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Traffic Congestion in London

Some very interesting testimony has been elicited as to the causes for congestion in streets and the best methods of obviating it through the investigation now being conducted in London by the Royal Commission on London Traffic. This Commission, it will be remembered, is the one which visited this country last fall and took the testimony of a number of traffic experts in this country, and the one with which William Barclay Parsons, of New York, has just accepted an offer to act as consulting engineer for a short time. The traffic situation in London differs radically from that in other cities, owing to a number of circumstances, among them the one that there are practically no tramways now of any kind in the strictly business section of the city, their places being taken up by omnibus lines and a few lines of underground railways. Other factors which render a proper solution of the situation difficult are the narrowness and crookedness of the leading thoroughfares and the unwillingness, up to the present time, on the part of Parliament to permit the construction of a tramway line on the Thames Embankment, which, if improved in this way, would greatly relieve the now crowded Strand and Fleet Street.

Some of the testimony already taken by the Commission in London indicates that, somewhat contrary to general belief, the introduction of an electric railway line, either single or double track, depending upon the width of the street, tends to relieve the traffic congestion. This is explained partly on the ground that electric cars are the most compact method of conveying persons through a street, and also partly because a line of moving cars gives direction to the vehicle traffic and assists in keeping the movement to the proper sides of the thoroughfare. The improvement is particularly noticeable when cars are substituted for omnibuses. It may be thought because omnibuses can run over any portion of the road they are less liable to cause blockades, but in the opinion of the highest experts this facility of movement is by no means entirely advantageous. On the contrary, the practical consequence of this condition is that an omnibus is more difficult to pass by a faster traveling vehicle than a car, by reason of the fact that it is liable at any moment to turn to one side, rendering it extremely dangerous to pass between it and another vehicle at anything like close quarters. In addition, omnibuses in attempting to pass one another cause much obstruction, while railway cars are compelled to follow each other without the possibility of blocking the traffic by interference with each other. Moreover, the cars can be operated at a higher speed, and, if equipped with efficient brakes, at equal or greater safety, as compared with the omnibus, and for this reason also are less likely to block the ordinary vehicular traffic.

In discussing this question before the Royal Traffic Commission recently J. Edward Waller, of the well-known firm of London engineers, mentioned 30 ft. as the minimum width of street on which, in his opinion, a double-track line of street railways could advantageously be laid, and 22 ft. as the corresponding minimum width for a single-track line. This width is based on the space required for a car to pass one line of vehicles alongside of the curb without encroaching on the space required for the passage of the cars. Mr. Waller also believes that underground tube railways cannot serve the traveling population in the same way that street railways can, as the underground stations are necessarily at some distances apart, and are inconvenient of access by reason of the depth at which such railways must generally be built, and that while subways can be used in place of tramways in certain cases, especially where the route crosses any of the main arteries of traffic, they should be resorted to only in case of absolute necessity, owing to the large expense involved in their construction.

The Finances of Interurban Roads

In spite of the generally good returns secured in electric railroading we are at present hearing a good many wails from the interurban and country roads in various parts of the country, and the official reports of various States show a condition of affairs that is not altogether encouraging. We have vast faith in the future of electric railroads, but if we read the signs of the times aright it is time to run up a cautionary signal and to nail it to the mast. We have had a period of magnificent building, and to judge from the plans now maturing it has not yet begun to wane to any notable extent. Thirty years ago the railroad industry at large underwent just such an experience, and the results, while very gratifying from the standpoint of mileage, were not in the long run altogether good. In the fullness of time the hopes of the builders will, doubtless, be fulfilled, but the original investors in some cases have small hope of sharing in the ultimate benefits. In view of this experience caution is a good thing to cultivate, for, after all, electric railroading is subject to the general laws of economics that govern all enterprises dealing with public transportation, and it should learn from the experience of its predecessor as well as its own.

We have over and over advised electric railway men to study the operating methods of general railroading, and in addition we would commend the study of their financial conditions. Of the paying quality of a good urban electric road there is little doubt; some suburban lines and some interurban lines are similarly happy in their prospects; but a good many systems have just now an outlook that is by no means cheerful. Of course, we must realize the fact that in most electric, as in most other railroads, the real investment is represented by the bonded indebtedness, and that the stock represents merely the contingent possibilities of future business, but understanding all this there still remains the unpleasant fact that a good many lines are hard pressed to meet their fixed charges and the necessary appropriations for the up-keep of the system.

The financial problem is at bottom a brutally simple one. An interurban road is built, let us say, at a cost, all ready to run, of $30,000 per mile, reckoned in its bonds. It must then earn net profits of, say, $3,000 per mile to pay the fixed charges and to allow even the most modest sum for depreciation of the physical assets. To obtain this return it must do a gross business enough larger to take full account of all the operating and miscellaneous charges. From past experience with such roads one certainly would not be safe in assuming these charges to be less than about 60 per cent of the gross earnings. Hence, it follows at once that the gross earnings should be about $7,500 per mile, in order to enable the road to pay interest on its bonds and maintain its assets. If the road costs $20,000 or $40,000 per mile, and operates on 50 per cent or on 70 per cent of its gross earnings, the principle remains the same. This is a rough and ready way of getting at the situation, but it is one long since applied to railroads in general. If one considers the number of interurban lines of his acquaintance that are earning $20 per day per mile of track, or more, he gets a pretty good view of the general situation. Twenty dollars means at least 400 fares taken in for each mile of track per day—if the terminal receipts are large, of course, the regions of scanty traffic are helped out, but the longer the road the more such help is required. There is, naturally, the constant hope of increased traffic, and when in a tight place the hope that by the time depreciation has begun to get in its work and elaborate rehabilitation is necessary, circumstances may justify an increase in the securities, but this is purely speculative, however legitimate such speculation may be regarded.

Granting the danger of the situation, the next question that arises is that of ways and means to escape it. The first thing in most cases is to see whether all reasonable means have been taken to keep up traffic. The whole income of an electric road is made up of those wretched little nickels. Every time a passenger gets tired of waiting for an overdue car and takes a steam road, every time a conductor fails to see a signal and diverts a passenger, one of those nickels takes wings. If the manager gets scared at small earnings and thinks that he can save money by changing 15 minutes' headway into half-hour headway, more nickels vanish, and while operating charges diminish receipts diminish more rapidly by far. We earnestly wish that some one could figure out the effect of better service on traffic. There is little doubt that in any region, with even rather ineffective competition, cutting down the number of cars or running them without sharp adherence to schedule, is a losing game, and in many instances doubling the service will, at least, double the receipts. A road can ill afford to make enemies of the owners of those nickels.

Then there needs to be a careful overhauling of the expense account. On interurban roads the cost of power is often, not to say generally, excessive, owing sometimes to badly planned distribution systems, and sometimes to shiftless methods of operation. Every unnecessary dollar spent for coal means that somebody has got to gather up twenty of those nickels to square accounts. If the power stations are badly planned, or the distribution system is inefficient, as it often is, owing to the methods chosen, more nickels still have to be collected. It is within bounds to say that a considerable proportion of interurban and cross-country roads are in a condition which will require the most shrewd and careful attention to the details of operation to pull out the balance sheet unscathed. And it is the little things that count here, for just as the whole income is made up of small change so is the whole possible saving made up of apparently trivial items, save when unskilful planning has entailed needless sources of expense.

The Vermillion Peril

We have several times discussed, half in fun and half in earnest, the bearing of the automobile upon the rights and prospects of existing rapid transit systems. The subject is growing in interest, particularly in view of the determined attempts to influence legislation so as to allow automobilists the practical monopoly of the highways. It must, at the start, be recognized that the devil-wagon has come to stay. It contains the elements of great practical usefulness, and while thus far developed in a scatter-brained sort of way by a heterogeneous mob of manufacturers, only a few of whom turn out a first-class product, is certain, sooner or later, to enter upon a stage of sound growth. At present thoroughly skilful engineering is a great rarity in the automobile business, and while almost every machine has some excellent points, few have many. We call to mind, for example, a very simply and thoroughly made gasolene car, in which the whole sparking device on which the action of the motive power depends, is placed unprotected below the body, where it can catch all the mud and dust of the road. Another has a capital engine coupled with a delicate needle-valve carburetter which goes wrong upon the slightest provocation. And so a long list might be written, as any automobilist knows only too well, of conspicuous and unnecessary failings. We have not yet approached the time when one can go out and buy at a reasonable price any one of a dozen makes of automobile with the certainty of getting a good, reliable machine which will do sterling service. In other words, the business has not yet passed out of the exploitation stage and gotten upon a standard manufacturing footing. But it almost goes without saying that such is the history of most innovations, and that in a few years the automobile will come upon a sound basis. What will be then its relation to other means of progression?

We are not inclined to share the roseate view of those who hold that the world will enter upon an automobile era, in which a swarm of flying devil-wagons will fill the highways and furnish the general means of transportation for everybody. In the very nature of things the automobile must continue to be a costly machine, particularly if designed for anything above the most moderate speed. In the first place, it must have well-designed and very strong running gear, of the very best material, planned so as to avoid all unnecessary weight. Second, it must have light, powerful and reliable engines, of some kind capable of continuous heavy work, and in capacity ranging from 5 hp to 25 hp and upwards. Third, it must have a boiler and furnace, or carburetter and sparking devices, or a storage battery, coupled with strong and reliable auxiliary working and governing devices. Fourth, it must have a strong, well made and well-finished carriage body to ensure reasonable comfort, and this alone is no small item of expense, as every user of ordinary carriages must realize. Finally, it must be carried upon rubber or other highly resilient tires, which are never likely to be cheap either in first cost or maintenance. The net result is that an automobile of good quality, even of the more modest sort, is not likely to be cheap in first cost, and the cost of motive power, care and maintenance is likely to stay rather high. In other words, even with the cheapening that comes from manufacture on a large scale the number of private turnouts will be limited by the question of cost, just as the number of private vehicles is now limited. More than this, it takes more care and skill to run an automobile than to drive a horse, which imposes a further limitation. The mere question of money is likely to prevent automobiles from being a serious factor in the general rapid transit problem, so far as private ownership is concerned.

As regards possible competition with street railways the automobile omnibus is the one thing to be considered. Such vehicles have made no shining success thus far, but with further development in manufacture it will, doubtless, be possible to obtain a fairly reliable public vehicle, and then the trouble will begin. As regards competition with street cars on any fair basis we have little to fear. The vehicle working on good track with motive power supplied from a central plant, at good economy, must always retain an advantage over the vehicle running on the street by its own small engines. More than this, for a given carrying capacity the street car requires far less labor for its operation than a 'bus line. Of course, it is conceivable that one might build an automobile omnibus as big as a street car, but unless confined to a definite track it would be far too unwieldly to be permitted in a public street. The bicycle, with its low cost, easy storage and general convenience, was a far more serious menace to the receipts of tramway companies than the automobile is likely to be, and the bicycle has already ceased to be a menace in spite of its one-time popularity. No machine which requires even a low degree of skill for its successful use can ever find universal adoption in the sense in which the need for rapid transit is universal.

Even if automobile omnibus lines could be successfully worked commercially on the basis of a 5-cent fare, which is highly improbable, we think they would prove an intolerable nuisance on the streets. The car of Juggernaut would be a harmless plaything compared to them, when once they began to blockade the streets. As already outlined in the editorial on the London situation, in another column, a tramcar confined to a definite track, where everyone can steer clear of it at will, can be safely worked at much greater speed than if it were unconfined and free to dodge about over the street at the will of the motorman. Pedestrians have still some rights that must be respected, and one of these is some degree of assurance as to the location of fast running vehicles.

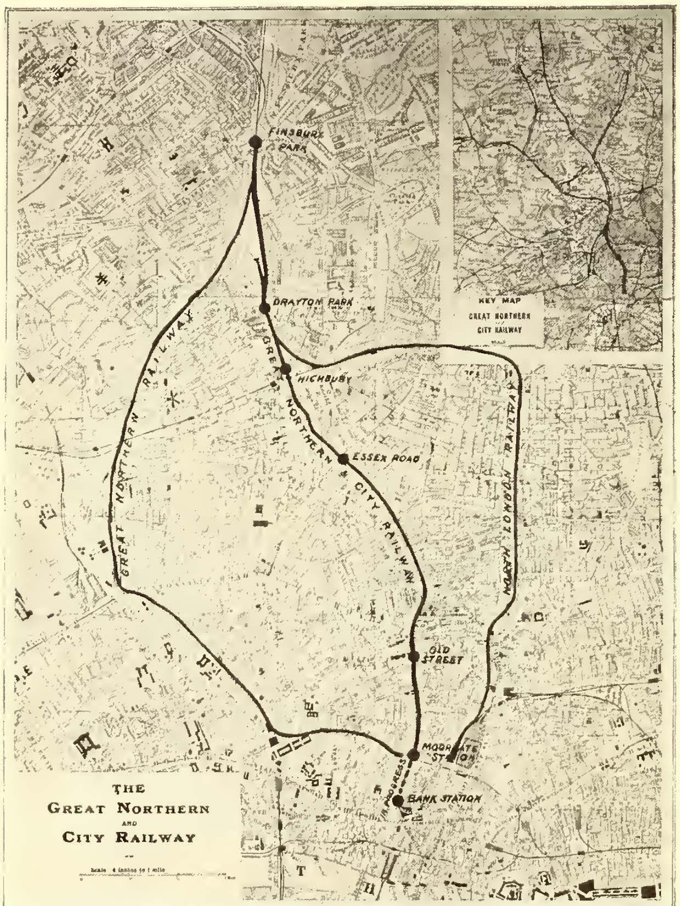
The particular danger to rapid transit interests in the automobile craze lies not in legitimate competition but in unfair discrimination. The whole headstrong crew of automobile scorchers, caring absolutely nothing for the rights of others upon the public roads, are using every effort to have all restrictions upon speed removed. To be sure, they are but a minority of the main body of automobilists, but they carry the influence that always attaches under a popular government to those who screech loudly that they are being oppressed. If private vehicles run unmolested at 25 m. p. h. or 30 m. p. h., then what is to hinder an automobile 'bus line from doing the same thing, and if such speed is legalized, which is the constant effort of the scorchers, then a new weapon will be put in the hands of the swine who desire the "common people," who use street cars, to take to the back alleys, while they, the self-chosen elect, pre-empt the streets. Even now, when an interurban or suburban trolley company tries to secure rights over streets that may better enable it to serve the public, there is a good chance that it will be met by a bid from some representatives of the Pharisaical "better element" to establish a "nice, gentlemanly" automobile line over the same route. Let once the speed limit be raised and the Pharisees could offer not only more "select" vehicles but higher speed. Bluffs of this sort have already been worked to a certain extent, and unless the street railways get down to work they will find extensions blocked in many directions. Let us have fair play in this matter, and hold all vehicles using the public roads to the same speed limits rigorously enforced. If the trolley car, confined to a track that keeps it in a definite line, is limited to 10 m. p. h., hold all other power vehicles to the same limit. If the automobilist is permitted to run 20 m. p. h. in the suburbs, give the street cars, which serve a thousand times more people, the same privilege.

The Turbine Situation

Just at present the steam turbine is at a very interesting stage of its industrial development. Recent tests give a more encouraging view of its economy that were justified by the earlier work, the best of them showing a result quite comparable with that reached by triple expansion engines. If this promise is borne out in commercial use the turbine will have taken a very long step toward replacing the reciprocating steam engine. Its inroads are already severely felt in the engine business, and from the present outlook will be felt more rather than less. Aside from all technical questions the turbo-generator is, or ought to be, very much cheaper than any form of reciprocating engine of similar efficiency. There are now, or soon will be, no less than four manufacturers of the first importance turning out steam turbines, which are, or should be, on the same high plane of quality and efficiency. With this introduction of active and genuine competition it is safe to say that the price of turbo-generators will fall from a level based on a tentative reduction below the prices of ordinary engine sets, to figures representing good ordinary returns upon manufacturing investments. A thoroughly well-made steam turbine will never be as cheap as the layman might figure from its size and weight, but it will, nevertheless, become very much cheaper per unit of power than the present open quotations. If the alternating-current railway motor takes the place in the art that its friends claim for it there will be an additional reason for a brilliant commercial outlook for the steam turbine. Its weakest point has been the practical necessity of using with it an alternating-current generator, but with the new field open for alternating-current working this property ceases to be a serious limitation. Indeed, the steam turbine may become an additional argument in favor of alternating currents.

THE GREAT NORTHERN & CITY RAILWAY

The Great Northern & City Railway, for which ground was broken in October, 1898, has now been opened for public ser-



MAP OF GREAT NORTHERN & CITY RAILWAY (TUBE) AND GREAT NORTHERN & GREAT LONDON (STEAM) TERMINALS FINSBURY PARK TO MOORGATE VIA THE GREAT NORTHERN & CITY RAILWAY

vice, and will, no doubt, prove an excellent addition to London's famous "tubes." The organization and engineering features of this project were dwelt upon at length in the Street Railway Journal of March 1, 1902, but before entering upon a general description of the railway it may be well to recapitulate the salient facts regarding its origin.

ORGANIZATION

The act authorizing the Great Northern & City Railway was passed in 1892, Sir Douglas Fox & Partners, together with the late J. H. Greathead, being the engineers. The company for the construction of the line was formed in 1896, with a capital of £2,080,000. The contract for the entire work was taken over by S. Pearson & Son, Ltd., of Westminster, under the supervision of the consulting engineers, Sir Douglas Fox & Partners. The contractors also undertook to operate the line for three years after its opening for traffic.

LINE

The line joins the important Great Northern (steam) Railway station at Finsbury Park, just at the 4-mile radius, with the heart of the city in an almost straight line. It is 3½ miles long, and, as will be seen from the accompanying map, is the shortest and most direct underground route from this station to London's business section. The line in the center is the Great Northern & City Railway route, those to the right and left being respectively the North London Railway and Great Northern Railway routes.

The traffic prospects of the new line are excellent, as it runs through a very densely populated district of workers, who, up to the present time, depended for entrance to the city on omnibuses and tramways, both of which take considerably more than double the time to reach the city that is required by the tube trains. This economy in time is expected to attract a great deal of traffic. It is estimated that at least 5,000,000 passengers per mile, or a total of 17,000,000 passengers per annum, may be looked for from local business alone. These figures are considered very conservative, as the Central London Railway, for instance, is carrying about 7,000,000 passengers per mile per annum. About 30,000,000 passengers per annum are brought to Finsbury Park, via the suburban trains of the Great Northern Railway. It is figured that at least one-third of these passengers will use the new direct line in preference to the roundabout older ones, thus adding 10,000,000 passengers per annum, making an annual total of 27,000,000 passengers.

