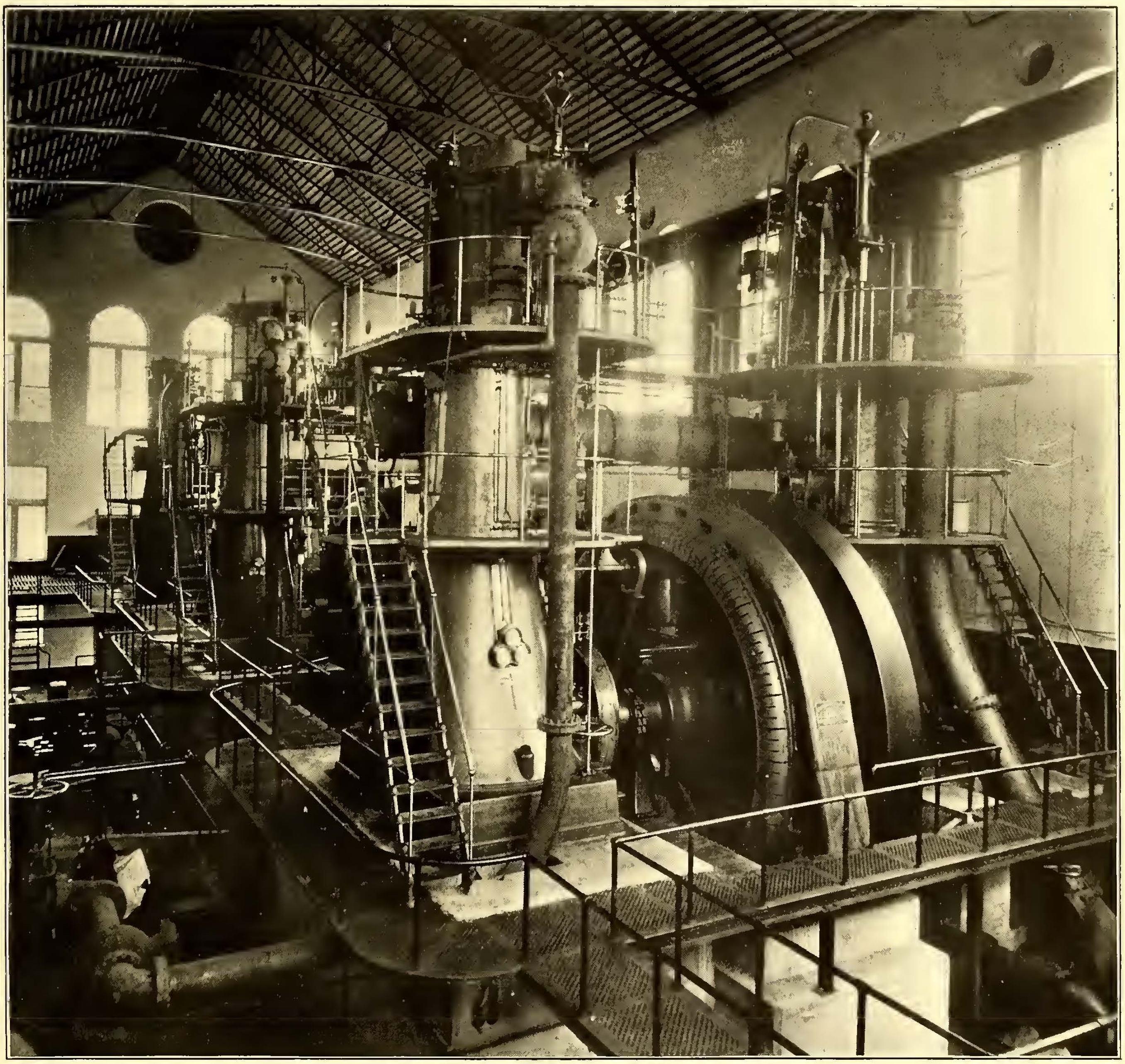
The power station of the Fonda, Johnstown & Gloversville Railway is unquestionably one of the largest and most up-to-date interurban stations in the country. The site selected is at Tribe's Hill, on the Mohawk River, a few miles from Amsterdam, at a point where the interurban road leaves the river, which it has paralleled all the way from Schenectady. The building is on a level with the tracks of the New York Central & Hudson River Railroad, which it faces, and is about 40 ft. below the elevation of the electric line. The building has an outside measurement of 164 ft. 4 ins. x 191 ft. 2 ins. It is of pressed brick exterior with limestone and terra cotta trimmings, and is divided into three sections. The boiler room at the north side measures 85 ft. x 162 ft.; the engine room, 52 ft. x 153 ft. 3 ins. and 74 ft. from the basement floor to the peak of the roof, and a wing 21 ft. 4 ins. x 143 ft. 4 ins. at the front side of the building. The roof of the engine room section is supported on steel trusses and perlins.

SECTION OF MAIN POWER HOUSE

The coal bunkers are located on the boiler room roof, which is approximately on a level with the interurban track, and they are reached by a steel viaduct, cars being run in from the main line and coal dumped into the bunkers, five in number, having a total capacity of 1200 tons. Coal is conveyed from each bunker to the boiler room below by the Hunt Conveyor system. There are valves at the base of the bunkers and at the bottom of the chutes, and the bunkers are suspended in connection with automatic scales. Coal is dumped into 1-ton cars, which operate through the center of the boiler room on a track of 22-in. gage. There are sidings in the center of the boiler room permitting cars to pass, and at the end of the room there is a turn-table by which cars may be shifted to sidings in the house.

STEAM PLANT

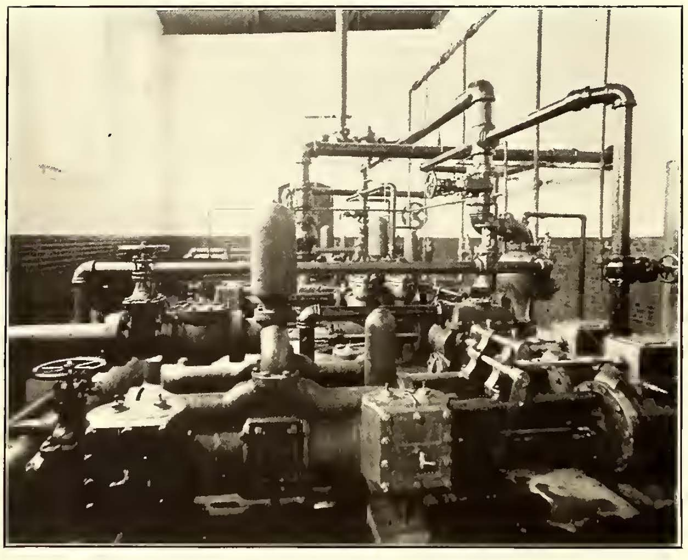
The boiler equipment consists of ten 500-hp Scotch marine type boilers furnished by the Springfield Boiler & Manufacturing Company, Springfield, Ill. These occupy the east half of the boiler room, there being space on the other side for a duplicate layout. The boilers have two furnaces, each measuring 8 ft. x 4 ft., of the Morrison corrugated type, and Springfield rocking grates. There are 135 tubes, 16 ft. long and 3½ ins. in diameter. The boiler shells are 10 ft. 6 ins. in diameter, and the shells are 1 3-32 ins. thick. Boiler shells are covered with 3 ins. of asbestos, and the smoke flue and box have 1½ ins. of asbestos covering. The boilers are hand-fired and the ashes are dumped through chutes into the basement where standard coal cars receive them. These cars are then hauled to the main line by electric locomotive. The boiler room floor and boilers rest on steel columns, which also support the overhead coal bunkers. There are four columns to each bunker and they are tied together. The main smoke-box, which measures 8 ft. x 10 ft., is suspended under the roof of the boiler room to the rear of the boilers. Connecting it with each boiler is a 42-in. smoke flue. After entering the smoke-box the smoke is drawn down to a similar smoke-box containing a Burpee's patent American fuel economizer outfit. The blower for the economizer outfit has a 12-in. fan operated by a small marine engine. The economizer tubes are kept free from soot by means of a system of scrapers operated by a small marine engine through a set of gears. The smoke-box is arranged with sets of dampers so that the economizer outfit may be cut out and direct draft used. The stack is at the east side of the boiler house. It is 172 ft. high, and has a flue which is 13 ft. in diameter at the base and 10 ft. at the top. The stack is constructed of radial brick. The main steam header is 18 ins. in diameter and 175 ft. long;



ENGINE ROOM OF MAIN POWER HOUSE AT TRIBE'S HILL flanges are 1¼ ins. thick, of riveted pipe. There is an 18-in. Crane gate-valve in the center of the main line, dividing the two sections, and ten 8-in. Lunkenheimer check valves, one for each boiler. At the top of each boiler is a Pearson type automatic valve. The main header has two 18-in. x 30-in. expansion joints, furnished by the Taunton Locomotive Manufacturing Company. Above the main header is an auxiliary header, 7 ins. in diameter, which is provided with a number of valves so that in case of accident to the main header any combination of boilers may be used. All steam piping has long bends instead of angles, and all pipes are covered with 3 ins. of asbestos.

ENGINE ROOM

The engines, three in number, are of the Allis-Chalmers vertical cross-compound condensing type, with cylinders of 28-in. x 60-in. x 48-in. stroke. The cylinders have water relief valves in each end and are provided with the Reynolds-Corliss



PUMP ROOM

automatic valve gear. The steam exhaust valves are operated by separate eccentrics providing for automatic cut off. The main journals are 22 ins. in diameter and 38 ins. long, and the shaft is 26 ins. in diameter in the center and weighs 45,000 lbs. The bearings and cross-head slides have water jacketed frames of the Reynolds circular type. The fly-wheel is 20 ft. in diameter, has a 20½-in. face, and weighs 100,000 lbs. The engine has an auxiliary governor which shuts off the steam when the speed runs above 95 r. p. m., the normal speed being 94 r. p. m. There is also an electrical speed controller in connection with the governor, which is used in synchronizing. The apparatus consists of a motor mounted on a screw on the regulator column, and is so adjusted that its movement may be controlled from the switchboard. By the operation of this switch the motor may be made to move backward or forward along the screw, thus increasing or decreasing the weight on the governor balls, and changing the speed of the engine to suit the required conditions. In this way several engines driving alternating-current machines may be made to run in unison.

At 94 r. p. m., with 160 lbs. steam pressure and condensing at 26-in. vacuum, the engines are guaranteed to develop 1700 hp, with a steam consumption not to exceed 13½ lbs. per indicated horse-power per hour, and when developing 2250 hp not more than 18 lbs. per indicated horse-power per hour. The normal load of each engine is 1700 hp, and they are guaranteed to develop 2250 ihp without excessive heating. The total weight of each engine is 380,000 lbs.

AUXILIARY EQUIPMENT

At the base of each engine is a Wheeler surface condenser having 2625 sq. ft. of cooling surface. There are two Wheeler double-inlet circulating pumps, each driven by a 12-in. x 12-in. marine-type vertical engine. They operate at 320 r. p. m., and are capable of delivering 4000 gals. per minute against a friction head of 5 ft. The engines and condensers are connected to the main exhaust pipe so that either engine or condenser may be operated in any combination desired; there is a gate valve for each condenser and each engine. Each engine also has a Davis automatic relief valve so that the engine can exhaust into the atmosphere if necessary. The main pump room is located in the basement of the boiler house. The equipment includes two Chandler duplex compound-condensing tower pumps, two boiler feed pumps of the duplex pot-form type, with two cylinders 12 ins. in diameter, and four 16-in. single-acting water plungers having 18-in. stroke, provided with Fisher governors and relief valves; two independent air pumps and condensers, which take care of the exhaust steam from the boiler feed and tower pumps. Below the basement floor is a hot-well, 14 ft. x 7 ft. x 7 ft. This receives not only the condensation from the condensers, but all condensation from the main steam line, headers and separators, so that there is practically no loss of water in the entire house. Water in the hot-well is replenished by a float valve in the tower line. Water in the tower is maintained at a certain level, and a bell rings in the engine room when it falls below this level.

Water for the circulating system is pumped from the river through a 20-in. steel main laid in a tunnel passing under the tracks of the New York Central Railroad. The feed-water pumps are arranged so that they may take water by suction direct from the hot-well, from the tower or from the river.

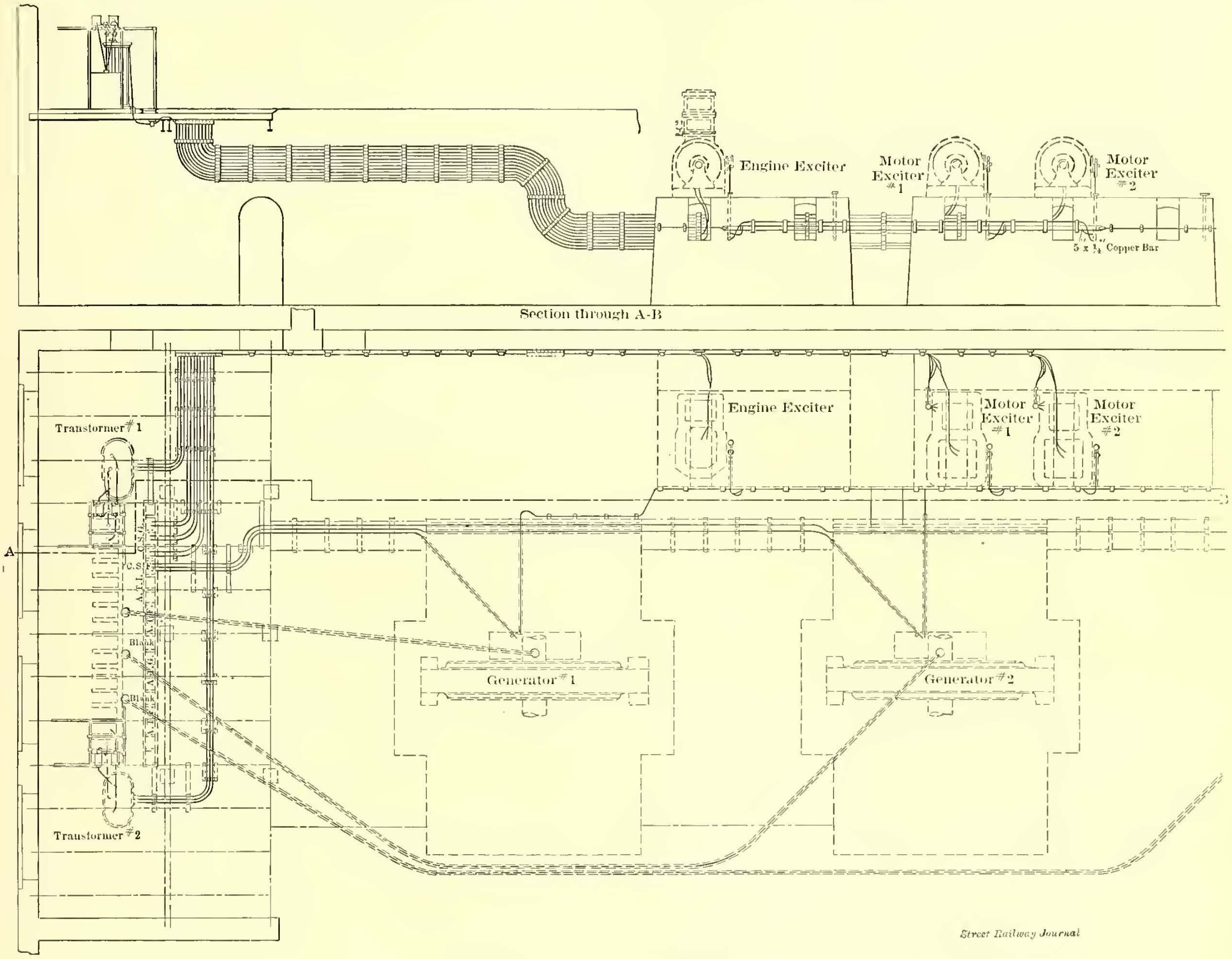
As auxiliaries in case of trouble with the economizers there are two National feed-water heaters, installed by the National Pipe Bending Company, of New Haven, Conn. The heaters are located between the economizers and the pumps, and are heated by means of the exhaust from the auxiliaries.

The oiling system in the house is very complete. There are large elevated tanks in the upper part of the engine room with supply pipes to all engine oil cups. Oil from the engines flows by gravity to two No. 10 Turner oil filters and then to supply tanks located in the basement. There are two sets of oil pumps which are cross connected, so that either may be used to pump cylinder oil or engine oil. There are also separate air compressors which are used to pump oil out of barrels and deliver it to the supply tanks. The compressors also supply air for blowing the dust from the generators and from the back of the switchboard.

ELECTRICAL EQUIPMENT OF THE MAIN AND SUB-STATIONS

For the supply of direct current to the line between Schenectady and Gloversville, three direct-current feeding points or sub-stations were considered necessary, these being located about 10 miles apart. One of these was located in the existing generating station in Johnstown, where space left for a future 300-kw engine and belted generator proved to be ample for three 300-kw converters, their transformers and switchboard, with a space for a fourth. It is of interest to note that these converters have a much greater overload capacity than the old-fashioned generator, thus showing a space economy of some 5 or 6 to 1 in units of the same capacity. Another sub-station was located near Amsterdam, and with it is combined apparatus for lighting the city. The third sub-station (purely railway) was located between Amsterdam and Schenectady (in the town of Glenville), at a point somewhat more than halfway from the Amsterdam sub-station to the section breaker between the direct-current trolley system of this road and that of the Schenectady Railway Company. The location more than halfway to the end of the feed was chosen in order to keep up the best trolley voltage at all points with a given amount of direct-current feeder copper, considering the fact that the feeders are carried through without break from sub-station to sub-station, lines supplied from the Amsterdam sub-station, and the Fonda division supplied from the Johnstown sub-station, three converters were ordered for each of these stations, one for light loads and two for regular service, with one spare.

The converters are the standard machines manufactured by the General Electric Company, six-pole, running 500 r. p. m., with ventilated fields, open type collector rings, series shunt and equalizer switches mounted on machine frames, and other improvements up to the date of their manufacture. Each converter is fitted with field break-up switch for use when starting



WIRING PLANS OF MAIN STATION

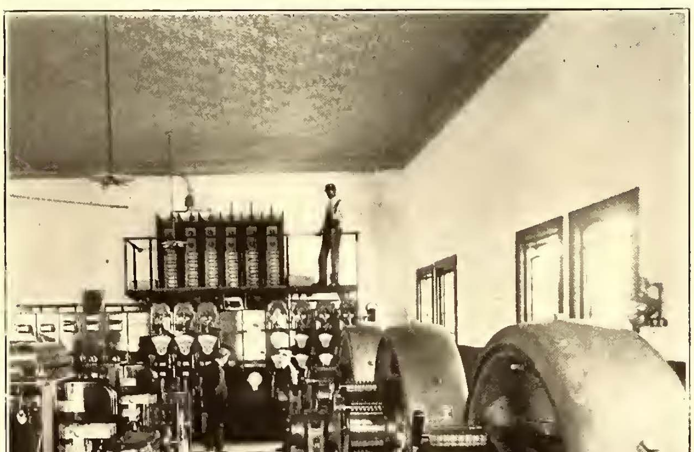
thus giving all cars between sub-stations a feed from both ends.

The Glenville sub-station feeds a section of the track carrying interurban cars only, with no local or city traffic.

The equipment of these cars, four 75-hp motors, will take in multiple position, when accelerated rapidly, 800 amps. per car. In order to take care of this swing of load, together with 100 or 200 amps. which may be demanded by other loads at the same time, without running more than one converter, the 300-kw size was chosen, the maximum carrying capacity of this size being 1000 amps. momentarily at 600 volts, on the basis of 100 per cent overload. Two of these converters were ordered for the Glenville sub-station, thus making one spare, as this substation will, in all regular service, supply only one car each way, and the equipment is figured for one of these cars accelerating and one running or drifting. Converters of the same size were used in both of the other sub-stations in order to make the apparatus interchangeable. On account of the local urban from the alternating current side, and this break-up switch is made double throw, the lower throw reversing the normal connections between armature and field so that the shunt field winding opposes the magnetism set up in the machine by the alternating currents. By this means the polarity of the machine is readily reversed when, in starting from the alternating-current side, the machine comes up with wrong polarity, that is negative to trolley and positive to ground. This is a recent improvement over previous practice in which reversing was accomplished only by pulling the machine out and throwing it in again on the hit or miss principle.

The converters being all of the same size and there being a spare converter in each sub-station, the usual arguments for single-phase transformers did not exist in this case, and three-phase transformers were adopted on account of lower cost, less floor space, etc. One 330-kw three-phase transformer is installed with each converter. These transformers are of the air-blast type, of shell construction, with three sets of coils similar to those of three single-phase transformers, but combined in one shell which serves as a common magnetic circuit. Primary windings are connected in Y with the secondaries in delta, the primaries being provided with taps for changing the ratio of the transformer in 2.5 per cent steps up to 10 per cent, the secondaries being provided with one-half voltage taps in two phases for the purpose of "starting in the corner." In explanation of this term, it should be said that the converters are started by applying to them one-half their normal voltage obtained from one-half of the turns of the secondaries of the transformers. One corner of the delta is connected through to one collector ring of the converter in either the starting or running position of the switch. In the starting position the other two rings of the converter are connected to one-half taps in the two sides of the delta adjacent to this corner; in the running position these two rings are connected to the other two corners.

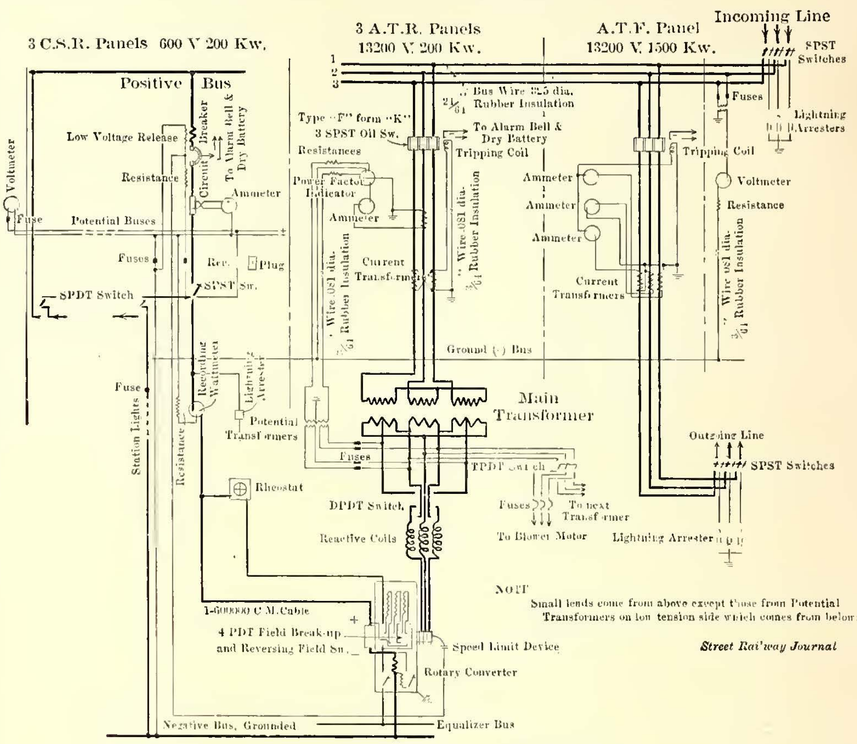
There is also provided between each transformer and the corresponding converter one three-phase reactive coil. This is designed to give a boost of about 30 volts alternating current with full load current of the converter leading and a depression of about the same amount with full load lagging. This boost or depression in each phase amounts to about 70 volts boost or depression of the direct-current voltage. These reactive coils stand over the air-blast chamber provided for the trans-



SUB-STATION EQUIPMENT AT JOHNSTOWN

formers and are cooled by a small amount of air taken from them.

The high-tension line voltage chosen was the highest standard for which the General Electric Company builds generators without step-up transformers. This pressure, 13,200 volts, is ample for distribution from the generating station at Tribe's Hill to the present sub-stations, and for all extensions up to a



WIRING PLAN FOR SWITCHBOARD

maximum distance of about 25 or even 30 miles from the generating station, which is as far as there is any immediate prospect of an extension of this system. To take care of the high-tension power at this voltage in the sub-stations, three single-pole form K oil switches of the hand-operated type connected through mechanism to one handle on the switchboard panel are provided for the supply of each step-down transformer unit. These switches are rendered automatic by the use of current transformers, relays and tripping coils, no high-tension fuses being used. Similar switches are also provided for

CABLEWAY IN SUB-STATION AT JOHNSTOWN

cutting in or out either or both of two transmission lines to each sub-station, these switches being provided for each end of each of these lines. These, however, have not been utilized, as it has been considered preferable to put some of the cost of the second transmission line into the first, thus rendering the one transmission line more nearly infallible. The line between the generating station and the Amsterdam sub-station is in operation twenty-four hours per day—all day for the railway and all night for lighting service. On this account a rather novel expedient was here tried; that is, the use of four transmission wires for a three-phase circuit, one of the four being a spare, and connected to knife switches at each end so that any one of the other three line wires may be cut out at both ends and replaced by the spare wire. It is anticipated that by this means one wire may be killed in case of a punctured insulator, a cross or a break, and service may be continued by means of the spare wire. As this part of the line follows the track and may be reached from a tower wagon, it will be possible to replace an insulator or make other repairs on the dead wire while the other three are in use.

The generating station contains three main units, one of which was intended for light loads and two for ordinary service, with one reserve. These units are rated at 1000 kw each on a very moderate temperature rise, allowing for a 50 per cent overload for two hours and 100 per cent momentarily, the engines being made of corresponding power. It was anticipated that the all-night lighting load would, after a short time, become sufficient to give a fairly economical load to one of these units, and for this reason the complication of a smaller unit was not considered advisable. These units run at 94 r. p. m., requiring, therefore, thirty-two poles to give twenty-five cycles. They are of the usual General Electric type, with revolving fields wound with copper ribbon on edge and with stationary armatures wound with heavily mummified coils of the double chain type in two slots per pole per phase. As noted, these units generate 13,200 volts directly in their windings.

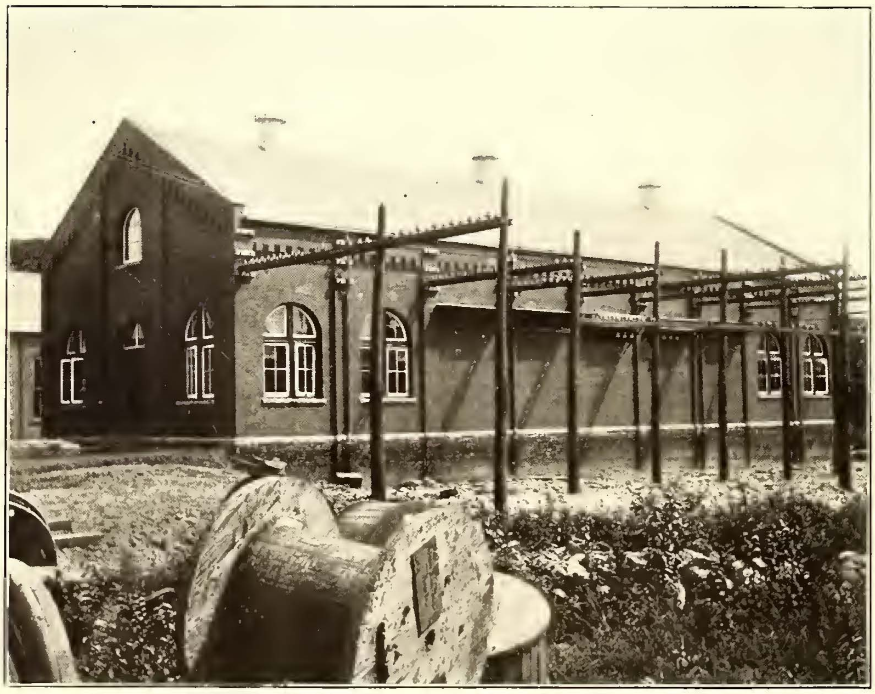
For the excitation of these units three exciters are provided, one being engine driven and intended, as a rule, only for use in starting the plant, but made of sufficient size to excite all three generators, thus serving as a reserve. This exciting unit consists of a marine set. The other two exciters are driven by induction motors supplied from the high-tension bus, through three-phase oil-cooled core type step-down transformers, one for each exciter. The switchboard equipment is somewhat similar to that of the sub-stations, three single-pole, form K, hand-operated oil switches being provided in the circuits of each generator, and in the supply circuit of each step-down transformer for the exciters. The outgoing high-tension lines to the sub-stations are equipped with motor-operated, form H oil switches. These have a very great kilowatt-breaking capacity, and this is considered necessary on account of the fact that they are automatic, and one of them must break the whole power of the station in case of a short circuit on the corresponding line. The generator switches are not automatic, the idea being to keep the generators in parallel on the bus when an overload or short pulls out one of the lines.


ROTARIES, TRANSFORMERS AND SWITCHBOARD IN AMSTERDAM SUB-STATION

High-tension lightning arresters with disconnecting switches are provided at each end of each transmission line. Each line is also equipped at its ends with a simple form of indicator to show whether the line is alive or dead. This consists of a light wheel with tangential points and balanced on a step bearing. The repulsion of the air particles from the points causes the wheel to rotate at high speed when the line is alive, unless the wire is grounded.

The lighting equipment of Amsterdam sub-station comprises three motor generator sets designed to receive 25-cycle power and deliver 60-cycle power. A 25-cycle system with motor generator sets for lighting purposes, although somewhat more expensive than a 60-cycle system with 60-cycle converters, was considered preferable to the latter on account of the superiority of the low-frequency converters, and also on account of the opportunities given by the motor generators for lighting voltage regulation, either hand or automatic, to take care of all speed or load fluctuations. Two of these motor generator sets are of 500-kw capacity each, the third being a smaller one, rated at 200 kw and intended for carrying the all-day load. One of the large sets is of sufficient size to carry the full evening load for some time to come, leaving the other as a reserve, and space is provided at the end of the station for a third large set when the load becomes so great as to require the two large ones, leaving no reserve with the present equipment.

It is of interest to note that this sub-station is designed for extension with the greatest ease. For example, although one of the railway converters at present installed is a spare, space is provided for a future converter at the other end of the station for a future motor generator set. In addition to these reserves and spaces for future reserves the station is built about midway of the lot so that either end of the building can be extended for even further additions, one end for lighting and the other end for railway. The switchboard, 60 ft. in length, is continuous, with railway panels at one end in front of the railway machines and lighting panels at the other end in front of the lighting machines. Blank panels have been provided in the board for future converter and lighting motor-generator sets for which space is provided in station.



AMSTERDAM SUB-STATION, SHOWING HIGH-TENSION LINE SUPPORTS

Of the two large motor-generator sets the motors are wound for 13,200 volts, thus doing away with step-down transformers. The smaller set is provided with a three-phase step-down transformer giving 370 volts, the same as the transformers for the converters, so that in case this transformer is crippled the small synchronous motor-generator set could be supplied from one of the railway transformers. Each motor-generator set is provided with its own direct-connected exciter. The small motor-generator set is started just as are the converters, by means of alternating currents introduced directly into the motor windings, these currents being of lower voltage than normal, and this lower voltage being obtained by means of a starting switch, which cuts in only part of the transformer windings in the starting position. In the case of the large motor-generator sets this method was, of course, not available, as there are no transformers supplying these sets. To take care of the starting of these sets without the expense of duplicate compensators with their switches, etc., use has been made of the primary windings of the railway step-down transformers. Taps are provided in these Y-connected primary windings and taken to an oil switch mechanically interlocked with the motor switch, so that the large synchronous motor can be connected first to 6600 volts until it comes up to synchronism, after which it can be thrown over to 13,200 volts without danger of cross-connecting these two sources of supply. The high-tension bus of this sub-station is divided in two sections by means of knife switches, with part of the converters and part of the motor generator sets on each section, so that at times of light load one section can be shut down to clean up or to extend or repair the bus or any of its branches to and including the oil switches supplied from it. The incoming line is cut into either or both sections of the bus.

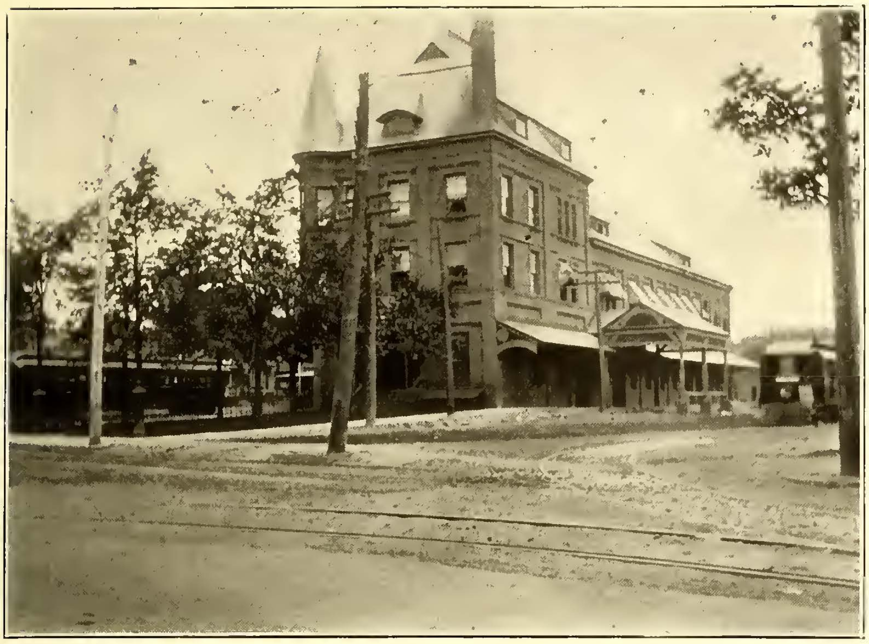
Careful provision has been made for obtaining proper phase relation of the 60-cycle generators. After the motor generator sets have been brought up to speed and locked in step with the supply circuits, it is obvious that the generators may have any one of several phase relations, owing to the fact that the generators have more poles than the motors. Provision has been made for slipping the motors back one pole at a time by means of field reversing switches until the generators are in phase with each other. The generators supply three-phase currents at 2300 volts to one set of busbars, from which power is taken to five fifty-light constant-current transformers for arc circuits, and to twelve outgoing incandescent lighting feeder circuits, eight of which are provided with C. R. regulators and compensated voltmeters.

Provision is made for obtaining energy records on the system by means of an induction recording wattmeter on each of the main generators of the power station, and a recording wattmeter on the output of each converter and each motor-generator set. The first set of wattmeters gives the total output of the steam power plant, while the second gives the sub-station output, the difference being the power lost in transmission lines, transformers, converters and motor generator sets.

MACHINE SHOP

The layout in the wing is an unusual one for an interurban power house. A space, 50 ft. x 25 ft., is utilized as a machine shop, and it is equipped with lathe, drill press, planer, shaper and other tools that might be required in caring for a plant of this kind. There is a large store room fitted up for the systematic handling of duplicate parts and supplies of all kinds. A third is arranged for a drafting room, and it is fitted with tables and necessary apparatus, and files for the convenient handling of drawings and blue prints. Adjoining this room the chief engineer has a private office and connected to it is a private bath room. Adjoining the boiler room is a large toilet room equipped with tubs, shower bath and individual metal lockers for the use of the men.

The entire plans for the buildings, electrical apparatus, engines and all features of the installation were designed under



PASSENGER STATION AND HEADQUARTERS BUILDING AT GLOVERSVILLE

the supervision of Charles H. Ledlie, consulting engineer, St. Louis, and were carried out by H. O. Rockwell, resident engineer, and W. W. Guest, chief draughtsman. All electrical equipment was installed by the General Electric Company, while the engines, feed-water pumps, tower pumps and piping were installed by the Allis-Chalmers Company.

ORGANIZATION AND OPERATION

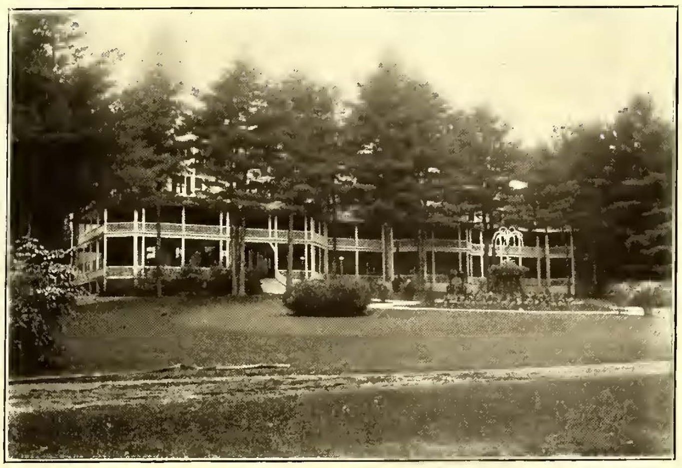
The company's headquarters is at Gloversville in a handsome brick structure, which is also the station for both the electric and steam divisions. The entire system is covered by a private telephone line with the exchange in the headquarters building, and the telephone system is connected with that of the Glens Telephone Company, of Gloversville. Waiting rooms and ticket offices are maintained in all towns. Baggage is checked on the electric division, but on this portion of the system there is no freight or express business, the reason for this being obvious when one considers the close relationship existing between the company and the New York Central Railway.

Through tickets are also sold from Schenectady to the park at the end of the steam line at the rate of $1.45 per round trip, good any time; and on Sundays, holidays and for picnics the rate of $1.00 is made. Between Amsterdam and Schenectady the company sells a book for thirty days, which gives fifty-four rides for $9.00. The book is not transferable.

The company pays its men 17½, 18, 19 and 20 cents, according to the amount of service. Promotion is by order of seniority, men starting extra on city lines, then going to the Fonda-Gloversville, and finally the interurban lines. The electric system is operated in two divisions, the entire system being in charge of H. O. Rockwell, who has the title of assistant general superintendent.

PARKS AND AMUSEMENTS

The company owns and operates Sacandaga Park, a beautiful natural park located on the river of the same name, and almost surrounded by mountains, the foot-hills of the Adirondacks. The company property embraces 250 acres, which have been laid out and improved by professional landscape artists. The river was dammed in two places, making a shallow pond which affords excellent bathing and boating. The company has a number of steel rowboats, and there is a toboggan slide into the river, use of which is free to bathers who pay 25 cents for bathing suits. The toboggans are drawn up by endless chains. The park is thoroughly sewered and is laid out with water pipes delivering spring water, which comes from the mountains, 3 miles away. A large portion of the park is laid out with streets, and building sites and summer cottages are leased to desirable applicants. There are 150 cottages and several small hotels, in addition to Adirondack Inn, operated by the company. This is equipped with every convenience to be found in the most up-to-date hotels. The building is illuminated throughout with electricity, and each room has a bath room adjoining. Accommodations are provided for 200 guests. There is a large ball room adjoining, and frequent "hops" are given to guests and favored visitors. The park also has a dance pavilion which is let out to private parties. There is a summer theater, beautifully situated at a



ADIRONDACK INN, SACANDAGA PARK

SUMMER THEATER, SACANDAGA PARK

side of a wooded ravine having a stage backed by the river. A high-class vaudeville programme is given each evening during the season, attractions being furnished by the J. W. Gorman Amusement Company, which has a circuit of a number of parks in New York State.

Other attractions include a railway baseball park, with scheduled league games, laughing gallery, installed by the Ingersoll Construction Company, of Pittsburg, and a steam-operated merry-go-round of very elaborate design, manufactured by G. A. Dentzel, of Philadelphia. The attractions mentioned are operated by the company, in addition to which there is a photograph gallery, restaurant and a number of fancy goods stands, for which privileges are let out. During the season there are three daily concerts by Prouty's Orchestra, of Boston. The popularity of this resort will be appreciated when it is stated that on July 4 the attendance was over 20,000.

The entire system affords a delightful route for pleasure seekers, particularly the electric division, which, for a number of miles, affords a view of the picturesque Mohawk Valley, backed by a range of mountains. The Mohawk River, through which the aborigines were wont to ply the canoe, the old Albany turnpike, the Erie Canal, through which packet boats were operated in the early days of the last century, the New York Central, with its great steam railroad of four tracks, and the double-track electric line, all parallel, give striking evidence of the remarkable advances in the way of transportation facilities afforded in the valley of the Mohawk for the last 100 years.

THE ALBANY & HUDSON THIRD-RAIL SYSTEM

The fertile territory to the south of Albany is being developed by the Albany & Hudson Railroad Company, whose line from Albany to Hudson, through the counties of Columbia and Rensselaer, and touching a number of small towns, was placed in operation in November, 1900. Over a portion of the distance the line follows the New York Central & Hudson River Railroad, but over the remaining portion it is back in the country at some distance from the river.

The line in question is the only third-rail electric road in Eastern New York, and at the time of its construction it was looked upon as one of the highest examples of third-rail practice in the country. The enterprise was fully described in the Street Railway Journal of Feb. 2, 1901, and as few changes have been made since that time, a brief review only is necessary.

Current for the operation of the road is supplied from the water-power plant situated in Kinderhook Creek, 10 miles north of Hudson. Four varieties of generating apparatus are installed at this house, making it a very novel combination. These include railway circuits, operating at 25 cycles, lighting circuits operating at 60 cycles, direct-current generators for the section of the line adjoining the house, and an auxiliary steam plant. The main building is 82 ft. x 142 ft., containing the water-wheels, dynamos and engines, while the boiler house is 52 ft. x 80 ft. Water is brought from the dam in two 7½ ft. penstocks. These penstocks are tapped by pipes leading to the turbines which are placed along the side of the house adjoining the river. The turbines are in the lower of a series of three floors into which the bay on that side of the building is divided. They are ten in number, of various capacities for running the different generators, exciters, etc. They are of the Victor type, supplied by the Stilwell-Bierce & Smith-Vaile Company, of Dayton. The generators extend into the main building, and beyond these are the engines so situated that they may be readily coupled to the shafts of the generators. The engines are three in number, two 1000-hp Ball & Wood marine type, and one 750-hp Buckeye cross-compound condensing horizontal type. The first two of the engines are arranged to drive 750-kw generators, while the other engine has two shafts in line with two 250-kw single-phase generators. There are three Bulkley injector type condensers, one for each engine, and the condensers have a duplicate system of piping, by which they receive water from the penstocks.

Two feed-water pumps are arranged to take water from the penstocks or from the hot well. Steam is furnished by three 500-hp Aultman & Taylor water-tube boilers. Natural draft is used, the chimney being 125 ft. tall x 6½ ft. flue.

As the power station is close to the main line, a considerable portion of the power generated is direct current. Two 200-kw direct-current generators are connected to water-wheels. For the high-tension transmission there are three 750-kw, 25-cycle, three-phase generators, delivering 12,000 volts directly from their windings. Exciting current for the field is generated by two 60-volt exciters, driven by independent water-wheels.

Switches are located in two galleries above the water-wheels. The switchboards are located in the first gallery, and include panels for the exciter, the three-phase generators, single 60-cycle generators for lighting, and the 600-volt railway generators; each set being separated by passage-ways. The several switch and transformer cells are in the upper gallery, and include oil switches, separated by soapstone barriers, oil potential, and current transformers electrically connected to instruments on the switchboard panel, being of the usual type now employed by the General Electric Company, but which were advanced departures at the time this station was installed. The instruments on the switchboards are supplied by instrument transformers, and no high-tension lines are brought to the board. The outgoing feeder lines are protected by high-tension fuse blocks of the explosion type. The high-tension lines are mounted on 35-ft. poles, spaced 100 ft. apart. At the top of the pole is a cross-arm carrying lighting lines, and below this are cross-arms carrying duplicate three-phase 25-cycle lines. Lines are mounted on 5-in. triple petticoat porcelain insulators. The wires are No. 1 and No. 4 copper. There are three sub-stations located at Hudson, North Chatham and East Greenbush. The stations at Hudson and East Greenbush are in buildings designed exclusively for the purpose, while the North Chatham station is a part of the railway station containing express room, waiting room and ticket office. The equipment of each station includes one 200-kw and one 400-kw rotary converters, supplied with air-blast transformers, oil switches, switchboards, and other standard General Electric equipment.

The third-rail is sectioned at the sub-stations, there being two feeder panels in each sub-station, one feeding north, and the other feeding south. The third rail is of 80-lb. T, the same as the track rail, but it is made in lower carbon, thereby reducing its electrical resistance. The ties for the track are spaced on 2-ft. centers, and every fifth tie is extended to form a support for the third-rail insulators. Insulators are made of wooden blocks, topped with malleable cast-iron caps. At all points where the road crosses highways or farm lanes, the third rail is interrupted, but the circuit is maintained by cable connection placed underground. For collecting the current there are four contact shoes, two for each side. As the road is single-track, and there is only one third rail, only two shoes are in use at any given time. There is a switch on the platform of the car, which enables the motorman to place the controller upon either pair of shoes, or the trolley wheel.

The car equipment of the road is of very high class, and includes thirty-six cars. The regular passenger coaches are 53 ft. 6 ins. over all, and are in two types. Cars designed for summer use have low drop windows, and are finished in white ash and light colored bird's-eye maple, while the winter cars have mahogany finish, elaborately inlaid. The summer cars have slat seats, while the winter cars have Heywood Brothers & Wakefield-Wheeler patent seats, upholstered in carpet. A portion of these cars have smoking compartments, while others are designed for handling baggage and express. The summer cars have four General Electric 57 motors, while the winter cars have General Electric 51 motors. The type-M control is used, and cars are coupled in trains of two and sometimes three. The company is obliged to run the cars singly in the cities of Albany and Hudson, where they run over the streets. The company has four 43-ft. express cars, and does quite an extensive express business. Of course, in the city streets, the trolley is used. The road is run on steam railroad principles, and the line is covered by both telephone and telegraph, the former being used for despatching cars. The company is installing a semaphore block signal system, which is to be operated by station agents, and which will cover three stations.

Motormen and conductors are obliged to pass a very rigid examination as to their knowledge of operating and equipment, and each man is examined three times a year. The company states that not one man in ten who applies for a position is able to pass the examination, which is evidence as to the care used in making safe operation the all-important item.

The company operates Electric Park, located on a beautiful sheet of water, known as Kinderhook Lake. It is equipped with all desirable accessories for a park of this kind, including a large summer theater, where vaudeville performances are given every afternoon and evening. The park is run strictly on temperance principles, and is well patronized by the best class of people from Albany and Hudson. While the park is not self-sustaining, it is a great inducement to travel, and adds greatly to the receipts of the road. On July 4, of this year, the company handled over 12,000 people, without a single accident, and the only delays were caused by the drawbridge at Albany. These delays made it very difficult to operate on schedule, but by issuing eighty-one special orders the system was kept moving in very satisfactory shape, and without a single breakdown in cars or equipment.

At the present time, the company is lengthening out all sidings, laying about 4 miles of track in this manner, with the view of ultimately double-tracking the entire road. The operation of the road is at present in the hands of J. S. Gillespie, who was formerly assistant division superintendent of the Baltimore & Ohio Railroad.

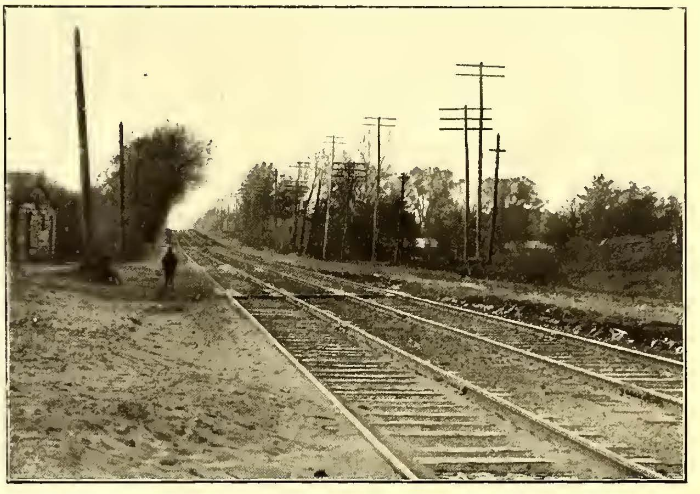
The officers of the company are: C. L. Rossiter, president; A. M. Young, first vice-president; George G. Blakeslee, second vice-president and general manager; L. B. Grant, secretary; H. G. Runkle, treasurer; R. P. Leavitt, electrical engineer; J. Bersel, mechanical engineer, and J. S. Gillespie, superintendent.

For five months last year the company was in the hands of a receiver, Mr. Blakeslee, the present general manager. It was reorganized on March 1, 1903, with the officials here named. During the five months of the receivership, which were the poorest of the year, the road paid all operating expenses and earned money enough to pay all fixed charges, including bond interest.

SCHENECTADY'S CITY, SUBURBAN, AND INTERURBAN ELECTRIC RAILWAY FACILITIES

It would be hard to find a better example of the rapid advancement of the electric railway industry than that afforded by the growth of the Schenectady Railway Company. Only a few years ago, in 1894, this system consisted of 2 miles of single track with an equipment of four closed cars. The management at that time seriously considered the advisability of cutting down the service to three cars on account of the lack of patronage, but to-day it is operating over 75 miles of track and has in course of construction about thirty-six additional miles, while its equipment has increased to over 100 cars, handling during the year closed, July 30, 1903, over 7,000,000 passengers.

Schenectady is now the hub of an electric railway system extending like the spokes of a wheel in all directions. To the



SCHENECTADY-ALBANY LINE OVER OLD STONE TURNPIKE

north, a double-track road to Ballston Spa and Saratoga, a distance of 22 miles, is about completed. To the east, a double-track road to Troy, a distance of 16 miles, was completed in March of the present year. To the southeast, a double-track road to Albany, a distance of 15½ miles, has been in operation for over two years. To the south, a road is contemplated to South Schenectady and Altamont, a distance of 11 miles; while to the west a connection has been made with the Fonda, Johnstown & Gloversville Railroad, making it possible to ride from Albany to Gloversville, a distance of 50 miles, without change of cars.

The extraordinary growth of this system may be attributed to the rapid increase in the population of the city of Schenectady, due to the development of the two large industries—the General Electric Company and the American Locomotive Company. The increase in the population of the city is shown by the following table:

1880	13,655
1890	19,902
1892	22,730
1899	28,791
1900	31,683
1902	53,000

The average number of employees of the General Electric Company and American Locomotive Company is as follows: 1891, 4457; 1901, 10,827; 1903, first quarter, 15,408; with a total annual pay roll of nearly $2,000,000.

The development during the last year has been similar to that of some of the Western boom cities. Entire new districts have been laid out and 1475 houses erected and occupied. Schenectady is also the home of Union College, one of the oldest institutions of learning in the country.

OPERATION

In the city of Schenectady six lines are operated under the following headway: State Street-Scotia, 10 minutes; Bellevue-Aqueduct, 7½ minutes; Union Avenue, 7½ minutes; "A" Belt, 5 minutes; "B" Belt, 5 minutes; State Street Stub, 15 minutes. These lines cover 22.66 miles within the city limits.

One of the most difficult problems the company had to contend with was the handling of the large number of employees of the General Electric Company in the short space of time allowed before and after shop hours. The company has successfully solved the problem by the building of a loop at the entrance to the works with the necessary storage tracks from which extra cars can be fed into the main line without interrupting the regular traffic. In this manner about 3000 people are loaded and unloaded from the cars in less than half an hour without any apparent discomfort. In order to accommodate the large number of employees of the General Electric and American Locomotive Companies who live in neighboring towns, special cars are run directly from the works over all interurban lines both morning and night.

LINE CONSTRUCTION FOR DOUBLE-TRACK, WITH POLE AT ONE SIDE—BRIDGE CROSSING MOHAWK RIVER

INTERURBAN LINES

Both the Troy and Albany divisions are operated on a 15-minute headway from 9 a. m. to 8 p. m., and on a 30-minute headway at other hours of the day. On the hour a special service has been established between Schenectady and Albany, called the "Schenectady-Albany Limited." The trip is made in 45 minutes, without stops outside the city limits, no extra fare being charged. A similar service will soon be put into effect on the Troy division. Round trip tickets to Troy and Albany are sold at 40 cents, and are interchangeable; single fare, 25 cents. Commutation books, containing fifty-two tickets and limited to one month are furnished for $7.50. Although all the lines controlled by this company abound in most picturesque scenery, that afforded to passengers on the Troy division is especially notable. At points on this line views of the beautiful Mohawk Valley, the Adirondack, Catskill and Green Mountain ranges may be obtained, providing a panorama of river and mountain scenery which can hardly be excelled in any other part of the country.

With the completion of the Ballston-Saratoga division passengers will be taken from Albany and Troy by means of a cut-off around the city of Schenectady directly to Saratoga in about an hour's time. In order to make this possible the company is erecting, near the Aqueduct, and just outside of the northerly city limits of Schenectady, a double-track steel bridge, having a total length of 1,769.53 ft. This is being built by the American Bridge Company, and is of the riveted lattice truss type, resting on ten concrete and masonry piers. This bridge will be 45 ft. above low water.

TERMINAL STATION

The company has made the necessary plans for a large terminal station in the center of the city of Schenectady. In this station will be located the executive offices of the company and the offices of the various departments. The building will also contain suites of offices which will be rented. This terminal station will have a commodious waiting room. The interurban cars, as well as some of the city local cars, will loop around this office building, thus enabling the Albany, Troy, Saratoga, Amsterdam, Johnstown and Gloversville passengers to be conveniently transferred to the cars desired. This terminal station will be the first of its kind erected in any of the Eastern cities.

ROLLING STOCK

The rolling stock of the company is of the most modern type, equipped throughout with electrical apparatus manufactured by the General Electric Company. A brief description follows:

CITY CARS

29 single-truck closed cars equipped with two G. E.-67 motors.
8 single-truck closed cars equipped with two G. E.-57 motors.
4 double-truck closed duplex cars equipped with G. E.-52 motors.
6 eight-bench and twelve nine-bench single-truck open cars, equipped with G. E-67 motors.
12 thirteen-bench double-truck open cars, equipped with G. E.-67 motors.

INTERURBAN CARS

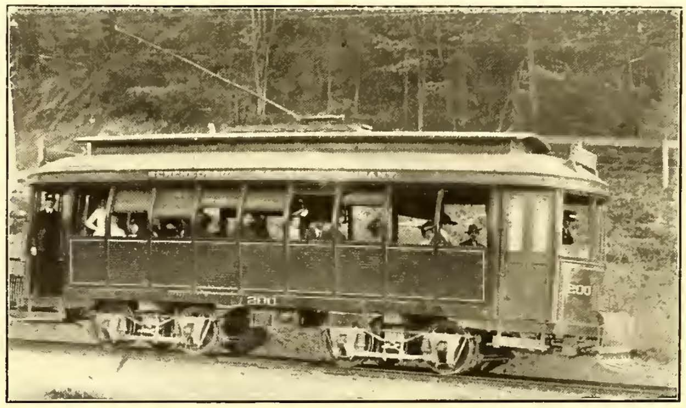
12 40-ft. double-truck closed cars, equipped with G. E.-57 motors.
10 47-ft. double-truck closed cars, with smoking compartment, equipped with G. E.-57 and G. E.-73 motors.
6 51-ft. double-truck semi-convertible cars, equipped with G. E.-73 motors

MISCELLANEOUS EQUIPMENT

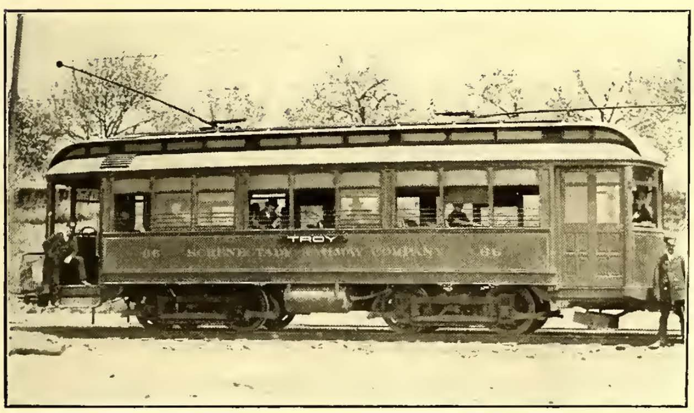
6 motor flats.
25 dump cars.
6 express cars.
3 rotary snow plows.
3 small snow plows.
1 sprinkling car.
1 sand car.

The cars owned by the company were furnished by the St. Louis, Brill, Stephenson, Laconia and Jones car companies.

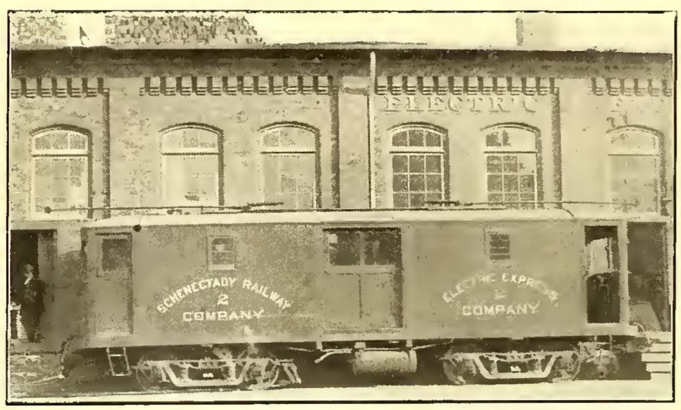
SINGLE-TRUCK CITY CAR



DUPLEX CONVERTIBLE CAR



CAR FOR LOCAL SERVICE ON INTERURBAN DIVISION



SPECIAL CAR FOR EXPRESS

The latest equipments are the six 51-ft. Brill semi-convertible cars. The interior of these cars is divided into two compartments, separated by hard-wood partitions, having single sliding doors. The smoking compartment is 11 ft. 10 ins. long, and the passenger compartment, 27 ft. 10 ins. long. Both compartments are furnished in dull mahogany, handsomely carved, and with a ceiling of bird's-eye maple with gold stripings. Seats are upholstered in leather. The platforms have enclosed round-end vestibules sheathed with steel. The trucks are equipped with four General Electric 73 motors, and the General Electric type-M system of train control is used.

All of the company's interurban cars are equipped with the Magann system of air brakes. The storage tank, capable of holding air at 250 lbs. pressure, is suspended below the car. At all car houses and sub-stations compressor outfits are arranged to supply a full charge of air in less than 1 minute. The Albany cars are fitted with the Flood emergency track shoe-brake, as it is considered necessary to take extra precaution on account of the 10 per cent grade in Albany. The shoe is pick shaped, and the wheel runs up on it and becomes locked, the track bearing onto the lower side of the pick. The brake is operated by a hand lever. A view of a truck equipped with this brake is shown.

All cars on the Troy division carry mail boxes on the front end, and if they desire to do so people along the route may stop cars to mail letters.

TRACK AND LINE CONSTRUCTION

All interurban tracks are laid with 75-lb. T-rails, thoroughly ballasted with either gravel or broken stone 1 ft. under the ties, and filled up even with the base of rail. Tracks are well trenched, and careful attention has been paid to drainage, several miles of 6-in. tile having been laid alongside and between tracks.

On the city lines 7-in. to 9-in. girder rails, Lorain Steel Company's section, are used. Section houses provided with hand cars and all necessary track tools are maintained at several points on the interurban lines, and the tracks are carefully inspected daily. Warning signals are provided at all danger points and clusters of lights mark these spots at night.

All stations or stops along the lines are given numbers in consecutive order, which are announced by the conductor, thus making it impossible for passengers to become confused as to their whereabouts either by day or night.

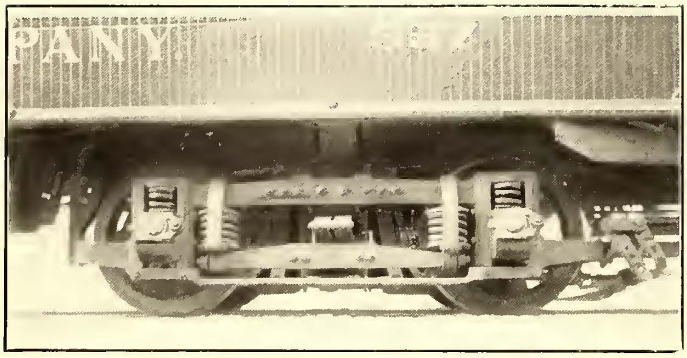
The overhead work on the present system is all span construction, with 35-ft. and 40-ft. chestnut poles set 100 ft. apart. Center pole, double-bracket construction has been installed on the Ballston division, 35-ft. octagonal yellow pine poles embedded in concrete being used. The tracks on the latter division are on 13-ft. centers and the roadbed is graded 29 ft.

The trolley wire on interurban lines is 0000 grooved, and on city lines 000 grooved.

There are several bridges on the system. At the Scotia crossing of the Mohawk River the company extended the piers of the county wagon bridge and erected a superstructure of its own. The bridge consists of eight spans of pony truss type. The total length of the bridge is 773 ft., of which 396 ft. is laid with single track and 372 ft. double track, there being a siding on the bridge. On the Troy division there is a steel trestle 203 ft. long, with an average height of 16½ ft., and on the Aqueduct line there is a pony lattice bridge 103 ft. long with an average height of 26½ ft.

CAR HOUSES AND REPAIR SHOPS

The company has car houses on Fuller Street and on McClellan Street, Schenectady, the latter having been recently erected. The building is 300 ft. long by 116 ft. wide. It is of brick, with timber roof, and has eight tracks, each entrance being provided with Kinnear rolling doors. In the center four of the tracks have pits 75 ft. long, and at one side there are two tracks having pits 75 ft. long. The first mentioned pit has a brick wall through the center. One section of the building is partitioned off for a blacksmith and machine shop, 17 ft. wide by 42 ft. long. One of the tracks extends through this shop. Included in the equipment of this shop is a 21-in. Barnes drill press, a Buffalo forge, a No. 3 Challenge tool grinder and a 4-ton Harrington hoist, together with all other necessary equipment for handling light repairs. The building has a wing 66 ft. long by 25 ft. wide. The front portion is used for the receiver's room. The center room is for employees, and is provided with individual lockers extending entirely around the sides of the room. Opening from this is a large toilet room. In the rear is a stock room and office for the storekeeper, with a separate room for the shop employees.

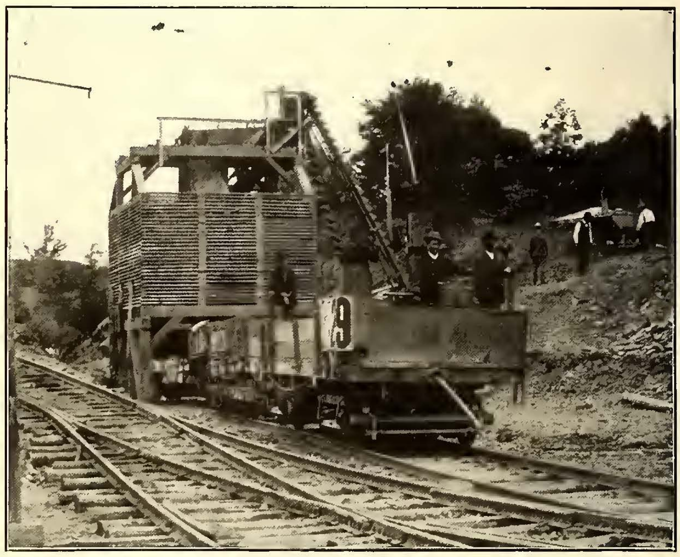


INTERURBAN TRUCK EQUIPPED WITH EMERGENCY BRAKE

ROTARY SNOW PLOWS

The Fuller Street lay-out includes several buildings, being the original car houses and shops of the company. One entire side is utilized for freight and express business. It is equipped with double doors and has a track at the side of the house. The other side of the house is utilized for the main repair shop. The equipment includes a 100-ton 40-in. x 9-in. Niles wheel press, a 36-in. x 16-in. Fitchburg wheel lathe, a 36-in. Niles boring mill, an 18-in. x 8-in. Reed lathe, a 21-in. Barnes drill press, a Yankee drill grinder, a 4-ft. x 4-ft. Buffalo forge, a No. 4 Challenge tool grinder, two Patten motor lifts and a 5-ton 17-ft. span Morris crane.

Plans have been completed and work will shortly start on a very complete repair shop, and when this is completed the Fuller Street shop will be used exclusively for a car house. The new building will be in three sections, the outside measurements being 201 ft. x 210 ft. 4 ins. The first section will include an armature room, machine and blacksmith shops. Adjoining it will be an erecting room which will have 300 ft. of pits. The center section will have two floors. The front is to be utilized for offices and the balance of the section will be utilized for storerooms. The first floor has a steam road track running through it. In front there is a team entrance provided with a platform scale. In the rear will be a large storeyard for rails, ties, special work and other large material. The third portion of the building will have three tracks and will be divided in the center, the front being for the paint shop and the rear for carpenter shop. In addition to the machinery already owned, which will be centralized here, the company will purchase two 15-ton hand-operated cranes, a power rail bender, a motor flat car equipped with an electrically-driven crane of 5 tons capacity, shapers, planers, boring mills and other machine shop equipment. The pits will be open, provided with concrete piers, and will have tracks provided with hydraulic jacks.



HAULING MATERIAL FOR ROAD CONSTRUCTION

In Schenectady the company has a well-equipped emergency house, with tower wagons provided also with hose crossings, tools and wire. The house is arranged similar to a fire engine house and is connected with the fire department alarm system. The wagons respond to calls in all districts covered by the lighting and railway system. Four men are in constant attendance.

FREIGHT AND EXPRESS

The freight and express business of the company is very extensive. It is practically all through business between Albany and Schenectady. It is expected that arrangements will soon be made for a similar service on the Troy and other divisions. The freight and express business is conducted by the Electric Express Company, which maintains a distinct organization. Freight stations have been established in both Schenectady and Albany, the latter being in connection with the station of the United Traction Company. The business is divided into three classes. Class A, provides wagon service at both ends, handled at 30 cents per cwt.; Class B, goods which are not handled at either end, 10 cents per cwt.; Class C, goods which require wagon service at only one end, 15 cents per cwt.

SCENE IN THE FREIGHT STATION

The company maintains three double and three single teams in Schenectady, and one double team and two singles in Albany. The cars make four round trips per day, and have a running time between cities of an hour and fifteen minutes. The cars are equipped so that they may be run two or more together in multiple unit. The electric road handles no free baggage. The express company calls for trunks in either city and delivers them in the other at 40 cents each. There was formerly a large amount of trucking between the two cities, but the electric line has wholly done away with this practice. About four-fifths of the business is made up of incoming goods purchased by Schenectady merchants. Recent figures on freight business are shown herewith:

May, 1,272,173 lbs., incoming; 366,587 lbs., outgoing. June, 1,431,444 lbs., incoming; 315,901 lbs., outgoing.

ADVERTISING

The company handles is own advertising, the patronage being largely local, and a charge of $7.50 per car per month is made.

DISCIPLINE

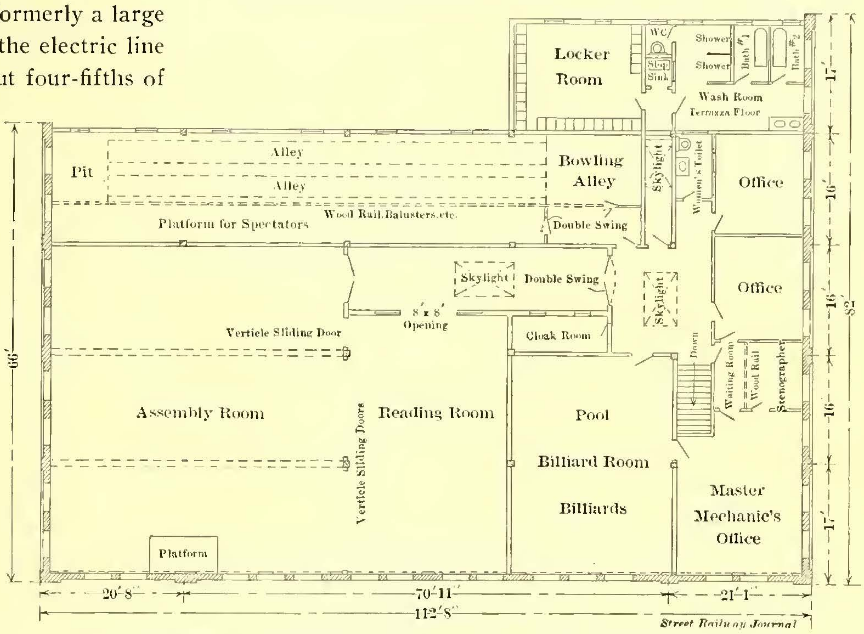
The company is extremely liberal in its treatment of its employees. Promotion is by order of seniority. The men start extra on the city cars and are moved up to regular cars, extra on local interurban cars, and finally to regular on a limited interurban car. The schedule of wages paid is as follows: City lines, 18 cents for the first three months and 20 cents thereafter; interurban lines, 22½ cents for the first year; 23 cents for the second year; 23½ cents for the third year; 24 cents for the fourth year, and 25 cents for the fifth year. All men are allowed ten days vacation with full pay after one year's service. The superintendent keeps a card index system, and a record of each man is kept in a filing case, together with application, medical examination and reports relative to his work. There are three ways of action in case of infraction of rules. First, by inspector; second, by letter; third, by a call before the superintendent. The latter action is seldom taken. The first failure to report on time calls for a suspension of two days. If repeated again within six months a suspension of five days; the third time within six months the offender is called before the superintendent for trial.

BENEFIT ASSOCIATION

A second story has been recently added to the Fuller Street car house and fitted up with an unusually complete club room for the employees. The four front rooms are utilized for the office of the master mechanic, the company's physician, the express manager and office of the benefit association. The club rooms include a billiard and pool room, a locker room, wash room with bath tubs and shower baths, two bowling alleys with platform for spectators, a reading room and an assembly room with platform and stage. The partitions between the assembly room and reading room are vertical sliding doors, so that the rooms can be thrown together for large assemblies. The dues of the association are 50 cents a month, which is deducted from the pay of the men each month. The constitution provides that if the fund is not sufficient to meet the obligations the board of trustees shall have the right to assess each member not to exceed an additional 50 cents a month. Disability by reason of accident or sickness insures the member an income of $1.00 per day for a period not to exceed ninety days. The death of a member provides an insurance of $150. The management of the association is vested in a chairman and six members. The chairman is always an officer of the Schenectady Railway Company, who appoints three members of the board of trustees, the other three being elected by a majority vote of the men.

PLEASURE TRAFFIC

The company has purchased a large tract of land at the east end of Ballston Lake on the new branch, and is planning a very elaborate summer park. There will be a large casino, dance hall, pavilion, toboggan slide, merry-go-round, baseball park, trotting track and numerous other up-to-date features.



OFFICES AND ASSOCIATION ROOMS, FISHER STREET CAR HOUSES

The company now operates Brandywine Park, Schenectady, which is let out to picnics. It contains a pavilion, refreshment stands and other buildings.

A very remunerative departure is the outing feature, advertised as "Twilight Trolley Tours." Special cars leave the city station each evening and run for 12 miles and return over one of the interurban divisions. The cars are decorated with colered incandescent lights, and have a shield, star or crescent on the front dash. These ornaments are wired with a single terminal, and the cars are used in regular service during the day. A charge of 25 cents is made for the ride, and the load is limited to the seating capacity of the thirteen-bench open cars.

LIGHTING DEPARTMENT

In addition to the express company the Schenectady Railway Company also operates the lighting and gas companies. The installed load of the lighting company amounts to an equivalent

The distributing system in the center of the city will be mainly underground, ducts being laid for this purpose and the cable now being in process of installation.

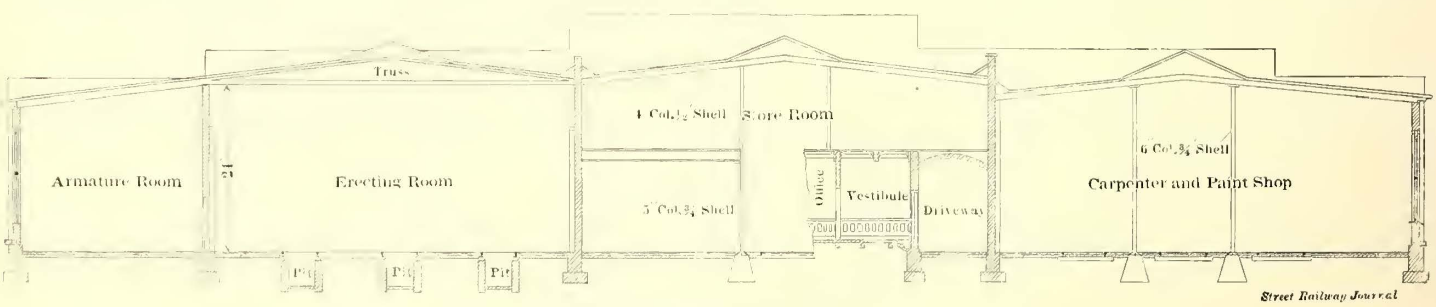
The system consists of 60-cycle, single-phase, 2300-volt primaries, with manholes and subway transformers and a system of three-wire secondary mains. The outlying portions of the city will be fed by means of underground cables through the business part, then changing to overhead feeders. The

MAIN CAR HOUSE

of about 84,000 16-cp lamps, while the meters for measuring this current number 4556. While a great deal of the lighting is used for stores and signs, yet over 50 per cent of the light is used for domestic purposes. This fact and the great number of meters installed in proportion to the population is one of the features of the lighting system. The lighting company also furnishes the power for lighting the street lamps of the city, the series alternating-tub transformer system, with inclosed arc lamps being used. Current is obtained from Spier's Falls,

system of three-wire secondaries and banded transformers is used wherever convenient, individual transformers only being used in isolated cases.

A contract has just been obtained from the city of Schenectady for furnishing apparatus (pumps, motors, etc.) and power for pumping water used for public purposes. This plant will consist of vertical high-head turbine centrifugal pumps of a capacity of 12,000,000 gals. daily, direct-connected to 800-hp, 40-cycle induction motors. This will be one of the first installa-



CROSS-SECTION OF MACHINE SHOP

Mechanicville, and the General Electric Company in a similar manner to the railway current, and is supplied to the Dock Street sub-station, Schenectady. The apparatus consists at present of motor-generator sets and of static transformers. Owing to lack of capacity three of the feeders are run on 40 cycles, but the intention is ultimately, when the new Dock Street station is completed, to furnish 60 cycles throughout. The new Dock Street station will contain three 500-kw and three 250-kw motor-generator sets, and will be a model in every respect, using the most up-to-date switching and other apparatus.

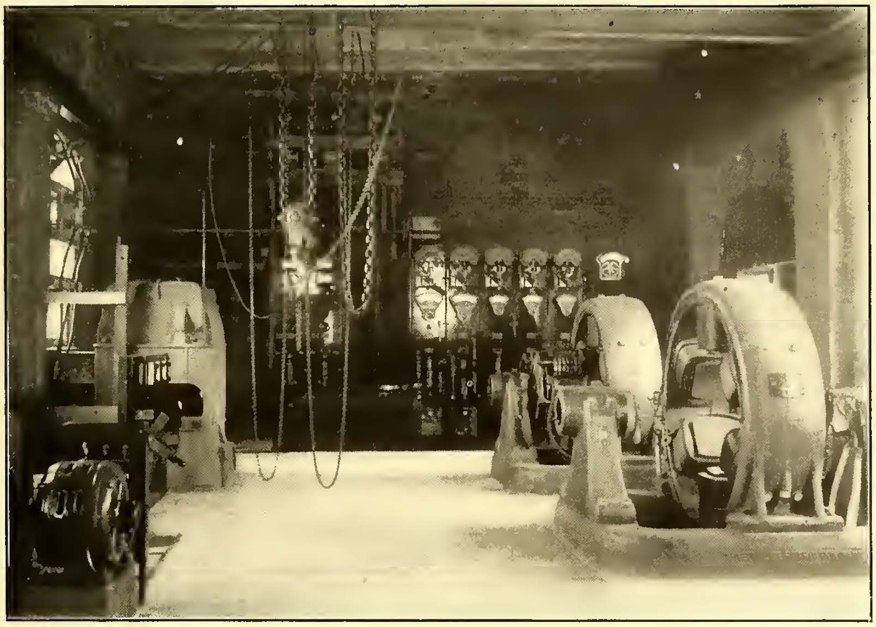
tions of its kind in the world, and will be unique in type, and it is proposed to make it a model.

GAS LIGHTING

The recent purchase of the Mohawk Gas Company has added another link to the company's properties. Extensive plans have been made to rebuild and add to the local plant, some of the work having been already completed. The maximum capacity of the generating plant will be 1,750,000 cu. ft. The company is now serving 3500 customers, 60 per cent of them using prepayment meters. Both coal and water gas is manufactured.

POWER SUPPLY

The power used for operating the Schenectady Railway is furnished mainly by the Hudson River Water-Power Company from the large water-power plant at Mechanicsville, augmented at times by the steam plant of the General Electric Company. The power is transmitted from Mechanicsville at a voltage of 10,000 and a frequency of 40 cycles over two entirely different routes. One of these transmission lines crosses the country about in a straight line from Mechanicsville to the General Electric Works at Schenectady, touching Alplaus and crossing the Mohawk River at the Scioto Bridge. This is the main line, and consists of three No. 3 O. B. & S. bare copper wires mounted on double petticoat porcelain insulators. The power transmitted over this line is used to supply the wants of both the General Electric Company and the Schenectady Railway Company. The power used by the railway company in the Dock Street sub-station is delivered by two No. 1 B. & S. three-conductor cables, one being used exclusively for the railway load and the other for lighting the city, the current being transformed to 2300 volts for this purpose.