TUNNELS

The underground portion of the line consists of two 16-ft. diameter tunnels, opening out to nearly 23 ft. diameter at the stations. As the diameter of the Central London Railway tubes is 11 ft. 8 ins., and the City & South London Railway only 10 ft. 6 ins., the new line is able to carry much larger rolling stock and enjoy much better ventilation than the others. The track and tunnels are also arranged to permit the standard cars of the Great Northern Railway to run through the Great Northern & City Railway's tubes should it be found desirable to make the necessary connections.

STATIONS

The portion of the railway opened first has for its present city terminus (until the authorized extension to the Lothbury corner of the Bank of England is completed) a station at that part of Moorgate Street which adjoins the stations of the Metropolitan and City & South London Railways. At this place there is a common station for the City & South London and the new line which allows passengers to transfer from one to the other without coming to the surface. This facility will

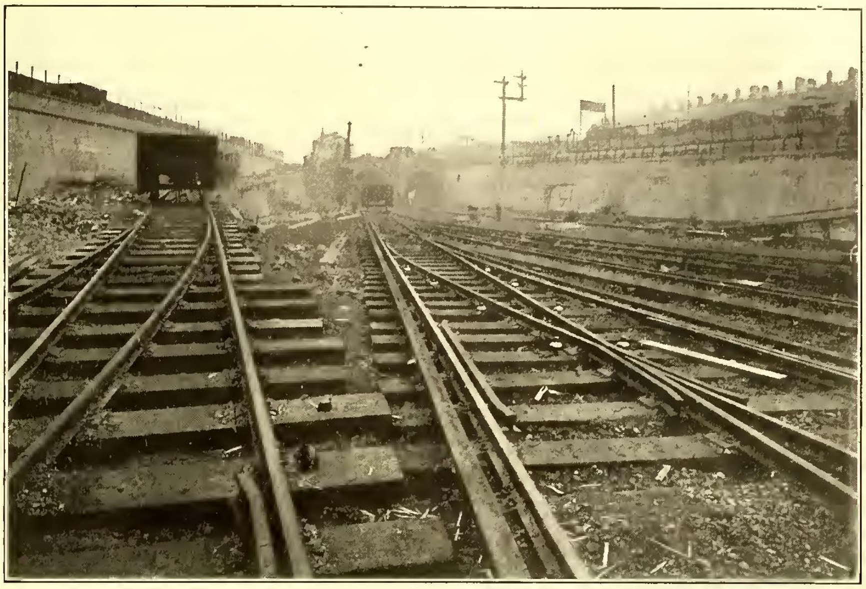
MOORGATE STREET STATION, THE PRESENT TERMINUS OF THE GREAT NORTHERN & CITY RAILWAY prove a great convenience to people passing between the north and south of London.

Going northward, the next station is Old Street, where the City & South London and Great Northern & City have common surface accommodation. The junction of Old Street and City Road is a very busy center, and the new line will cater jointly with Farrington Street for the large traffic coming from the Great Northern system, which at present has available only the latter station for use.

The following station, Essex Road, is in close touch with extensive tramway systems running at right angles, and is close to the Agricultural Hall.

The next station, Highbury, will tap an important and populous district as soon as completed. This station was not a part of the original scheme, but work has advanced so far as to enable its completion within a few months without interfering with the general running of the part now open.

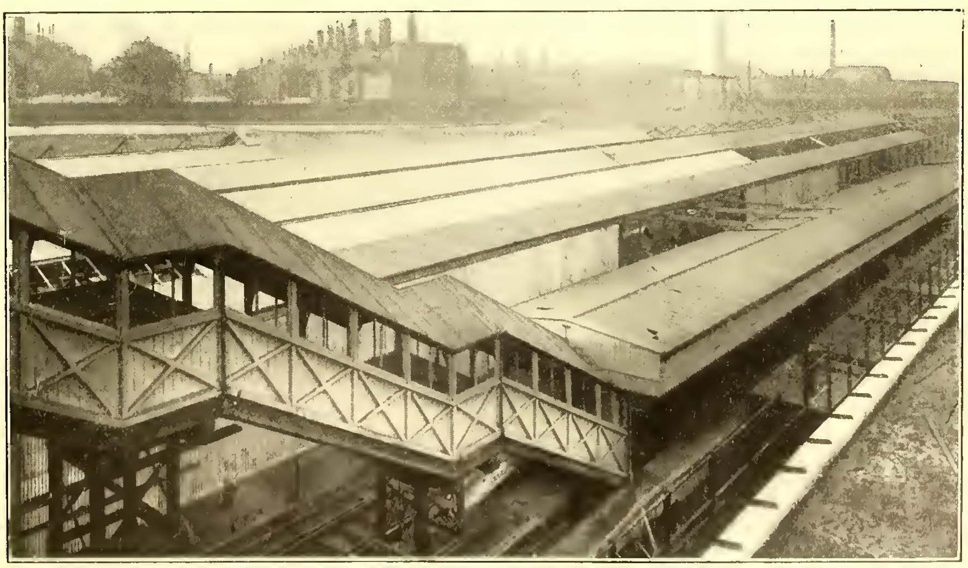
At the next stopping place, Drayton Park, the line comes to the surface. Extensive repair and car shops have been provided at this point for the accommodation of the rolling stock. Originally it was intended to effect physical connection here with the Great Northern Railway. The act of 1892 gave powers for such connection, but after extended negotiations with the Great Northern Railway Company it was decided that Finsbury Park station would be incapable of handling the large number of Great Northern and other trains coming from the north and south, as well as the trains from the new line without seriously interfering with the Great Northern main line traffic. To meet this difficulty the Great Northern Railway Company offered to find the money for the connection to Finsbury Park station, which is now the northern terminus of the combined scheme. Here an extensive ticket office and other facilities have been constructed, in about twelve months, without interfering in the slightest degree with the traffic of the Great Northern Railway, notwithstanding that the main line expresses run right over the top of the workings within a few inches of the miners' heads. The placing of this structure so close to the level of the permanent way will enable the interchange of traffic at Finsbury Park to be carried on with the least exertion and inconvenience to the traveling public.



DRAYTON PARK, WHERE THE TUBES COME TO THE SURFACE

CROSS-OVER AT ENTRANCE TO TUBES AT DRAYTON PARK STATION

Ample elevator accommodation has been provided for dealing with the masses of people unloaded from the trains every few minutes. Easy inclines and stairways will enable the passengers to reach the subway platforms (about 40 ft. below the rails of the Great Northern Railway) in almost less time than the elevators can be filled, lowered and emptied. The electric elevators at Moorgate Street and Essex Road were supplied by Easton & Company, of Erith. Those at Finsbury Park had to be modified, in view of the small head room, and are electro-hydraulic. They were sup-



DRAYTON PARK STATION ON THE SURFACE

plied by the Chester Engineering Hydraulic Company.

STAIRWAYS AND PLATFORMS

All of the station stairways and passages are unusually wide, to prevent congestion. The terminal station platform is 450 ft. long, and the other stations 420 ft., allowing ample margin for the trains and their possible lengthening should the traffic demand it.

MEANS FOR LESSENING NOISE

A novelty in connection with the construction of the tunnels of the Great Northern & City Railway is the introduction, for a very great proportion of their length, of a vitrified blue brick invert. It has been demonstrated by trial runs that this material combined with a cast-iron roof will minimize noise and vibration. It is less resonant than complete iron rings, and the fact that the tubes are constructed of such different materials makes the transmission of sound waves more difficult with a consequent noise reduction.

MOTOR CAR USED ON THE GREAT NORTHERN & CITY RAILWAY

SAFETY PRECAUTIONS

In view of the recent disastrous fire in the subway of the Paris Metropolitan Railway, it is interesting to know that all possible fireproofing and other precautions have been taken in the construction of the Great Northern & City Railway's lines. Even the signalmen's cabins are fireproof structures, and the station platforms are built of solid concrete and iron. An independent lighting system is used throughout the tunnels, so that in the case of a breakdown of the generators furnishing traction current, or other accident, the tunnel will not be in darkness. If the passengers are obliged to alight and walk along the tunnel, they will be amply provided with means of getting to the nearest station by the aid of this illumination and a continuous fireproof concrete gangway.

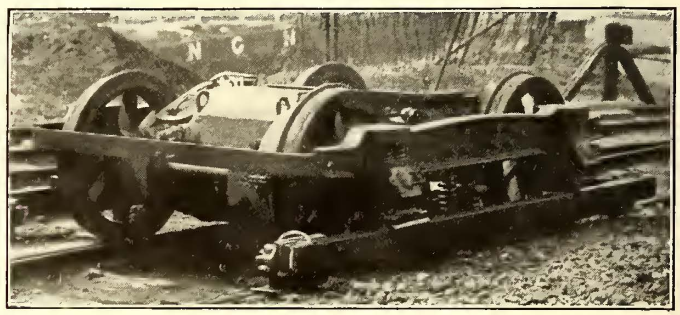
VIEW SHOWING THE CONSTRUCTION OF A STATION

ROLLING STOCK

The standard trains are made up of seven cars, three motor and four trailers, having a total approximate seating capacity of 430. The first motor car is at the front of the train, the second in the center, and the third at the end. The approximate weight of the loaded train is 200 tons.

The cars were built by the Electric Railway & Tramway Carriage Works, Ltd., of Preston, and the Brush Electrical Engineering Company, Ltd., of Loughborough. They are supplied with Westinghouse quick-acting brakes. Each motor car carries a British Thomson-Houston motor-driven air compressor, reservoir, etc. There are also conductors' emergency cocks at the end of each car for applying the brakes in case of need.

The cars are 50 ft. 6 ins. long, 12 ft. 2 ins. high, and 9 ft. 4 ins. wide, this width being equal to that of the widest cars used over any other British railway. They are handsome teak structures with steel underframes, are of the corridor type, have center doors and are provided with roomy seats. Each motor car is carried on two McGuire trucks, having 36-in. diameter driving wheels. The trailer cars are mounted on Brush trucks. On each truck of the motor cars is mounted one 550-volt, series wound, direct-current motor. Current is collected by four collector shoes per truck.



TRUCK FOR MOTOR CAR

VIEW SHOWING VITRIFIED BRICK CONSTRUCTION

The capacity of each motor is 125 hp, rated on the basis of 75 degs. C. rise in temperature above the surrounding air after

1 hour's run on full rated load. The gear is of steel, machine cut, and enclosed in a waterproof case.

The motors are controlled by the type "M" multiple-unit control system. An interesting fact in connection with this installation is that the Great Northern & City Railway was the first British electric railway to adopt the multiple-unit control system, the type adopted being chosen after elaborate tests.

SERVICE

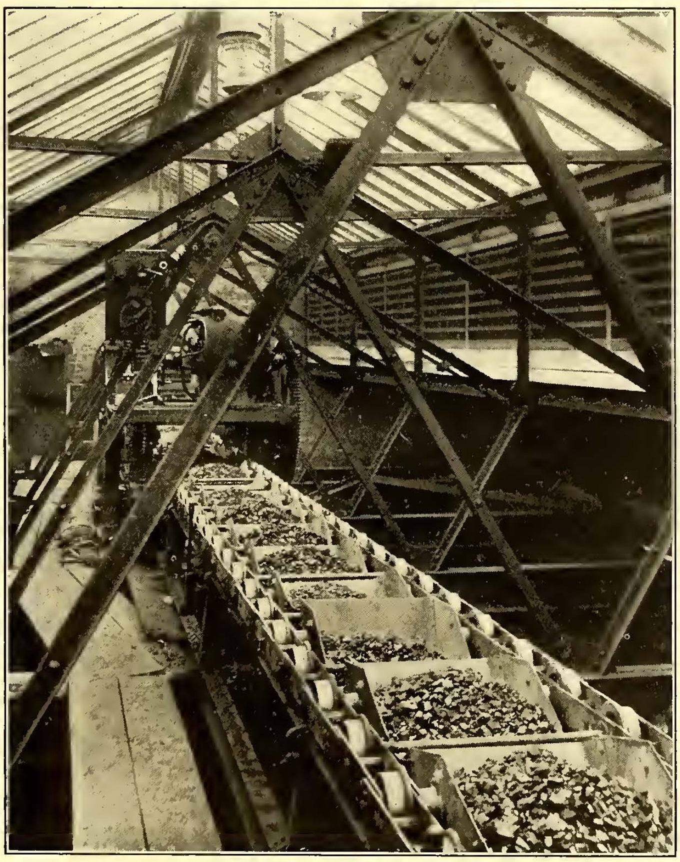
A 3-minute service will be introduced, single trips being completed in 13½ minutes, which permits four intermediate of 20 seconds each. The trains will be shuttled at the termini, thus avoiding shunting around the stations.

It is hoped to be able to maintain a 3-minute service throughout the day simply by shortening the trains, so that they may be run profitably on such short headway.

The fare between Moorgate Street and Finsbury Park is 2 pence, and some of the intermediate stations have penny fares to either of these places.

POWER STATION

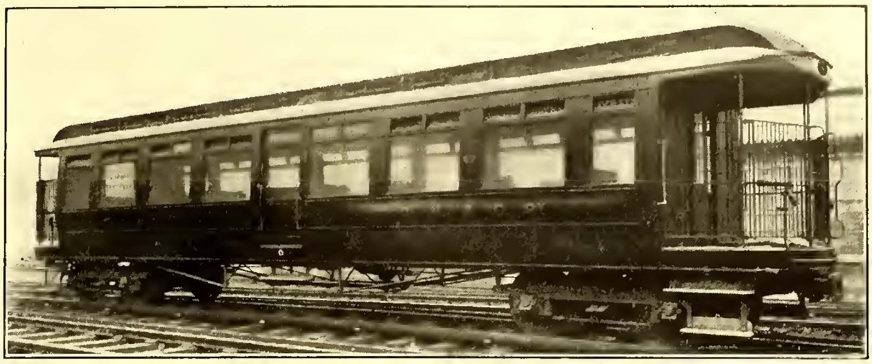
The power for operating the system is supplied from a single generating station located at Poole Street, New North Road, about a mile north of Moorgate Street station. The length (3½ miles) of the line and position of the generating plant are such as to enable the system to be operated without feeding in at several points, the current being transmitted directly to the collector rails. The generating machinery also furnishes the current for lighting and the operation of the passenger elevators.



ELECTRICALLY DRIVEN GRAVITY BUCKET CONVEYOR

The site adjoins the Regent's Canal, from which water is taken for condensing and other purposes, and returned to the canal at a point 300 ft. on the down-lock side of the in-take. Its connection with the Regent's Canal also permits fuel to be delivered cheaply alongside, from whence it is conveyed to the storage bins and fires by a Hunt gravity bucket conveyor, which handles 30 tons of coal an hour.

Steam is supplied by ten Davey-Paxman "Economic" boilers, each having an effective grate area of 40 sq. ft., and capable of evaporating 11,200 lbs. of water per hour at 212 degs. F. when using coal giving 13,500 B. T. U. The boilers are fitted with Vicar automatic stokers, which are driven by two motors.

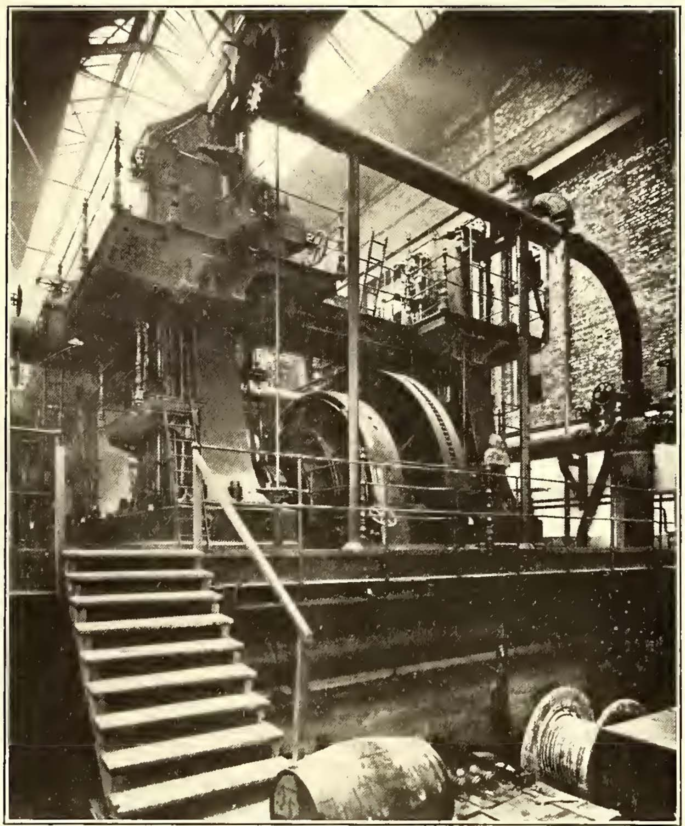


TRAILER CAR USED ON THE GREAT NORTHERN & CITY RAILWAY

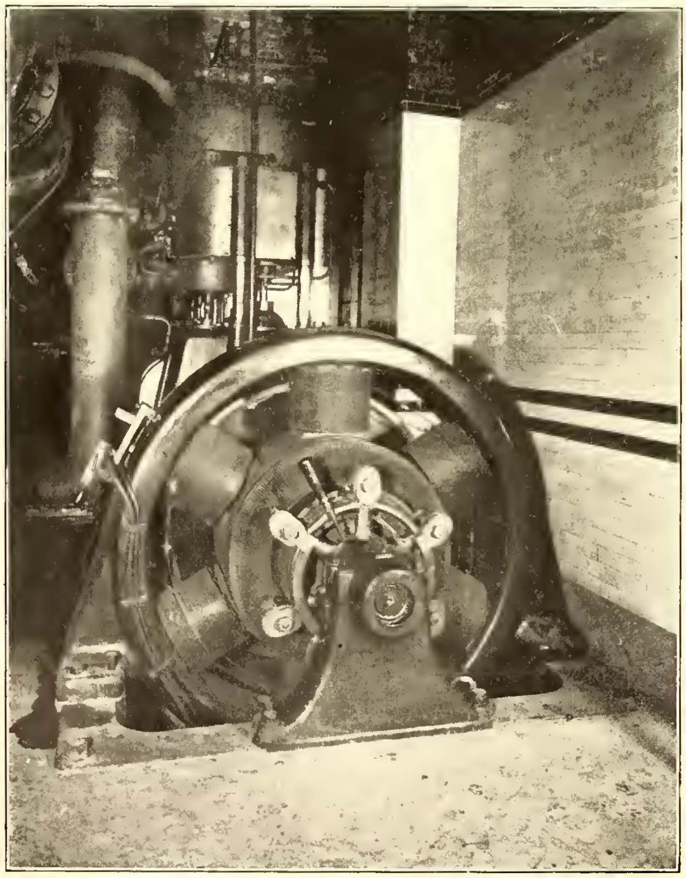
The four main engines are of the vertical cross-compound type, built by John Musgrave & Sons, Bolton. The engines give 1250 hp at 100 r. p. m. and of 150 lbs. pressure. They have fly-wheels, weighing about 45 tons each, and are capable of sustaining 100 per cent overload momentarily. They are direct connected to four railway-type generators, rated at 800 kw each, but capable of taking for 2 hours, without objectionable heating, a load up to 1200 kw. These generators are also able to carry momentary overloads of 100 per cent without injurious sparking. They are compound wound to give 525 volts at no load and 575 volts at full load.

BOILERS AND STOKERS IN POWER STATION

Two Peache engines, of the single-acting, tandem-compound type, built by Davey-Paxman & Company, drive two six-pole, 120-kw generators at 375 r. p. m. They are compound wound for the same voltages as the main generators, and have an overload capacity of 50 per cent for 2 hours. They will supply power for lighting of power house, etc., and for operating the electrically-driven auxiliary plant when it is not convenient to take power from the main generators for this purpose. There are four Wheeler surface condensers, each having a cooling surface of 2400 sq. ft., and arranged with steam-driven



DIRECT-CONNECTED GENERATING SET IN POWER STATION



AUXILIARY GENERATOR AND ENGINE

combined air and circulating pumps. They are capable of maintaining a 26-in. vacuum when dealing with 2200 lbs. of steam per hour.

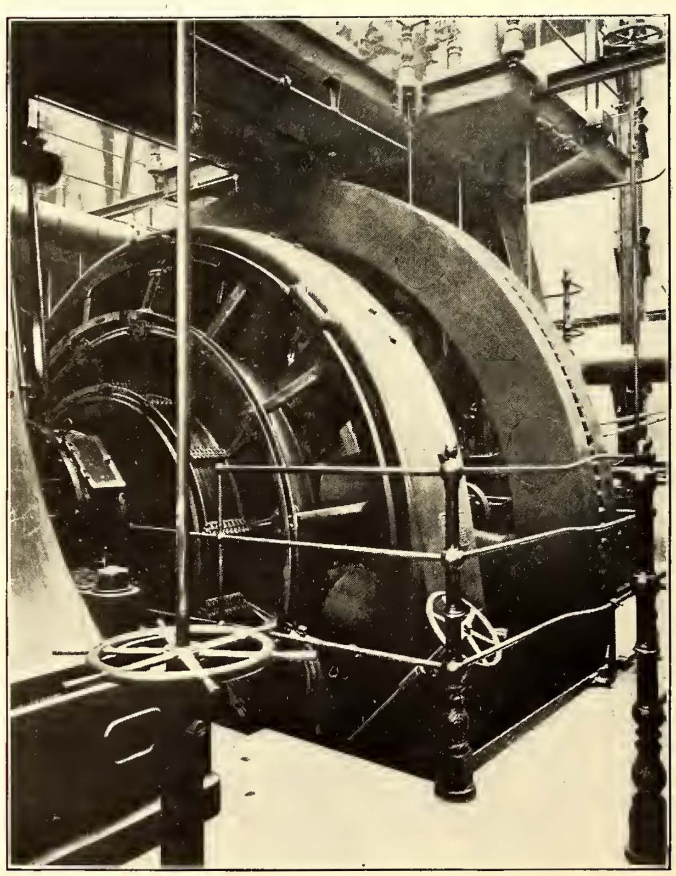
There is also an auxiliary condenser of the same type, capable of handling the auxiliary plant and boiler feed pumps' exhaust. These condensers discharge into a hot well, from which the water is delivered by two three-throw vertical lift pumps of the Blake-Knowles type, driven by enclosed motors. All the condensers have combined air and circulating pumps, driven by steam.

In addition to the supply from the canal mentioned previously, water can be obtained from the city mains. A storage tank has been provided connected directly to the latter.

The water taken from the canal is dirty, and varies in hardness from time to time during the year by reason of floods and droughts. For softening and purifying both this and the town water, which is also variable, a Desrumaux plant, capable of treating 8500 gals. per hour, has been installed in the rear of the boiler house. This gives water having its hardness reduced to 5 degs., and alkalinity to about 6 degs., free from solids. An automatic arrangement is adjusted between the softener and storage tank, whereby the softening process is suspended and recommenced as occasion may require, thus giving a continuous supply of purified and softened water, with a minimum of supervision.

A Masson-Scott plant is installed for removal of oil and grease from the water of condensation and for the purification of the water for boiler feed purposes. This plant is capable of dealing with 10,000 gals. per hour.

The oil and grease which has passed through the steam engines is in the form of a divided emulsion, so fine in its character that it is impossible to remove it by mechanical filtration alone, chemical treatment as well as filtration being essential. The apparatus is thus a combined plant for first chemically treating, and finally filtering every gallon of water which leaves the surface condensers, producing a perfectly



800-KW DIRECT-CURRENT GENERATOR

clear effluent, free from grease or chemical admixtures and of a fixed degree of hardness suitable for boiler feed purposes.

A switchboard, consisting of four main-generator, four-feeder, two-auxiliary generator panels, three-auxiliary power and three-auxiliary lighting panels, is installed in a gallery at one end of the engine room, commanding a view of all the main generators. The circuit breakers are of the magnetic blow-out type, and the measuring instruments of the astatic illuminated dial and feeder type.

Cables run from the switchboard along the outside of the boiler house wall and then down a special cable shaft into the tunnels. The bus-bars on the board are so divided that the auxiliary-generator lighting and auxiliary-motor panels can be isolated from the main generator and heavy feeder panels by the operation of one switch, insuring the uninterrupted operation of the lighting system if any accident occurs to the main power circuits. Separate paper-insulated feeding cables are provided for traction, for lighting and for elevators, and rubber insulated cables for lamp circuits and connections.

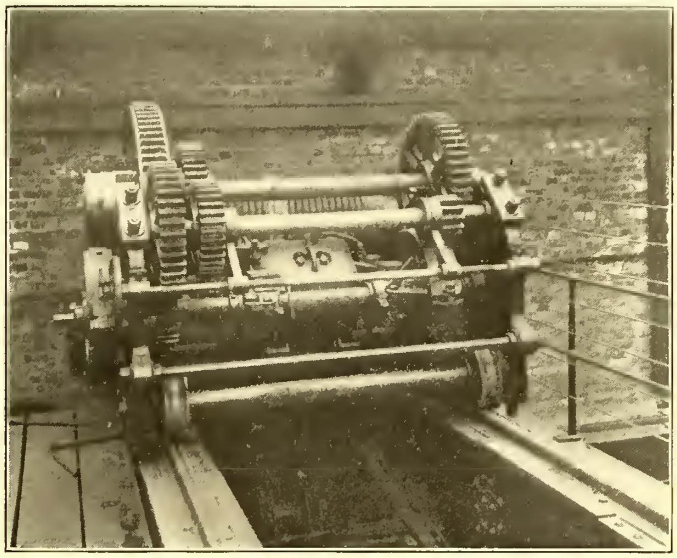
The rest of the station plant comprises steam-driven feed pumps, motor-driven economizer, two motor-driven lift pumps, storage and receiving tanks, water softening plant, one 30-ton three-motor overhead crane, etc.

POWER CIRCUITS

Two insulated conducting rails are used per track, one being for the return current. Both rails are placed outside of the running rails. The conducting rails are of channel section, weigh 80 lbs. per yard, and are rolled to about 42-ft. lengths. They are of a special quality of low-carbon steel, having a conductivity 14 per cent of that of pure copper of equal cross-section. These rails are supported on earthenware insulators, 10 ins. outside of the gage, carried on spindles supported by cast-iron brackets fixed to the ties. The system of collector rails is divided up into four sections, fed independently from the generating station. The running track is laid to standard gage, and consists of 85-lb. flanged rails laid on longitudinal stringers in the tunnels and on cross-ties in the open. As it carries no current it is not bonded.

LIGHTING CIRCUITS

All lighting circuits are carried in iron tubes, and the tunnels are provided with lamps every 100 ft. The passenger stations are lighted on the rail and street level by enclosed arc



TRAVELER OF OVERHEAD CRANE IN POWER STATION

lamps, and station switches are fixed which control the incandescent lamps in the tunnel half-way to the next station in each direction. The lamps are placed five in series, and the circuits are run so that there is never more than the voltage of one lamp between two adjacent wires in the same pipe. Special throw-over switches are provided to take the lighting current from the conductor rails when the special lighting cables are not charged.

GENERAL VIEW OF ENGINE ROOM

PERSONNEL

The chairman of the board of directors of the Great Northern & City Railway Company is Sir Charles Scotter, the other directors being the Earl of Lauderdale, Sir Henry Burdett, K. C. B., Lord Knollys, G. C. V. O., and Charles Steel, who has recently joined the board, and was formerly the general manager of the Great Northern Railway, and, therefore, brings special experience to bear upon the traffic problems connected with this line.

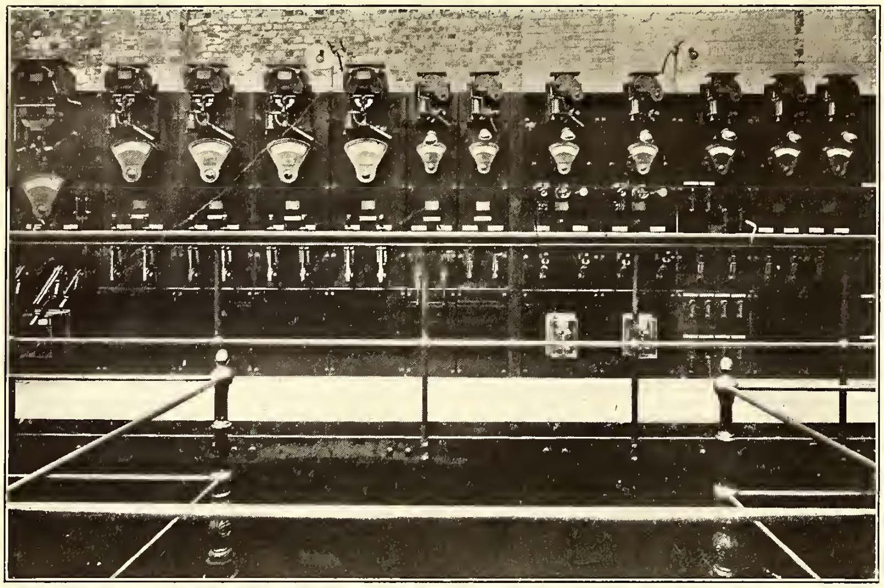
The line from its southern end to Drayton Park has had for its engineers Sir Douglas Fox & Partners, represented by Daniel L. Hutchinson; from Drayton Park to Finsbury Park, including the repair shops and carriage sheds carried out by the Great Northern Railway Company, has had for its engineer Alexander Ross, chief engineer of the Great Northern Railway, and W. H. Sadler.

E. W. Moir, one of the directors of S. Pearson & Son, Ltd., the general contractors for the whole of the railway, has had charge of the line, on their account, during its progress.

The general control and the engineering of the running line has been taken up by R. P. Brousson, who has had considerable experience in the electric traction installations, both in connection with the Central London Railway and during the construction of this work.

Messrs. Pearson's agents in charge of the southern and northern ends of the work, respectively, have been B. Everett and H. Japp.

The whole of the engineering work for the British Thomson-Houston Company, Ltd., was under the direction of A. H. Walton, manager heavy traction department, assisted by Messrs. Winkfield, Dundas and Thomas.



SWITCHBOARD IN POWER STATION

TERMINALS AT THE ST. LOUIS EXPOSITION

The St. Louis Transit Company has decided upon the location of its various terminal loops at the Louisiana Purchase Exposition grounds for handling the immense crowds of the Exposition. The map herewith shows the constructed and authorized lines of the St. Louis Transit Company, the location of the World's Fair grounds at Forest Park, and the terminal loops which will be operated by the St. Louis Transit Company during the fair; the latter are indicated by dots. As will be seen there will be six of these, four on the northern boundary nearest the principal buildings, and two on the southern boundary. To the four northern loops access is had over four routes. The two southern loops are served by one route. The arrangement of the St. Louis Transit Company's system is such that it will be quite feasible to route cars over all portions of the city to the fair grounds, because of the several cross-town lines. The miles of street occupied by the company's tracks are 176.41. The miles of single track are 358.65. But little additional track will be laid this spring, and that will be confined mainly to the vicinity of the fair grounds. It is estimated that passengers can be handled at the rate of 50,000 per hour at the six terminal loops, which is probably a very conservative estimate.

The plans for all the terminal loops have not been fully decided upon at the present writing, but the plans for the two loops nearest the main entrance have been worked out and are shown on this page, through the courtesy of C. A. Moreno, chief engineer of the company. These are both double-track loops, and one is provided with an extra storage track. These loops will be fenced in and provided with turnstiles, so that incoming and outgoing passengers can be kept separate. In order to provide for simultaneous loading of a large number of cars when people are leaving the fair, a movable fence will probably be provided, by which it will be possible to change the relative size of the loading and unloading compartments. Thus, in the morning and early evening, when people are arriving at the grounds in large numbers, there will be a necessity for considerably more track space on which cars can stand to unload passengers than for loading track space, as but few persons will be leaving the grounds at such times, and cars can load so quickly that they will not need as much standing room as they will late in the evening when there is a great crowd leaving. When the crowd begins to leave, the fence can be moved along so as to use the greater part of the loop trackage as a loading track. The company now operates on maximum schedule 893 cars, and it is expected to increase this to 1500 cars when necessary during the Exposition.

It will be noticed on the map that the Wabash Railroad is between the principal terminal loop shown in the diagram and the main entrance. To avoid a grade crossing at this point a

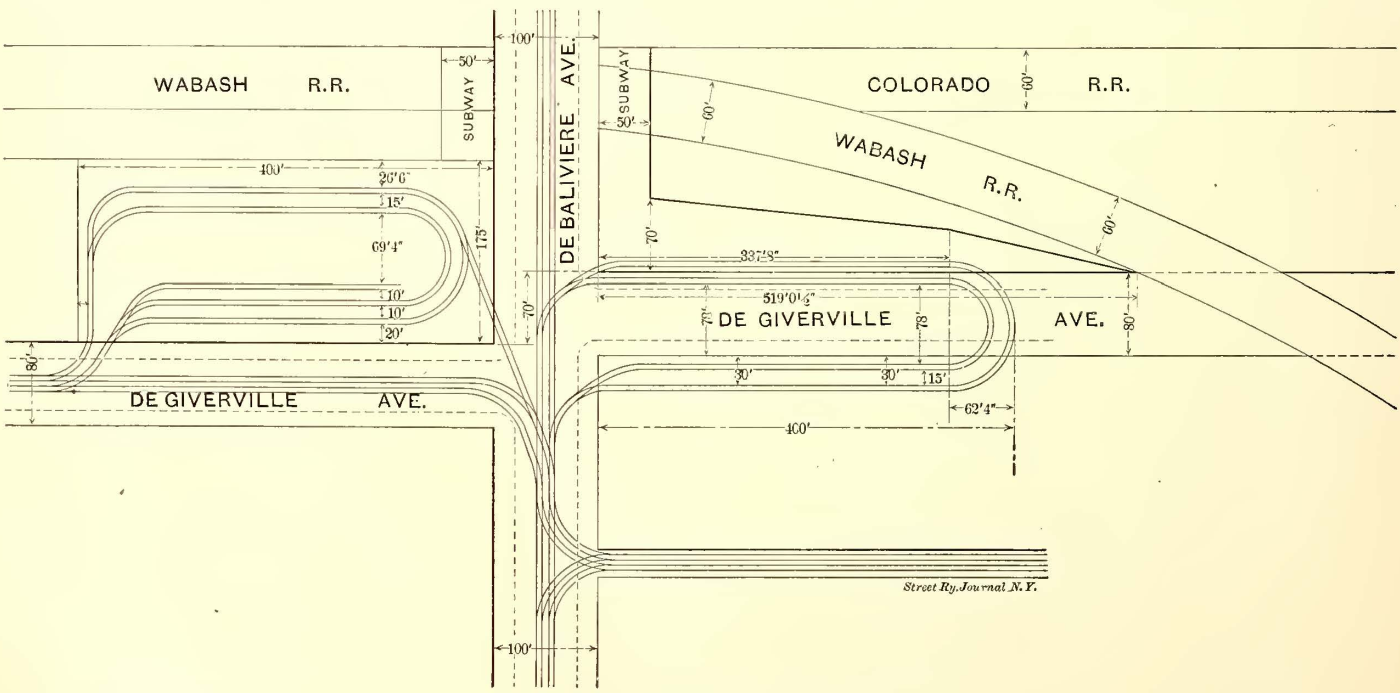
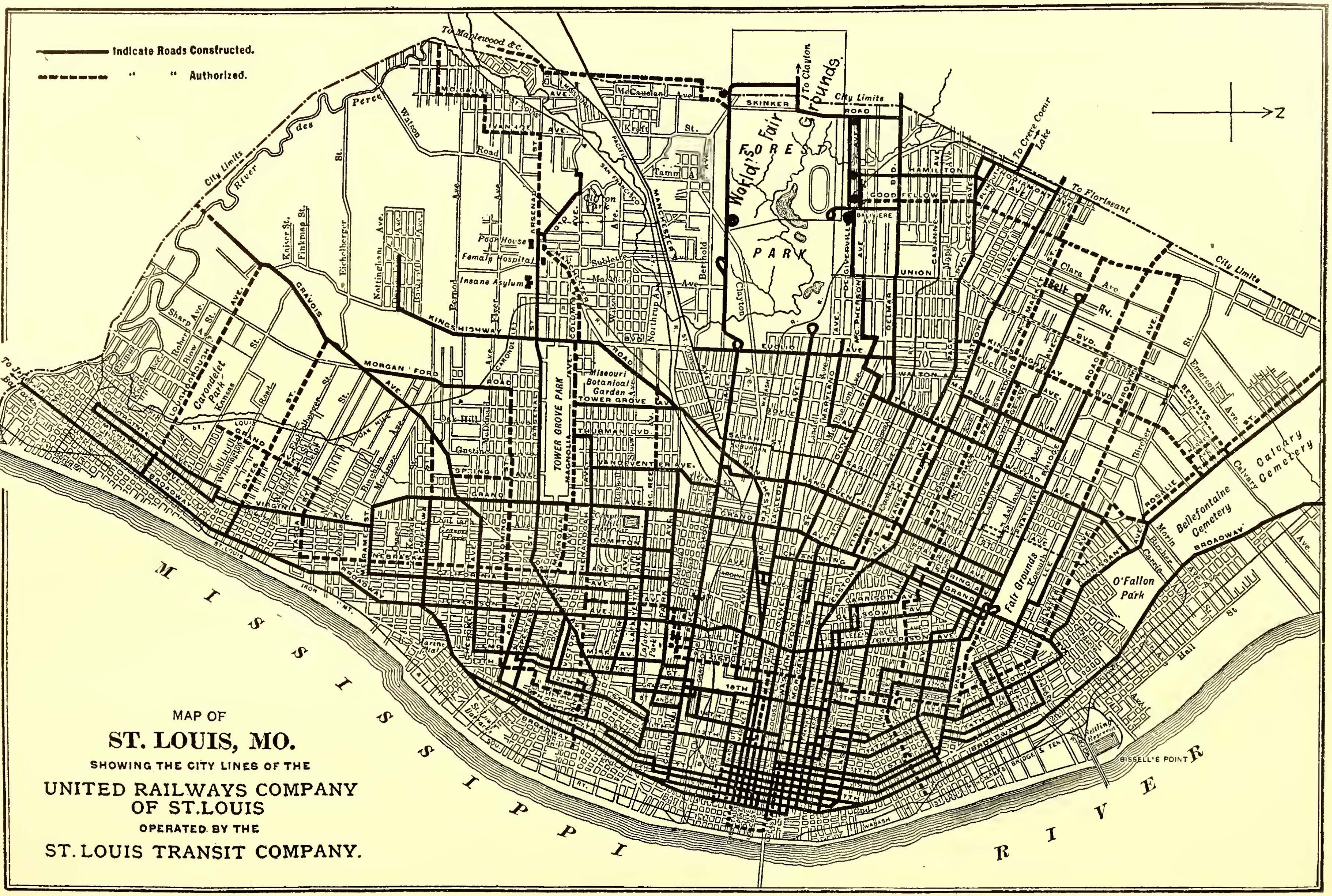