TROY SUB-STATION

The second transmission line starting from Mechanicsville passes along the canal through Watervliet, where it turns, and following the line of the Schenectady Railway Company's Troy division tracks, enters the Troy sub-station of the company located at Lathams Corners. From here three No. 2 B. & S. wires follow across country to the Albany sub-station of the Schenectady Railway Company, located at Karner, on the line of the company's Albany division. Duplicate lines then follow the tracks located on the Albany-Schenectady turnpike into Schenectady, to the General Electric Works, thus making almost a circle from Mechanicsville around through the sub-stations and the General Electric Works back to Mechanicsville. When the new Dock Street sub-station is completed these transmission lines will be changed somewhat. The lines from the Albany sub-station will be rebuilt to consist of duplicate aerial lines of No. 1 B. & S. bare copper from Albany sub-station to the city limits. The current will then pass underground through duplicate paper-insulated cables, each consisting of three No. 1 B. & S. stranded wires, made into a cable, to the new Dock Street station, instead of going direct to the General Electric Works. The connection between the new Dock Street station and the General Electric power house will be by three 3-conductor 3-O B. & S. cables, placed in duct in the street. The line from the General Electric Works to Mechanicsville will remain unchanged.

The Hudson River Water-Power Company will furnish power from another source, i. e., Spier Falls, situated approximately 40 miles from Schenectady, over a transmission line direct to the power house of the General Electric Company. The voltage of this line will eventually be 30,000.

Another steam source for supplying power to the railway company, besides the present power house of the General Electric Company, will be the large steam turbine station now being built by the General Electric Company, which will contain at present three 1500-kw Curtis steam turbine sets, and will use Stirling boilers and electric auxiliaries. The station is designed, however, for a much larger capacity.

DOCK STREET POWER HOUSE

The old power house on Dock Street is a one-story building, having a frontage on Dock Street of 74 ft., and extending 119 ft. toward the tracks of the New York Central Railroad Company. The station is divided longitudinally by a party wall into a boiler room on the south side and an engine and dynamo room on the north side. The use of steam has been discontinued, although the machinery has not been dismantled. The boiler room contains one Stirling and three Babcock & Wilcox boilers, aggregating about 1030 hp, while the engine equipment consists of one Erie simple and two vertical Westinghouse compound; one Ball & Wood having been sold recently. The railway machinery at present operating in the station consists of three rotary converters, made by the General Electric Company, each of 300-kw capacity and 760 r. p. m. There is also one 200-kw, 800 r. p. m. compound-wound General Electric rotary converter. The 10,000-volt, 40-cycle, three-

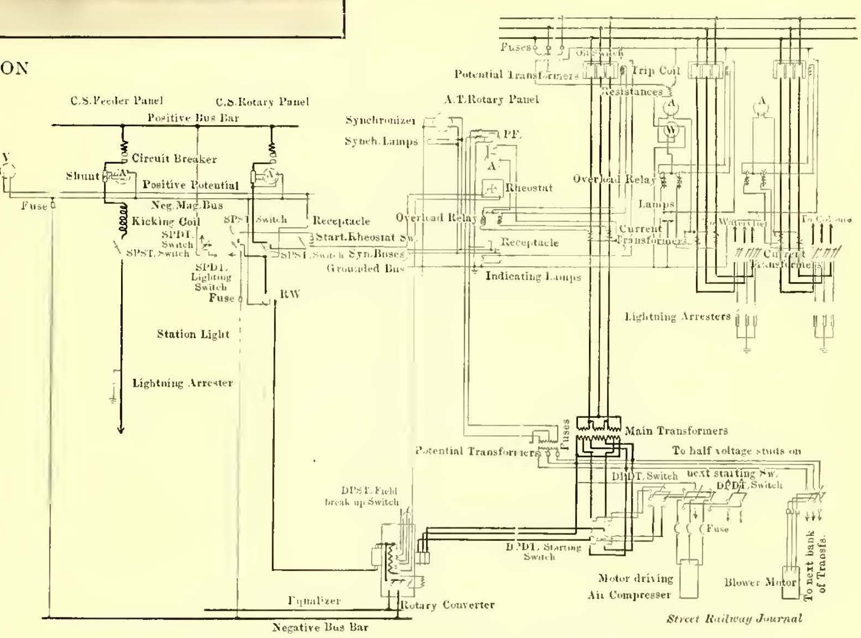
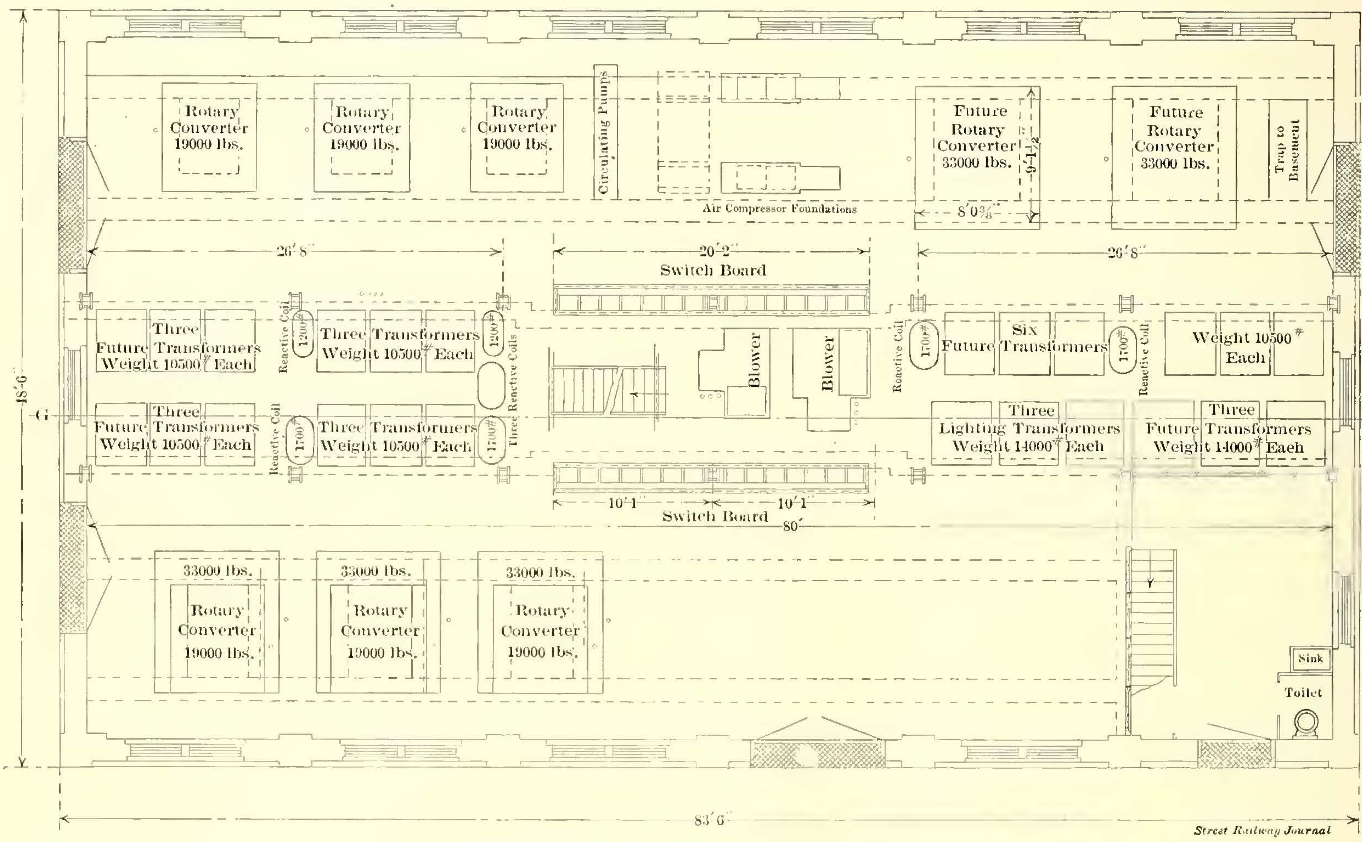


DIAGRAM OF WIRING CONNECTIONS OF TROY SUB-STATION phase current from Mechanicsville is fed into the three 300-kw rotary converters through nine static transformers of the air blast type, each of 110-kw capacity, and which transforms the voltage from 10,000 to 372.

The 200-kw rotary converter is fed through a 225-kw three-phase air blast transformer. All of these transformers are provided with additional leads connected to the middle points of the secondary windings in order that the rotary converters may be started from the alternating-current side at half voltage, thus cutting down the starting current.

The railway switchboards are of the standard General Electric type for such installations, and are of black enamelled slate, provided with the usual circuit breakers, ammeters, knife-blade switches, etc. One of the panels is provided with a total tension panels are all of the General Electric standard pattern, provided with circuit breakers, ammeters, etc.

The 10,000-volt panels are provided with single-pole oil-break switches, mounted in separate brick cells, about 10 ft. back of the panels themselves. The switches are provided with overload relays, and in the panels themselves are mounted horizontal, edgewise, black oxydized finish, ammeters, voltmeters, power factor indicators, and one round-pattern induction recording wattmeter. The bus-bars back of the panels are heavily insulated and carried on an insulated iron frame-work. All of the 10,000-volt feeders enter the station overhead and are connected with a suitable number of lightning arresters of the Wirt type. At this station there is also an air compressor for use in connection with the Magann air storage system.



PLAN OF SUB-STATION AT BALLSTON

Thomson recording wattmeter. The 10,000-volt operating switchboard is placed in a gallery above the low-tension boards, and is equipped with oil switches, ammeters, etc.

TROY SUB-STATION

The Troy sub-station of the railway company is located at the intersection of the Loudonville Road and the Troy-Schenectady Turnpike. The building is one-story and cellar, 26 ft. x 70 ft. The station is built of brick and is thoroughly fireproof in construction. The floor is of concrete with a granolithic top. The apparatus consists of three 300-kw rotary converters operating at 760 r. p. m. The transformers are of the three-phase air blast type, and are two in number, each of 330-kw capacity. Each converter is also provided with a reactive coil in the alternating-current side for the purpose of regulating the voltage. Part of the cellar is made into an air blast chamber for the transformers, while in the other part of the cellar the cable work and wiring is carried on insulators fastened to the walls and converter foundations. The switchboard is of black enamelled slate, and is made up of three direct-current feeder panels, two direct-current rotary panels, two alternating-current rotary panels and three 10,000-volt panels. The low-

This air compressor is operated by a 20-hp induction motor belted to it.

ALBANY SUB-STATION

The Albany sub-station is a one-story frame structure with cellar, occupying a space 45 ft. sq. The lot on which it stands is 75 ft. x 100 ft. The apparatus installed in this sub-station is similar to that in the Troy sub-station.

BALLSTON SUB-STATION

This plant is in process of construction, and is intended to furnish current for the operation of the Ballston division of the railway company. The following apparatus is in process of manufacture by the General Electric Company:

Three 300-kw, 40-cycle compound-wound General Electric rotary converters running at 800 r. p. m.; three air blast 220-kw transformers, provided with double secondary windings, one blower set consisting of a 2-hp, three-phase induction motor, direct coupled to a 35-in. Buffalo forge fan; two 45-kilo-volt-ampere air blast reactive coils; one 20-hp three-phase induction motor with two pulleys for operating a Magann compressor, and the necessary switchboard panels for the above apparatus.

NEW DOCK STREET SUB-STATION

The property on which the new Dock Street sub-station is built has a frontage on Dock Street of 180 ft., while the distance on the rear next to the New York Central Railroad Company's tracks is 368 ft. The depth of the lot is 165 ft. The new sub-station is 165 ft. 8 ins. front by 45 ft. 2 ins. deep, and is of brick and steel construction, thoroughly fireproof throughout. The station is without a cellar for the reason that at times of freshets water from the Mohawk River and Erie Canal overflows, and would, in all likelihood, flood the cellar. The outside walls of the basement are faced with brown stone and the basement itself is divided off by means of brick partition walls into air blast chambers, bus-bar compartments and oil-switch cells.

On the first floor is located all of the transforming apparatus, and this floor is of steel and concrete construction, and is finished as a "terrazza" floor. The railway apparatus to be placed in this sub-station consists of two 600-kw, 600-volt, six-phase, 40-cycle rotary converters, together with two 90-kilo-volt-ampere air blast static transformers; two 300-kw, 600-volt, three-phase, 40-cycle rotary converters, and two 45-kilo-volt-ampere air blast reactive coils, and six 110-kw, 10,000-volt primary 40-cycle air blast transformers. Space has been left for a future 600-kw rotary converter.

All of the 10,000-volt bus-bars, etc., are placed in the basement between brick and concrete barriers, and each phase is thoroughly insulated. The transmission and primary lines leading to the transformers are electrically operated by means of the General Electric type-H oil switches, these switches being placed in brick cells. The switchboard panels are placed on the opposite side of the station from the Form H switches, and the operating voltage is reduced by means of potential and current transformers so that at the switchboard panels it will not be greater than 150 volts. The current for operating the Form H switches is furnished by means of a storage battery, built by the Electric Storage Battery Company, of Philadelphia, and consists of fifty-five type E-9 cells. The 10,000-volt bus-bars are arranged so that they can be sectionalized by means of knife disconnecting switches. All of the switchboard panels are of black enamelled slate, and the instruments have the marine finish. Each of the three-phase incoming line panels has a capacity of 4000 kw at 10,000 volts, and each panel contains the following:

One horizontal edgewise ammeter, one horizontal edgewise voltmeter, one double-pull overload relay with lamp for indicating the open and closed position of the oil switches, one controlling switch for type-H oil switches, together with the necessary current and potential transformers and static dischargers.

There are two three-phase outgoing line panels with a capacity of 1500 kw at 10,000 volts, and each panel contains one horizontal edgewise ammeter, one polyphase induction recording wattmeter (railway pattern), together with relays, controlling switches, indicating lamps and current transformers and static dischargers.

Each of the three-phase rotary converter panels is equipped with a power factor indicator and horizontal edgewise ammeter and a three-phase induction recording wattmeter, together with overload relay, controlling switches for type-H oil switch, indicating lamps and secondary transformers.

The lighting of the Dock Street power house has been worked out with a view of providing against any possible failure of current. The ordinary lighting will consist of twenty-four arc lamps, placed on brackets fastened to the sides of the wall and lighted by means of current from the ordinary lighting circuits of the company. As an emergency lighting a number of incandescent lamps will be mounted on the roof girders and will be fed from the railway circuit. Should both the railway and lighting fail, arrangements have been made for placing a number of lights on the storage battery.

The station will be provided with a traveling crane having a capacity of 15 tons, and will be arranged in such a manner that the track for this crane extends outside of the building under an archway, so that teams driving under this archway may be unloaded directly by the crane.

It will be seen that the transmission and distribution system employed provides against almost every possible contingency, and practically insures the company against shut downs. When current is transmitted from Spier Falls additional protection will be afforded, and the flexibility of the system will be correspondingly increased. This combination of generating plants, supplying current at different points, insures a better distribution, and has furnished the engineers opportunity for improving the regulation as well.

It may be said that the character of the service required of the Schenectady company makes it an unusually interesting study for street railway managers, and that the results of its operation have been a revelation to experienced transportation men. This is especially true of the express and freight department, in which the facilities of the company have been overtaxed from the beginning. The method of handling this traffic most advantageously has been a subject for considerable discussion; there still seems to be difference of opinion. Local conditions, of course, have much weight in determining the most practical method. Although the company has a well-defined policy on this subject, further developments with the growth of the business will be awaited with interest. One important feature of this service is the handling of fruit and garden truck. The quickness of transit and the relative freedom from the jolting incident to hauling by teams brings small fruit to the market in good condition.

ORGANIZATION

The company maintains a very complete system of records and accounts. The general manager has constantly before him tabulated statements of all equipment and the condition, and these are brought up to date at frequent intervals. All operating expenses and receipts are figured on a basis of eighteen-hour cars per day, and each item of expense is charged to its proper account. A detailed statement for each month, together with similar statements obtained from well-known roads employing the same system, is posted for comparative purposes in the office of the general manager. The operating expense sheet for the month of May, 1903, gives the receipts per eighteen-hour car as $51.62, which is claimed to be higher than the receipts of any other similar proposition in the country. The operating expenses are given at 60.9 per cent of the gross receipts. The figures do not include the lighting business or the express business, as these are operated as separate organizations.

Officers of the company are: Hinsdill Parsons, president; E. F. Peck, general manager; James O. Carr, secretary-treasurer; J. J. Magilton, auditor and assistant treasurer; C. C. Lewis, chief engineer; F. G. Sykes, electrical engineer; C. F. Coffin, manager gas department; E. J. Ryan, manager express department; Frederic Smith, superintendent; J. H. Aitkin, purchasing agent. Directors: Hinsdill Parsons, E. F. Peck, E. W. Rice, Jr., G. E. Emmons, F. O. Blackwell, H. C. Wirt, J. R. Lovejoy, A. L. Rohrer, W. L. K. Emmett.

INDEPENDENT WATER-POWER DEVELOPMENT

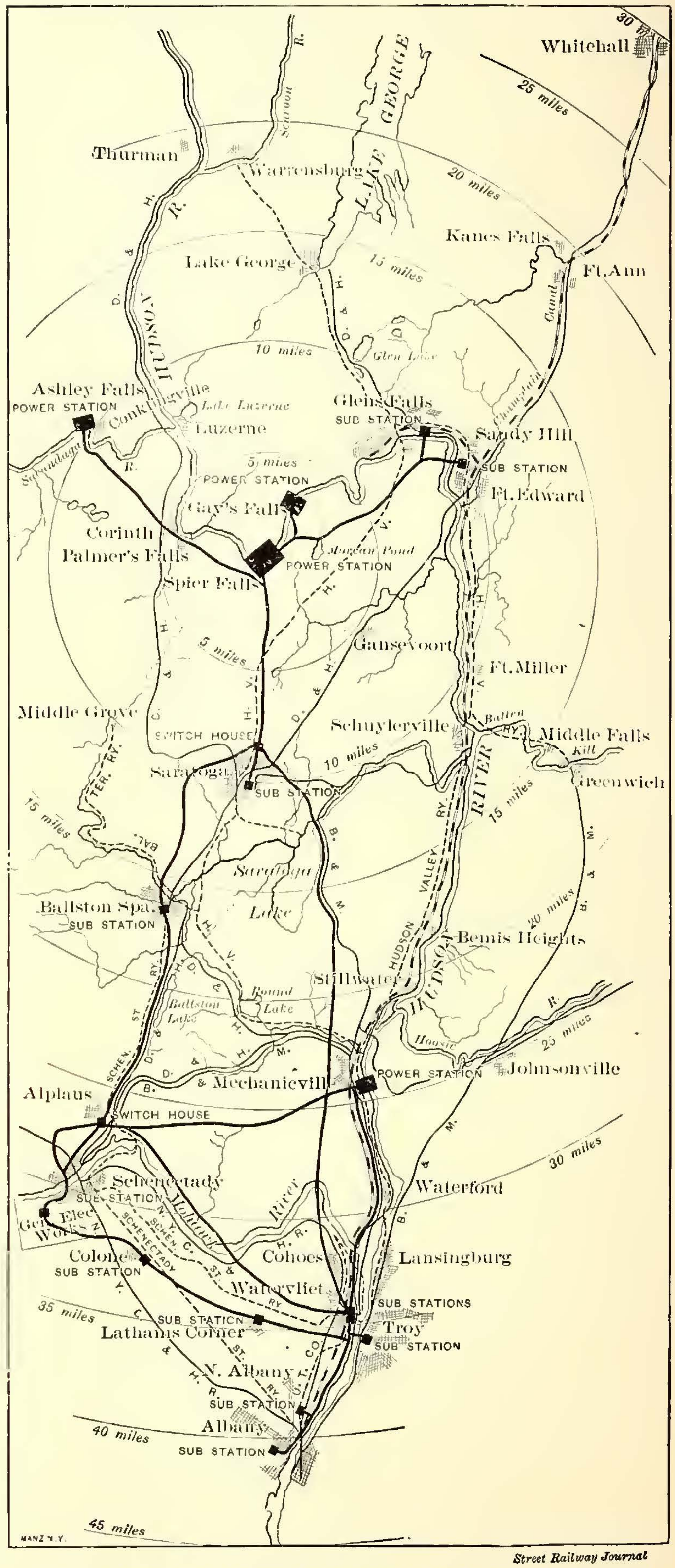
The development of water-powers in the Hudson River Valley has revolutionized the methods of power generation and transmission for several of the leading electric railway properties in Eastern New York, and plans now being worked out promise still further to displace steam plants.

Much of this development has been due to the efforts of the Hudson River Water-Power Company and its subsidiary companies, the Hudson River Electric Company and the Hudson River Power Transmission Company.

At the present time the largest water-power plant in operation in the valley is that of the Hudson River Power Transmission Company. This company was organized in 1897 to erect and maintain a dam on the Hudson at Mechanicsville, for the development of water-power, and to generate and sell electric current. The plant was completed and placed in operation in October, 1900. The station is a substantial brick and steel structure, erected at the west end of the concrete dam, which is 850 ft. in length. The installation consists of fourteen pairs of Stilwell-Bierce water-wheels, directly connected to seven 750-kw General Electric generators. There is also an auxiliary steam plant of 1250 hp, together with switchboard, transformers and other apparatus necessary for handling the current. The company's transmission lines extend to Troy, Albany and Schenectady. A large portion of the output is utilized by the General Electric Company and the Schenectady Railway Company. The company also has a long term contract with the United Traction Company of Albany, under which the latter utilizes from 3600 hp to 4000 hp. at the rate of $20 per horse-power per year. A number of manufacturing plants at various points are also supplied by Mechanicsville.

At Spier Falls, near the foot of Mount McGregor, 40 miles north of Albany, the Hudson River Electric Company will shortly place in operation a plant which will exceed in volume any similar plant in the East, and will be second only to the plants at Niagara Falls and Sault Ste. Marie. The transmission lines will be longer than any east of the Rocky Mountains. Current will be furnished for electric light, power and railway operation in Albany, Troy and Schenectady, and a number of smaller places. This system will be connected in with that of the Mechanicsville system, and all clients will thus be enabled to receive power from either or both systems. The dam is located in the Hudson, between Mount McGregor and another spur of the Adirondacks; and the river is raised 50 ft. above the old bed, and then dropped through water-wheels with a head of 80 ft. The dam is 1820 ft. long, about 100 ft. maximum height above bed rock, and contains 180,000 cubic yards of masonry. The dam extends down to bed rock the entire width of the river and is anchored at each end in the solid ledge of the mountain side. Stone laid in concrete with close joints forms the regular construction of the main dam. A large amount of excavation was necessary, and compressed air has been used extensively in the work, the tools being operated by alternating-current motors, taking current from the water-power at Mechanicsville, 23 miles south. The minimum flow of the river at Spier Falls is about 2000 cu. ft. per second, but during the flood seasons this is sometimes increased to 50,000 cu. ft. per second. This great variation between high and low water will be reduced by storage dams at several lakes near the head waters of the river. An in-take canal was formed by a dam 403 ft. long at right angles to the Saratoga end of the river section. From the intake, ten penstocks carry the water down to the power house which extends along the river bank.

The power house is a one-story brick structure, 70 ft. 10 ins. x 392 ft. inside. The house is divided lengthwise, into two rooms by a brick wall 6 ins. thick. Across the upper end of the building is the transformer and switchboard room, and the remainder is divided by the wall mentioned into generator and wheel rooms. The foundations are of concrete, and the rock is excavated under the building so as to give a depth of



MAP OF HUDSON RIVER ELECTRIC POWER TRANSMISSION SYSTEM

14 ft. of tail water. Beneath the floor of the wheel room is an opening 21 ft. 6 ins. wide, and extending the entire length. Across this opening is placed 36-in. box girders, spaced on 14 ft. centers, and between pairs of these girders the water-wheels are mounted. Water passes from the canal through ten steel tubes of 12-ft. diameter. Before entering the house these tubes

pass through a heavy masonry retaining wall that protects it from water on the side toward the canal. Each of the ten tubes connects with a wheel case that contains a pair of turbine wheels, mounted on a horizontal shaft. In eight of these tubes the turbines are rated at 5000 hp each, under a head of 80 ft., and in the other two cases the wheels are rated at 3400 hp. The larger wheels are direct-connected by shaft extending through into the generator rooms to generators rated at 2500 kw, while the smaller wheels will drive 2000-kw generators. The generators are of the revolving field type, three phases, 40-cycle, and built by the General Electric Company. They are capable of sustaining 25 per cent overload indefinitely, and an efficiency of 95 per cent at full load is guaranteed. The water-wheels were manufactured by the S. Morgan Smith Company, of York, Pa., and the Swain Manufacturing Company, of Lowell, Mass. Each pair of wheels is governed by Lombard and Sturgiss governors, belted to the shaft. To each of the two cases containing the 3400-hp wheels there is connected a small wheel case, whose turbines drive two 125-volt, 150-kw exciters for the main generators.

From the foregoing, it may be stated that the total capacity of the water-wheels is 46,000 hp, and the total capacity of the main generators 24,000 kw or 32,000 hp. Cables are led from the generators to a room beneath the switchboard end of the building. In this room is the low-potential switchboard equipped with standard apparatus and the bus-bars. From this room the lines run to an air-tight chamber, under the transformers.

There are thirty 833-kw and seven 607-kw General Electric air-cooled transformers. The three-phase, 40-cycle current generated is raised to a pressure of 26,500 volts by the transformers. To the rear of the transformers are the high potential, transformer, selector and bus sectionalizing switches, and the line oil switches. Along the river side of the building is the operating board, containing meters for each machine, and the feeder lines. There are also auxiliary switches operating the switches on the low-tension board, and in the high potential chamber. There are also switches on pedestals, adjoining each machine, so that any machine may be cut in or out independent of the others. Included in the layout is a carpenter shop, a boiler house containing boilers for steam heating and for thawing-out purposes; a machine shop for light repairing, and a general storehouse and an office building.

The transmission lines consist of five circuits designed for 30,000 volts, the voltage for the house being 26,500 volts. The lines are of 000 bare wire, strung on heavy porcelain insulators, placed equalaterally on locust cross-arms. The poles are of chestnut and spaced 90 ft. apart, each line consisting of two circuits. These lines transmit to sub-stations located at Glens Falls, Fort Edward, Saratoga, Ballston, Schenectady and Watervliet; all of these stations are under construction. In Saratoga and Ballston the company has lighting franchises and the stations are to be equipped with both lighting and railway apparatus.

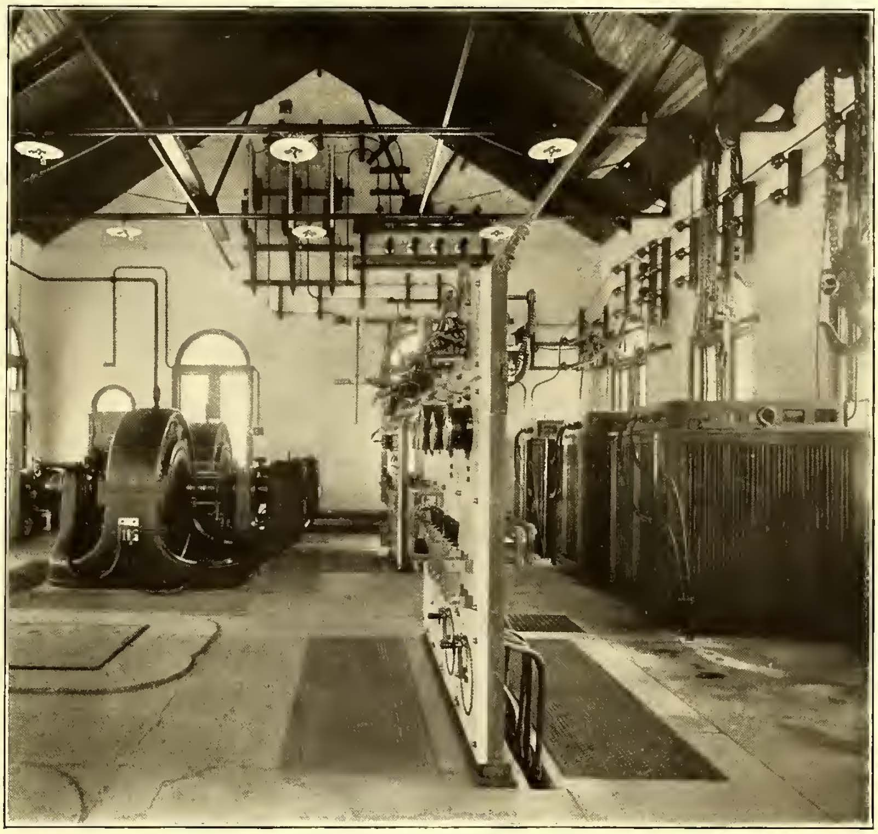
The development of this water power cannot but have a most stimulating effect on the industries of this region.

THE UTICA & MOHAWK VALLEY RAILWAY

The Utica & Mohawk Valley Railway Company, which, although not connected directly with the systems reaching Saratoga, may be classified very properly as belonging to that region, presents some unique features in its power equipment that are worthy of note from an engineering point of view.

The system comprises 87.8 miles of track, 94 motor cars, and 61 other cars, besides the power and sub-station equipment which is here described. The company will own and operate practically the entire street railway systems of Utica, Rome, Little Falls, Herkimer, Mohawk, Ilion, Frankfort, Clinton, New Hartford, Deerfield, Oriskany and Whitestown. Numerous extensions are now in progress.

Power is obtained from the Utica Gas & Electric Company, and is delivered in Utica over that company's 20,000-volt, 60-cycle, three-phase transmission line. Part of the power is utilized in Utica through rotary converters, and the balance is transmitted to the Frankfort and Little Falls sub-stations, eleven and twenty-one miles to the east, respectively, and to the Oriskany sub-stations, twelve miles to the west.



FRANKFORT SUB-STATION

The Utica sub-station was designed originally for three 500-kw rotary converters, and the other sub-stations for three 300-kw outfits, but as the first instalment comprised only eight 300-kw machines, these were distributed among the stations then ready: Four in Utica, two in Oriskany and two in Frankfort. The Little Falls station was not in operation at that time, but has recently been equipped with two 300-kw converters, one being new and the other one taken from Utica, where it was replaced by a new 500-kw machine. All of the 300-kw rotaries in the Utica sub-station will eventually be displaced by 500-kw units, and will be removed to the other sub-stations.

The Utica sub-station is equipped with three Westinghouse 550-kw oil-insulated, self-cooling transformers connected in delta, receiving the 20,000-volt, three-phase current and reducing it to 360 volts for use on the Westinghouse rotary converters, delivering direct current at approximately 600 volts. The wiring is so arranged that in case of trouble any transformer can be disconnected in a moment and the rotaries operated on the remaining two transformers connected in V.

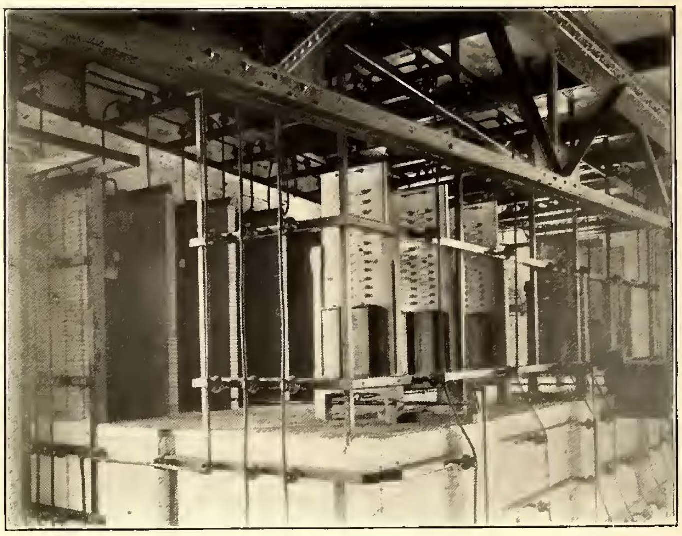
The rotaries operate from a common set of bus-bars, both alternating current and direct current, and have no choke coils or inductance in the alternating-current leads other than that coming from ordinary wiring, which in this case is practically negligible. The rotaries carry their loads under these conditions without sparking and with no shifting of load from one machine to the others, the division being equal over all ranges.

The switchboard is made up of the usual alternating-current and direct-current rotary converter panels, alternating-current load panel and direct-current feeder panels. The alternating-current panels are mounted by themselves, and the direct-current panels form a separate switchboard. The boards are of blue Vermont marble and are equipped with the latest types of Westinghouse instruments, switches and circuit breakers.

The Frankfort, Little Falls and Oriskany sub-stations each have the same equipment of transformers, consisting of three 330-kw oil-insulated, self-cooling units. The general arrangement of these stations is the same as that of the Utica substation, except in the matter of switchboards. These differ in that the feeder panels are placed on the left of the direct-current rotary converter panels. This arrangement permits of as many alternating-current and direct-current rotary converter panels and direct-current feeder panels as may be desired without disturbing in any way those already installed.

All the stations are protected by Westinghouse low equivalent lightning arresters and static interrupters, and although the lightning has been exceptionally severe during the last season, no difficulty has been experienced in any of the stations of the railway company due to this cause.

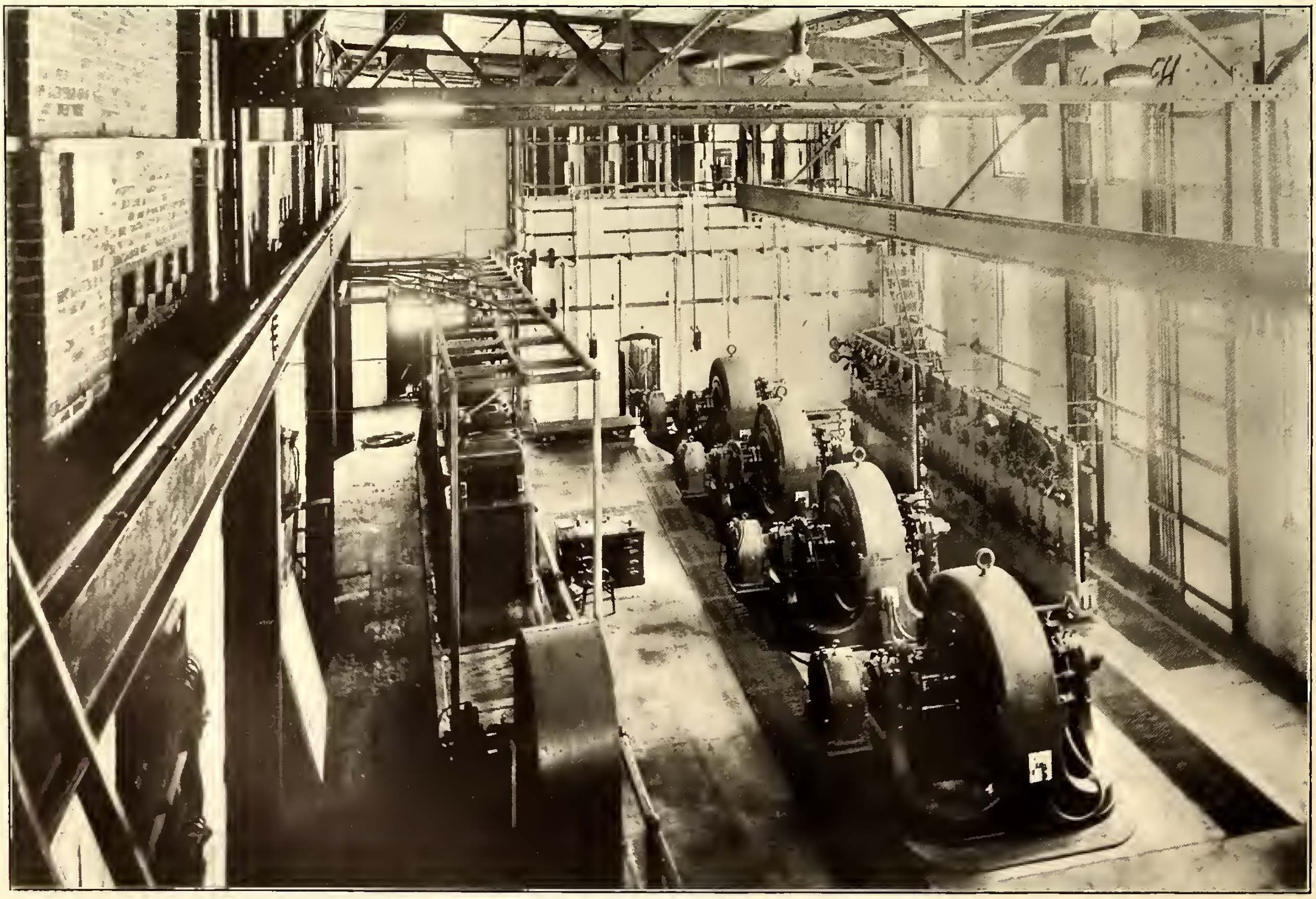
Stick type circuit breakers or fuse switches are placed in the 20,000-volt lines as they enter each sub-station. They have proved very effective in cases of short circuit, either on the lines or in the stations.



LIGHTNING ARRESTERS

The entire equipment of all the substations was furnished by the Westinghouse Electric & Manufacturing Company, and was installed under its supervision.

The cars operating between Rome and Little Falls, a distance of about 40 miles, are equipped with four No. 56 Westinghouse railway motors and air brakes. The smaller double-truck cars are fitted with four No. 68 railway motors.



INTERIOR MAIN STATION AT UTICA, SHOWING ROTARIES, TRANSFORMERS AND SWITCHBOARD

STANDARD PRACTICE IN CITY TRACK CONSTRUCTION

THE specifications and drawings presented in this article show the types of track construction adopted as standards for present work by fourteen of the large street railway companies of the country. These include specifications of track for down-town paved streets and for outlying streets which may be unpaved or paved with macadam or similar pavement. As a resume of the most advanced practice of the country in track construction, and as presenting methods of construction adopted as a result of the experience not only of one management, but of many, this collection of data should be of more than ordinary value. Before entering into a general description and comparison of methods, the types of construction adopted by the various companies will be specifically described. In this description the practice followed in New York and Brooklyn will not be given, as it was given in detail in the "New York number" of the STREET RAILWAY JOURNAL, published in October, 1901, but the practice of fourteen other prominent city railway companies will be described. For this information the publishers of this paper are indebted to the courtesy of the engineers of track construction and managers of the respective companies for their great courtesy in supplying the information. The publishers realize that the practice of other companies than those mentioned below contain many features which are worthy of commendation and study, but were obliged, on account of the space available, to confine themselves to the cities mentioned, which, as a whole, represent the largest systems in the country outside of New York and Brooklyn.

UNITED RAILWAYS & ELECTRIC COMPANY, BALTIMORE

The United Railways & Electric Company, of Baltimore, considers Lorain Steel Company 107-lb. No. 333 its standard, although it is also laying some Pennsylvania Steel Company, section No. 200. These 9-in. grooved rails are for construction in paved streets. They are laid on Georgia pine ties, of dimensions 6 ins. x 8 ins. x 8 ft., spaced 2 ft. between centers. The ties are tamped up with 3 ins. of gravel. No other ballast or concrete is used. The standard distance between track centers is 10 ft., although this is reduced when necessary in narrow streets. The rails are in 60-ft. lengths, and are laid with broken or alternating joints. No tie-plates are used, but tie-rods are placed every 6 ft. Angle-bar joints have been used recently. On girder and grooved rails these are 22 ins. long with eight bolts. All joints are between ties.

For macadamized roads this company's standard rail is Pennsylvania Steel Company No. 200. For exposed T-rail it formerly used Pennsylvania section No. 7, but within the last year has adopted A. S. C. E. standard 60-lb. T-rail. This T-rail is spiked to hewn chestnut ties 6 ins. thick, with a face of from 6 ins. to 12 ins. These ties are 8 ft. long, placed 2 ft. between centers. The ballast is 4 ins. deep under the ties, and is filled in between the ties to the base of the rail, sloping off to the roadbed 18 ins. outside of the ends of the ties. The rails are in 30-ft. lengths, laid with broken joints and no tie-plates.

The standard bond for city streets is a tinned No. 0 copper bond wire, fastened to the rail with channel pins. Some of the heavy bonding is done with No. 0000 wire. The standard bonding on exposed T-rail on suburban lines is No. 0 tinned copper wire, fastened with channel pins.

COMPLICATED TRACK AND SPECIAL WORK CONSTRUCTION IN NARROW STREETS IN BOSTON

BOSTON ELEVATED RAILWAY COMPANY

The rail used in Boston paved streets is somewhat in the nature of a compromise between a girder and a grooved rail. It has a groove, but the lip of the groove, as seen by the accompanying section, is ½ in. lower than the head of the rail. The groove is of a form which will not retain dirt, but offers considerable inducement to vehicle wheels to follow the rail.

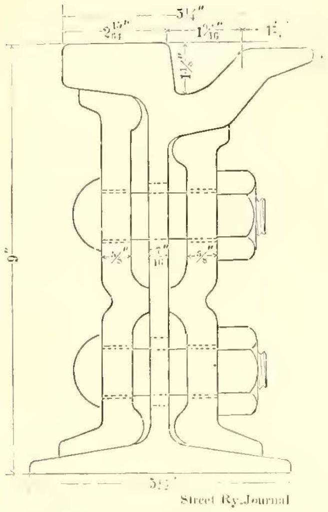
Several sections of track construction used in Boston are illustrated. For track construction in paved streets, if the pavement of the entire street is laid on a concrete base, the ties, which are 6 ins. x 8 ins. x 6½ ft., are bedded for their entire length in concrete, and the concrete is carried down to the bottom of the ties and throughly tamped under the base of the rail between ties. If the pavement is not laid on concrete the ties are bedded and tamped in gravel. The gravel is brought up to the top of the ties, and granite blocks are used for paving, except on reservations, where tracks are filled in with loam within 1 in. of the top of the rail. The ties are placed 2 ft. 6 ins. between centers.

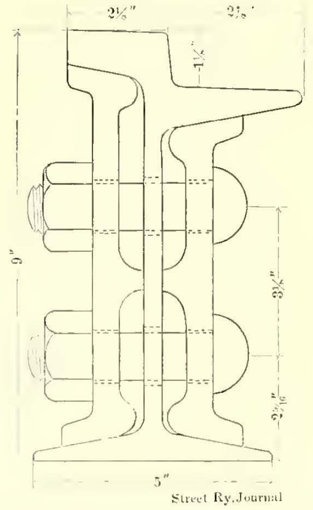
It has been the custom heretofore to break joints in laying track; but it has recently been decided that there is no marked advantage in such construction. The joints are now laid opposite. Tie-plates are omitted in all paving in brick or asphalt on a concrete base. Where the paving is granite a cast-iron tie-plate about 1½ ins. in thickness is used, so that the height from the tie to the top of the rail is about 10 ins. No concrete is placed under the ties, as it has not been found any advantage. The track construction is securely bonded to the rest of the street by the fact that the tie is bedded in the concrete and the rail rest upon the concrete. If there is any settling of the street the track, of course, goes with it; but this would occur in any event, even if there were concrete under the tie. The joints are angle-bar joints, having twelve bolts. The

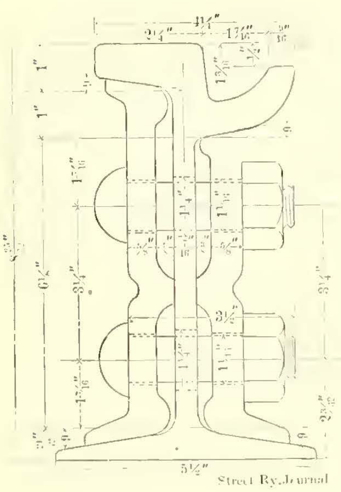
RAIL COMPOSITION SPECIFIED IN BOSTON

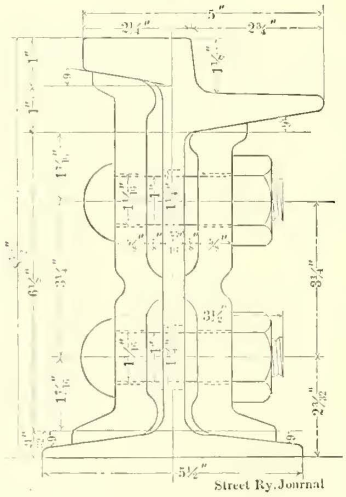
	Per Cent	Per Cent
Carbon	.50	.60
Manganese	.80	1.00
Sulphur, not to exceed.....		.08
Phosphorus, not to exceed.		.08
Silicon	.10	.15

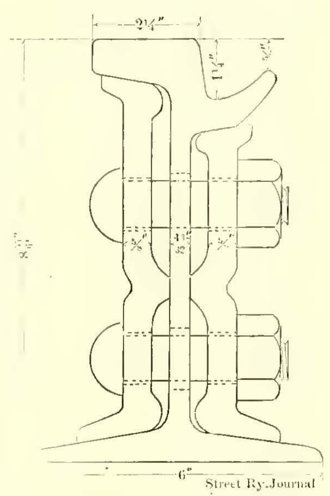
Rails having carbon below .50 per cent will be rejected.
Rails having carbon above .62 per cent will be rejected.
Steel for rails made by Bessemer process.

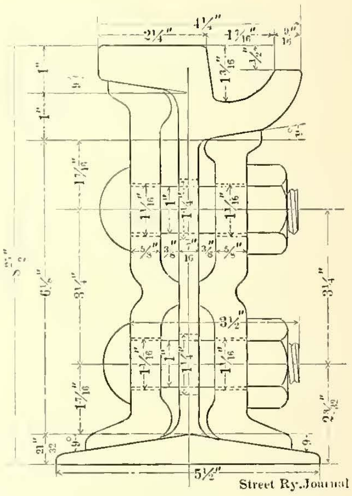

STANDARD GROOVED RAIL IN BALTIMORE

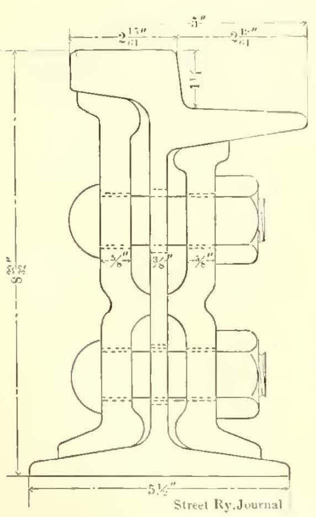

STANDARD GIRDER RAIL IN BALTIMORE

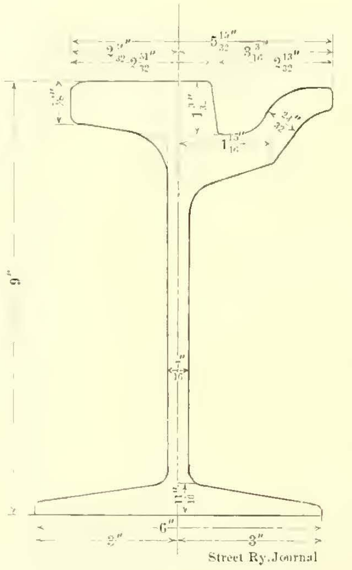

STANDARD GROOVED RAIL IN BOSTON

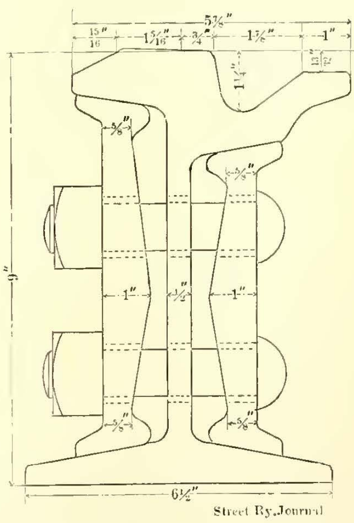

STANDARD GIRDER RAIL IN BOSTON

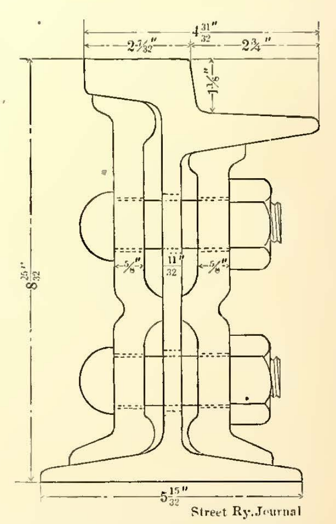

STANDARD GROOVED RAIL IN BUFFALO


STNDARD GROOVED RAIL IN CLEVELAND


STANDARD GIRDER RAIL IN CHICAGO


STANDARD RAIL RECOMMENDED FOR CHICAGO


STANDARD GROOVED RAIL IN PHILADELPHIA


STANDARD GIRDER RAIL IN PITTSBURG

form of construction used in outlying streets where a reservation has been made alongside the roadway, so there is no paving, is to lay a 7-in. T-rail, Pennsylvania section, No. 206. The object of the deep T-rail is to give a depth of 8 ins. of loam over the ties for raising grass. The composition of rails is specified in the table on the opposite page.

Most of the recent bonding has been with protected rail-bonds. The company is now experimenting with soldered bonds.

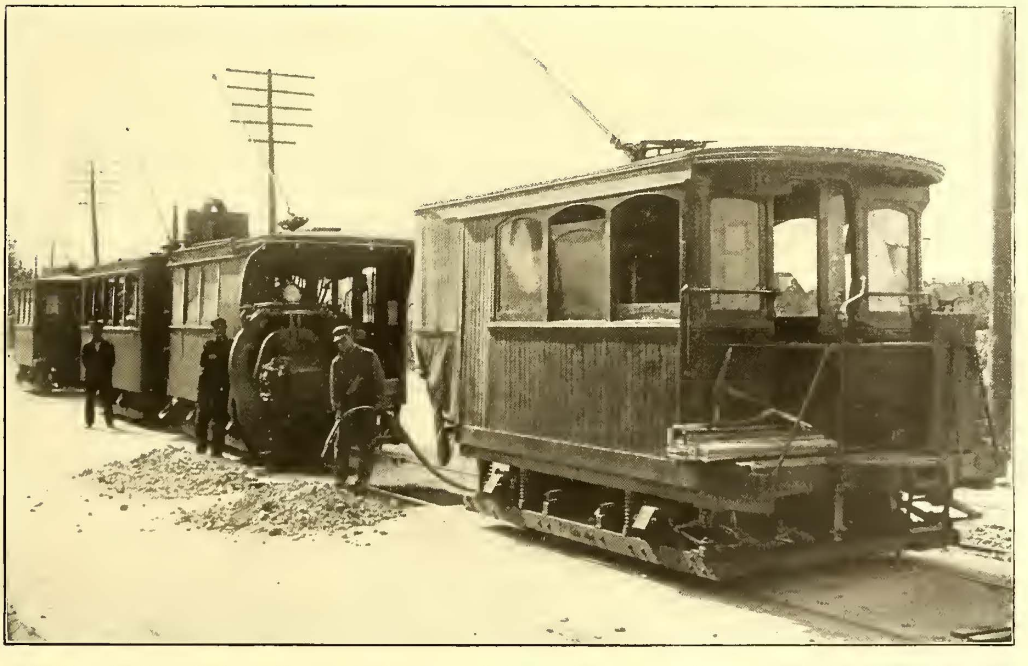
The company finds that the life of untreated ties is from four to five years in loamed reservations, and twenty years or longer under pavement.

BUFFALO RAILWAY COMPANY

The Buffalo Railway Company has an unusually high percentage of new and standard track construction. In paved streets a 94-lb. section, No. 313, of the Lorain Steel Company is the standard. This is a rail with rather narrow groove, with the lip of the groove 5/8 in. below the head of the rail. The track construction of this company is notable because of the fact that electrically welded joints are its standard.

Two forms of track construction are employed, both of which depend mainly on concrete to support the rails. Where granite block paving is permitted the full width of double track, including devil strip, the track is supported on a solid bed of concrete extending about 8 ins. below the base of the rail.

The track is held to gage and partially supported by ties placed every 5 ft. Every other tie is of metal, the others being of wood. In places where asphalt paving is laid in the devil strip the concrete beam form of construction is employed. A wedge-shaped beam of concrete, 18 ins. wide at the top and 8 ins. deep, is laid under each rail. Ties are placed every 5 ft.



SAND BLAST CAR AND ELECTRIC TRACK JOINT WELDING APPARATUS IN BUFFALO

Concrete is tamped under every other tie at the time the concrete stringers are laid. The remaining ties support the track during construction when the concrete is being laid, and are laid on tamped stone. The paving in this case between the rails is supported simply on sand foundation except where it is above the ties. Both forms are illustrated on the following page.

For suburban or outlying streets a 9-in. girder rail has been extensively employed for paved streets. In macadam and dirt roads a 6-in. Shanghai T-rail, weighing 72 lbs. per yard, is used. If the track is exposed A. S. C. E. standard T-rail is laid. The spacing of ties on suburban work is 2 ft. between centers. The ties are white oak, 6 ins. x 9 ins. x 8 ft. They

ELECTRICALLY WELDING RAIL JOINTS IN BUFFALO

are laid on broken stone ballast 8 ins. deep. No tie-plates are used, but rail braces are used on the outside of each rail and on curves.

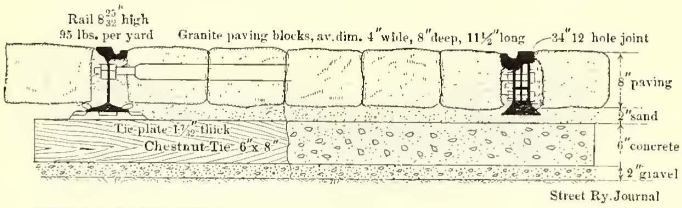
The composition of rail specified is:

	Per Cent	Per Cent
Carbon	.43	.53
Phosphorus, not to exceed.		.10
Silicon, not to exceed......		.20
Manganese	.80	1.10

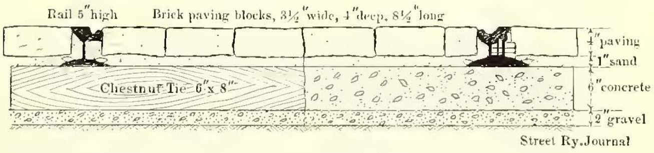
Bonding is unnecessary on the electrically-welded track, as the conductivity of the joint is so high and the percentage of breakages so low. As special work at frogs and crossings is not electrically welded to the balance of the track it is bonded with bonds having electrically-welded terminals. On suburban work bonds of the protected type applied with a screw compressor are used.

As the introduction of a successful electrically-welded track practically makes the life of a rail limited only by the wear of the head, some calculations have been made at Buffalo as to the probable wear of rails. On some track ordinarily having cars on 2-minute headway (but during the Pan-American Exposition having cars on 30-second headway) the wear has been found to be 1/8 in. in four years.

The company now has over 100 miles of electrically-welded track. The electric welding process, as carried on at Buffalo when begun in 1899, was notable as being the first application on a large scale of a successful method of electrically welding rail-joints, although the first experiments with this particular method were made at Johnstown in 1897. Track construction in Buffalo stands alone to-day as an example of the most extensive application of electrically-welded rail-joints. The joint



CROSS SECTION OF STANDARD 9-IN. TRACK IN BOSTON

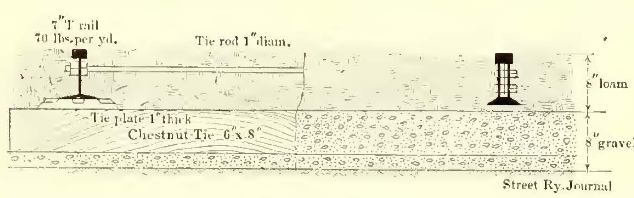


CROSS SECTION OF STANDARD TRACK WITH 5-IN. RAIL IN BOSTON

plates are welded to the web of the rail by means of bosses on the plates, which limit the area of the welding to the area of the bosses, and so insure a high temperature at the point of welding. There is one boss directly at the joint between the rails, and in addition a boss at each end of the joint plate. The center bosses are welded first and those at the ends afterwards. In the welding five cars are employed. One of these is the welding car proper, which carries the welding clamps and welding transformers. The second carries a rotary converter, which receives direct current from the trolley and supplies alternating current to the welding transformer. The third car has a motor-driven booster for raising the trolley voltage whenever the drop is so great that there is danger that a successful weld will not be made. The fourth car is a sand-blast car, which cleans the rails before welding. The fifth car carries a motor with emery wheels for grinding off any inequalities in the joint after it is completed. The number of breakages in the electrically welded track in Buffalo has been very small. In fact, on recent work the breakage is so small as to be hardly worth mentioning, being but a very small fraction of 1 per cent. The details of the electric welding process were given in the STREET RAILWAY JOURNAL of June, 1899, and September, 1899.

CHICAGO CITY RAILWAY COMPANY

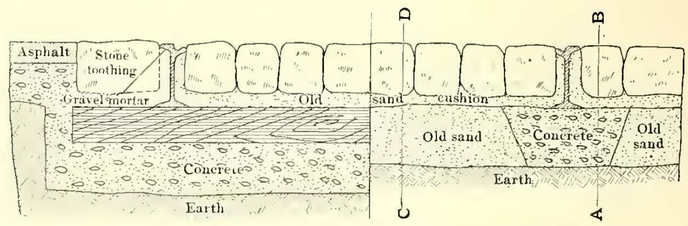
The Chicago City Railway Company on the last track laid employed a 9-in. girder rail with wide tram for vehicle wheels. This rail weighed 95 lbs. to the yard, being Lorain Steel Company's section 297. These were laid on white oak ties, 6 ins. x 6 ins. x 8 ft., spaced 2 ft. between centers. No tie-rods were



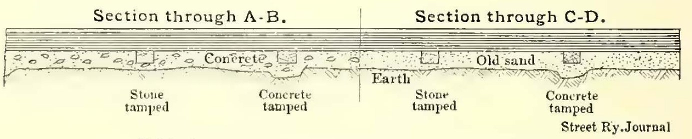
STANDARD SECTION OF TRACK WITH T-RAIL IN RESERVATIONS IN BOSTON

used, but malleable cast-iron tie-plates with braces hold the track to gage. The ties rest on sand. The joints are cast welded. This was the company's standard construction until recently. It is possible that in the future in paved streets this company will use concrete stringer construction without ties, but at present writing this is uncertain, since the matter of the extension of the company's franchises is now under consideration and is not settled. It is in order to mention in this connection that the report of Bion J. Arnold, as expert for the city of Chicago, to investigate the transportation problem of Chicago, recommended that in well-paved and clean streets a grooved rail of the form shown on page 330 be adopted as the standard. This rail would be, to a large extent, self-cleaning. The object of the bevel on the head is to allow dirt to slide off the head of the rail.

As to bonding, a good cast-welded joint is considered by this company sufficient to furnish electrical conductivity, but a copper supplementary wire is run, since there is a city ordinance requiring it. For getting around special work Crown bonds are used. Although no very accurate figures are avail-



CROSS SECTION OF TRACK ON CONCRETE BEAMS WITH WOOD TIES IN BUFFALO

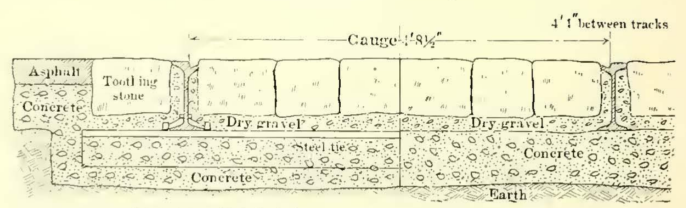


LONGITUDINAL SECTION OF ABOVE

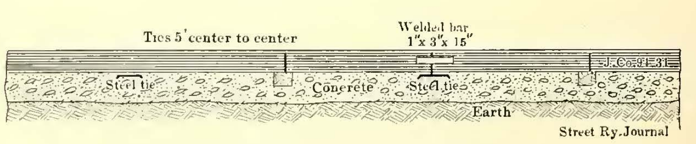
able as to the life of track and rails, Richard McCulloch, assistant general manager, has estimated approximately that a certain piece of girder-rail track was worn out after the passage of 3,000,000 cars, that is, the head was worn so that the car wheel flanges touched the tram of the rail. The wheel flanges used on this road are unusually shallow, being but ⅝ in.

CLEVELAND ELECTRIC RAILWAY COMPANY

The standard for Cleveland track construction is now a rail similar to that used in Boston, except in streets where the tracks run along a grass plat, as along the boulevards. The track is laid on ties that are placed 2 ft. between centers, except that three are placed under each joint. The joints are staggered. Three inches of concrete are placed under the ties. Two kinds of joints have been used extensively, the cast-welded joint and the twelve-bolt 36-in. angle-bar. On a boule-



CROSS SECTION OF TRACK ON CONCRETE BEAMS WITH STEEL TIES IN BUFFALO

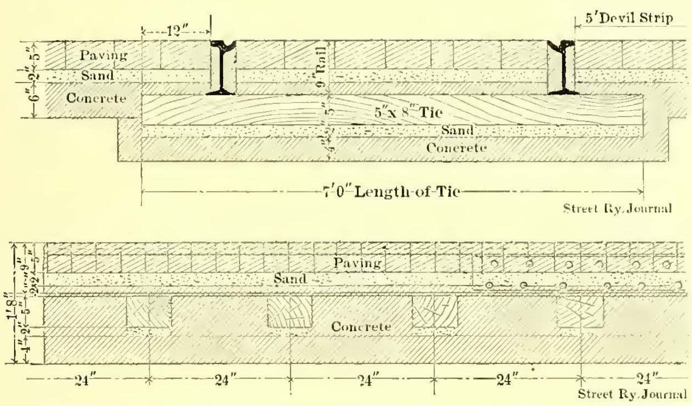


LONGITUDINAL SECTION OF ABOVE

vard line recently constructed 80-lb. standard A. S. C. E. rail in 30-ft. lengths was employed. This construction is shown by the accompanying engraving. The bonds used are single or double No. 0000 protected leaf bonds, 10 ins. and 12 ins. long, placed under the fish-plates. Some 90-lb. girder rail has been down nine years, under a 3-minute service. This has cast-welded joints. It is said to be good for another nine years.

DENVER CITY TRAMWAY COMPANY

The Denver City Tramway Company has always been a company which has given special attention to good track work. This was one of the first companies to employ the T-rail successfully in paved streets where the traffic is heavy, and was the first to use what is commonly known as the Shanghai or high T-rail. Its standard rail for down-town service is a 72-lb. 6-in. Shanghai rail, in 60-ft. or 62-ft. lengths. A section of this rail with the standard joint is shown herewith, together with a section of the track construction. The track is laid on Texas heart-pine ties, 6 ins. x 8 ins. x 6 ft. They are laid an unusually short distance apart, being 21 ins. from center to center. They are laid in gravel ballast, which surrounds the ties and extends 8 ins. below them, except in paved streets, where concrete is used between the ties. In preparing the trench care is taken that the ground is thoroughly settled. The usual method is to flush the trench thoroughly with water and then roll it with heavy rollers. The ties are first shovel-tamped from end to end, and then tamped with iron tamping bars. During the last four or five years the plan has been adopted of painting all rails with one or more coats of asphaltic paint, because Denver soil is more or less impregnated with alkali and mineral salts. This paint has retarded corrosion and electrolysis very much.



CROSS AND LONGITUDINAL SECTION OF TRACK CONSTRUCTION ON LAKE AVENUE, IN CLEVELAND

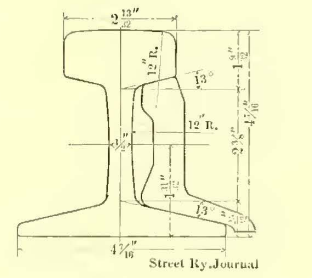
For outlying unpaved streets standard A. S. C. E. 65-lb. T-rail, in 60-ft. lengths, is used.

The standard bond for the 72-lb. Shanghai rails in the paving is the Brown plastic bond. For 65-lb. rails in unpaved streets the bond used is the Ohio Brass Company's flexible copper and the Crown flexible copper, both of which have given good results. All copper contracts on bonds are amalgamated before application by the use of the Brown's solid alloy. It is found that this prolongs the life of the bond, and also increases the conductivity. The standard joints are shown in connection with the standard rails, being ordinary four-bolt angle-bars. All track is laid in cool weather, with rails butted tightly together. The rails give out much sooner when expansion is allowed for than when laid closely butted together. As to life of track and ties good Texas heart-pine ties will last from seven to twelve years in Denver. White oak ties have been in for fifteen years, and are still good. Red and black oak ties are good for six to eight years. Native pine and spruce will last from four to seven years. The life of the rail depends upon the nature of the joint. With a tight joint and well-ballasted track, supposing that the ties are in good shape, a 72-lb. Shanghai rail, it is thought, should last thirty years in Denver. The composition of the 72-lb. Shanghai rail follows:

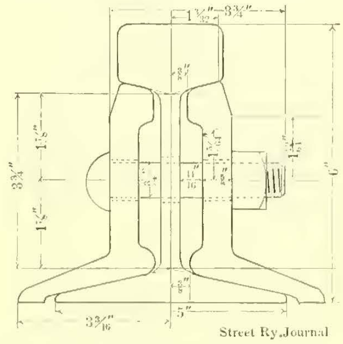
	Per Cent	Per Cent
Silicon	.10	or over
Phosphorus	.10	or less
Carbon	.46	.56

DETROIT UNITED RAILWAY COMPANY

The Detroit United Railway Company lays a narrow grooved rail in paved streets. The last rail laid was 90-lb., section No. 317, of the Lorain Steel Company. Some of the first experiments in the United States with tracks supported by concrete stringers in place of ties were made in Detroit. The first con-



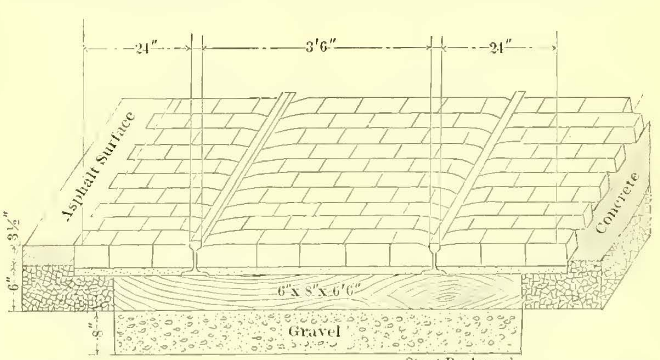
STANDARD T-RAIL FOR UNPAVED AND SUBURBAN STREETS, DENVER.



STANDARD RAIL FOR PAVED STREET IN DENVER.

struction of this kind was laid on concrete stringers only 6 ins. thick. These were not strong enough to support the rail and the present construction uses concrete stringers 12 ins. thick by 18 ins. wide. The concrete stringer is brought up around the web of the rail high enough so that brick paving can be laid with but a thin cushion between the paving bricks and the concrete. The upper part of the concrete stringer is, of course, continuous with the concrete foundation of the asphalt or brick paving. Now that concrete stringers 12 ins. thick are used, and the stringers are made a part of the concrete foundation of the paving, no trouble has been experienced from lack of sufficient support. Some of the earlier construction, where paving was not entirely removed and concrete was laid in trenches under each rail without having any foundation in common with the paving, was not a success.

For holding the track to gage a wooden tie is now placed every 30 ins. Formerly a metal tie every 10 ft. was all that was laid to maintain the gage. The present construction, therefore,



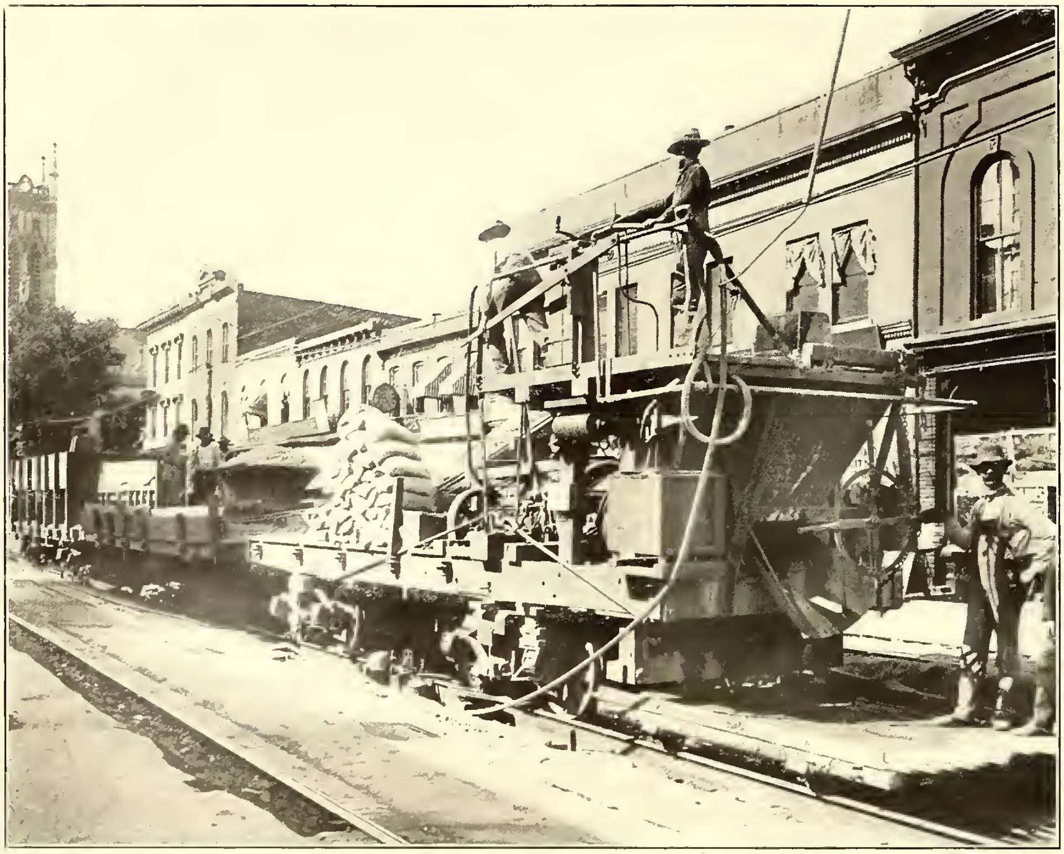
ISOMETRIC DRAWING OF STANDARD TRACK CONSTRUCTION WITH T-RAIL IN DENVER

with its closely spaced ties, is a partial abandonment of the plan of depending entirely on concrete stringers for track construction. "Continuous" rail-joints are used extensively.

Bonding has been done with various types of bonds, Crown bonds being very popular with the management.

As to the life of track, one example can be cited which is on Woodward Avenue, near the Campus Martius, where cars operate during some parts of the day under 1-minute headway. This track had been laid thirteen years up to 1902, when it was practically worn out, as the wheel flanges were touching the bottom of the grooves. The depth of the flange on new wheels of the Detroit United Railway is ⅝ in.

In the city track construction which has been done this year by the Detroit United Railway a novel concrete mixing outfit devised by John Kerwin, superintendent of track, has been used. Two views of this outfit are shown herewith.



CONCRETE MIXER USED IN TRACK CONSTRUCTION IN DETROIT

In the process followed in Detroit there are no piles of cement, stone or sand dumped on the street. The car shown in both views in the foreground is the one which is equipped with the concrete mixer. The mixer is driven by a motor, which is supplied with current through a fish-pole connection with the trolley line, as seen. The two cars seen in the rear are supply cars for bringing sand and stone. There is a track on each car, and when the three cars are coupled together the tracks on the three cars are connected by fish-plates. When the supply cars are empty they are taken away, and two more open ones shoved in in their place. A small dump-car operates over the tracks on the cars, and the cement, stone and sand for the concrete is dumped into this car. The car holds a cubic yard of stone, ½ yd. of sand and ½ barrel of cement. The sand is placed in the car first. The cement is spread on top of the sand. This is done on the second car of the train. The small dump-car is then backed into the rear car and loaded with stone. This stone car has a false bottom, which is high enough to allow the small car to pass under. The men then raise the false bottom, which allows the stone to drop into the small car. After the car is filled it is pulled up the incline to the big hopper of the concrete mixer by means of a cable driven by the motor and controlled by the lever on the operator's stand. The machine turns out a batch of concrete every 5 minutes. The small car placed in front of the machine has a loose bottom, so that the men can distribute the concrete evenly the entire width of the roadbed.

This small car is pulled by a horse to where the concrete is being put under the track. Water is brought in a hose from a nearby hydrant. A boy on the controlling platform operates the water valves. The tank seen on the far side of the mixer is for measuring the right amount of water for each batch of concrete. The machine is operated with nine men, and it is considered that it saves about $20 a day in labor. The concrete is mixed in a revolving drum, which is 8 ft. in diameter and 4 ft. long. The whole outfit was built last winter in the shops of the track department of the Detroit United Railway, and is mentioned later to be Mr. Kerwin's design.

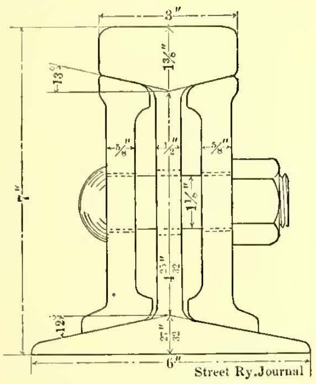
INDIANAPOLIS TRACTION & TERMINAL COMPANY

The Indianapolis Traction & Terminal Company practically has two standards of track construction in paved streets, one employing girder rail, Lorain, 93-lb., No. 206; the other a new special rail section, 91-lb., No. 375. The girder rail is laid on streets where only city cars will pass. The new special 91-lb. rail mentioned is a high T-rail with a wide head, and has been designed, like the Milwaukee rail mentioned later, to be easily paved to, and yet to permit the passage of interurban cars with deep wheel flanges, of which there is a large number entering Indianapolis over the city system.

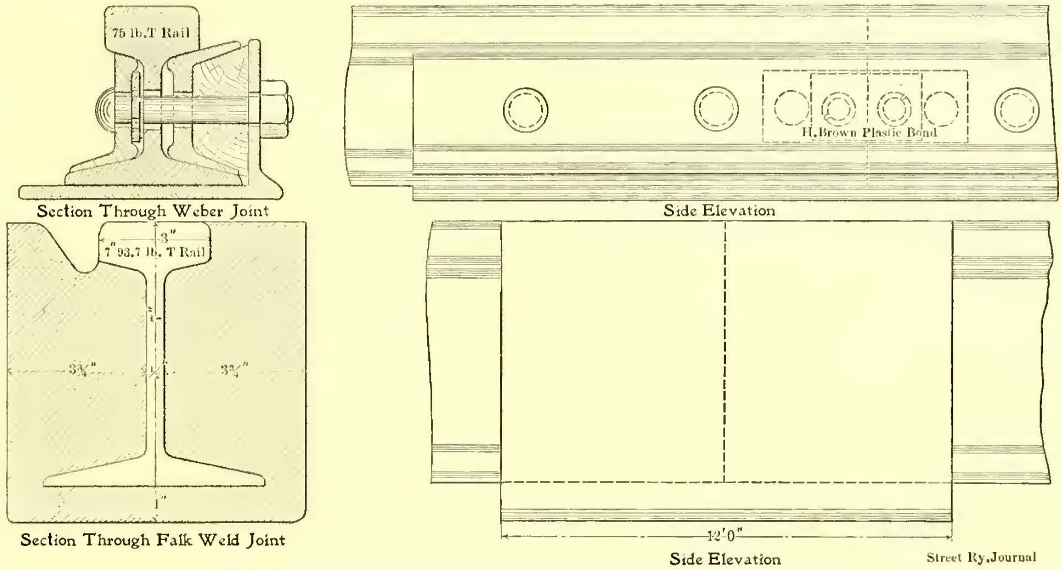
CONCRETE MIXER USED IN TRACK CONSTRUCTION IN DETROIT

The standard rail for this service is 7 ins. high, and has a head 2¾ ins. wide, to reduce amount of overhang of wide-tread interurban car wheels. For outlying unpaved streets 70-lb. standard A. S. C. E. T-rail is laid. This company's standard tie is 6 ins. x 8 ins. x 7 ft., of white oak. The ties are laid 2 ft.

2 ins. between centers, and ballasted with gravel concrete, which extends 6 ins. under the tie, surrounds the tie, and is brought to within 4½ ins. of the top of the rail. Some track has also been laid with ties spaced 10 ft. between centers, with a concrete beam 20 ins. wide and 9 ins. deep under the rail, and extending to within 5½ ins. of the top of the rail. The management seems to favor the regular tie construction first described. On the Shanghai T-rail and on ordinary T-rail continuous rail-joints are used with four bolts.



STANDARD T-RAIL IN MILWAUKEE



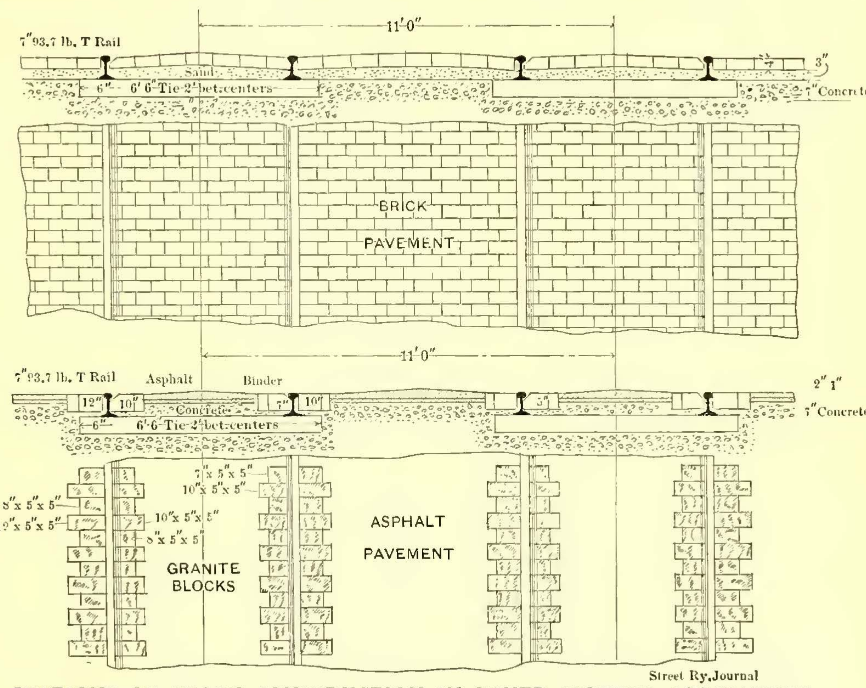
STANDARD CAST WELDED JOINT USED IN MILWAUKEE

The standard bonds are No. 0000 protected bonds, 10 ins. long under the fish-plates, also No. 0000 28-in. wire cable bond over the fish-plates. The bonds are applied with a screw compressor. The track is cross-bonded with No. 0000 wire every 500 ft. between the rails of one track, and every 1000 ft. is a cross-bond connecting the four rails of the double track.

THE MILWAUKEE ELECTRIC RAILWAY & LIGHT COMPANY

The Milwaukee Electric Railway & Light Company some time ago succeeded in securing the approval by the city authorities of T-rail construction for paved streets, with results beneficial both to the company and the public. Recently a special new design of T-rail has been adopted as the standard for all future work. A section of this new design is illustrated herewith. It is 7 ins. high, and in many respects does not differ materially from the Shanghai T-rail which has been used extensively in other Western cities. The principal feature of note is the wide head, which is no less than 3 ins. in width. The idea in having such a wide head is that in the future interurban cars should be equipped with wheels having treads and flanges more nearly approaching the standard steam railroad wheel tread than is now common. With a rail having the head 3 ins. wide a car wheel with a tread 3½ ins. wide could be used without having the wheel seriously overhanging the rail and bearing on the pavement. Of course, the T-rail also admits of as deep a car-wheel flange as may be desired.

Plans and sections of this company's standard track construction in asphalt pavement and in brick pavement are here shown. Track is laid on 6-in. x 8-in. and 6-ft. 6-in. ties, placed every 2 ft. Six inches of concrete are tamped under each tie and the paving foundation consists of 6 ins. of concrete as shown. No tie-rods are used, as this rail has a very broad base and tie-rods are liable to cause a weak spot in the paving. All joints in the various tracks are cast-welded, a peculiar form of joint being used which facilitates paving. The joint is rectangular in form without any of the curved lines which have made cast-welded joints difficult to pave to satisfactorily. In asphalt streets granite toothing blocks are laid alongside of each rail. In Milwaukee the city pays for the original laying of the pavement and the company pays for the maintenance of the pavement between its tracks and 12 ins. outside its tracks. Granite toothing blocks extend out 12 ins., or to the limit of the distance that the company must maintain paving.



SECTIONS OF TRACK CONSTRUCTION IN PAVED STREETS, MILWAUKEE

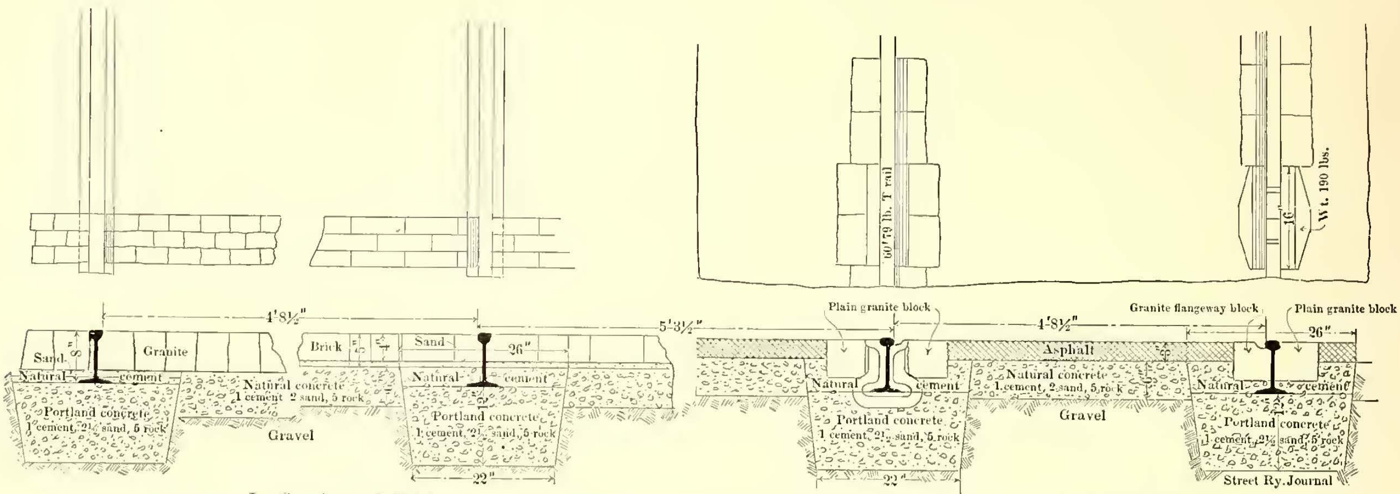
On unpaved suburban roads 75-lb. standard A. S. C. E. T-rail is laid. On this track the Weber joint is used, with Brown plastic rail-bonds. Cast-welded track is not bonded, as the iron is poured hot enough to make a true weld between the joint and the rail.

TWIN CITY RAPID TRANSIT COMPANY, MINNEAPOLIS AND ST. PAUL

The track construction of the Twin City Rapid Transit Company, of Minneapolis and St. Paul, in down-town paved streets has been notable for several years, because it was one of the first roads to lay a T-rail in streets paved with asphalt in a city where girder rail had been the rule before. Sections of the standard track construction are shown herewith. The rail used is 8-in. Shanghai T, weighing 79 lbs. to the yard. The concrete beam which supports each rail is 22 ins. to 24 ins. wide and 12 ins. thick under the rail. This is Portland cement concrete. The base of the rail rests directly on this. Around and above the base of the rail is placed 3 ins. of natural cement, if the paving is of brick, and less if the paving is granite. The sections illustrated show the track in asphalt, brick and granite paving. A cast-welded joint 16 ins. long and weighing 190 lbs. is employed. This joint is of somewhat unusual shape, as it extends out from the head of the rail so as to make a substitute for paving at that point. On the inner side the joint has a flange way, which gives the effect of a grooved rail at the joint. The object of this peculiar form of joint is to facilitate paving around the joint and to provide that there shall not be a weak point in the paving at the joint. The rails are purchased in 60-ft. lengths. On old construction tie-rods were used to hold the track to gage, but recently some track has been laid without, with good results, although the non-use of tie-rods is not well enough established to be called standard.

The spaces between and around the paving blocks are filled with Portland cement grout, and fourteen days is allowed for the concrete to thoroughly set before allowing any traffic whatever upon the rails. In less substantially paved streets ties, spaced 2 ft. between centers, are used. These ties are 6 ins. x 8 ins. x 8 ft. A 6-in. concrete base of natural cement is placed between and around the ends of the ties, and on this a sand cushion is spread. The brick or stone paving is set and grouted with Portland cement grout.

For suburban construction a 5-in. 80-lb. A. S. C. E. standard T-rail is adopted. Ties, 6 ins. x 8 ins. x 8 ft., are spaced 2½ ft. between centers. Continuous rail joints are used on this track. Atkinson bonds are standard on this work.

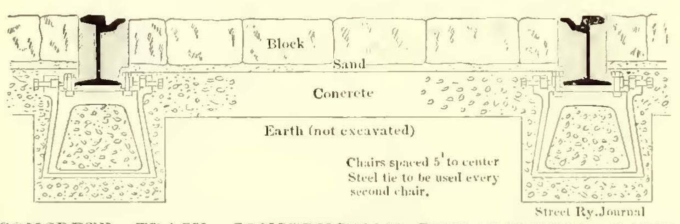


In Granite and Brick. In Asphalt.

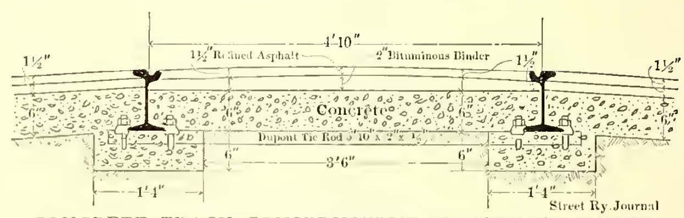
STANDARD TRACK CONSTRUCTION IN BRICK AND ASPHALT PAVED STREETS—TWIN CITY RAPID TRANSIT COMPANY

PHILADELPHIA RAPID TRANSIT COMPANY

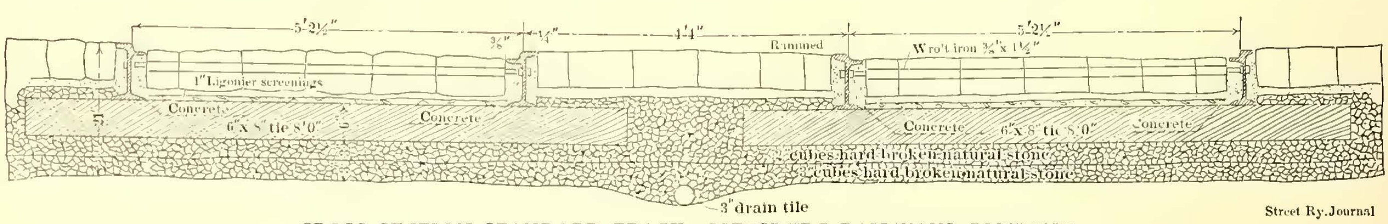
The Philadelphia Rapid Transit Company uses for its standard track construction in streets having heavy traffic a grooved rail known as Lorain Steel Company's section 371, which weighs 137 lbs. to the yard. Where the travel is lighter Lorain, section 206, weighing 93 lbs. to the yard, is used. This latter section is also used for suburban service if the streets are paved. For unpaved suburban streets A. S. C. E. standard 90-lb. T-rail is used. Track in paved streets is now being laid on concrete stringer construction, a section of which is here illustrated. Chairs are spaced 5 ft. apart. A steel tie is used in connection with the chairs at every second chair, or every 10 ft., and provision is made on these chairs for the adjustment of the gage. The concrete stringer extends 15 ins. under the base of the rail. The foundation of the paving between the tracks is a bed of concrete 6 ins. thick. The concrete stringers are 17 ins. wide. All rails are laid with broken joints. The zinc joint previously described in the STREET RAILWAY



CONCRETE TRACK CONSTRUCTION—PHILADELPHIA RAPID TRANSIT COMPANY



CONCRETE TRACK CONSTRUCTION IN ASPHALT PAVED STREET—ST. LOUIS TRANSIT COMPANY



CROSS SECTION STANDARD TRACK—PITTSBURG RAILWAYS COMPANY

JOURNAL of April 18, 1903, page 589, has been very successful, although it can hardly be called the standard joint for the company's use as yet. This joint consists of rolled steel joint plates surrounding rail-web and base, between which and the rail a filling of zinc is poured. Track construction in the past has been laid on 5-in. x 9-in. x 8-ft. ties, spaced 2 ft. between centers. Where zinc joints are used no bonds are necessary. On other track a protected form of bond, about No. 0000, is used. The composition of rails, as specified in the contracts of the company, follows:

	Per Cent	Per Cent
Carbon	.45	.55
Phosphorus, not over......		.10
Silicon		.20
Manganese	.80	1.00

As to the wear of rails experience in Philadelphia seems to indicate that under the heaviest traffic there the life of the ordinary girder rail is not over ten years.

PITTSBURG RAILWAYS COMPANY

The Pittsburg Railways Company uses a 90-lb. girder rail, Lorain section, No. 206, in 60-ft. lengths in its construction. This is laid on ties, and the ties are on a foundation of broken stone. This broken stone is in two layers. The upper layer is in 12-in. cubes and the lower layer in 3-in. cubes. The foundation extends to a depth of 21 ins. below the top of the rail. The ties are 6 ins. x 8 ins. x 8 ft. Concrete is used around the rail to fill in the space between the head and base of the rail. The rails are laid directly on the ties, and tie-rods are used. Cast-welded rail-joints are now being laid. Ties are spaced 24 ins. between centers. For suburban service 80-lb. T-rail and Lorain Steel Company's 78-lb., section 206, have been used. Two protected rail-bonds are used at joints where the rails are not cast-welded, and cross-bonds are placed every 80 ft.

UNITED RAILROADS OF SAN FRANCISCO

The standard rail in San Francisco is a 9-in. girder rail, Lorain Steel Company's 109-lb., No. 340, for basalt block pavement, and for bitumen paving on concrete foundation a 7-in. girder rail weighing 96 lbs. per yard, Lorain, section 357. For between centers. The "Servis" tie-plate is used and redwood ties. Rails are purchased under two different specifications as to composition. The light rails, weighing under 70 lbs. to the yard, have compositions specified as follows:

	Per Cent	Per Cent
Carbon	.38	.48
Phosphorus, not to exceed.		.10
Silicon, not to exceed......		.20
Manganese	.70	1.00

For rails weighing 90 lbs. to 100 lbs. per yard the specifications are:

	Per Cent	Per Cent
Carbon	.45	.55
Phosphorus, not to exceed.		.10
Silicon, not to exceed......		.20
Manganese	.80	1.00

Nearly all joints are cast-welded. As to life of ties, ties with broken stone ballast underneath and with sand or gravel between and over the ties, will last from twelve to fifteen years. If they are placed in loam, or in a soil that holds moisture, they last from seven to ten years.

ST. LOUIS TRANSIT COMPANY

The St. Louis Transit Company lays track, as shown by the cut on the opposite page, using a concrete beam under each rail and a Du Pont tie-rod, which is in the nature of a metal tie, to hold the track to gage. These tie-rods are placed every 6 ft. and clamped to the base of the rails, thus preventing all tilting. The concrete stringer supporting the rail is 8 ins. x 18 ins. The foundation of the pavement, the bottom of which is flush with the base of the rail, is a bed of concrete 6 ins. thick, on top of which the asphalt is placed. The standard rail is a 9-in. grooved rail, either the 100-lb. section, No. 363, of the Lorain Steel Company, or the 98½-lb. section, No. 241, of the Pennsylvania Steel Company. The rail-joints now being used are "Continuous" and angle-bar.

For suburban service the St. Louis Transit Company uses a 95-lb. 9-in. girder rail. In dirt streets ties are laid to support

TABLE OF TRACK CONSTRUCTION IN PAVED STREETS IN FOURTEEN CITIES OF THE UNITED STATES

CITY AND NAME OF COMPANY	Kind of Rail for Paved Streets	Kind of Joints	Manner of Supporting Track—Ties or Concrete Stringers	Manner of Holding Rails to Gage	What Bed Under Ties	What Bed Around Ties
Baltimore—United Railways & Electric Co.	Grooved	Angle bar (8 bolts)	Ties 6 in. x 8 in. x 8 ft.	Tie rods 6 ft. apart	Sand	Sand
Boston Elevated Railway Co.	Grooved	Angle bar (12 bolts)	Ties 6 in. x 8 in. x 6 ft. 6 in.	Tie rods	Gravel	Concrete
Buffalo Railway Co.	Grooved	Electric welded	Concrete bed and concrete stringers.	Ties 5 ft. apart	Concrete	Concrete
Chicago City Railway Co.	Girder	Cast welded	Ties 6 in. x 8 in. x 8 ft.	Brace tie plates	Gravel	Gravel
Cleveland Electric Railway Co.	Grooved	Cast welded and 12-bolt angle bars	Ties 5 in. x 8 in. and 5 in. x 7 in.	----------------	Concrete	Concrete
Denver City Tramway Co.	Shanghai T	4-bolt angle bars	Ties 6 in. x 8 in. x 6 ft. 6 in.	Tie rods	Gravel	Concrete
Detroit—United Railway	Grooved	Continuous	Concrete stringers	Ties 30 ins. apart	Concrete	Concrete
Indianapolis Traction & Terminal Co.	Girder and new Shanghai T	Continuous	Ties 6 in. x 8 in. x 7 ft.	Tie rods	Concrete	Concrete
Milwaukee Electric Railway & Light Co.	New Shanghai T	Cast welded	Ties 6 in. x 8 in. x 6 ft. 6 in.	Ties	Concrete	Concrete
Minneapolis—Twin City Rapid Transit Co.	Shanghai T	Cast welded	Concrete stringers	Tie rods 10 ft. apart	----------------	------------
Philadelphia Rapid Transit Co.	Grooved	Zinc	Concrete stringers	Special chair and tie rod	----------------	------------
Pittsburg Railways Co.	Grooved	Cast welded	Ties 6 in. x 8 in. x 8 ft.	Tie rods	Broken stone	Broken stone
San Francisco—United Railroads	Girder	Cast weld	Ties 6 in. x 8 in. x 8 ft.	----------------	Concrete (bitumen paving), Broken stone (block paving)	Concrete, Broken stone
St. Louis Transit Co.	Grooved	Angle bar and continuous	Concrete stringer	Dupont tie rod	----------------	------------

cable yoke construction, Lorain Steel Company's 7-in. girder rail, weighing 100 lbs. to the yard, section No. 338, is the standard. For suburban service Illinois Steel Company's, section No. 7010, weighing 70 lbs. to the yard, is standard. Electric track is laid on ties 6 ins. x 8 ins. x 8 ft., with 3 ins. of ballast under the ties. If concrete is used 4 ins. of ballast is placed under the ties. With a 9-in. rail ties are placed 4 ft. between centers. With a 7-in. rail they are spaced 3 ft. between centers. Under a T-rail on suburban track they are placed 2 ft.

the track. In Telford pavement concrete supports the track. The track is bonded with No. 0000 bonds, with compressed riveted heads made by the company. A protected bond is used on surface track. A large number of old rails are used as a supplementary return circuit in the neighborhood of the power house.

The accompanying table summarizes some of the principal points in the track construction of the various companies whose work has been briefly described in the foregoing article.

GENERAL CONCLUSIONS

Looking at electric railway construction in the paved streets of our larger cities to-day, as outlined in this article, it is seen that the methods of the different companies which have been described here are at considerable variance in some respects. One of the most noticeable differences is in the use of concrete stringers as the principal support of the rail in some types of construction, and the retention of regular tie construction by other companies. Although there are still many companies which employ ties instead of stringers for rail supports, the use of concrete stringers is on the increase, so that it may be said there is a decided tendency toward concrete stringer construction in this country at the present time. It is less than ten years since concrete stringers were first used in the United States, although it is and has been the most common construction in England for some time. Several of the roads enumerated in this article as using concrete stringers have only recently adopted it. It is difficult to draw a hard and fast line of distinction between concrete stringer construction and construction in which ties afford the main support of the rails, because some construction is in reality a combination of the two methods. Where ties or tie-rods are placed at intervals of 10 ft. they can have but little to do with forming a support of the rail, and their use in such cases is confined mainly to holding the track to gage and surface while the concrete is being put in and is hardening. In such a case there is no question but that the track should be classified as concrete stringer construction. When, however, ties are placed more frequently—5 ft. apart or less—they may have much to do with supporting the track as well as in holding it to gage during construction.

Where ties are used it will be noticed that some companies tamp concrete to a considerable depth below the ties, while others simply surround the tie with concrete. One prominent example of this latter form of construction is that of the Boston Elevated Railway Company. The experience of this company has led its management to believe that concrete is unnecessary under the ties if they are surrounded with the concrete which forms the foundation of the paving. Experience at Denver has led to the same conclusion, and the concrete is not extended below the ties in the Denver construction. Extraordinary precautions, however, are taken at Denver to see that the earth and gravel below the ties are thoroughly settled before the track is laid.

Experience both with ties and with concrete stringer construction has taught that the foundation of the track and paving should be as nearly identical as possible, and that the bed, if of concrete, should be thoroughly bonded together. What failures of concrete stringer construction have occurred seem to have been due almost entirely to lack of common foundation between the track and paving.

Methods of holding the track to gage where concrete stringers are used instead of ties are considerably at variance. At Detroit metal ties were used in the most approved construction until recently, when they have been abandoned in favor of wood ties. At Philadelphia and at St. Louis tie-rods, which are almost analogous to metal ties, but without the large bearing surface of a tie, have been adopted. Tie-rods in both the Philadelphia and in the St. Louis construction are below the base of the rail, and hence do not interfere in any way with the paving. At Minneapolis track has been laid both with and without tie-rods, and no final conclusion has been reached. An ingenious combination of metal and wooden ties has been made in Buffalo, where, on some of the construction, every other tie is of metal. The wooden ties form the support for the track while the concrete is being poured and tamped under the rails and metal ties. In Buffalo in one form of construction there adopted the company has carried the concrete stringer idea to the extreme, and has made one solid bed of concrete the entire width of the track, instead of laying a beam under each rail only. The other Buffalo construction in which concrete stringers are laid under each rail is notable for going to the other extreme. These concrete stringers are not bonded to the concrete which forms the paving foundation, and, in fact, there is no concrete except under rails and the ties, which are 5 ft. apart.

Taking everything into consideration, it is likely that the success or failure of concrete stringer construction will depend partly on how good a foundation there is under the street to begin with. In this connection it is pertinent to mention the practice which has been adopted in the reconstruction of track at Kansas City. Here the question of whether concrete stringer or tie construction shall be used is answered by the kind of foundation upon which the track is to be laid. In a street where the paving is on a good concrete foundation, and settling has taken place for years, concrete stringers are used, and form a part of the general street foundation. If the paving is without a substantial foundation, which is frequently the case on some of the outlying streets, ties are laid.

Comparing the practice of to-day with that of ten years ago, the increasing use of grooved as a substitute for girder rails is noticeable. The increase in the number of cities where T-rails are used in paved streets is also a matter of note, and should be a matter of congratulation. Of the cities on the list, Denver has always used T-rail. At Minneapolis, St. Paul, Milwaukee and Indianapolis the T-rail has been introduced in place of the girder rail, formerly required in those cities. There is certainly no cause for complaint on the part of the people of those cities, as the surface of the street in which T-rails are used is much better than it would be with a girder rail. From the company's standpoint the life that it is possible to obtain from the T-rail is much greater than could be obtained from the girder, assuming, of course, that the wear of the rail-head rather than the giving down of the joints determines the life of the rail. With interurban car wheels having deep flanges but little wear can take place on an ordinary girder or grooved rail before the cars are running on the wheel flanges. This condition exists on some of the track in several cities to-day. With the T-rail the amount of wear that can take place before the track is worn out entirely is independent of the car wheel flanges. The T-rail is a center-bearing rail, and with the wide base of a Shanghai T-rail there is but little tendency for the rail to tip over and get out of gage. As far as presenting a smooth street surface for vehicles is concerned the T-rail, when properly paved to, is practically as good as the grooved rail, and has the advantage that the groove will never clog with ice or dirt so as to interfere with the operation of the cars. There is the possibility that under the extremely heavy traffic on some of the narrow streets of our greatest cities a T-rail construction would permit of too rapid deterioration of the paving next to the rail, although this is as yet largely a matter of theory, as the T-rail has been notably successful wherever given a fair trial.

The grooved rail, as adopted in American cities, has usually been modified considerably from the grooved rails common in Europe. The narrow grooves used in Europe, and those laid several years ago in this country, were, exactly as street railway men anticipated, failures from an operating standpoint, as the grooves were so narrow that they became clogged with dirt upon the slightest provocation. The girder rail was extensively used in this country as a compromise. It made a considerable break in the smooth surface of the street, but to compensate for this there was a tram on which the wheels of an ordinary vehicle could run and find a smooth track. Some have attributed the original adoption of the girder rail to the desire of street railway companies to maintain their paving in good shape by maintaining an iron track for vehicles; others to the desire of the companies to keep team traffic moving at a brisk pace ahead of the cars rather than to have it delayed by the poor paving which was common in American cities several years ago, and which has not altogether disappeared yet. Be this as it may, the street railway manager of the last ten years has realized that the team traffic which takes to the rails is responsible for no small share of the rail wear, and is, furthermore, responsible for an immense amount of delay, because of the unwillingness of drivers to leave the track when once their wagons are in it.

It is evident that there are many aspects to the rail question. A municipality might urge the adoption of a grooved rail because of the unbroken street surface which it permits. On the other hand, it might be urged on behalf of the municipalities that the use of the girder rail relieves the paving from much wear. From the standpoint of the operating street railway man the girder rail is good, because it always insures a clear flangeway, which can never become clogged. It is bad, because of the inducement it offers to teams to follow the tracks, and thus delay cars and cause excessive track wear. These two objections have become very serious during the last few years in some cities, and while a grooved rail is not altogether ideal yet it is undoubtedly true that it tends to relieve the trouble from delays of traffic caused by the slowness of teamsters in leaving the track, and it always tends to keep the team traffic away from the track, if the balance of the street has good paving. If the street railway company maintains the paving between the tracks this tends to reduce the wear on the paving, so that the grooved rail is not altogether bad from an operating standpoint, especially if it has a wide, self-cleaning groove, as have most of the recently laid grooved rails. With a grooved rail having such a shape of rail that the dirt will be forced out by the car-wheel flanges, rather than packed in the bottom of the groove, there seems to be little trouble.

The street surface with a grooved rail and with a T-rail around which there is proper paving, is practically the same from the standpoint of the public. From the company standpoint, if the street traffic is very heavy the maintenance of paving might be greater with the T-rail than with the grooved, but in all other respects the T-rail is better, because it is cheaper in first cost than a grooved rail of equivalent stiffness, and has possibilities of many more years of life than the grooved rail. For cities where the entrance of interurban cars is becoming very important, not only to the companies but the cities themselves, earnest consideration should certainly be given to a form of track construction which is well adapted for interurban car wheels having a safe depth of flange. At Indianapolis, which is one of the most important interurban centers in the United States, and where a magnificent interurban terminal depot is now being erected in the heart of the city, and at Milwaukee, where similar conditions exist, it was wisely concluded by all concerned that a form of construction should be adopted which would be suitable for interurban cars, and which would permit of track once laid being operated over by interurban cars for many years without disturbing the street for relaying track. The result has been the form of T-rail track construction which has been outlined before in this article. The T-rail sections for Milwaukee and for Indianapolis are both of very recent origin. Both have wide heads, in conformity with the wide treads of interurban car wheels. The rail used at Philadelphia and the one proposed by Bion J. Arnold as standard for Chicago, both have heads which are beveled so that the wheel tread does not bear on the full width of the head when the rail is new. The section proposed by Mr. Arnold has a very marked bevel, amounting to 5-32 in. in a width of 11-16 in. The reason given by Mr. Arnold for advocating this form of head is that it provides for car wheels with broad treads, and that the beveled surface at the back of the tread will prevent the wheel from crushing or wearing the pavement where the pavement comes in contact with the rail-head. This point might, perhaps, be stated more clearly by saying that the chances that the paving will get in the way of the car wheels is lessened by the form and width of the rail-head, and if car wheels less than the width of the head are used the presence of the bevel allows of some little rail wear before a lip begins to form on the outer part of the rail head. At any rate, this new rail also provides for wide-tread wheel, although not as wide as the new sections of T-rail to be used at Milwaukee and at Indianapolis. In this connection it is interesting to note that the first Shanghai T-rails, which were designed by Mr. Beeler for use on the Denver lines, had what was then considered a wide head to present a bearing surface to the whole width of the car-wheel tread ordinarily used in city service. One possible use of a bevel on the outer edge of a rail head, as in the proposed Chicago rail, would be to insure a place into which dirt could slide from the head of the rail, even if the paving were slightly higher or exactly flush with the top of the rail. This feature is provided for in a very pronounced manner by the rail used at Kansas City, which is a center-bearing girder rail with a narrow tram on each side of the head. The only use of the outer tram is to insure a clear space next to the head of the rail into which dirt will fall from the head of the rail, and to prevent paving from being brought into interference with the wheels.

Practice is fairly well divided between welded joints and joints employing bolts. Some of the roads on the list have made cast-welding an absolute standard for paved streets, but the majority have considerable track with both bolted and cast-welded joints. It is claimed by some that cast-welding changes the character of the steel at the joints, so that the joints do not wear the same as the rest of the track, and will in time hammer down. Other companies have noticed nothing whatever of such an effect. The earlier troubles with defective electric welding seem to have been entirely overcome in the work done at Buffalo, where electric welding is the standard, and has been put into such extensive use. Troubles with excessive joint depreciation, which were so common ten years ago, do not seem to be as serious with bolted joints as formerly, probably owing to the very much heavier rails now common and the better character of the foundation. Nevertheless, it is probably true that where welded joints are used a somewhat lighter rail can be satisfactorily employed than if bolted joints are used, since a good welded joint so nearly approximates the strength of the unbroken rail. The joint being experimented with at Philadelphia, in which zinc is used to make a tight fit between the joint plates and the rail, seems to be giving good satisfaction, and the results will be watched with considerable interest. If successful this joint will be a happy compromise between the welded joints, which require such a large amount of apparatus for their manufacture on the street, and bolted joints, which are easily installed but more likely to require attention after being once in place.

STANDARD OVERHEAD CONSTRUCTION IN CITY STREETS

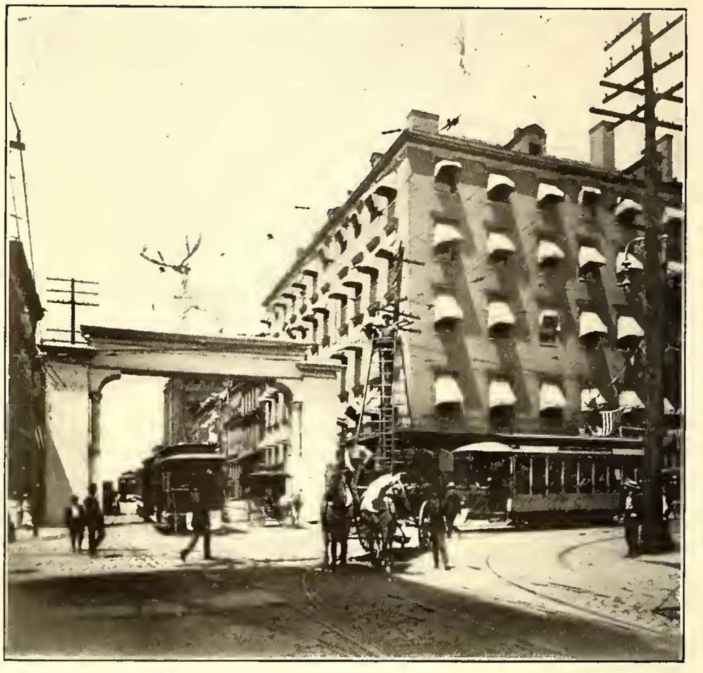
SINCE the general change of motive power from horse and cable traction to electric traction, interest has somewhat died out in overhead construction in large cities, as this construction has usually proceeded along tolerably familiar lines. Nevertheless, an investigation of the standard types of overhead construction adopted by fourteen of the principal street railways of the country shows that there are points of difference which make the study and comparison of methods worth while.

UNITED RAILWAYS & ELECTRIC COMPANY OF BALTIMORE

This company uses round trolley wire in sizes No. 0 and No. 00. Span wire is 5-16 in. galvanized stranded wire. Overhead feeders are 500,000 circ. mil cables and No. 0000 solid conductors. The standard poles are 5-in. and 4-in., two-section, steel tubular. Terra cotta conduit, with 3-in. ducts is used. Feeders and trolley wire are calculated for a maximum drop of voltage of 10 per cent.

BOSTON ELEVATED RAILWAY COMPANY

The standard trolley wire of the Boston Elevated Railway Company is No. 00 round wire. Span wires are 5-16 in., galvanized iron, 7 strands. Feeders are triple braided, waterproof copper wire, with a maximum size of 1,000,000 circ. mils. For straight line work a three-section steel tubular pole is used, weighing from 700 lbs. to 800 lbs., with sections 6½ ins., 5½ ins., and 4½ ins. For locations requiring a stronger pole, one with sections 7½ ins., 6½ ins. and 5½ ins., and weighing 950 lbs. to 1050 lbs., is used. For curves, an 8½-in., 7½-in. and 6½-in. pole, weighing 1450 lbs. to 1500 lbs., has been adopted, while, of course, on the elevated division the third rail is used. One of the accompanying views shows the point at



CORNER EUTAW AND BALTIMORE STREETS, SHOWING OVERHEAD CONSTRUCTION

which the change is made from the overhead to the third rail. The company has several types of conduits, the standard being

VIEW ON CLARK STREET, NEAR ADAMS, CHICAGO, SHOWING STANDARD OVERHEAD CONSTRUCTION IN DOWN-DOWN STREETS a single-duct vitrified tile conduit laid in concrete. The company considers a 20 per cent drop in voltage under maximum load conditions the greatest drop permissible, this being on the outlying feeder sections.

BUFFALO RAILWAY COMPANY

The Buffalo Railway Company uses a No. 00 round trolley wire, with 3/8-in. stranded span wires. The largest feeders are 500,000 circ. mil. They are covered with waterproof insulation. Camp single-duct conduits 3 ins. in diameter are standard. A drop in voltage of 20 per cent is considered the maximum allowable under any circumstances.

CHICAGO CITY RAILWAY COMPANY

The Chicago City Railway Company uses No. 00 round trolley wire, with galvanized stranded span wires 3/8 in. in diameter. The largest feeders are 500,000 circ. mil copper with waterproof insulation. The last conduit was American vitrified conduit in multiple ducts. The standard poles for straight line work weigh 900 lbs., and are in three sections, 7 ins., 6 ins. and 5 ins. in diameter, respectively. On curves an 8-7-6-in. pole is used. The practice is now to put two strain insulators in the span wire between the trolley hangers and the poles. The company makes its own brass work for overhead fittings. The Knox hanger, with a clip which is fastened to the trolley wire by hammering, has been the standard for many years. In laying out new overhead work to be fed from sub-stations, a maximum drop in voltage of 15 per cent in the direct-current feeders would be calculated. At the present time the company's system is being fed from direct-current stations, which are likely to be soon superseded, so that the company's present practice is hardly a criterion of what it would be with a reconstructed system.

AT FAYETTE AND NORTH STREETS, BALTIMORE

INCLINE AT NORTH STATION, BOSTON, SHOWING CONNECTION BETWEEN SUBWAY, SURFACE AND ELEVATED TRACKS

CLEVELAND ELECTRIC RAILWAY COMPANY

The Cleveland Electric Railway Company uses No. 00 hard-drawn round copper trolley wire. On narrow streets the standard span wire is 5-16-in double galvanized steel stranded wire, and for wide streets 3/8-in. wire. All new feeders are 1,000,000 circ. mil. The standard pole is a three-section pole, 7 ins., 6 ins. and 5 ins. in diameter, weighing about 620 lbs. On curves a 1600-lb. pole, 8 ins., 7 ins. and 6 ins. in diamter, has been adopted. The company has no conduits. Plans are shown herewith of the company's standard side pole construction, and also some bracket construction recently put up.

DENVER CITY TRAMWAY COMPANY

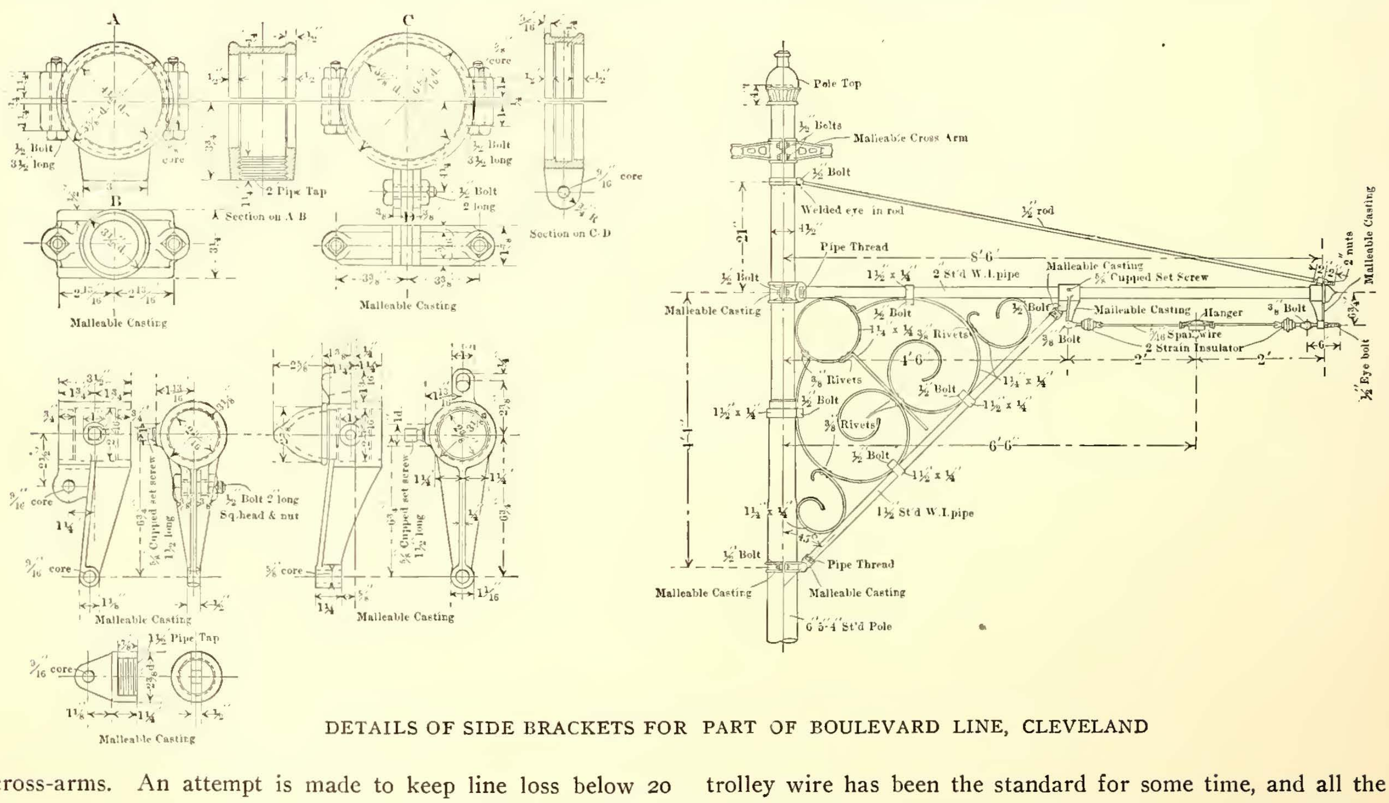
The Denver City Tramway Company uses No. 0 round trolley wire. Span wire is 5-16 in. for double track, and 1/4 in. for single track spans. The largest feeders are 500,000 circ. mil stranded copper, with waterproof triple braid covering. The only underground conduit used is for about 300 ft. from the power house. The maximum drop in voltage for which the lines are calculated is about 10 per cent. A very accurate alignment of the trolley wire is maintained on curves, and cars operate around curves at higher speed than is usual in most cities.

DETROIT UNITED RAILWAY COMPANY

The Detroit United Railway Company has tried several kinds of trolley wire, and is now using No. 00 round copper wire. Span wires are 5-16 in. on all straight-line cross-span work, but some ¼-in. span wire is used for pull-overs on special work. The largest cables are 1,000,000 circ. mil, of which a great number are in use, and good results are

VIEW OF CLIFTON BOULEVARD, CLEVELAND, SHOWING PART OF 5½ MILES OF DOUBLE TRACK ROAD RECENTLY BUILT BY THE CLEVELAND ELECTRIC RAILWAY COMPANY

being obtained. The pole spacing is not over 110 ft. on such lines. The latest standard construction is with 675-lb. iron poles, 30 ft. high, well set in concrete. Every eighth span is a feed-in span of No. 00 copper. All feeders are placed on iron



DETAILS OF SIDE BRACKETS FOR PART OF BOULEVARD LINE, CLEVELAND

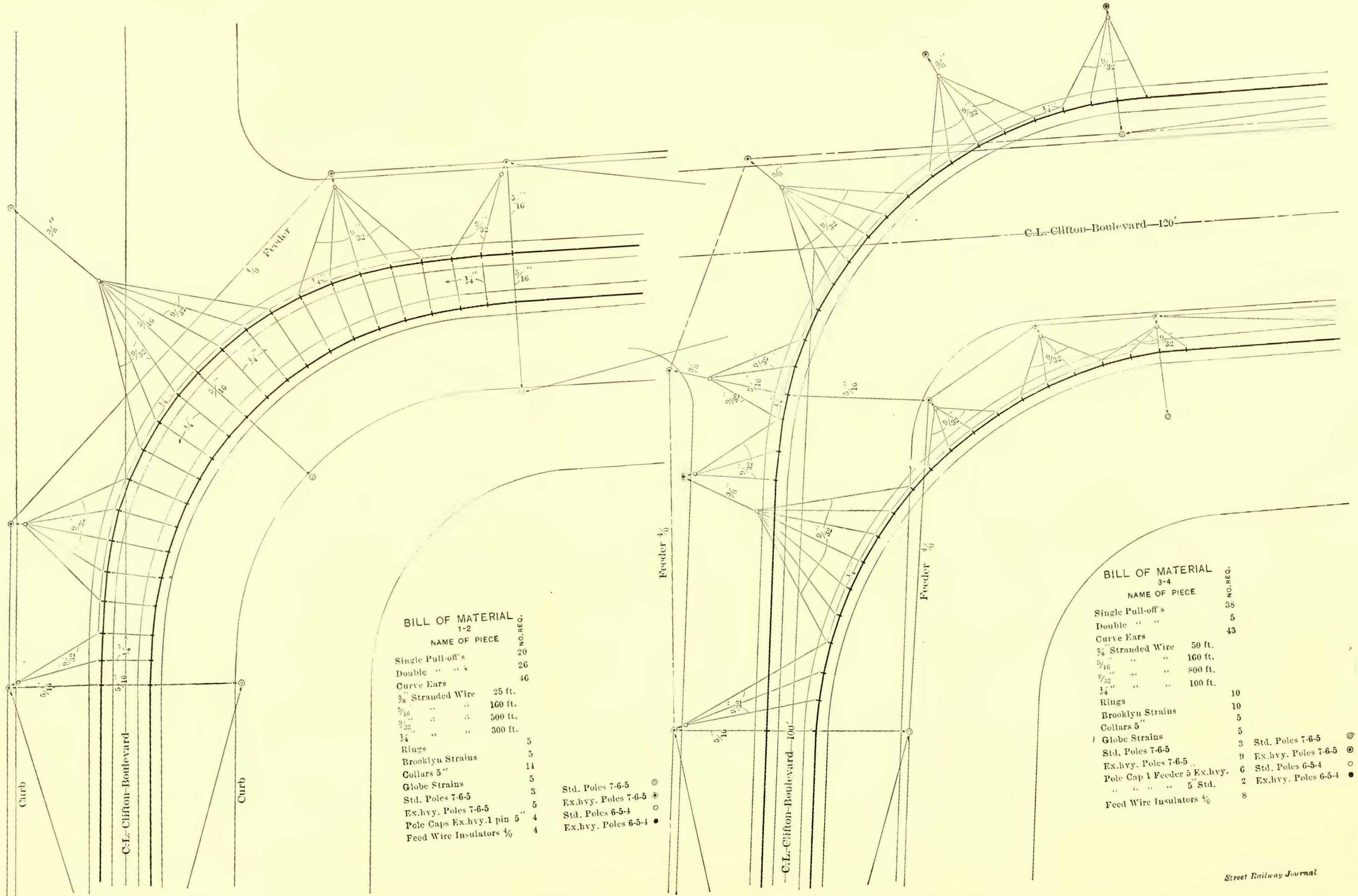
cross-arms. An attempt is made to keep line loss below 20 per cent.

INDIANAPOLIS TRACTION & TERMINAL COMPANY

The standard overhead construction of the Indianapolis Traction & Terminal Company is now side-pole construction, although a large number of center poles are still in use. The trolley wire is No. 00 round wire. The size of the span wire varies from ⅜ in. to ⅝ in., according to the width of street and strain. The standard form of overhead construction is illustrated herewith. A strain insulator is placed in the span wire next to each pole. The straight line hangers are galvanized wire next to each pole. The straight line hangers are galvanized iron. The poles are in three sections, weighing 600 lbs. for straight line work, and as high as 1400 lbs. at corners. The largest feeder cables are weatherproof copper wire, of 500,000 circ. mil section. The maximum permissible drop in voltage for ordinary operation is considered to be 20 per cent. A plan of the overhead construction, corner of Illinois Street and Washington Street, the principal street railway center of the city, which all cars pass, is shown on page 344.

THE MILWAUKEE ELECTRIC RAILWAY & LIGHT COMPANY

The standard construction of the Milwaukee Electric Railway & Light Company differs in a number of details from the construction adopted by the majority of city roads. Figure 8 trolley wire has been the standard for some time, and all the miscellaneous older types of trolley wire which were originally put up in Milwaukee are being replaced with figure 8. The size used is the equivalent of No. 000 round wire. No trouble has been experienced in the handling of this wire since linemen



PLAN OF OVERHEAD WIRES AT CURVES ON CLIFTON BOULEVARD, CLEVELAND have become accustomed to it. The span wire is ½-in. double galvanized stranded wire. All the feed wires inside of the city limits have been placed under ground in the shape of 1,000,000-circ. mil, paper-insulated, lead-covered cables. Outside of the city limits considerable aluminum overhead feed wire has

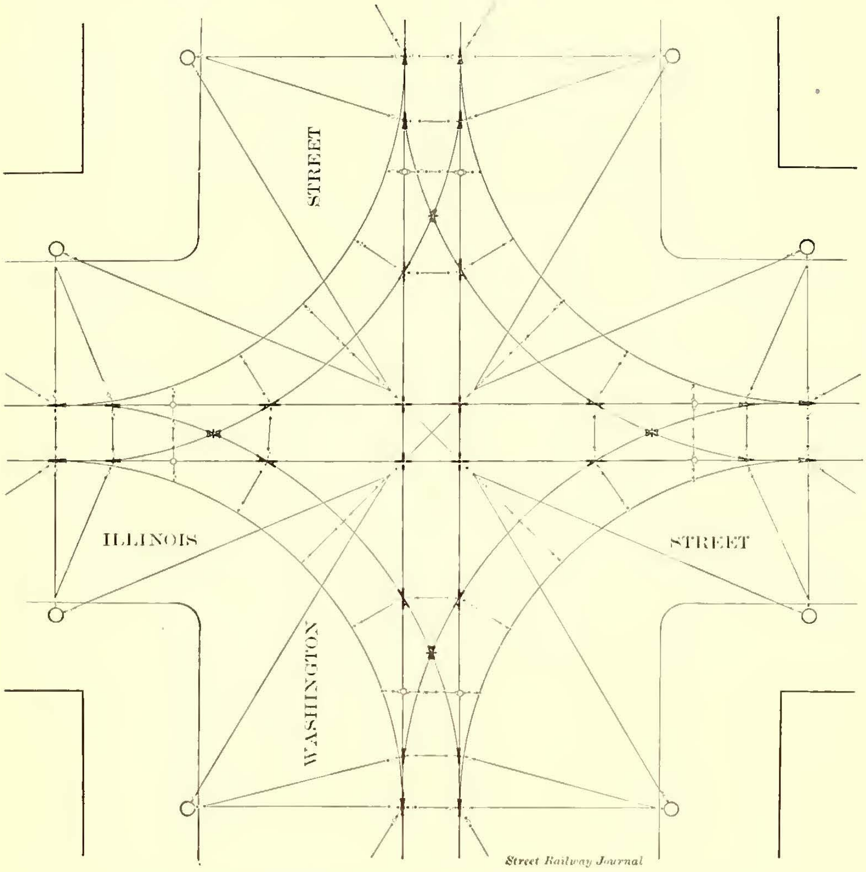


DIAGRAM SHOWING COMPLICATED CONSTRUCTION, CORNER ILLINOIS AND WASHINGTON STREETS, INDIANAPOLIS

been employed. Although large in section, the aluminum feeders weigh less for a given conductivity than copper feeders, and consequently put less strain on a pole line which carries a given amount of current. The conduit into which the underground feeders are placed is Camp single-duct vitrified tile. Poles for straight line work in the city are two-section steel tubular poles, 8 ins. and 7 ins. in diameter, weighing approximately 850 lbs. each. They are 28 ft. long. The poles are set in concrete.

It will be seen from these specifications that the overhead work in Milwaukee in general is somewhat heavier than prevails in other cities. The most radical change from ordinary line work adopted in Milwaukee, however, is the abolition of insulating trolley wire hangers. The trolley wire hangers are entirely of metal. The insulation is all obtained by strain insulators in the span wire, of which there are two in series between each pole, and the trolley wires. The trolley wire hangers are made up similar in appearance to an ordinary trolley wire hanger, with the omission of the insulating bolt. By making a trolley wire hanger purely mechanical and not depending upon it for electrical insulation, it can be made, of course, very substantial. This, together with the use of figure-8 wire, has reduced the troubles from the trolley wire hangers becoming loose or defective to practically nothing. For strain insulators, two Johns-Manville ball strain insulators are placed in each span wire. Every one of these insulators is tested in the shop, both electrically and mechanically, before it is put on the line. For new construction, span wires are made up in the shop, cut the proper length, so that there is no assembling to do on the line.

TWIN CITY RAPID TRANSIT COMPANY, MINNEAPOLIS AND ST. PAUL

The Twin City Rapid Transit Company uses figure-8 wire, equivalent to No. 00 round wire. The span wire used consists of three strands of No. 11 galvanized iron wire. The largest overhead feeders are 500,000-circ. mil, copper-insulated, with triple braid. Underground conduits are McRoy multiple duct vitrified clay. The company uses a peculiar form of trolley wire hanger of its own manufacture, in which insulation is secured by a stick of wood which is supported in the middle from the bracket or span wire, and on each end of which the trolley wire clips are supported. This was described in the STREET RAILWAY JOURNAL of April 5, 1902. The company has a very heavy direct-current feeding system, and aims to maintain the maximum drop of voltage on its lines to within 5 per cent.

PHILADELPHIA RAPID TRANSIT COMPANY

The Philadelphia Rapid Transit Company uses No. 00 trolley wire. The standard poles are shown by the engraving on page 346. Feeders are almost entirely under ground, in the shape of paper-insulated and lead-covered cables. The largest cables are 1,500,000 circ. mil. For overhead work the cables are triple braid insulation, 500,000 circ. mill in size. The lines are laid out for approximately a 10 per cent drop in voltage for the load which it is estimated will occur on the line. When the load overruns this, of course the drop is greater. Direct-current feeders have an insulation 5-32 in. thick, of saturated paper, and a lead covering of the same thickness. For

JUNCTION HOWARD AND FAYETTE STREETS, BALTIMORE, WITH TOWER WAGON AT WORK

straight line work a round-top bell trolley wire insulator is used, with soldered ears 15 ins. long, and weighing 14 ounces.

The poles have a sleeve which fits over them at the ground line to protect them against rust at that point. On the Chicago Union Traction lines, a cast-iron sleeve, fitting loosely, was put at the ground line. Between the sleeve and the pole pitch was poured.

PITTSBURG RAILWAYS COMPANY

The standard trolley wire of the Pittsburg Railways Company is No. 00 round. The span wire is 5-16 in. seven-strand galvanized iron wire. Iron poles on straight line work are 7 ins., 6 ins. and 5 ins. in diameter for heavy work, and 6 ins., 5 ins. and 4 ins. for lighter work. The feeder poles are 31 ft. long, and those not carrying feeders 28½ ft. long. Both copper and aluminum overhead feeders have been used to a considerable extent. The company attempts to maintain the drop of voltage on its lines within 50 volts.

UNITED RAILROADS OF SAN FRANCISCO

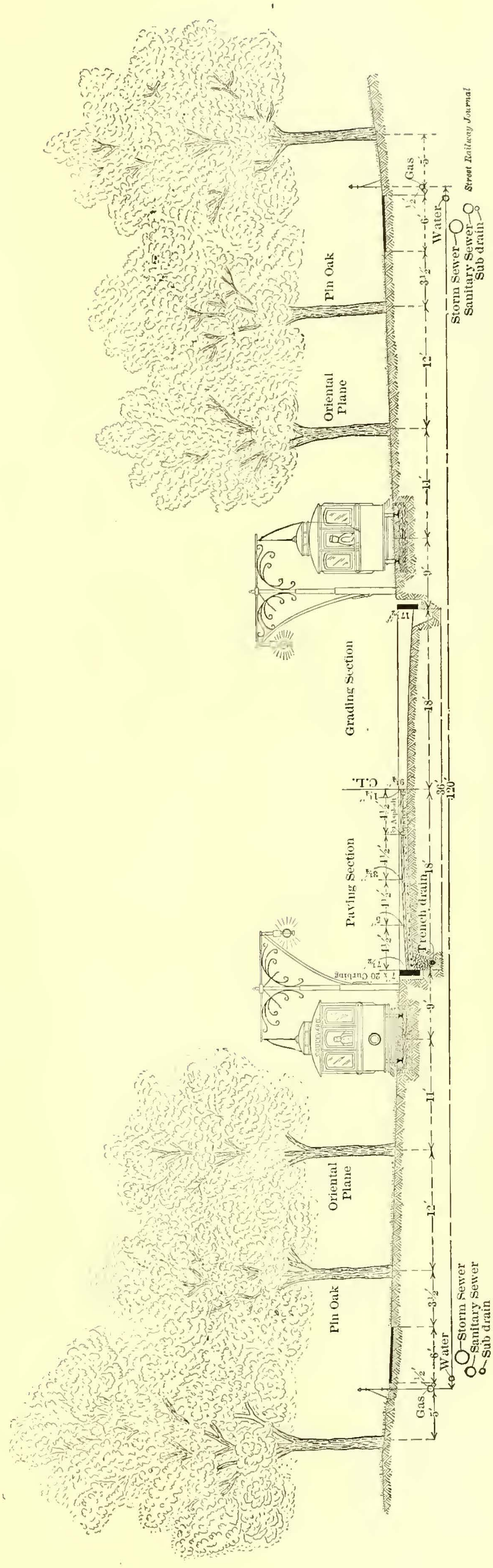
The United Railroads of San Francisco have several kinds of trolley wire, including No. 0 hard-drawn copper, Nos. 0 and 00 phono-electric, No. 0000 grooved hard-drawn, and figure 8 of 330,000 circ. mil section. The span wire adopted for future construction is 5-16-in. galvanized stranded wire. The largest feed wire is 1,000,000 circ. mil copper. For straight line work iron poles 7 ins., 6 ins. and 5 ins. in diameter are standard. For outlying streets wooden poles 8 ins. at the top and 12 ins. at the bottom, 30 ft. long, of redwood, are standard. The company attempts to maintain the drop in voltage within 20 per cent.

ST. LOUIS TRANSIT COMPANY

The St. Louis Transit Company uses as standard on its new work No. 00 round trolley wire. The span wire is seven-strand 5-16-in. double galvanized steel wire. The maximum size of feeders used in overhead work is 1,000,000 circ. mil. The standard poles for straight line construction are 6 ins. and 5 ins. in diameter, and 7 ins. and 6 ins. in diameter, with weights 545 lbs. and 650 lbs. These are in 28-ft. and 30-ft. lengths. On curves, 1025-lb. poles are used. The conduits are cement-lined iron pipe. Trolley wires are insulated by a Johns joint strain insulator at the pole, and by a trolley wire hanger with wooden insulation of the company's own manufacture, and described in the STREET RAILWAY JOURNAL for Aug. 8. These trolley wire hangers have an insulating bolt in which a cone-shaped piece of wood furnishes the insulation. The ear for holding the trolley wire is 15 ins. long, and is clinched or hammered to maintain the wire. No solder is used. The voltage at the power station is kept at 600, and ordinarily the drop on the city lines does not exceed 500 volts.

GENERAL CONCLUSIONS

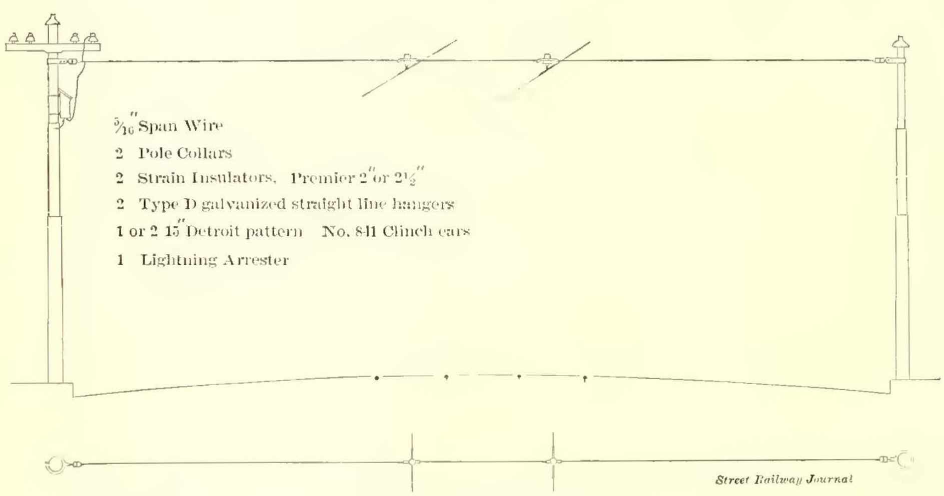
Center pole construction has practically become obsolete for city work. There are plenty of cities where center poles are still used, but the number in use is on the decrease rather than on the increase. Although they are more sightly than the side pole and span wire construction, street railway companies have found them objectionable on account of danger that accidents will occur by passengers and employees being struck with the poles, on account of the small clearance between the car and the center pole. Wire netting is necessary to protect all windows or other openings where there is a possibility that passengers or employees will stick out heads or arms where they might be struck in passing center poles. This netting in itself is objectionable, and even where it is present, it is not always practicable to so completely "cage in" the passengers and employees that they never get hurt in this way. Center poles are also somewhat of an obstruction to team traffic, and sometimes prevent teams from clearing the track as soon as they other-



CROSS-SECTION OF CLIFTON BOULEVARD, SHOWING COMBINATION POLES FOR RAILWAY AND LIGHTING SERVICE, CLEVELAND wise would. Center-pole and track construction has also been the source of considerable trouble, through the rigidity of the brackets and consequent breakage of the trolley hangers. This objection has been overcome by various flexible types of brackets and also by trolley hangers not so much affected by the hammering of the trolley wheels against the rigid bracket hangers, as were the old types. In interurban bracket construction, where poles have been placed far enough from the car, this construction is all right.

TABLE OF OVERHEAD CONSTRUCTION

	Kind of Trolley Wire	Size of Span Wire	Kind and Max'mum Size of Feeders (Overhead)	Lightest Poles for Straight Line Work	Number of Insulators between Trolley and Pole	Type of Underground Conduit	Volts Drop for which New Lines are Calculated
Baltimore United Rys. & Elec. Co..	Round 0 & 00	5/16 in.	500,000 cm copper	5-4 in.	2	Terra cotta	50
Boston Elevated Ry	Round 00	5/16 in.	1,000,000 cm copper	750 lb. 6½-5½-4½ in.	2	Single duct terra cotta	100
Buffalo Ry........................	Round 00	3/8 in.	500,000 cm copper	....	2	....	100
Chicago City Ry	Round 00	3/8 in.	500,000 cm copper	900 lb 7-6-5 in.	3	Mult. duct terra-cotta	75
Cleveland Electric Ry...	Round 00	5/16 in.	1,000,000 cm copper	625 lb. 7-6-5 in.	..	....	125
Denver City Tramway Co....	Round 0	5/16 in.	500,000 cm copper	....	2	....	50
Detroit United Ry.....	Round 00	5/16 in.	1,000,000 cm copper	675 lbs.	2	.. ..	100
Indianapolis Traction & Term'l Co.	Round 00	3/8 in.	500,000 cm copper	600 lbs.	2	....	..
Milwaukee Electric Ry & Light Co	Fig. 8 = 000	½ in.	....	850 lbs. 8-7 in.	2	Single duct tile	..
Minneapolis Twin City R. T. Co..	Fig. 8 = 00	3-11	500,000 cm copper	....	2	Multiple duct tile	25
Philadelphia Rapid Transit Co......	Round 00	....	....	915 lbs. 8-7-5 in.	2	....	50
Pittsburg Rys. Co	Round 00	5/16 in.	1,500,000 cm aluminum	....	..	Cement lined and single and multiple duct tile	50
San Francisco United Railroads....	All kinds in use	5/16 in.	1,000,000 cm copper	7-6-5 in.	2	....	100
St. Louis Transit Co	Round 00	5/16 in.	1,000,000 cm	545 in. 6-5 in.	2	Cement lined iron pipe	100

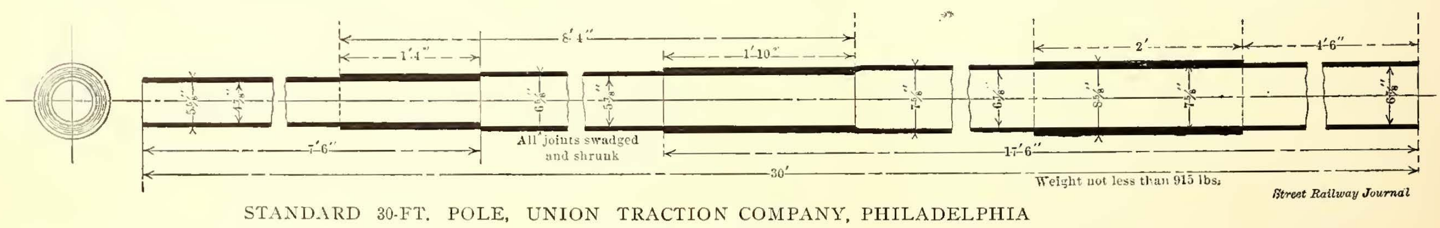


STANDARD OVERHEAD CONSTRUCTION SPAN WORK WITH STEEL POLES, INDIANAPOLIS

There has been a general increase in the strength, both mechanically and electrically, in overhead construction. Double insulation between the trolley wire and a steel pole is now common, where formerly a single insulation was used. In some cities three insulators are in service between the trolley wire and steel poles, one at the trolley wire hanger and two strain insulators in the span wire. One radical move introduced at Milwaukee is doing away with insulation at the trolley hanger entirely, and depending on the insulation of two strain insulators and the span wire. This is a very substantial construction, and permits of a trolley hanger which can be made very strong mechanically. The only objection which might be urged to it would be that the span wires are alive inside of the strain insulators. This objection is not of much practical weight, because if a foreign wire falls across the span wire it is almost certain to come also in contact with the trolley wire, because it will slide along the span wire until it strikes a trolley wire.

Practice is fairly well divided between two-section steel poles, as against three-section poles. Aluminum feeders do not seem to have found extensive use as yet for city direct-current work, although one company reports very favorably on it for use in outlying districts where their apparent great size is not objectionable. The lighter weight of aluminum for given conductivity relieves the pole line of considerable weight and makes aluminum popular with linemen who first object to it.

Figure-8 trolley wire does not seem to have met with favor in the majority of places, but companies which have adopted it have thoroughly trained line crews to handle this class of work. Certainly little fault can be found with the quality of the overhead construction done by companies which have adopted it.



STANDARD 30-FT. POLE, UNION TRACTION COMPANY, PHILADELPHIA

Another variation from common practice is the use of wood for insulators and hangers by the St. Louis Transit Company. Many small companies have used wood at various times within the past few years from motives of economy, and it was used in some of the early roads, but the St. Louis Transit Company is probably the first large city company to adopt this construction for its regular work.

STANDARD PRACTICE IN ROLLING STOCK FOR CITY SERVICE

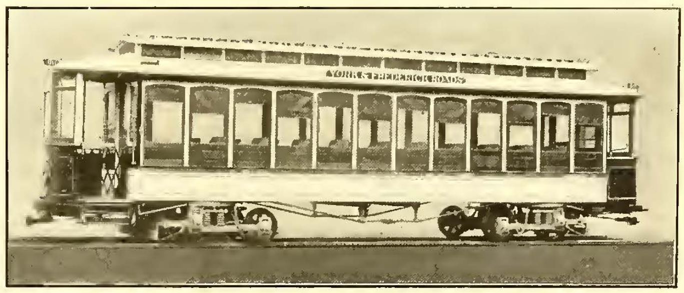
THE main object of this article is to put into convenient form for reference and comparison a brief description of each of the standard cars for city service adopted by fourteen of the larger city street railway systems of the United States, to the end that an idea of the general trend of practice in rolling stock may be obtained. An acquaintance with the rolling stock in one or two cities or in a certain locality is apt to result in a very different opinion as to the trend of modern practice than a broad view of the situation the country over. It is this broad view that this article is intended to afford.

By way of explanation it should be said that in this article no attempt has been made to include anything but the latest adopted standard cars of each company on the list. Every company has considerable variety in its rolling stock. Few companies have not seen fit to change their standard type of car from time to time, in order to keep pace with the progress of the electric railway art. The tendency has been ever toward larger cars. On nearly every road can be seen, from the cars in service during busy hours, the history of the growth of rolling stock during the past ten years, beginning with the single truck, 5-ton to 7-ton cars, built originally for horse traction, and ending with the long double-truck cars, equipped with four motors each, and weighing from forty to fifty thousand pounds. It is but natural to inquire what will be the ultimate limit of this increase in the size of cars. With each increase it has been the prevailing opinion among street railway men that larger cars would not be advisable; but in spite of this, the growth has been going on steadily. Are the present largest cars enumerated in the following pages the limit of size for city service? Will still larger cars be used, or will there be a reaction to shorter cars?

STANDARD SEMI-CONVERTIBLE CAR USED IN BALTIMORE

Speculation on these on these points is probably useless. The increase in size of cars for use in large cities has, of course, been made possible by the freedom from the limitations of horse traction. It was not thought when electric traction first came in that long cars were desirable in large cities. It was argued that they would be slow to load and unload, and would necessitate slow schedules. Experience seems to have demonstrated to the contrary, however, and other considerations have made the adoption of long cars hard to resist by the management of any large city system. The long car carries more people with a given expense for motorman's and conductor's wages than does the short, but what is still more important, the easy-riding qualities of the long car, due to the use of double trucks, make it very popular. To be sure, if long cars are to be run fairly well loaded all day, the headway between cars on a given route must be considerably longer between long cars than between short cars, and it may not be desirable to increase the interval a passenger may wait for a car.

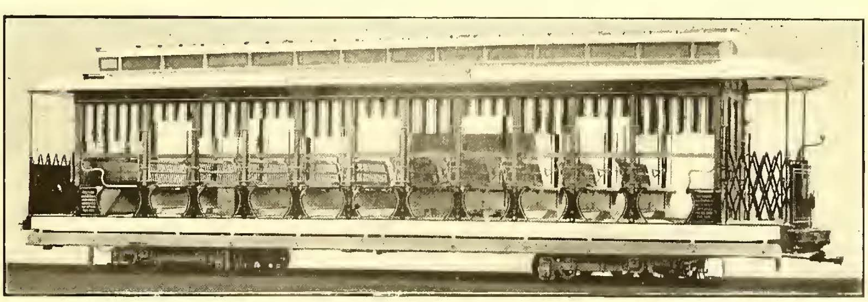
The force of this objection depends mainly on the size of the city. In a small city this has practically prohibited the introduction of long cars, because there are usually not enough passengers to fill even short cars operated on an uncomfortably long headway. In large cities there is sufficient traffic, so that cars are well filled when operated on short headway in any event, be they long or short, so that this objection does not hold.



STANDARD SEMI-CONVERTIBLE CAR USED IN BALTIMORE

When a long car is extremely crowded during rush hours there is no doubt much missing of fares by conductors. On this point it is argued that no well-managed company wants to operate its cars so extremely crowded, for more reasons than one, and that they will be so operated only a very small part of the time. This is usually true, although it is a matter frequently beyond the company's control. However, a full discussion of the question of long vs. short cars, or short cars and trailers would require a separate article, and, perhaps, be useless, since the long car has come into such general use in the largest cities, and conditions are so generally unsuited to it in small cities.

Following are the descriptions of standard cars used by fifteen companies for heavy city traffic, accompanied by a table giving the principal dimensions. In each case, what is called the standard city car, or cars, of any company are the types of cars most recently adopted by that company, without reference to any of the older rolling stock which that company may have in service. The principal dimensions are put in tabular form for convenience in reference.



STANDARD OPEN CAR USED IN BALTIMORE

UNITED RAILWAYS & ELECTRIC COMPANY OF BALTIMORE

The standard closed car of the United Railways & Electric Company of Baltimore measures 28 ft. over end panels, 38 ft.

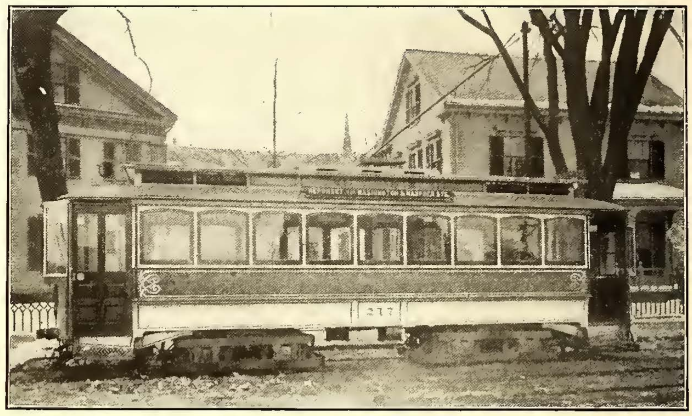
END VIEW OF STANDARD BOSTON CLOSED CAR

over crown pieces, and has a width over sills and panels of 7 ft. 6 ins., and over posts at belt rail of 7 ft. 10 ins. The side sills are 4¾ ins. x 7¾ ins., and are plated inside with ⅝-in. x 7-in.

COMBINATION MAIL AND PASSENGER CAR USED IN BOSTON

steel, turned at the end sills and bolted to them. The end sills are 4¾ ins. x 6⅞ ins., and the center and intermediate posts 3½ ins. x 5⅞ ins. The crown pieces are 2¼ ins. x 18 ins. The platforms are 5 ft. long, and are provided with a dash extending around one side. The four platform timbers are 8 ins. deep, and the outside timbers are reinforced with angle-iron. A somewhat novel feature has been introduced in the platforms by fastening on the top of the regular platform flooring wooden strips 2 ins. wide, with ½ in. space between them. These strips are similar to those used in the inside of the car but are run crossways instead of longitudinally. The object is to drain the water from the platforms, and they certainly make a very dry and clean looking platform. The cars, which weigh 21,760 lbs. without passengers and motors, are mounted on maximum traction trucks and are fitted with portable vestibules. The end door is set slightly to the side nearest to the step, so as to make the interior easy of access and exit.

The standard twelve-bench open car of the company has the following dimensions: Length over crown pieces, 38 ft. 9 ins.; distance from center of corner posts over crown pieces, 3 ft. 8 ins.; width over sills, 7 ft. 5 ins.; width over posts at belt rail, 7 ft. 10 ins. The side sills are 4¾ ins. x 7 ins., and are plated with ⅝-in. x 9-in. steel; the crown pieces are 2¾ ins. x 12 ins., and the cross joints are 3½ ins. x 6¼ ins. This car is fitted with a 9-in. running board with folding step irons. The top of



STANDARD CLOSED CAR USED IN BOSTON

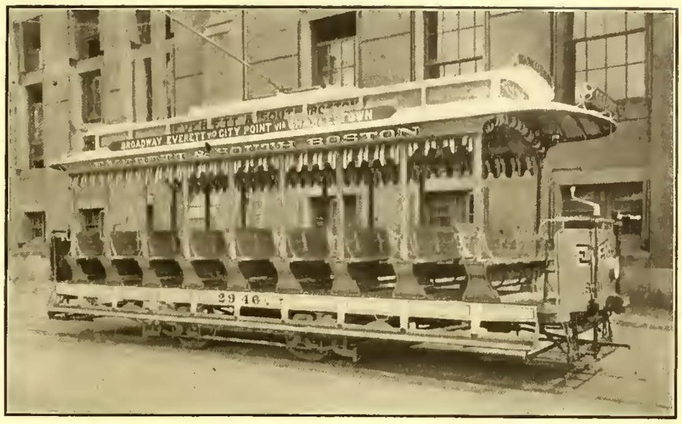
the running board from the rail head is 18½ ins., and the distance from the step to the following is 16 ins. These cars are also mounted on Eureka maximum traction trucks, and weigh without passengers and motors 23,100 lbs.

BOSTON ELEVATED RAILWAY COMPANY

The standard closed car of the Boston Elevated Railway Company is one having a 25-ft. body, with platforms about 4 ft. long. The width at the sills is 6 ft. 8 ins., and the width at the belt rail 7 ft. 6 ins., curved panels being used. The step is 16 ins. from the rail. The step is 13 ins. below the platform and the platform 7 ins. below the car floor. This car seats thirty-four passengers on longitudinal seats. It weighs 24,660 lbs., complete, without passengers. A number of maximum traction trucks are used, although the more recent practice is toward center swivel double trucks. For summer use the standard is a twelve-bench open car, which is approximately the same size as the standard closed car. The dimensions of all

STANDARD TWELVE-BENCH OPEN CAR USED IN BOSTON these cars can be seen on the accompanying table. These open cars weigh a little less than the closed cars, but in general they correspond very closely to the closed cars. There is also a standard nine-bench open car on single trucks, the dimensions of which are given in the table.

The Boston Elevated, like many others, does not attempt to operate the same type of car on every route, as some forms of car are better suited to certain classes of traffic than others. The company, however, does aim to standardize the equipment operated from each large car house, and carries this to a point where, as a rule, each car house is supplied with car equipments, such as trucks, motors, etc., of the same make. The practical advantages of this plan in the way of a minimum quantity of repair and renewal parts, etc., are apparent. The standard cars referred to above are those which, on the whole, have proved themselves best suited to the traffic conditions in Boston.

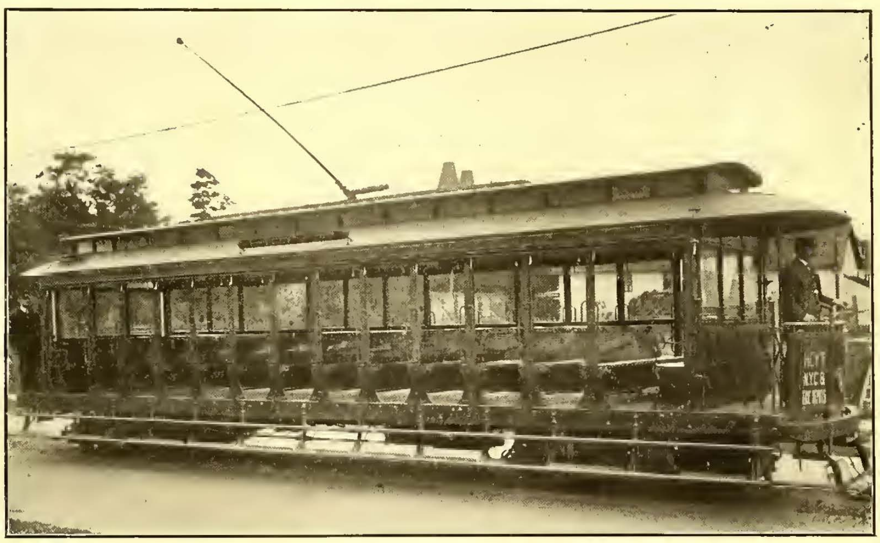


STANDARD NINE-BENCH OPEN CAR USED IN BOSTON

STANDARD CLOSED CAR USED IN BUFFALO FOR CITY SERVICE

BUFFALO RAILWAY

The standard closed car of the Buffalo Railway, which is now part of the International Traction Company, is a double-truck car with a 30-ft. 6-in. body and a length over all of 40 ft. 8 ins. The platforms are 4 ft. 3 ins. These cars weigh 29,180 lbs. without motors and 40,180 lbs. with motors. They have side seats, with a seating capacity of forty passengers. The latest practice is to equip these with air brakes. A number of electric brakes are in use at Buffalo, also. The company has a separate equipment for summer use. The standard summer car is on double trucks, and has a length of 42 ft. 11 ins., seating eighty-four passengers on fourteen benches. These cars are equipped with four motors each, and weigh 27,424 lbs. without motors, or somewhat less than the closed cars.