DIAGRAM SHOWING PROPOSED LOOPS OF THE ST. LOUIS RAPID TRANSIT COMPANY IN FRONT OF MAIN ENTRANCE TO WORLD'S FAIR GROUNDS

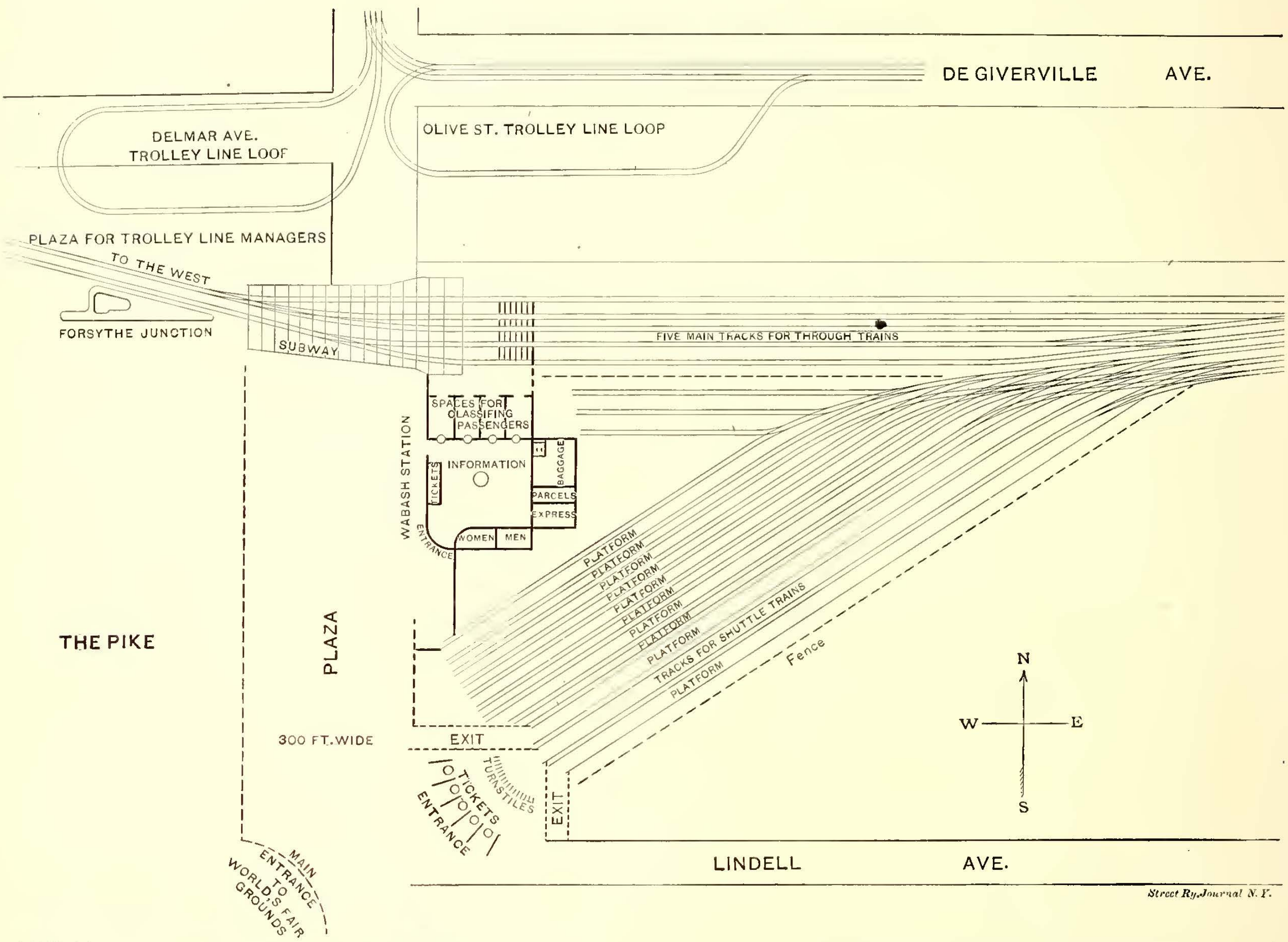


TERMINAL LOOPS FOR EXPOSITION SERVICE SHOWN THUS ●

subway is to be built under the Wabash tracks, so that passengers leaving the transit company's loop need not cross the steam railroad tracks at grade.

The plan below shows the arrangement of the Wabash Railroad terminal at this same point, and also the location of the subway just spoken of. Just south of the Wabash terminal, devoted to shuttle trains, is to be one of the loops of the Suburban Railway Company. The Suburban Railway Company will also have three other loops reaching the north and west side of the grounds. From this it will be seen that the Wabash Railroad is making extensive operations to handle through and local traffic at the main entrance of the grounds. As compared to previous Expositions, however, the steam railroad service will be at a disadvantage, because of the distance of the Union Depot from the business center. Nevertheless, the Wabash will undoubtedly carry many people who are so located as to be conveniently near the Union Depot or some other station on the way to the Fair grounds. The Wabash Railroad is spending about $60,000 on its World's Fair terminal, and expects to be able to handle about 25,000 passengers per hour by means of suburban trains running between the Exposition grounds and the Union Depot. Both this terminal of the Wabash and the Union Depot are to be elaborately fitted up with classification compartments, so that passengers for a certain train can be admitted into the particular compartment for that train before the train arrives, which will save considerable confusion which might arise in an attempt to load a through train hurriedly.

The St. Louis Car Company is planning to exhibit at the Louisiana Purchase Exposition the handsome private car which it is now constructing in its shops for President John I. Beggs, of the Milwaukee Electric Railway & Light Company.



GENERAL PLAN OF WORLD'S FAIR TERMINAL STATION, ST. LOUIS, SHOWING WABASH RAILROAD TRACKS IN FRONT OF MAIN ENTRANCE, ELECTRIC RAILWAY LOOPS AND SUBWAY

WEAR OF BEARINGS IN ELEVATED SERVICE

Master mechanics of surface lines will look with envy on the records of bearing wear made by motors in elevated service. A motor car of the Metropolitan West Side Elevated Railway, of Chicago, was recently taken into the shop for general overhauling and renewing of bearings after a service of nearly one year, and it was not on a tripper run, either. On surface roads it is customary to consider that the length of time or the mileage that a motor car can run without overhauling is determined principally by the wear of the armature bearings. In other words, the motor can be allowed to run without a general overhauling as long as the armature bearings will last. When these bearings have worn out, since the motor must be taken to the shop anyway, it is customary to give it a general overhauling. The long life of bearings in elevated service, as compared to service on the street surface, where bearings last only one-sixth to one-half as long, is probably due partly to the use of oil instead of grease by the elevated roads and to the freedom from dust and dirt. It has been observed by managers of large city systems that there is considerable difference in the bearing wear on different routes of the same system. This is accounted for by the kind of street surface over which the motors run.

The Boston Elevated Railway Company is trying to prevent the improper use of free transfers. The chief offenders against the company are the small boys, who secure the tickets of passengers who are not going to use them, and sell them to would-be passengers. Some sections of Boston are at present anxious to secure additional transfer privileges from the company, but in the face of present abuses, which greatly reduce the legitimate income of the company, it is impossible to make further concessions.

PACIFIC ELECTRIC RAILWAY COMPANY'S SYSTEM—II

In the last issue of the Street Railway Journal an article was published on the main features of the extensive system of interurban roads in the neighborhood of Los Angeles, and the track construction of these roads was described in detail. It is the intention in the present article to take up the overhead construction and passenger stations and give some particulars of the Mt. Lowe branch, leaving for subsequent articles the power station, car houses and particulars of the operating practice.

OVERHEAD CONSTRUCTION

The overhead system of the Pacific Electric Railway is practically a standard overhead center-pole construction, wherever center poles can be used, which includes all private rights of way and practically all of the line excepting some few streets entering cities or towns. The center-pole construction comprises a transmission line, feeder line and the trolley line. The poles are set 115 ft. apart on straight track and at appropriate distances on curves. For the standard construction adopted for new work 40-ft. Oregon or Washington cedar poles are used, with two cross-arms at the top, which carry on glass insulators the usual six-wire, high-tension transmission system, the wires being arranged on the equilateral triangle form, approximately 3 ft. apart. The transmission standard is three-phase 50-cycle, 15,000 volts; 4 ft. below the lower cross-arm of these two is placed the cross-arm which carries the feeders and telephone

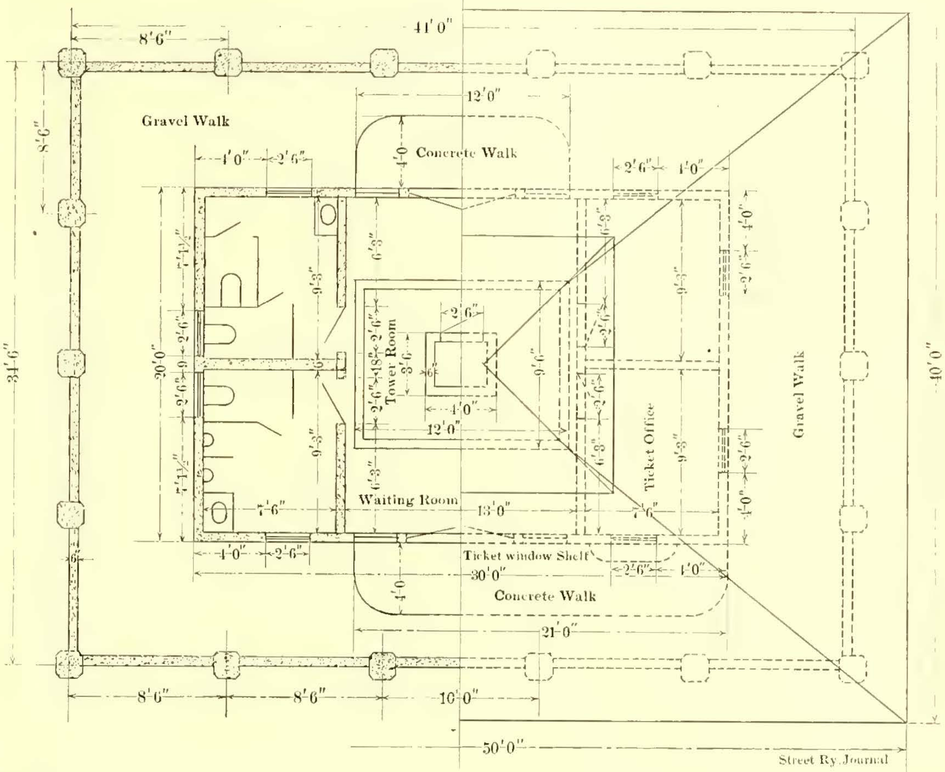


FIG. 2.—PLAN OF COMBINATION WAITING AND SUB-STATION BUILDING

wires, and 4 ft. below this is carried the usual gas-pipe cross-arm which supports the two trolley wires. All of the devices are extremely simple, the trolley wire, which is No. 000 grooved, being carried on a span below the pipe, which gives it the required flexibility. The pipe is usually run through the pole, but in some cases is supported by special socket castings, secured to the pole. The end castings, or pendants which support the span wire, are of cast-iron, but hereafter a light malleable casting is to be used.

The poles are set approximately one-seventh of their length in the ground as usual. They are painted with pure white coating above the base line, and to a height of about 5 ft. above the rail they are painted the bright red color which is used throughout for designating Pacific Electric cars and apparatus. No treatment has been generally employed for the butts of the poles, but 200 poles have been treated for testing the usefulness of certain iron and wood preserving compounds. The cross-arms are painted red, and where they carry any lines but those used for telephone purposes they are marked with white below the pins.

A standard line contains six No. 3 wires for transmission purposes, mounted on No. 17 Locke insulators, with porcelain bases and iron pins. The porcelain bases are suspended on curves by cast-iron bases. The standard feeder for suburban work where stations are about 8 miles or less apart is 600,000 circ. mils bare copper. Two telephone lines are run throughout—one of which is connected directly to the engine room and sub-stations for the use of the power department, while the other is connected to the despatcher's office and all the several conductors' telephones along the line.

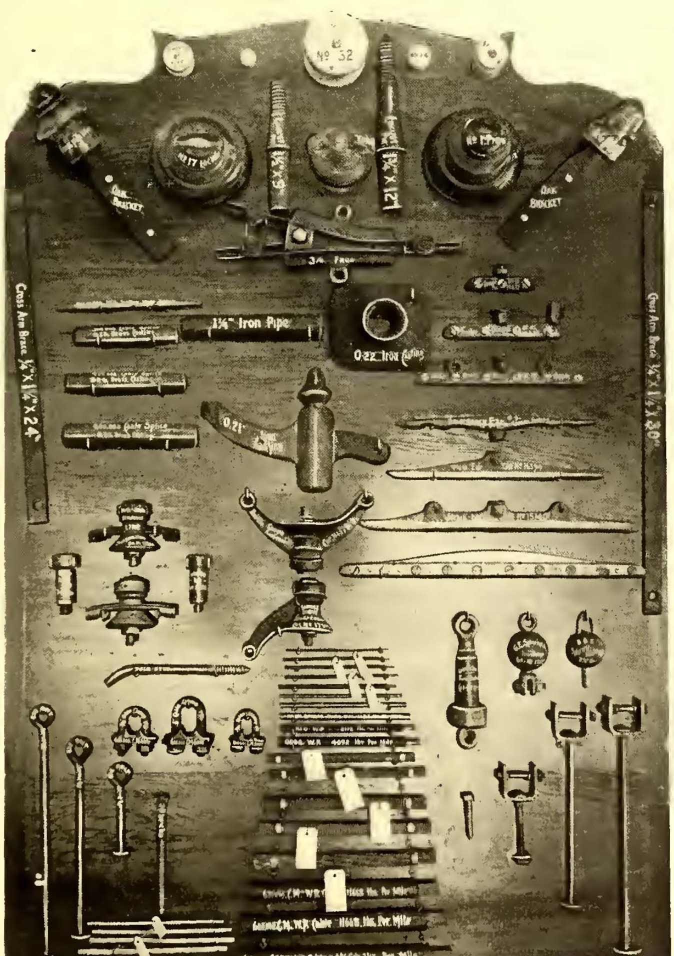


FIG. 1.—STANDARD OVERHEAD LINE APPLIANCES, PACIFIC ELECTRIC RAILWAY

In Fig. 1 is illustrated a board of seventy-four parts used in the standard overhead construction on the Pacific Electric Railway Company's lines. Outside of the special end castings for the iron pipe trolley bracket, the emergency ear, and the 22-in., 18-screw trolley-wire splice, which are of the company's own design, the fittings are of standard manufacture. The views of the track construction on the Monrovia line, Figs. 5, 8 and 19, in the last issue, show the standard overhead con-