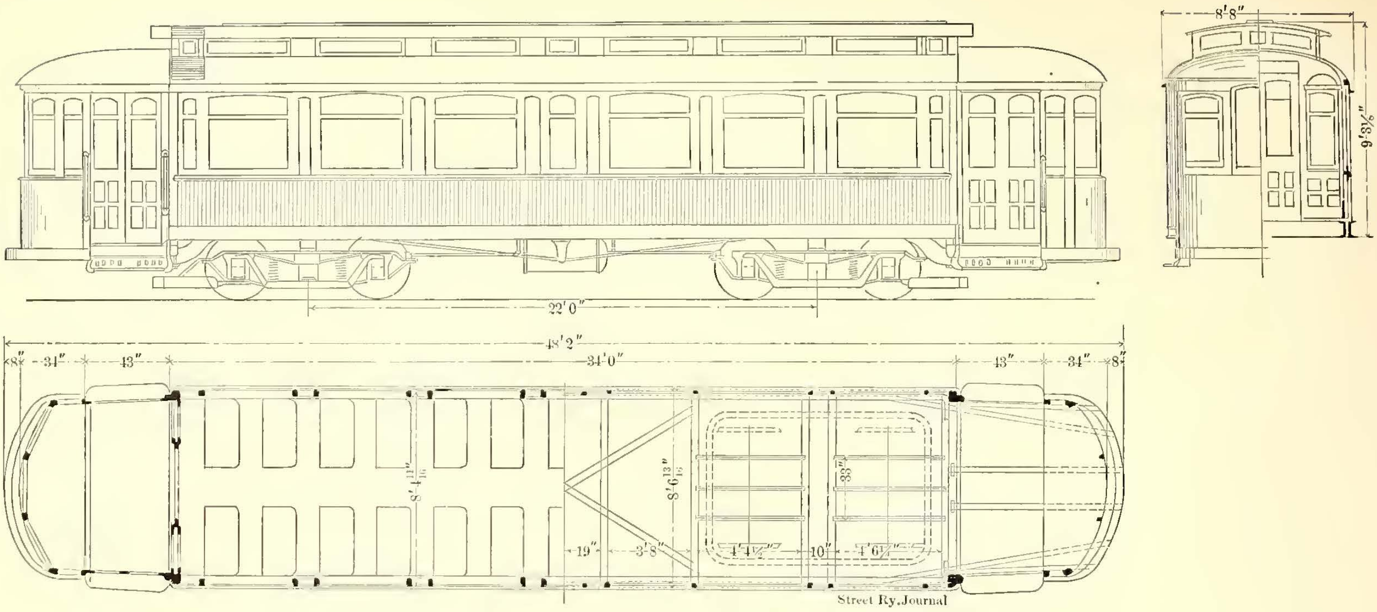
STANDARD FOURTEEN-BENCH OPEN CAR USED IN BUFFALO

CHICAGO CITY RAILWAY COMPANY

The Chicago City Railway Company has begun to equip its lines with a semi-convertible car which has attracted considerable attention the country over. This car is probably the most expensive of any of the cars enumerated in this list of standard city cars, on account of its size, weight and interior finish. It is, as can be seen, the heaviest car on the list, weighing, empty, about 48,000 lbs. It represents the extreme of the present tendency toward long, heavy cars.

The car body is 34 ft. long, length over all 48 ft. 2 ins., the platform being 6 ft. 5 ins. In order to get plenty of room in the center aisle between the cross seats which are used, the car bodies have been made very wide, as local conditions permitted this. This width of the car bodies, together with the fact that the backs of the seats are made narrower than the bottoms, gives a comparatively wide aisle, much better suited to carrying a standing load during

STANDARD SEMI-CONVERTIBLE CAR USED BY THE CHICAGO CITY RAILWAY



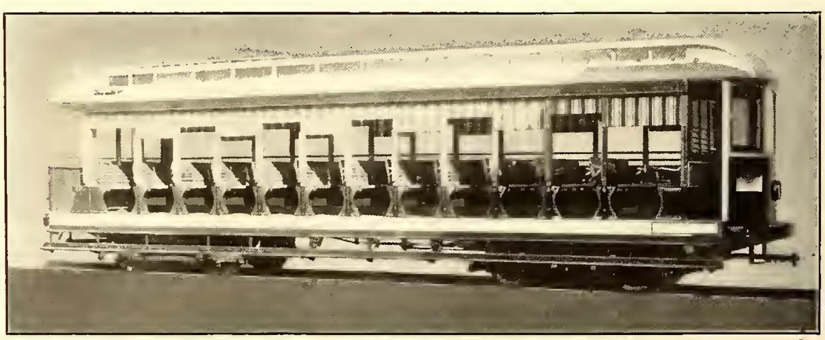
PLAN AND ELEVATIONS, SEMI-CONVERTIBLE CAR—CHICAGO CITY RAILWAY

rush hours than the majority of aisles to be found in cross seat cars.

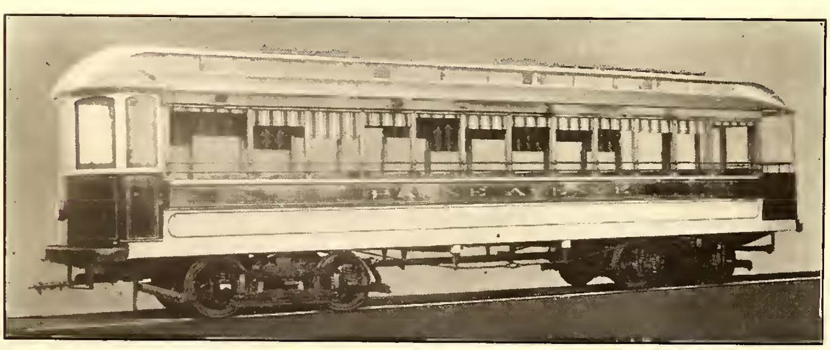
STANDARD CLOSED CAR USED IN CLEVELAND

These cars have double channel iron sills under each side of sufficient strength, so that no other longitudinal sills are needed, which gives a clear space for the trucks and the car bottom, which permits of a low-hanging car body. This, together with a 10-in. rise from the platform to the car floor, makes but a single step between the street and the platform. The Chicago City Railway has been putting on a large number of these new cars, and they have proved so popular that it is probable they will be used in great numbers in the reconstruction of Chicago street railways, which is soon to come about. This is the type of car recommended in the report of B. J. Arnold on the Chicago transportation problem. The St. Louis & Suburban Railway also uses a large number of this type. It is a semi-convertible car, adapted for use in both summer and winter. The sashes lower into the space between the sheathing and the inner wall.

In order to permit a low window-sill, which is desirable with a semi-convertible car, there is a space between the two channel irons which form each side sill, and the lower part of the sash when the window is down occupies this space. Both platforms are long, and the long, low step, together with the wide aisle, makes the car one which discharges and receives passengers quickly. The opening at each end has double sliding doors, and is the full width of the aisle when both doors are open. The doors are independent of each other, however, so that one door can be opened without disturbing its mate. For the exit of one passenger it is not necessary to open both doors, but at transfer points both doors can be opened and passengers can enter or leave the car two abreast.



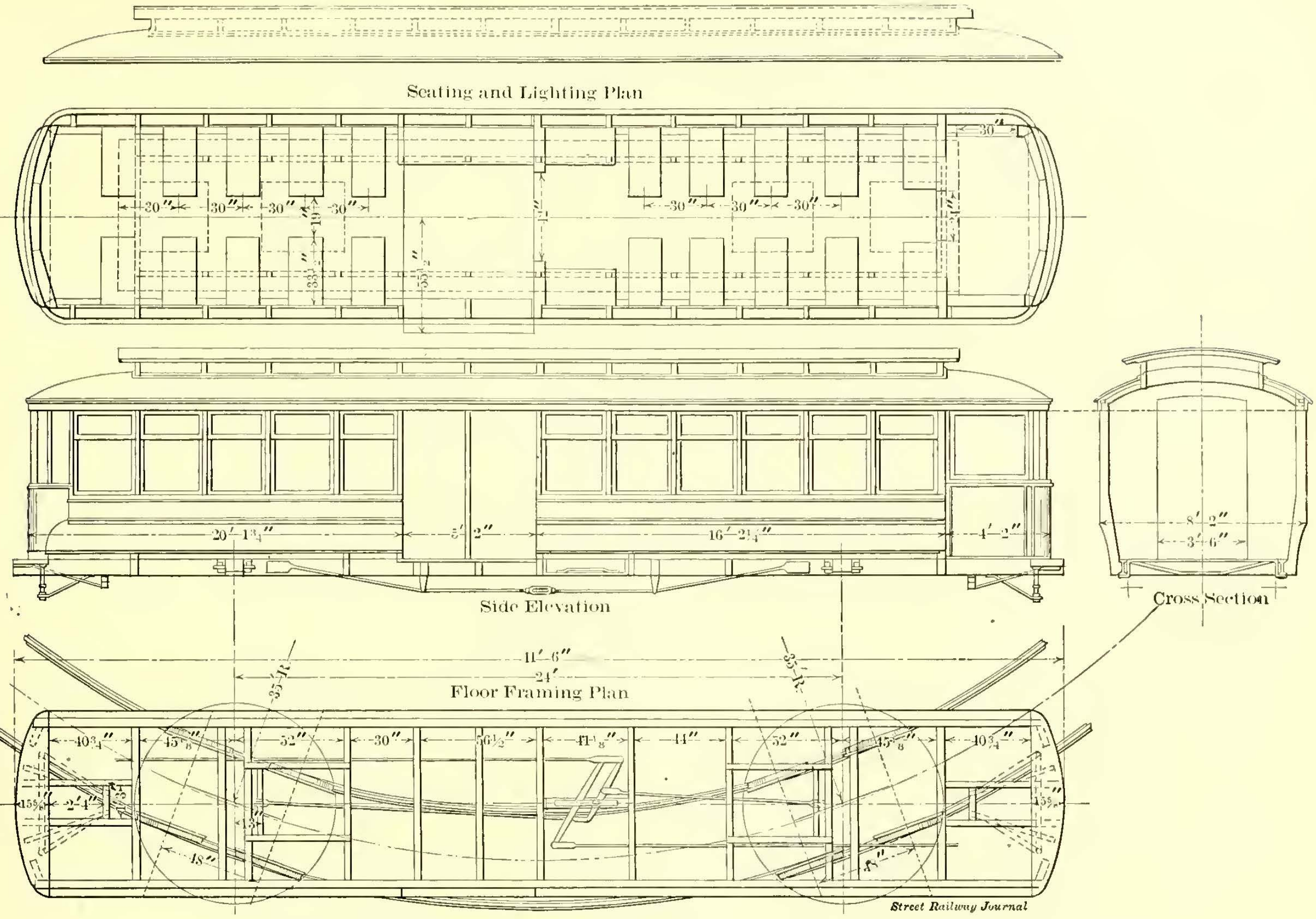
STANDARD FOURTEEN-BENCH OPEN CAR USED IN CLEVELAND



STANDARD FOURTEEN-BENCH OPEN CAR, INSIDE CLOSED PANEL, USED IN CLEVELAND

CLEVELAND ELECTRIC RAILWAY COMPANY

The Cleveland Electric Railway Company in its last orders specified longitudinal seat cars, 43 ft. over all, with 30-ft. body, for use on double trucks. The weight is 28,000 lbs. Hand brakes are used. The rear platform is 6 ft. long, and of the Detroit type, with a space separated by a railing from the entrance, to accommodate a large standing load on the rear platform. The front platform is kept closed at all times, and is 5 ft. long. On this car

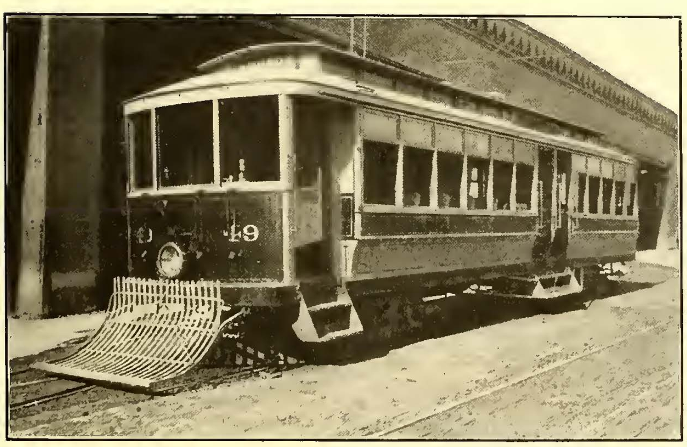


PLAN AND SIDE ELEVATION OF COMBINATION CAR USED IN DENVER

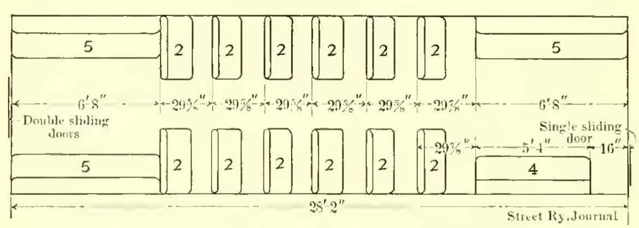
two steps are required to get to the platform, these steps being 17 ins. and 13 ins. in height, respectively. There is a rise of 8 ins. from the platform to the car floor. This is a car suited only for winter use. For summer, fourteen-bench open cars are used. These are about the size of the Buffalo cars, seating eighty-four passengers. They are somewhat heavier, weighing 40,000 lbs. They are equipped with hand brakes. Two steps are required.

DENVER CITY TRAMWAY COMPANY

At Denver an entirely different car is found from that used in the Eastern and Central States. It could be called a compromise between the closed car of the East and the combination car of the Pacific coast. In dimensions it corresponds very closely to the other larger cars in use over the country. It has no rear platform, and nothing which could possibly be called such, although there is a space at the rear of the car which corresponds to a platform. The passenger entrance is at the side. The forward part of the car is a closed body for non-smokers. It is equipped with cross seats, and can be converted into an open car in summer by lowering the windows. The rear of the car is provided with similar windows, but is designed to be used more as an open compartment than is the front compartment. The entrance being at the side between the two compartments, loading and unloading is easier than if there was



STANDARD COMBINATION CAR USED IN DENVER

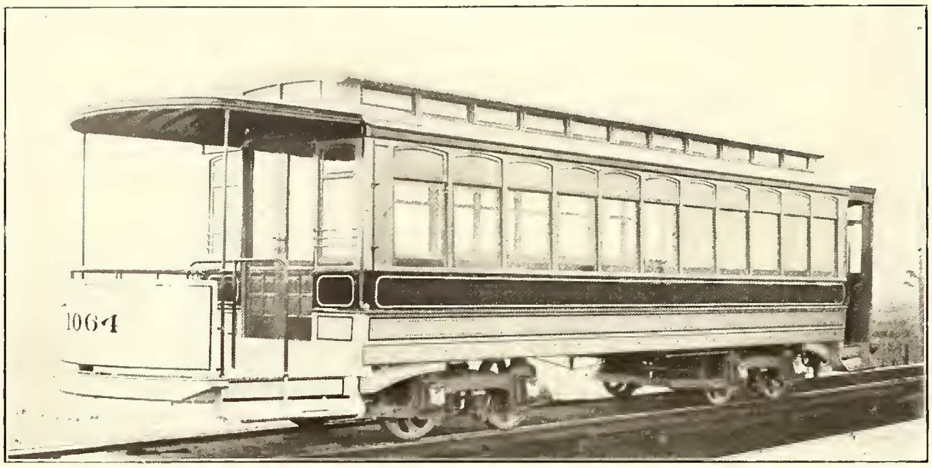


SEATING ARRANGEMENT OF DETROIT CAR

only an exit at the rear platform, though, of course, the conditions in this respect are practically equivalent to what they would be in a car with both front and rear platforms open. There is this in its favor, however, that the side entrance is more easily watched by the conductor, and, further, it is not likely to be crowded with standing passengers, as a platform would be. It is not a place where people naturally desire to stand, as they would on a platform at front or rear. The Denver car certainly has many points to recommend it, especially for a climate like that of Denver, which is of a character between that of the Eastern and Central States, where there is great variation in temperature, and that of the Pacific coast, where the temperature varies so little. This car serves admirably as a summer car, and yet affords protection during the brief sharp cold spells which sometimes occur in Denver.

DETROIT UNITED RAILWAY

The Detroit United Railway Company, on its city lines, has in the past operated mainly single-truck cars of the old-style open and closed types. Recently large orders placed by it have been for the semi-convertible type of car, with center aisle and cross seats, which can be used summer and winter. These cars are mounted on double trucks of $4\frac{1}{2}$ ft. wheel base. The bodies are 28 ft. 2 ins. long; the length over all, 41 ft. The seating capacity is forty-three. The majority of the seats are cross seats, though at each end of the car are longitudinal seats, to give more room around the entrance. The front platform is 5 ft. 6 ins. long, and has a compartment for the motorman and a hot-air heater separate from the passenger entrance. Passengers can enter and leave by the front platform without in any way disturbing the motorman. The rear platform is 6 ft. 6 ins. long, and, of course, is of the Detroit type, with provision for a large standing load, and a passenger entrance partitioned off from the balance of the platform by a railing.



STANDARD SEMI-CONVERTIBLE CAR USED IN DETROIT

INDIANAPOLIS TRACTION & TERMINAL COMPANY

The Indianapolis Traction & Terminal Company has recently made extensive additions to its rolling stock in the shape of double-truck cars suited for both summer and winter use. It can hardly be said, however, that this company is working entirely in the direction of the semi-convertible car, since the open car is used to such a great extent for extra heavy traffic during the summer, that it is a question whether it will ever be entirely superseded by the semi-convertible type. The double-truck semi-convertible cars, one of which is illustrated herewith, has a length of body of 32 ft.; length over all, 45 ft. The rear has a 6-ft. Detroit type platform. At the forward end is a motorman's cab, which is closed off so that passengers can enter the car by the forward platform without interfering with the motorman.

STANDARD SEMI-CONVERTIBLE CAR USED IN MILWAUKEE

The car is of large seating capacity, accommodating fifty-two passengers. A Baker hot-water heater is placed in the motorman's cab. Part of the seats are longitudinal and the balance cross seats. As seen from the engraving, the Indianapolis car has straight sides and sheet steel panels. This is the only company among those enumerated in this article that is now using sheet steel panels in place of wood. The general arrangement of the platforms is similar to that of the Detroit car, which has been heretofore illustrated. Air brakes are employed. Other dimensions and particulars of this car can be obtained from the table. The company also employs a large number of open cars on single trucks. These have a length of 34 ft. 5 ins. over all. They have twelve benches and seat sixty persons. The other dimensions are obtainable from the table.

THE MILWAUKEE ELECTRIC RAILWAY & LIGHT COMPANY

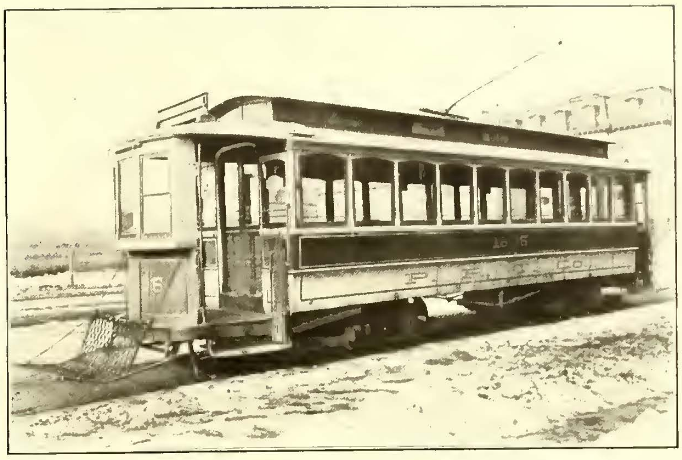
The Milwaukee Electric Railway & Light Company about seven years ago adopted a standard car for use the year round,

STANDARD SEMI-CONVERTIBLE CAR USED IN INDIANAPOLIS

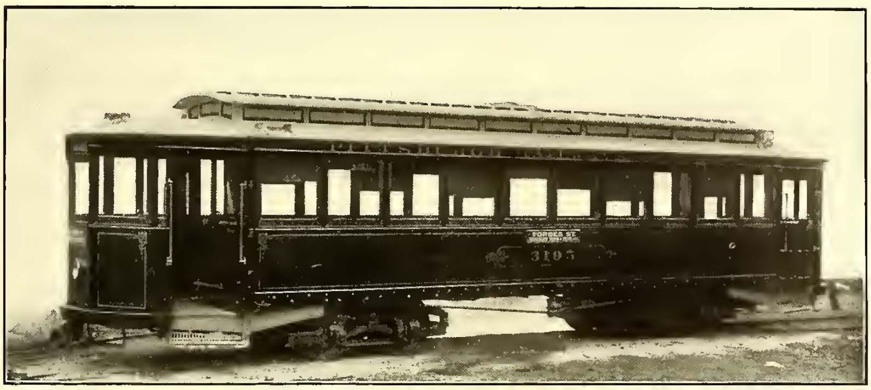
and this car, with improvements in details with each successive new order, has remained the standard ever since. It is probably true that no other company in the United States has maintained so nearly a standard car for so long a period of time, and it speaks well for the wisdom shown in the selection of a car in the first place that so few changes have been found necessary. Of course slight improvements are made in each new order. The car is simply a carefully designed type of semi-convertible car, of the style here illustrated. Some small improvements have been made over the car shown. The car was first equipped with two motors, but about six years ago the use of four motors was begun, this being the pioneer company to adopt four motors for city service. This practice has been continued ever since. The car seats forty-four passengers, all the seats being cross seats, except that there is a longitudinal seat in each corner of the car.

There is one step between the ground and platform, and a rise from the platform to the car. This, when first introduced, was somewhat of an innovation, as previous to the time this car was designed cars on center-swivel trucks which would accommodate four motors on 33-in. wheels and have the platform low enough so that there was no need of more than one step between the platform and the ground were almost unknown. The use of four motors with a low car floor was made possible by a skillful design of the car sills and platform, together with the design of an M. C. B. type of truck, which had a low frame, and which would permit of as low car sills as the wheels would clear. An M. C. B. truck so designed that the frame would not be higher than the wheels was developed for use at Milwaukee, and has since found favor in other places, notably under the Chicago car, before illustrated.

The latest order of city cars for Milwaukee will have 29-ft. bodies, and will be 41 ft. long over the bumpers. The platforms are 5 ft. long. The width of the car body at the belt rail is 8 ft. 5 ins. The new cars will differ from the car illustrated herewith by having the window-sills 4 ins. lower. Double side sills will be used to allow the sashes to be lowered between them. This will make the car more nearly an open car when the windows are lowered in summer. Owing to the narrow bridges in Milwaukee, it is necessary to put wire netting at each window in the summer when the windows are open. Although this general type of semi-convertible car was first used in large numbers on maximum traction trucks at St. Louis, it was first used with four motors at Milwaukee, and was there first introduced in large numbers as a uniform standard car. The influence of the practice in both of these cities as regards the adoption of the semi-convertible type of car has been considerable.



STANDARD SEMI-CONVERTIBLE CAR USED IN PHILADELPHIA

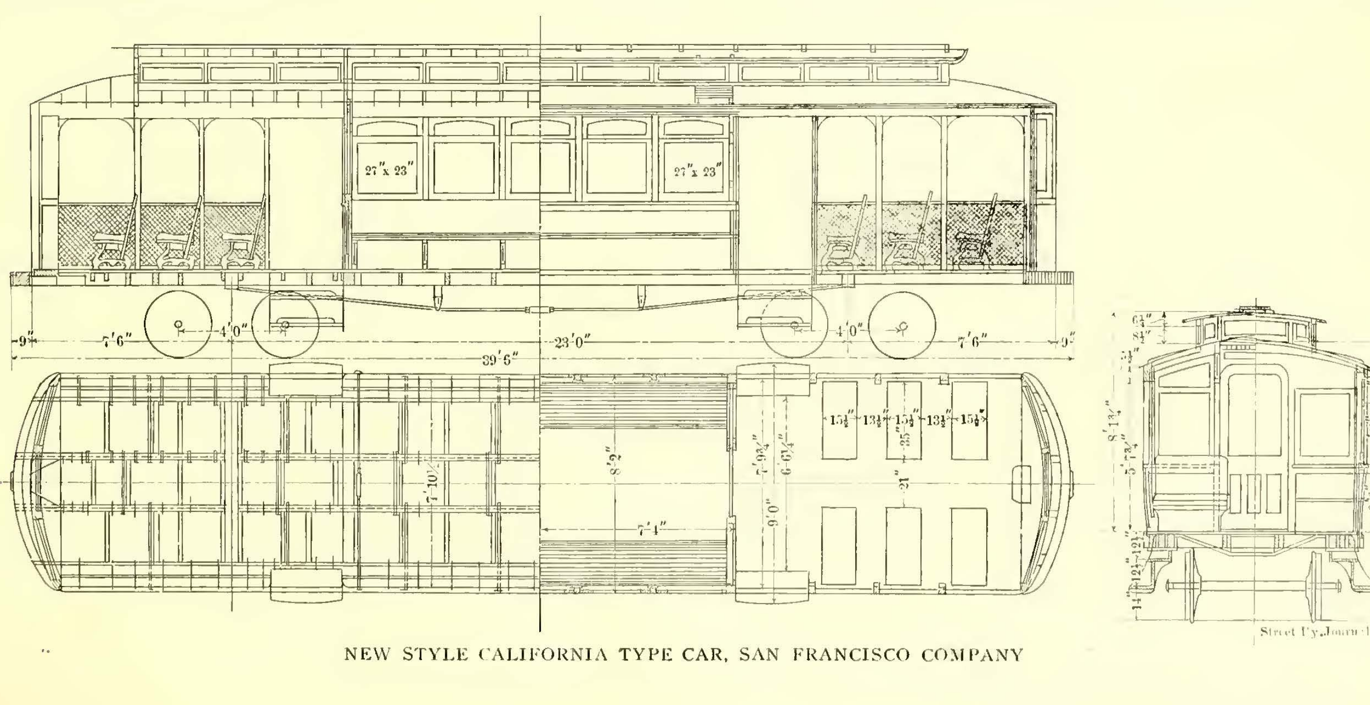


STANDARD DOUBLE-TRUCK CLOSED CAR USED IN PITTSBURG

TWIN CITY RAPID TRANSIT COMPANY, MINNEAPOLIS AND ST. PAUL

The Twin City Rapid Transit Company, operating all the lines in Minneapolis and St. Paul, is another company which has come to the semi-convertible car as the most satisfactory type for general city use. It also has a number of open cars which are brought into service for the extra heavy traffic to parks and other resorts in the summer. For general city service, however, the company has gradually been working toward a car which is reasonably well adapted to all seasons. The Twin City car approaches more closely an interurban car than the majority of city cars included in this list. The car floor is high, and requires two 18-in. steps and a 5-in. riser from the platform to the car. As to seat-capacity, the car is equal to the Chicago and Indianapolis cars, which seat fifty-two. The front part of the car has cross seats, there being fourteen of these. The rear part of the car has side seats, to facilitate entrance and exit.

One notable feature about these cars is the solid double floor. There are no openings nor trap-doors with which to get at the

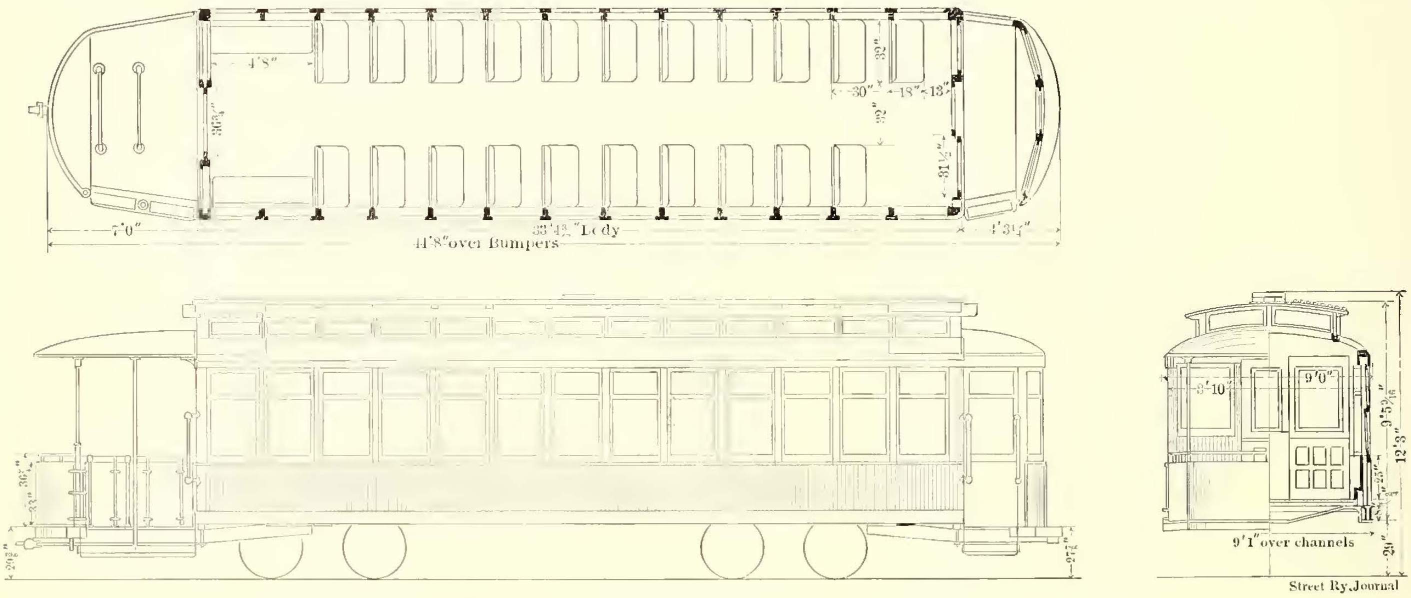


NEW STYLE CALIFORNIA TYPE CAR, SAN FRANCISCO COMPANY motors. All the work on motors is done from the pit, or by taking the trucks out from under the bodies. The double floor is mainly for the object of warmth in winter. The cars have double windows in winter, and are heated with hot water, so that in spite of the cold climate, they are very much more comfortable vehicles than are to be found in some of the cities where the winters are not so severe. The standard open cars mentioned have center aisles, and are entered by the rear platform, just as a closed car would be. The sides are permanently closed with wire netting. All the Minneapolis cars have the Minneapolis gate, which is opened and closed by the motorman for the entrance and exit of passengers. This gate is kept closed at all times, except when the car is standing still. All these cars are equipped with straight air brakes. The weight of the semi-convertible or closed car is 43,000 lbs., and that of the open car, 26,500. The former is equipped with four motors and center-swivel trucks, and the latter with two motors, and with maximum traction trucks. The seating capacity of both is the same, being fifty-two persons.

STANDARD COMBINATION CAR USED IN SAN FRANCISCO

PHILADELPHIA RAPID TRANSIT COMPANY

The recently adopted standard car for the Philadelphia Rapid Transit Company is a semi-convertible car, 38 ft. over all, with 28-ft. body. The company in Philadelphia was one of the first of the Eastern companies to come to the semi-convertible type, although it is the last company on the list to make the change from the ordinary closed type with longitudinal seats. The Philadelphia car is somewhat in the nature of a compromise between the large cars of Minneapolis and Chicago and the shorter cars of Buffalo and Boston. The platforms are of moderate length, being 4½ ft. The car bodies are low enough so that but one 13-in. step is needed to reach the platform, with an 8-in. rise from platform to car floor. This car seats forty passengers, and weighs, without load, about 32,000 lbs.



PLAN OF STANDARD SEMI-CONVERTIBLE CAR—ST. LOUIS TRANSIT COMPANY

TABLE SHOWING PRINCIPAL DIMENSIONS OF STANDARD OPEN AND

Number	City and Name of Company	Closed and Semi-Convertible Cars									
		Single, Double or Maximum Traction Trucks	Length of Body	Length Over All	Length of Platforms	Width of Car Body at Sills	Width of Car Body at Belt Rail	Height Side Top Rail from Floor	Height of Step from Rail	Height from Step to Platform	H'ght Riser from Platf'm to Car Floor
1	Baltimore—United Rys. & Electric Co	M. T.	28 ft.	38 ft.	5 ft.	7 ft. 6 in.	7 ft. 10 in.	6 ft. ⅛ in.	15 in.	13½ in.	7¾ in
2	Boston Elevated Railway Co	M.T. and double	25 ft.	33 ft. 3 in.	4 ft.	6 ft. 8 in.	7 ft. 6 in.	5 ft. 7 in.	16 in.	13 in.	7 in.
3	Buffalo Railway Co	Double	30 ft. 6 in.	40 ft. 8 in.	4 ft. 3 in.	7 ft. 8½ in.	8 ft. 2 in.	6 ft.	16 in.	13¼ in.	8 in.
4	Chicago City Railway Co	Double	34 ft.	48 ft. 2 in.	6 ft. 5 in.	8 ft. 8 in.	8 ft. 8 in.	5 ft. 8 in.	16 in.	12 in.	10 in.
5	Cleveland Electric Railway Co	Double	30 ft.	43 ft.	5 ft. and 6 ft.	6 ft. 6 in.	8 ft. 2 in.	6 ft. ⅛ in.	17 in.	2 steps 17 and 13 in.	8 in.
6	Denver City Tramway Co	Double	36 ft. 4 in.	41 ft. 6 in.	Side entr. 5 ft. 2 in.	7 ft. 3½ in.	8 ft. 2 in.	6 ft.	14½ in.	2 steps 11 and 12 in.	3½ in
7	Detroit—United Railway Co	Double	28 ft. 2 in.	41 ft.	6 f. 6 in. 5 f. 6 in	8 ft. 1 in.	8 ft. 1 in.	--------	14⅝ in.	13½ in.	10 in.
8	Indianapolis Traction & Terminal Co.	Double	32 ft.	45 ft.	6 ft.	8 ft. 4 in.	8 ft. 7 in.	6 ft.	17 in.	12 in.	9 in.
9	Milwaukee Electric Railway & Light Co	Double	29 ft.	41 ft.	5 ft.	8 ft. 1 in.	8 ft. 5 in.	-------	------	----------	-----
10	Minneapolis—Twin City Rap. Tran. Co.	Double	33 ft. 1 in.	45 ft. 2½ in.	5 ft. 3 in.	8 ft. 5⅞ in.	8 ft. 5⅞ in.	5 ft. 10¾ in.	16 in.	2 steps 18 in.	5 in.
11	Philadelphia Rapid Transit Co	Double	28 ft.	38 ft.	4 ft. 6 in.	7 ft. 9½ in.	8 ft. 3 in.	5 ft. 10 in.	15⅞ in.	13 in.	8 in.
12	Pittsburg Rys. Co.	Single	19 ft. 11 in.	30 ft.	4 ft. 5 in.	6 ft. 7½ in.	7 ft. 2 in.	5 ft. 9½ in.	16 in.	12 in.	8 in.
		Double	30 ft.	42 ft. 8 in.	5 ft. 6 in.	8 ft. 6 in.	8 ft. 6 in.	5 ft. 10 in.	15 in.	13 in.	10 in.
13	San Francisco—United Railroads	Double	California type 38 ft.	39 ft. 6 in.	Two side entrances, 2 ft. 8 in.	8 ft. 2 in.	8 ft. 2 in.	5 ft. 7¾ in.	14 in.	2 steps of 12½ in.	None
14	St. Louis Transit Co	Double	33 ft. 4¾ in.	44 ft. 8 in.	3 ft. 6¼ in. & 7 ft	9 ft. 1 in.	9 ft.	6 ft.	14¾ in.	13 in.	13 in.

PITTSBURG RAILWAYS COMPANY

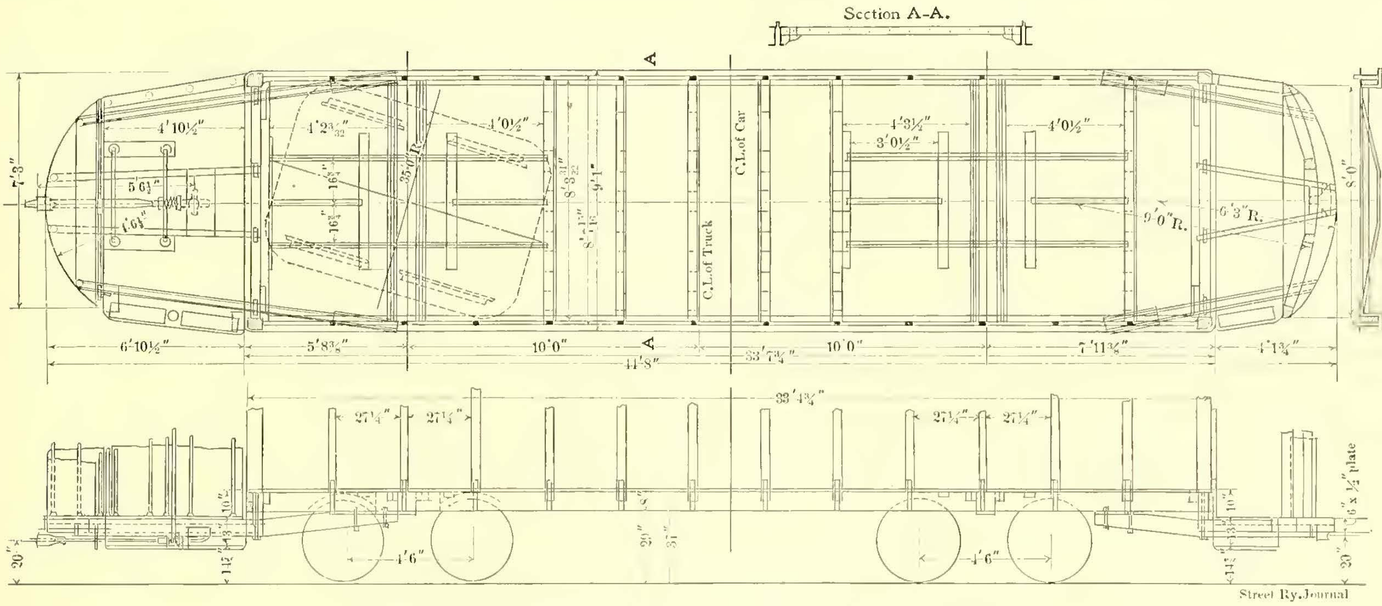
This company has three standard types of cars, viz., a single and a double-truck closed car and a single-truck open car. With the latter an open trailer is usually run. The company does not have any double-truck open cars, as the width of the streets through which the cars run does not permit of their use.

The most recent cars ordered by the Pittsburg Railways Company are double-truck cars, 42 ft. 8 ins. over all, with 30-ft. bodies. They have side seats and are very wide, being 8 ft. 6 ins. at the sills. They have long straight sides. A Westinghouse magnetic brake is used on these cars.

The single-truck closed cars have a body length of 19 ft. 11 ins., and a length over all of 30 ft. They are considerably narrower than the double-truck cars, being only 6 ft. 7½ ins. wide at sills and 7 ft. 2 ins. wide at the belt rail. Both single and double-truck closed cars are fitted with longitudinal seats. The single-truck open cars are 24 ft. 3 ins. over all, 7 ft. 10 ins. wide and have eleven benches.

UNITED RAILROADS OF SAN FRANCISCO

In San Francisco the United Railroads have retained the California type of combination car, which is so generally in use on the coast. The older type of car had longitudinal seats facing outward on the open parts of the car at either end. On the new cars the seats on the open part will be cross seats with center aisles, an arrangement made feasible by the adoption of air brakes in place of the long lever hand brake which is used on the older cars for regular service stops. Owing to the grades of San Francisco, both track and wheel brakes are put on all cars. The new car is 39½ ft. over all. The entrances are at the side, as indicated on the plan on page 353. The closed part of the car has side seats. The seating capacity is forty-four, and the weight, without passengers, 33,500 lbs.



PLAN OF BOTTOM FRAMING, ST. LOUIS TRANSIT COMPANY

ST. LOUIS TRANSIT COMPANY

As St. Louis was the original battle ground of the semi-convertible car, in fact, a city where in former days, before consolidation, when competition was strong between the lines, there was an extensive trial of dozens of different styles of cars, the final result of the evolution is interesting. It might almost be said that all of the street railway systems of St. Louis were equipped with semi-convertible cars before the majority of the large city roads in the United States had begun to realize that such a car was anywhere near feasible for heavy city traffic. There was a theory at one time that a car with cross seats and a narrow center aisle could never by any possibility be a success for heavy city traffic. Nevertheless, the hot competition between rival companies in St. Louis previous to the consolidation of a majority of these companies caused the various managements to seek anything in the way of rolling stock that would

CLOSED CARS USED IN FIFTEEN LARGE CITIES IN THE UNITED STATES

Closed and Semi-Convertible Cars.				Open Cars										
Cross or Side Seats	Seating Capacity	W'ght Complete Without Pass'g's	Kind of Brakes	Single, Double or Maximum Traction Trucks	Length Over All	Width Over All	Height Side Top Rail from Floor	Height Running Board from Rail	Height from Running Board to Floor	Number of Benches	Seating Capacity	W'ght Complete Without Pass'g's	Kind of Brakes	Number
Side	46	i21,760	Hand	M. T.	38 ft. 9 in.	7 ft. 10 in.	6 ft. 1 in.	18½ in.	16 in.	12	60	i23,100	Hand	1
Side	34	24,660	Hand	Single. M. T. and double	29 ft. 4 in. 34 ft. 2 in.	7 ft. 6 in. 7 ft. 6 in.	5 ft. 5 in. 5 ft. 5 in.	19½ in. 19½ in.	15½ in. 16 in.	9 12	45 60	15,080 22,073	Hand Hand	2
Side	40	40,180	Straight Air	Double	42 ft. 11 in.	8 ft. 9½ in.	5 ft. 7 in.	§12¾ in.	§12 in.	14	84	34,924	Air & hand	3
Cross	52	48,000	Air	*	*	*	*	*	*	*	*	*	*	4
Side	34	28,000	Hand	Double	43 ft.	8 ft. 2 in.	6 ft. 1 in.	2 steps 13⅝ in.	12 in.	14	84	40,000	Hand	5
Cross	48	34.000	Straight Air	*	*	*	*	*	*	*	*	*	*	6
Side and cross	43	------	Storage Air.	*	*	*	*	*	*	*	*	*	*	7
Side and cross	52	32,000	Air	† Single	† 34 ft. 5 in.	†7 ft. 10 in.	†5 ft. 8 in.	†18 in.	†16 in.	†12	†60	†18,000	† Hand	8
Cross	44	------	Hand	*	*	*	*	*	*	*	*	*	*	9
Side & 14 cross	52	43,000	Straight Air	M. T.	‡41 ft. 6¾ in.	‡8 ft. 3⅛ in.	‡5 ft. 7½ in.	------	------	‡26	‡52	‡26,500	‡ Hand	10
Cross	40	32,000	Straight Air	*	*	*	*	*	*	*	*	*	*	11
Side Side	30 50	i17,100 i32,600	---------- Magnetic	Single Double	24 ft. 3 in. 34 ft. 2 in.	7 ft. 10 in. 7 ft. 10 in.	-------- --------	17½ in. ------	16 in. ------	11 11	55 --	---- ----	Magnetic	12
Cross outside Side inside	44	33,500	Straight Air wheel and track	*	*	*	*	*	*	*	*	*	*	13
Cross	50	40,000	Storage air	*	*	*	*	*	*	*	*	*	*	14

* Same cars summer and winter. † The long closed semi-convertible car is also used in summer. ‡ Also uses semi-convertible car in summer. § Two 12-in. steps
i Weight without motors.

increase the popularity of the road. It was discovered that long, double-truck cars, or what is now called the semi-convertible type, were extremely popular, and once the use of these was introduced, various companies were forced by competition to adopt them. However, it should not be considered that, until the present, there was anything like a standard type of car in use in St. Louis, though many varieties of the same general type were in use in large numbers. The recent large order placed by the St. Louis Transit Company for new equipment, preparatory to handling World's Fair traffic, has necessarily settled what is to be the standard car of the St. Louis Transit Company for some time to come. This is a car, 44 ft. 8 ins. over all, with body 33 ft. 4 ins. long. The seating capacity is fifty persons. It is of the semi-convertible type, adapted for use the year round. It has cross seats 32 ins. wide, except that there are two side seats at the rear end. The cars are mounted on center-swivel short wheel base trucks, with two motors on each truck. The width of the car is practically 9 ft., being about the same at the sills as at the belt rail. These cars also have the channel bottom construction, whereby channel irons act as side sills, and form the principal support of the car bottom. The front platforms are 3½ ft. long, and are intended only for the motorman, and for entrance to, and exit from, the car. The rear platform is a modification of the Detroit platform, which has provision for a large standing load, and is worth special attention. It is 7 ft. long, and is divided into three divisions by hand rails. The division next to the door is intended to be kept clear for exit of passengers. The other divisions are for the standing load. The object of the second hand railing is to offer a convenient support to those who are standing on the platform. The railing which divides that part of the platform set aside for the entrance from the balance of the platform has an opening at one point in which the conductor can stand. Some previous railings were simply bent to form a niche at one point, which was intended for the conductor; but the opening in the railing was found better.

GENERAL CONCLUSIONS

Next after the increase in length and weight of cars, which is the most marked present tendency in connection with street railway rolling stock, the increasing popularity of the semi-convertible car is most noticeable. The semi-convertible car has been adopted in Chicago, Denver, Detroit, Indianapolis, Milwaukee, Minneapolis, Philadelphia and St. Louis. The old plan of having closed box cars with longitudinal seats for winter use, and open cars for summer use, is adhered to in Boston, Baltimore, Buffalo, Cleveland and Pittsburg, and as well, it might be added, in New York city, where the combination car is also used to some extent. San Francisco, also, has the combination car, which is a compromise between an open and a closed car, and which is the generally accepted car for use on the Pacific coast. Of the companies enumerated in the table, those at St. Louis and at Milwaukee were the first to extensively use the semi-convertible equipment for both summer and winter. The other companies have only recently made large purchases of this type of car. Going outside of the companies enumerated in the table, it is to be noted that at Kansas City and at New Orleans the semi-convertible car has also been adopted. It might be thought that in an extremely warm climate like that of New Orleans an open car would be the only one feasible. So far is this from being the case, however, that before the semi-convertible car was introduced it was customary to operate closed cars in New Orleans the year round, because of the severe thunder showers which occur so frequently, and which come up so quickly in the summer, and which make open cars very unpleasant. The semi-convertible car was found to be a very happy compromise between an open and a closed car. In northern latitudes, as at Milwaukee and Minneapolis, the early adoption of the semi-convertible car was partially brought about by the fact that there are so few days in the year when an entirely open car is altogether desirable. It was considered better to have a car which would more nearly suit average conditions than the old open and closed equipments.

There are two main reasons which have been responsible for the adoption of the semi-convertible car. One is that the public likes it, and the other is that it offers the companies a means of maintaining both a summer and a winter equipment without the necessity of investment in a double set of car bodies, and the expense of changing from summer to winter equipments. The reasons the public likes the semi-convertible car are, that when closed it is a cross-seat car, which is pleasanter to ride in than the closed longitudinal-seat car; it affords better protection in stormy weather than an open car, and can carry a standing load, which does not as seriously interfere with those occupying seats as would a standing load in a longitudinal-seat car. To be sure, the average semi-convertible car does not give the passenger as great a sense of freedom or of being out in the open air as do most open cars, but this is counter-balanced by the advantages they present in bad weather. There is another point in favor of the semi-convertible car which is not frequently touched upon, but it is one which the passenger appreciates nevertheless, and that is that a passenger can board the car quickly and select a seat at leisure after the car has started without the inconvenience attending the securing of a seat in a well-filled open car. On an ordinary open car, and with the fast schedules and short stops common in large cities, there is likely to be both annoyance to the passenger and delay of the car through failure of the passenger to discover a vacant seat the instant the car stops. The more active passengers will mount the running board and find seats after the car starts, but with women and children this is not feasible, and on some roads is not allowed. Such passengers like a car which is accessible from one end to the other when the car is in motion, without the use of the running board. The ordinary open car may be compared to the compartment passenger cars of England, and the semi-convertible, to the American steam railroad coach. The compartment type of car was at one time considered an improvement over the American elevated railway coaches, because of the facility of loading and unloading through so many doors. Experience demonstrated, however, that considerable time was lost by passengers going from one compartment to another trying to find or decide upon a seat. The same comparison holds between a semi-convertible car and an open car.

This is not intended as an argument for or against the open car, but simply a statement showing the reasons why the semi-convertible car, with some of its drawbacks, is finding increasing use. That it has certain drawbacks, none can deny. When used as a closed car it has not the capacity for a large standing load that an equivalent length of old-style closed car with longitudinal seats would have, and the seating capacity is no greater than that of the longitudinal-seat car of the same length. Compared to an open car, the semi-convertible car has not the seating capacity that an open car of the same length would have. As to freedom from accidents, the semi-convertible car has considerable advantage over the open car with running board. The conductor and motorman can watch the two entrances of a semi-convertible car more closely than they can watch the whole length of the running board on an open car, and there is not the danger that passengers will fall when entering or leaving at the step that there is when entering or leaving by a running board, especially if there is a step in addition to the running board, as is likely to be the case with double-truck open cars.

Assuming that a road is equipped with a sufficient number of semi-convertible cars to handle the maximum load which will occur during the closed car season, what is to be done to provide for the additional loads which usually come during the open-car season? This is a question that is answered by the majority of companies using these cars, by having open cars to bring out for extra summer traffic. Such traffic comes only in pleasant weather, in any event, so that the open car, which incidentally has a large seating capacity per foot of length, is best adapted for this class of work. Companies which have adopted the semi-convertible car are generally retaining the best of their old open cars for use in the summer, especially for summer resort traffic and pleasure riding on hot evenings. In St. Louis a car which is practically without a roof has been extremely popular. This car has an awning, which is commonly rolled up. It seats ninety-six persons, and is much sought after on warm evenings.

Although the present practice in railway work, as shown in this article, is entirely toward long cars, it must not be inferred that railway managers are entirely unanimous in their belief in this type of car for all classes of work. It is undeniable that a sentiment has arisen within the last year or two among several progressive managers toward the use of shorter cars with trailers, the principal object being the resulting reduction in power. Whether this fact will result in the actual introduction and trial of trains of this kind remains to be seen. Such an experiment would certainly be of interest.

Regarding the type of seats used, it seems to be the opinion of many managers that the cross-seat car is for all lines, except those where the greater part of the business is a short-haul traffic, the coming style of all-the-year car. This is evidenced by the quantity of cross-seat cars that are being built at the present time, not only for combination city and suburban service, but also for city street service. Philadelphia is a striking example of the change from longitudinal to cross-seats, and the last 600 cars built for this company have all been made with this style of seat. In St. Louis the experience has been exactly the same, and where this system of cross-seats is employed the semi-convertible car is, of course, particularly adaptable.

Cross-seat cars, with their short centers to the seats, provide greater seating capacity than the longitudinal-seat cars, which is a point in their favor, and, again, passengers can be carried to a very much better degree of satisfaction to themselves than in the case of the longitudinal-seat cars, particularly where the ride is a long one. On the other hand, the cross-seat cars have not the actual carrying capacity of the longitudinal-seat cars.

The objection to the cross-seat, center-aisle car, that the aisles were so narrow that it was difficult for persons to pass in them, has been overcome by increasing the width of the cars whenever this was possible, and by making the backs of the seats 2 ins. narrower than the bottoms.

The increase in the weight of cars during the past few years is somewhat astounding to those who have not paid particular attention to this feature. Not only has the total weight per car increased, but the dead weight per passenger has also increased. On the single-truck motor cars, common eight years ago, the dead weight per passenger averaged about 600 lbs., unless the cars were of unusually heavy construction, or for some local reason were provided with extra heavy motor equipment. On the cars enumerated in the table accompanying this article, the dead weight per passenger for the closed and semi-convertible cars is in the neighborhood of 800 lbs. The Chicago City Railway car weighs over 900 lbs. per passenger. The dead weight, figured on the basis of seating capacity, perhaps is not entirely fair, because the standing room provided on the Chicago City Railway car is considerably more than on other cars which weigh less and seat the same number of passengers. The Chicago car has wide aisles and very long platforms at both ends.

In the matter of platforms, there is even more variety than in the car bodies themselves. The Detroit type of platform is used also in Cleveland, Toledo, Indianapolis and St. Louis, in addition to the city where it originated. In connection with the Detroit type of platform on the rear of the car, a front platform, providing for entrance of passengers and yet having a separate compartment independent of the passenger entrance for the motorman, is commonly used. In Denver the platform as a means of entrance to a car has been done away with entirely, and a side entrance substituted. In San Francisco the side entrance is also used, in connection with the combination car. A side entrance car is also used at Des Moines, Ia. The length of platform, where the Detroit platform is not used, is seldom more than 5 ft., the average being, perhaps, 4 ft. 8½ ins. The opinion of railway managers is not fully in accord in favor of the Detroit platform, particularly in the case of single-truck cars, where it creates in the minds of passengers a wish to stand on the platform instead of in the car. The objection, of course, is that this practice throws the weight at the very worst point, i. e., at the extreme end. On the other hand, the platform is popular because it solves the smoking problem, and also permits those who wish to ride in the open air to do so and make their seats available to others.

Sheet steel panels do not seem to have come into very general use. At Indianapolis and Los Angeles they are the standard construction. The extremely dry climate in Los Angeles during the summer, which causes a shrinkage of wood panels, is responsible for the adoption there. They were formerly used at Detroit, but wood is now employed there instead.

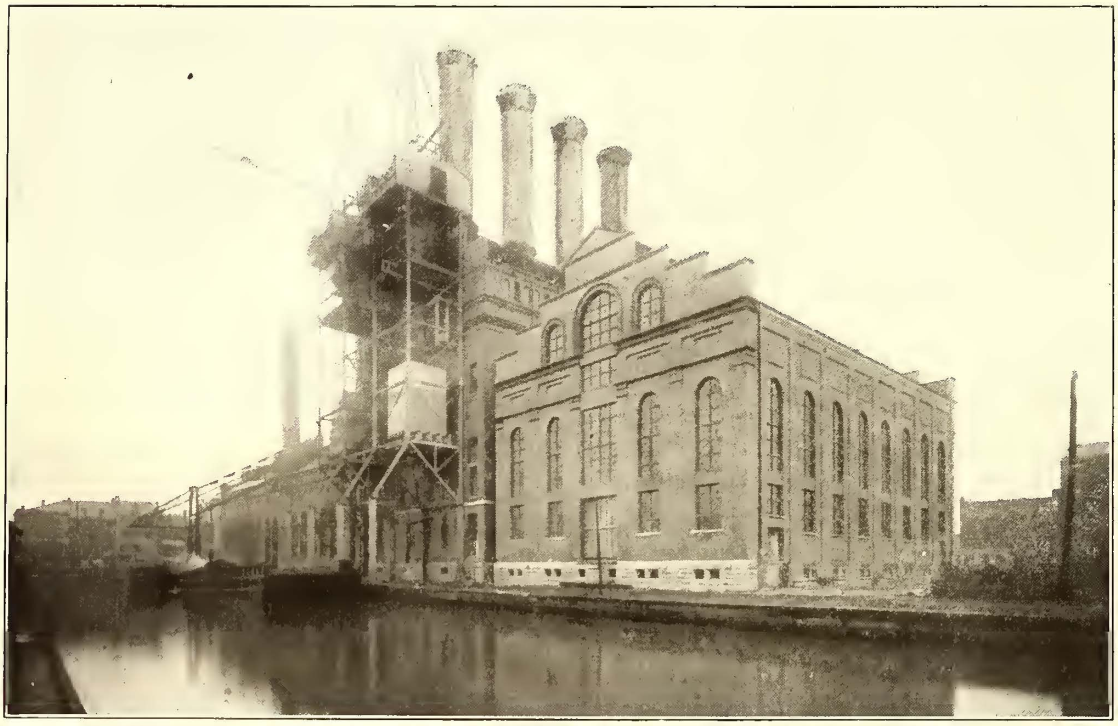
The increase in height of car floor, which necessarily came with the change from single-truck to double-truck cars, has, of course, necessitated more steps to get to the car floor. This has been commonly provided for by having one step between the platform and the street, as formerly, and increasing the height of the step or riser from the platform to the car floor. Some companies, however, have preferred to make two steps from the platform to the ground, bringing the platform nearer the level of the car floor. The height from the rail to the top of floor is, of course, dependent largely upon the style of motor that is used. Where center pivotal trucks with 30-in. wheels are used, perhaps the most general practice is to make the first step from the rail line to the top of the tread measure 16 ins., and the second step to the platform of the car 13½ ins. This allows an 8-in. step out of the car, the distance from the track over the floor being 37½ ins. The distance from the car floor to the top of the platform is usually made 8 ins.

The straight air brake with a motor-driven compressor is the most generally accepted method of braking long heavy cars. One notable exception to this is the St. Louis Transit Company, which is equipping all its cars with straight air brakes, to be supplied from storage tanks, which tanks are filled at compressing plants located at the ends of each route. This will be the first extensive application of the storage air system in a large city. The new Detroit cars use storage air brakes, while in Pittsburg a magnetic track and wheel brake is used.

POWER EQUIPMENT FOR CITY ROADS

THE equipment for supplying power to the majority of the large city railway systems of this country is the result of the gradual growth of the business, and for that reason it is usually not what would be installed if the various companies had begun operation in recent years, after modern methods of electric traction had been evolved. For example, the great electric railway power stations in New York city were planned and erected after electric railway power equipment had undergone about fifteen years of development. Outside of New York city, however, there is practically no place in the country where the electric railway system is of such recent construction. The usual problem before the management of a large street railway company is to make the best of what equipment is already installed, while enlarging the plant along lines which will be in the direction of true progress, and will not involve the entire throwing out of the power equipment after a few years. In order to do this statistics collected from the principal roads of the country show that the usual method of settling the problem has been to retain direct-current power houses and distributing systems for the greater part of the power supplied to the system, and to add alternating-current generators which supply sub-stations feeding more distant portions of the system, and thus make it possible to extend the system in all directions without undue investment in copper or excessive line loss.

City power house equipment in the United States has gone through three stages of development. In the first stage, belted or rope-driven generators were in use. Frequently the stations were run non-condensing with simple engines, and, taken altogether, power-house practice did not make use of all economies, even at that time, available for the production of steam power as cheaply as possible. Frequently these belted stations were poorly located as regards coal and water supply, and also so designed that they could not be readily extended. For these reasons there was an almost entire abandonment of old stations, beginning about ten years ago, when large direct-connected units of from 500 to 2000 kw were coming into use. Some companies were able to utilize the same buildings and land for the new stations, but in many cases these new stations were built on new locations better suited to economical power production. With the building of direct-connected stations favorably situated as regards coal and water supply, came the second stage of electric railway power-house construction. The third stage has been made possible by the introduction of alternating-current distribution at high voltages. Incidentally it has brought with it, in many cases, an enormous increase in the size of power house, because of the large area which any one power house can serve. This, in itself, brought up many new problems, especially as regards the freedom from breakdowns and the isolation of one part of a large generating station from other parts of the same station. Of this latter stage in electric railway construction, the Metropolitan Street Railway power house in New York marked the beginning.



EXTERIOR OF PRATT STREET STATION, BALTIMORE

A fair idea of the general condition of power equipment of a number of the leading American street railway companies may be obtained from the accompanying tables, one of which is a general table, giving the total capacity of stations supplying city lines in kilowatts, the total capacity per mile of track, the total capacity per car operated on maximum schedule, and the kilowatt-hours per car mile for one year. The second table applies especially to the more recent generating stations erected by the various companies. The third table relates to some of

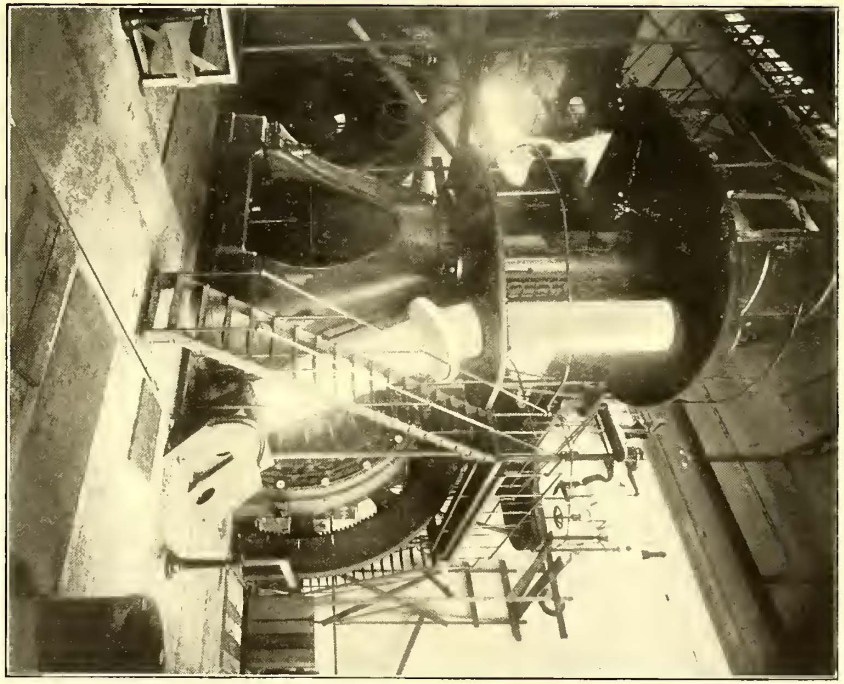
TABLE I.—POWER DATA FROM 14 AMERICAN STREET RAILWAYS

	Total Capacity, all Stations, in Kw	Total Capacity in Kw per Mile of Track	Total Capacity per Car Operated on Maximum Schedule, in Kw	Kw Hours per Car Mile for Year	Remarks
Baltimore—United Rys. & Electric Co	16,879	47.7	28.3	1.7	
Boston Elev. Ry,Co (for surface lines only	29,475	75.	21.8	2.39	See note *
Chicago City Ry	11,580	66.	20.	2.07	¼ equip., 44 ft. cars
Cleveland Electric Ry. Co	19,712	88.	----	2.06	
Denver City Tramway Co	7,000	43.7	31.1	2.10	
Detroit United Ry. Co	11,400	60.	28.	----	
Indianapolis Traction & Terminal Co	5,500	45.	----	1.9	
Milwaukee Electric Ry & Lt. Co	15,000	115.	50.	----	
Minneapolis—Twin City Rap. Trans. Co	----	----	----	2.7	Water & st'm power
Philadelphia Rap. Trans. Co	31,200	65.7	20.	1.66	
Pittsburg Rys. Co	19,200	47.6	----	2.72	
San Francisco—United R. Rs	8,335	45.	23.1	----	
St. Louis Transit Co	29,300	81.	32.5	2.91	Very fast schedule

* Output for surface cars assumed as 80 per cent. of total

the latest large engines. The companies included on this list are the United Railways & Electric Company, of Baltimore; the Boston Elevated Railway Company; the International Railway Company, which controls the Buffalo Railway Company's system; the Chicago City Railway Company, the Cleveland Electric Railway Company, the Denver City Tramway Company, the Detroit United Railway Company, the Indianapolis Traction & Terminal Company, the Milwaukee Electric Railway & Light Company, the Twin City Rapid Transit Company at Minneapolis and St. Paul, the Philadelphia Rapid Transit Company, the Pittsburg Railways Company, the United Railroads of San Francisco, and the St. Louis Transit Company. The New York and Brooklyn companies are omitted because of the extended description of their practice in this paper two years ago.

As said before, direct-current generation and distribution still supply by far the greater part of the power in these cities, as



GENERATING UNIT, LINCOLN WHARF STATION, BOSTON

well as in numerous cities which might have been included on this list. Nevertheless, alternating-current distribution is used to a limited extent by the majority, and by a few it is being introduced extensively. A brief review of the power situation in each city will be in order in connection with these tables, and as supplementary to them.

In Baltimore, previous to the consolidation of all the electric lines under the United Railways & Electric Company, there were nine direct-current power stations. The operation of so many direct-current plants was, of course, fatal to economy, and it was decided to provide for the needs of the present and the future by building a new power station adjoining the old Pratt Street power station, and to use alternating-current generators in this station, which would generate and transmit at 13,000 volts to the sub-stations, many of which would be located at the old power station. In Baltimore, therefore, alternating-current distribution will supply the greater part of the

TABLE II.—STATISTICS OF POWER STATIONS OF ELEVEN LARGE STREET RAILWAY SYSTEMS

City and Name of Company.	Normal Capacity of Station in Kilowatts	Max. Capacity of the Station in Kilowatts	Size Engine Room in Sq. Ft.	Sq. Ft. per Kw in Eng. Room (Nominal)	Size Boiler Room in Sq. Ft.	Sq. Ft. per Kw in Boiler Room	Number of Chimneys	Height of Chimney and Diameter of Flue	Mechanical or Natural Draft	Type of Condenser	Type of Economizer	Type of Feed Water Heater	Type of Mechanical Stoker	Type of Fuel Conveyors	Date of Completion of Station	Company's Designation of Station
Baltimore—United Rys. & Electric Co	12,000	16,000	11,790	.98	12,361	1.03	4	200 ft. and 13½ ft.	Natural	Barometric and jet	None	Closed and open	Roney	Keilholtz	1903	Pratt St.
Boston Elevated Ry. Co	12,900 8,100 4,300	17,200 10,800 5,800	24,360 8,192 8,866	1.89 1.01 2.06	...... 10,480 9,000	1.25 1.29 2.09	1 1 1	252 ft. & 13 ft. 8 in. 251 and 13 ft. 200 ft. and 10 ft.	Natural Natural Natural	Barometric, jet and surface Jet Barometric and jet	Green Green Green	Closed Closed and open Closed	Hand fired Roney & Acme Acme	Elec. loco. Hunt Link belt	1893-6 1902 1896 and 1902	Central Main Lincoln Wharf Charlestown
Cleveland Electric Ry. Co	6,100	8,200	9,120	1.4	16,412	2.6	2	232 ft.	Natural	None	None	Closed	Murphy	Carl.'st& McC'n	1902	Cleveland Elec.
Denver City Tramway Co	5,600	8,400	16,200	2.13	10,800	1.42	4	240 ft. and 11 ft. 240 ft. and 11 ft. 25 ft. and 9 ft.	Natural Natural Mechanical	Jet	Green	Closed and open	Stirling chain grate	McCaslin McCaslin	1903	....
Detroit United Ry. Co	4,000 5,900	5,300 7,900	15,795 15,209	3.9 2.6	14,674 15,209	3.66 2.6	1 1	180 ft. and 11½ ft. 185 ft. and 10 ft.	Natural Natural	Jet Jet	None Green	Closed and open Closed and open	Murphy Murphy	Hunt	1895 1895	A B
Indianapolis Traction & Terminal Co	5,000	7,500	14,248	2.59	7,720	1.05	2	{ 160 ft. and 7 ft. 175 ft. and 10 ft. }	Natural	Jet	None	Open	Roney	Hunt	1903	....
Minneapolis—Twin City Rapid Transit Co	21,000	30,600	17,340	.82	21,675	1.	2	225 ft. and 16 ft.	Natural	Jet	None	Open	Underfeed	McCaslin	Under cons.	....
Philadelphia Rapid Transit Co	7,500 3,750 5,000	10,000 4,500 6,000	16,128 12,228 11,520	2.15 3.27 2.30	14,112 16,128 11,520	1.88 4.30 2.30	2 1 2	170 ft. and 11 ft. 6 in. 60 ft. and 9 ft. 160 ft. and 7 ft. 7 in.	Natural Mechanical Natural	None Jet Jet	None American None	Open Closed Open	None None A. Box & Co.	Link belt Link belt Link belt	1894 and 1898 1894 1894	No. 1 No. 2 No. 3
Pittsburg Rys. Co	6,400 13,500	8,500 18,000	16,560 34,281	2.58 2.54	10,400 34,281	1.63 2.54	8 10	130 ft. and 7 ft. 130 ft. and 7 ft.	Natural Natural	Jet Jet	None None	Closed Closed	Roney Murphy	McCaslin Not decided	.... Under cons.	20th St. Brunot Island
San Francisco—United Railroads	9,600	12,800	13,776	1.4	19,363	2.0	1	152 ft. and 14 ft. 8 in.	Mechanical	Surface marine type	Green	....	Burn fuel oil	....	Under cons.	North Beach
St. Louis Transit Co	15,450 6,906	20,540 9,210	23,243 20,813	1.5 2.2	25,252 20,813	1.7 2.2	4 1	(3) 160x7½ (1) 202x14 202 ft.	Natural Natural	Surface with cooling towers Surface with cooling towers	....	Excelsior Excelsior	Green Green	McCaslin McCaslin	1901 1901	Central Northern

mileage in that city, since the conditions were favorable to such a change. It was imperative to do away with the small-uneconomical plants, and the large alternating-current power station was the natural outcome of the situation.

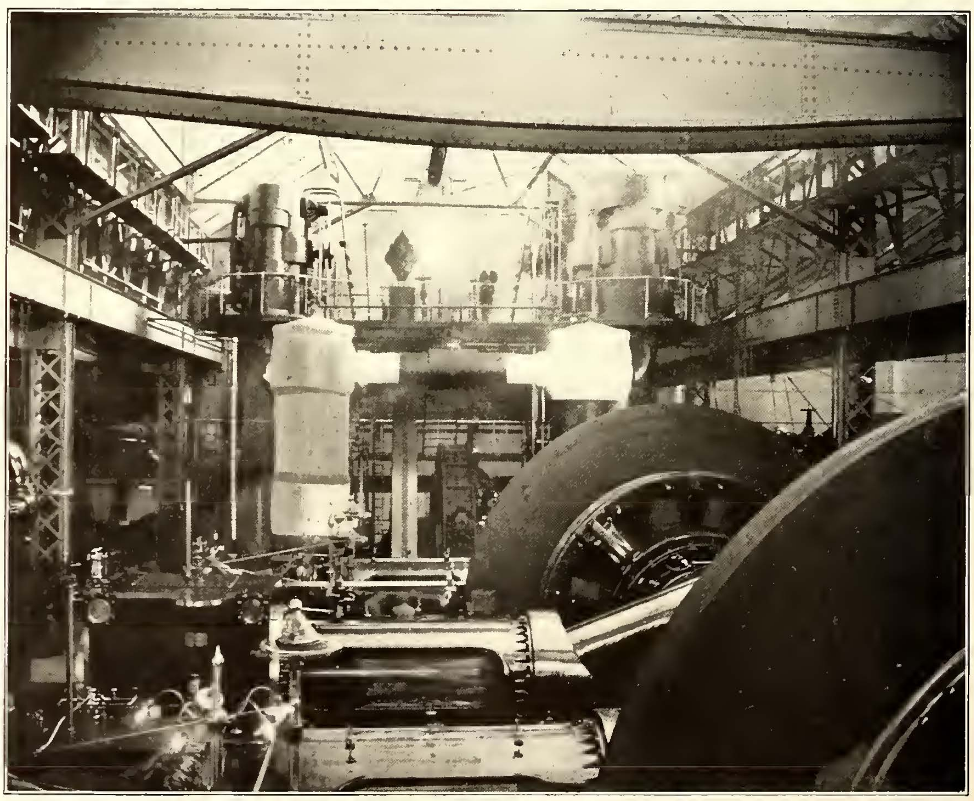
TABLE III.—STATISTICS OF ENGINES USED IN POWER STATIONS OF ELEVEN LARGE RAILWAY SYSTEMS

City amd Name of Company.	No. of Units	Size of Generator, Kilowatts	Rated H. P. of Engines	Type of Valves	Make of Engine	Size of Cylinders	R. P. M.	Steam Pressure, Lbs.	Lbs. Coal per Kw Hour	Cost Coal per Station
Baltimore—United Rys. & Electric Co.	6	2,000	3,000	Corliss	McIntosh & Seymour	33 in. and 68 in. x 56 in.	94	165	3.5	Pratt St.
Boston Elevated Ry. Co.	3	2,700	4,000	Corliss	Providence & west'h'se	44 in. and 88 in. x 60 in.	75	160	3.5	Lincoln wharf
Cleveland Electric Ry Co	..	2,400	3,500	Corliss	Reynolds vertical	40 in. and 68 in. x 60 in.	75	160	----	Clev. Elec. Ry
	..	1,600	2,250	Corliss	Reynolds horiz	32 in. and 64 in. x 60 in.	75	150	----	Clkq. City Ry
Denver City Tramway Co.	5	(3) 800 (2) 1,600	(3) 1,300 (2) 2,700	Greene-Wheelock-Hill Corliss	(3) Green-Wheelock (2) Reynolds)	23 in. and 52 in. x 48 in. 32 in. & 68 in. x 60 in. 32 in. & 64 in. x 48 in.	100 75 94	175	4.5	--------
Detroit United Ry. Co.	2	1,500	2,000	Corliss	Filer & Stowell	32 in. and 64 in. x 60 in.	..	------	----	B
Indianapolis Traction & Terminal Co	..	1,200	1,925	Corliss	Reynolds horiz.	32 in. and 60 in. x 60 in.	80	140	----	--------
Minneapolis—Twin City Rap. Trans. Co	1	3,500	6,000	Corliss	Reynolds horiz.	46 in. and 94 in. x 60 in.	75	175 (sup.)	*	*
Philadelphia Rapid Transit Co.	5	1,500	2,000	Corliss	Wetherill & Co.	26 in. & 40 in. x 48 in. 28 in. & 40 in. x 48 in.	80	145	----	No. 1
Pittsburg Rys. Co.	8	800	1,560	Corliss	Penn. Iron Wks.	30 in. and 54 in. x 48 in.	80	------	----	20th St.
	6	1,500	2,000	Corliss	Providence	32 in. and 62 in. x 54 in.	..	------	----	Brunot Isl'd
San Francisco—United Railroads	4	(8) 1,200	4 080	Marine	Union Iron Wks.	32 in. & 52 in. & 80 in. x 42 in	136	200	*	*
St. Louis Transit Co	4	2,250	3,400	Corliss	Fulton	36 in. and 70 in. x 60 in.	75	150	3.3 kw hrs. per gal. oil	

* Station not finished

At Boston, the Boston Elevated Railway Company, which operates both surface and elevated lines, has always adhered to direct-current distribution. In fact, this company has the most notable large direct-current distribution system in the country. Its policy has been to erect a number of large direct-current stations as required from time to time by conditions, and to enlarge each of these as the traffic grew. It has in all eight power stations. Its central power station is the outgrowth of the original central power station, erected when electric traction was first introduced. This original station is now maintained as an auxiliary to the central power station. It contains thirty-six 50-kw generators. In the same station are six 1200-kw generators, two of 1500 kw and the one of 2700 kw. The company has altogether five 2700-kw direct-current generators in its various power houses. About 20 per cent of the capacity of this company's stations is used to supply elevated lines, and 80 per cent to supply surface lines. The total capacity of the eight stations is 36,844 kw, of which 29,475 may be considered as devoted to surface lines, and this is the figure given in the table. This would leave 7369 kw available for the use of the elevated lines. The kilowatt-hours per car mile on the elevated lines is 4.2. The power station capacity in kilowatts per mile of elevated track is 460.

In Chicago, the Chicago City Railway still supplies its electric lines from two power stations, which belong to the first stage of electric railway power station development, as outlined heretofore. These stations contain simple engines and rope-driven generators, and since they hardly come within the range of modern power-station practice, particulars are not included in the tables. The Chicago Union Traction Company supplies all its lines with direct current from five direct-current power houses. The Chicago City Railway Company contemplates the building of a large alternating-current power station on the Chicago River, at Thirty-Ninth and Halsted Streets, as soon as its franchise extensions shall have been definitely arranged for. This will probably be a steam turbine station, although plans are not fully determined upon. About one-quarter of the company's rolling stock is double-truck cars, 44 ft. over all, weighing 48,000 lbs. without load. The balance of the equipment consists of single-truck motor cars, weighing about 16,000 lbs. without load. These facts should be taken into account in considering the kilowatt-hours per car mile. The station capacity given includes the capacity of a 750-kw storage battery.



INTERIOR OF CENTRAL POWER STATION, BOSTON

In Cleveland, until recently there were two companies, which have recently been consolidated under the Cleveland Electric Railway Company. There are, therefore, two direct-current power stations, one of which is used to supply the eastern lines, and the other the western lines. The Cleveland Electric Railway power house contains some old belted apparatus, which is held as a reserve, and also has as large a direct-current generator as is to be found outside of the Boston power houses. No alternating current is used in Cleveland.

The Denver City Tramway Power Company, which supplies the Denver City Tramway Company with power, has recently built a new power station, which is a combination alternating and direct-current plant. The Denver City Tramway Company has some very long suburban lines, which are supplied by sub-stations. The main distribution in the central part of the city is by direct current. This company's rolling stock consists almost entirely of double-truck cars.

The Detroit United Railway supplies its city lines from two power houses adjoining each other. The power houses are good examples of the best power house engineering of seven years ago. The interurban lines of this company are supplied from other stations. An extensive storage battery auxiliary is in use.

At Indianapolis, the distribution is entirely by direct-current from the West Washington Street power house. This power house was begun in 1894, and has been added to from time to time, as required.

The Milwaukee Electric Railway & Light Company has a railway and lighting power house on the river near the business portion of the city. This supplies direct current for all the lines in the city of Milwaukee. A temporary power station, containing vertical engines driving alternating-current generators, is now being put into commission. The plans of this company contemplate the erection of a large alternating-current generating station, in which it is but natural to suppose that steam turbines will be employed, if the experience of other companies with them is satisfactory. Direct-current distribution will be retained for most of the city lines.

At Minneapolis and St. Paul, the Twin City Rapid Transit Company has the use of a water-power plant of 7500-kw capacity, but this is not now sufficient; and a steam plant with an ultimate capacity of 21,000 kw is being built. At present, however, only one 3500-kw unit will be installed. The steam plant adjoins the water-power plant, which is between Minneapolis and St. Paul, but somewhat nearer Minneapolis. The station voltage is 3450 volts, three-phase, at which voltage power is transmitted to a sub-station in Minneapolis. For transmission to St. Paul, the voltage is raised to 13,000. Storage batteries are employed in the sub-stations.

The Philadelphia Rapid Transit Company has three principal power houses, all of which generate direct-current. It is also building a temporary power plant at Second Street and Wyoming Avenue, containing two 1000-kw three-phase General Electric generators. The station will generate and transmit at 13,200 volts. The entire transmission will be underground. This station will transmit to two sub-stations. It will, of course, supply only a small portion of the power required by the system.

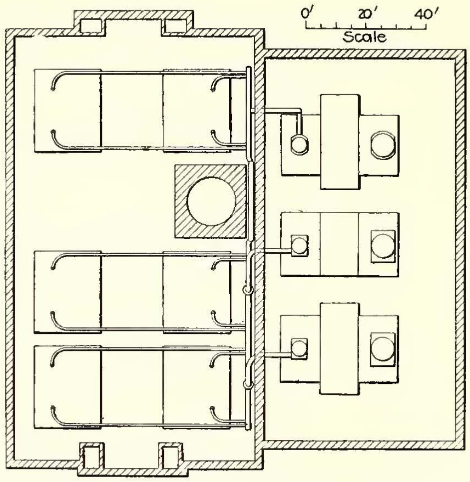
At Pittsburg, the Pittsburg Railways Company operates eight direct-current stations, the least economical of which will be shut down on the completion of the new alternating-current station on Brunot Island on the Ohio River. Extensive storage battery auxiliaries have been used in Pittsburg for the last five years.

The United Railroads of San Francisco have five cable power stations and five electric power stations in operation. A new alternating-current power station is being built in a favorable location for securing coal and water. The completion of this station will make it possible to shut down all but one of the electric plants now being operated, and will do away with the necessity for purchasing power, which is now being done to supplement the power supplied by the company's power houses. Oil is the fuel used in San Francisco, this being the only large company in the United States, except that at Los Angeles, to use fuel oil instead of coal.

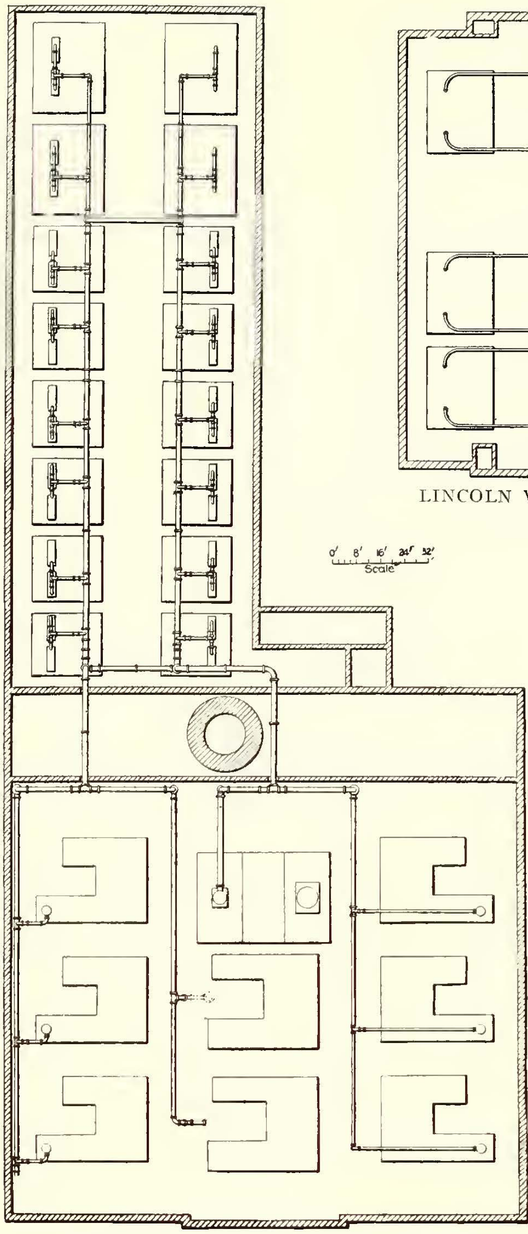
At St. Louis, the St. Louis Transit Company inherited five fairly good direct-current power houses from its predecessors. With the idea of consolidating affairs, the station at Park and Vandeventer Avenues was enlarged, to make the largest direct-current power station in electric railway service in the United States. The output of this station is 30,000 amps., all of which passes through one recording watt meter. At the same time that this central power station was being remodeled to its present size, what is known as the Northern power station was built to supply the northern part of the company's territory, and also to generate alternating current for transmission to sub-stations at such points as might seem desirable. After these stations were built, it was found necessary, however, to continue some of the best of the older generating plants, so that the consolidation idea has not been entirely carried out. Preliminary plans were drawn up recently for a large alternating-current station in East St. Louis, across the river, where coal can be obtained cheaply and without the danger of coal blockades, which danger is always present in St. Louis, because of the limitations to traffic imposed by the necessity of bringing all coal across the river on two bridges. This project was abandoned, however, and a contract entered into with the Union Electric Light & Power Company, which is building a mammoth generating station on the banks of the Mississippi River, not far from the business portion of St. Louis.

From this review of the situation it will be seen that in the majority of the cities there are direct-current plants sufficiently modern to admit of the production of current at a cost nearly as low as it can be produced in the latest type of station. Alternating-current stations for supplying a large proportion of the load are in use, or under construction in New York, Kansas City, Baltimore and San Francisco. Combined direct and alternating-current stations, where direct current is used to supply the greater part of the system, and where distant parts are supplied by alternating current, are in use at Brooklyn, Denver, Milwaukee, Philadelphia, Pittsburg and St. Louis. At Buffalo and at Minneapolis and St. Paul, water-power is used to such an extent that most of the current is transmitted at high potential, and supplied to the railway system through rotary converter sub-stations. In both cases auxiliary steam plants are maintained for carrying peak loads.

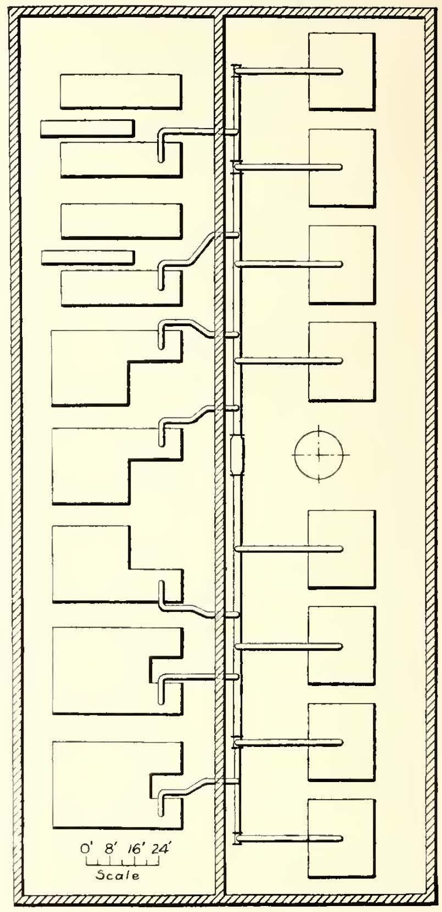
There is considerable difference between the lay-out of a large alternating-current station, in which nearly all the power for supplying the system is concentrated, and the lay-out of smaller direct-current plants. It is not entirely a difference due simply to the difference in the size, although this has much to do with it. It is partially a difference due to the realization by engineers that the concentration of an immense amount of generating apparatus under one roof makes possible interruption of service to a much greater extent than would be possible where a number of stations are in operation. The plan of isolation of one section of a station from another is being very thoroughly carried out in large plants. Special precautions were taken in the first large alternating-current stations for the isolation of high-tension bus-bars from each other, and the separation of the generators into groups, so that trouble with one group would not affect the other. Next after the spread of trouble on high-tension lines, interruptions are most to be feared from the steam piping and boiler-room end of the plant. In fact, the whole plan of connecting large generators, engines and boilers in parallel permanently on the same bus-bars and pipe lines has been thoroughly abandoned in the construction of very large power houses. With the introduction of units as large as 5000 kw, there is not the necessity for permanent multiple operation of the entire station that there used to be with the smaller units. There is a tendency on the part of



LINCOLN WHARF STATION, BOSTON

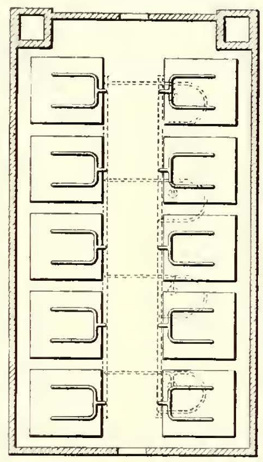


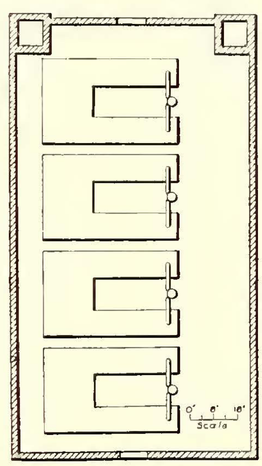
CENTRAL POWER STATION, BOSTON



NORTHERN POWER STATION, ST. LOUIS

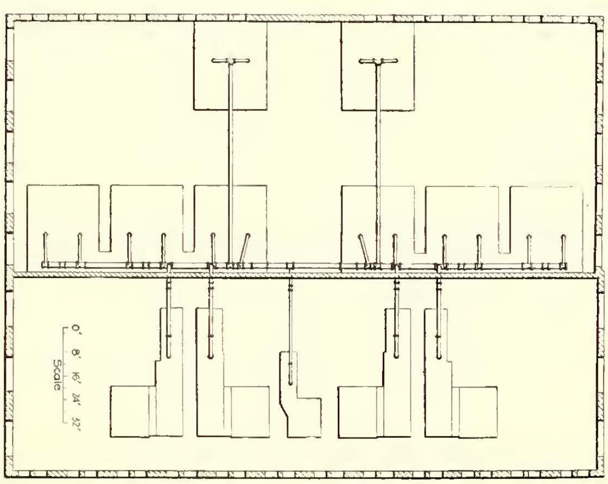
Second Floor



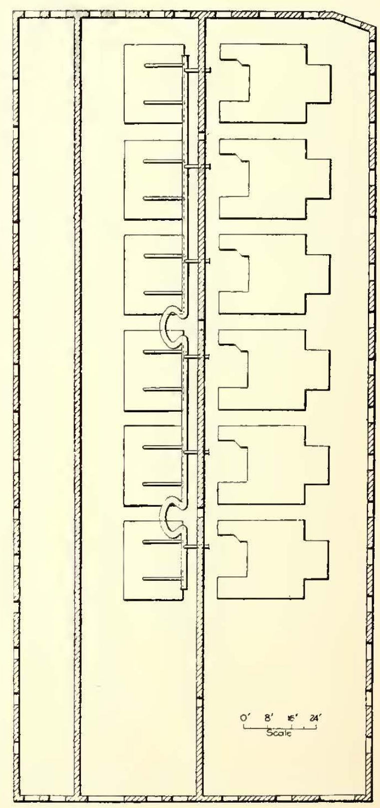


Ground Floor

BEACH STREET POWER STATION, PHILADELPHIA



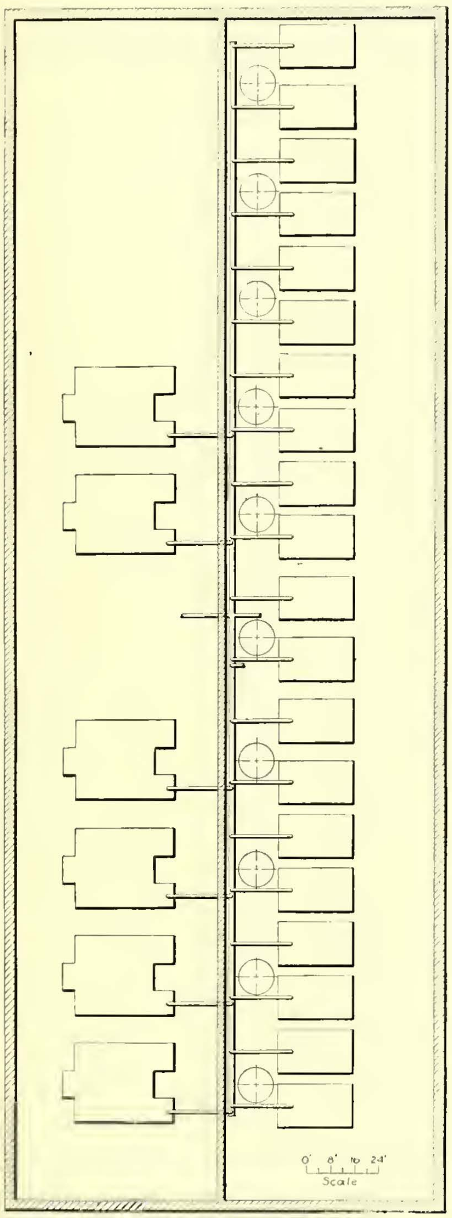
DELAWARE AVENUE POWER STATION, PHILADELPHIA



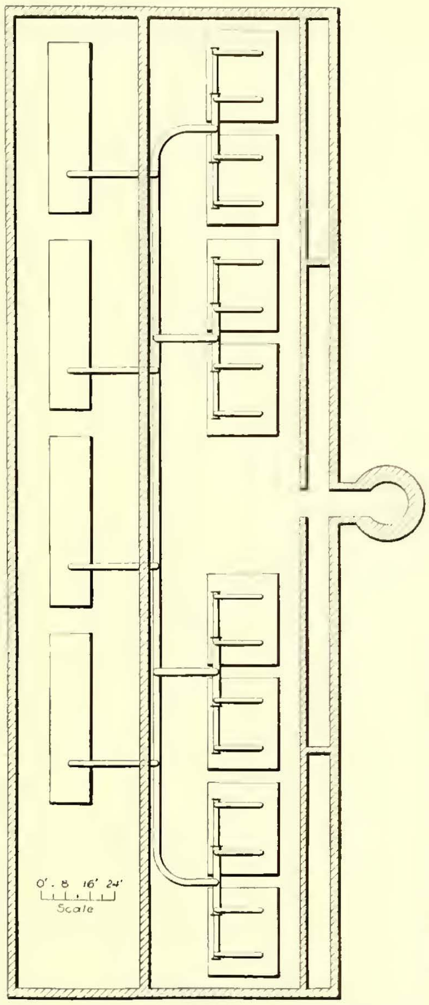
TWENTIETH STREET STATION, PITTSBURG

PLANS OF SEVERAL LARGE CITY POWER STATIONS, SHOWING LIVE STEAM PIPING AND ARRANGEMENT OF BOILERS AND ENGINES; SCALE, 1-64 IN. EQUALS 1 FT.

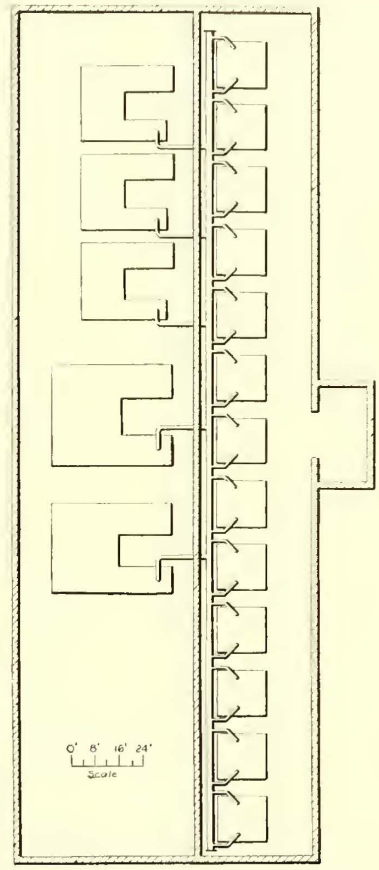
those now designing stations with units this size to make each unit with its boilers a section of the station by itself, capable of being operated in parallel with other units, but only through the medium of steam piping and electrical connections, which can quickly and effectively be opened. In several stations better provisions have been made for isolating electrical troubles than have been made to prevent the spread of trouble due to a break in the steam piping at any one point. The difficulty in preventing the spread of trouble from steam pipes is due mainly to the fact that it is frequently impossible to reach essential valves to shut off steam from the broken part, as long as steam is escaping. Electrically operated valves are now being introduced, which will reduce this danger.



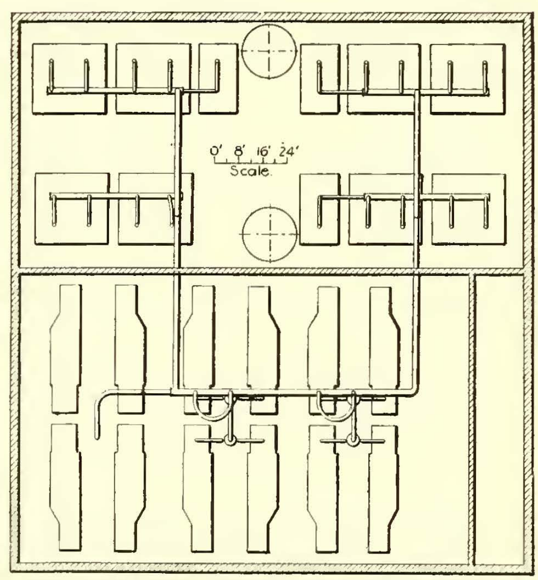
BRUNOT ISLAND POWER STATION PITTSBURG



NORTH BEACH POWER STATION, SAN FRANCISCO, CAL.



NEW CENTRAL STATION, DENVER



THIRTEENTH AND MT. VERNON STREETS STATION, PHILADELPHIA

PLANS OF SEVERAL LARGE CITY POWER STATIONS, SHOWING LIVE STEAM PIPING AND ARRANGEMENT OF BOILERS AND ENGINES; SCALE, 1-64 IN. EQUALS 1 FT.

The immense quantity of coal required by the largest stations makes it necessary to devote a great deal of attention in the design of the plant to facilities for storing coal and for handling it rapidly, as well as to the railroad yards adjoining the plant, if coal is received by rail.

Whatever the policy adopted by a company for the supply of current to its lines in the future, and whatever the method of taking care of the growth of the system, every company which has been operating for a number of years finds itself with old apparatus on its hands. This apparatus is naturally kept in operating condition as a reserve, and to carry the load at times of extra heavy traffic. Even though the old apparatus is uneconomical, the company can much better afford to kept it as a reserve than install newer apparatus to lie idle the greater portion of the year.

In a steam turbine plant radical changes have to be made in design, as the boiler room must be much larger, in proportion to the generator room, than in an engine-driven plant. The plan usually followed in the few large steam turbine power stations that have been designed, has been to place boilers on both sides of the generator room, although one notable exception to this is the plant of the Commonwealth Electric Company in Chicago, where the boilers are placed on one side of the generator room only, and are all on the ground floor.

POSSIBLE ECONOMIES IN CENTRAL STATION AND DISTRIBUTION SYSTEMS

BY PHILIP DAWSON

THE growth during the last few years of the applications of electricity has been so rapid that at the present day there are not many branches of mechanical industry in which electric energy does not play a very important part. Hence, large stations for the production and distribution of this most important form of power are springing up on all sides. One of the most important, if not the most important, sphere for the use of electricity has been found in its application to mechanical traction, in which branch enormous strides have been made during the last decade.

When considering the problem of the economical production and distribution of electrical energy, there are two more or less distinct lines along which it is possible to seek for a solution. The first consists in making improvements in the existing type of machinery employed, such as the introduction of coal-handling apparatus, mechanical stokers and labor-saving devices generally, to replace the manual labor formerly employed. The second consists of radical changes in the system employed, as, for instance, the substitution of rotary prime movers, such as steam turbines, for the reciprocating steam engine, or possibly in future times dispensing with steam boilers entirely, and using gas engines driven by producer gas. It is quite within the bounds of possibility that the future may bring forth some form of gas turbine which may prove more economical than anything which we have at the present day.

This article is primarily intended to deal with the general subject of power station economy, particularly in connection with the design of systems intended for the production and supply of energy to electric tramways and railways, but at the same time it must also have a considerable bearing on the design of any power-producing plant. It is not the intention of the author in this article to attempt to lay down the law as to what should be done in any particular case, but rather to consider with an impartial and unprejudiced mind the general trend of modern practice both in Europe and America, as exemplified by the attempts which have been made by the engineers of various nationalities to obtain greater economy and improve working conditions generally.

Although, as has been stated above, this article does not treat exclusively of electric traction power plants, yet it is intended to apply particularly to this branch of engineering, and this fact will naturally have considerable influence in dictating the type of machinery to be employed. It is impossible to hope for the best results if power plants are designed simply to produce electric energy, without due consideration of the purpose for which the power will be used. Any traction system is composed of a number of parts or sections, which, however excellent they may be individually, will never produce a satisfactory result unless they all harmonize and work in with one another. If one portion is weak or inefficient the whole system suffers accordingly, so it should be the endeavor to bring each part to the highest possible pitch of perfection, but unless there is unity and concord all this will be lost.

Thus, it should never be forgotten that the power plant and distribution system of a railway, important as it undoubtedly is, is, after all, only a means to an end, and should be treated as such. The chief object of a railway is to earn money by carrying passengers as expeditiously and cheaply as possible. In all attempts to improve the economy of such system, only that true economy which embraces the whole general condition of affairs should be followed, and not that kind which deals with minute and isolated points, whilst completely disregarding the welfare of the whole.

In looking round at the different engineering practices of Great Britain, the United States of America, and the Continent of Europe, one sees that though there is a certain resemblance between them, there is likewise a marked individuality, and that each has its own peculiar characteristics. Also, when one looks back upon what used to be the standard practice in each of these countries it is obvious that there has been a considerable interchange of ideas, which have been begotten, not only by their own experience, but also of a careful study of the successes and failures in different countries, and that these ideas have been applied to their own special cases in the light of the knowledge thus gained. In some instances this has been carried almost too far, and there has been a tendency to forget that local conditions vary enormously, and should be carefully considered.

A very great improvement in power-station operation has been brought about by the introduction of the numerous labor-saving devices now in common use. A large majority of these have had their birthplace in the United States, and were first installed and operated there, but have since been adopted by other countries. One of the most prominent instances of labor-saving apparatus is to be found in the very complete machinery for handling coal and ashes, now usually considered a necessary adjunct of any large power station. In a considerable number of the most modern stations the coal is untouched by hand from the time when it arrives in the trucks or barges, to the time when it is fed into the furnaces of the boilers, and it is also automatically weighed in the course of its progress. The empty buckets of the conveyor are commonly employed to remove the ashes from the boilers and deposit them outside the station. The saving of time, labor, and cost resulting from the mechanical handling of coal, is very considerable, and, owing to the fewer times that it is handled, the damage to the coal is reduced to a minimum. The installation of coal-handling apparatus is now almost universal practice.

Mechanical stokers are also pretty generally used, and of these there are a very large variety. In Great Britain the moving chain grate type is very largely used, though there are numerous other types in operation. Continental practice inclines toward the use of hand stoking in preference to mechanical, especially in Germany, where the cheapness of labor may possibly have some influence in the matter.

This, however, would seem to ignore the fact that one great advantage of mechanical stokers is that much cheaper coal may be burned, and that the nuisance from smoke is greatly decreased owing to the more perfect combustion.

In the matter of boilers there have been no very drastic changes or radical departures from former practice during the last few years. In the United Kingdom the Babcock & Wilcox type of water-tube boiler is much favored, and this type of boiler is being installed in a large majority of the new power plants which are being erected. At the present day boilers of this class are in operation in some 30 per cent of the total electric tramway stations of Great Britain; most of these boilers are of the pattern first designed for land work, but latterly there has been a tendency to adopt a special type intended primarily for marine purposes, which occupies less space than the land type. The chief difference in the construction of the land and marine type of boilers, is that in the land type the steam and water drum (or drums) runs longitudinally from the front to the back of the boiler, in the same direction as the water-tubes, whereas, in the marine type this drum is placed across the front headers, at right angles to the tubes and the upper ends of the rear headers are connected to the drum by horizontal tubes. Also in the marine type the water-tubes slope downward from back to front, instead of upward, as in the land type. Excellent results have been obtained with these boilers. Cylindrical boilers of the Lancashire, Cornish or Scotch marine type are not often installed in large plants nowadays, unless for some special, and generally local, reasons.

Continental practice is, in the main, radically different in this respect, from that either of Great Britain or the States. Here we find the predominating boiler to be of the two-story type, usually consisting of one cylindrical boiler mounted on the top of another; the lower one is frequently of the Lancashire type, while the upper one consists of a plain cylindrical shell with smoke tubes. The water-tube type of boiler is not as much in evidence on the Continent as in Great Britain and the United States.

Mechanical draught is typical of American practice, though not by any means universal in that country. Indeed, America is the proud possessor of some of the largest and tallest smokestacks in the world. The practice of using forced or induced draught is, however, steadily spreading, and certainly has in many cases important advantages to recommend it. The first cost is usually much less than that of a large chimney, it is more flexible in use, and, in the event of extensions being required, can be increased to the extra capacity necessary with far greater ease, and it is particularly useful where economizers are employed.

When we come to consider steam engine practice of the present day, there are various interesting points to be observed. British practice with but few exceptions leans strongly toward the vertical engines of early days.

Originally American engines were as universally horizontal as English engines are vertical, but latterly, for large units, they have been coming round to the British way of thinking, and the vertical type represents their standard practice. At the present day the standard engine of both countries for heavy traction work is the vertical cross-compound, slow-speed engine, with the generator mounted between the cylinders, although, as mentioned further on, steam turbines are finding great favor for large alternating current units. Triple-expansion engines are not common for this class of work.

The general trend of German practice nowadays appears to be toward horizontal engines. At one time a large number of vertical engines of the so-called "steeple" type were built, but the complication of, and necessary attention required by, the Sulzer type of valve gear which is so much used, rendered such engines difficult and expensive to operate. There are, nevertheless, a large number of vertical engines installed in Continental power stations.

There is a very defined and marked difference in the design of Continental engines, and those of either Great Britain or America, which is largely a matter of national characteristics. Almost all British and American engineers have an ingrained desire for simplicity, and will never use two parts, if by any means one part will answer the same purpose, regarding machinery as a means to an end which should be approached as directly and expeditiously as possible. The Continental engineer, on the other hand, seems to look on a mechanical device as an end in itself, and fairly revels in a complexity of parts. This is abundantly evident in the complicated and intricate valve gears which one sees on German and Swiss engines. They work well and give good results, and have stood the test of many years' running, but one cannot help wondering if it is really necessary for them to be so complicated, and whether the same result could not have been obtained in a simpler manner.

In England and America the Corliss valve, which originated in the latter country, is very largely employed, especially in America. On the Continent the poppet valve is more common. This is mainly due to the fact that superheated steam is more exclusively used on the Continent than elsewhere, and Corliss valves do not work satisfactorily with it. There can be little doubt but that superheated steam tends toward economy, and it is most probable that in the course of time its use will spread and extend in a marked degree. England was the first country where experiments with superheated steam were carried out, some forty years ago, but the many obstacles in the path of would-be users led to the subject being practically shelved. One of the chief causes of failure was the fact that the lubricants then employed could not stand the high temperature, and decomposed with disastrous results. The soft packing in glands and stuffing boxes also gave considerable trouble. Since then, however, Continental engineers have taken up the subject, and by dint of hard work and experimenting have removed most of the difficulties in the way of the use of superheated steam. Mineral oils are now used, which can stand the high temperatures involved, and metallic packing has replaced the older soft packing, thus doing away with the destructive effects in this direction.

In the opinion of the writer, one of the chief advantages, if not the greatest, obtained by using superheated steam, is that initial condensation of steam in the cylinder is done away with, and also the re-evaporation of the condensed water during the later stages of expansion, and while exhausting.

The table on page 366 gives some results which were obtained at the Berlin Electricity Works on a Sulzer engine, with various degrees of superheat, and may be of interest.

Forced lubrication is essentially characteristic of British practice. It was originally applied exclusively to high-speed engines, but it has since been extended to slow-speed engines as well, with most favorable results. Forced lubrication has recently been applied by the author to some engines put in by him for the South Lancashire Tramway system. These engines are of German make, constructed by the Augsburg Nürnberg Maschinenfabrik, and the makers were at first most reluctant to employ this method of lubrication. The results, however, have been so good that they have since become quite converted to the system, and are now perfectly satisfied.

Most engineers are looking very hopefully toward the steam turbine as a factor in central station economy, both in first cost, space occupied, and cost of operation, and there seems little doubt but that considerable advances in this direction will be made before very long. The steam turbine was first established as a commercial success in Great Britain by the Hon. Mr. Parsons, and the turbine which bears his name is now well known in most civilized countries. America has followed suit, and has produced in the Curtis turbine a rival whose progress will be watched by all engineers with the greatest interest. These turbines are being installed for the first time in the United Kingdom in the power house of the Yorkshire Power Company.

Turbo-generators of 5000-kw capacity, of the Parsons type, are also being installed in the power houses of the Metropolitan and Metropolitan District Railways, which will supply power for the electric operation of the Inner Circle.

Turbines are also being installed in the power house which will supply electric energy for working the electric railway lines around New Castle.

There is distinct economy to be obtained in the use of steam turbines, not only in operating expenses, but also in first cost. They occupy less space than reciprocating engines of the same power; in the larger sizes the floor space required with turbines of the Parsons type is only one-half or even one-third that of vertical steam engines and the headroom required is extremely small. The Curtis turbine, though taking up more headroom than the Parsons turbine, occupies even less floor space than the latter. As a consequence of this, where turbo-generators are installed, the engine room does not require to be nearly so large or costly, and owing to the superior lightness of the parts, the engine room cranes need not be so powerful. Turbines are especially suitable where it is desired to build the power station in two stories, since, owing to the entire absence of vibration, the boilers can be put on the ground floor and the turbines on the floor above; there are many engineers who have a very great objection to putting the boilers above the engines, and hold that such a method is bound to give trouble sooner or later. There are, however, several power stations which have been built on this principle, with very satisfactory results.

In the matter of cooling towers, British and Continental practice, taken as a whole, are very similar, and somewhat opposed to that of the United States of America. In the last case it is most common to use towers in which the water is cooled by artificially produced draughts, by means of fans, either driven by steam or electrically. On the Continent, however, it was found that better results were obtained by means of natural draught towers, of which the Klein cooling tower is a typical example. This tower is of German origin, but has been somewhat extensively introduced into England, where it has found considerable favor. The whole apparatus is made of wood; the hot water is allowed to trickle over the surface of a number of wooden strips set close together, and arranged in the base of a wooden shaft or chimney. The draught thus produced draws a current of cold air through the wooden strips and effectually cools the water owing to the large surface of the latter which is exposed to its action. A certain quantity of water is lost by evaporation, but a good deal of this is condensed in the upper and cooler parts of the chimney.

TESTS OF 3500-HP SULZER ENGINE AT THE BERLIN ELECTRICITY WORKS

(Horizontal, Four-Cylinder, Triple-Expansion, Double-Tandem Engine	Highly Superheated Steam			Medium Superheated Steam		Dry Saturated Steam	
Steam pressure at throttle in lbs. per sq. in	181	180	181.5	181	185	177	184
Temperature of steam at high pressure cylinder throttle, per cent	314.36	316.1	312.28	225.8	224.96	201.1	201.1
Superheat at throttle, per cent.	122.7	124.65	120.49	34.2	32.3	10.35	8.8
Speed of engine in revolutions per minute	83.5	83.0	82.8	83.7	83.5	83.4	83.9
Indicated horse-power of engine	2516.1	2507.1	2506.4	3684.2	3406.1	2760.4	2513.4
Brake horse-power of engine	2252	2242	2243	3423	3144	2447.5	2249
Mechanical efficiency, per cent	89.5	89.5	89.5	92.9	92.3	90.3	89.5
Feed water consumed per hour, lbs	22,831	22,733	22,756	43,855	40,106	31,755	29,054
Steam consumed per I. H. P. hour, lbs	9.074	9.0[illegible]7	9.079	11.903	11.774	11.716	11.162
Steam consumed per B. H. P. hour, lbs	10.138	10.139	10.145	12.812	12.756	12.974	12.919

In some situations a cooling tower may play a very important part in the problem of economical working. Much of the good resulting from economical steam engines will be nullified if the condensing arrangements are faulty, and it is impossible to maintain a good vacuum with an insufficient supply of cooling water. Cooling ponds are very simple, but also somewhat inefficient, unless of very large area.

A characteristic feature of Continental practice is seen in the preponderance of auxiliaries directly connected to the main generating units. Thus, in the majority of cases the air pumps are driven directly from the main engine, usually either from the tail rod of the piston, or by a crank-shaft. Also it is common practice to mount the exciter armature on the shaft of the main generator. There is doubtless a good deal which might be brought forward in defense of these practices, but the independent auxiliaries adopted by British and American engines alike, appear to be a far more convenient arrangement and to possess very considerable advantages over the method in vogue on the Continent.

It is not the intention of the author in this article to go deeply into the question of how best to drive auxiliaries, nor to touch otherwise than lightly upon the vexed question of the relative merits of steam and electricity for this work. In most large stations it is generally best to effect some sort of compromise, some of the units being driven by steam and others by electricity. Much has been said and written affirming or denying, according to the point of view, the saving and economy effected by electrically driven auxiliaries, but it is practically impossible to generalize upon the subject, as it is one of those in which conditions and circumstances peculiar to each case may completely alter the whole complexion of affairs, making, in one case, steam, and in another, electricity, preferable.

As regards accumulators, Continental, and more particularly German, engineers are far more lavish in installing them in power stations than is the case in either England or America. Some reason for this trait may lie in the very extensive use of triple expansion engines for traction purposes, which do not give their best results under variable loads, so that large batteries of accumulators are used so as to equalize the load as far as possible. Most American and British engineers are agreed, however, that under ordinary circumstances, it is better to dispense, as far as possible, with heavy batteries in large traction power stations, and there are many arguments in favor of their view of the case. For one thing, the larger the system operated, the more uniform the load is likely to be, and in any case, a modern generating plant can take care of very considerable fluctuations without either damage to itself or serious loss of efficiency. Furthermore, when dealing with large units, a small percentage variation in the load means a very considerable amount of power, and a very large and expensive battery would be required to produce any appreciable effect, and the extra cost entailed, both in original outlay and upkeep, is so large that any ultimate economy resulting from its use is extremely problematical. In small stations accumulators are very useful, and several examples could be pointed out in Great Britain and the United States where their installation has been productive of considerable economy of working.

But though practically all English-speaking engineers hold the same view, that as regards accumulators in large power stations, their room (and they occupy a good deal) is preferable to their company, yet it must not be supposed that there is no sphere of action for accumulators in connection with large power installations. Where, as is so often done nowadays, the power is generated at high pressures in a central station and transmitted for transformation and distribution to various substations, it has been found that accumulators in the latter, used in connection with the rotaries or motor generators, give excellent results. They equalize the load on the rotaries and consequently the load on the high-tension feeders also, thus enabling smaller cables to be used than would otherwise be possible, as they can be worked nearer their maximum capacity. This method of procedure has been followed out by the writer in the power distribution scheme for the South Lancashire Tramway system, for which he and his partners are the engineers.

A great improvement in the ease and economy of operation of accumulators has been brought about by the introduction of the reversible boosters. By the use of these useful machines the output of the battery is automatically varied to suit the demand, without the use of the complicated and rather unsatisfactory arrangement of automatic switches which was formerly required. These boosters are not so much used in America as they are on the Continent and in Great Britain, where there is little doubt their utility will soon be even more generally recognized than it is at the present day. An interesting example of a reversible booster is to be found in the power station of the Orleans electric tramways, where gas engines are employed; the booster installed there was one of the first of this kind to be used in practical everyday working.

Many engineers are looking eagerly and hopefully forward to the time when the gas engine shall displace the steam engine, and, although at the present moment the latter may be said to be holding its own, such rapid strides have been made of recent years that there is no saying exactly what may be in store for us in the near future. The old gas producers (and the future of gas engines is inseparably bound up with that of gas producers) labored under the great disadvantage of requiring anthracite coal, but the more recent ones, such as the Mond producer, has overcome this disadvantage and burns ordinary coal, which is a most important step forward.

The extent of our present knowledge on the subject does not yet seem to be sufficient to justify discarding the tried and trusty steam engine for the somewhat uncertain gas engine; and there are several difficulties to be overcome before the latter will be deemed suitable for installation in large and important power stations. Despite the toil and labors of that hardworking body, "The Gas Engine Research Committee," there is still much concerning the internal working of a gas engine that is wrapt in mystery. However, this branch of engineering is receiving great attention at the present day, both in England and on the Continent, and considerable advances may be reasonably expected in the course of the next few years.

There is a very vexed question which has been occupying the attention of engineers of all countries, viz., the question of the best voltage at which it is safe to operate motors. In Great Britain, till quite recently, 500 volts has been the maximum pressure permitted by the Board of Trade, but, owing to the probable introduction of electric traction on British railways the subject has recently been reopened by the "Standardization Committee," which is now sitting in London. It has practically been decided that for railway work 600 volts should be allowed, but the Board of Trade has indicated that this is the very highest pressure which they can sanction. On the Continent of Europe, as much as 750 volts has been permitted, but it is questionable whether any very material advantage will be gained thereby, in view of all the difficulties which this additional pressure will introduce in the design of railway motors. To reap the full benefit from high pressures necessitates an alternating current motor.

Polyphase electric traction was first introduced on the Continent of Europe, and more particularly in Switzerland, where the local conditions were found to especially favor this system. The railway between Burgdorf and Thun, which was built by Messrs. Brown and Boveri several years ago, was equipped on this principle, and many other mountain railways have since been built in Switzerland. The results, as far as is known, have been satisfactory, but it must be borne in mind, that in these cases the number of trains or cars operated is comparatively small, and the question of repairs is therefore not of much consequence; furthermore, the electrical energy is in most instances generated by water-power, so that any amount of waste of energy is not felt, as it would be were coal used for generating purposes. The question of long-distance railways is one which has recently come to the fore, and, although in the United States there are several lines operated by continuous current motors, the engineers of all countries are agreed, that in order to render electric traction on long-distance lines feasible, some system of alternating-current motors will have to be adopted; in this connection Messrs. Ganz & Company, of Budapest, have carried out a series of experiments culminating in the equipment of the long-distance road between Lecco and Sondrio, which has already been described in the pages of the Street Railway Journal, and the efforts of American engineers to develop a single-phase motor for long-distance roads are being watched with the greatest interest by all European engineers.

In conclusion, it may be stated, that owing to the very large increase in the size of power stations, engineers and managers on both sides of the ocean are beginning to realize the importance of every economy which can be effected, no matter how small. Thus, in order to be able constantly to supervise the control and operation of a station the writer's firm now makes a practice of installing their hot-wells on scales, so that at any moment the amount of steam used per kilowatt can be ascertained. Automatical apparatus is now available to record not only the temperature, but also the composition of gases escaping up the chimney, and coal-weighing machines are supplied which automatically register the amount of coal consumed by each boiler.

The writer believes that as regards large steam plants for polyphase work, the future lies with the steam turbine and high-pressure water-tube boiler, forced lubrication, superheated steam, independent auxiliaries driven electrically, and all labor-saving appliances, in the shape of coal and ash handling apparatus, combined with mechanical stokers. Under certain conditions, particularly in the neighborhood of blast furnaces, the gas engine may render great services, but we must learn more about this branch of engineering before it is possible to say exactly what position the gas engine of the future will hold.

MODERN REPAIR SHOP METHODS

BY RICHARD McCULLOCH

THE descriptions and data here given are taken from the practice of the Chicago City Railway Company. It is not intended to claim for this company any superiority either in methods or economy of repairs, but the data here given will indicate to some extent what may be accomplished in heavy city railway work. This company having outgrown its old shops has recently built and equipped an entirely new plant, requiring an investment in buildings and machinery of something over $450,000. A ground plan, showing the general arrangement of the shops, reproduced from an article descriptive of these shops which appeared in the Street Railway Journal for March 7, 1903, is given in Fig. 2. The equipment is such as to lead one to expect great economy, but wages are too high in Chicago to realize this expectation. This company operated during the year 1902, 206 cable trains, 125 double-truck, four-motor, electric cars, and 402 single-truck, two-motor electric cars. It has one central repair shop and six car houses, in which car repair work is done.

The various classes of work done at the car houses are: Inspection and cleaning of electrical equipment; adjustment and overhauling of brakes; renewal of wheels and truck parts; inspection of grips; minor repairs to car bodies, such as replacement of broken windows and car fittings; minor repairs to electrical equipment, such as renewal of motor bearings and brushes; renewal of controller parts, renewal of trolley bases, poles and wheels, and repairs to car wiring. As a general rule the work done at the car houses consists of inspection, cleaning, oiling, renewals, and replacements, it being the intention to confine all genuine repair work to the shops.

The following tools form the equipment of each car house:

Two hydraulic pit jacks.

Two two-ton chain blocks.

One portable forge.

One anvil.

One post drill.

One grindstone.

The necessary hand tools, such as hammer, wrenches, chisels, punches, etc.

In the car house, where double-truck cars are cared for, there is added to this equipment a motor driven oil pump, furnishing oil to five sets of oil jacks for raising bodies off the trucks. It is intended to dismount and thoroughly inspect and clean every electrical equipment each ninety days. The cost of dismounting, inspecting, cleaning and overhauling the truck, motors, and electrical equipment of double-truck, four motor cars, is $8.00; and of single-truck, two-motor cars, $4.00.

The organization of the repair shop department consists of a master mechanic in charge of all repair work, both at the shops and car houses, with the following foremen:

One assistant in charge of repair work in car houses.

One foreman in charge of the machine shop.

One foreman in charge of the blacksmith shop.

One foreman in charge of the foundry.

One foreman in charge of the electrical repairs.

One foreman in charge of tin work, saddlery and upholstering.

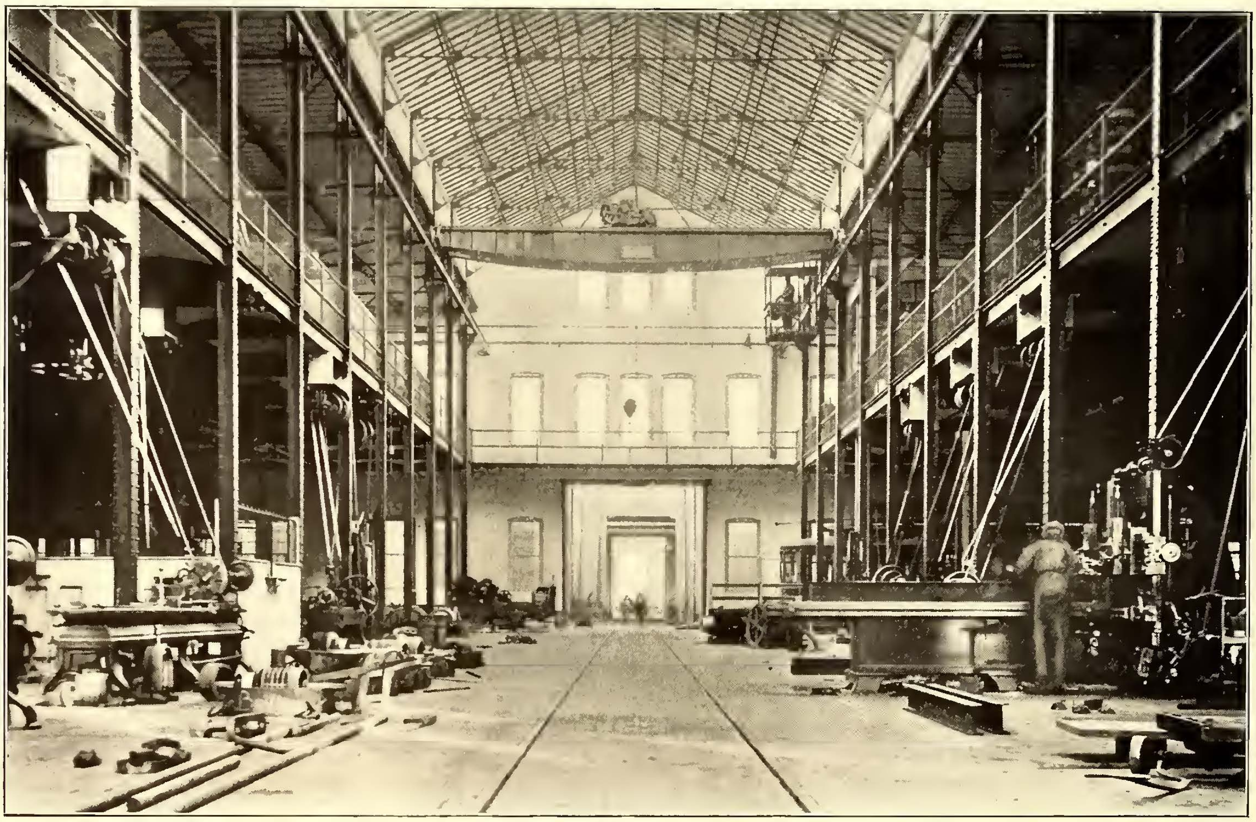


FIG. 1.—MAIN BAY OF MACHINE SHOP—REPAIR SHOP OF CHICAGO CITY RAILWAY

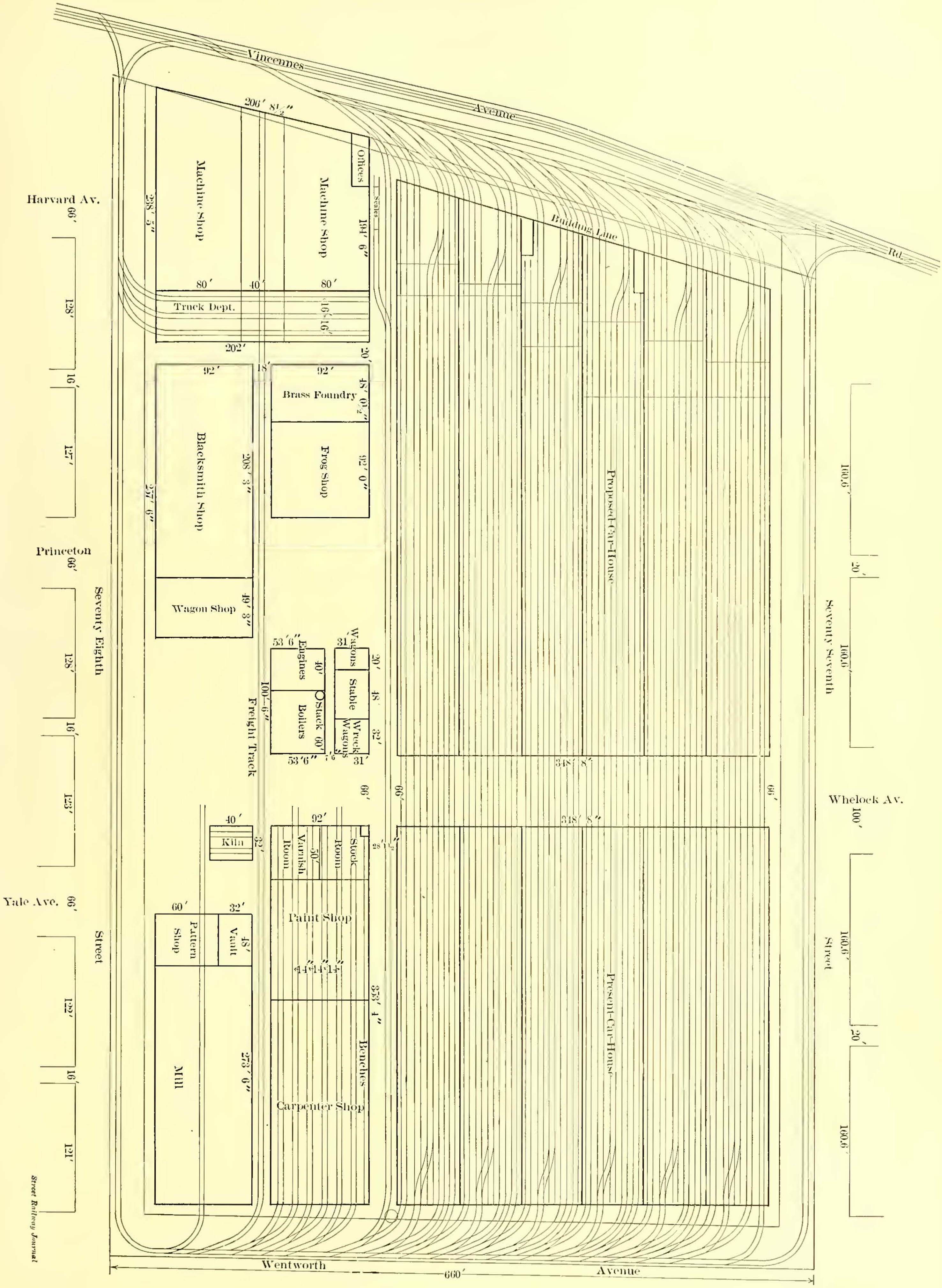


FIG. 2.—PLAN SHOWING ARRANGEMENT OF NEW REPAIR SHOPS AND CAR HOUSE OF THE CHICAGO CITY RAILWAY

One foreman in charge of the wood mill.

One foreman of truck repairs.

One foreman of car body repairs.

One foreman of painting.

The total number of men in the repair shop and in the car houses engaged in repairs, varies from 300 to 350, according to the time of year. Work at the repair shops is carried on during nine hours. The working day during five days in the week is slightly longer than nine hours, allowing the shops to close two hours earlier Saturday afternoon. Each workman registers the time of entrance and departure on a time clock placed at the shop door, and the time so registered serves as a basis for the pay roll.

Table No. 1 shows the classification of the operating expense accounts used in charging up shop time. This schedule is printed on card board and posted conspicuously in the various departments of the shop, so that each foreman and each workman may know to what number any work should be charged. Construction accounts and any particular job for which it is desirable to keep the time separately are given special numbers.

Table No. 1.—Classification of Expense Accounts in Charging Up Shop Time in Repair Shops Department

ACCOUNT NO. 1.—MAINTENANCE OF TRACK AND ROADWAY

Charge No.

101 Item A. Shop work on rails, rail fastenings, welded joints, etc.
102 Item B. Shop work on steam railroad crossings.
103 Item C. Shop work on street railroad crossings, cross-overs, curves, frogs, guard-rails, run-offs, switches, switch-mates, turn-outs, etc.
105 Item E. Shop work on material for fences, bridges, culverts, trestles, subways, tunnels, viaducts, etc.
106 Item F. Shop work on track tools.

ACCOUNT NO. 2.—MAINTENANCE OF ELECTRIC LINE

107 Item A. Shop work on poles and pole-fixtures, overhead line appliances, etc.
108 Item B. Shop work on rail-bonds, underground line appliances, etc.
109 Item C. Shop work on line tools.

ACCOUNT NO. 2 A.—MAINTENANCE OF CABLE TRACK AND CONDUIT MACHINERY

110 Item A. Shop work on yokes, slot-rails, iron frames and covers, sand-plates, etc.
111 Item B. Shop work on cable-pulleys, shieves, pit machinery, etc.

ACCOUNT NO. 2 B.—MAINTENANCE OF CABLES

112 Item A. Shop work on tools for splicing tables, appliances for handling cables, etc.

ACCOUNT NO. 3.—MAINTENANCE OF BUILDINGS AND FIXTURES

113 Item A. Shop work on material and fixtures for electric power-plant buildings.
114 Item B.—Shop work on material and fixtures for cable power-plant buildings.
115 Item C. Shop work on material and fixtures for all other buildings.

ACCOUNT NO. 4.—MAINTENANCE OF STEAM PLANT (ELECTRIC)

116 Item A. Shop work on engines, engine parts, appliances and fixtures.
117 Item B. Shop work on cranes, hoists and other engine-room appliances.
118 Item C. Shop work on boilers, boiler-fittings and appliances, pumps, heaters, tanks, etc.
119 Item D. Shop work on coal and ash-conveying machinery and other boiler-room appliances.
120 Item E. Shop work on piping and steam-fitting, valves, etc.
121 Item F. Shop work on other steam plant equipment.

ACCOUNT NO. 4 A.—MAINTENANCE OF STEAM PLANT (CABLE)

122 Item A. Shop work on engines, engine parts, appliances and fixtures.
123 Item B. Shop work on cranes, hoists and other engine-room appliances.
124 Item C. Shop work on boilers, boiler-fittings and appliances, pumps, heaters, tanks, etc.
125 Item D. Shop work on coal and ash-conveying machinery, and other boiler-room appliances.
126 Item E. Shop work on piping and steam-fitting, valves, etc.
127 Item F. Shop work on other steam plant equipment.

ACCOUNT NO. 5.—MAINTENANCE OF ELECTRIC PLANT

128 Item A. Shop work on generators.
129 Item B. Shop work on switch-boards and switch-board appliances.
130 Item C. Shop work on storage batteries, transformers, boosters, etc.
131 Item D. Shop work on other electric plant equipment.

ACCOUNT NO. 5 A.—MAINTENANCE OF CABLE PLANT

132 Item A. Shop work on cable winding machinery.

ACCOUNT NO. 6.—MAINTENANCE OF CARS

(Passenger Cars and Mail Cars)

133 Item A. Shop work on trucks and truck parts, including truck-frames, truck-sides, wheels, axles, pedestals, oil-boxes; brakes and brake appliances, life-guards, fenders, etc.
134 Item B. Shop work on car-bodies, including platforms, vestibules, roofs, bonnets, window-sash; sand-boxes, gates, grab-handles, and all fixtures and appliances attached to the platform, except brakes, brake-appliances and fenders.
135 Item C. Shop work on car-fixtures and trimmings, including headlights, signs, gongs and bells, curtains and curtain fixtures, seats and covering for seats, stoves and stove-parts, electric heaters, electroliers, lamps, Pintsch gas equipment, stationary fare-registers, brass fixtures and trimmings, wire screens and all fixtures and trimmings inside of the car.
136 Item D. Car painting.

ACCOUNT NO. 7.—MAINTENANCE OF ELECTRIC EQUIPMENT OF CARS

(Passenger Cars, Mail Cars, Work Cars, Snow Sweepers and other Snow Equipment)

137 Item A. Shop work on motors and motor-parts, including armatures, fields, commutators, brush-holders, gears and gear-cases, pinions, bearings, motor-frames and parts, etc.
138 Item B. Shop work on trolleys and trolley-parts, controllers and controller-parts, appliances for power, lighting and heating circuits, including circuit-breakers, cut-out boxes, lightning arresters, rheostats, etc., and all car-wiring.

ACCOUNT NO. 7 A.—MAINTENANCE OF GRIPS

139 Item A. Shop work on grips, grip-parts, appliances and fixtures.

ACCOUNT NO. 8.—MAINTENANCE OF MISCELLANEOUS EQUIPMENT

140 Item A. Shop work on water and sprinkling cars, sand-cars, supply-cars, coal-cars and all other work cars.
141 Item B. Shop work on salt-cars, snow-plows, sweepers, scrapers and all other snow equipment.
142 Item C. Shop work on wagons and vehicles.
143 Item D. Shop work on harness equipment.
144 Item E. Shop work on other miscellaneous equipment.

ACCOUNT NO. 9.—MISCELLANEOUS SHOP EXPENSES

145 Item A. Shop work on repairs and renewals of shop machinery, tools and appliances.
146 Item D. Shop superintendence, including wages of superintendent and timekeeper.
147 Item E. Miscellaneous shop labor, including wages of engineer, oiler, electric light man, watchmen, tool boy, teamster, etc.

MISCELLANEOUS ACCOUNTS.—NOS. 23, 23 A, 24, 27, 33.

383 (23—Item I) Shop work on track-cleaning tools.
384 (23A—Item C) Shop work on tools for cleaning cable conduit.
388 (24—Item C) Shop work on tools for removal of snow and ice from tracks.
390 (27—Item B) Shop work on printing presses and appliances.
202 (28—Item B) Shop work on repairs and renewals of office furniture and fixtures.
408 (33—Item A) Shop work on "damage" wagons and vehicles. (Wagons and vehicles damaged by collisions with C. C. Ry. Co. cars.)

Table No. 2.—Subdivision and Itemization of Pay Rolls for the Year 1902

DEPARTMENT NO. 5.—REPAIR SHOPS DEPARTMENT.

Item.	Employees	Wages and Salaries	Per Cent
1. Pattern department	5	$3,318.13	2.3
2. Foundry department	8	5,252.05	3.7
3. Blacksmith department	21	12,663.32	8.8
4. Woodworking department	11	7,514.81	5.2
5. Machine department	36	21,661.35	15.1
6. Tinning department	17	10,690.33	7.4
7. Painting department	40	22,612.94	15.7
8. Car truck department	27	15,780.56	11.0
9. Car repairing department	39	23,546.95	16.4
10. Motor repairing department	20	11,307.17	7.9
11. Miscellaneous shop labor	9	5,422.38	3.8
12. Superintendent, assistant superintendent, timekeeper	3	4,020.00	2.7
	236	$143,789.99	

DEPARTMENT NO. 7.—CAR HOUSE DEPARTMENT

Item	Employees	Wages and Salaries
1. Clerks	16	$12,384.83
2. Watchmen, car pushers, car placers, etc., elevator men	49	36,655.77
5. Car cleaners	63	41,060.61
6. Lamp and headlight tenders	12	7,133.99

7. Car stove firemen	16	3,970.00
8. Wreck wagon crews	14	10,615.47
9. Other car house employees (not engaged on repair work)	18	10,591.78
11. Stablemen	3	1,522.31
	191	$123,934.76

DEPARTMENT NO. 7.—CAR HOUSE DEPARTMENT (SHOPS)

Item	Employees	Wages and Salaries
1. Foremen	5	$4,436.75
3. Car inspectors, motor inspectors and cleaners (electric)	15	10,188.73
4. Car inspectors, grip inspectors and cleaners (cable)	9	6,709.39
10. Other car house employees (engaged on repair work)	86	62,981.50
	115	$84,316.37

Table No. 2 shows the division of the pay roll for the year 1902, according to occupation. It may be interesting to note that the machine shop, car repairing and painting departments are about equal and are the largest items, being each more than fifteen per cent of the total.

Table No. 3 gives the amounts of the labor accounts for the shop and car houses. Of the shop pay roll, car repairs are only 61.5 per cent, construction accounts forming 11.4 per cent, power plant repairs 3.4 per cent, and track and line repairs 4 per cent.

Table No. 4 gives an itemization of the repair accounts.

Table No. 3.—Distribution and Charge of Pay Rolls for the Year 1902

DEPARTMENTS OF REPAIR SHOPS—CAR HOUSE (SHOPS).
DEPARTMENT NO. 5.—REPAIR SHOPS DEPARTMENT

Account	Amount
1. Maintenance of track and roadway	$3,288.16
2. Maintenance of electric line	1,668,83
2A. Maintenance of cable track and conduit machinery	822.10
2B. Maintenance of cables	248.73
3. Maintenance of buildings and fixtures	1,934.46
4. Maintenance of steam plant (electric)	1,695.57
4A. Maintenance of steam plant (cable)	924.02
5. Maintenance of electric plant	1,331.36
5A. Maintenance of cable plant	637.80
6. Maintenance of cars	58,300 50
7. Maintenance of electric equipment of cars	17,144.04
7A. Maintenance of grips	5,350.48
8. Maintenance of miscellaneous equipment	6,498.84
9. Miscellaneous shop expenses	24,038.08
14. Miscellaneous supplies and expenses of power plant (electric)	1.07
20. Wages of car house employees	32.00
22. Miscellaneous car service expenses	1,104.22
23. Cleaning and sanding track	23.13
27. Printing and stationery	2.85
28. Miscellaneous office expenses	346.01
29. Stores expenses	1,315.60
30. Stable expenses	2.75
32. Miscellaneous general expenses	611.88
33. Damages	23.43
1016. Track elevation	10.93
1017. Boulevard intersections	2.20
1026. Construction of new car house at Seventy-Seventh Street and Wentworth Avenue	1,469.17
1027. Track and electric line construction in new car house at Seventy-Seventh Street and Wentworth Avenue	222.23
1029. New booster for Forty-Ninth and Oakley Avenue electric power plant	24.34
1030. Reconstruction of Wentworth Avenue tracks from Sixty-Third Street to Seventy-Ninth and Halsted Streets	6.00
1032. Reconstruction of Archer Avenue car house	31.56
1033. New storage battery for Twenty-First and State Street power plant	132.21
1035. Rearrangement of overhead and underground feeders	6.86
1036. Construction of new boiler house at Fifty-Second Street power plant	148.88
1037. Installation of five new boilers at Fifty-Second Street power plant	240.79
1038. Construction of Sixty-Ninth Street tracks from Sixty-Ninth and Vincennes Road to Sixty-Eighth and Cottage Grove Avenue	247.11
1040. New electric power plant at Twenty-First and Dearborn Streets	340.89
1041. Construction of new repair shop buildings at Seventy-Seventh Street and Wentworth Avenue	9,339.11
1042. Installation of new coal conveyor at Forty-Ninth and Oakley Avenue electric power plant	6.93
1044. Removal of general repair shops	4,100.62
1046. Reconstruction of Archer Avenue tracks from State to Ashland	114.25
	$143,789.99

The wages paid in this shop are as follows:

	1902 Cents per hour			1903 Cents per hour		
Machinists	27½		30	30	33	
Machinists' helpers	17½		20	20	22½	25
Blacksmiths	27½		31⅝	30	3·	
Blacksmiths' helpers	19⅜			22		
Brass moulders	25		30	25	30	
Armature winders	25	27½	33	25	27½	33
Electrical helpers	10	15	18	10	15	18
Tinners	26¼		27½	26¼		27½
Harness makers	25			25		
Wood mill workers	20	25	27½	20	25	27½
Cabinet makers	25	27½		25	27½	
Car washers (paint shop)	17½			17½		
Rough painters (paint shop)	20	22½		20	22½	
Varnishers and finishers	25			25		
Stripers and letterers	27½			27½		

	Rate per day of 10 hours 1902			1903		
Car house repairers	$1.75	2.00	2.25	$1.92½	2.20	2.47½

The machine shop is equipped with three-wheel boring machines, one-wheel grinding machine, one hydraulic wheel press, twelve lathes, two planers, two shapers, six drill presses, two turret drill presses, one turret lathe, one double bolt cutter, one six-spindle nut tapper. For large work there has been installed a two-center lathe, the centers swinging respectively 26 ins. and 48 ins. As work which requires a swing of 48 ins. is rather infrequent this lathe is kept normally at work on the 26-in. centers. The largest planer has a travel of 10 ft., and is a convenient tool for planing motor frames and large castings. The wheel grinder is used for grinding the flat spots out of old wheels which are good enough to send back to the car houses again. The turret drills are most convenient machines for performing a series of operations on small castings, such as trolley wheels, controller parts, etc. The bolt cutter and nut tapper are used very largely in working over old bolts or for making special bolts. Large numbers of bolts which are sent in on account of defective or worn-out threads, and would otherwise be scraped are sheared off, cut with new threads and made into shorter bolts. For standard parts jigs and templates are used as much as possible. Table No. 5 gives the cost of performing some of the usual operations in this shop. Fig. 1 is a view of the machine shop. In the arangement of the machinery it was intended that the tools for heavy work should

DEPARTMENT NO. 7.—CAR HOUSE DEPARTMENT (SHOPS) BY DIVISIONS

	Division No. 1	Division No. 2	Division No. 3	Division No. 4A	Division No. 4B	Division No. 5	Total
6 Maintenance of Cars	$5.210.73	$9.350.14	$6,209.04	$6.509.58	$9.769.47	$7.588.10	$44.637.06
7 Maintenance of Electric Equipment of Cars	.....	3.991.58	725.32	3.992.22	2.516.40	4.155.79	15,381.31
8 Maintenance of Miscellaneous Equipment	1.25	.....	8.10	.....	.....	4.40	13.75
9 Miscellaneous Shop Expenses	.....	912.50	940.85	836.75	991.60	900.00	4.581.70
20 Wages of Car House Employes	3.916.19	3.279.95	4.435.18	3,248.52	1,942.84	2,643.45	19,466.13
22 Miscellaneous Car Service Expenses	.....	.....	114.31	117.61	.....	.....	231.92
30 Stable Expenses	4.50	.....	.....	.....	.....	.....	4.50
	$9.132.67	$17.534.17	$12,432.80	$14.704.68	$15,220.31	$15,291.74	$84.316.37

be underneath the crane and beside the track, so that heavy material could be handled entirely by the crane.

The electrical department contains five machines for winding coils or banding armatures, a wire cleaning and taping machine and three armature coil taping machines. Armature coils are made in forms upon lathes, taped in the machines, dipped in varnish and thoroughly dried in a steam baking oven before being used. Burnt-out fields are allowed to accumulate until there are enough to work on. The exterior insulation is then stripped, the wire insulation burnt off, the wire retaped and rewound into a field in the taping machine. By using old wire for this purpose there is a saving of $1 to $3 in the cost of each field. The entire difference between the cost of old and new wire is not saved, because there is additional labor occasioned by the use of scrap wire, and an expensive tape is necessary for reinsulating the wire. No bad results have been noticed on account of the use of scrap wire. Before the exterior insulation is put on the field the coil is thoroughly baked in the oven. Table No. 6 shows the cost of some of the work done in the electrical department and also illustrates the difference in cost between field coils wound with old and new wire.

In the tin shop repairs to headlights, sand-boxes, oil cans, waste boxes, etc., and all the repairs to the galvanized iron work, gutters and down-spouts of the company's buildings are taken care of. The equipment consists of punches, rollers, shears and formers. A nickel plating and burnishing plant is operated in connection with this shop.

In the upholstering shop, repairs to harness, awnings, cur-

Table No. 4.—Operating Expense Statistics for the Year 1902

MAINTENANCE OF CAR EQUIPMENT (PASSENGER AND MAIL CARS)

MAINTENANCE OF CARS

Maintenance of cars (954 cars in 1902) (account No. 6)	$177,922.87
Maintenance of one car per annum	187.00
Maintenance of cars per car mile run	.545

ITEMIZATION OF ACCOUNT NO. 6—MAINTENANCE OF CARS

Item	Amount	Per Cent of Total
A. Repairs and renewals of trucks, truck parts, life guards, fenders, etc	$107,264.12	60
B. Repairs and renewals of car bodies	34,835.86	20
C. Repairs and renewals of car fixtures and trimmings	11,315.55	6
D. Car painting	24,507.34	14
	$177,922.87	100
Pay roll charges	$98,665.04	55
Other charges	79,257.83	45
	$177,922.87	100

DETAILS OF CAR PAINTING

Cars repainted	49
Cars revarnished and touched up	1,017
Repairs of cars painted	277
Amount expended for car painting per car (954 cars in 1902)	$25.69

ITEMIZATION OF CAR PAINTING.

	Amount	Per Cent of Total
Pay roll charges	$16,381.38	67
Other charges	8,125.96	33
	$24,507.34	100

MAINTENANCE OF ELECTRIC EQUIPMENT OF CARS (ALL CARS)

Maintenance of electric equipment of cars (Account No. 7) (527 equipments in 1902; 125 4-motor, 402 2-motor)	$70,733.12
Maintenance of electric equipment of cars per equipment per annum (Account No. 7)	134.00
Maintenance of electric equipment of cars per equipment per car mile run	.386

ITEMIZATION OF ACCOUNT NO. 7—MAINTENANCE OF ELECTRIC EQUIPMENT OF CARS (ALL CARS)

Item	Amount	Per Cent of Total
A. Repairs and renewals of motors and motor parts	$51,405.08	73
B. Repairs and renewals of trolleys and parts, controllers and parts, power circuits, etc	19,328.04	27
	$70,733.12	100
Pay roll charges	$26,866.76	38
Other charges	43,866.36	62
	$70,733.12	100

OPERATION OF ELECTRIC EQUIPMENT OF CARS

Operation of electric equipment of cars (527 equipments in 1902)	$14,918.88
Operation of electric equipment of cars per equipment per annum	28.00
Operation of electric equipment of cars per equipment per car mile run	.081

ITEMIZATION

	Amount	Per Cent of Total
(Account No. 20. Item D) Wages of car inspectors, motor inspectors and cleaners	$10,324.09	69
(Account No. 21. Item A) 37½ per cent of lubricants, waste and rags for cars	3,672.58	25
(Account No. 21. Item E) Trolley rope (50 per cent of Item E)	659.64	4
(Account No. 21. Item F) Commutator brushes	262.57	2
	$14,918.88	100
Pay roll charges	$10,324.09	69
Other charges	4,594.79	31
	$14,918.88	100

MAINTENANCE AND OPERATION OF ELECTRIC EQUIPMENT OF CARS

Maintenance and operation of electric equipments of cars (527 equipments in 1902)	$85,652.00
Maintenance and operation of electric equipment of cars per equipment per annum	162.00
Maintenance and operation of electric equipment of cars per equipment per car mile run	.467

ITEMIZATION.

	Amount	Per Cent of Total
Maintenance	$70,733.12	83
Operation	14,918.88	17
	$85,652.00	100
Pay roll charges	$37,190.85	43
Other charges	48,461.15	57
	$85,652.00	100

MAINTENANCE OF GRIPS

Maintenance of grips (172 grips in 1902) (Account No. 7A)	$22,391.67
Maintenance of grips, per grip per annum (Account No. 7A)	130.00
Maintenance of grips per cable car mile run	.157

ITEMIZATION.

	Amount	Per Cent of Total
Pay roll charges	$5,343.32	24
Other charges	17,048.35	76
	$22,391.67	100

OPERATION OF GRIPS

Operation of grips (172 grips in 1902)	$8,218.42
Operation of grips per grip per annum	48.00
Operation of grips per cable car mile run	.058

ITEMIZATION.

	Amount	Per Cent of Total
(Account No. 20. Item E) Wages of car inspectors, grip inspectors and cleaners	$6,749.39	82
(Account No. 21. Item A) 15 per cent of lubricants, waste and rags for cars	1,469.03	18
	$8,218.42	100
Pay roll charges	$6,749.39	82
Other charges	1,469.03	18
	$8,218.42	100

MAINTENANCE AND OPERATION OF GRIPS

Maintenance and operation of grips (172 grips in 1902)	$30,610.09
Maintenance and operation of grips per grip per annum	178.00
Maintenance and operation of grips per cable car mile run	.215

ITEMIZATION.

	Amount	Per Cent of Total
Maintenance	$22,391.67	73
Operation	8,218.42	27
	$30,610.09	100
Pay roll charges	$12,092.71	40
Other charges	18,517.38	60
	$30,610.09	100

Table No. 5.—Machine Shop—Cost of Performing Various Operations

Labor in turning axle, cutting key-way, boring wheels and pressing wheels on axle.

(a) 30-inch wheels fitted on 4-inch axle for No. 49 Westinghouse motor.

Turning axle, 2½ hours at 25c	$ .63
Cutting key-way, ½ hour at 30c	.15
Boring and fitting wheels, ½ hour at 33c	.16
Pressing on wheels, ½ hour at 20c	.10
Total cost	$1.04

(b) 33-inch wheels fitted on 4½-inch axle for G. E. 67 motor.

Turning axle, 3½ hours at 25c	$ .88
Cutting key-way, ½ hour at 30c	.15
Boring and fitting wheels, ½ hour at 33c	.16
Pressing on wheels, ½ hour at 20c	.10
Total cost	$1.29

Cost of trolley wheels.—Material.

100 brass castings, 3 lbs., at 15c	$45.00
100 graphite bushings at 10c	10.00
Labor.	
Boring and facing 100 wheels, 4 hours at 30c	1.20
Turning 100 wheels, 2 hours at 30c	.60
Pressing in bushings, 1 hour at 15c	.15
Total cost of 100 wheels	$56.95
Cost per wheel	.57

Re-bushing and turning old wheels.—Material.

100 bushings at 10c	$10.00
Labor.	
Pressing out old bushings, 1 hour at 15c	.15
Pressing in new bushings, 1 hour at 15c	.15
Turning, 2 hours at 30c	.60
Total cost for 100 wheels	$10.90
Cost per wheel	.11

Table No. 6.—Electrical Repair Department—Cost of Performing Various Operations

TABLE NO. 6.—ELECTRICAL REPAIR DEPARTMENT—COST OF PERFORMING VARIOUS OPERATIONS.

Note—These estimates are based on the following cost prices:
No. 4 d. c. c. magnet wire, 15⅞c. per lb.
No. 5 and No. 6 d. c. c. magnet wire, 16c. per lb.
No. 6 square d. c. c. magnet wire, 21½c. per lb.
No. 7 d. c. c. magnet wire, 17c. per lb.
No. 0.220 asbestos covered wire, 19c. per lb.
No. 9 d. c. c. magnet wire, 18c. per lb.
No. 10 d. c. c. magnet wire, 18c. per lb.
No. 11 d. c. c. magnet wire, 18½c. per lb.
Scrap magnet wire for re-insulating, 10c. per lb.
Commutator bars, 22c. per lb.
Amber mica, 95c. and $2 per pound, according to size.

	Labor	Material	Total
Rewinding No. 12 Wesinghouse armature	$5.00	$12.73	$17.73
Rewinding No. 49 Westinghouse armature	5.30	14.31	19.61
Rewinding No. 3 Westinghouse armature	6.46	13.75	20.21
Rewinding G. E. 800 armature	11.57	18.27	29.84
Rewinding G. E. 67 armature	6.71	18.60	25.31
Rewinding No. 5 Walker armature	7.89	16.09	23.98
Manufacturing one No. 12 Westinghouse field coil (new wire)	0.95	8.17	9.12
Manufacturing one No. 12 Westinghouse field coil (old wire re-taped)	1.19	6.94	8.13
Manufacturing one G. E. 67 field coil, new wire	0.79	10.07	10.86
Manufacturing one G. E. 67 field coil (old wire re-taped)	1.12	6.78	7.90
Manufacturing one No. 12A Westinghouse field coil, new wire	0.88	12.81	13.69
Manufacturing one No. 12A Westinghouse field coil (old wire re-taped)	1.47	7.95	9.42
Manufacturing one No. 3 Westinghouse field coil, new wire	0.97	8.63	9.60
Manufacturing one No. 3 Westinghouse field coil (old wire re-taped)	1.47	6.95	8.42
Manufacturing one No. 5 Walker field coil, new wire	0.86	9.15	10.01
Manufacturing one No. 5 Walker field coil (old wire re-taped)	1.10	7.82	8.92
Manufacturing one No. 49 Westinghouse field coil, new wire	0.86	8.10	8.96
Manufacturing one No. 49 Westinghouse field coil (old wire re-taped)	1.19	6.64	7.83
Manufacturing one G. E. 800 field coil, new wire	1.08	11.70	12.78
Manufacturing one G. E. 800 field coil (old wire re-taped)	1.45	9.85	11.30
Manufacturing No. 12 Westinghouse commutator.	1.51	13.15	14.66
Manufacturing No. 12A Westinghouse commutator	1.59	22.56	24.15
Manufacturing G. E. 800 commutator	1.59	11.66	13.25
Manufacturing No. 5 Walker commutator	1.51	8.57	10.08
Manufacturing No. 3 Westinghouse commutator	1.51	11.55	13.06
Manufacturing No. 49 Westinghouse commutator	1.72	19.88	21.61

Details of winding G. E. 67 armature—Material.

65 lbs. No. 9 magnet wire at 18c	$11.70
6 sq. ft. No. 20 manila paper	0.04
45 yds. No. 4 sleeving	0.32
234 yds. ¾-inch linen tape	0.94
3 lbs. No. 16 band wire	0.58
1½ lbs. solder	0.25
4 sq. ft. fibre	0.11
2 lbs. India mica	1.76
1½ lbs. ¾-inch friction tape	0.36
2 lbs. 1½-inch friction tape	0.49
1½ sq. yds. drilling	0.11
3 quarts voltalac	1.12
3 sq. yds. No. 10 empire cloth	0.78
¼ lb. glue	0.04
Labor—	
Winding armature coils, 2½ hours at 0.175c	0.44
Gluing armature coils, 6 hours at 20c	1.20
Taping armature coils, 2½ hours at 15c	0.37
Cutting, tinning, dipping coils, 3 hours at 17c	0.51
Stripping, rewinding, soldering armature, 12 hours at 0.275c	3.30
Turning commutator, ½ hour at 0.275c	0.14
Banding armature, 5 hours at 15c	0.75
Total cost of rewinding armature	$25.31

Details of winding G. E. 67 field coil—Material.

48 lbs. 0.220 asbestos covered wire at 19c	$9.12
1 sq. yd. No. 10 empire cloth	0.26
1½ sq. yds. sheeting	0.10
1½ lbs. friction tape	0.37
1 pint Monarch insulating paint	0.15
1½ sq. ft. No. 20 manila paper	0.01
½ pint P. & B. paint	0.06
Labor—	
Winding coil, 1 hour at 17½c	0.17
Insulating, 2¼ hours at 27½c	0.62
Total cost of field coil	$10.86

Table No. 7.—Operation of Blacksmith Shop for One Day—July 24, 1903

Hammering old car axles into 1¾-in. x 1¾-in. guards for track work. Nine hours' work.

Plant for doing this work, one oil furnace, one 1500 lb. steam hammer and appurtenances.

Estimated cost of plant—$2,500.

Material—	
1374 lbs. old axles at 9c	$12.37
35 gals. fuel oil at 4.5c	1.58
Labor—	
Blacksmith, 9 hours at 33c	2.97
2 helpers, 18 hours at 22c	3.96
Total cost of 132 ft., 1374 lbs., 1¾ ins. sq	$20.88
Cost if purchased, 1374 lbs. at 2.15c	29.54
Saving by use of scrap	$8.66

Table No. 8.—Operation of Brass Foundry for Two Days—July 17 and 18, 1903

Castings made	No. of pieces	Weight
Grip dies No. 1	186	1860
Grip dies No. 2	296	1776
Grip jaws top	4	300
Grip beams	4	400
Controller parts	100	125
Shop repairs	8	15
Construction account	30	60
Total	628	4536

Average weight per casting, 7.23 lbs.

MATERIAL AND LABOR

Material—	
Brass—4301 lbs. at 13c	$559.13
Copper—338 lbs. at 14c	47.32
Zinc—10 lbs. at 5.65c	.56
Tin—90 lbs. at 28.35c	25.51
Fuel oil—125 gals. at 4.5c	5.62
Total cost of material	$638.14
Labor	24.44
Total cost of 4536 lbs	$662.58

Cost per pound, 14.6c.