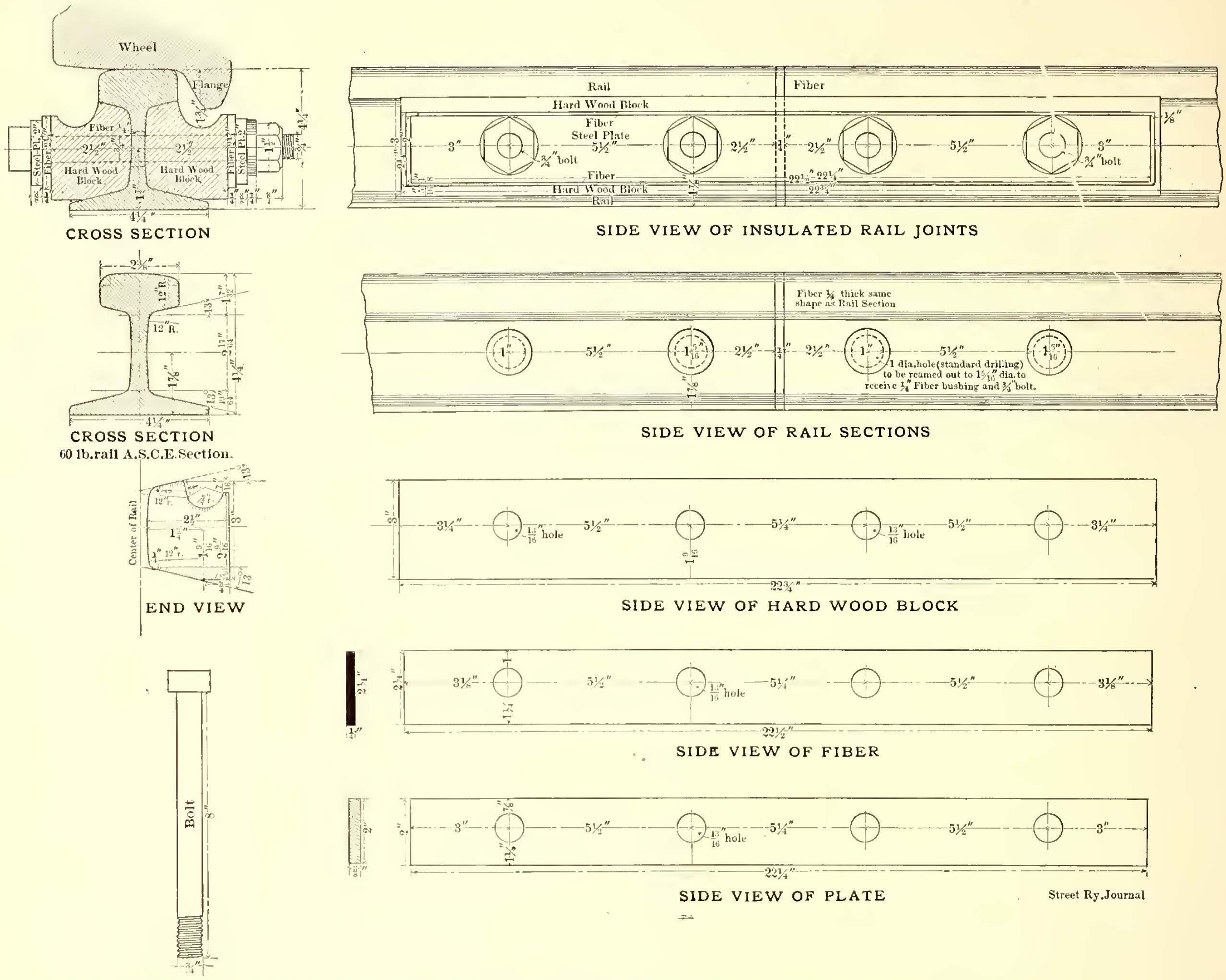


FIG. 3.—INSULATING RAIL JOINTS USED IN CONNECTION WITH THE ALTERNATING-CURRENT BLOCK SIGNAL SYSTEM

struction. The views of the Long Beach line work, Figs. 10, 11 and 18, also in the issue of Feb. 27, show 35-ft. poles with

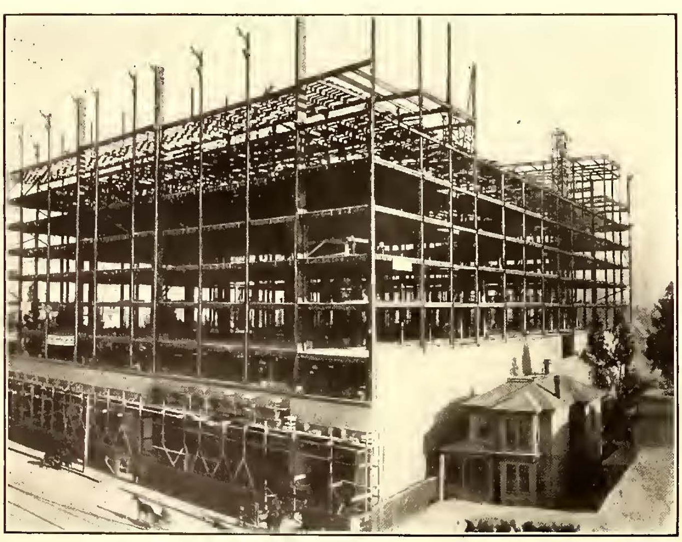


FIG. 4.—VIEW OF TERMINAL STATION BUILDING, TAKEN DURING CONSTRUCTION

six high-tension wires on one cross-arm. In the city of Long Beach, as may be seen in Fig. 12, the poles are of square sawed redwood.

BLOCK AND STATION SIGNALS

In order to ensure safe operation of trains and to provide for the convenience of the passengers, the company is working out, under the direct supervision of R. S. Masson, electrical engineer, an interesting system of block signals as well as special car-signalling apparatus for the use of passengers at stations. The block signal system will be unique, in that it will be centrally energized, alternating current being used. It will be installed on all the interurban lines, standard signal stands with semaphores and lamps for home and distant signalling being used, with blocks averaging a mile in length. The system of signals to be adopted is the same that is used by the large trunk steam roads. Alternating current will be used for the semaphore movements, and no direct-current motors and batteries will be installed in the signal stands, the entire system being operated from a central source of power. One rail is to be used for the signal system, the different blocks being set off by the form of insulated rail-joint illustrated in Fig. 3. The insulation between rail ends in this joint is fibre, ¼ in. thick, and the joint is made by two hardwood blocks, 22¾ ins. long and 2½ ins. thick, and two ¼-in. fibre strips, 22½ ins. long, the whole being held in place by steel plates with four ¾-in. bolts.

For the present but one rail will be employed for the direct-current track return, but with the introduction of choke coils it is believed the signal rail may be used for carrying both the alternating current and the return direct-current. The system will be automatic in the usual sense, and it will also be arranged so that in case of unusual conditions on the line the chief despatcher can throw all the signals to caution, thus compelling all cars to proceed at half-speed, or, if necessary, he can throw all signals to danger position, thus stopping all cars and tying up the system. Then, afterward, the signals can all be thrown to clear position by the despatcher, thus allowing the service to be resumed. This signal system, in connection with the telephone lines, will enable the company to operate its cars with the highest degree of safety and also with maximum economy and efficiency. The block signals at the Southern Pacific crossing on the Long Beach line, and illustrated in Fig. 11 in the last issue, were installed by the Southern Pacific Company, and are of the Taylor type.

DESTINATION SIGNS

On portions of the company's systems, such as the Long Beach line and the Pasadena Short Line, cars of different routes are operated, and at night a passenger who wishes to signal a car has no means of knowing which one is his, so he has to signal every car that approaches until he gets the right one. Illuminated signs have been suggested as a remedy for the difficulty, but the expense of equipping all the cars with these signs and of keeping them lighted would not be a small one. It is doubtful also if the signs could be distinguished on account of the brilliant arc headlights which are used on the cars. The plan that has been adopted is to install at each

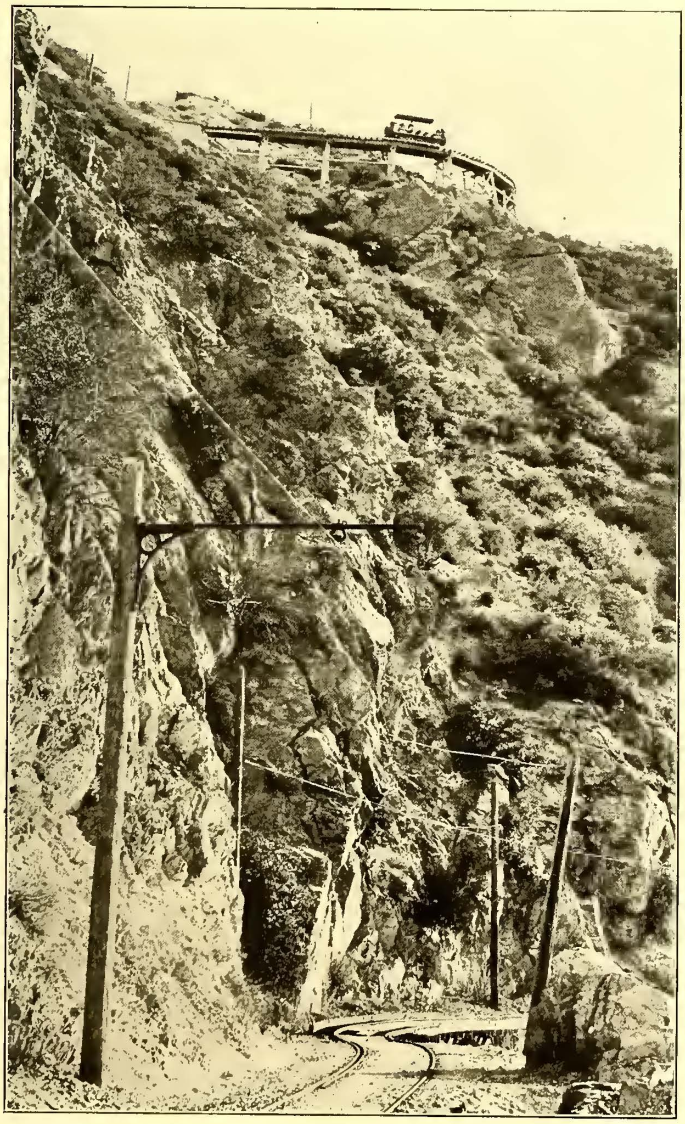


FIG. 5.—SCENE ON MT. LOWE DIVISION, SHOWING CIRCULAR TRESTLE ABOVE

station where cars of two or more lines pass, a stop signal of special construction. This signal will be provided with different-colored lights, as many as four colors being practical. Each colored light will indicate a certain line of cars, and the motormen will be able to distinguish the lights at a distance, so that he can readily come to a stop. For each light there will be arranged a lever, properly labeled, and when a person at the station wishes to board a car he pulls the proper lever, and thus lights the proper lamps, when he sees a car approaching.

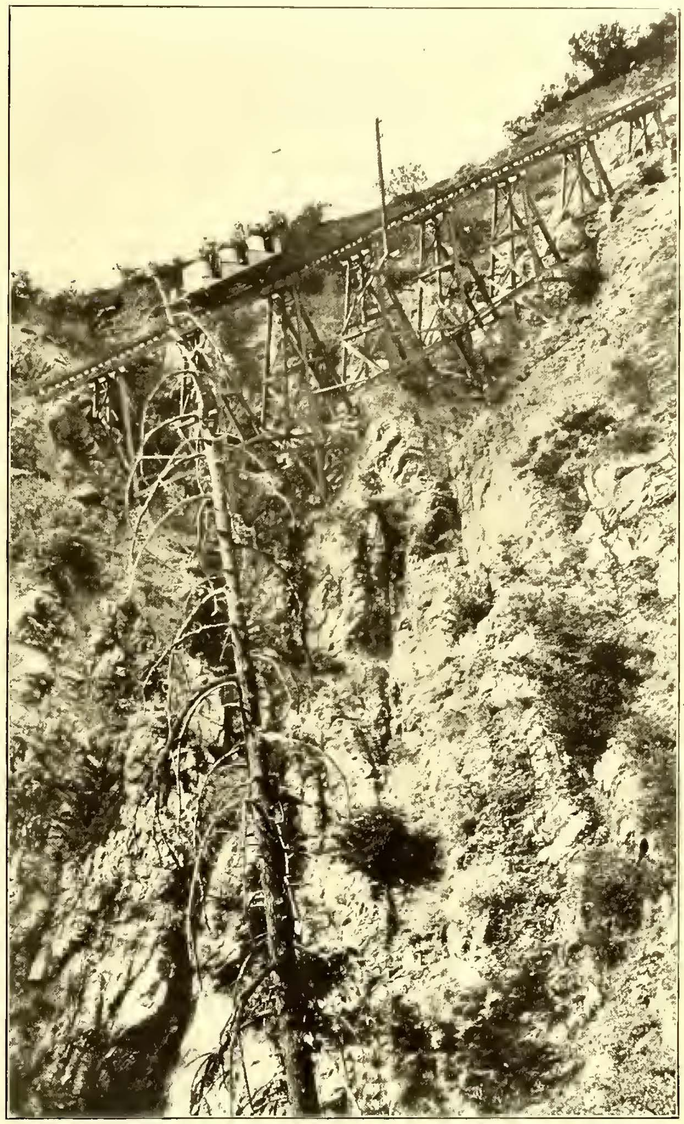


FIG. 6.—LONG BRIDGE ON CABLE INCLINE BETWEEN RUBIO CANYON AND ECHO MOUNTAIN, SHOWING CAR WITH INCLINED SEATS

If the car is the right one the motorman stops, and if not it passes by without losing any time. These levers will be held in normal position by springs, and as the small boy is apt to meddle with them, the springs will be strong enough to prevent children from operating them.

Signals will be arranged on a wooden pole beside the track. There will be (for a three-route line) three colored incandescent lamp signals, side by side, at the top of the pole, and below that three semaphore arms of corresponding colors arranged one below the other. When a passenger pulls the proper lever at the base of the pole, the corresponding semaphore arm comes to a horizontal position and the lamp of the same color is lighted. The lever is held in that position until the motorman acknowledges that he has seen it by blowing his air whistle. The system will be similar to the one in use on the Seattle-Tacoma Interurban Railway.

As the signals must necessarily be placed where any one can operate them, the public will be warned that any malicious interference with them will result in their removal, and it is believed, with proper precautions in the instructions for operating the first one, the people will soon be educated to regard them as they do the government mail boxes.

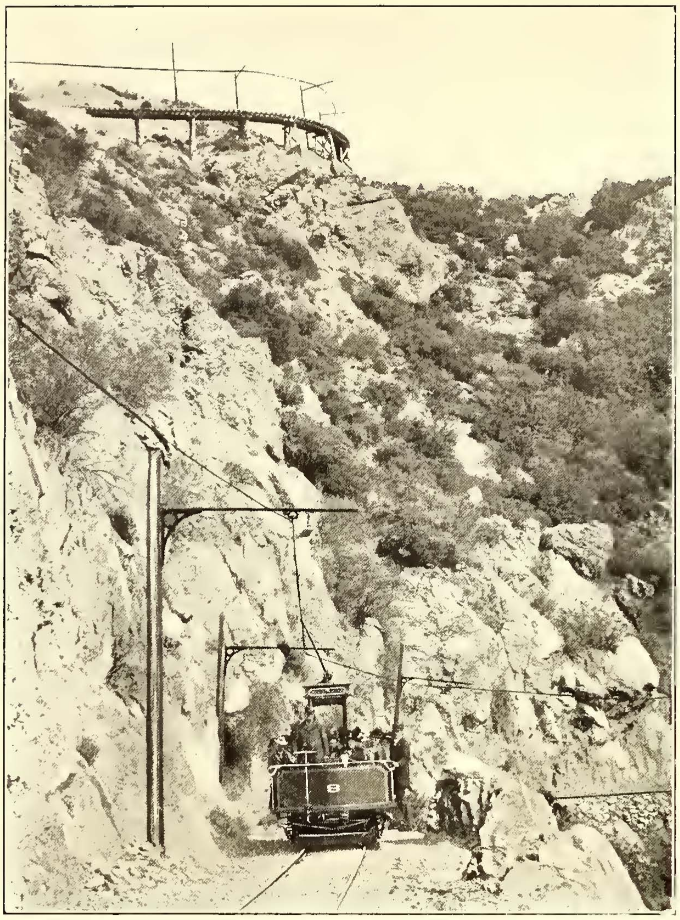


FIG. 7.—TROLLEY CAR ON ALPINE DIVISION, CIRCULAR TRESTLE ABOVE

TERMINAL STATION BUILDING

On the southeast corner of Sixth and Main Streets, Los Angeles, the Pacific Electric Railway Company is erecting a combined terminal station and office building. This structure will be nine stories high on Main Street, and ten stories on Los Angeles Street, which runs parallel with Main. The building extends 285 ft. on Sixth Street, and has a frontage on Main Street of 211 ft. Nearly all of the first story of the building, which has a clear height of over 25 ft., will be given up to station purposes, serving as a union depot for all the interurban lines of the Pacific Electric and Los Angeles Interurban Railway Companies. These lines now start in front of a temporary station across the street from the new building. In the new quarters there will be a train house, 80 ft. x 285 ft., in which there will be two tracks running practically the entire length of the building, connecting with the Main Street tracks by Y's. For the accommodation of the public there will be a general waiting room, 80 ft. x 100 ft.; a ladies' waiting room, 40 ft. x 60 ft., both provided with all modern conveniences; a dining room, 80 ft. x 100 ft., with lunch counters adjoining, and three store rooms, each 24 ft. x 80 ft., which will be leased to merchants. There will also be provided the necessary ticket offices, newsstands, check rooms, information bureau, etc., as well as the chief despatcher's office, from which all car movements will be governed. Ample space in the train house will be provided for keeping extra cars in constant readiness for emergencies and for occasions such as trolley parties, etc.