To cover the cost of general superintendence, insurance, depreciation, repairs, etc., the sum of one cent should be added to this price per pound.

Cost of plant approximately, $3,000.

tains, etc., are made. Two power sewing machines are used.

A complete laundry, consisting of two washing machines, one extractor, one wringer and one ironing machine, is in use. One washing machine is used for washing towels and curtains, and the other for washing oily waste.

In connection with the upholstering shop a plant is maintained for the manufacture of rotary cane brooms for the electric sweepers. A great many of these brooms are made, as sweepers are used throughout the entire year for cleaning the right of way. A power machine is employed in this shop for splitting the cane.

The equipment of the blacksmith shop consists of eight down-draft forges, four oil-heating furnaces, one 1500-lb. steam hammer, one 600-lb. steam hammer, two Bradley hammers, one bulldozing and bending machine, one forging machine, three power punches and shears. The blast for the forges is furnished by an electrically-driven fan, and a suction induced by another fan takes away the smoke and gases through the hood over the fire, so that the air in the blacksmith shop is as pure as in any other shop. The air and smoke ducts consist of sewer pipe laid under the floor. One of the oil-heating furnaces serves the steam hammers, one the Bradley hammers, one the bulldozer and one the forging machine. A view of the forging machine, with the oil furnace beside it, is shown in Fig. 3. The advantages of oil for this work are that the heat may be perfectly regulated, that the furnace is ready for work within a few minutes after turning on the oil, that as soon as work is finished the supply of oil may be shut off, leaving no waste fuel as in the case of a large coke fire, that the manual labor involved in caring for the fire is small, that the capacity of the furnaces is so great that the machines served by the furnace may be kept in continuous operation without the necessity of the blacksmiths standing waiting for the iron to heat. The debated question of fuel economy is outweighed by these very evident advantages. The cost of hammering 1¾-in. x 1¾-in. iron out of broken or worn-out axles by means of the 1500-lb. hammer and oil furnace is shown in Table No. 7. Worn-out axles are also hammered out into switch tongues.

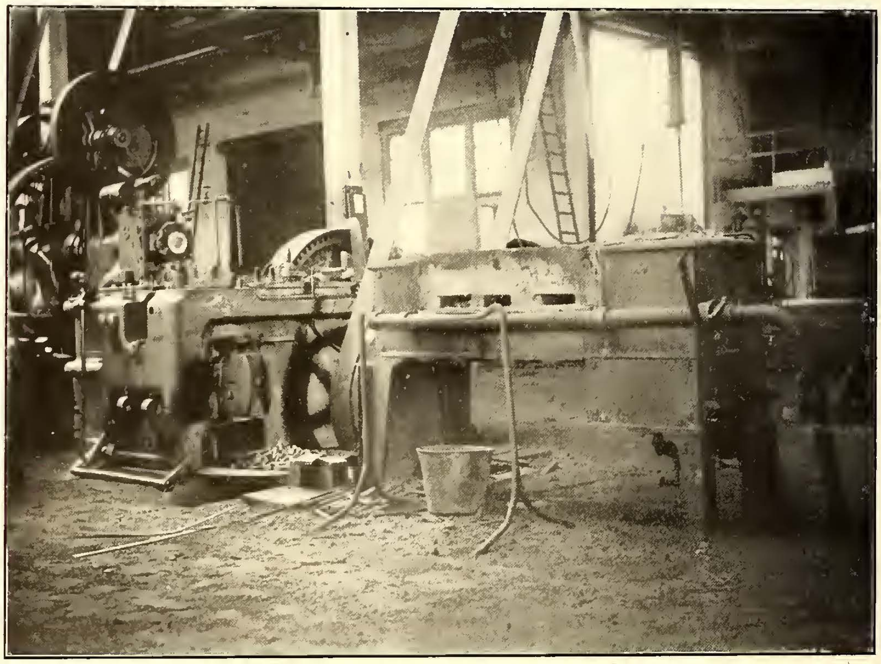


FIG. 3.—FORGING MACHINE FOR MAKING BOLTS AND RIVETS, WITH OIL FURNACE BESIDE IT

Adjoining the blacksmith shop and under the same foreman is a frog shop, where special work for the track is made. A great deal of this consists of T-rail crossings, of which the Chicago City Railway Company has 385 to maintain, on account of the numerous grade crossings with the steam railroads. The equipment for this shop consists of two small saws, a rail bender, two drill presses and one frog and switch planer, with a stroke of 18 ft., all of which are motor-driven.

The equipment of the brass foundry consists of one power shears, one core-drying oven, two babbitting furnaces, and one oil-melting furnace, with a capacity of melting 500 lbs. on one charge. This latter furnace is arranged something like a Bessemer converter, swinging on trunnions for pouring. Table No. 8 shows the cost of producing brass castings in this shop. A view of the brass melting furnace is shown in Fig. 4.

A wood mill contains saws, planers, surfacers, molding, mortising and tennoning machines, and all the machinery necessary to make car repair parts out of rough lumber. In the wood mill is also located the pattern shop. The only power machine in the paint shop is a paint grinding machine driven by a small electric motor.

A printing establishment for printing transfers and stationery is operated by the company, and should be considered in connection with the shop although it is not located at the shop but at the general office. The cost of printing transfers is shown in Table No. 9.

The power for the entire shop is furnished by motors running on a 500-volt circuit. For special reasons it was considered best in this installation to build a small electric plant at the shop, and all the motors are normally run on a metallic circuit, but an emergency switch is provided, by means of which the shop load may be thrown on the trolley circuit in case the shop plant is not running. Beside the steam engines running the generators there is not a steam engine in the plant. Large machines are provided with individual motors, and the other machines are driven in groups from shafting, an effort having been made to group together those machines which are likely to be running at the same time. Thus, in the machine shop the small machines are divided into three groups, each group being driven by a separate motor. Individual motor driving for each machine would have been very expensive of installation, and would have necessitated very serious complications in the electric wiring to get changes of speed.

Having thus briefly given the equipment of the shops it would be well to take up some of the questions which present them-

Table No. 9.—Cost of Printing Transfers for the Year 1903

Total transfers printed, 131,183,500.
Estimated value of plant, $5,000.

Labor	$2,202.90
Paper	3,267.41
Ink	181.50
Wire staples	53.25
Plates	309.60
Sharpening knives	10.00
Other expenses	58.25
Apportioned rent	300.00
Light and power	125.75
Depreciation and insurance at 20 per cent	1,000.00
Interest on $5,000 at 4 per cent	200.00
Total cost of 131,183,500 transfers	$7,708.66
Total cost per 1000 transfers	5.88

selves in shop practice. The best shop practice should follow as nearly as possible the best manufacturing practice. The secret of diminishing cost in modern factory methods lies in the ability to put through large quantities of material of a similar nature at the same time, to do nothing by manual labor which may be done by machinery, to employ as much as possible automatic tools, and to drive these tools at their maximum capacity. It is not possible to do all of these things in a repair shop, the advantage of the factory being that the same general class of work is done at all times, and that certain men perform only one operation, while, except in the very largest shops, the great variety of work which must be done in a street railway repair shop limits the economies which may be effected by restricting the range of operation of the same workman. Obviously a great step toward decrease in shop cost is the standardization of parts. It may be impossible to standardize car bodies, trucks, motors and car equipment, but it is possible to standardize parts, such as journals, brasses, axles, wheels, car trimmings, trolley wheels, trolley poles and bases, car couplers, etc. A great step in this direction has been made by the steam railroads, and the American Street Railway Association has had a very thorough report from a committee on this subject.

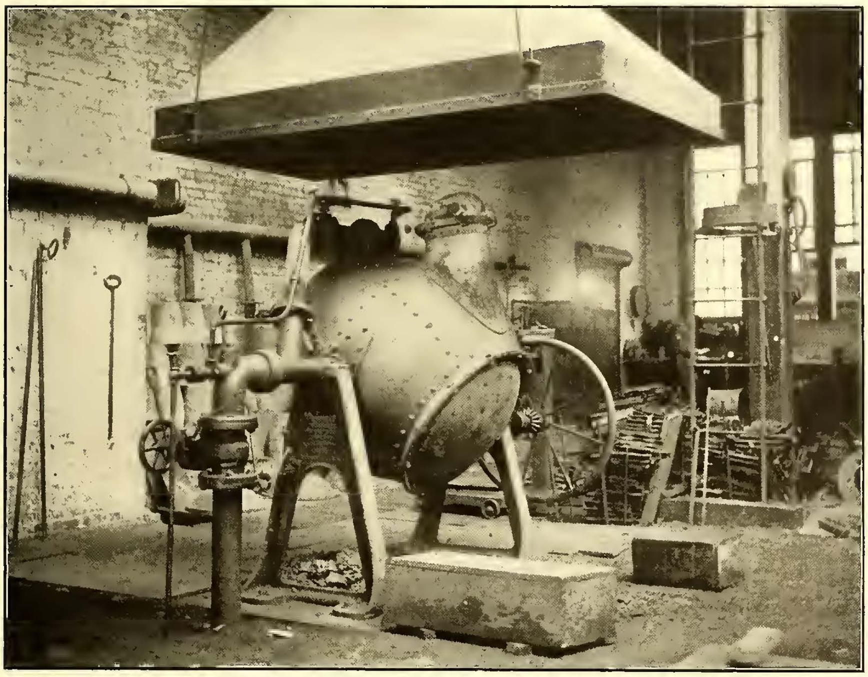


FIG. 4.—OIL FURNACE FOR MELTING BRASS

There may be a considerable difference of opinion between managers of different properties as to what is the proper standard, but there is no reason why standard parts should not be adopted on the same system or on several systems under the same general management. Having once adopted a series of standard parts a set of jigs and templates may be made in the shop and automatic tools installed which will reduce to a minimum the cost of any supplies manufactured in large quantities.

The work done in a shop may be divided into repairs of apparatus and renewals of worn-out apparatus. There is no escape from the repairs, but the matter of renewals usually involves the manufacture of certain parts, and the question often arises in street railway shops as to whether it is better policy to prepare to make these parts in the repair shops or whether it is better to buy them from manufacturing concerns. Master mechanics and foremen are inclined to rush unwisely into manufacturing, partly because of their desire to have a large shop and partly because they often deceive themselves as to the true cost of the articles manufactured by them, forgetting to charge such items as superintendence, insurance, depreciation, rent, etc., all of which enter legitimately into the cost price. No railway company should go into manufacturing unless it can be demonstrated that it can manufacture supplies much cheaper than it can buy them, and unless the demand for these supplies is so great that the plant bought for their manufacture and the men employed in their manufacture may be continuously employed. There are special instances of railroads located at a great distance from markets where the time necessary to get supplies makes it obligatory to manufacture certain articles, but these are the exceptions. If the question is fairly considered it will be found that, as a general rule, it is only the largest roads which can afford to manufacture at all.

It is difficult to arbitrarily enumerate the best shop methods because conditions vary in different parts of the country according to prices of labor and material, the equipment of each particular road, and the severity of the service. There is always the personal element, the executive and mechanical ability of the master mechanic and the foremen, which means success in its presence and mediocrity or failure in its absence, no matter what is the shop equipment. The following list enumerates briefly the matters to be looked after to insure the greatest economy in shop operation:

(1) The concentration of all the shops in one place and under one management.

(2) A simple organization by which there is a responsible head for each department, reporting to the shop foreman or master mechanic.

(3 The arrangement of the shops so that material progresses continuously just as in a well-arranged factory.

(4) Good light, heat and sanitary conditions throughout the shop. Men will always work better and more cheerfully when they are comfortable.

(5) Plenty of sunlight and the use of artificial light as little as possible.

(6) The handling of material, as far as possible, by hoists and cranes, facilitating the progress of material and avoiding the employment of skilled men at laboring work.

(7) A judicious working over of the scrap. Careful costs should be kept to determine in which cases this will pay and in which cases it will not.

(8) If manufacturing is done, the use of modern factory methods, such as manufacture in large quantities, the employment of automatic tools wherever possible, and the operation of these tools at their utmost capacity.

(9) The use of modern, improved machine tools. It is poor economy to use out-of-date tools, and it is poorer economy to use a man where a machine will do the work.

(10) The organization of some simple system of inspection and testing of apparatus before it leaves the shop. If the size of the shop does not warrant the employment of inspectors the foreman of the department or the general foreman himself should inspect and stamp each article so that the responsibility can always be located.

(11) The use of some simple system for periodically checking the cost of work done. This should be done fairly, however, and all items properly chargeable should be taken into account.

COMPOUND WOUND VS. SHUNT CONVERTERS

BY P. M. LINCOLN

It was not many years ago that the commercial success of the rotary was in doubt. Lack of flexibility in regard to voltage changes, the difficulty in starting, and most of all a tendency to hunt were looked upon as disadvantages that more than offset its smaller cost and higher efficiency as compared to a motor generator set. The engineer, however, attacked the problem, and, by means of various improvements, notably the grid damper, has succeeded in overcoming most of the inherent difficulties of the rotary. That his success has been complete is attested by the fact that the capacity of rotaries built by a single manufacturing company for Greater New York alone amounts to over 180,000 kw. This statement is more startling when it is considered that three years ago there were probably no rotaries of that capacity in operation in the whole world.

Except in specific cases the question with the engineer is no longer one between rotaries and motor generators, but one as to the particular kind of rotary. When the question has thus narrowed down to one of variety, one difference between types that is particularly apt to attract the engineer's attention is that between the compound and shunt rotaries. It is the particular object of this paper to discuss the advantages and disadvantages of the compound wound as compared with the shunt rotary. The advantages that will be discussed are:

First. The ability of the compound rotary to correct automatically for line drop.

Second. Beneficial reaction of the compound rotary on the generating system.

Third. Ability to obtain within limits any desired voltage characteristic from compound rotaries.

The disadvantages that will be taken up are:

Fourth. Somewhat greater complication.

Fifth. Greater liability of runaway condition.

Let us take up these points in order:

First. The ability of the compound rotary to correct automatically for line drop.

The ability to compound automatically is not always a necessity. If the amount of load to be carried as well as its time period can be foretold and the load changes are slow, the desirability of automatic compounding largely disappears. Such a condition obtains, for instance, where a rotary is used for incandescent lighting. In this case the adjustment of voltage needs to be so exact that the regulation by hand is usually a necessity whether compounding is used or not. If hand control be used for voltage regulation it may also be used for regulating the field of the rotary by the shunt, which, in compound rotaries, would be done automatically

When we come to the consideration of a railway load conditions are quite different. Here the load fluctuations cannot be foretold either in regard to time or amount, and are both sudden and violent in character; further, the maintenance of a given exact voltage is not nearly so important as in incandescent lighting. In this case the compound winding is usually indispensable if a constant or rising voltage characteristic is desired.

The compound winding is particularly necessary where the "drop" in the alternating-current system is considerable. This "drop" is the resultant of two elements, the ohmic and the inductive. The voltage at the collector rings of a rotary is further the resultant of the generator volts and the "drop." When the current taken by a rotary is lagging with respect to the e. m. f. supplied by the line, the inductive element of the line drop takes up such a position as to make the rotary voltage less than the generator voltage. The greater the angle of lag the greater subtractive effect has a given inductive "drop." On the other hand if the current taken by the rotary is leading with respect to the e. m. f. supplied by the line, the inductive element of the line drop takes up such a position as to increase the generator voltage. The greater the angle of lead the greater the additive effect of a given inductive "drop." The ohmic element of the "drop" is subtractive at all times, being a maximum when the angle between the current and e. m. f. is zero, and becoming less than this maximum as the angle departs from zero in either direction.

It is evident from these facts that if we can cause the current taken by a rotary to change automatically from lagging at no load or at small loads to leading at large loads we will automatically cause this inductive element of the "drop" to change from subtractive at small loads to additive at large loads, and thereby obtain compounding. To thus automatically change the angle between the current taken by a rotary and the generator e. m. f. is the function of the series winding of a rotary.

A somewhat fuller explanation of this last statement may be of interest. To generate a certain voltage at a given speed requires in any electrical machine, rotaries included, a certain magnetic flux through the armature, and to produce this flux a certain number of ampere turns is required in a rotary, or, for that matter, any other electrical machine. There exist two sources of excitation tending to force magnetic lines through the magnetic circuit—the field winding and the armature winding. If the excitation from the field windings of a rotary is not sufficient to produce the voltage that is supplied by the line, a current circulates in the armature in such a manner as to strengthen the field. The smaller the number of ampere turns furnished by the field winding the greater must be the assisting number furnished by the armature. This armature exciting or magnetizing current is lagging with respect to the e. m. f. of the line.

On the other hand, if the ampere turns in the field winding are more than sufficient to produce in the rotary the voltage supplied by the line a current circulates in the armature in such a manner as to oppose the field winding. The greater the amount of excitation furnished by the field winding the greater must be the opposing excitation furnished by the armature. This armature-demagnetizing current is leading with respect to the line e. m. f. The field ampere turns are automatically increased with the load by the series winding, and thus the current taken by the rotary may be changed from lagging at no load or light loads to leading at heavy loads.

In order to obtain an actual rise in voltage as the load increases it is usually necessary to insert an inductive resistance of some kind in the rotary circuit. It is usual to construct the transformers so that they are highly inductive and thus obtain the inductance for compounding.

In case the rotaries are operated directly from the generators it becomes necessary to insert choke coils in the rotary circuits in order to obtain compounding. It is evident, therefore, that when the benefits of compounding are desired it is necessary to use compound-wound rotaries together with suitable inductances in the rotary circuits.

This feature of automatic compounding is one of the principal advantages of the compound-wound rotary.

Second. Beneficial reaction of the compound rotary on the generating system.

An alternating-current system is peculiar in that the excitation for its generators may be obtained not only from the field of the generators themselves, but also from the field of any synchronous machine attached to the system. It is well known that two alternators may be run in parallel, one with a very strong field and the other with a very weak field, and that the voltage of this combination will be somewhere intermediate between that which either would have been alone. Making one of these generators a motor or a rotary will not change the condition so far as excitation is concerned. Over-exciting a synchronous motor or a rotary will produce a leading current in the generator armature, which in turn reacts on the field in such a manner as to assist the excitation. A series winding on a rotary, therefore, automatically compensates or tends to compensate for the drop in generator voltage, which a given increment in the power taken by a rotary would otherwise cause.

In a system carrying both lighting and railway load on the same generators, this point is of the utmost importance. The writer has in mind a plant where rotaries to the capacity of over 2000 kw are connected to the same bus-bars as supply the light for a city of 75,000 inhabitants, and excellent service is being rendered to both branches of the system. The rotaries are all compound wound, and, in the writer's opinion, such a combination of services from the same generators without compounding the rotaries would be absolutely impossible.

It is evident, therefore, that the reaction of a compound rotary on the generating system may be of the utmost benefit.

Third. Ability to obtain within limits any desired characteristic from compound rotaries.

The effect of a given series winding may be reduced by any desired amount by the well-known method of shunting. The series winding is usually designed to meet the condition that requires the maximum strengthening of field that will be desired. Its effect can then be cut down to the amount required by shunting. Further, if a drooping characteristic is desired the series can be reversed so as to oppose the shunt winding. One instance in which such a characteristic might be valuable is in the operation of rotaries in parallel with a storage battery on a fluctuating load without a booster. With a sufficiently drooping characteristic the necessity for boosters in such a combination would be entirely done away with. The rotary could be made to carry practically a constant load, while the storage battery would alternately discharge on the peaks of the load and charge on the hollows. Such a layout would, of course, involve a very considerable fluctuation in the voltage supplied to the line, but this condition is a fault of the storage battery and not of the compound rotary. That a rotary can be made to meet such a condition is further proof of its greater flexibility.

Now to consider some of the points of disadvantage:

Fourth. Somewhat greater complication.

The greater complication consists only in the addition of a series coil. This makes necessary the addition of an equalizer and of the necessary switchboard apparatus to take care of this addition. At the worst it is far from a serious item. No one would think of giving up compound-wound direct-current generators in favor of shunt on these grounds, and the additional complication is in each case about the same. This point may, therefore, be thus briefly dismissed.

Fifth. Greater liability of runaway condition.

In the opinion of some engineers the increased possibility of obtaining a runaway condition is the greatest defect of the compound as compared with the shunt rotary. At first glance this defect appears to be a serious one, because when any compound rotary runs as a motor in normal direction the series coil acts against the shunt and tends to weaken the field. A careful analysis, however, will show that possibility of runaway on account of the series coil is extremely remote.

The simultaneous conditions that must be fulfilled in order that a runaway condition shall obtain are:

First. That the alternating-current end of the rotary be entirely disconnected.

Second. That the current to cause the runaway condition shall come from a source outside the direct-current bus-bars upon which the rotary is operating.

Third. That the direct-current operating the rotary as a motor must reach a value of at least full-load current and usually much more than full load.

To discuss these points more in detail:

First. It is evident that so long as the alternating-current end of the rotary is connected to the line the rotary can run at no higher than synchronous speed. It is impossible, therefore, to attain a dangerous speed under these conditions unless the speed of synchronism become dangerous—a condition with which the series coil has nothing to do. A runaway, therefore, must occur either before the rotary has been synchronized in starting up, after the rotary has been pulled off at the alternating-current end in shutting down, or during a period when the rotary is accidentally disconnected at the alternating-current end.

Second. All rotaries in a given sub-station feeding into the same system are invariably connected to the same bus-bars, positive, negative and equalizer. If one of these rotaries is running as a direct-current motor from the current supplied by the others the path of the current is practically all through the equalizer bus, and, therefore, not through the series coil of any of the machines. The direct path through the equalizer from the rotaries which are operating normally to the one running as a direct-current motor is shunted by the series coil of the rotary operating as a motor in series with the series coils of the other rotaries. The resistance of this series coil circuit is invariably sufficient to keep any large proportion of the current from taking this path. When running as a motor from current furnished by its own sub-station, therefore, a rotary acts practically as a shunt motor and the series coils do not enter the problem. In order to obtain a runaway condition, due to series coils, the direct-current producing that condition must come from a source outside the sub-station in which the rotary is running.

Third. Practically all rotaries will stand at least double normal speed with safety. Increase in speed, therefore, does not become dangerous until it has become twice the normal. In very few rotaries does the series field, under full load conditions, have more than half the ampere turns of the shunt. That is, with full-load ampere turns in the series winding opposing the shunt the resultant field strength is still one-half normal, and the maximum speed that can be attained with normal voltage will be no more than double, or within the limits of safety. But to attain even this condition requires the assumption that a motor running without load will take full-load current— a condition which is obviously absurd. Five per cent of full-load current would cover the losses at no load even in the worst cases. The rotary would, therefore, operate practically as a shunt motor.

In a question of this nature, however, prognostications of a theoretical nature should give place to results of practice. Among all of the thousands of compound rotaries now in use the writer has never heard of a single instance in which the series coil has caused a runaway.

Recent Traction Apparatus

NEW BLOCK SIGNAL SYSTEM FOR SINGLE-TRACK ROADS

A new block signal system which possesses a number of valuable features has been in use for over a year on the Tamaqua & Lansford Street Railway, of Lansford, Pa., a line operating 20 miles of track and about 1700 car miles every day. The system is automatic and allows the operation of double-headers, triple-headers, or, in fact, any number of extra cars with perfect safety. It also warns the motorman of any car, while he is passing through a block, if the system has become disarranged during the time since he passed the block signal, and also warns him if a car going in the opposite direction has entered the block in disregard of the signal. That these three advantages are of great importance in practical operation will be realized by the practical operating manager, and that they can be secured by a simple arrangement of electrical circuits is remarkable. The experience of the Tamaqua & Lansford Railway shows that the system is not affected by weather conditions, that the signals have been found to operate equally well in rain, snow and sleet, and that lightning has no ill-effects upon the system. They have been in operation in a number of the severest thunder storms that visit this section, but none

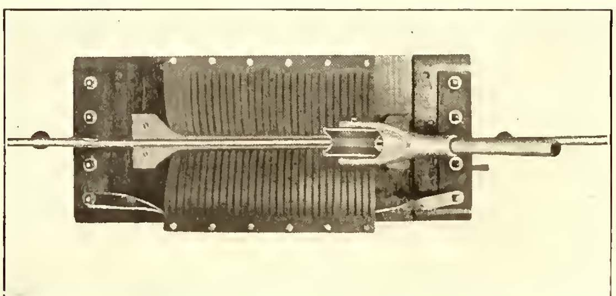


FIG. 2.—VIEW, LOOKING UP FROM BELOW, OF CONTACT MAKER

of the apparatus has been injured by lightning, due to the protective devices used and the fact that the circuits are only momentarily in connection with the overhead work of the trolley, as will be seen by a study of the diagram which appears in this article.

The general arrangement of the system is shown in Fig. 1. Each side of the signal turn-out is fitted with a contact-maker, illustrated in Fig. 2, and connected as shown in Figs. 1 and 3. This contact-maker consists of a sort of trough mounted on a wooden insulating block and composed of a double row of steel springs somewhat in the form of combs surrounding the trolley wire. One side is connected with the feed wire, as shown, and the other with the signal wire. The passage of the trolley wheel makes a circuit from one side to the other, and the entrance to the contact device is beveled to allow the easy automatic entrance of the wheel.

When the trolley wheel engages the contact device on entering a block it energizes an ingenious circuit controller which is shown in diagram in Fig. 1, and in detail in Figs. 4 and 5.

Normally, the signal circuit of an empty block is grounded at both ends. It includes a series of green lamps distributed along the block in any desired positions, and red lamps at the extreme ends of the block. The feed-wire connections to the signal circuit are normally open. The practical advantage claimed for this arrangement is that the signal circuit being normally dead, no accidental grounding through bad insulation, falling telegraph or telephone wires, etc., can energize the circuit and cause false signals. In case of any such accidental "ground" the system will still work on the entrance of a car into the block affected, but the dulling of the lamps in the portion shunted by the accidental ground will show the existence of trouble and help the repair gang to locate it without trouble.

Upon entering a block, a frog of special construction causes the trolley wheel automatically to take the right-hand branch of the divided trolley wire and engage the contact device thereon. The

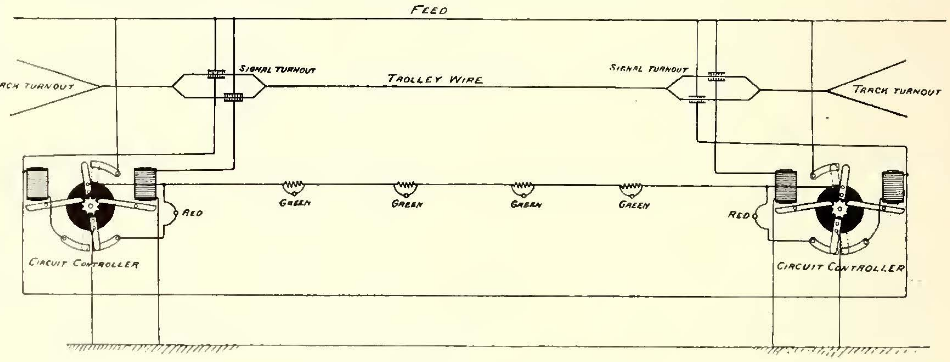


FIG. 1.—DIAGRAM OF CIRCUITS

current supplied from the contact device operates the circuit controller at that end of the block. That cuts out the ground at that end of the signal circuit, and cuts in the feed connection at that end, as shown in dotted lines, Fig. 1. This causes all the green lamps to glow and also the red light at the far end of the block. The green lights show the motorman that the block ahead is clear, and the far red light shows the motorman of a car approaching the other end of the block, that the block is occupied by a car coming toward him.

If another car follows the first, the glowing green light and the absence of any red light show the motorman that a car is ahead of him going in the same direction, and if his instructions are to trail that car he goes into the block under control. This does not change the signals, but moves the circuit controller a notch further.

When the first car goes out of the block at the far end, it operates the contact device in the right-hand branch and sets back the controller at the other end, one notch. If it was the only car in the block, it cuts out all the lamps and puts things back in the position shown in full lines in Fig. 1. If there are one or more cars following in the block, each car sets the controller back a notch, but only the last one will put the lights out. If the motorman sees the red lamp glowing at the end of the block as he leaves it, he knows that another car is trailing him.

If a motorman overruns a red lamp danger signal and enters a

FIG. 3.—VIEW OF CONTACT MAKER IN OVERHEAD SYSTEM

block while a car is in it running in the opposite direction, it cuts out both grounds and extinguishes all the lamps. This notifies the motorman in the block that a car has entered it from the other end in defiance of the signals, or that the system is out of commission, and he must stop or feel his way out. If a car enters a block wrongfully through failure of brakes or for any other reason, backing out will reset the system in its proper condition.

Two types of lanterns are used: the one shown in Fig 6, which is only employed for the intermediate, tell-tale lights, and that shown on the pole, Fig. 7, in which are the red lights placed at the extreme ends of the blocks. Two lanterns of similar construction to those in which the red lights are contained, but with only one reflector, one lamp, and one green glass in each, showing its light toward the entrance of the block, are placed about four pole lengths away from the red lanterns and further in the block. The arrangement of both of these lanterns is clearly shown in Fig. 7. In this view the red and warning green signals are shown on adjoining poles simply so that they could be more readily included in the picture. It will be understood, however, that in practical operation they are not so close together.

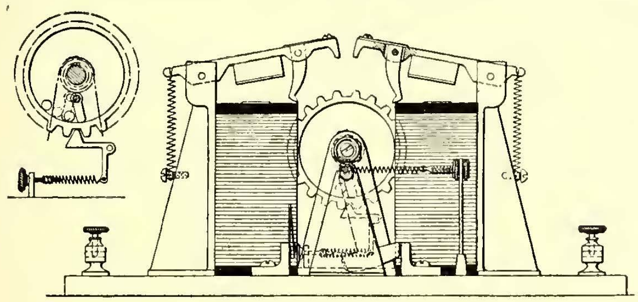
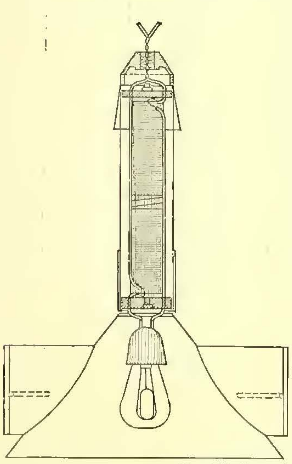


FIG. 4.—CIRCUIT CONTROLLER

The peculiar and strong feature of the lanterns with reflectors and thin colored glass is that in strongest sunlight they present a markedly different appearance when the lamp is lighted from that shown when the lamp is out, and as signals can be read at a distance of an eighth of a mile in broad daylight. While these lanterns are simple they are nevertheless effective and are the result of many experiments to produce a better lamp signal for daylight use than is possible with the employment of lights and lenses, as has been the practice heretofore.

Fig. 6 shows one of the intermediate green lights. In the simplest and cheapest installation all of the lamps are in series, as shown in Fig. 1. A resistance is placed in a shunt around each lamp, except those in the red lanterns. The red lamps should be replaced when they have been in service for about half of their rated life hours, or say once a month, for if a red lamp burns out the circuit is arranged to go practically out of commission, in order to increase the factor of safety. The life of the green lamps, or those with the coil in shunt, is increased greatly by the shunt, and will usually be 3000 hours.



Street Ry.Journal

FIG. 6.—INTERMEDIATE LIGHT SIGNAL

It will be seen that the code of rules to be used with the system is most simple. Every motorman knows that a red light means danger and a green light means safety. Upon this it is only necessary to base six rules: (1) When light shows red, don't enter a block. (2) When light shows green, enter under control. (3) When no light shows, enter at will. (4) When lamps fail to light on entering a block, back out. Special rules for the running of cars when the signals of a block are wholly or partly out of order can be provided by the management to meet special conditions and systems of operation. (5) When lights go out while in block, proceed with extreme caution. (6) When light shows red upon leaving a block, look out for trailers.

If one of the green lamps burn out, the current passes through the shunt resistance, and the rest of the system remains unaffected, with the exception of a slight dimming of the lamps. If one of the red lamps burns out, it disables the system for cars entering the other end of the block, rule 4 applying. If both red lamps burn out, it disables the system completely until they are replaced.

When the cost of extra wiring is not prohibitive, the manufacturers advise connecting the green lamps in multiple. When the number of green lamps in any one block exceeds the voltage capacity of the signal current, the multiple connection must, of course, be used. With the multiple arrangement, one lamp main is connected up to the ground switch of the controller at each end. The other lamp main is connected to the feed switch at each end.

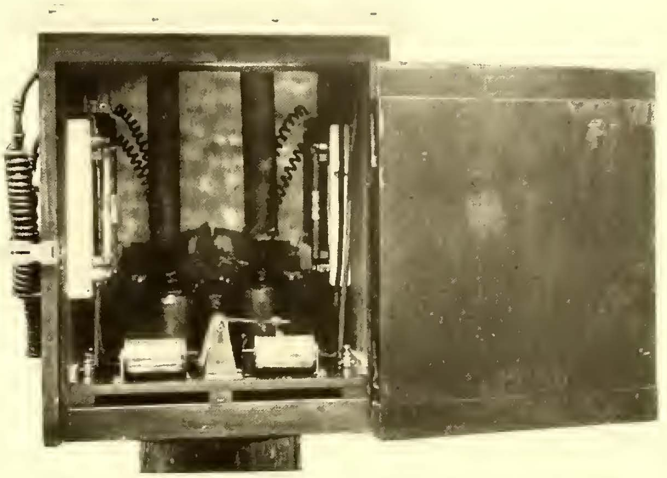


FIG. 5.—CIRCUIT CONTROLLER BOX OPEN

Semaphores may be used in addition to the lamps, if desired, and the manufacturers have a system in preparation in which the current, not dependent upon lamps for continuity, first sets the far signal and is then switched back to operate the near signal, thus securing the certainty that both ends of the block are guarded before a car enters it, and eliminating all possibility of accident through failure of the far signal to work.

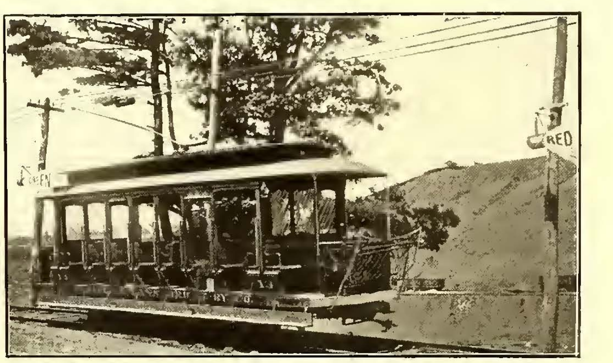


FIG. 7.—CAR AT BLOCK SIGNAL

This system was invented by Howell W. Souder of Tamaqua, and is being put on the Market by the Eureka Automatic Electric Signal Company, of Lansford, Pa.

NEW COMMUTATION TICKET

The National Ticket Company, of Cleveland, Ohio, is introducing a new form of commutation ticket that is meeting with considerable favor. It was originally designed for the Lake Shore & Michigan Southern Railway, and has since been adopted by several interurban electric railways. The agent's stub, coupons and contract are in one continuous strip folded conveniently for carrying in the pocket, and completely prevents manipulation by passengers, as coupons cannot be presented detached or old coupons inserted in new cover, as is often done with the old style commutation books. It has other advantageous features which are readily discernible upon examination of the ticket itself.

PROGRESS IN UNDERGROUND ELECTRIC RAILWAYS IN LONDON

In the entire field of electric traction no greater interest is shown in any plans than those which promise to revolutionize the system of intercommunication of the City of London. Substantial progress is now being made with the work of conversion, and it is expected that in the early part of 1904 electric trains will be running on some portion at least of the underground railways.

METROPOLITAN POWER HOUSE, WITH AMERICAN AND ENGLISH FLAGS ABOVE STACK

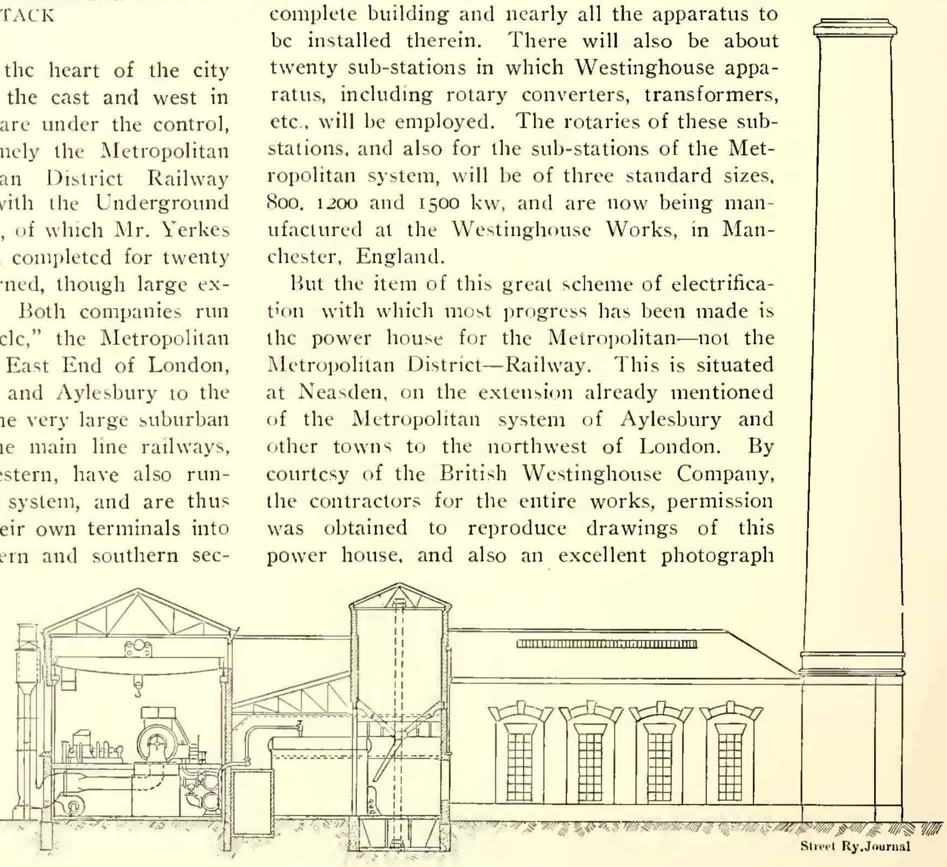
The underground lines which penetrate the heart of the city itself, and extend through the suburbs, to the east and west in particular, to a very considerable distance, are under the control, for the most part, of two companies, namely the Metropolitan Railway Company, and the Metropolitan District Railway Company. The latter is now connected with the Underground Electric Railways Company of London, Ltd., of which Mr. Yerkes is the master spirit. These roads have been completed for twenty years in so far as their city lines are concerned, though large extensions have been made on the outskirts. Both companies run trains on part of the so-called "Inner Circle," the Metropolitan running trains round the circle and to the East End of London, and also on a long branch line to Neasden and Aylesbury to the Northwest, while the District trains cover the very large suburban neighborhoods to the West. Several of the main line railways, notably the Great Western and North-Western, have also running powers on parts of the underground system, and are thus enabled to bring their passengers beyond their own terminals into the center of the city. The northern, eastern and southern sections are mostly cared for by the local trains of the main railways, whose terminals in these cases are for the most part more conveniently situated for the business districts. So much for the steam railways.

Next in turn is the rapidly developing tube railway system. There are at present three such lines in operation, all of course electric, namely, the Central London, the Waterloo & City, and the City & South London Railways. Of these the last was the pioneer, being indeed the first electric railway in Great Britain, and has now been working with uninterrupted success for a number of years. It runs from the city under the Thames and through the populous districts south of the river, having a total length of 6½ miles. The two side by side tubes, for the "up" and "down" trains respectively, are of considerably smaller diameter than those adopted in subsequent lines of the same character, and still smaller than the sizes which experts recommend for future tubes, namely 13′6″. The gage is standard, and the third rail of channel section, inverted, and secured by glass insulators to alternate ties. The rolling stock is of light character, the trains consisting of four carriages, capable of seating 130 passengers, and a locomotive. These latter develop 80 hp at 20 m.p.h, and are 32 in number. The first fourteen of these had series control, but all the others have the usual series-parallel arrangement. The average speed maintained is 14¼ miles per hour. This line has now been running regularly for nearly thirteen years, a fact which few Londoners, except those who daily use it, seem to realise.

The next London electric railway owed its inception to the enterprise of a main line railway company. The terminal of the London & South-Western railway, to which is brought daily an enormous local passenger traffic, is situated on the southern side of the Thames, at a considerable distance from the heart of the city. This drawback being recognized, powers were obtained for a tunnel railway from the terminal, known as Waterloo, to an underground station adjoining the Bank of England, the Stock Exchange, etc. This line has now been running about five years, and has fully justified the enterprise of its promoters. The rolling stock is of a much heavier character than that of the pioneer line, and locomotives are not used, the motors being mounted on the end cars, which are used as locomotives alternately according to the direction in which the train is running. The third tube railway now running, the Central London, is too recent to require description.

In addition to the foregoing there are numerous tube schemes in various stages of progress, a large proportion of them coming under the control of the same group as the District railway, viz.: the Underground Electric Railways Company of London. The electric power house being erected for all these lines, and also it is believed to feed part of the road jointly owned by the District and Metropolitan, is now being pushed forward by the British Westinghouse Company, which has obtained the contract for the complete building and nearly all the apparatus to be installed therein. There will also be about twenty sub-stations in which Westinghouse apparatus, including rotary converters, transformers, etc., will be employed. The rotaries of these sub-stations, and also for the sub-stations of the Metropolitan system, will be of three standard sizes, 800, 1200 and 1500 kw, and are now being manufactured at the Westinghouse Works, in Manchester, England.

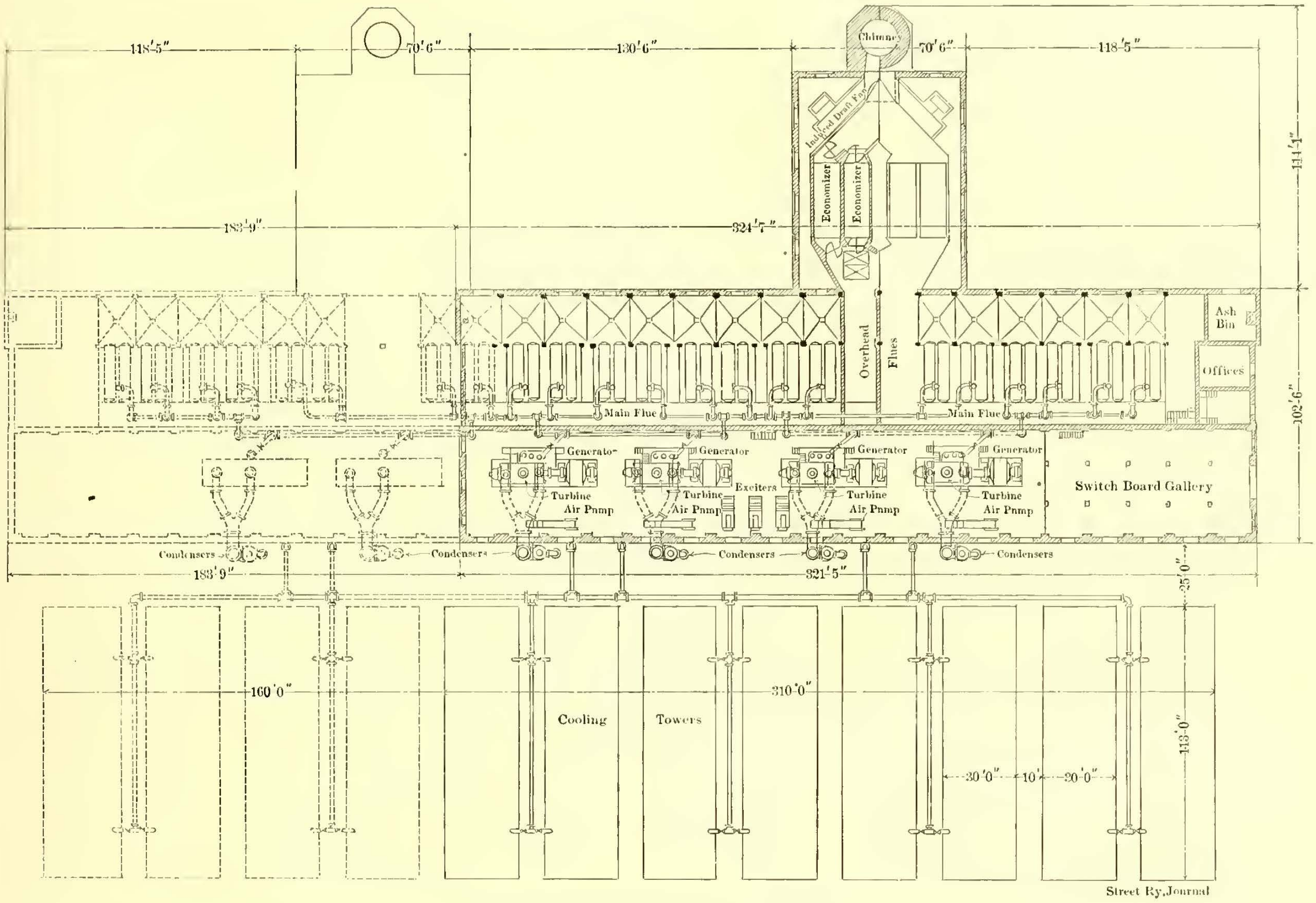
But the item of this great scheme of electrification with which most progress has been made is the power house for the Metropolitan—not the Metropolitan District—Railway. This is situated at Neasden, on the extension already mentioned of the Metropolitan system of Aylesbury and other towns to the northwest of London. By courtesy of the British Westinghouse Company, the contractors for the entire works, permission was obtained to reproduce drawings of this power house, and also an excellent photograph



CROSS-SECTION OF POWER STATION

taken during the process of building. The works are of particular interest as being the first instance of a large traction station employing only steam turbines. The turbines are of the Westinghouse parallel-flow type, steam entering at the center of the single cylinder and expanding through rows of blades to exhaust chambers at either end. Each turbine has its separate air-pump and

Alberger barometic condenser, while condenser water is supplied from two Klein cooling towers for each unit. The power station buildings are being constructed to contain four 3500 kw turbo-generator units, of which, however, only three will be put in at first. As indicated in the plan of the station, provision has been made for



PLAN OF POWER STATION, LONDON

a further extension to contain two more sets, with equivalent boiler plant and cooling towers and a second smoke stack. The first smoke stack, which is now, as will be seen, complete, is 200 feet high by about 15 feet internal diameter. The steam raising plant is to consist of 16 Babcock & Wilcox boilers, i. e., four to each turbine. The coal will be carried by an endless conveyor to the roof of the engine room, and then tipped into bins as required; from the bins it will feed down to the stoker hoppers by gravity. The main steam and exhaust piping will be located in the basement of the engine house, the condensing apparatus, with the exception of the air-pumps, being outside the buildings. The same conveyor will be used for handling coal and ash.

The turbines will drive alternating current generators of 3500 kw each, three-phase at 1000 r. p. m. They will be of the rotating field type, and will generate current at 11,000 volts for transmission direct without the interposition of step-up transformers. The switchboards will be at the end of the engine room, elevated on a gallery from which a clear view over the sets can be obtained.

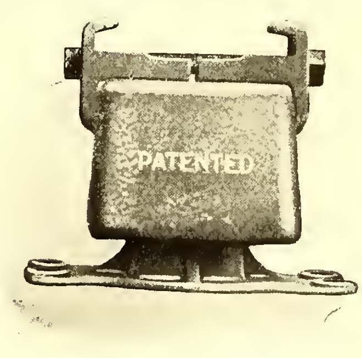
The entire layout of the power-house is convenient to a high degree, the compactness of the turbo-generators being very striking when compared with a plant of similar capacity using reciprocating engines and slow speed generators.

Orders have been issued to the officials of the Berlin underground and overhead railway to light all tunnels by wires wholly disconnected with the leads which supply current to the cars, and to install apparatus enabling train hands to cut off current anywhere and thus stop trains approaching the scene of an accident. The officials are also ordered to stop the overcrowding of cars.

VITRIFIED CONDUITS AND INSULATORS

The Standard Vitrified Conduit Company, of New York, has completed its factories at South River, N. J. These are said to be the largest of their kind in the world, and to produce more conduit than any six of the other conduit factories in the United States. This company manufactures conduits and third-rail insulators exclusively, and as it has unlimited quantities of pure stoneware clay on its premises, this advantage, combined with its experience in the art of clay working, should make the quality of its manufactures equal to, if not better, than any other conduit on the market.

The works are now in full operation, producing 100,000 ft. of conduit a day, and also manufacturing the Manhattan third-rail insulator. The company recently made over 43,000 insulators for the Scioto Valley Traction Company, in Ohio, and has done a large business with other street railway companies, especially in Pennsylvania, which have third rail systems. The Manhattan Railway Company, of New York, after a series of exhaustive tests, adopted the insulator, which is shown in the accompanying cut.. Most of the other third-rail systems which are using this type of insulator have adopted practically the same pattern.



MANHATTAN THIRD-RAIL INSULATOR

At the Convention at Saratoga, Sept. 4, 5 and 6, this company will be represented by B. S. Barnard, vice-president and secretary, with a thorough exhibit of its product.

NEW TRAMWAY SWITCH

The Keefer Car Switch Company, of Albany, N. Y., has recently placed on the market a railway switch which is operated from the car without stopping the latter, thus dispensing with switchmen besides saving time.

As shown in Fig. 1, this switch consists essentially of a bed-

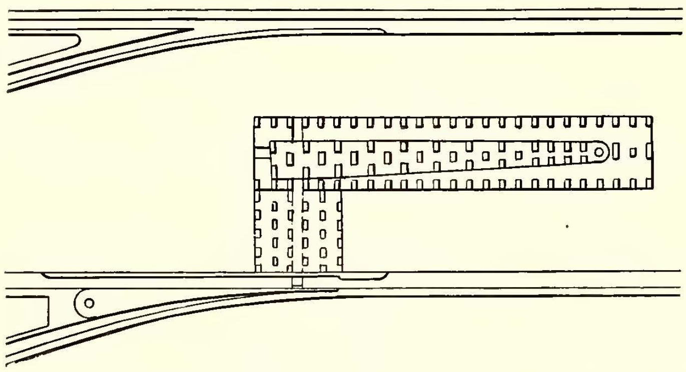


FIG. 1.—GROUND PLAN OF AUTOMATIC SWITCH

plate and a shifting block pivoted thereon. This shifting block is adapted to engage with a cross-bar running in a groove. By referring to Fig. 2 it will be seen that a lever carrying a shoe at the lower end is attached to the car. When this lever is in its normal position the shoe is not in contact with the shifting block, but upon pressing down the plunger which projects through the car platform, the shoe is brought in contact with the shifting block, which in turn engages with the cross-bar in the groove, thus throwing the switch.

By the use of this device the car platform is not affected by wrenching or otherwise by the operation of switching. The inventor of this switch has not only provided for the pull of the shoe from the front of the platform, but has also by adjustment of the cross-bar with the shifting block made it possible to use

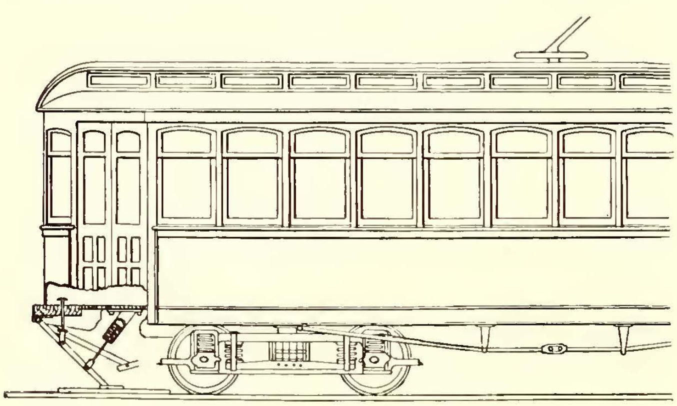


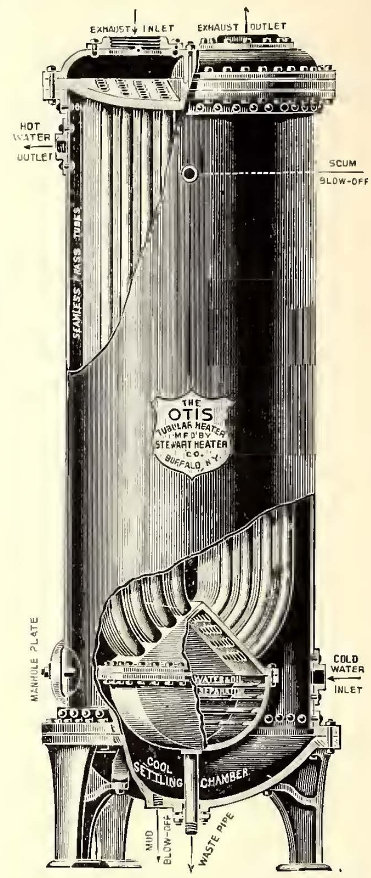
FIG. 2.—SIDE ELEVATION OF AUTOMATIC SWITCH

one set of plates regardless of the length of throw required. The switch is simple in construction, lies entirely on the surface, requires no weights or delicate adjustments, no connection with drain or sewer and may be attached to any switch point in use. The successful operation of the switch requires only that the motorman shall press his foot on the plunger when approaching a switch to see the switch point thrown in the desired direction.

FEED-WATER HEATER AND PURIFIER

The accompanying illustration shows an Otis feed-water heater and purifier, manufactured by the Stewart Heater Company, of Buffalo, N. Y. This device is used to thoroughly heat the feed water by the exhaust steam before it enters the boiler, to separate the mud and sediment from the feed water, and remove it easily and quickly from the heater; also to collect and carry off the scum from the surface of the water, and the condensation and oil from the exhaust.

The body or shell of heater is made of boiler iron or steel, the top end of which is riveted to a heavy cast-iron ring, with a projecting rim cast upon its outer surface, forming a flange, to which the tube sheet and top dividing plate is attached by one row of bolts. The lower end of shell is riveted to a heavy cast-iron conical bottom, which is supported by four legs, making a substantial base for the heater.



TUBULAR FEED-WATER HEATER AND PURIFIER

In operating the heater the exhaust steam enters the heater at the top, passes down one section of tubes into the enlarged space of water and oil catcher, where the water of condensation and oil is separated, then passes up through the other section of tubes, thus passing twice through the entire length of the heater, heating the feed water to the boiling point. The exhaust steam can then be used for other purposes or can be exhausted into the atmosphere.

The water enters the heater near the bottom, and passing upward in contact with the heated tubes, gradually becomes thoroughly heated, and is discharged as near the top as practicable without carrying the scum that is on the surface of the water into the boiler.

This heater is guaranteed to heat the feed water to the boiling point with the exhaust steam without causing any back pressure when the company's standard heater is used, and that all impurities in the feed water that will precipitate at that temperature will be deposited in the heater before the water enters the boilers. This heater will separate and carry off the water of condensation from the exhaust, and will extract the oil from the exhaust so that the exhaust steam can be used for heating purposes, and the condensation from the heating coils be returned to the boilers without injury to them. Scale will not accumulate in this heater, and all necessary cleaning can be easily and quickly done.

MOTOR COMPRESSORS FOR STREET RAILWAY SERVICE

Economy in the wrong place is extravagance, especially in the equipment of railways and cars. Probably in no part of the car equipment is this false economy more often practiced than in the air-motor compressor. Ample compressor capacity should be provided to meet not only the auxiliary appliances calling for the use of air, as well as the brakes, but also to provide against leaky pipes, temporary derangement of minor parts, and other accidents.

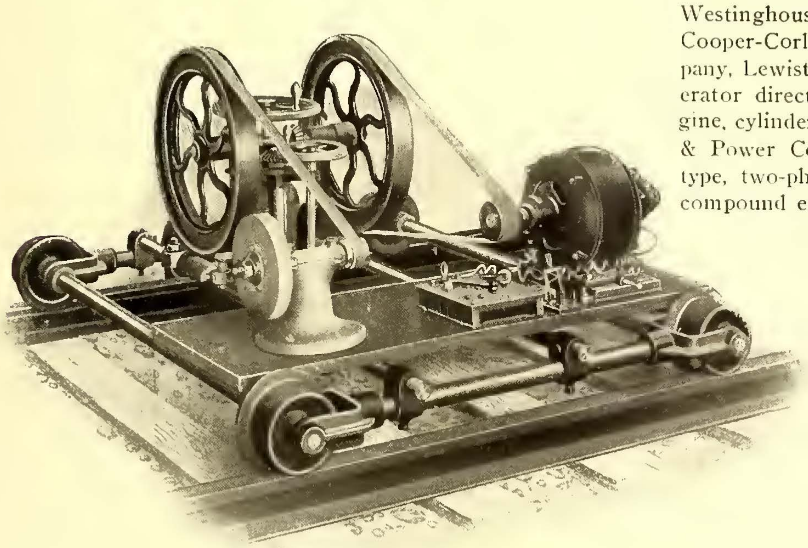
Another practice, the wisdom of which is questioned, is the enclosing of the motor compressor. While this reduces the noise somewhat, it is claimed that it is at the sacrifice of mechanical efficiency, and it is pointed out that whether the box is on or off, the noise to the occupant of the car is about the same, the extra noise being noticeable only to one outside, and that to no great extent.

The generation of heat is inseparable from the compression of air. In stations where the service is continuous, a water jacket is usually provided to absorb the heat, but in street railway air-brake service the compressor is often boxed. Those who are opposed to this plan suggest that those parts of the compressor itself that become heated will be subjected to the draft of air and cooled, thereby increasing the efficiency and life of the machine. The interior of course must be protected from dirt and other foreign matter by providing means to render it practically dust proof, as, for instance, making the casing integral with those parts which heat in running, in order that the casing may serve to aid in dissipating the heat generated.

It is along the lines here indicated that the motor compressors made by the Westinghouse Traction Brake Company are constructed. In the electric pump governor made by the same company, a simple diaphragm with pneumatic pressure and a slide valve is used instead of high resistance magnet coils. This company disapproves the use of magnet coils on the ground that they are easily damaged and liable to frequent break downs in service, while the slide valve, once fitted, rarely gets out of adjustment. It is similar to the slide valve used in the triple valves of this company's make. It is of very rugged construction and is not liable to easy derangement.

MOTOR-DRIVEN TRACK DRILLING MACHINE

The Ludlow Supply Company, of Cleveland, Ohio, has recently added manufacturing to its supply business, and is this year developing many devices for use in the construction of electric rail-



MOTOR-DRIVEN TRACK-DRILLING MACHINE

ways. One that it has made a specialty of is the Cleveland track-drilling machine, operated by hand or electric power.

The accompanying cut shows one of its machines operated by a 1-hp electric motor. It also shows the emery wheel attachment which the company is putting on nearly every machine this year. With this machine it is possible to drill a 2⅞-in. hole through a 70-lb. A. S. C. E. rail in from 30 to 35 seconds. The hand-power machine for the same purpose was illustrated in the Street Railway Journal for Aug. 15.

Among the many street railways using these machines are the following:

Union Traction Company, Anderson, Ind.; Illinois Valley Traction Company, Ottawa, Ill.; Interborough Rapid Transit Company, New York; New York & Long Island Traction Company, Hempstead, L. I.; Pittsburg, McKeesport & Connellsville Railway, Pittsburg, Pa.; Cleveland, Painesville & Ashtabula Railway, Cleveland, Ohio; Northern Ohio Traction & Light Company, Akron, Ohio; Cincinnati & Columbus Traction Company, Cincinnati, Ohio; Dayton & Western Railway Company, Dayton, Ohio; Toledo & Western Railway Company, Toledo, Ohio; Detroit, Monroe & Toledo Short Line Railway, Detroit, Mich.; Ohio & Indiana Railway & Light Company, Angola, Ind.; Louisville Railway Company, Louisville, Ky.; Consolidated Railway & Power Company, Salt Lake City, Utah; Everett Railway, Light & Power Company, Everett, Wash.

RECENT RAILWAY INSTALLATIONS

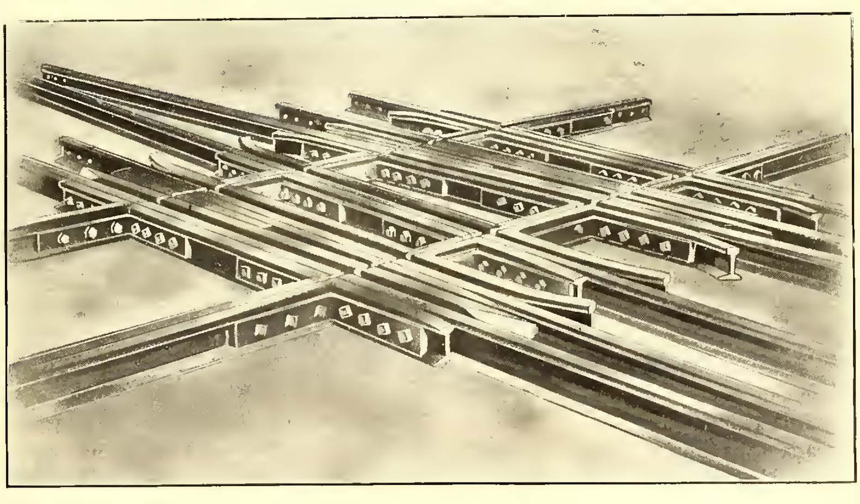
Rossiter, MacGovern & Company have just completed for the Hudson Valley Railroad Company, Glens Falls, N. Y., the installation of a 525-kw General Electric 10-pole generator direct-connected to an Allis-Chalmers tandem compound engine with cylinders 22 ins. and 42 ins. x 42 ins., running at 90 r. p. m. They have also installed the complete steam equipment, consisting of feed and water pumps, feed water heater, steam piping, condenser, etc. This complete unit was erected and in actual operation within forty-five days from signing contract. Rossiter, MacGovern & Company take considerable pride in this class of work. They will be very glad to have their friends visiting the Saratoga Convention inspect this unit, as they regard its not only as a fair example of the kind of apparatus they sell, but also of the class of construction work they are accustomed to install. In this connection they wish to call attention to the fact that they not only buy and sell street railway apparatus of all kinds, but are making a specialty of high-class construction work, turning the apparatus over to the purchaser in complete operating condition.

Among the several important contracts recently closed by this company with street railways are the following: Twin City Rapid Transit Company, Minneapolis, Minn., one 1630-kw. 100 r. p. m. Westinghouse generator direct-connected to cross-compound Cooper-Corliss engine; Lewistown & Reedsville Traction Company, Lewistown, Pa., one 375-kw. 215 r. p. m. Westinghouse generator direct-connected to Westinghouse tandem-compound engine, cylinders 23 ins. and 40 ins. x 20 ins.; Kokomo Railway Light & Power Company, Kokomo, Ind., two 300-kw. Stanley engine type, two-phase, 60-cycle generators connected to Russell cross-compound engines, together with condensers, switchboards, etc.; Montreal Terminal Railway Company, Montreal, Canada, twenty Westinghouse 12-A railway motor equipments complete.

SPECIAL RAILWAY CROSSING

The accompanying cut, which shows the crossing of an interurban electric railway with three steam railroad tracks, is fairly representative of the intricate construction necessary in crossing steam railroads where tracks are so closely arranged. The crossing illustrated was made by the Indianapolis Switch & Frog Company, of Springfield, Ohio.

Crossings of this design are built by this company with easer or reinforcing rail, which serves to carry locomotive tires and prevents their striking the abutting rails of the electric railway track,



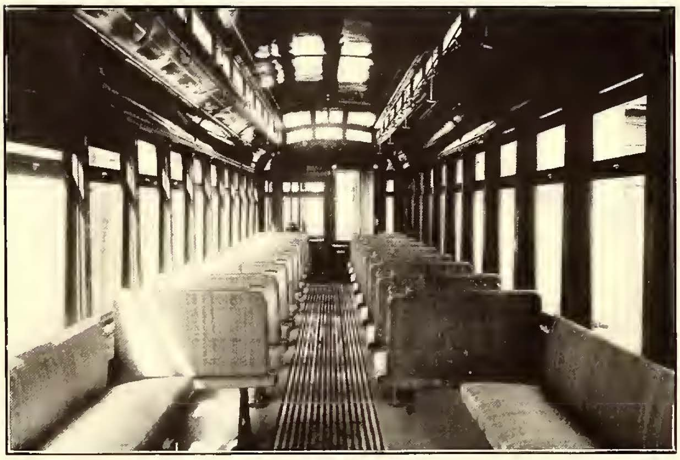
SPECIAL RAILWAY CROSSING

adding very materially to the life of the crossing and preserving the alignment. They are constructed with solid rolled steel filler and extra heavy corner irons and bolts, built for exacting service and heavy traffic.

This company has given special attention to the requirements of interurban railways and has furnished numerous railways throughout the country with entire equipments of special work, such as crossings, frogs, switches, stands, curves and car house layouts. It has recently completed the equipping of a new plant, the main building of which contains over 2 acres of floor space, and has added a line of new machinery and appliances which more than doubles its capacity.

SEMI-ACCELERATOR CARS FOR OMAHA & COUNCIL BLUFFS

The American Car Company recently sent to the Omaha & Council Bluffs Street Railway Company ten cars of its patented semi-accelerator type, like the one shown in the accompanying



INTERIOR OF OMAHA CAR

illustration. The remarkably rapid growth of these cities—there is a population of over 200,000 within 6 miles of the Union Station, of Omaha—has made it necessary to use every means to shorten the stops to the utmost extent. The illustration of the interior shows the position of the door on the left side, and as one can readily understand, not only is the distance between the door and the step shortened, but the passengers are kept from standing on the platform in the way of those passing in and out. The cars run in one direction only, and therefore the seats are arranged with stationary backs. At the rear end, which is chiefly used for ingress and egress, the longitudinal seat on

EXTERIOR OF OMAHA CAR

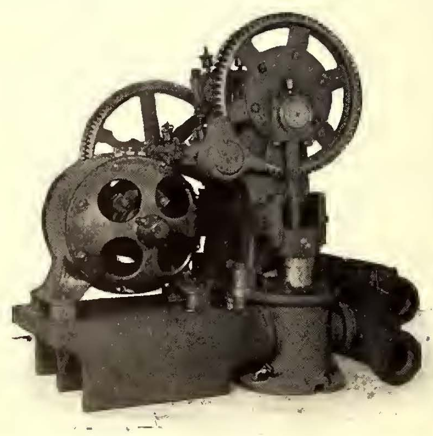
one side is 68 ins. long and on the other side (the door side) the seat is 51 ins. long. At the forward end there are no longitudinal seats. Space is made at the door by the use of a single seat at that side.

The windows are double, the upper sash being stationary and the lower arranged to drop into pockets which extend down between the double sills. The front platform is vestibuled and a hot water heater placed in the corner opposite the door. The interior finish is in natural cherry with birch ceilings, neatly decorated. The underframing of the cars is unusually powerful The center sills are composed of I-beams extending the full length of the body and placed 15 ins. apart. The side sills are double 2¾ ins. x 7¾ ins. each, plated on the outside by ⅝-in. steel, and have upper and lower trusses, the upper truss rod of ⅜ ins. x ½-in. steel is gained upon the posts 16½ ins. from the floor. The four platform knees are plated with angle iron, the two center knees having the angle iron bent up and connected with the I-beam center sills back to the bolster. Angle iron bumpers of the Brill patented type strengthen and protect the ends of the platform. Distance from center to center of posts is 2 ft. 8 ins. Thickness of side posts is 3¼ ins., and thickness of corner posts 3¾ ins.

Level of cars over end panels, 34 ft.; length over crown piece, 45 ft.; from panel over crown piece, 5 ft. at front end and 6 ft. at rear; width over sills, including sill plates, 8 ft. 3¼ ins. From rail-head to step, 18 ins.; from step to platform, 14½ ins.; from platform to car floor, 9 ins. The cars are mounted on the American Car Company's M. C. B. truck No. 14, with 6 ft. wheel base, 33-in. diameter wheels, and are equipped with four 38-hp motors.

MOTOR-DRIVEN TRIPLEX PUMP FOR GENERAL SERVICE

The accompanying cut illustrates an electric triplex pump manufactured by the Deming Company, of Salem, Ohio, which man-



MOTOR-DRIVEN TRIPLEX PUMP

ufactures a very extensive line of pumps and other hydraulic machinery. This pump, which is built for 150 lbs. pressure, embodies the best results of many years' experience in designing and manufacturing pumping machinery. Pumps of this type are used in many mills, factories and power stations for tank and boiler feeding and fire service where economy of fuel is an important item. They are built for operation not only by direct or alternating current motors, but also by gas, gasoline and oil engines.

The construction varies in the different sizes, but embodies in each steel crank shafts in one piece; cut gearing; pinion shafts adjustable toward and from crank shafts; ample bearings; outside guided and outside packed plungers (plungers have no rubbing contact in the pump-base); large valve areas; suction and discharge openings on either end of pump, and in the large sizes the valve chamber can be attached to either side of base. When arranged for direct connection to electric motor, the pump is furnished complete with a sub-base and intermediate gearing for any make of motor, the motor pinion being always made of rawhide. The whole outfit is especially suitable whe-e the installation must be made in a minimum amount of space. The increasing business of the company, particularly in power pumps, has recently necessitated an extensive addition to its former works.

TRACK AND MOTOR TESTING INSTRUMENTS

The improved testing instruments exhibited by R. W. Conant, of Cambridge, Mass., are attracting much attention, especially two of the latest, to be shown at the Saratoga Convention. The T-pole bond tester is shown in Fig. 1, as it appears when being used. The principle of this instrument involves the use of a telephone receiver, in which the sound is augmented by a special intensifying attachment devised by Mr. Conant. First contact is made at three points on the rail, giving two sections of equal length, one being solid rail and the other including the joint; then a resistance box is manipulated until no roaring is heard in the telephone, indicating that the electrical effect of the two sections of track on the telephone are then equal. This manipulation of the "balancing switch" takes about a second and its position then shows on a scale the ratio of the resistance of the joint section to the solid section of equal length.

The contact apparatus consists of a center pole with steel chisel welded to a socket at its lower end, to which are bolted by one thumbscrew two extension beams reaching out on the rail 3 ft. on either side. These carry two hardened steel chisels which are kept sharp by a hand-stone furnished and carried in the case of the instrument. The edges are set so as to extend in the direction of the length of the rail, while the center chisel edge is at right angles to the rail length.

The extension beams are of a light elastic wood and are tough and springy. The wrought steel knees, by means of which the extension beams are bolted to the center chisel, are permanently fastened to the beams in such positions that when the T is placed on the rail the outer chisels touch first, while the center chisel edge is about 2 ins. above the top of the rail. Then by resting the hollow of the foot on one side, near the center, the T is sprung down so that the center chisel rests firmly on the rail. This springing action forces the other chisels outwards with a scraping movement that cuts them into contact with the rail.

With the T-pole connected to the instrument and the telephone in position the operator places T-pole on rail with rail-joint under one beam. The instrument is started by switch at side, and the balancing switch is placed on the point numbered one. A roaring

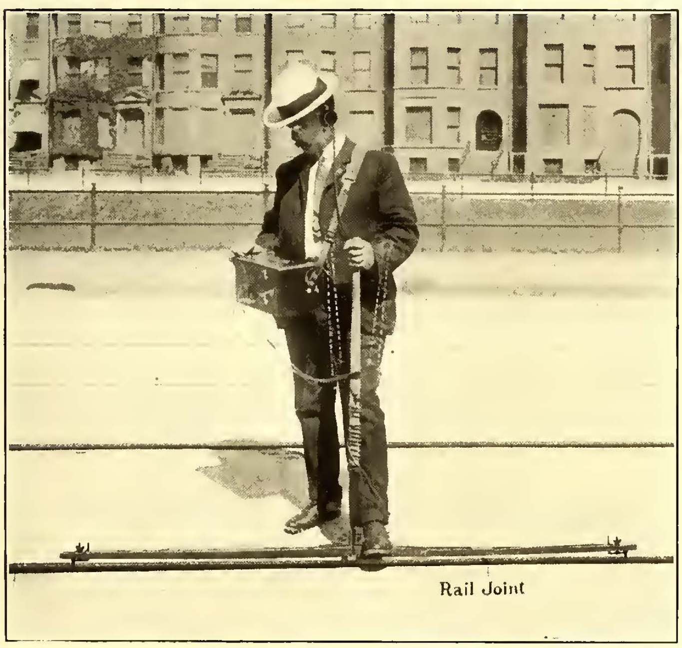


FIG. 1.—T-POLE BOND TESTER

sound in telephone indicates that balancing switch is to be moved to point of silence. When this has been done the number at which the switch stands is read off. This number shows the value of the resistance of the rail-joint in terms of the standard length of rail spanned, which is 3 ft. The instrument cannot be burnt out or injured by open joints and tests with one operator 1000 joints per day.

Fig. 2 illustrates the Conant motor tester in operation on a car. This instrument measures the magnetic strength of the motor coils and not their resistance, and defects, therefore, show up in their true relative importance as affecting the operation of the motors. Its construction is such that it can be readily operated by the car-house man, and its use does not involve any calculation or particular care in regard to making exceptionally good contact. All that is necessary is to push the contact awls through the flexible wire as it comes from the motor. It has been adopted by many street railways.

Its systematic use has developed some very interesting causes of motor trouble, among which may be mentioned the following: A field may be thoroughly baked out but does not always short circuit until it has run a few trips and heated up. After the short

FIG. 2.—USING MOTOR TESTER ON CAR

circuit has developed under some conditions the arc welds the turns together, and when the motor cools off it is still short circuited, but sometimes the jarring and contraction in cooling will cause the short circuit to temporarily disappear. The ability of the instrument to test while the motors are hot is therefore invaluable in such cases. This it is able to do since its indications are unaffected by resistance changes.

A short circuit caused by moisture, usually found in the lower spools, has not the same faculty of disappearing, presumably because the wires are held more tightly together, since but little of the insulation has been destroyed. These coils usually appear as good as new when first stripped, and it is not until a layer or two is unwound that a greenish coloring is noticed on the cotton and usually at the corner of the coil the two wires will be pitted and show where the arcing has welded them together.

Rewinding defects are of surprisingly common occurrence, such as insufficient insulation under the inside end of the field coil, use of improper soldering fluids, resulting in the deterioration of the insulation, etc.

Both the motor and bond testing instruments have been constantly improved in such particulars as experience has shown would result in increasing their durability. The Boston Elevated Railway Company and the Massachusetts Electric Companies are among the large railways extensively using these devices.

AMUSEMENTS FOR STREET RAILWAY PARKS

The degree of success attained in attracting summer traffic is an important factor in the earnings of many street railway companies, especially of those owning picnic grounds. In some instances such parks are managed directly by the railway company, but it is often found advantageous to permit some manufacturer of amusement devices to control such places at his own expense, the railway company receiving a part of the gross receipts.

One of the most successful builders and managers of amusement apparatus for railway parks is the Ingersoll Construction Company, of Pittsburg, Pa. The members of this firm—Frederick Ingersoll, president, and E. E. Gregg, secretary and treasurer—have had long and successful careers in this line of work as they have never offered any but legitimate attractions. This company makes the well-known figure 8 roller coaster and the Ingersoll laughing gallery. The company states that it has found these two attractions to be great favorites with street railway managers, and believes that no picnic park is complete without one or both of them. The figure 8 roller coaster is said to be especially successful. As a proof of the company's confidence in its amusement devices wherever introduced, it is prepared to undertake the entire expense of constructing and maintaining an operating plant, agreeing to give to the park owners a certain percentage of the gross receipts.

The Ingersoll Construction Company has aranged to have a display of its novelties at the Saratoga Convention, and its exhibit will, no doubt, be found of interest and value to all connected with amusement enterprises.

NEW TYPES OF "ALL-WIRE" RAIL-BONDS

The Ohio Brass Company, of Mansfield, Ohio, manufacturer of the "All-Wire" rail-bond, will shortly announce, through a new catalogue, the placing on the market of a number of new types and forms of these well-known bonds.

The unit or "one-piece" principle on which these bonds are made is a very desirable feature, as by avoiding all cast or welded joints a greater degree of mechanical strength and electrical efficiency is secured than would otherwise be possible. The weakest part of all bonds is the junction point between the terminals and strands, and, as the "All-Wire" bond has no joint at this point, the strength of the bond at this point is as great as at any other part.

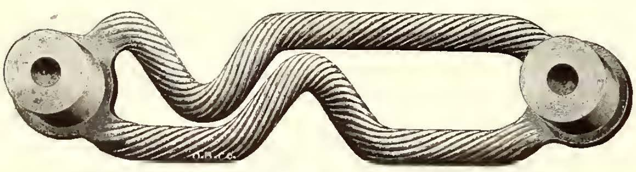


FIG. 1.—TYPE F, FORM 5, "ALL-WIRE" BOND

The type-F bond, one form of which is illustrated in Fig. 1, is especially adapted for use under the fish-plate, and as the strand enters the terminals at points almost diametrically opposite, the bond holes may be located close to the bolt holes in the rails, so that a relatively short bond of this type can often be used to advantage.

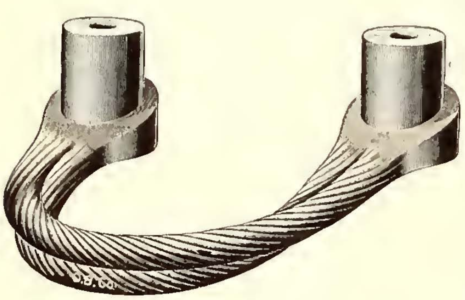


FIG. 2.—TYPE D, FORM I, "ALL-WIRE" BOND

In Fig. 2 is shown the type-D, form No. 1, "All-Wire" bond, which is designed especially for use on elevated structures and third-rail systems, where the bond can be placed underneath the rails and close to their extremities. The taper in the head of the terminals is such as to compensate for the taper of the rail base.

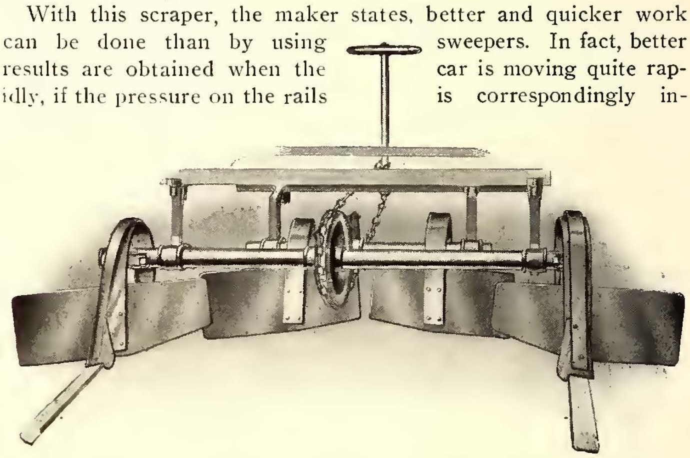
The type-G bond, illustrated in Fig. 3, while somewhat different from the other forms of "All-Wire" rail-bonds, has the same fundamental principle in its make-up, being made of a number of strips of soft, cold-rolled copper, the ends of which are perfectly welded together, forming solid copper terminals. The bond is applied to the rail ends by being soldered to them, and special tools are furnished for cleaning the ends of the rails and soldering the bonds in place. The form illustrated is intended for use on the lower surface of the rail base, or the upper surface of the rail, where it will not interfere with the fish-plates. Another form of this bond is made which is designed for attaching to the outer side of the ball of the rails, or in some cases where space will permit, under the tram of girder rails. Where bonds of this type are properly soldered to the rails it is practically impossible for them to become loose, as only a violent and determined effort will detach them. This bond is claimed to possess a greater degree of flexibility than is possible in any other form of bond now on the market.

FIG. 3.—TYPE G, FORM I, "ALL-WIRE" BOND

IMPROVED TRACK AND SNOW SCRAPER

The accompanying cut illustrates the well-known Kalamazoo track and snow scraper, manufactured by the Root Track Scraper Company, Kalamazoo, Mich. This scraper, which is easily handled by the motorman alone, is designed to clean all the snow from between the rails and 9 ins. outside the same, throwing it each way from the center. It will also thoroughly clean the top of the rail and groove.

With this scraper, the maker states, better and quicker work can be done than by using sweepers. In fact, better results are obtained when the car is moving quite rapidly, if the pressure on the rails is correspondingly increased. It deposits the snow farther from the track, not requiring large plows to clean up the banks thrown out. The cost of this device is said to be about one-twentieth of a sweeper for doing the same work, and there is no extra expense for labor and replacing worn-out brooms.



KALAMAZOO SCRAPER

The company claims that if this snow scraper is used on every fourth or fifth car, the others being equipped with its ordinary single-track scrapers, the motors will be fully protected from snow and the roadway kept in excellent condition.

The Hudson Valley Railway Company has given this company permission to place a "Kalamazoo" snow and track cleaner and an 18-in. single scraper on a car during the convention. Those present will therefore have the opportunity of witnessing practical tests of these devices.

A MODEL GEAR PLANT

Within the past two years the R. D. Nuttall Company, the well-known gear and pinion manufacturer, of Pittsburg, Pa., has expended a large sum of money for new machinery of the most advanced type and for improving its extensive works, so that it could properly take care of its rapidly increasing trade. The company now again finds it necessary to add to its equipment twenty-three of the latest type gear cutting machines as well as additional worm gear machinery, mills, lathes, etc., to correspond. In regard to the new gear cutting machinery, the company believes that this is the largest individual order for such machines ever placed.

The company has also made a corresponding increase in the capacity of its power plant, and when all of above machinery is in place its claim of operating the largest and most complete gear cutting plant in the world will be further verified.

SCRANTON OIL FILTER

In the accompanying Fig. 1 is shown a new oil filter which is being placed on the market by the Scranton Oil Filter Company, Scranton, Pa. In this apparatus the filtering material is composed of wicks, the filtering being pre-eminently capillary. Water is used in the outer compartment of the upper chamber,

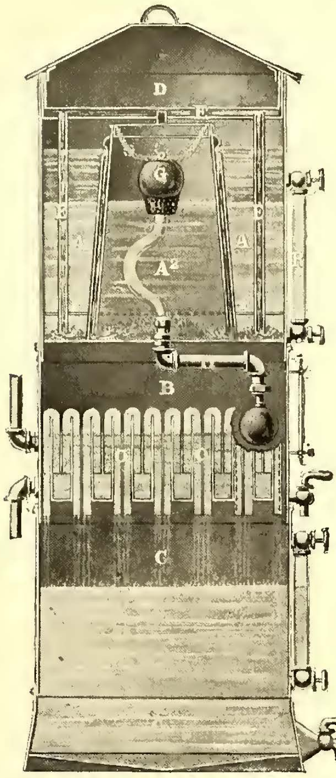


FIG. 1.—VERTICAL SECTION SCRANTON OIL FILTER

but not for filtering purposes; it is only used to agglomerate and precipitate entrained water which may be held in the oil. An original feature of the apparatus is the ability to double or treble the capacity of any size of filter by the insertion of one or more

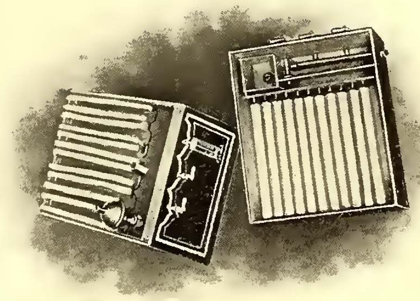


FIG. 3.—FILTERING TRAYS

trays of filtering wicks without interfering with any other part of the filter. Thus a filter of 60 gallons daily filtering capacity can be increased to a daily capacity of 120 gallons by the insertion of a second tray of wicks.

Fig. 1 illustrates a vertical section of a single style of filter. The entire filter consists of three separate sections; the base or lower section being the receptacle into which the purified oil falls after filtration, whence it is drawn off for use. The middle section contains the filtering wicks, where the principle of absorption, or capillary attraction, is applied in the final purification of the oil. This section is called the filtering tray, and in the middle thereof is constructed the heating chamber into which is affixed a steam coil with a heating capacity suited to the requirements of the tray. All the oil is heated in this compartment before it comes into contact with the capillary wicks. The upper or top section of the filter is called the receiving tank and consists of several members, the uppermost of which is called the hopper, into which the impure oil is deposited for filtration. From this hopper, by vertical tubes, the oil is conducted downward to the bottom part of

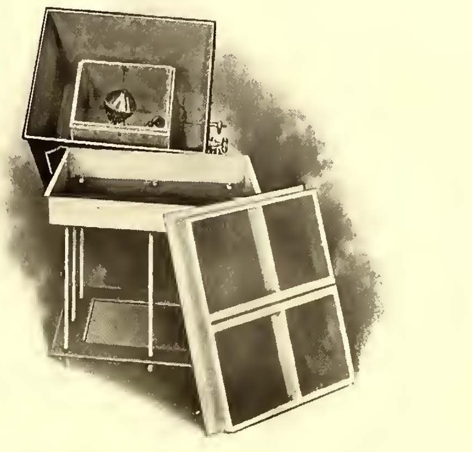


FIG. 2.—HOPPER AND DRIP PAN

the upper section, from whence it rises by specific gravity to the top of an inner receiving tank, where it passes through perforated openings into a sleeve by which it is again conducted to the bottom of the inner receiving tank, where, through a suitable opening, it rises to the top of the inner receiving tank. From this tank it is drawn down by a floating skimmer, sustained by the specific gravity of an air-tight, super-affixed sphere, through a flexible tube, and thence through a governor valve, into the wick chamber below and thence to the wicks themselves. The functions of the operations of the upper compartment of this filter are two fold,—first to separate from the oil all entrained water, and secondly to remove all such impurities as are of greater specific gravity than either oil or water. All water and other impurities thus separated are drawn off from time to time through a faucet. All such foreign matters as are of a lesser specific gravity than the oil pass down through the floating skimmer and the flexible tube to the filtering wicks where they are finally and entirely separated from the oil.

The manufacturers claim that the operation of this filter in purifying all kinds of lubricating oils is absolutely perfect, and that when the oil is drawn off at the base of the bottom tank for re-use it is chemically pure.

The details of the operating parts of the machine are shown by Figs. 2 and 3.

COUNCIL COMMITTEE'S REPORT ON TOLEDO FRANCHISE EXTENSION

The Council committee on street railways has advised the Council to kill the ordinance proposed for the Toledo Railways & Light Company for an extension of franchises for 18 years. The company offered six tickets for a quarter and universal transfers. The committee advises that the Council accept nothing less than three-cent fares and universal transfers, including the interurban lines as well as the city lines; also making it compulsory on the part of the company to extend the use of its tracks to all roads entering the city, together with regulations regarding street paving. The company declares that such an ordinance will not be accepted, and that it has made its best proposition. The sentiment of the Council appears to be to delay matters. The most important franchises of the company expire in seven years.

THE ANNUAL MEETING OF THE PENNSYLVANIA STREET RAILWAY ASSOCIATION

The next annual meeting of the Pennsylvania Street Railway Association will be held on Wednesday, Sept. 23, 1903, at the Park Hotel, Williamsport, Pa.

IMPROVED METHOD OF VENTILATION USED ON NEW CARS FOR LEICESTER, ENGLAND

Dick, Kerr & Company, Ltd., of London, England, have recently delivered to the Leicester Corporation a sample car built by the Electric Railway & Tramway Carriage Works, Ltd., Preston, Lancashire, which embodies features new and important in railway car construction. These features are principally an improved method of ventilation, and an improved design of interior finish, which have helped to produce a very satisfactory car a long way in advance of what has come to be universally known as the "Preston standard top-seat car."

FIG. 1.—UPPER PART OF CAR, SHOWING HINGED WINDOW

The provision made for ventilation will be readily understood from the accompanying Fig. 4, which shows a cross section of a top-seat tram car roof constructed to provide for an inlet of fresh air, and an outlet for the foul hot air that ascends to, and fills, the upper part of the car.

The inlet for fresh air is provided for through the usual line of hinged windows placed above the large fixed glass windows, universally used in recent tram car work. These hinged windows were first adopted by, and have since become an essential feature of, the Preston standard top-seat car. They are shown in the diagram at the points marked *A A*, and the circulation of the air that takes place from the outside into the car is shown by the arrows marked *B B*. These hinged windows, which are arranged in the outside walls of the car on each side, have proved to be the best means for the admission of fresh air into the car that has yet been devised, and it is said that they have been universally copied by all the principal car-builders throughout England in tram car work. With the use of these windows experience has shown that the only thing wanting for thoroughly ventilating a tram car was some provision for a further supply of fresh air from the outside into the car, and a means for the escape of the foul hot air, which ascends to the roof, and which cannot get out without interrupting the current of fresh air passing into the car through the hinged windows already referred to. This increased supply is provided for by a hinged sash on each side of the end door in each end of the car, marked on the diagram *F F*. These sashes can be opened in exactly the same way as the sash *A A* at the sides when additional fresh air is required. They are also provided with perforated louvre panels *G G*, on the outside, and being in the end of the car they admit of a large supply of fresh air passing into the car without interfering with the arrangement of colored signal lenses, and without allowing the admission of water in wet weather.

FIGS. 2 AND 3.—INTERIOR VIEWS OF CAR

The outlet for the foul air has been provided for by a recess made in the roof of the car, marked *C C*, which is just above the hinged windows above referred to. The circulation of the foul hot air through this recess to the outside is shown by the arrows marked *D D*. On the outside of the car on each side and connecting with this recess are fixed ventilators, marked *E E*, constructed in such a way that no air can pass into the car at these points, but the ventilators exhaust or draw the hot air out when the car is running. It will be noted that this recess *C C*, not only connects directly with the interior of the car, but that it also connects with the roof space *H H H*, between the millboard ceiling and the main deck, and that this space, which in ordinary tram cars is a dead air space, without means of escape, is thoroughly ventilated by this arrangement.

If required, a further outlet for the hot air in the top of the car may be provided for by perforating the millboard ceiling to connect with this space and indirectly with the ventilators on the outside of the car.

It will also be noted that this exhaustion of the air by the ventilators through the recess and roof space is not arranged with any means for preventing their action and the escape of the foul

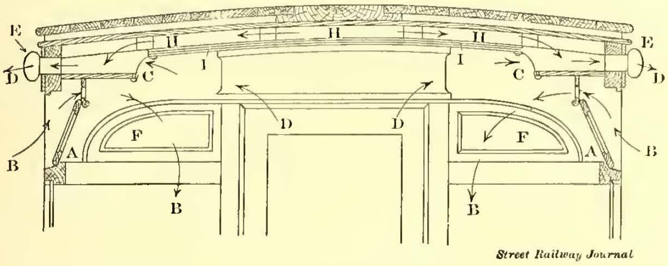


FIG. 4.—DIAGRAM OF VENTILATING ARRANGEMENT

hot air continually taking place. The effect of this construction and arrangement of ventilation is that the interior of the car is constantly provided with a circulation of fresh air into, and the foul air out of, at the points named absolutely without dangerous or annoying draughts.

The application of this principle of ventilation to the car lends itself to a very satisfactory treatment in the way of interior design and general finish, which adds very largely to its appearance. The accompanying photographs clearly show this. The woodwork connected with the interior finishing is done in oak and mahogany, and has been treated in an entirely original way, much to the advantage of its general appearance.

TRUSS PLANK HEATERS FOR CROSS-SEAT CARS

One of the improvements brought out recently by the Consolidated Car Heating Company, of Albany, is the use of a longitudinal heater for cross-seat cars attached to the truss plank instead of being placed under the seat itself. Fig. 1 shows the position under the seat of this heater, which is entitled Type No. 93. As will be seen from Fig. 1, it is carried along the side of the car, occupying about the same space on an electric car that steam pipes do in a railroad coach, but does not project so far into the car. In many cases sufficient heaters are furnished to extend the full length of the car. With this type of heater it is impossible to overheat the seats, the heaters being placed near the floor and a 30-in. section never being arranged for a consumption of more than 500 watts.

Fig. 2 shows three 30-in. sections of this heater, and the method of carrying the wire in a molding underneath the heaters. In some cases no leads are used and the wires for connecting the heaters are fastened to the heater coils before placing the cases in position; there are, therefore, no joints between the heaters and never any exposed wires.

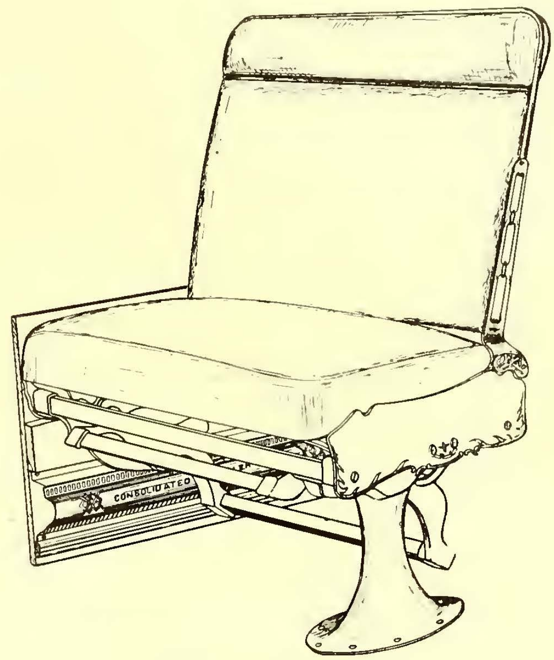


FIG. 1.—POSITION OF HEATER UNDER SEAT

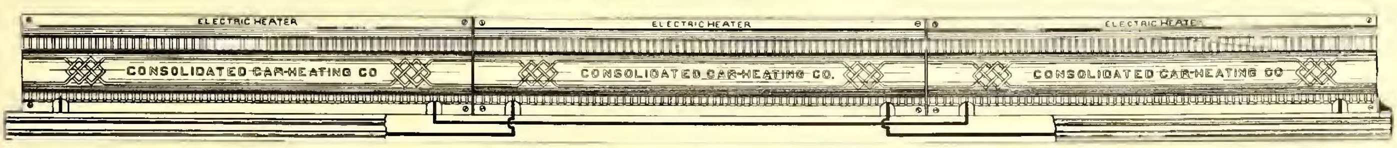


FIG. 2.—WIRING ARRANGEMENT OF HEATERS

This heater is used on a number of parlor cars, and where these cars have dark trimmings it is finished in copper bronze. Otherwise the case is finished in gold bronze.

The heater is used on Aurora, Elgin & Chicago Railway, Chicago & Joliet Railway, several of the new roads built by Westinghouse, Church, Kerr & Company, and on a number of other high-speed interurban railways.

THE ENGINEERING OF HEATING SYSTEMS

William H. Schott, engineer, Chicago, Ill., is making a specialty of the engineering of exhaust and live steam central station heating systems. The plants so far constructed by him have mostly been hot water heating systems, operating by exhaust steam from electric light and railway stations. Mr. Schott has special apparatus of his own design which he uses in the plants he constructs, including a new hot water heater, pipe line construction in the street and piping of buildings. The buildings are connected in multiple across the hot water heating mains, but the radiators in each building are piped in series with a high-resistance by-path around each radiator. Another feature which goes to make the systems planned by him a commercial success is the use of an automatic pneumatic temperature regulating system, so that the temperature is regulated by thermostats in each room in the building, the air for the operation of the valves in connection with this system being supplied from the central station. This in itself means a great saving in the number of heat units which must be sent to each customer.

Mr. Schott designs his systems on a very low pipe resistance, that is, he uses large enough pipe throughout the entire system so that the amount of power required to circulate the water is small compared to some of the other hot water heating systems in use. This, of course, increases the cost of installation, but keeps down the cost of operation.

Mr. Schott aims to construct only successful heating plants, and does not hesitate to advise his clients against putting in hot-water or steam heating plants where his investigations do not convince him that such plants would be commercially successful.

Among the towns where heating plants have been installed according to this method are: La Fayette, Ind.; Elwood, Ind.; Peru, Ind.; Connorsville, Ind.; Galesburg, Ill.; Coshocton, Ohio, and Mt. Vernon, Ill. A plant is now being installed at Indianapolis, 3000 ft. from the business center of the city. It is primarily for steam heating, but will have an electric light plant in addition.

GRADE BUILDING MACHINE

An improved elevating grader has recently been put on the market by the National Drill & Manufacturing Company, of Chicago, Ill., which claims that its grader possesses certain features

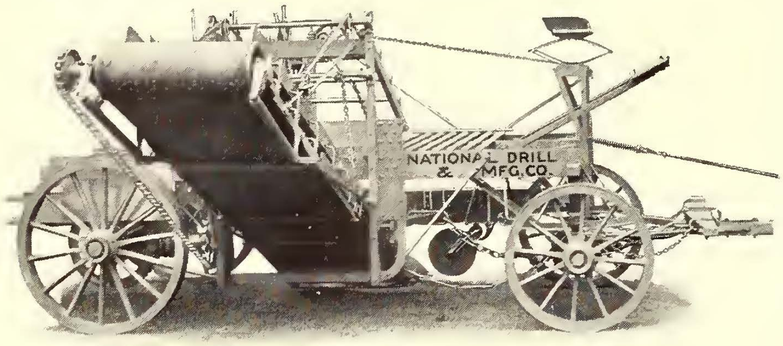


FIG. 1.—ELEVATING GRADER

which overcome many of the difficulties encountered in the operation of machinery of this class.

Those who are familiar with elevating graders in general, are aware that heretofore the entire draft of the plow has been brought either directly or indirectly on to the machine. This, of course, has been a drawback to its successful operation in many classes of soil, and has necessitated the expenditure of more power than should really be required to move the amount of earth handled.

The National elevating grader, as shown in Fig. 1, overcomes this difficulty. The draft of the plow itself is carrried direct on the evener, being transmitted by a heavy draft chain which passes the king bolt and is hooked to the plow standard. This chain is intercepted in front of the elevator by a spreader bar, which can be raised or lowered as the conditions require, thus regulating the angle of the pitch, assumed by the plow point. This is an important feature, particularly when plowing in hard ground. After a plow is gaged to the required pitch it is not necessary to give it any further attention, as the spreader beam holds it in position permanently.

This illustration also shows a turn buckle brace for adjusting the elevator, running from this side of the elevator hanger to the elevator itself. This is a valuable feature when it is necessary to straighten a belt which has stretched unevenly and is running crooked.

Fig. 2, the rear view of elevating grader, shows the hand wheels and levers for controlling and regulating the machine in operation.

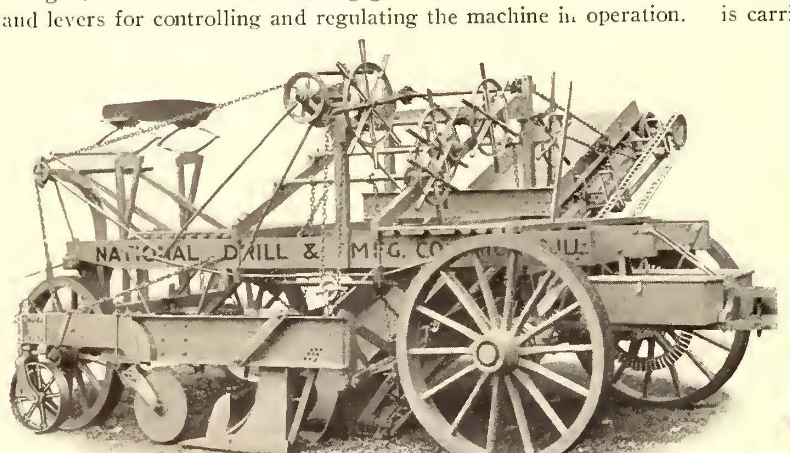


FIG. 3.—METHOD OF ADJUSTING PLOW

The center hand wheel is employed for spooling up the two lines of chain that tighten the belt. This is a decided improvement over the old method of tightening by lever, as it is absolutely unlimited in its scope. In fact, the makers claim that the only limit which this belt tightener has is the strength of the belt itself. Those who have operated elevating graders in wet, slippery soil, particularly when loading wagons, are fully aware of the difficulties which have been met in attempting to keep the belt tight, as it has invariably been the case that the belt would slip more or less as soon as the rollers became wet.

This illustration also shows the construction of the elevator. No truss rods are required underneath it, and therefore there is nothing to catch on the wagons which are driven under the elevator when the machine is used as a wagon loader, the outer end of the elevator being provided with rollers which act as a guard for the chain and prevent it from catching on the edge of the wagon box.

Fig. 3 shows the method of adjusting the plow so that it can throw a furrow on the carrier, no matter what the conditions of the soil may be. Frequently it is necessary to change the tilt of the plow so that the mould-board will scour. This has been done formerly by a complicated scheme involving a number of castings and bolts, which must be first loosened and the castings then adjusted until the proper pitch is found. On this machine, however, it is possible to tilt the plow at the will of the operator without requiring him to leave his position on the platform. This is accomplished by a hand lever on the extreme right, working in conjunction with a slide underneath the machine, and the tilting upright riveted to the rear end of the plow beam. It is, therefore, possible to adjust the plow to a fractional part of an inch and lock it in any position which

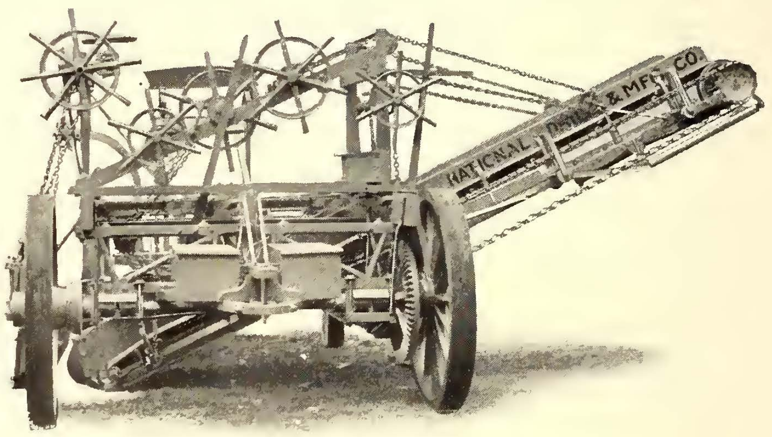


FIG. 2.—REAR VIEW OF ELEVATING GRADER

seems most effective. The general frame of the machine is built of heavy timbers, reinforced wherever required by steel rods and trusses, so that strength and durability are obtained. The elevator is carried above a yoke which forms a continuous tie underneath the elevator and prevents sagging of the frame. There are a number of other features in this machine which are interesting to those engaged in railroad or electric traction line construction, about which the manufacturer will be very willing to give information. This company also produces a full line of wheeled and drag scrapers, contractors' dump wagons, grading plows, etc.

ELECTRIC CAR HEATER

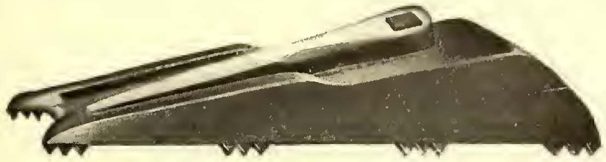
A new and very desirable style of car heater for large interurban electric cars has recently been placed on the

ELECTRIC CAR HEATER

market by the H. W. Johns-Manville Company. It is designated Wall Heater, class B, and is shown in the accompanying illustration. The construction of this heater is similar to the company's class K heater, which has been on the market for several years past and is used in cars having cross-seats. Each heater is 30 ins. long and 5 ins. high, held firmly in place by reconstructed granite heads or supports located at each end of the heater. These irons support the resistance coils and furnish superior insulation, thereby preventing short circuits and the cutting out of resistance due to contact formed by sagging coils. The casing is very strong and ornamental and will stand foot pressure without injury.

THE SNOW REPLACER

The accompanying cuts illustrate the Snow car and locomotive replacer for which Wendell & MacDuffie, of New York, are exclusive Eastern agents. Replacers of this type weigh from 160 to 210 lbs. per pair and are made of open hearth steel or air furnace malleable iron.

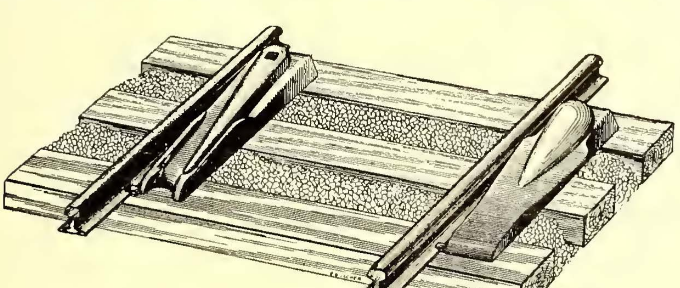


INSIDE FROG

These replacers do not require clamps, and frogs will not turn over or push away from rails. They clear brake hangers, brake levers and sand pipes, and can be placed parallel or at an angle to the rails, according to the position of derailed trucks; nor will they break wheel flanges.

These replacers are reversed by simply moving the tongue in one frog, and as they are wedge-shaped they can be placed well underneath the derailed wheels. It is claimed that they will replace locomotives and cars quicker and surer than other similar devices. As the wheels are run up on their treads instead of their flanges, both wheels and frogs are saved from damage.

OUTSIDE FROG



CAR AND LOCOMOTIVE REPLACER

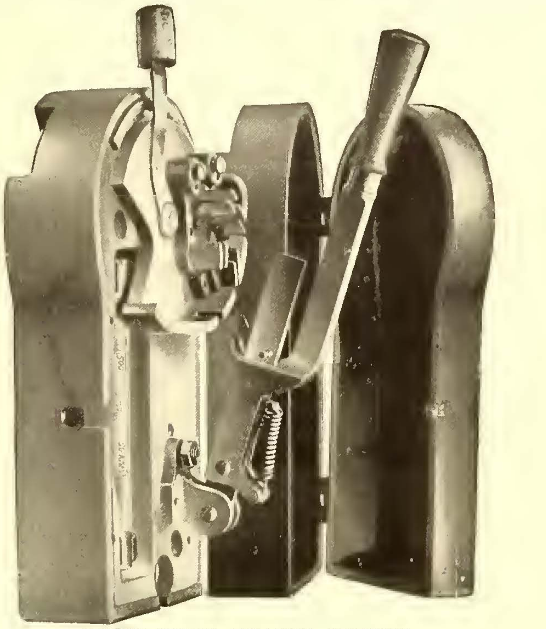
The maximum height is at end of replacers, thus reducing the grade by one-half up which wheels must mount in re-railing.

These replacers are standard on about forty large railroads and are in extensive use on hundreds of others.

The Lake Shore Electric Railway Company is attracting widespread attention because of the remarkable increase in its eornings. For the first nine days of this month the road earned $23,080, an increase of $10,060 over the same period last year. It is probable that the road will show a surplus this month of more than $10,000 over operating expenses, interest charges and taxes. Under the receivership about $350,000 were expended in betterments, and since the receivership about $125,000 have been expended.

REGULATING HEATER SWITCH

In order to meet the increasing demand of large electric cars requiring a greater number of heaters to satisfactorily heat them, the H. W. Johns-Manville Company has enlarged the three-point car heater regulating switch, shown in the accompanying cut, increasing its capacity to 60 amps., and mounting in the insulating base block a Sachs "Noark" enclosed fuse. This complete controlling and protective device is now combined and enclosed in an iron box, requiring less room than heretofore and being absolutely safe and reliable under all conditions. Closing the quick break knife blade automatically locks the switch, which is necessary before the cover of the box can be closed, and any movement of the regulator handles is prevented until the knife blade is released.

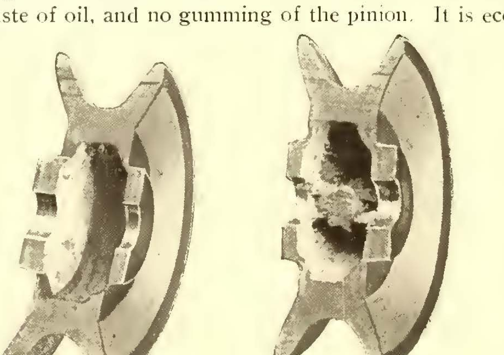


REGULATING HEATER SWITCH

NEW TROLLEY WHEEL

The new C. B. & E. trolley wheel, shown in the accompanying cuts, will, it is claimed, outwear any other similar device heretofore in use on trolley systems. It is entirely self-lubricating, and requires no attention, except refilling the oil chamber. It is made by Collins, Bouchard & Emery, Bradford, Pa.

This wheel combines a graphite bushing with an automatic feeding oil chamber, which can be quickly filled when necessary without removing the wheel from the fork. There is no friction, no drip or other waste of oil, and no gumming of the pinion. It is economical, clean, possesses perfect conductive power, and requires no attention, except refilling with oil after once being properly in place.



SECTION OF TROLLEY WHEEL

This wheel costs but little more than the ordinary wheels now in use, and its life is said to be three times longer. It has been severely tested on long-distance suburban runs, fully meeting all the requirements. It is guaranteed to easily outclass in efficiency any other trolley wheel, and to thoroughly eliminate all the vexatious troubles usually caused by inferior trolley wheels.

NEW CARS FOR THE LAKE SHORE ELECTRIC RAILWAY

The first of ten handsome cars built by the J. G. Brill Company for the Lake Shore Electric Railway of Cleveland, Ohio, was given a trial trip over the lines on July 22. Officials of the railway and of the cities along the route with newspaper correspondents and others composed the party which made the entire trip from Cleveland to Toledo, a distance of 160 miles. There was no attempt to make fast time, but simply to note performance of the trucks under ordinary conditions and to acquaint the officials and others with the car and its appointments. About Sept. 1 regular trips will commence, running through cars from Cleveland in 4½ hours, which is practically the time taken by the steam railroads.

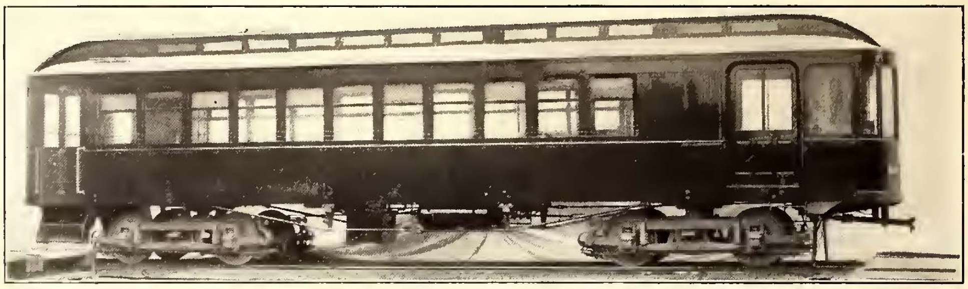


FIG. 1.—EXTERIOR OF LAKE SHORE CAR

The cars are divided in three compartments—passenger, smoker and baggage. The passenger compartment is equipped with a salon of standard character, having an oval window at the side. This compartment is 23 ft. 10 ins. long, and seated for thirty passengers. The seats are leather-cushioned, are extra high in the back and long in the seat. The interior is finished in natural cherry with ceilings painted "Pullman Green." Along each side of this compartment is placed a continuous brass rack for packages, and an electric light over each seat. A novel feature consists of a smoking compartment with a curved hardwood partition, the upper part of glass, as shown in the illustration of the interior and in the floor plan. The seats in this compartment are also upholstered in leather. This feature of the car will doubtless prove very attractive to travelers. The compartment is 9 ft. in length, and seats about twelve passengers. The floor is covered with zinc. The baggage compartment is 11 ft. 9 ins. long, and has a 40-in. sliding door on either side. The motorman's compartment, located in the forward right-hand corner of this compartment, is of ample size, as will be seen by the diagram. A hot water heater has its place in the corner of the baggage compartment. As the cars are intended to be run in one direction, one cab only is necessary. Entrance to the car is by the rear end, the platform being flush with the car floor. Three steps are used on each side, enclosed in folding doors and provided with trap doors. Swinging doors are provided between the compartments. The windows are arranged to raise in the regular steam car fashion. They are composed of a couple of sashes, the upper one of which is stationary. Three-bar brass window guards extend the full length of the passenger and smoking compartments. The corner posts at both ends of the car are double and have curved-glass narrow windows between. The vents have a separate opening to each, and between the passenger and smoking compartments is placed a transom, so that there is separate ventilation from the deck for the compartments. The length of the cars, measured over the vestibules, is 49 ft. 7 ins.; width over sills and sheathing, 8 ft. 6 ins.

FIG. 2.—INTERIOR OF LAKE SHORE CAR

Long leaf yellow pine side sills are double, and have ⅜-in. x 12-in. steel plates sandwiched between, for the full length of the body. The outer sill is 4 ins. x 8¾ ins., and the inner 2¾ ins. x 7⅞ ins., heavily bolted together through the plate. The center sills are 6 ins. x 7 ins., and inclose I-beams for the full length of the car. Intermediate sills are 4¾ ins. x 6⅞ ins., plated with ½-in. x 6-in. steel; the end sills of white oak are 5¼ ins. x 6⅞ ins. The needle beams are double-trussed, and 1½-in. diameter undertruss rods extend from bolster to bolster. The flooring is double, and the space between is filled with mineral wool to deaden sound, and at the same time increase the warmth of the car.

The cars are equipped with patented specialties of the builders' make, such as radial draw-bars, angle iron bumpers, "Dedenda" gongs, and "Dumpit" sand boxes. The trucks are the Brill No. 27A 2, capable of making the highest speed desired. Each car is equipped with four 75-hp motors. The wheels are 34½ ins. diameter, with steel tires; axles, 5⅜ ins. Weight of car and trucks without motors, 52,000 lbs.

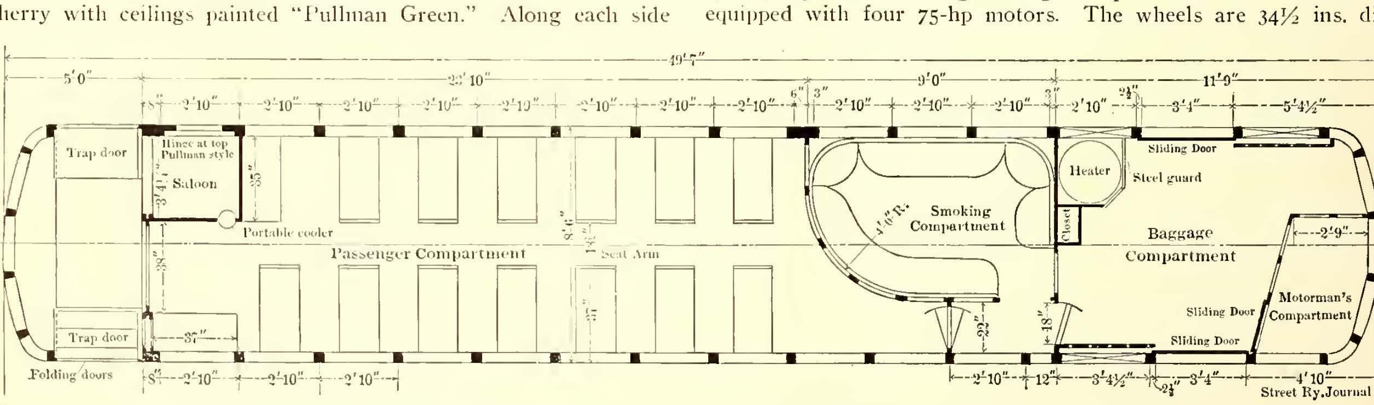


FIG. 3.—FLOOR PLAN OF LAKE SHORE CAR

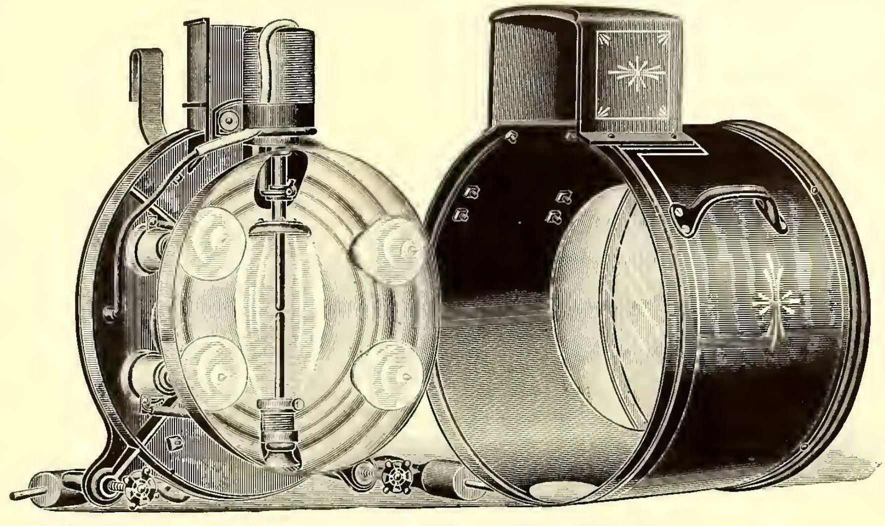
PROPOSED NEW CAR WORKS FOR CINCINNATI

Wm. H. Stewart, Jr., Union Trust Building, Cincinnati, is at work on the organization of a new $500,000 car company for Cincinnati, to build electric cars. A. L. Jacobs, formerly of the Pullman shops, is mentioned as the probable general superintendent.

COMBINATION ARC AND INCANDESCENT HEADLIGHT

The Globe Electric Manufacturing Company, Cleveland, Ohio, has placed on the market a combination arc and incandescent headlight, especially adapted for interurban and city railway service. Many electric railway companies object to the use of arc headlights, because of the intensity of the light while on city streets, and the inefficiency of dimming devices. The company's new type, known as the Climax, is adapted for both city and interurban service, since it is provided with an incandescent circuit, which may be utilized while in city streets. The change from arc to incandescent is accomplished by turning a two-point switch placed in the vestibule.

The lamp has one magnet coil, and the ring clutch mechanism is so simple that jarring has no effect upon its operation. The gas cap at the top of the globe is supported by a tube holding it in place. The globe holder and carbon holder are very simple, and will not get out of order. There are two separate reflectors, both having the same focus, a double reflector being necessary, because of the incandescent attachment. The front reflector is perfectly plain, and there is no shadowing whatever. Both reflectors are made of aluminum, which possesses several advantages over plated reflectors. The lamp has two adjustable bumpers which enables the motorman to lower or elevate the projected rays of light after the lamp has been set in focus. To reduce traveling of arc, 3/8-in. carbons are used. The lamp mechanism is fastened to a cast-iron back and the sheet steel casing is secured to the same by two screws.



COMBINATION ARC AND INCANDESCENT HEADLIGHT

The lamp is 18 ins. high, 10 ins. deep and 14 ins. in diameter. No soldering or riveting is used in the construction. The solenoid is protected and covered by a cast-iron hood which is bolted to the casing. Owing to its simple construction the lamp is easily cleaned and trimmed. It will operate on currents from 1½ amps. up, and is claimed to be the most economical and efficient lamp of its type on the market.

BALANCED TROLLEY WHEEL

The Lumen Bearing Company, of Buffalo, N. Y., has just put upon the market an improved form of the Ideal trolley wheel, which is the result of experiments and tests extending over the past year.

CROSS-SECTION OF BALANCED TROLLEY WHEEL

The principal change from the old form is in the groove, which, being wider, allows a greater wearing surface and consequently a longer life, while the improved shape of the flange gives greater strength to withstand a blow and eliminates all liability of rubbing against the trolley wire.

While the life and efficiency of the Ideal trolley wheel has been greatly improved in the new form it still retains all the merits of a perfectly balanced construction which has given this wheel a reputation for its high mileage records.

It is said that a standard trolley wheel 1 ounce out of balance will exert a hammer blow of 4.8 pounds on the trolley wire when running at a speed of 20 miles an hour, and the same wheel if increased to a speed of 40 miles an hour will exert sufficient force to throw itself off the wire. To this is due the fact that wheels of the same composition often give vastly different results when run under the same conditions.

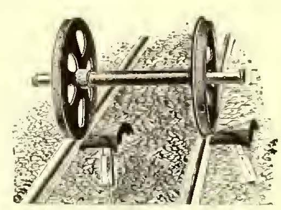
The effect of a trolley wheel slightly out of balance is especially noticeable in the bushing which wears much faster on the light side and soon throws the wheel out of true. This is often attributed to a defective bushing, but it is due to a lack of balance in the wheel.

The contact ring in the Ideal trolley wheel is made of pure lake copper, cast and hammered, which gives a density and uniformity impossible in an ordinary casting. The flanges are stamped from .095 dead soft, cold rolled and pickled steel, giving a maximum of strength and a minimum of weight, and are firmly held together by a Lumen bronze hub which is cast around them in a metal mould, insuring perfect uniformity and balance. The Ideal trolley wheel is adapted to fit any standard harp and is fitted with standard graphite bushings.

This wheel may be seen at the exhibit of the Lumen Bearing Company during the Saratoga Convention.

CAR REPLACER

The accompanying cut illustrates one of the motor and street car replacing frogs made by the B. E. Tilden Company, Chicago, Ill. These frogs will replace derailed cars to any rails by gravitation from replacers, as shown in the illustration, as soon as the car wheel comes up to an altitude equal to the top of the rails. It is immaterial whether cars be pulled ahead or backed up, because as the frogs are double enders the result is the same. They are complete self-holding motor car replacers. It is said that these replacing frogs will replace any rolling stock in about one-fourth the time consumed by other devices. This latter feature is of great importance when derailments occur, as serious traffic blockades are thereby avoided. It is suggested that no motor car should be run without these replacers being a part of its equipment, an electric switch being a part of each replacer. These replacers are in use on hundreds of steam and electric railways, among the latter being the following: Amsterdam Street Railway Company, Amsterdam, N. Y.; Austin Rapid Transit Railway Company, Austin, Tex.; Buffalo Railway Company, Buffalo, N. Y.; Boston Elevated Railway Company, Boston, Mass.; Brooklyn Rapid Transit Company, Brooklyn, N. Y.; Butte Electric Railway Company, Butte, Mont.; Citizens' Street Railway Company, Memphis, Tenn.; Denver City Tramway Company, Denver, Col.; Exeter, Hampton & Amesburg Street Railway Company, Exeter, N. H.; Fitchburg & Leominster Street Railway Company, Fitchburg, Mass.; Helena Power & Light Company, Helena, Mont.; Harrisburg Traction Company, Harrisburg, Pa.; Los Angeles Railway Company, Los Angeles, Cal.; Lowell, Lawrence & Haverhill Street Railway Company, Lowell, Mass.; Twin City Rapid Transit Company, Minneapolis and St. Paul, Minn.; Zanesville Electric Street Railway Company, Zanesville, Ohio.



CAR REPLACER

THE UNI SIGNAL SYSTEM

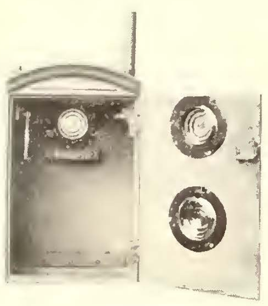
The Uni Signal Company, of Boston, Mass., has placed on the market a signal system for trolley railways, which consists of three parts, namely: the terminal box and lightning arresters, the signal box and signal movement, and the trolley switch. The terminal box, which contains the lightning arresters, is attached to the pole through external lugs cast on the box at such a height that the wires may directly enter the box. The wires enter the box through porcelain bushings as in transformer design. This terminal box is connected to the signal box by a 1-in. lined conduit pipe through which the signal wires lead to the same. The wires from the terminal box are lead three each on two sides of the box to two slate terminal boards with clips for enclosed fuses.

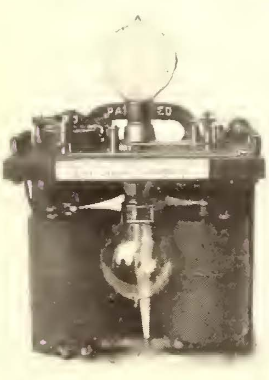
The signal box is attached to the side of the pole. This arrangement is used so that the green or safety signal lamp can be seen by the conductor after a car has passed the signal box, thus allowing him to check the motorman. In this respect the box is said to differ from all other signal boxes.

The signal movement is mounted on a cast iron frame which supports all its parts and also furnishes the means (through a handle cast integral with the frame) whereby the entire movement can be removed from the signal box. This is done by turning a lock button, which projects through the handle, and removing the six enclosed fuses from their clips, when the movement can be lifted out of the box. This permits easy and thorough inspection of the signal movement.

The signal movement, which does not contain a single spring, consists of three magnets, one switch lever, three contact disks, and one resistance plate, together with the necessary connections. There are two large magnets of semaphore design with internal armatures, thus allowing them to be attached directly to the back plate without loss of magnetization and also increasing the effective radiating surface of the magnets. The large magnets are respectively the lighting and extinguishing magnets. The function of the small magnet is to lock the armature of the lighting magnet whenever the red lamp at that end is lighted. This method prevents any car which might run under a lighting switch with the red lamp set against it from extinguishing the signal. The magnetic lock is instantaneous and requires no moving part to operate, as all it has to do is to hold its armature against its seat. The small magnet can do this because there is no air gap in its magnetic circuit, while there is a quarter air gap in the lighting magnet circuit at that time and the current is approximately the same in both.

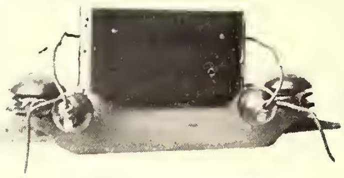
TERMINAL BOX


BOX WITH MOVEMENT REMOVED


SIGNAL MOVEMENT


BOX OPEN

Between the magnets is placed the switch lever, made of aluminum to decrease the inertia. As this switch does not break live circuits it can give no trouble. The circuit is broken in the box at three different points, according to the operation to be performed. The breaking is accomplished by a disc contact, is quick in operation and gives two breaks in series in its operation. The resistance plate is enameled and attached to insulated studs on the back of the movement. Care has been taken not only to insulate all current-carrying parts, but also to isolate them.

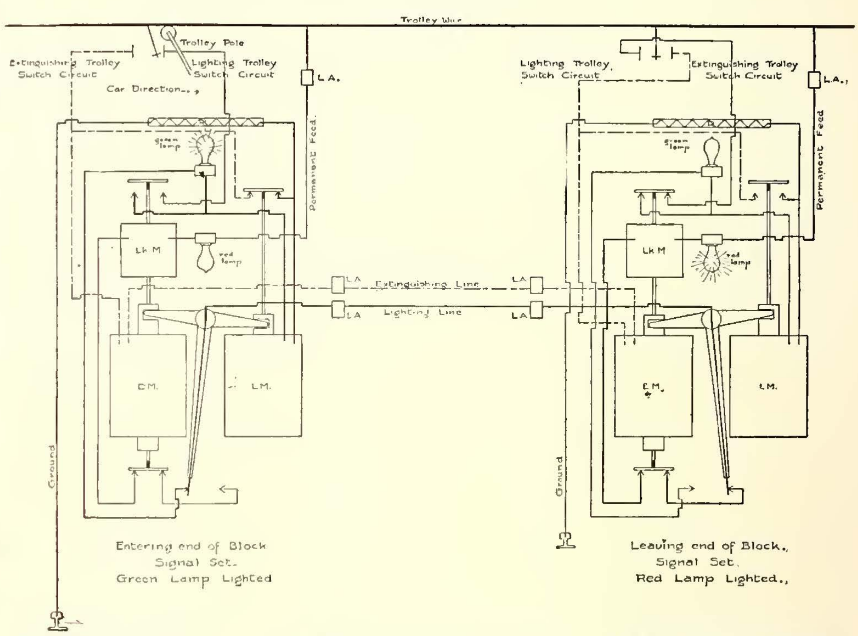

TROLLEY SWITCH


BOX CLOSED

The system, the wiring for which is shown below, operates as follows: When a car passes under a switch at the entrance to a block it causes current from the trolley wire to pass through the lighting magnet and resistance plate to the ground at that end. This causes the switch lever to be thrown over to the left-hand contact of the switch, which then causes current to be taken from the leaving end of block passing through the red lamp, locking magnet at that end, and then through the lighting signal line to the entering end, where it traverses the green lamp, lighting magnet and resistance plate to ground. To extinguish the signal, current is taken from the trolley at the extinguishing switch, through the extinguishing magnet at that end, and thence through the extinguishing line to the entering end where it passes through the extinguishing magnet and resistance plate to ground.

It would appear at first thought that there would be current through both magnets at the entering end, and, of course, under that condition the switch lever could not be restored to its normal condition. Observation, however, has shown that as soon as a current is established the gravity armatures in the extinguishing magnets are raised, the one in the leaving end of the block opens the lighting circuit and, therefore, cuts off the lighting magnet in the entering box, allowing its extinguishing magnet to operate. The wiring diagram shows that loss of current will not restore the signal nor will a cross between the signal lines.

The Uni Signal Company will have an interesting exhibit of its apparatus at the Saratoga Convention, and the representatives of the company will be pleased to give further details of the operation of this system.



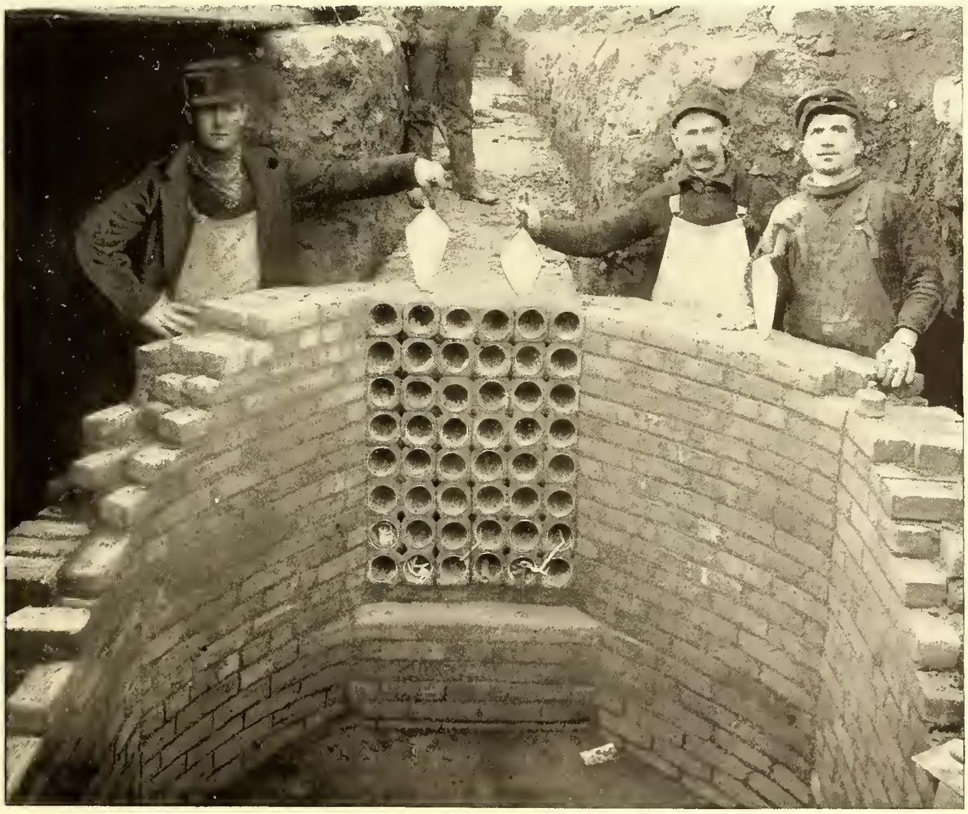
R.—Resistance plate.
Lk. M.—Locking magnet.
E. M.—Extinguishing magnet.
L. M.—Lighting Magnet.
L. A.—Lightning Arrester.
WIRING DIAGRAM

ENLARGEMENT OF NEW YORK SUBWAY POWER HOUSE

The New York Rapid Transit Subway Commissioners have purchased an additional lot, 108 ft. x 200 ft., on which to build an addition to the power house now building between Fifty-Eighth Street and Fifty-Ninth Street and Eleventh Avenue to the Hudson River. The addition will make the plant the largest and most expensive in the world. It will cost altogether $7,000,000, and will be capable of generating 132,000 hp. In the boiler plant at first will be set up seventy-two boilers, each capable of producing 500 hp. The fuel of these boilers will amount to 1000 tons of coal a day. The coal will be carried by belt conveyors to a storehouse 80 ft. above the ground, with a capacity of 25,000 tons. The ashes from these 1000 tons a day will be carried by cars to scows lying in the river. The walls of the building will be of cut granite and terra cotta and pressed brick. The windows will be fitted with steel frames and the roof will be of terra cotta and glass. There are five brick chimneys to rise above the plant. They are unusual in their construction, in that their bases will rest on steel platforms about 40 ft. above the floor of the power house. Building the stacks from the ground up would have occupied a great deal of valuable space in the middle of the building. The chimneys will reach a height of 265 ft. Work on the main station, which has been delayed considerably through labor troubles, is now progressing satisfactorily, but it will be impossible to make up the time that was lost.

EXTENSIVE UNDERGROUND FEEDER CONDUIT CONSTRUCTION IN BROOKLYN

Some inte-esting underground feeder conduit construction is being carried out in Brooklyn by the Brooklyn Rapid Transit Company, as indicated by the accompanying cut. This illustration shows a 48-duct run, leading from the north side of the Third Avenue power house of the Brooklyn Rapid Transit Company, now under course of construlction, and was built by G. M. Gest, of New York and Cincinnati, who has made a specialty of this class of work. The conduit shown is for direct-current feeders. A smaller conduit system, built by the same contractor, leads from the south side of the building and carries the alternating wires.



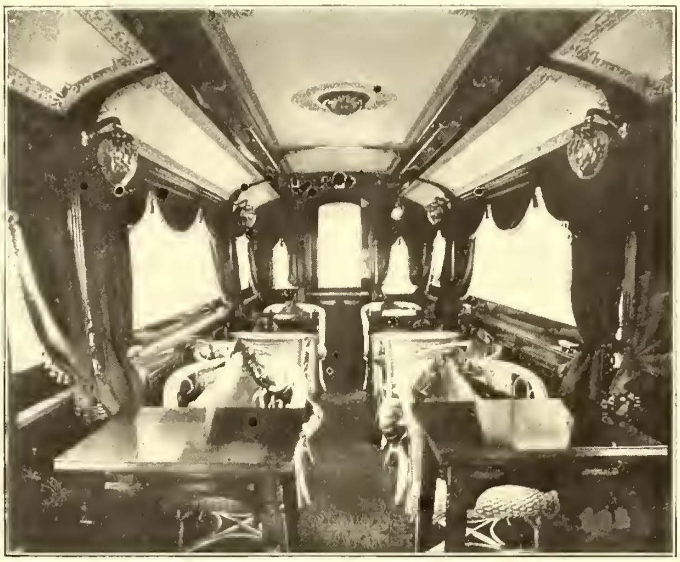
LAYING CONDUIT IN BROOKLYN

Extensive conduit construction is also going on in other parts of Brooklyn, notably East New York and the Twenty-Eighth Ward. The work is being carried on very quickly and neatly without causing disturbance to traffic.

LUXURIOUS RAILWAY TRAVELING

The accompanying illustration shows the interior of a car which has been constructed by the Brush Electrical Engineering Company, Limited, for use on ceremonial occasions on the Birmingham & Midland, Dudley & Stourbridge, and South Staffs lines, associated with the British Electric Traction Company.

It is of the single deck type, with a raised roof, is mounted on a



ENGLISH PRIVATE CAR

Brush standard four-wheel truck, and equipped with motors of the company's standard pattern.

The ornamental features are of special interest. The interior is finished in fumigated wainscot oak, with carvings over the doorways, and at the head of each side pillar. These carvings are continued over the roof, dividing it into three panels, which correspond in size to the width of the side windows.

The car comfortably contains ten chairs of white pulp cane, with loose down cushions covered with crimson silk to match the Axminster carpet. The green casement cloth curtains are fringed and festooned and looped back to the pillars with cords and tassels. Four small oak tables to match the woodwork of the chairs are placed between the chairs, with ash trays and electric bells within easy reach. The ceiling is of figured "Alhambrine" painted white, with an ornamental border picked out in gold. The whole of the metal work inside the car is nickel-plated. The interior is lighted by thirteen 8-cp lamps, arranged in two circuits.

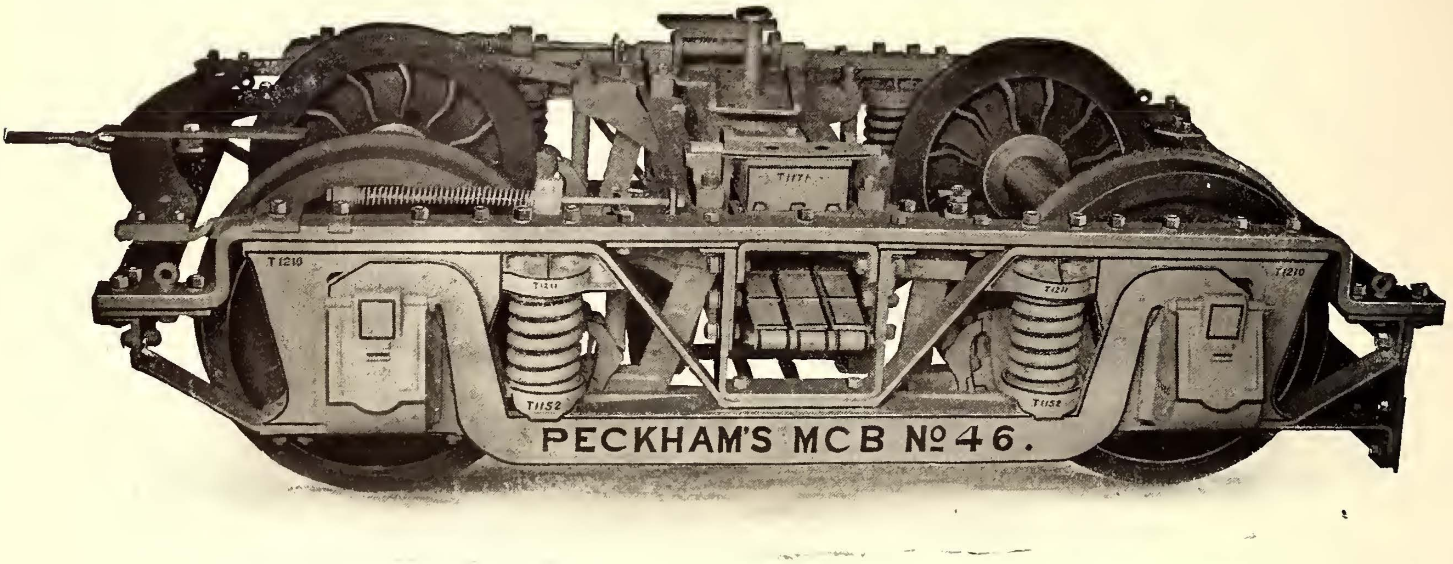
The exterior of the car is handsomely painted and decorated in keeping with its general character.

A commission, composed of representatives of the Imperial, Prussian, Bavarian, Saxon and Baden State railroads, recently observed a test of a new brake, known as the Steiner distance brake. This brake is claimed to be an improvement upon the air brake now in use. It is so connected with the air brakes of a train that when the front wheels of a locomotive pass over a danger or halt signal placed upon the tracks, it will automatically put on the brakes and open the whistle valve. The apparatus worked with perfect satisfaction, even at 83.75 miles an hour, but because of the extraordinary strain to which it was subjected an important part thereof was broken.

PECKHAM'S M. C. B. TRUCK NO. 46

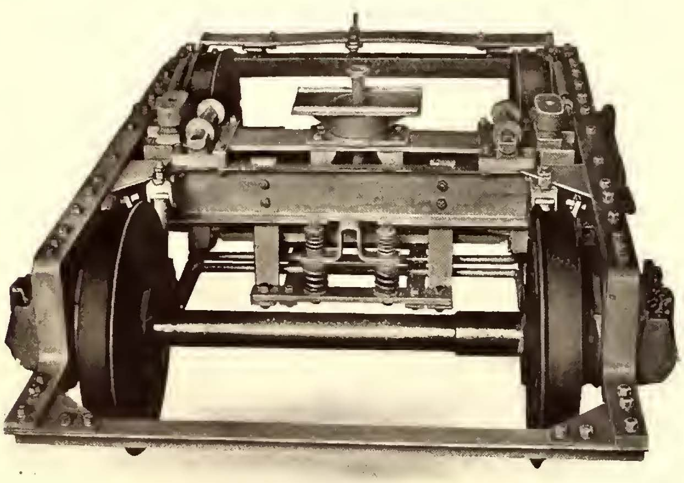
Several types of the M. C. B. form of truck, as built by the Peckham Manufacturing Company, have been illustrated in recent issues of this paper, and are interesting from the fact that they are constructed for high speed interurban service. The latest addition to this full line of trucks is the M. C. B. No. 46, which is designed expressly for steam railway service.

Peckham's patent combination side frames are used in the construction of this truck. They consist of a combination with two equalizing bars, of a center truss frame rigidly secured to the pedestals and top frames, forming an "extra strong" construction. This combination gives a double factor of safety, as the center frame alone is sufficiently strong to carry the weight of the car without the aid of double equalizing bars which are arranged on each side of the pedestals.



SIDE VIEW OF PECKHAM'S M. C. B. TRUCK NO. 46

The transom bars are 10-in. bulb angles secured rigidly to the top frames and to the center arch bars. The top frames and transom bars are rigidly secured to each other by a center steel plate gusset, which makes a rigid center brace that prevents the truck from getting out of square.


END VIEW OF PECKHAM'S M. C. B. TRUCK NO. 46

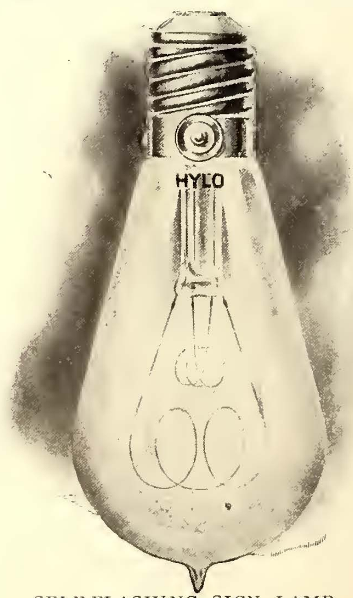
The top frames extend all around the truck. The end sections are of angle bar shape firmly secured to the side bars and corner plate gussets by machine turned bolts driven into machine reamed holes. The corner gussets prevent the truck frame from getting out of square. The bolsters are of forged steel, 10 ins. wide, and supported from the transom by forged links in one piece.

The motor suspension is from the transom bars and is provided with spiral springs. The arch-bar members are 4 ins. x 1½ ins. The journal boxes are of M. C. B. standard pattern with journals 5 ins. x 9 ins. The axles are hammered steel, 6½ ins. in diameter. The pedestals are semi-steel castings, machine fitted to the journal boxes and top frames. All bolts are machined to an exact size and driven into machine reamed holes. The brakes are of inside construction and provided with the Taylor non-chattering brake hanger.

The carrying capacity of the truck, with a factor of safety of six, is 60,000 lbs. per truck, or 120,000 lbs. per pair. With 6½-in. axles and 33-in. steel-tired wheels its weight is 10,500 lbs.

SELF-FLASHING SIGN LAMPS

One of the most remarkable incandescent lamps now on the market is the self-flashing sign lamp, manufactured by the Phelps Company, of Detroit, Mich., makers of the well-known Hylo lamps. This lamp, as shown in the accompanying cut, is of the regular Hylo type, with big and baby filament. Inside an ordinary Edison base there is a mechanism which turns the light up and down from the big to the baby filament at irregular intervals.

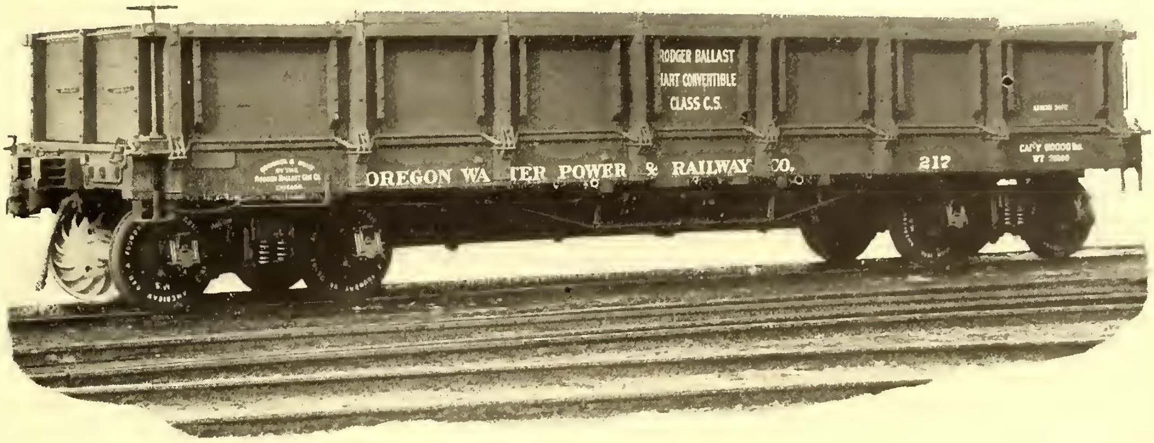


SELF-FLASHING SIGN LAMP

Each lamp is an independent unit and operates in any socket. There is an endless variety of movement, very different from the monotonous round of the old style flashers. When words are flashed on and out in the old style much of their attractiveness is lost because the sign is dark a large part of the time. The Hylo lamp sign is never dark, and the words on it can be read at a glance, because every lamp has either the large or small filament burning. A few lamps are winking up and down all the time, producing a shimmering appearance both beautiful and puzzling. It is evident that lamps of this kind may be used to great advantage for decorative purposes on special cars and in street railway parks. The Phelps Company states that its turn-down lamps are meeting with great favor, there being now over half a million users of them.

CONVERTIBLE CONSTRUCTION, BALLAST AND GONDOLA CAR

The Hart convertible construction, ballast and gondola car, illustrated herewith, which is manufactured by the Rodger Ballast Car Company, Chicago, Ill., has been in service during the past three seasons on some of the principal interurban electric railways with very satisfactory results. This car has the great advantage of combining three types in one, as it can readily be converted anywhere on the line without tools, expense or loss of time into a car suitable for three distinct classes of service.



FLAT-BOTTOM GONDOLA CAR

As a center-dump construction or ballast car it will automatically dump its entire contents onto the center of the track, the flow of material being so regulated that small or large quantities can be deposited either for track raising, tamping in or top dressing.

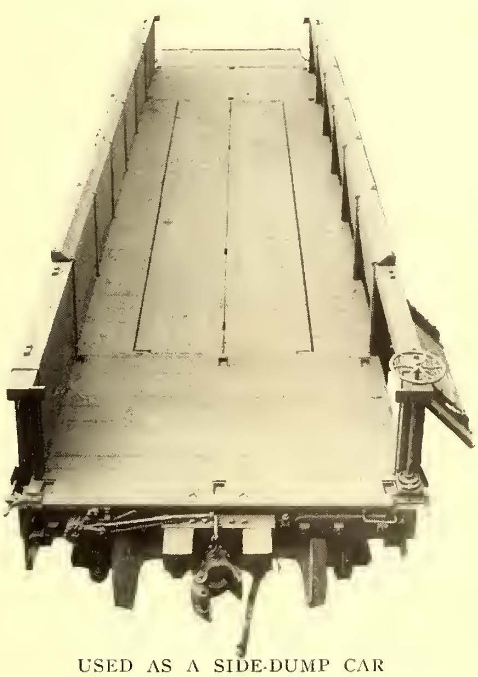
It can be converted into a side-dump car for use with top plow for depositing material on one or both sides of the track, or it will automatically dump about two-thirds of its load on the sides without plowing.

The car can also be readily converted into a standard flat-bottom gondola, suitable for coal, ore or general freight service.

By using this car the material is deposited in the center of the track just where it is needed, saving extra handling in comparison with flat cars where the material is first thrown off onto the sides of the track and afterward shoveled onto the track. As the ballast is deposited in the center of the track it does not become intermixed with soil, thus assuring a safe and permanent roadway under all conditions. The waste of ballast incident to two handlings and its becoming intermingled with soil is eliminated. The car will handle all kinds of material, being provided with large openings in the bottom for use as an automatic center dump car and equally spacious openings for side-dump or top-plow work.

This car is built to carry as much material as four flat cars of the same length and width and as much as from six to ten small hopper cars, thus effecting a great saving in first cost, train service, trackage, switching and maintenance. In capacity the standard varies from 80,000 lbs. to 100,000 lbs., with cubic capacity up to 38 cu. yds.

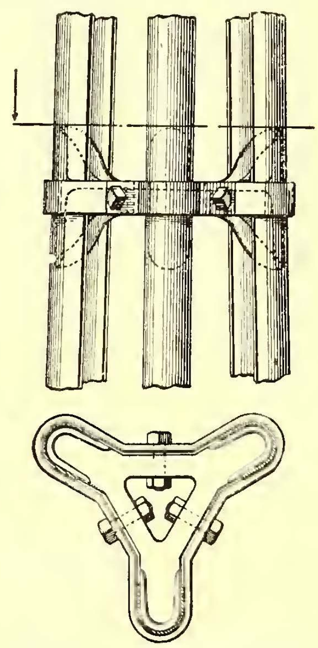
USED AS A CENTER-DUMP CAR


USED AS A SIDE-DUMP CAR

TRIPARTITE STEEL POLES

The accompanying cuts show a side elevation and section of the Tripartite steel pole made by the Franklin Rolling Mill & Foundry Company, Franklin, Pa. This pole differs from all others in being made up of three high-carbon rolled steel U's, formed like a tripod and constructed to make a tapered pole. In this pole there are no bolt or rivet holes. The three U's are held apart by spreaders and clamps, which reinforce the legs and hold them absolutely in rigid position.

It is claimed for this type that it is not only cheaper in first cost, but can also be installed for less money, as for positive anchorage only a 3-ft. set is required. Tests of this pole have shown that it does not take a set when an extra load is put on it by heavy winds, snow or ice. It can be transported in parts and assembled on the grounds along the line. It can also be painted internally as well as externally, thus insuring longer life.


SECTION AND SIDE ELEVATION OF TRIPARTITE POLE

Owing to its construction it is an entirely different pole than the structural steel poles, built up with rivets, which were used in the early days of electric railway work. It possesses all of the advantages of the structural pole, i. e., its lightness and strength, together with none of its disadvantages, such as multiplicity of parts. The poles have been used on a number of roads with satisfactory results.

Besides making this pole for electric railway and lighting companies the company is also prepared to contract according to customers' specifications for all overhead work, including Tripartite steel poles, span, trolley, feed-wire, all fixtures, bonds and bonding, set and lined up complete in working order.

A FINE PRIVATE CAR

The private car shown in the accompanying illustrations, lately built by the J. G. Brill Company for H. A. Everett, of Cleveland, Ohio, is unique in plan and appointments and one of the finest of its kind ever turned out by the builders. Provided with stateroom and kitchen, the car may be used for long inspection trips. The large windows at either end, with the bottom of the sashes but 12 ins. from the floor, make these portions of the car exceedingly bright and attractive. A cab is furnished at both ends, as the car is intended to be run in either direction. The trap doors over the three entrance steps are utilized for cab flooring to save space. The partitions separating the cabs from the car are provided with curtains, which, when drawn down, add to the privacy of the compartment. One end of the car has six large leather-covered chairs and is intended for a smoking room. A swinging door closes this compartment off from the rest of the car. The other end, which may be called the parlor, is provided with five easy chairs and a lounge. Both compartments and passageway between have parquetry flooring of a tasteful design, and are covered with handsome rugs. The coloring throughout is green in varying harmonious shades. The exterior of the car is painted dark green and decorated with gold scroll work. The draperies, curtains and rugs are of the same color, and the ceilings are of a delicate tint of pale green decorated with gold. The finish is rich mahogany with marquetry inlaid work. Between the smoking room and parlor there are four compartments; an office with stenographer's desk and chair, and provided with a safe; next a kitchen with electric stove, conveniently located sink and folding lavatory; closets for provisions and utensils; a stateroom, 6 ft. x 7 ft. 3/8 ins., with three-quarter-size handsome brass bedstead, a closet in one corner with large mirror in the door, and a wash basin in the other corner with mirror at the side of it. The door of the toilet room opens into the smoking compartment. The toilet room is large enough to accommodate a hot-water heater of the latest type. An oval window admits light. In the corner of this room, opening into the smoking room, is a linen closet, below which is the coal box for the heater.

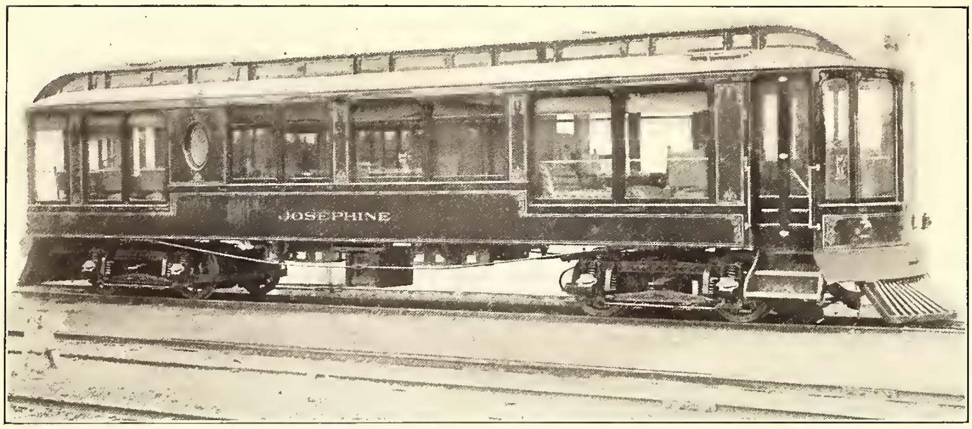


FIG. 1.—EXTERIOR OF PRIVATE CAR

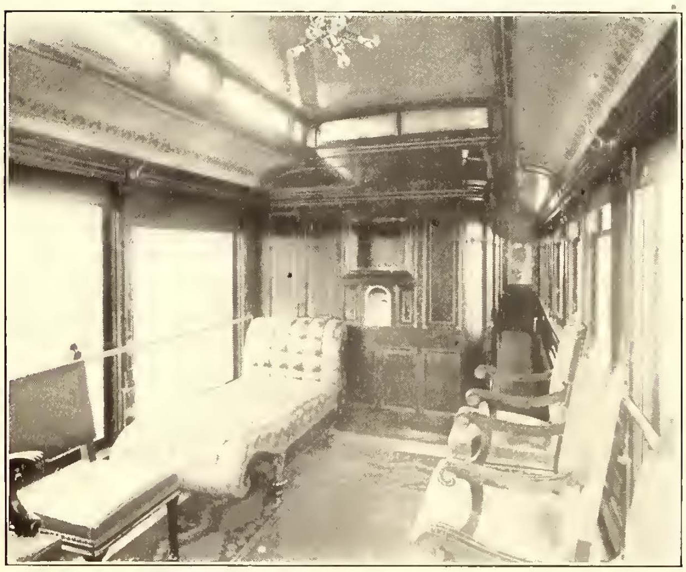


FIG. 2.—PARLOR OF PRIVATE CAR

The flooring is double and the interspace of 5½ ins. is filled with mineral wool. Trap doors which give access to the motors are arranged to fit neatly, so that their presence is only apparent by close scrutiny. The length of car body is 48 ft. 6 ins.; measured over the bumpers, 49 ft. 6 ins.; height from rail to top of roof, 12 ft. 1⅜ ins. The side sills are 4¾-in. x 8½-in. long-leaf yellow pine, with 3/8-in x 12-in. plates on the inside. I-beams, placed 15 ins. apart, extend from crown piece to crown piece, enclosed in wooden stringers, each measuring over all 6 ft. 8 ins. The intermediate sills are 4½ ins. x 5¾ ins. and the crossings 4½ ins. x 7½ ins. From truck to under side of sill is 37⅜ ins., which height being greater than that of the regular rolling stock on the lines of which this car is to be operated, an angle iron bumper 14 ins. deep is placed at either end to prevent injury to the vestibules of other cars in case of collision. Substantial cow-catchers project 20 ins. beyond the bumpers. From track to top of lower step is 15⅞ ins. Risers are 10 ins. deep each.