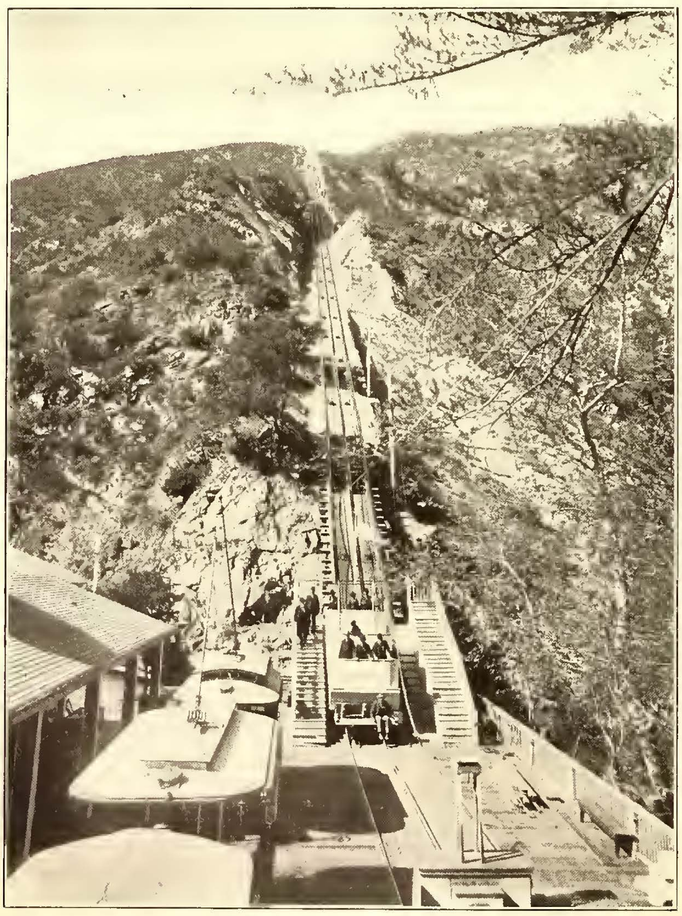


FIG. 8.—BASE OF CABLE INCLINE RAILWAY

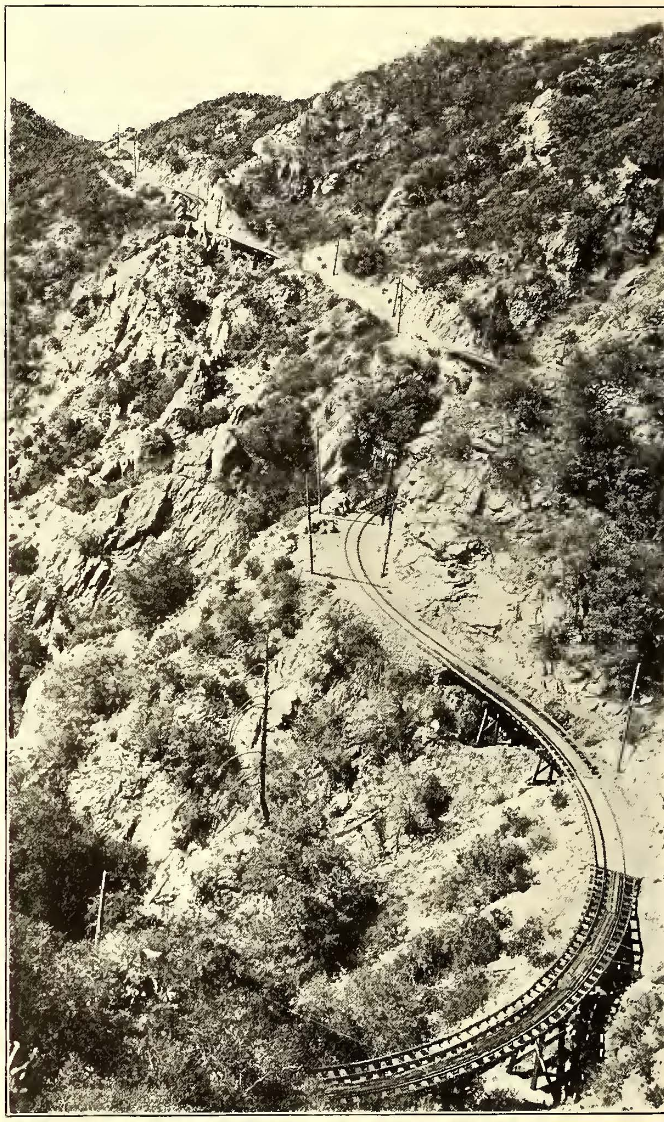


FIG. 9.—BIRD'S-EYE VIEW OF PART OF ALPINE DIVISION

The building will be entirely fireproof, the construction consisting of a steel structural framework, with concrete for foundations, basement walls, floors, etc. A reddish buff brick with terra-cotta trimmings will be used for the exterior walls, the general design being plain and simple, with a dignified and substantial appearance. Fig. 4 is a view of the structure taken in December, and hence is somewhat incomplete, but is presented as showing the steel framework. The eighth and ninth floors of the building will be devoted entirely to the quarters of the Jonathan Club, one of the features of the eighth floor being a roof garden, covering an area of approximately 10,000 sq. ft., between the two light wells. On the seventh floor will be located the offices of the railway companies and various other corporations in which Henry E. Huntington is interested. Parts of the sixth floor and all of the fifth, fourth, third and second floors will be fitted up in the most modern manner and rented as offices. The interior finish will be made as nearly fireproof as possible. The building will be lighted throughout by electricity, and will be heated by low-pressure steam by means of the Paul system. There will be eight electric elevators, six on the Main Street side and two at the Los Angeles Street entrance. The building will cost upward of $1,000,000, and its floor area is said to be greater than that of any other building west of Chicago.

FIG. 10.—TYPICAL CURVES ON MT. LOWE LINE

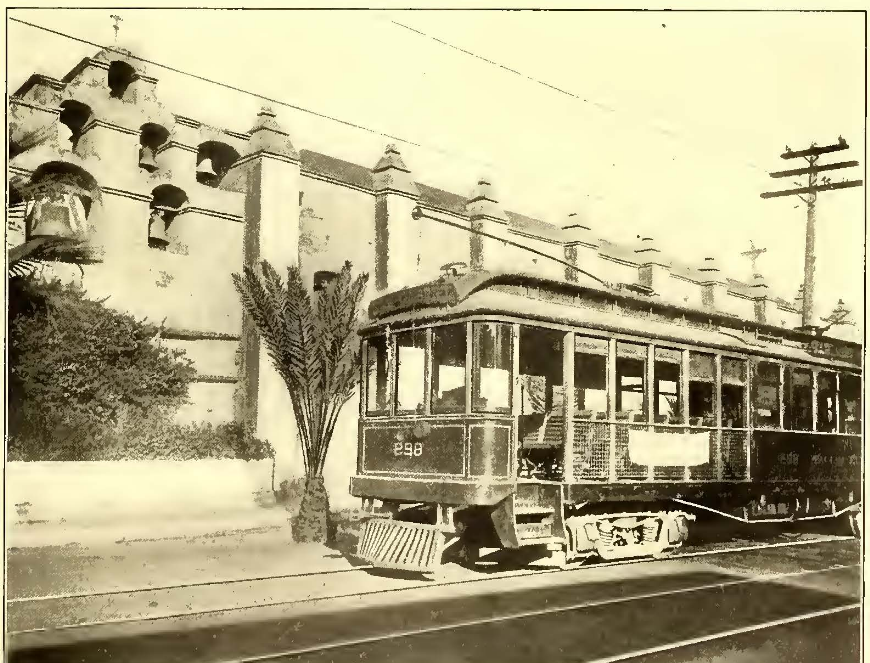


FIG. 11.—TROLLEY CAR PASSING ST. GABRIEL MISSION

SUBURBAN STATIONS

At important stations on the interurban lines the company is planning to erect depot buildings for the convenience of the public. As the company handles no freight, each of these stations will practically consist of a waiting room and ticket office. Fig. 2 shows the plan adopted for buildings to be erected at junction points. It consists of a 20-ft. x 30-ft. building, with projecting roof, supported by Mission style arches.

The extreme dimensions of the roof will be 40 ft. x 50 ft., and of the outside wall 34 ft. 6 ins. x 44 ft. The entire structure will be built of concrete, and a gravel walk will surround it under the projecting roof. In front of the two doors and under the ticket window will be concrete walks. A small room, 9 ft. 6 ins. x 12 ft., will be provided in the tower of the building for the use of the assistant despatcher if necessary.

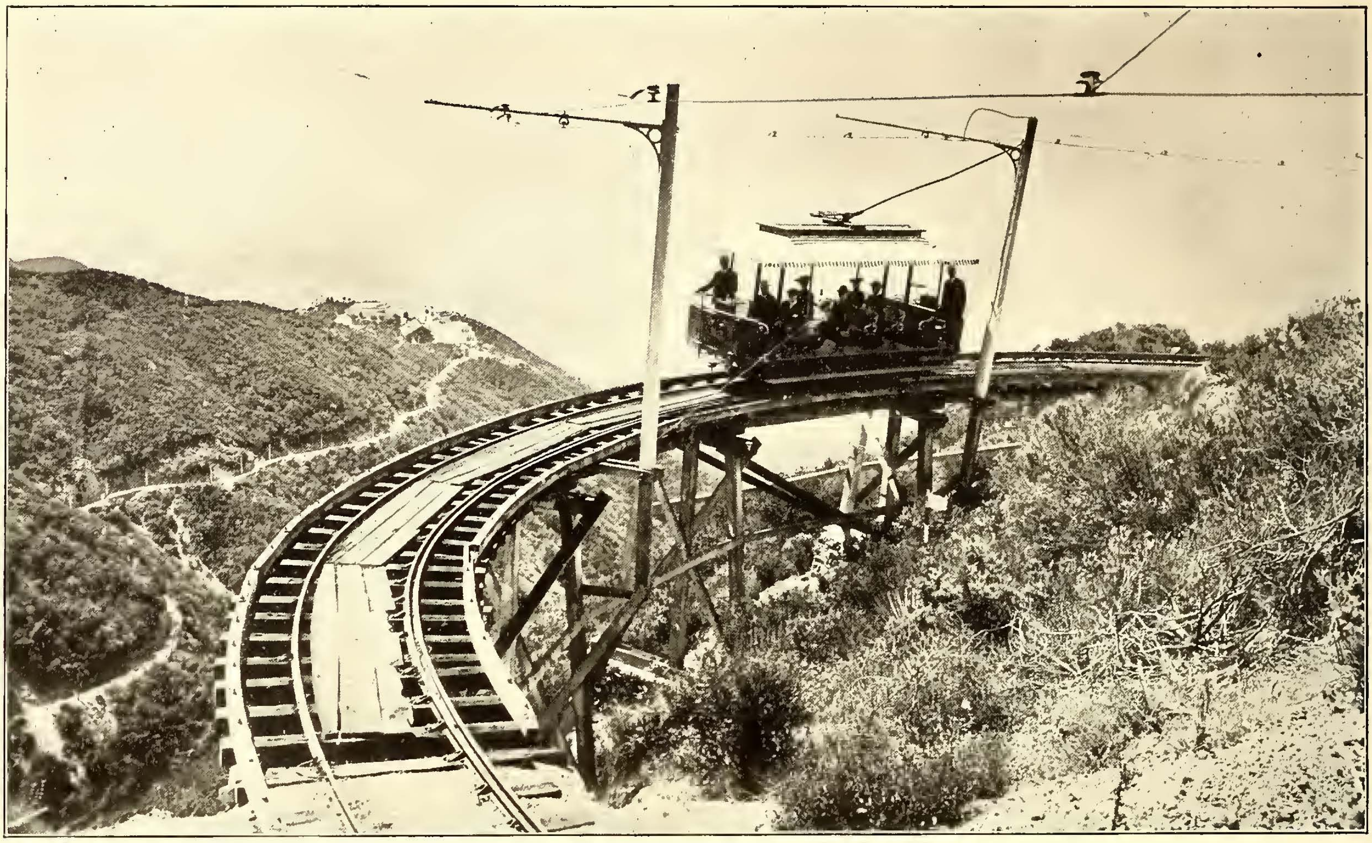


FIG. 12.—TROLLEY CAR ON CIRCULAR RAILWAY, MT. LOWE DIVISION

MT. LOWE LINE

The branch of the Pacific Electric Railway which ascends Mt. Lowe contains some interesting bits of track construction. The road was built about ten years ago by Professor T. S. C. Lowe, and the property was acquired by the present owners two years ago, when the Los Angeles & Pasadena Railway and other lines were absorbed. The Mt. Lowe cars start from Los Angeles and pass through Pasadena to Altadena, where they enter upon a private right of way, and ascend the foot hills on grades as high as 8 per cent to Rubio Cañyon. This line, between Altadena and Rubio, has recently been changed to broad gage and improvements made in the alignment. The large double-truck cars on this portion of the line have recently been equipped with Westinghouse magnetic traction brakes, which increase materially the safety of operation of the cars on the heavy grades.

At Rubio Cañyon change is made to an inclined cable railway, which carries the passengers to the top of Echo Mountain, at an elevation of 3500 ft. A view of this road is shown in Figs. 6 and 8. This cable track has a horizontal length of 2250 ft., and a slope of 2581 ft., giving a vertical rise of 1265 ft., with grades varying from 48 per cent to as high as 60 per cent. At one point there is a bridge 200 ft. long, the ends of which have a difference in elevation of 120 ft. The cars have inclined seats, as may be noted in Fig. 6. The cable is operated by an electric motor on Echo Mountain, where is also located a sub-station for the upper trolley line.

Change is made at Echo Mountain to the narrow-gage electric trolley line, which, in its 4 miles of length, ascends to an elevation of 5000 ft., the terminus being Alpine Tavern, a picturesque structure built in the Swiss style. This electric line is constructed on a uniform grade of 7½ per cent, with many curves and loops. With the exception of the track at the Echo Mountain end the longest piece of tangent track on the whole line is but 227 ft. long. The sharpest curve has a radius of 60.1 ft., with 264 degs. 39 m., and forms one end of a loop. A

FIG. 13.—TYPICAL SCENE AT LONG BEACH ON THE PACIFIC

number of views of this line are presented in Figs. 5 to 10, while Figs. 5 and 12 show unique features on the line, consisting of a circular bridge. This bridge is built on a radius of 60.1 ft., and is 252½ ft. long, the curve having 246 degs. 38 m.

PACIFIC LINES

Fig. 11, which is of a 49-ft. trolley car on the electric line passing San Gabriel Mission, is typical of the change that has

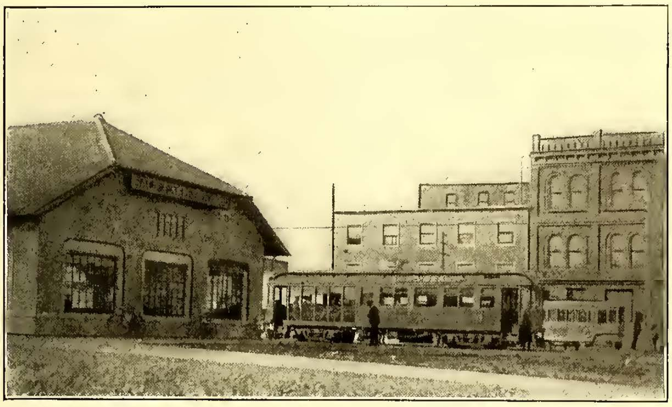


FIG. 14.—SALT LAKE STATION AT LONG BEACH

been wrought by the electric railway in Southern California, and fairly represents the old and the new. The San Gabriel Mission was founded in 1777 by Franciscan Fathers, is one of the most interesting points in Southern California, and is visited by many tourists yearly.

Fig. 12 is a typical scene at Long Beach, on the Pacific Electric Railway Company's system. This is one of the most popular resorts in the vicinity of Los Angeles, and the pleasure traffic to this resort is a source of considerable profit to the company. Fig. 13 is a view taken from the pleasure wharf at Long Beach, showing one of the standard cars.

NEW K-28 CONTROLLER FOR THE ST. LOUIS TRANSIT COMPANY

In the STREET RAILWAY JOURNAL of Feb. 6, 1903, a description was given of the new Westinghouse No. 95 motors, designed specially for the St. Louis Transit Company's 450 new cars. In connection with these motors a new type of controller, also including some improvements specified by the St. Louis Transit Company, is being used. This controller is known as the K-28 controller of the General Electric Company, and is a modification of that company's former four-motor controllers.

In this new controller insulating rings are placed between the contact fingers of the reverse drum. These insulating rings are the same molded insulation used elsewhere in the type-K controllers. The object of these rings is, of course, to do away as far as possible with flashing across between the contact fingers on the reverse drum when the reverse is improperly used by the motorman. It has been a frequent source of complaint with

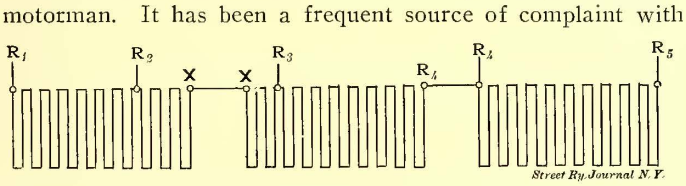


FIG. 2.—CONNECTIONS OF GRID RHEOSTATS FOR USE ON CAR EQUIPPED WITH FOUR W-95 MOTORS AND K-28 CONTROLLERS

four-motor equipments that the reversing cylinders are burned out because of their use in the following manner: The motorman, desiring to make an unusually quick stop, will turn off the current and pull the reverse lever, which, on a four-motor equipment, will cause the motors to act as generators without using the main controller drum. Although terribly hard on the motors this would not injure the controller were it not that the motorman frequently throws the reverse handle back to forward position before the motors have come to a standstill. The result is a very severe arc between the contacts on the reversing drum, which is likely to injure the controller.