Brill No. 27-E-2 trucks carry the car. The wheel base is 6 ft. 6 ins. and the wheels 33 ins. The wheels are steel tired. Each truck is equipped with two 75-hp motors. Total weight of car and trucks, with motors, 66,940 lbs.

OVERHEAD CONSTRUCTION ON OHIO INTERURBAN RAILWAY

The Cincinnati & Columbus Traction Company, of Cincinnati, Ohio, recently placed with the H. W. Johns-Manville Company, through its Cleveland branch, a contract for sufficient overhead line material to build 55 miles of new road. The construction will consist of parallel trolley wires of the 000 grooved-wire type. After careful comparisons of the designs of overhead material submitted, it was decided to adopt the well-known Johns-Manville extra heavy galvanized round top hangers with ¾-in. studs

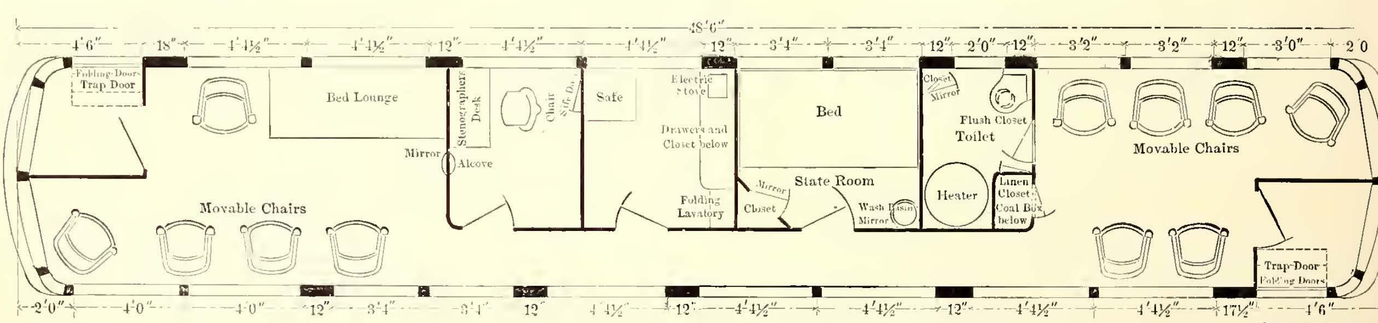


FIG. 3.—FLOOR PLAN OF PRIVATE CAR

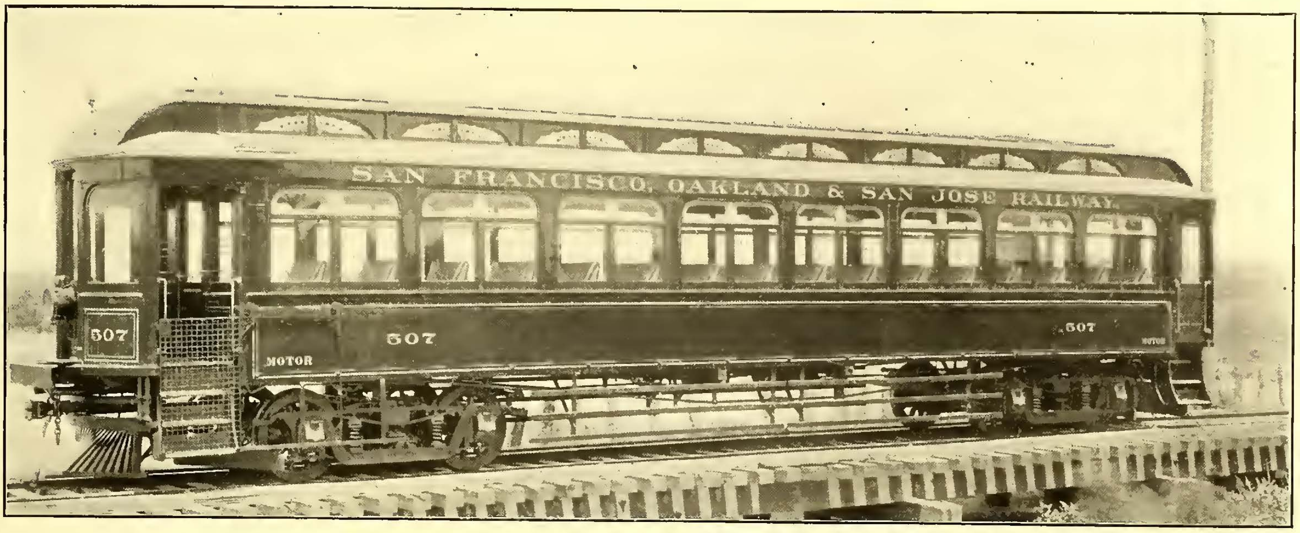
provided with deep petticoats, insuring the best of surface insulation. These are attached to galvanized straight line yokes having a center dimension of 6 ins. between trolley wires.

The Combination mechanical and soldier clip, 15 ins. long, which is made of one piece only, and has proven so successful in the East on extra heavy construction, will also be used in conjunction with the extra heavy hangers and "Giant" type of pullovers. "Giant" strains and "Philadelphia" section insulators will be used throughout.

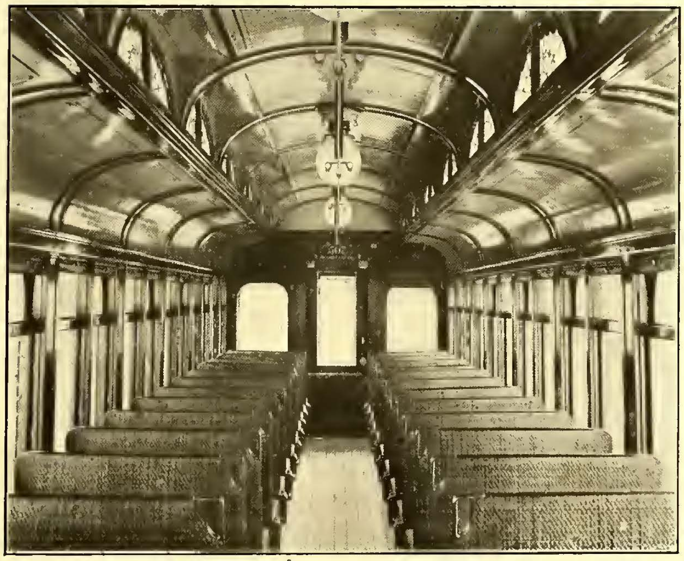
CARS FOR HEAVY SERVICE AT OAKLAND, CAL.

Heavy electric railroad construction is active around San Francisco just now. The electric cars for the North Shore Railroad, a converted steam road, have been illustrated in these columns. The present article is devoted to the rolling stock of a no less interesting undertaking which will give electric railway service approximating that given at present by steam roads, but in many respects superior. The transportation at Oakland, Cal., is peculiar. Oakland is to San Francisco as Brooklyn is to Manhattan in New York city. Many people in business in San Francisco live in Oakland. The journey from San Francisco to Oakland involves a half hour ride on the ferry. On the Oakland side of the bay the ferries cannot reach the shore because of shallow water, and piers or moles have been built out into the bay several miles for ferry landings. The Southern Pacific Railroad owns the only moles heretofore in existence, and has operated a suburban train service from the ferries to the heart of Oakland. From there passengers would take the street cars of the Oakland Transit Consolidated Company for various parts of the city. The arrangement was a cumbersome one from a traffic standpoint.

Interests identical with those behind the Oakland Transit Consolidated have constructed a new mole 17,000 feet long into the bay at Oakland, and will operate a line of ferries between there and San Francisco. The cars illustrated herewith for the San Francisco, Oakland & San Jose Railway are to take passengers as they come from the ferry and carry them to Oakland. As the crowds from a ferry boat are large the equipment was selected with a view to moving a large number of people at a time at intervals of 30 to 15 minutes, or whatever interval the ferries run at. The cars are 54 ft. 7 in. over bumpers, and 9 ft. wide. They are simple in construction, having but one unbroken compartment, and short platforms similar to those used on steam railroad coaches. Every bit of space is utilized for seating and the seating capacity is 64. One side of each platform is provided with folding doors which form a cab for the motorman when at the forward end, or are folded up against the dash when at the rear end, and not in use as a cab. The doors when folded up, as in the latter case, form a closet for the "Type-M." controller and air brake valve. The arrangement is very neat. The interior lighting is by arc lamps and arc headlights are used. The trucks are the St. Louis Car Company's No. 23 B. The car bodies, seats, arc lamps for interior and arc headlights were also the product of that company.



LONG DOUBLE TRUCK CAR FOR OAKLAND



INTERIOR OF OAKLAND CAR

MOMENTUM RAILWAY BRAKES

The Momentum Brake Company, Ltd., Toronto, Ont., announces that it intends to exhibit at the Saratoga Convention its momentum railway brake. This brake, which was fully described in the Street Railway Journal for June 13, is said to be very economical, as the power required for its operation is derived from the momentum of the car. Its certainty and quickness of operation prevents serious and costly accidents.

The brake is constructed with a compensating spring in the controlling device, so as to make the skidding of wheels practically impossible. Motormen who have handled cars equipped with this brake state that very little sand is necessary to avoid skidding. Of the thirty odd cars of the Toronto Railway Company using this brake not one has reported flat-wheel trouble.

The connections between the brake mechanism and brake staff have been so arranged that by reversing the movement of the brake staff, back-roll will be prevented while on a grade.

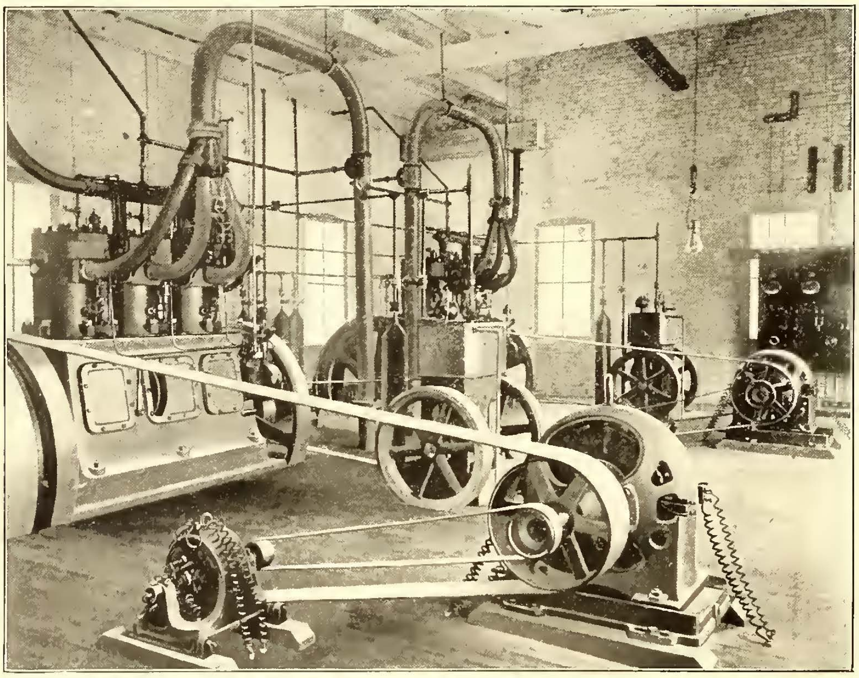
The weight of the complete equipment for either single or double trucks is about 300 lbs. Several of the Toronto equipments have been arranged so that both motor and trail cars are braked by the motorman.

After several weeks' test the South Chicago City Railway Company has ordered thirty momentum brakes and has adopted this type as its standard. Thirty-five equipments have also been ordered by the Toronto Railway Company, and three trial equipments are to be installed in Philadelphia.

AN OIL ENGINE POWER STATION

There have certainly been many developments in the power field during the last few years. The power user has not only now a wide choice in steam engines before him when selecting his equipment, but must also consider the possibilities of steam turbines and gas engines. In addition to these, if the advocates of the oil engine are to be believed, this machine will also be a factor in station construction before long. Considerable attention was attracted some years ago by the claims made for the Diesel engine, but it is only recently that this engine has been used in central power station work. The accompanying engraving shows a view of a new electric lighting plant at Jewett City, Conn., in which one of these engines has been in operation for a short time.

The oil supply for the engine is kept in two storage tanks set under ground. Their combined capacity is 6500 gallons. The oil, which is crude, costs 4.5 cents per gallon, delivered. From the main tanks it is pumped to a vertical tank holding forty gallons and from this tank it is supplied to the engines.



AN OIL ENGINE INSTALLATION

The latter were built for the American Diesel Engine Company, of New York, by the International Power Company, of Providence, R. I. They are operated on the well-known Otto cycle, but differ from the ordinary gas and oil engines in that there is no explosion in the cylinders but a steady combustion of the fuel at high-compression temperatures. The combustible is ignited at this temperature without the need of spark or other apparatus.

The oil is admitted to the cylinder by means of a valve operated by a shaft driven by the main shaft through an intermediate gear. It is forced into the cylinders by compressed air through a series of perforated brass washers, and enters in the form of a fine spray. The air which supports the combustion is drawn into the cylinder through an automatic mushroom valve, and is compressed on the up stroke to between 450 and 525 lbs. per sq. in., which corresponds to a temperature of about 1000 deg. F. The fuel valve remains open for about 1-10 of the working stroke and the fuel is let in and consumed during the whole or a part of this period, as determined by the action of the governor. When the supply of fuel stops the gases of combustion work expansively during the remainder of the stroke. The combustion is singularly complete on account of the large quantity of oxygen in the cylinder at the beginning of the working stroke. It is stated that the thermal efficiency of the engine is as high as 35 per cent.

In general outward appearance, the Diesel oil engine resembles the ordinary type of steam engine. The reciprocating parts are all enclosed within the engine housing which is fitted with detachable plates for easy access. The Jewett City station contains two engines of 75 hp each, and each drives a 60-kw Westinghouse single-phase 60-cycle alternator. The engines are guaranteed to operate on 0.47 lbs. of oil per brake horsepower-hour at full load, and on 0.5 lbs. of oil per brake horsepower-hour from friction load to full load. With oil at 4.6 cents per gallon this means about one cent per kilowatt-hour.

SAFETY CAR STRAP

The accompanying cut illustrates the Myers Y-formed safety car strap which has very recently been placed on the market. This strap, which marks a great advance upon the ordinary single style, is designed to prevent accidents to passengers when a car is going around curves or when it is suddenly stopped or started, as the strap does not slide along the strap rod like ordinary straps. With this form, the effect is the same as if the passenger were holding on to two straps.

SAFETY CAR STRAP

Straps of this type do not tend to accumulate at some one point on the rods on account of car vibration, and they are never near enough to each other to enable a passenger to hold two in one hand. Experience has shown that accidents are more likely to occur at the ends of a car rather than at the center, and it is therefore advisable to place a number of straps at the extreme ends, which can be done by attaching one end of each strap inside and the other outside the end rod supports. The strap branches are each 6 ins. long and are furnished with buckles and holes enabling each branch to be lengthened about 3 ins. The length of the middle piece is about 11½ ins. For the convenience of the passenger who is obliged to stand the handle is padded with fine, soft leather, and medicated to prevent the secretion of germs.

Owing to the Y-shape of these straps, they will give double the life and strength of ordinary straps, because the tension is divided among the branches. On the ordinary strap the weight of a man is concentrated at one point; the strain on the bar, therefore, is maximum at that one point. By using this car strap the strain on the bar is distributed over 6 ins., thereby reducing to a minimum the possibility of bar breakage.

A limited service has been put on the Rapid Railway System between Detroit and Port Huron, Mich. Two special limited cars run daily each way, stopping only at Detroit, Mount Clemens, New Baltimore, Anchorville, Marine City, the Oakland and Port Huron.

CARS FOR THE DETROIT, MONROE & TOLEDO SHORT LINE

For interurban service between Detroit and Toledo, 75 miles distant, and for local and suburban service, the Detroit, Monroe & Toledo Short Line Railway Company has adopted as its standard the type of passenger car illustrated herewith. These cars are now being built by the John Stephenson Company, and they embody several novel features. They are all of the standard steam railroad construction, so as to insure great strength, and in their appointments are in line with the standards set by the most recent examples in interurban cars in the West. They are divided into regular passenger and smoking compartments, with toilet rooms, ice coolers and other conveniences for interurban service. Only in the motor equipments do the cars vary, those intended for through interurban service being geared higher than the others.

HIGH SPEED CARS BETWEEN DETROIT AND TOLEDO

The length of the car body over corner posts is 40 ft., while the extreme length over the buffers is 52 ft. The length of the vestibule is 4 ft. 6 ins., and the length of the rear platform is 5 ft. The extreme width of the car is 8 ft. 6 ins., and the height from the under side of the sills to the top of the roof is 9 ft. The interior finish and furnishings are attractive and comfortable throughout and were selected with the view of suiting the convenience of the passengers and best meeting the requirements of the service. Thus, the appointment of the regular passenger and smoking compartments differ somewhat. In the former the seats are of the Hale & Kilburn walk-over type, upholstered in crimson plush. They have high backs and head rolls. The cushions are 34 ins. long and 17 ins. wide. In the smoker the same type of seat is used, but the finish is in white woven rattan. Extending the entire length of the car are parcel racks, furnished by the Dayton Manufacturing Company. Hot-water heaters of the Peter Smith type are to be used. Stanwood sleet steps are provided, and the vestibule trap doors are of the Zimmerman type. When the vestibule is closed in and this door is in position, it rests upon two angle-irons fastened securely on each side of the door step, about 1½ ins. below the floor level, so that the door will be on a level with the vestibule floor, and in reality form a part of it, as it will extend out over the step to the vestibule door, thus making a continuous flooring for the entire inclosure. It is not hinged at the side, but when it is desired to get it out of the way so that the steps may be used for admitting passengers, it is raised like the leaf of a table and allowed to drop into a longitudinal pocket provided at the back of the step. It can be replaced by pulling it out of the pocket and letting it down upon the angle-iron rests. A pin at the rear of the step holds it securely in position and prevents the motion of the car from jarring it out of place.

The electrical equipments were furnished by the Westinghouse Company, and comprise Nos. 76-S and 86 motors. The cars equipped with the 76 motors are geared to run 65 m. p. h., and are to be used for local and suburban service, on a schedule calling for 45 m. p. h. to 50 m. p. h.; those with 86 motors are geared for 100 m. p. h. to 110 m. p. h., and will be used on through cars running at 50 m. p. h. to 60 m. p. h. Peckham trucks with 36-in. wheels will be used. Each car will have Christensen air brakes. One of these cars will be exhibited at Saratoga

MODERN SWEEPERS AND SPRINKLERS

The McGuire Manufacturing Company, of Chicago, Ill., has now under way at its works a combined sweeper and sprinkler of most unique design for Wellington, Australia. When completed the machine will have the appearance of an ordinary street car. Two tanks 14 ft. long by 6 ft. high, with a capacity of 1500 gallons each, form the body of the car. A passage of 2 ft. 6 in. wide separates the tanks and is covered like a common street car, with a provision made for the trolley-board. The sweepers are at each end, and, being of small diameter, are placed under the overhang. The sprinklers are so arranged that the street may be sprinkled ahead of the sweeper brooms or after, as may be desired. One of the particular advantages of such construction is that it can be knocked down and shipped in small packages, which are easily put together at destination.

The company shipped two sprinklers to South Africa early in the spring and another to Sao Paulo, Brazil, and has but lately shipped trucks to Bangkok, Siam, and North Sidney, Nova Scotia. The receipt of orders from such distant points by a company located so far inland as Chicago is certainly complimentary to the method of advertising, or perhaps to the product of this company.

There is now in the yards of the McGuire Manufacturing Company a 4500-gallon pneumatic sprinkler just about completed for the Rhode Island Company. This machine, or one similar to it, will be exhibited at the Street Railway Convention at Saratoga. It is claimed for this machine that it will sprinkle a street 100 ft. wide and six miles long with one charge. It is equipped with the company's latest type sprinkler head. The interesting features of the new head are that the quantity of water used can be regulated by the motorman to correspond with the speed at which the machine is run and a series of levers enables the operator to control the spray of water completely. It may be permitted to sprinkle 50 ft. from the side of the car or lessened to any desired distance, or the sprinkling may be confined to the track only.

The important feature of this machine is that the last gallon of water in the tank can be driven, through the aid of compressed air, the same distance as when the tank is full.

Inasmuch as many cities are agitating that street railway companies should sprinkle the streets, the operation of this sprinkler at the Saratoga Convention should prove interesting.

ALLFREE ENGINES

The distinctive feature of the engines built by the Ironton Engine Company, Ironton, Ohio, is the valve and valve-operating mechanism employed. The highest steam economy obtainable was sought in their design, and, as the cylinder clearance and cylinder condensation are two sources of excessive loss, an effort was made to reduce these. The valve shown in Fig. 1 was therefore determined upon, as by its use the cylinder clearance could be reduced to from 1½ per cent to 1¾ per cent of the piston displacement. The steam admission is from the "inside," the result being that all cylinders are jacketed with live steam a little over half their circumference tending to materially reduce the initial condensation. When desirable, cylinders can be steam-jacketed their entire circumference. A further advantage possessed by this valve is its very light construction, its perfect balance, and the facility with which all wear can be compensated for. The convex faces are fitted with packing strips which automatically take up the wear be-

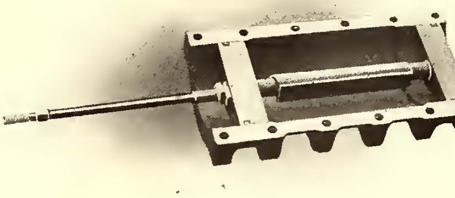


FIG. 1—VALVE

tween valve and pressure plate, and also obviate any tendency of the valve to stick upon starting.

The valve is operated through the medium of what the builder terms an "expansion gear." This gear is illustrated in Fig. 3, and two sectional elevations are shown in Figs. 4 and 5. The action of the gear is as follows: Eccentric rod *A* connects to the governing eccentric and operates the entire rocker arm as a whole, exactly similar to a high-speed automatic engine. Eccentric rod *B* connects to a fixed eccentric upon the shaft set opposite to the crank and connects to the sector *G* at the point of *F*. This sector is

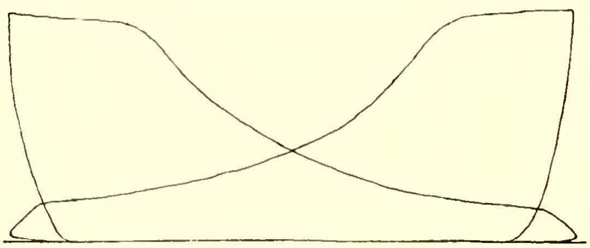


FIG. 2—INDICATOR CARDS

mounted in the rocker arm upon the shaft *E*, and its movement forward and backward rotates pinion *H* first in one direction then the other. Pinion *H* is finished at engine side with a $\frac{3}{8}$-in. crank, *J*, to which the valve knuckle is connected. The throw of the crank *J*, due to its rotation by travel of the sector *G*, will either increase or decrease the normal speed of the valve, which is imparted by the rocker arm as a whole. This accelerating and retarding effect upon the valve is so timed that the rapid movements take place at the opening and closing of ports, and the retarding effect occurs after closing of the admission, and before opening of exhaust. The result is a steam distribution exactly similar to that

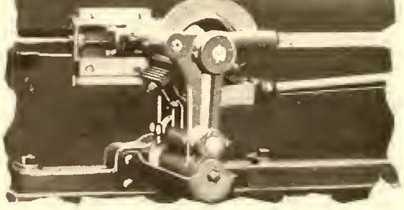


FIG. 3—EXPANSION GEAR

obtained from Corliss engines having double eccentrics, excepting that exhaust closure is not constant. The variation in the exhaust closure is, however, just sufficient to compensate for the difference in mean temperature of the cylinder for varying loads, so that the resulting pressure of compression is constant. A graduated load card shows compression lines all merging into one at admission.

Fig. 2 is a reproduction of a characteristic indicator card which accurately illustrates the advantages derived from the valve.

By using this gear the maker claims that the weight of valve and valve-operating mechanism are greatly reduced as compared with four-valve machines, the clearance is materially reduced, and the working parts are comparatively few in number, and are easier to maintain in adjustment. The action of the valve being positive, and no releasing gear or dash pots being present, the speed of rotation may be materially increased as compared with Corliss engines, resulting in a reduction in the size of the machine, cost of foundation, and very materially reducing the cost of direct-connected generators. The gear is much more quiet in operation and requires fewer repairs and adjustments than are necessary for the four-valve machines.

Another distinctive feature of this engine is the governor shown

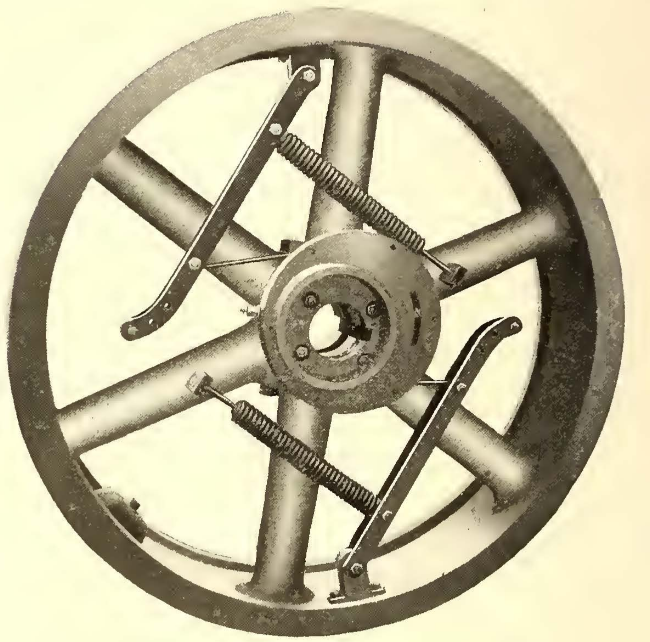
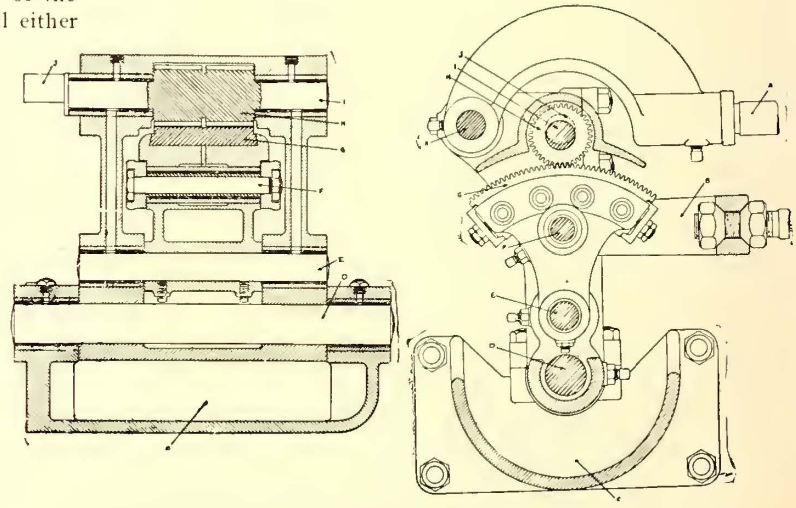


FIG. 6—GOVERNOR

in Fig. 6. This governor is of the inertia centrifugal type, but differs from others of this type in being absolutely symmetrical, and the center of gravity is maintained coincident with center of rotation for all points of cut-off. The method of suspension results in a more desirable port opening and steam distribution than is



FIGS. 4 AND 5—SECTIONAL VIEWS OF EXPANSION GEAR

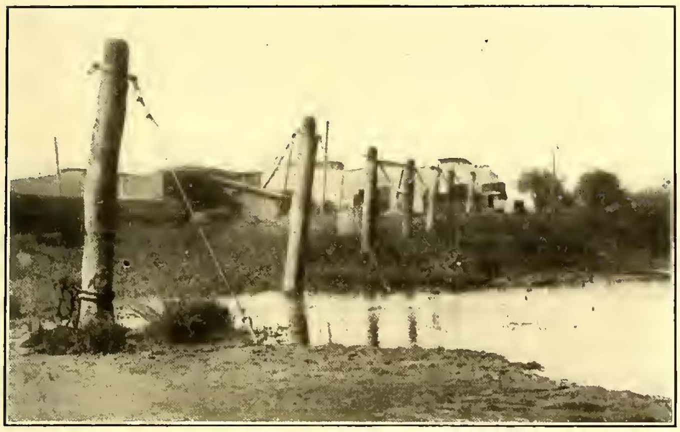
obtained from other types of inertia governor. Any desired degree of refinement of regulation is obtainable from this governor, the adjustments being made in each instance to meet the conditions of service to be performed.

Engines direct connected to alternating-current generators operating in parallel have the governors equipped with a device by which the speed may be increased or decreased from 5 per cent to 10 per cent above or below normal, while the engines are in operation. This device is operated through a worm gear and affects the speed by varying the point of suspension of spring and increasing or decreasing the tension thereof. It is possible to secure the most delicate adjustment by this device and impossible to injure the governor or produce racing of the engine.

A 175-hp engine of this type, operated at 185 r. p. m. under initial steam pressure of 100 lbs. and exhausting to the atmosphere, showed an actual water rate at full load of 23.1 lbs. per indicated horse-power per hour. No allowances whatever were made for entrained moisture, steam having been considered dry after having passed through one of our centrifugal separators.

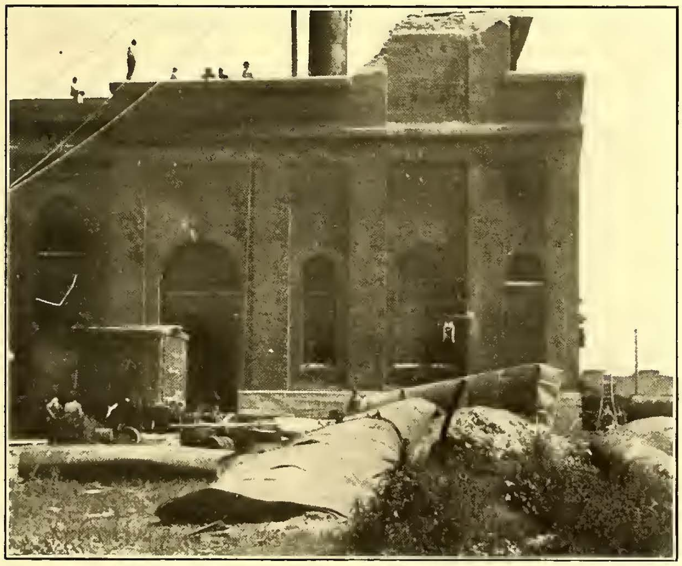
EFFECTS OF A SEVERE STORM

The accompanying illustrations were made from two photographs taken the day after the storm which wrecked the stacks of the large power house of the East St. Louis & Suburban Rail-



GUY ANCHORS FOR SUPPORTING STACK

way Company, East St. Louis, Ill. These stacks were 6 ft. in diameter, and 160 ft. high. They were guyed with ¾-in. steel cables to twenty-four 12-in. Stombaugh guy anchors, bored in to their full lengths. It is interesting to note that although the ¾-in.



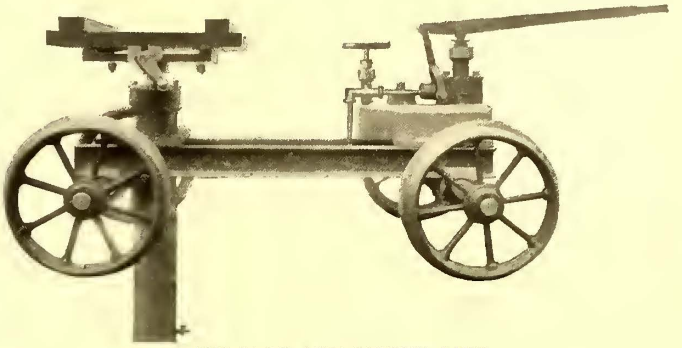
VIEW OF POWER HOUSE, SHOWING DESTRUCTION CAUSED BY STORM

cable was snapped like thread the guy anchors were not moved an inch by this severe test. The East St. Louis & Suburban Railway Company are now using these guy anchors for all of their pole guying.

Reports made by the Cincinnati Traction Company to the City Auditor indicate that the company has received during the past four months $19,455 under its traffic arrangements with the four interurban roads now entering the city. This is on a basis of 3 cents for each passenger carried within the city limits. Of this amount the city will, under the provision of an old franchise with the Cincinnati Street Railway, receive 5 per cent of the gross earnings. The City Auditor claims that the 5 per cent should be figured on the entire amount earned by interurban cars.

PIT JACK AND MOTOR LIFT

The City Machine Company, of Cleveland, Ohio, is manufacturing the pit jack and motor lift shown in the accompanying cut It is of the hydraulic type, using either oil or water, and one filling is sufficient for a year or more. By simply turning a valve and operating the lever the table may be raised to any required height. The table may be revolved, making it very convenient for changing motors. There is also a side adjustment of several inches, operating by a screw, which renders it possible



PIT JACK AND MOTOR LIFT

to readily locate screw holes in the motor casing. The device is very strong and durable.

Within the past few months the company has shipped equipments to the following railways: Detroit United Railway, Detroit, Mich.; Cleveland Electric Railway, Cleveland, Ohio; Cleveland, Painesville & Eastern Railway, Willoughby, Ohio; Cleveland & Southwestern Traction Company, Cleveland, Ohio; Eastern Ohio Traction Company, Cleveland, Ohio; United Traction Company, Albany, N. Y.; Rockford, Beloit & Janesville, Beloit, Wis.; Utica & Mohawk Valley Railway Company, Utica, N. Y.; St. Johns Railway Company, St. Johns, N. B. The device is not a new one, as it has been on the market in a small way for nearly fifteen years. The company states that it has never heard of a machine being broken or wearing out during that time.

AN APPROPRIATE PRESENT FOR SIR THOMAS LIPTON

The accompanying cut illustrates a novel "cup lifter," which was presented to Sir Thomas Lipton, on Aug. 19, with the compliments of the Duff Manufacturing Company, Pittsburg, Pa.

A SUCCESSFUL CUP LIFTER

This "cup lifter" is a miniature lifting jack made of silver, and is in the form of a small working model of the "Barrett" lifting jacks, bearing a handsome cup on the top of the lifting bar. The small jack itself stands 5 ins. high, and can be raised or lowered at will. This gift presents a very unique appearance, and as the jack and cup are handsomely finished, makes a very attractive ornament. Sir Thomas was highly pleased with it, and fully appreciated the "cup lifting" idea. The presentation was made by J. R. McGinley, president of the Duff Manufacturing Company, and J. W. Duntley, president of the Chicago Pneumatic Tool Company. Sir Thomas in response said that the America's cup was now in danger, as he had at last found a successful "cup lifter."

Owing to the action of the Eastern Ohio Traction Company in raising the price for carrying milk from 1½ cents to 2 cents per gallon, dealers along the route have thrown their supplies to creameries and cheese factories to force the railway to return to the old scale. The company claims that 2 cents a gallon is a fair price, as it delivers the milk at its freight station in the center of the city, whereas all the other electric roads operated into Cleveland oblige dealers to haul milk from the city limits. Heretofore this company has handled about 2000 gals. of milk daily.

THE FENDER QUESTION

BY DR. CHAUNCEY B. FORWARD

It has been my fortune in the past two or three years to have visited almost every large city in the United States, and I have often noticed differences in the operation and equipment of electric street railways, especially the many freak devices used on the front end of the cars ostensibly for protecting the unfortunate pedestrian who fails to get off the track in time. That the majority of fenders in use are ineffective, or at least unsatisfactory to the railway company using them, is plain to everyone who knows anything of the street railway business or has had occasion to talk with any of the officials on the subject. While the subject is one that some street railway companies appear to avoid, the people are clamoring for better protection and more safety, particularly in crowded cities. This is not at all remarkable, in view of the development of street railways in the past few years from "dinky bob-tailed" horse cars to the large heavy double-truck cars that carry 80 to 100 passengers comfortably, and more often nearly twice as many uncomfortably, at speeds of from 8 to 20 miles and more per hour.

With the larger and heavier cars has come increased speed, and as a result many lives have been sacrificed and limbs lost. I am told that the amount of damages paid on account of accidents constitutes one of the very large items in the operation of all electric railways, particularly in large and crowded cities. It has always seemed queer to me that the subject of fenders should cause most managers to throw a fit in anger. However, after giving the matter further consideration and investigation, I am not surprised that it is so. I find that there are almost as many patent fenders as there are car lines, and yet there are hardly a half-dozen worthy the name. I dare say there is not a railway official in the country who has not been pestered to death with fender men, claiming to have a device that will save them more each year than half their gross profits, more or less. The railways have tried and found wanting fender after fender, until at last they are all sick and tired of the subject, and the word fender is to the railway manager what a red rag is to a mad bull.

It seems strange that fender improvements have not kept pace with other advances in street railway equipment. The American inventor, however, does not allow such opportunities to go very long unimproved. In the past five months there has been brought to the attention of the railway managers a fender, or rather life guard, that will actually do all that is claimed for it, and a great deal is claimed for it. It is not my purpose in this article to advertise this particular fender any more than to say that I have seen it in actual operation pick up a living man at speeds from 1 mile to 20 miles an hour, yet the man was apparently unhurt. It might be said that this was a case of good luck on the part of the individual at that particular time, but I am told that he has tested the fender in this way many dozens of times, and that a hundred or more have done the same thing, and in no instance has any one ever been injured in the slightest. In addition to these trial tests it is said that this fender has saved a score of lives in accident cases in the past few months for the railways who have them in use on their lines. If these statements are true it seems to me that all the electric lines in the country would want to equip their cars at once. I do not mean to insinuate that the railway managers throughout the country would suddenly turn philanthropists for the benefit of humanity, as I have found the average manager a pretty keen man to look after the five-cent pieces for his company, but if in 90 per cent of the front-end accidents the victim can be picked up uninjured the dividends of the company would certainly be materially increased on account of the saving in damage claims.

My attention was attracted to this subject while in a certain newspaper office. The paper in question had been saying a good many things about the need of better fenders, and as a result of these articles it had received a number of communications from different inventors of fenders, complaining of their inability to get an audience with the railroad managers, or have their fenders given a trial.

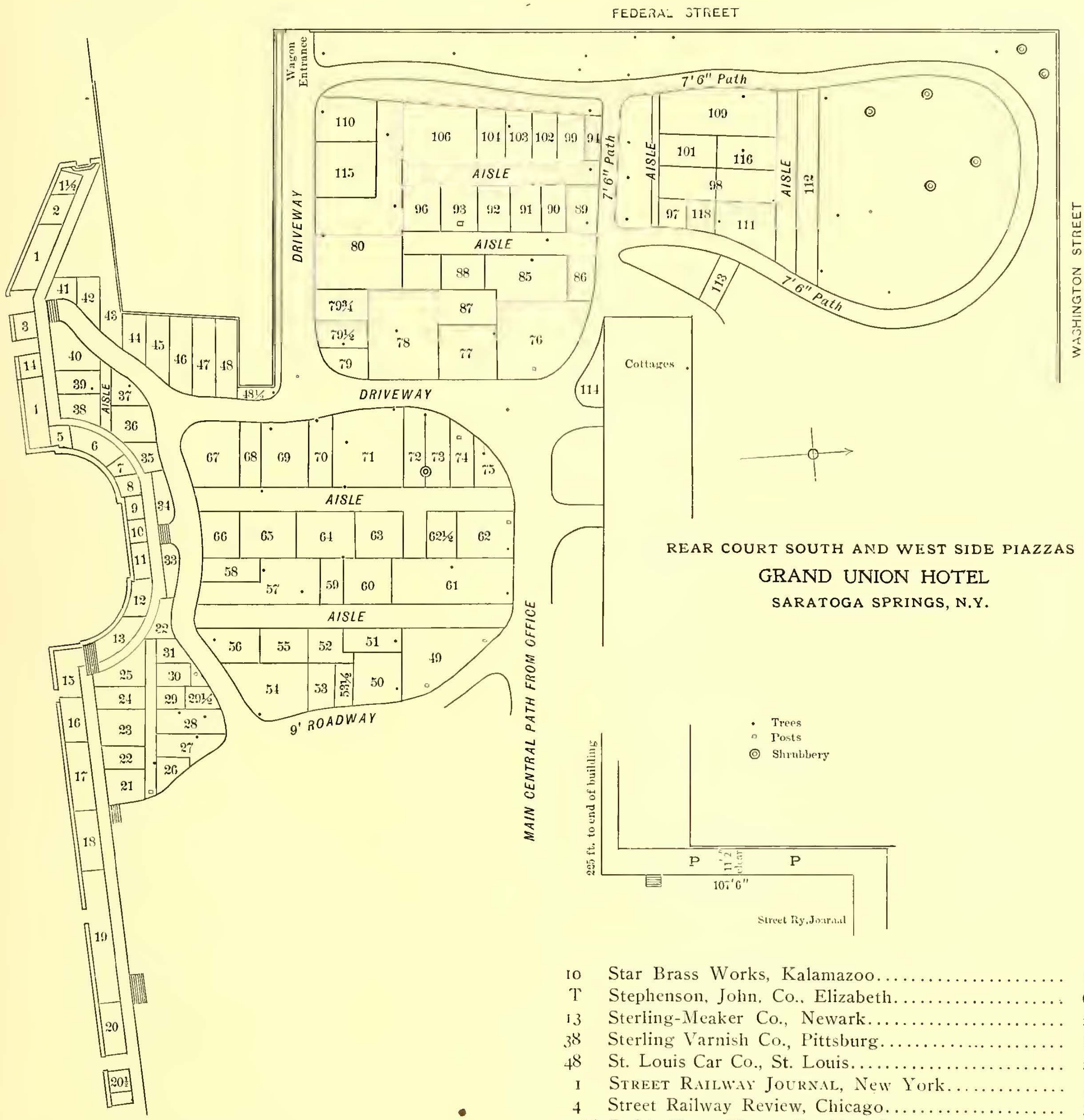
The way to reach most corporations is not by appealing to the humane aspect of the fender question, but to demonstrate to them in dollars and cents that it is to their advantage to adopt a real fender. If I were operating a street railway I would certainly give such an one a hearing and think it over.

EXHIBITORS AT THE SARATOGA CONVENTION

The following is a corrected list of exhibitors at the American Street Railway Association Convention at Saratoga, supplied by the chairman of the local committee on exhibits:

Location.	Name.	Space Sq. Ft.
16	Adams & Westlake Co., Chicago	200
30	American Automatic Switch Co., New York	100
36	American Brake Shoe & Foundry Co., Mahwah, N. J.	200
68	American Car Seat Co., Brooklyn	250
40	Atlas Railway Supply Co., Chicago	200
88	American Car & Fo ndry Co., Chicago	150
79¾	American Automatic Switch & Signal Co., Chicago	100
103	Anderson, Albert & J. M. M'f'g Co., Boston	200
113	Archbold-Brady Co., Syracuse	500
86	Baldwin Locomotive Works, Philadelphia	250
84	Bemis Car Truck Co., New York	850
92	Benjamin Electric M'f'g Co., New York	100
70	Berry Brothers, Detroit	200
11	Bliss, E. W., Co., Brooklyn	150
27	Brady Brass Co., New York	100
77	Brill, J. G. Co., Philadelphia	300
60	Brown, Harold P., New York	600
44	Bruck Solidified Oil Co., Boston	100
96	Bullock Electric M'f'g Co., Cincinnati	180
62½	Chase, L. C. & Co., Boston	200
69	Christensen Engineering Co., New York	400
32	Cook, Adam, & Sons, New York	100
3	Conant, R. W., Cambridge	100
61	Consolidated Car Fender Co., New York	1000
66	Consolidated Car Heating Co., Albany	300
73	Continuous Rail Joint Co., Chicago	200
17	Curtain Supply Co., Chicago	300
93	Climax Stock Guard Co., Chicago	150
—	Celluloid Co., New York	200
48½	Columbus Steel Rolling Shutter, Columbus	100
110	Chicago Pneumatic Tool Co., New York	600
53½	Chicago Mica Co., Valparaiso, Ind	100
114	Cheatham Electric Switching Device Co., Louisville	150
6	Dearborn Drug & Chemical Works, Chicago	200
39	Detroit Trolley & M'f'g Co., Detroit	200
—	Diamond State Steel Co., Wilmington	100
41	Duff M'f'g Co., Allegheny	100
63	Electric Storage Battery Co., Philadelphia	400
82	Electric Railway Equipment Co. (E. P. Morris), Cincinnati	1000
20¾	Edwards, O. M., Co., Syracuse	100
9	Field, C. J., New York	100
—	Federal M'f'g Co., Cleveland	100
53	Fabrikoid Co., Newburgh	100
50	General Electric Co., Schenectady	500
14	Globe Ticket Co., Philadelphia	100
57	Gold Car Heating & Lighting Co., New York	500
104	Gould Storage Battery Co., New York	200
18	Hale & Kilburn M'f'g Co., New York	250
12	Harrington, C. J., New York	200
42	Heywood Bros. & Wakefield Co., Philadelphia	100
79	Howe M'f'g Co., Scranton	100
90	Hipwood-Barrett Car Fender Co., Boston	300
—	Homestead Valve Co., Homestead, Pa	100
20	International Register Co., Chicago	200
91	Imperial Machine Co., Pittsburg	300
106	Ingersoll Construction Co., Pittsburg	600
67	Johns-Manville, H. W., Co., New York	600
94	Johnson Wrecking Frog Co., Cleveland	100
47	Kinnear M'f'g Co., Columbus	100
58	Knowles, C. S., Boston	225
74	Keefer Car Switch Co., Albany	100
25	Le Valley Vitæ Carbon Brush Co., New York	200
64	Lorain Steel Co., Lorain	500
59	Ludlow Supply Co., Cleveland	200

31	Lumen Bearing Co., Buffalo	100
27½	McLeod, Walter, Co., Cincinnati	100
76	Magann, G. P., Air Brake Co., Detroit	1000
102	Mayer & Englund Co., Philadelphia	200
105	Merritt & Co., Philadelphia	100
109	McGuire M'f'g Co., Chicago	600
55	National Carbon Co., Cleveland	300
69	National Electric Co., Milwaukee	400
7	National Ticket Co., Cleveland	100
56	National Lock Washer Co., Newark	250
51	Root Track Scraper Co., Kalamazoo	200
85	Rossiter, MacGovern & Co., New York	700
29	Railway Sander Co., Toronto, Can	100
113	Robins Conveying Belt Co., New York	200
—	Rogers Improved Journal Packing, Chicago	100
99	Railway Steel Spring Co., New York	200
97	Recording Fare Register Co., New Haven	100
20½	Sherwin-Williams Co., Cleveland	200
62	Standard Paint Co., New York	400
24	Standard Vitrified Conduit Co., New York	200



5	Newcomb, F. H., Brooklyn	100
49	Ohio Brass Co., Mansfield	875
19	Ohmer Fare Register Co., Dayton	500
—	Pantasote Co., New York	150
111	Parmenter Fender & Wheel Guard Co., Boston	150
78	Peckham M'f'g Co., New York	1000
71	Pennsylvania Steel Co., Philadelphia	1000
21	Pierce, T. Raymond, Boston	200
54	Pittsburg Reduction Co., Chicago	600
35	Pittsburg Switch & Signal Co., Pittsburg	100
112	Pneumatic Signal Co., New York	750
26	Railway Appliance Co., Albany	100
28	Railway Appliances Co., Chicago	200
10	Star Brass Works, Kalamazoo	100
T	Stephenson, John, Co., Elizabeth	600
13	Sterling-Meaker Co., Newark	250
38	Sterling Varnish Co., Pittsburg	150
48	St. Louis Car Co., St. Louis	200
1	Street Railway Journal, New York	300
4	Street Railway Review, Chicago	300
29½	Smith, Peter, Heater Co., Detroit	100
—	Standard Automatic Lubricator Co., Philadelphia	100
23	Symington, F. H., Co., Baltimore	200
98	Stanley Electric M'f'g Co., Pittsfield	450
—	Speer Carbon Co., St. Marys, Pa	100
1½	Security Register Co., St. Louis, Mo	100
80	Taylor Electric Truck Co., Troy	1500
46	Traction Equipment Co., Brooklyn	150
101	Templeton, Kenly & Co., Chicago	100
43	Uni Signal Co., Cambridge	100
118	Universal Brake Co., Lancaster	100
8	U. S. Curtain Co., Newark	100
116	United States Steel Co., West Everett	300
—	U. S. Electric Signal Co., West Newton	100

22	Van Dorn & Dutton Co., Cleveland	200
37	Van Dorn, W. T., Co., Chicago	100
75	Watson, W. T., Newark	180
72	Weber Railway Joint M'f'g Co., New York	200
2	Western Electrician, Chicago	100
P	Westinghouse Electric & M'f'g Co., Pittsburg	600
65	Wharton, Wm., Jr., & Co., Philadelphia	500
34	Wheel Truing Brake Co., Detroit	100

RECEPTION BY MR. VREELAND

President H. H. Vreeland, of the Interurban Street Railway Company, instituted five years ago the plan of inviting to his country residence at Brewster, N. Y., all of the staff of that company for a day's outing. The entertainment was so popular with all that Mr. Vreeland has followed the practice each year since that time, and each trip has been, if possible, more enjoyable than the preceding. The annual reception this year occurred on Aug. 22 and a cordial invitation was extended to all of the officers and heads of departments and divisions of the company, as well as to a few outsiders, to take the 9:08 train to Brewster. The party consisted of about sixty, and upon their arrival at Brewster they were met by brakes, which quickly conveyed them to the Tonetta Outing Club, of which Mr. Vreeland is a member, and where the clam bake, which is a feature of these annual outings, was being prepared. While awaiting this part of the entertainment Mr. Vreeeland's guests found much to interest and occupy them on the grounds of the club, which is very picturesquely situated, and the time passed quickly until the chef announced that he was ready to demonstrate how well they understood the preparation of clams at the Tonetta Club. It must not be inferred from this that this bivalve was the only viand which graced the tables, for there was a wide provision of other delicacies, all of which taste better at Brewster than anywhere else. After the tables had been cleared the guests repaired, by invitation, to Mr. Vreeland's residence, "Rest-a-While," where they were received by Mrs. Vreeland, assisted by a number of other ladies who live in Brewster. Mr. Vreeland's home is a large one and the grounds are very spacious, so that the evening passed quickly away, and it came in the nature of a surprise when the time for leaving was announced. The party returned to New York on a special train on the Harlem Railroad.

MR. BAKER LEAVES LONDON

The London County Council is about to lose the services of Mr. Alfred Baker, who has been the general manager of the southern system for some years. Mr. Baker is not a London man, having originally come from the Midlands, and as he has recently been offered the position of general manager of the Birmingham Tramways, he has decided to accept the position and will leave London as soon as his successor has been appointed. Mr. Baker will also receive a very handsomely increased salary which will commence at £1,300 per year and will rise by two yearly installments to £1,500, while the salary for the general manager of the London County Council is only £1,000 per annum. Tramway committees have not yet apparently fully realized the importance of such positions, and the fact that a tramway manager in London is only drawing a salary of £1,000 a year partakes of the ludicrous. Mr. Baker is therefore to be congratulated upon receiving the appointment from Birmingham, especially as it will afford a splendid opportunity for those talents which he possesses so fully, since Birmingham may almost be said to be a virgin field so far as electric traction is concerned. It will be Mr. Baker's work to get rid of the filthy, noisy steam tramways which have been so long a part of Birmingham's streets. Mr. Baker received his early training with the Nottingham & District Tramways Company and was general manager of that company from 1890 to 1897, when the Corporation of Nottingham purchased the tramways and took Mr. Baker over as their general manager. Mr. Baker came to London in 1899 and has, as stated above, had to advise the London County Council generally upon the whole system of its tramways in London.

STREET RAILWAYS IN VERACRUZ AND TABASCO, MEXICO

The following is a list prepared by Wm. W. Canada, United States Consul, of the railways operating in the consular district of Veracruz, Mex., including the State of Tabasco:

Ferrocarril Urbano de Alvarado, of Alvarado, operates only in the streets of that town. It has 3½ miles of 36-in. gage track; two cars; animal traction. Miguel Vives, proprietor and manager, Alvarado, Veracruz.

Ferrocarril Urbano de Jalapa operates a street railway in Jalapa. It has 1¼ miles of standard gage track; four passenger and five freight cars; animal traction. Felipe de Mazarraza, president, Tacubaya; Felipe de Mazarraza, Jr., general manager, Jalapa, Veracruz. P. O. box No. 6. There are no electric railways operating in Jalapa.

Ferrocarril Urbano de Cordoba operates about 5 miles of standard gage track in Cardoba. It has twelve passenger and twenty freight cars and one funeral car; animal traction. Jose A. Marquezhoyos, president; Adalberto Casas Rodriguez, manager, both of Cordoba, Veracruz.

Ferrocarril Urbano de Orizaba connects Orizaba, Rio Blanco, Nogales and Santa Rosa. Has 18½ miles of standard gage track, thirty-one passenger and nineteen freight cars; animal traction. Angel Jimenez Arguelles, proprietor; Eduardo Arroyo, manager, both of Orizaba, at Avenida de la Libertad No. 7.

Ferrocarril Urbano de Veracruz. This railway is operated by the "Veracruz Railways, Limited." Has tracks in nearly all streets in the city for freight and passenger service. Length of tracks, 11 miles; standard gage; twenty passenger, forty freight and several funeral cars; animal traction. Sir W. D. Pearson, president, London, Eng.; G. H. Beeston, manager; Edgar Heymans, superintendent. Address, Veracruz.

Tlacotalpam and Coatzacoalcos, Veracruz, have no street cars.

Frontera, Tabasco, has no street cars.

San Juan Bautista, Tabasco, has three lines of street cars, but further information is not available at present.

STREET RAILWAYS IN LEIPZIG

In a very complete report to the Department of Commerce and Labor, made by B. H. Warner, Jr., consul at Leipzig, some interesting facts are given concerning the street railways in operation in that city.

The first car line operated by horses was opened to the public in the spring of 1872. This road continued to operate until 1895, when two companies were given franchises to build electric railways. The concessions, almost identical in their restrictions, are for a period of forty years from the completion of the lines. According to the terms of the concessions, all the property of the companies is to revert to the city after the expiration of the grants, with the exception of property acquired within the last five years of the grants. Provision is made, however, for the acquisition of even this new property, and, further, provision is made for the acquisition of the latter property by the city at the expiration of twenty, twenty-five, thirty or thirty-five years.

After the first three full years the lines are in operation, they must pay the city for the use of the streets 2 per cent of the gross receipts, which amount will be increased 1 per cent after the lapse of every five years, until it reaches 5 per cent. The companies must pay for paving and repairing the streets where new tracks are put down and where the running of the cars is responsible for the rapid deterioration.

The Grosse Leipziger Strassenbahn Gesellschaft, the larger company, known as the "Blue Line," is capitalized at $2,380,000, which is divided into 10,000 shares of $238 each. It has a bonded indebtedness of $2,380,000, bearing 4 per cent interest per annum, which is divided into 6500 bonds of $238 each and 7000 bonds of $119 each. The company has paid regular dividends to its stockholders since 1896, when it began operations, as follows: For the years 1896, 1897, 1898, 1899, 1900, 1901 and 1902, 6, 8, 8, 8, 7, 5½ and 5½ per cent, respectively.

The Leipziger Elektrische Strassenbahn Gesellschaft, the smaller company, known as the "Red Line," is capitalized at $1,487,500, which is divided into 6500 shares of $238 each. It has a bonded indebtedness of $952,000, bearing 4 per cent interest per annum, which is divided into 2000 bonds of $238 each and 4000 bonds of $119 each. Regular dividends have been paid the stockholders since its organization, as follows: 1895 to 1899, 4 per cent per annum; 1900, 3 per cent; 1901, 2 per cent, and 1902, 2 per cent.

There are 131.17 miles of tracks, including those in the various car sheds, 77.2 miles of which belong to the larger company and 53.97 miles to the smaller. The former has had, for several years past, its own car shops. It has 275 motor cars and 112 closed and 30 open trailers—in all 417 cars in use. The smaller company has 130 motor cars and 20 closed and 30 open trailers—in all 180 cars in use. The smaller company's cars are fitted with the ordinary hand brakes, while those of the other (the Blue Line) have the latest Westinghouse air brakes attached, in addition to the hand brakes. The overhead trolley system is used by both companies.

Cars are run from 5:17 o'clock in the morning until midnight, upon schedules varying from 4 to 15 minutes apart. Municipal ordinances prescribe that street cars shall not run at a higher rate of speed than nine miles an hour in the business sections; with trailers, 7.2 miles; and in the suburbs, 15 miles, or 12 miles with trailers. Cars are not to be stopped at every corner to let passengers on or off, but at places perhaps 250 yards or less apart, marked for the guidance of the public by iron signposts placed a foot or two in from the curbstone. There are a certain number of standing-room places on the front and rear platforms of the car—perhaps 15 on an average. When these are taken and the inside is full, the conductor hangs out at the rear end of the car by the entrance a sign "Occupied," and no more stops are made to take on passengers until some are let off.

The fare for a single trip is 10 pfennigs (2.38 cents), which entitles one to a free transfer. Passengers carrying large baskets, bundles, etc., must pay a full fare for such. All employees of the city, as well as those connected with the police department, when in uniform, are entitled to ride upon the front platform free of charge, but never more than two at a time. In addition thereto, a large number of city officials—at the present time 560—are given "annual passes." To school children under 15 years of age are issued special cards, which are good only upon the lines running between their respective homes and the schools they attend and between certain hours of the day.

The wages of a conductor are $20 per month for the first year's service; the same amount is paid a motorman for the first six weeks he works. After their respective apprentice terms have expired they are paid from $21.42 to $28.52 per month, the amount being fixed by the length of time they have been employed. The men are given one day off in every six, seven or eight, depending upon the number of hours each one is compelled to work daily. A working day is usually from ten to twelve hours.

The streets are cleaned and sprinkled by the city government, and the cost of this work is charged to the railway companies.

In winter the companies keep their respective tracks clear with snow plows. The snow is piled on either side of the tracks and carted away by the city, which charges the companies 43 cents to 65 cents per wagonload containing about 71 cubic feet, the price depending upon the length of the haul.

For the benefit of those employees whose wages do not exceed $476 per annum, sick, accident, life insurance and assurety funds are established. These are also charged to the expense accounts, as is also the cost of the employees' uniforms, each man being provided with at least one uniform, two caps, an overcoat, etc., per annum, except, however, those who are working for the first year, from whose wages 10 pfennigs per day are deducted to pay for the uniforms.

The condition of the companies at the end of the calendar year 1902 is shown in the following statement:

Salaries	$278,335	$107,710
Expenses	296,370	136,566
Taxes	35,917	14,995
Interest account	98,175	45,431
Gross profits	309,391	94,834
Total debit	1,018,190	399,538
Credit (total income)	1,018,190	399,538

An extensive electric railway system is to be constructed in the city of Rosario by the Anglo-Argentine Company, an English syndicate. Several horse lines will be electrically converted. The scheme, according to South American advices, is a very comprehensive one, involving every quarter of the city.

AMONG THE MANUFACTURERS

THE CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., has just added to its extensive line of railway specialties the manufacture of arc headlights and guy anchors for electric railways.

THE PITTSBURG RAILWAY SUPPLY COMPANY, of Pittsburg, Pa., which recently organized with $1,000,000 capital, has not yet located its plant, although several very flattering offers of free sites and good bonuses have been made to it.

THE ALLIANCE ASBESTOS MANUFACTURING COMPANY has been organized to manufacture asbestos products of all kinds. The company will erect a large factory in Alliance, Ohio. Dr. W. J. Snyder is president, and H. M. Kayler is general manager of the company.

THE CURTAIN SUPPLY COMPANY, of Chicago, Ill., has engaged B. S. McClellan, who will come to it Sept. 1, as salesman. Mr. McClellan will have his headquarters in Chicago, and will cover Western territory. He has had a large experience among railroad men, having been with the Illinois Central and New York Central in important positions for some twenty-two years, and is well-known to the trade.

THE SPRAGUE ELECTRIC COMPANY has recently issued a third edition of Bulletin No. 206, relative to its direct current motors. The publication contains a list of standard sizes, weights, dimensions, etc., of round type, M. S. type six-pole, S. S. type six-pole single-field coil, and F. M. type motors. These motors are made in all sizes, from 1-20 to 1000-hp., are wound for a wide range of speeds and voltages, and can be shunt, series or compound wound, as may be desired.

THE IRONTON ENGINE COMPANY, of Ironton, Ohio, has given to Fairbanks, Morse & Company, of St. Louis, Mo., the agency for Allfree engines, which it manufactures, for the St. Louis district and the Mexican trade. Harron, Rickard & McCone, successors to the old Park & Lacey Company, of San Francisco, Cal., have secured the agency for California, Nevada and Arizona. Both agents are in receipt of a very complete line of catalogues, illustrations, etc., and expect to secure a very creditable portion of the orders placed in their territories.

A VERY FINE CATALOGUE has just been published by the Allis-Chalmers Company, Chicago, Ill. The book is replete with many excellent illustrations of the company's products, particularly Reynolds-Corliss engines, air compressors, Reynolds air pump and condenser, blowing engines, combined vertical and horizontal direct-coupled engines, Reynolds feed-water heater, girder-frame engines and numerous types of hoisting engines. The illustrations also include views of prominent power plants using this company's apparatus and of the West Allis and E. P. Allis works.

THE R. D. NUTTALL COMPANY, of Pittsburg, Pa., announces that it has in preparation, and will place on the market at the proper time, a practical and perfect sleet cutting device, which is light, strong and compact, can be carried by the motorman without inconvenience, quickly adjusted without removing the wheel, and without using tools of any description. This device is the invention of an experienced street railway man, and has been thoroughly tested. The company will carry a large stock of both standard and high-speed sizes, and will fill all orders from stock.

THE STANDARD ENGINEERING COMPANY, of Cleveland, has taken the contract for building the first section of the Cincinnati, Hamilton & Indiana Electric Railway, of which J. C. Hooven, of Hamilton, is chief promoter. The Standard Company will do the grading, bridge building and track laying for the section between Hamilton and Richmond, Ind. The line will enter Cincinnati over the tracks of the Cincinnati, Dayton & Toledo Traction Company from Hamilton. Work will start in the very near future. A. W. Jones, at present chief engineer for the Scioto Valley Traction Company, of Columbus, will be chief engineer of the new road.

THE UNI SIGNAL COMPANY, of Cambridge, Mass., has just published its Bulletin No. 1. This publication gives a very complete explanation of the Uni signal system, including wiring diagrams and illustrations of the parts used. This is a standard, automatic, non-interfering, two-line wire block signal system, applicable to all electric railway systems, and is especially adapted for all single track trolley electric railways where it is desirable to protect any section of track from both a head or rear-end collision. The Uni Signal Company believes that the adoption of this system will insure safety and obviate delays in traffic necessitated by cars always meeting at a predetermined turnout.

THE OHMER FARE REGISTER COMPANY, besides exhibiting at Saratoga its No. 3 register with safety locks and conductors' identification keys, which are printed with each register record, will exhibit its No. 4 register, which, in addition to all the good features of the No. 3 register, will register and indicate twelve different classifications of fares, print the number of each kind which has been registered at the end of each half-trip, and give to the railway company a complete record of each and every transaction. The company will also exhibit its "Latest Register," specially adapted for city lines for two, three or four classes of fares. This register is so constructed that it can be operated from the rod in the car used with any ordinary register, and with this register the cord is dispensed with. The company expects to be represented at the Saratoga Convention by the following: John F. Ohmer, vice-president and general manager; J. H. Stedman, secretary; Walter E. Hinmon, M. Macdonald, H. A. Eckert and C. W. Ketteman.

THE KNUTSON TROLLEY RETRIEVER, manufactured by the Trolley Supply Company, Canton, Ohio, is meeting with gratifying success, although it has been on the market only a few months. Street railway managers are quick to appreciate the value of any device resulting in improved service, and the success of this retriever is ample evidence of its efficiency. This device is made to instantly, automatically and unfailingly catch the trolley as it leaves the wire, pull it 4 to 6 ft. down and hold it there, out of harm's way. It works unerringly at any speed, however great, in spite of rain, snow or sleet, with trolley rope frozen or not, and without any attention from any one. It is easily and quickly reset and there is no need of touching it. Among the many railways which have recently adopted the retriever are the following: Canton-Akron Railway Company, Akron, Ohio; Stark Electric Railway Company, Alliance, Ohio; York Street Railway Company, York, Po.; Columbus, London & Springfield Railway Company, Columbus, Ohio; Union Traction Company, Anderson, Ind.; Indianapolis, Shelbyville Railway Company, Indianapolis, Ind.; Lehigh Traction Company, Hazleton, Pa.; Columbus, Buckeye Lake & Newark Traction Company, Newark, Ohio; Youngstown & Sharon Railway Company, Youngstown, Ohio; Detroit United Railway, Detroit, Mich.; Rockford, Beloit & Janesville Railway Company, Beloit, Wis.; Grand Rapids, Holland & Lake Michigan Rapid Railway, Holland, Mich.; Western Ohio Railway Company, Lima, Ohio. Shipments have also been made lately to France, Germany and South America. The company has issued a handsome booklet, describing the retriever, which it will gladly send to readers of the STREET RAILWAY JOURNAL on request.

A RECENT TESTIMONY to the value of flexible metallic conduit was made by Vice-President and General Manager Bryan, of the Interborough Rapid Transit Company, New York, in an interview published in the New York Sun August 12. Speaking of the fireproof construction of the new cars for the subway, and the impossibility of the Paris accident being repeated in New York, he says, according to the N. Y. Sun: "The wiring for lighting the cars is one roof away from the passengers. Two small wires are insulated with asbestos and carried in conduits of flexible metal." The flexible metallic conduit which he refers to is that manufactured by the Sprague Electric Company, who received the order for this type of conduit for the interborough car-wiring for lights. This type of conduit is said to be unequalled for car-wiring as well as the wiring of buildings where thorough protection to wires and insulation is essential. Its flexibility is such that it can be bent around corners and over obstructions with ease, the energy required to bend it being no more than is required to bend a manilla rope of the same diameter. No elbows, therefore, are required and the installation is reduced to absolute simplicity. It is self-evident that this type of conduit is well fitted to car wiring.

THE CONSTANTLY INCREASING DEVELOPMENT of electric railways, with the corresponding increase in the use of heavy, high-speed cars, is reflected in the remarkable growth of the National Electric Company's air brake business. During the first half of the present year this company's shipments of Christensen air brakes equalled the entire business of 1902, which was the largest year in the company's history. Among the recent orders for air brake equipments received are the following: Birmingham Railway Light & Power Company, Birmingham, Ala., 37; Little Rock Railway & Electric Company, Little Rock, Ark., 25; United Railway of San Francisco, San Francisco, Cal., 58; Pacific Electric Railway Company, Los Angeles, Cal., 90; Denver City Railway, Denver, Col., 25; Connecticut Railway & Lighting Company, Bridgeport, Conn., 36; Chicago City Railway Company, Chicago, Ill., 20; Lake Street Elevated Railway, Chicago, Ill., 40; Northwestern Elevated Railroad Company, Chicago, Ill., 35; Indianapolis Traction & Terminal Company, Indianapolis, Ind., 25; Tri-City Railway Company, Davenport, Ia., 16; Middleton & Danvers Street Railway Company, Danvers, Mass., 16; Boston & Worcester Electric Company, Boston, Mass., 27; Twin City Rapid Transit Company, Minneapolis, Minn., 177; Metropolitan Street Railway Company, Kansas City, Mo., 60; New Jersey & Sea Shore Railway Company, Atlantic City, N. J., 50; New Jersey & Hudson River Railway & Ferry Company, Edgewater, N. J., 18; Public Service Corporation, Jersey City, N. J., 150; International Traction Company, Buffalo, N. Y., 41; Brooklyn Rapid Transit Company, Brooklyn, N. Y., 52; Interborough Rapid Transit Company, New York, N. Y., 350; Cincinnati Traction Company, Cincinnati, Ohio, 70; Northern Ohio Traction Company, Akron, Ohio, 18; Philadelphia Rapid Transit Company, Philadelphia, Pa., 175; The Rhode Island Company, Providence, R. I., 233; Nashville Railway Company, Nashville, Tenn., 16; Chesapeake Transit Company, Norfolk, Va., 18; Seattle Electric Company, Seattle, Wash., 16; Tacoma Railway & Power Company, Tacoma, Wash., 26.

THE FOLLOWING IS A PARTIAL LIST OF ENGINE SALES for July, 1903, by the Allis-Chalmers Company, Chicago, Ill.: Chicago Beach Hotel, Chicago, Ill., one 16-in. x 36-in. heavy-duty direct-connected Reynolds Corliss engine; Knox Construction Company, Chicago, Ill., two 20-in. and 40-in. x 48-in. heavy-duty cross-compound direct-connected Reynolds Corliss engine; Richmond Cedar Works, Richmond, Va., one 24-in. and 36-in. x 48-in. heavy-duty cross-compound Reynolds Corliss engine; Barrett Manufacturing Company, Beloit, Wis., one 20-in. and 40-in. x 48-in. heavy-duty cross-compound Reynolds Corliss engine; American Aristotype Company, Jamestown, N. Y., one 18-in. x 36-in. girder frame Reyonlds Corliss engine; Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio, one 16-in. x 42-in. girder frame Reynolds Corliss engine; Fourche River Lumber Company, Chicago, Ill., one 24-in. x 48-in. heavy-duty Reynolds Corliss engine, one 20-in. x 42-in. heavy-duty Reynolds Corliss engine; J. I. Case Plow Works, Racine, Wis., one Reynolds air pump and jet condenser; Consumers' Heat & Electric Company, Bloomington, Ill., one 20-in. and 32-in. x 36-in. heavy-duty cross-compound Corliss engine; Union Sugar Company, San Francisco, Cal., one 18-in. x 36-in. girder frame Reynolds Corliss engine; Canton Oil Mill Company, Canton, Miss., one 16-in. x 42-in. girder frame Reynolds Corliss engine; Henry Du Pont, Wilmington, Del., one 26-in. x 42-in. girder frame Reynolds Corliss engine; Olds Motor Works, Lansing, Mich., one 16-in. x 42-in. girder frame Reynolds Corliss engine; The Clayton Oil Mills, Clayton, N. C., one 18-in. x 42-in. girder frame Reynolds Corliss engine; The Home stake Mining Company, Lead, S. D., one 18-32-34-in. x 42-in. combined horizontal-vertical triple expansion engine, three 320-hp Sederholm boilers; Lacey-Buck Iron Company, Birmingham, Ala., one 44-in. and 84-in. x 60-in. vertical standard furnace-blowing engine; C. A. Macdonald, Chicago, Ill., one 16-in. x 36-in. girder frame Reynolds Corliss engine, without crank, crank-shaft, wheel, etc.; Arkansas City Milling Company, Arkansas City, Kan., one 22-in. x 42-in. heavy-duty Reynolds Corliss engine; Manhattan Rubber Manufacturing Company, Passaic, N. J., one 24-in. and 40-in. x 42-in heavy-duty tandem-compound Reynolds Corliss engine; Charles B. Pride, Appleton, Wis., one 18-in. x 36-in. heavy-duty Reynolds Corliss engine, substituted for 14-in. x 36-in., sold May 25, 1903; Columbus, Buckeye Lake & Newark Traction Company, Columbus Ohio, one 34-in. and 68-in. x 48-in. vertical cross-compound condensing heavy-duty Reynolds Corliss engine; Lock, Moore & Company, Limited, Westlake, La., one 24-in. x 48-in. heavy-duty Reynolds Corliss engine; Georgia Cordage Mills, Decatur, Ga., one 16-in. x 42-in. heavy-duty Reynolds Corliss engine; Marquette Cement Manufacturing Company, La Salle, Ill., one 20-in. x 42-in. heavy-duty Reynolds Corliss engine; Coe Brass Manufacturing Company, Torrington, Conn., one 22-44-in. x 42-in. and one 19-38-in. x 42-in. combined horizontal and vertical compound Reynolds Corliss engine, two air pumps and two jet condensers.

THE FRANKLIN ROLLING MILL & FOUNDRY COMPANY now has in operation at Franklin, Venango County, Pa., a perfectly equipped and up-to-date plant in every respect. The plant is divided into five departments, comprising the steel pole department, rolling mill, malleable-iron foundry, gray iron foundry, steel and iron rivet department. The tripartite steel pole department has been established by the company as a specialty to fill a long-felt want, as wooden poles are becoming scarcer and dearer from year to year. As this company is the owner of the basic patents covering this pole, and is the only manufacturer of the same, it has been able to produce and sell these excellent poles at a price very little above that of wooden poles. These tripartite poles are specially designed to meet particular strain conditions, so that the purchaser is not obliged to pay for more metal than is actually required. This type is well fitted for electric railways, power transmission lines, telephone and telegraph lines, etc., because it is simple in construction and possesses great strength and elasticity. It can also be quickly and economically installed and, being made of high carbon steel, will not deteriorate. The company is prepared to guarantee the pole in every way, and will also contract for all the overhead construction with any railway company wishing to do so. The rolling mill department is used for the production of high-grade rolled steel for light structural work. A "U" section shape is a specialty of this department. This section is rolled from old steel rails and is high carbon, running from 30 to 40 points, which gives it strength and elasticity. This section is used in the construction of the tripartite steel pole for all overhead construction. The daily capacity of this department is about 80 tons. The malleable-iron department is equipped with the latest and most improved refined air furnaces, which produce the finest high-grade iron. The annealing ovens are arranged to insure perfect annealing. The gray iron department is furnished with one of the best cupolas known, and has a daily capacity of 50 tons. It is furnished with very heavy traveling cranes for handling any size castings. The steel and iron rivet department is equipped with the most improved furnaces and automatic machines for making soft rivets from Bessemer steel of structural sizes and any shaped heads. The capacity of this department is about 50 tons per day.

BRITISH INDUSTRIAL NOTES

J. G. White & Company, Limited, of London, have secured the tender for the supply and erection of the overhead line equipment of the Rochdale tramways, the amount being £21,619 13s. 10d. The same firm has also received the contract for the construction of the Colchester Tramways, including permanent way and overhead construction, amounting to £35,035.

G. D. Peters & Company, of Moorfields, London, who are the exclusive agents for Hale & Kilburn, of Philadelphia, have just issued a very interesting pamphlet showing a number of internal views of tramcars and railway cars fitted with their special seats, one of the views showing the interior of one of the cars recently built by the Brush Electrical Engineering Company for the Metropolitan District Railway, and which was furnished with Hale & Kilburn seats by G. D. Peters & Company. Another interesting view shows a sectional view of the rattan seating, which shows also the construction of the rattan. This rattan seating will undoubtedly become more and more popular in this country, as it is cool and cleanly and can readily be washed and kept clean.

The Elswick Coal Company, of Newcastle-on-Tyne, has placed a contract with Ernest Scott & Mountain, Limited, of the Close Works, Newcastle-on-Tyne, for a complete electric pumping plant for its North Elswick colliery. A feature of interest in connection with this plant is the fact that the colliery company is proposing to take the current for driving the pumps from the town supply mains. The plant consists of a Scott & Mountain horizontal slow-speed three-throw ram pump, delivering 400 gallons per minute against a vertical head of 800 ft., the pumps being driven by a Scott & Mountain multi-polar continuous-current electric motor of 130 hp, the pump and motor being placed at the shaft bottom and delivering to the rising main to bank. The current will be taken from the supply company's mains to the shaft top, then down the shaft to the pumps in-bye, these cables being of sufficient capacity to transmit 150 hp at 500 volts, the cables being insulated and heavily armored for protection in the shaft. Another installation recently secured by the same firm, is for an electric conveyor of the Brothers type for conveying railway material from one side of the Victoria Falls on the Zambesi to the other, and also to be used in connection with the erection of a bridge which the Cleveland Bridge & Engineering Bridge Company is supplying. The electric conveyor consists of a hoisting and traveling gear, which runs upon a wire rope, suspended from one side of the falls to the other, the distance being 830 ft., and the weight of the rope and the load is supported at each end by balanced cantilevers. The wire rope is being supplied by T. & W. Smith, of Newcastle, and the cantilevers and other work by the Cleveland Bridge Company. The current for driving this plant is generated by a portable steam engine and dynamo on one side of the falls, the current being conveyed across the falls by a hard-drawn copper conductor, and collected by rollers. The firm is now very busy with mining work, having contracts in hand for Walbottle Colliery, Consett Iron Company, Limited, both these collieries being in the Newcastle district; also for the Wigan Coal & Iron Company, Limited, North Manchester, the Llay Hall Colliery, North Wales, and a number of other important contracts.