In this new controller all contacts which carry the full current to the four motors in multiple are made double width, and have two of the standard contact fingers instead of one. The adjusting screws for the contact fingers have been done away with entirely, as they are believed to be unnecessary if the controller is properly put together in the first place, and only add

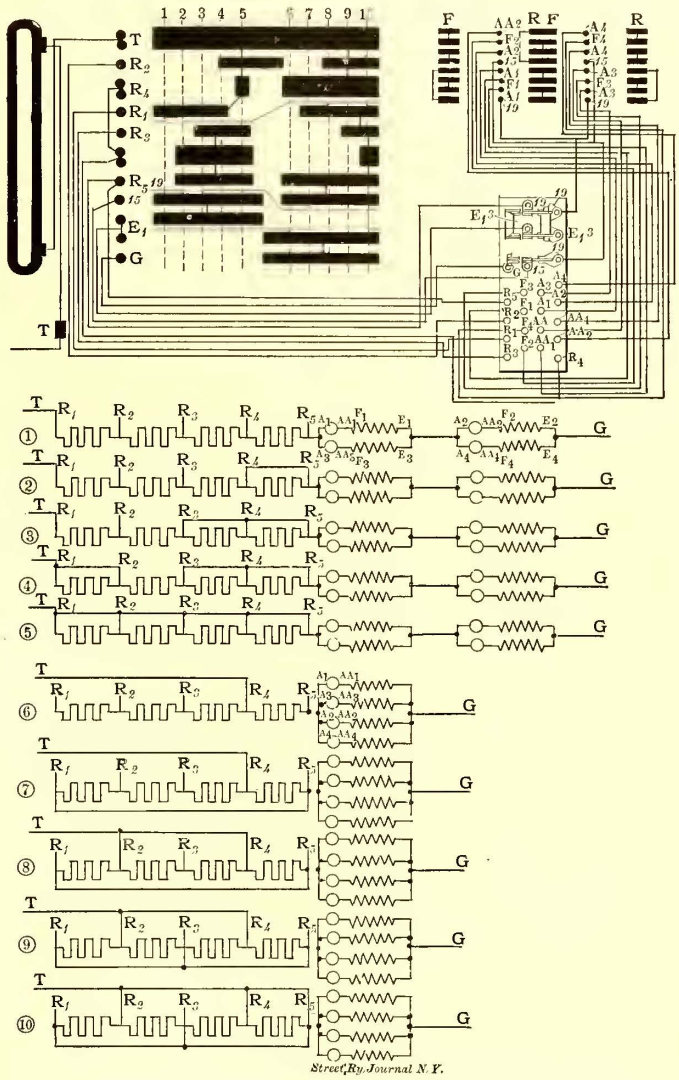


FIG 1.—DEVELOPMENT AND CONNECTIONS OF K-28 CONTROLLER

an unnecessary complication. Fig. 1 shows the development of connections of this controller. It will be noticed that a novel method of connecting the resistance has been employed on the seventh, eighth and ninth points. On these points a part of the resistance is used in parallel with another part in such a way as to avoid breaking up any one set of resistance into a small number of parts, and also to dissipate the heat through a large part of the resistance instead of confining it to a short section. The resistance of the various parts of the rheostat and also the resistance in circuit on the various points are as follows, with either the Westinghouse No. 95 motor or the G. E. No. 54 motor:

RESISTANCE APPROXIMATE

	Ohms		Ohms		Ohms
R 1 — R 2 =	.96	1 =	3.99	6 =	1.18
R 2 — R 3 =	.81	2 =	2.80	7 =	.83
R 3 — R 4 =	1.03	3 =	1.77	8 =	.53
R 4 — R 5 =	1.18	4 =	.81	9 =	.24
		5 =	.00	10 =	.00

The connections of the grid rheostats are shown in Fig. 2. The St. Louis Transit Company is having its own cast-iron resistance grids manufactured at a foundry in St. Louis.

THE MANX ELECTRIC RAILWAY

Among the many pleasure resorts in Great Britain and its immediate neighborhood which attract the summer tourist, it would be difficult to find one which is more beautiful or more popular than the Isle of Man. Some slight idea of its popularity may be gained from the fact that for the last four years between 350,000 and 400,000 visitors from the British ports have been landed annually in Douglas and Ramsey from May to September of each year. The actual figures taken from the Harbor Commissioners' returns are as follows:

	Visitors
1900	351,300
1901	390,100
1902	365,500
1903	391,300

A very large number of excursionists cross over to the island from Liverpool, and to meet the demands of these the Isle of Man Steam Packet Company has put into service two or three magnificent paddle-boats, supplemented by a second fleet of smaller and somewhat inferior vessels.

That the little island is deservedly an attractive summer resort will be readily admitted by anyone who has visited the place when holiday making is in full swing. Side by side with scenery which can hold its own with any to be found elsewhere in the British Isles, there are to be found modern recreations and amusements of all descriptions, while the visitor can travel with ease and celerity to the spots he wishes to explore, by means of the electric railway described in the following pages. By this modern method of transport a very large number of places of interest and entertainment are placed within easy reach of those who elect to lodge in Douglas, the chief town of the island. This railway has rendered the very greatest service in making accessible the most picturesque parts of the little island, and it contrives to do this without in any way spoiling the beauty of the country through which it runs. Hall Caine, the well-known novelist, in a letter to the general manager of the railway, has expressed himself as follows: "So far as I can see the charm is in no way disturbed. Your safe and commodious cars which traverse a piece of coast and mountain scenery that suggests the great new road from Sorrento to Amalfi (and in parts is only second to it in beauty) are, in my view, great contributors to the education and happiness of the hundreds and thousands who make the Isle of Man their annual resort."

This interesting and picturesque railway had its beginnings at a time when electric traction, as far as the United Kingdom was concerned, was quite a novelty. The formal opening took place in July, 1894, when the line from Douglas to Laxey was completely finished, but cars had been running during the previous year, as far as Groudle. Excluding the Brighton Beach and Ryde Pier lines, the only electric tramways open for traffic at that time, which could claim precedence over the Isle of Man Tramway (as it was originally called) were: Giant's Causeway, in Ireland, opened March, 1883; Blackpool Corporation, opened October, 1884; Bessbrook & Newry, opened October, 1895; Birmingham & Bournebrook, opened August, 1890. Thus this railway may justly pride itself upon being one of the earliest pioneers of the enormous development which has taken place in electric tramways and railways.

The history of the line may be briefly epitomised as follows: In 1893 cars were running as far as Groudle, the complete route through to Laxey being finished in the following year. At that time there were two main stations, one at Portevada, Douglas, and the other at Laxey, with a battery sub-station at Grudle. In 1895 a line was built running from Laxey up to the summit of Snaefill Mountain; this line was originally operated by a separate company, but was eventually purchased by the Isle of Man Tramway Company. Power for this line was supplied by a power station situated approximately half way up to the summit, assisted by a battery sub-station at Laxey. In 1897-1898 the present extension of the line to Ramsey was carried out, with a new generating station at Ballaglass, and some fresh plant at Laxey, to supply the additional power required. In 1898 there was also erected at Laxey a small water-power plant, utilizing the fall of water in the River Laxey.

In 1901 Dumbell's Bank failed, and brought with it the failure of the tramway undertaking in which it was heavily

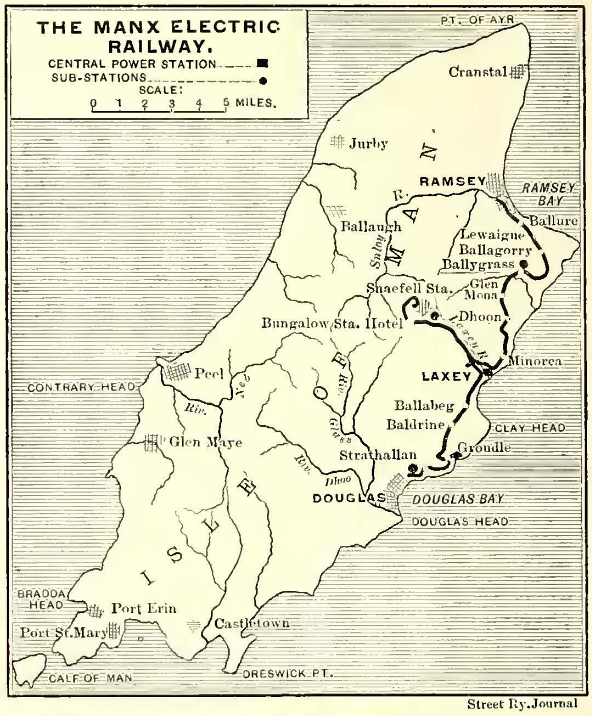


FIG. 1.—MAP OF ISLE OF MAN, SHOWING ELECTRIC RAILWAY

interested. The whole concern thereupon went into the hands of a receiver, and the portion outside the town of Douglas, which was electrically equipped, was taken over by the present company, the horse line and cable road within the town of Douglas being purchased by the corporation. The new company which took over the electrical undertaking carefully investigated the condition of it, and after having several reports presented to it by various elctrical experts, decided on the scheme worked out for them by its engineers, Messrs. Kincaid, Waller, Manville and Dawson, which has now been carried out. The main idea was to centralize, as far as possible, the various scattered power stations under one roof at Laxey, which is near the center of the whole system, and which, from all points of view, both as regards the facility of bringing coal to the power stations and the water supply, is the most suitable site.

The undertaking, as shown above, having grown to its present size from very small beginnings, was naturally a somewhat patched up affair, with the consequence that the working was not at all economical, the number of separate stations being a great disadvantage. The whole railway needed thoroughly remodeling, and a careful investigation of the condition of affairs soon showed that very little could be done by any further patchwork. New plant was obviously required, and this it was eventually decided to obtain, dispensing with such of the old plant that was thus superseded, but retaining those portions which could usefully be worked into the centralizing scheme. Not only was much of the old plant out of date and wasteful, but the total amount of power required at times of heaviest load was so great that the plant was dangerously overloaded. The whole of the additions and alterations made by the new company are given in full elsewhere.

The Manx Railway possesses many points of interest, not only from an engineering point of view but from the picturesque

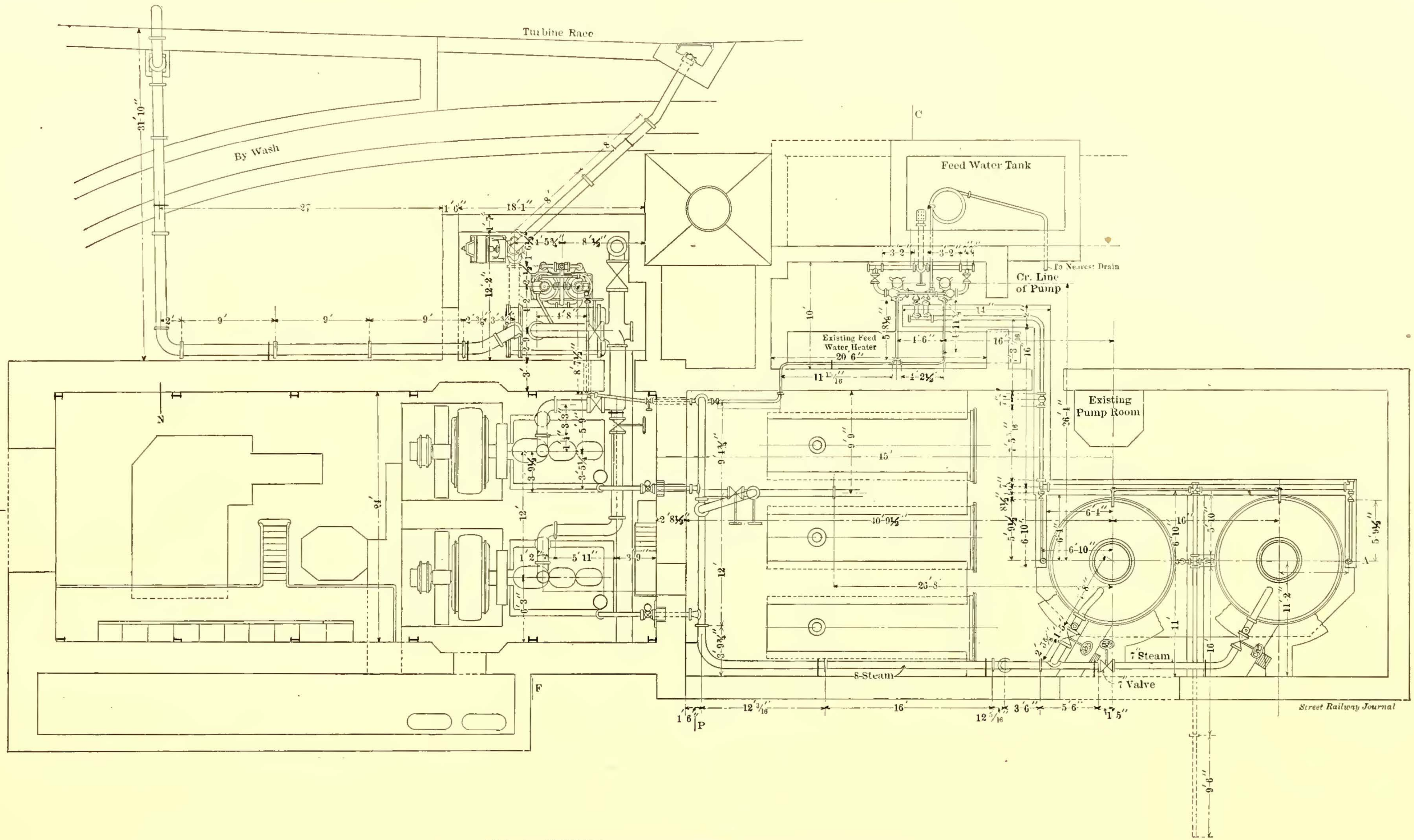


FIG. 2.—GENERAL ARRANGEMENT OF LAXEY STATION

and interesting nature of the route. It has formed a considerable additional attraction to Douglas in the eyes of the traveling public, and has done much to enhance the success of that popular holiday resort.

Quite apart from the electrical equipment the construction of the line was an engineering achievement of no small merit, and very serious difficulties were encountered, and innumerable obstacles had to be overcome. For a considerable portion of the distance between Douglas and Laxey, the line runs along the sea coast, and it was necessary for the track to be cut out of hard slate rock, along the face of the cliffs overhanging the sea. The work of construction was rendered especially arduous by the fact that it was necessary to construct a carriage and footway along the line until it meets the North Road.

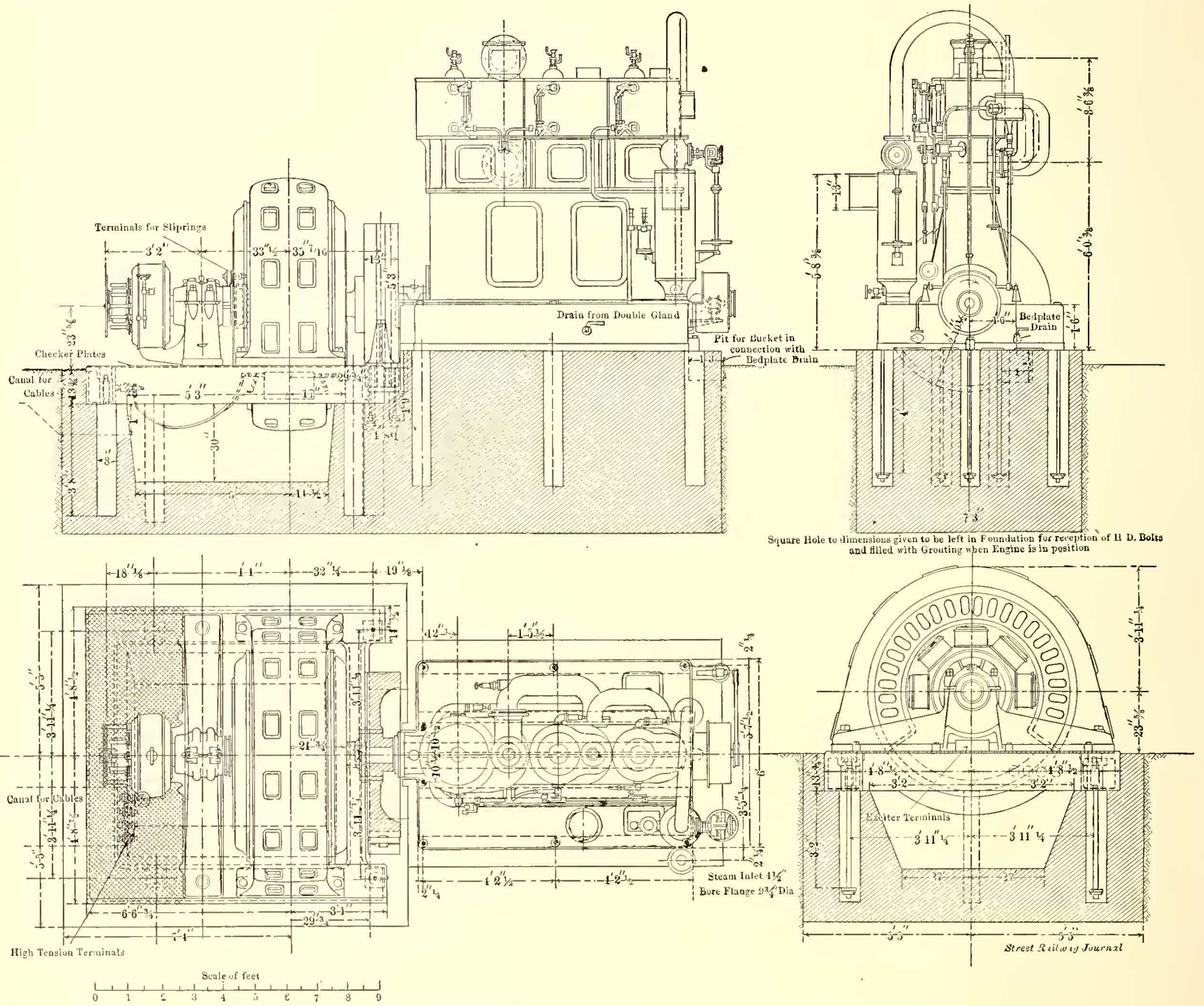
The route is by no means an easy one for the cars to negotiate, as the grades are continuous and often severe. Between Derby Castle and Onchan Head the line climbs steadily upward for 200 ft., the average grade being a little over 4 per cent. The line operates over its own right of way, and several bridges were built.

The original Douglas and Laxey line, which was opened in 1894, starts from Portevado, at the end of the Douglas promenade, and rises by a 4 per cent grade to Lagbirraph, which is nearly 260 ft. above sea level. From this point the line goes inland to Groudle Glen, in the course of which it descends about 130 ft. It passes the Groudle Hotel and the entrance to the Glen, and crosses a stream by means of a bridge 60 ft. high, climbing an average grade of 3¾ per cent to the point where it crosses the Douglas and Laxey main road. This is the highest point in the line, being some 330 ft. above sea level. For some distance the line runs alongside the high hoad, but never leaves its own specially constructed right of way; there is a run down to Garwick Glen, a steady rise to Ballabeg, and then another run down to Laxey.

The total length of the line from Douglas to Laxey is exactly 7 miles, double track throughout, the gage adopted being 3 ft.

The whole of the electrical equipment for this preliminary portion of the undertaking was carried out by Messrs. Mather & Platt, to the design of Dr. Edward Hopkinson, who acted as consulting engineer to the company. There were two power stations, one at Portevada, Douglas at one extremity of the line, and one at Laxey at the other end. The Douglas power station was furnished with three Lancashire boilers, 20 ft. long and 6 ft. in diameter, working at a pressure of 120 lbs. to the square inch. The engines were three in number, of the cross-compound vertical type, indicating 80 hp each, condensing. The generators consisted of two Manchester-type machines and one Mather-Platt type, driven by link belts with jockey pulleys. The output of each machine was 100 amps. at 500 volts. The station at Laxey was very similar to that at Douglas, except that there were only two instead of three generating sets, and the engines were run non-condensing.

One of the distinguishing features of the original line was the use that was made of accumulators, which were situated in a separate station at Groudle, some 2½ miles from Douglas.



FIGS. 3 AND 4.—300-KW HIGH-TENSION GENERATOR SET AT LAXEY

This station contained 256 chloride-type cells. In ordinary operation the battery was connected in parallel with the two generating stations on the line, charging and discharging according to the state of traffic. A motor generator in the accumulator station assisted in the charging process.

In the early days of this railway the storage battery was found particularly useful during the winter months, when very few cars were running, and those at long intervals. The line, as has been remarked before, was intended essentially for pleasure traffic during the summer months, but the Manx authorities would not allow the company to shut down entirely during the winter, and compelled it to run at least two cars each way every day of the year. The expense of keeping a steam generating station in operation for this minimum service would be excessive, so the accumulator station was installed to obviate this.

At present, although the schedule is not nearly so frequent during the out-of-season months, a very satisfactory regular service is maintained between Douglas and Ramsey, while special late cars are frequently put on to suit the convenience of passengers on the occasion of large social or other gatherings at places served by the line. These special arrangements are a very great credit to the energy and enterprise of the present manager, Harold Brown.

The Snaefell Railway being a pleasure line, pure and simple, only runs during the season, and is shut down altogether for the rest of the year.

The original Isle of Man Tramway Company was, as already stated, not financially successful, and went into liquidation, and was eventually purchased by the Manx Electric Railway Company, Ltd., which now owns and operates the lines. At the time of purchase the state of affairs was as follows:

The lines electrically equipped consisted of those running from Douglas to Ramsey, via Laxey, and the Snaefell Mountain line, which has a junction with the former line at Laxey. There is no physical connection between the Snaefell line and the Douglas and Ramsey line, this being quite out of the question on account of the difference in gage (one being 4 ft and the other 3 ft.), if for no other reason. The length of the main route from Douglas to Ramsey is 17 miles, 7 furlongs; the track is 3-ft. gage and is double throughout. Fig. 1 shows a map of the island, giving the route taken by the railway.

The Douglas and Laxey section was constructed in 1893 and 1894, is 7 miles long, and was laid with 56-lb. T-rails. The section from Laxey to Ramsey was constructed during 1897 and 1898, and is laid with 62½-lb. T-rails. In both cases creosoted ties, spaced 3 ft. apart on the average, were used.

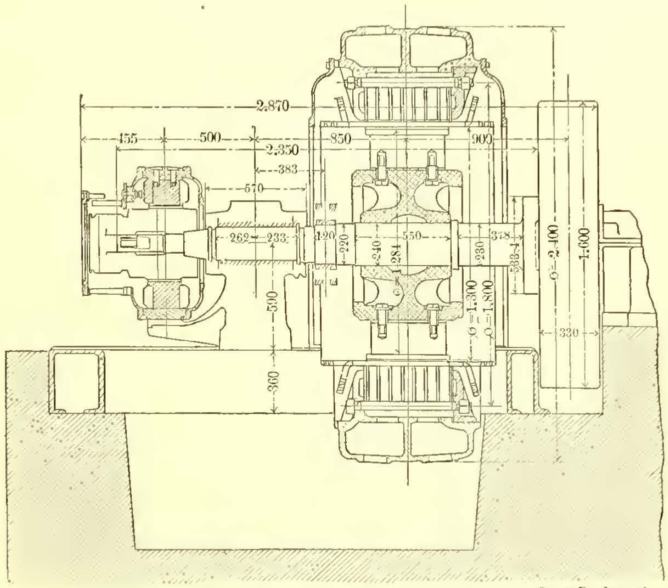


FIG. 5.—ALTERNATOR AND EXCITER

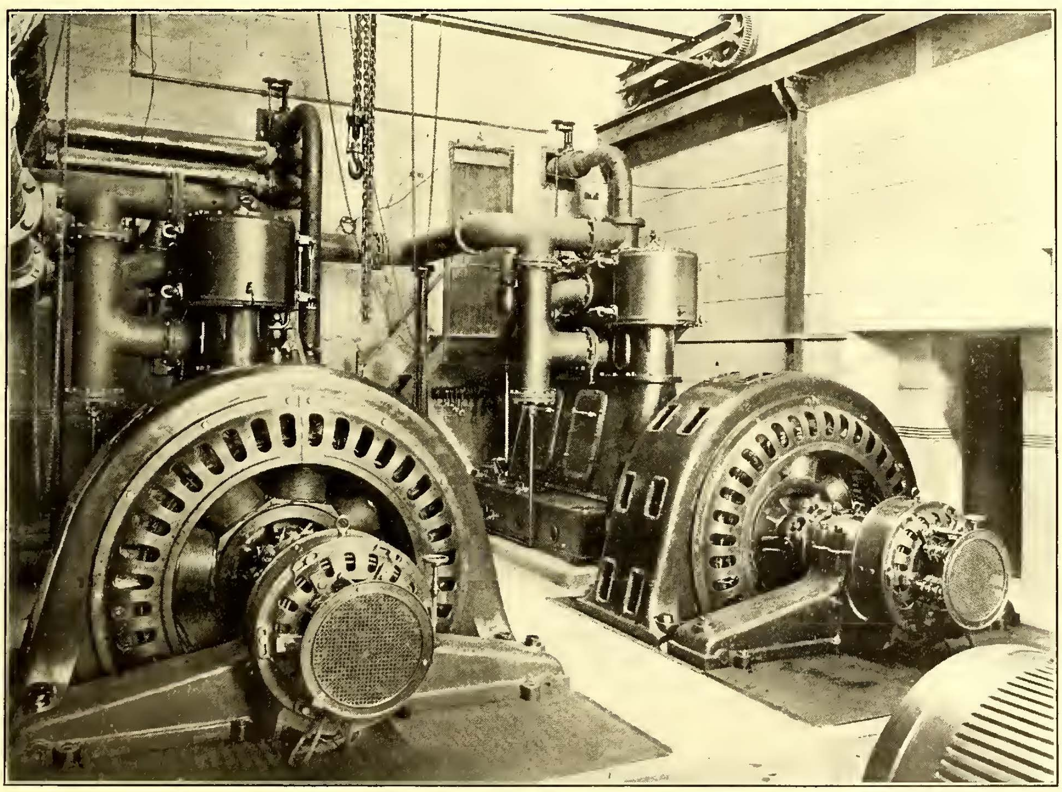


FIG. 6.—HIGH-TENSION GENERATING SETS AT LAXEY POWER STATION

The rails on the Douglas and Laxey section were originally bonded with flat copper-strip bonds, but in 1900 one-half the track, and all the cross bonding, was done again with Columbia bonds, leaving the old bonds in position; the Columbia bond is used throughout on the more recent section of the line.

The line was equipped with No. 0 B. & S. trolley wire, flexibly suspended from steel bracket poles. The usual double insulation was employed throughout except for about half a mile, which, being exposed to the action of the sea water, was provided with quadruple insulation.

An underground cable was laid from Douglas power station to Ramsey and looped into the various power stations enroute. An additional feeder cable, 2½ miles long, was laid from the Ballaglass power station toward Ramsey, to maintain the pressure at the end of the line. The whole of the feeder cable was 37-14, lead sheathed and armored (Callender's make), and laid directly in the ground between the two tracks. There was an underground telephone and pilot cable laid between Laxey and Ramsey.

Feeder pillars connecting the feeders to the overhead wires were fixed about every half-mile along the route.

The Douglas power station is situated at Portevada, about 280 yds. from the Douglas terminus. The boiler house is a stone building, 49 ft. 6 ins. x 42 ft.; the roof is of corrugated iron, and one side of the building is closed with wood to allow for extension. The original plant consisted of three Lancashire boilers, built by Galloways, each boiler measuring 20 ft. long and 6 ft. in diameter; space was provided for one additional boiler. There was a Mather & Platt jet condenser, capable of condensing the steam from all four engines in the engine house, and there was also an underground tank holding 33,500 gals. adjoining the boiler house, from which the feed and circulating water was drawn; this tank was fed by two independent streams. The stack was of iron on a concrete base, 12 ft. sq. and 7 ft. high. The shaft was 60 ft. high and 5 ft. in diameter.

The engine room is also of stone, with a boarded roof, covered with corrugated iron. The building contained three Galloway vertical compound engines, indicating 90 hp, at 150 r. p. m. and 120 lbs. steam pressure. The high-pressure and low-pressure cylinders measured 10 ins. and 20 ins. in diameter, respectively, with a stroke of 18 ins.; the fly-wheel measured 9 ft. in diameter. The generators, of the shunt-wound type, were supplied by Messrs. Mather & Platt, and had an output of 100 amps. at 500 volts, when driven at the speed of 700 r. p. m.

The traction switchboard consisted of five panels, one for each generator, one for the circuit and test purposes, and one spare.

The electric lighting plant consisted of one Bellis high-speed engine of 75 hp, direct coupled to a 50-kw Mather & Platt alternator, having an output of 50 amps. at 1000 volts, at 415 r. p. m. There was also a motor alternator giving 30 amps. at 1000 volts, the motor being supplied with current at 500 volts from the traction sets. These machines had their own separate high-tension switchboard, with the necessary switches and instruments for running either of the two, on two main circuits.

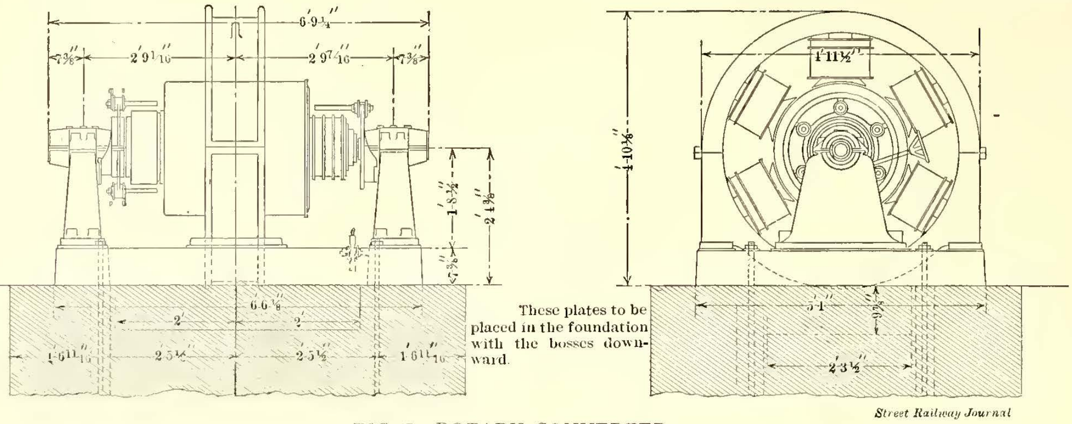


FIG. 7.—ROTARY CONVERTER

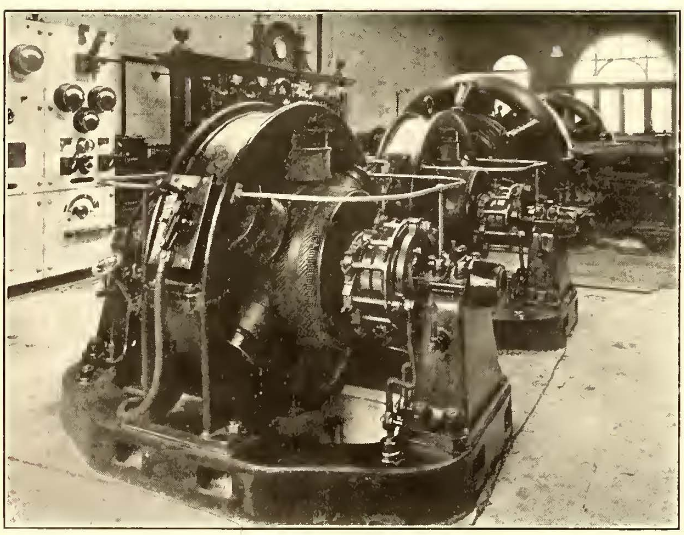


FIG. 8.—BALLAGLASS SUB-STATION

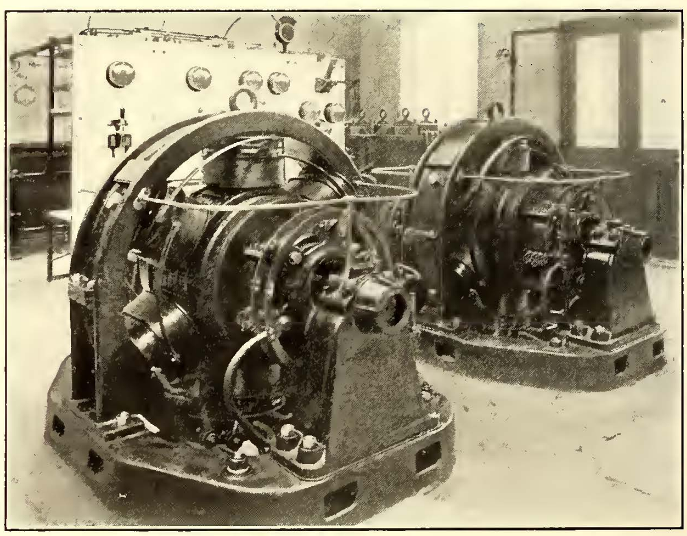


FIG. 9.—BALLAGLASS SUB-STATION

The main steam pipes were of cast-iron, duplicate lines being supplied for each engine. Arrangements were made whereby the engines could work either condensing or non-condensing, as desired.

The Groudle battery sub-station, situated about 2 miles from Douglas, was a wooden building, 61 ft. long, 17 ft. wide and 9 ft. high to the eaves. The battery consisted of 256 cells of the chloride R-type, with a capacity of 140 amps. for 4½ hours. The building also contained a booster of 12-kw capacity for charging purposes.

The Laxey power station, 7 miles from Douglas, is also a stone building with a corrugated iron roof. The steam raising plant consisted of two Lancashire boilers, similar to those at Douglas, and one Galloway boiler, 20 ft. x 6½ ft., which was installed at a later date. A feed-water heater, using exhaust steam, is fixed adjoining the boiler house, and a concrete tank, 15ft. long, 7 ft. wide and 4 ft. deep, supplied the feed water. The stack was similar to that at Douglas.

The engine room plant consisted of two Galloway engines belted to two Mather & Platt 50-kw generators, identical with those installed at Douglas. This formed the original equipment, which in 1898 was supplemented by a Robb Armstrong (Canadian) tandem compound horizontal engine, direct coupled to an E. C. C. multipolar generator, giving an output of 240 amps. at 500 volts, at 175 r. p. m. This engine indicates 180 hp when supplied with steam at 120 lbs per square inch, and running at 175 r. p. m. The cylinders measure 13 ins. and 20 ins., by 20-in. stroke, and the fly-wheel is 7 ft. in diameter.

This station also contained a 12-kw booster for charging the Snaefell battery and for raising the pressure on the different feeder cables.

The switchboard contains seven slate panels, each measuring 7 ft. x 2 ft. Three of these were provided for controlling the current from the three generators; two were for distributing the current on the various circuits, and for testing purposes, and the remaining two were for controlling the water-power plant at Laxey, which is described later on.

Duplicate lines of steam pipes were provided for each

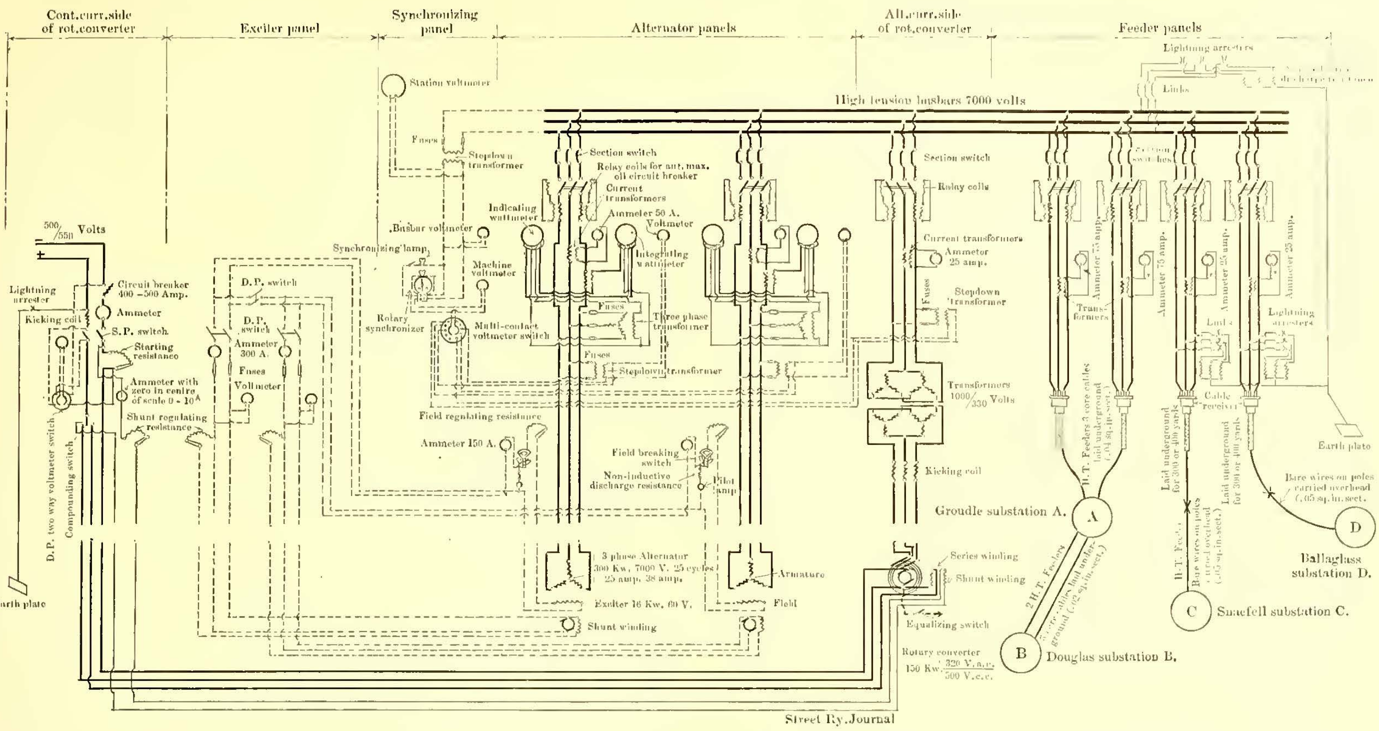


FIG. 10.—DIAGRAM OF SWITCHBOARD CONNECTIONS AT LAXEY GENERATING STATION

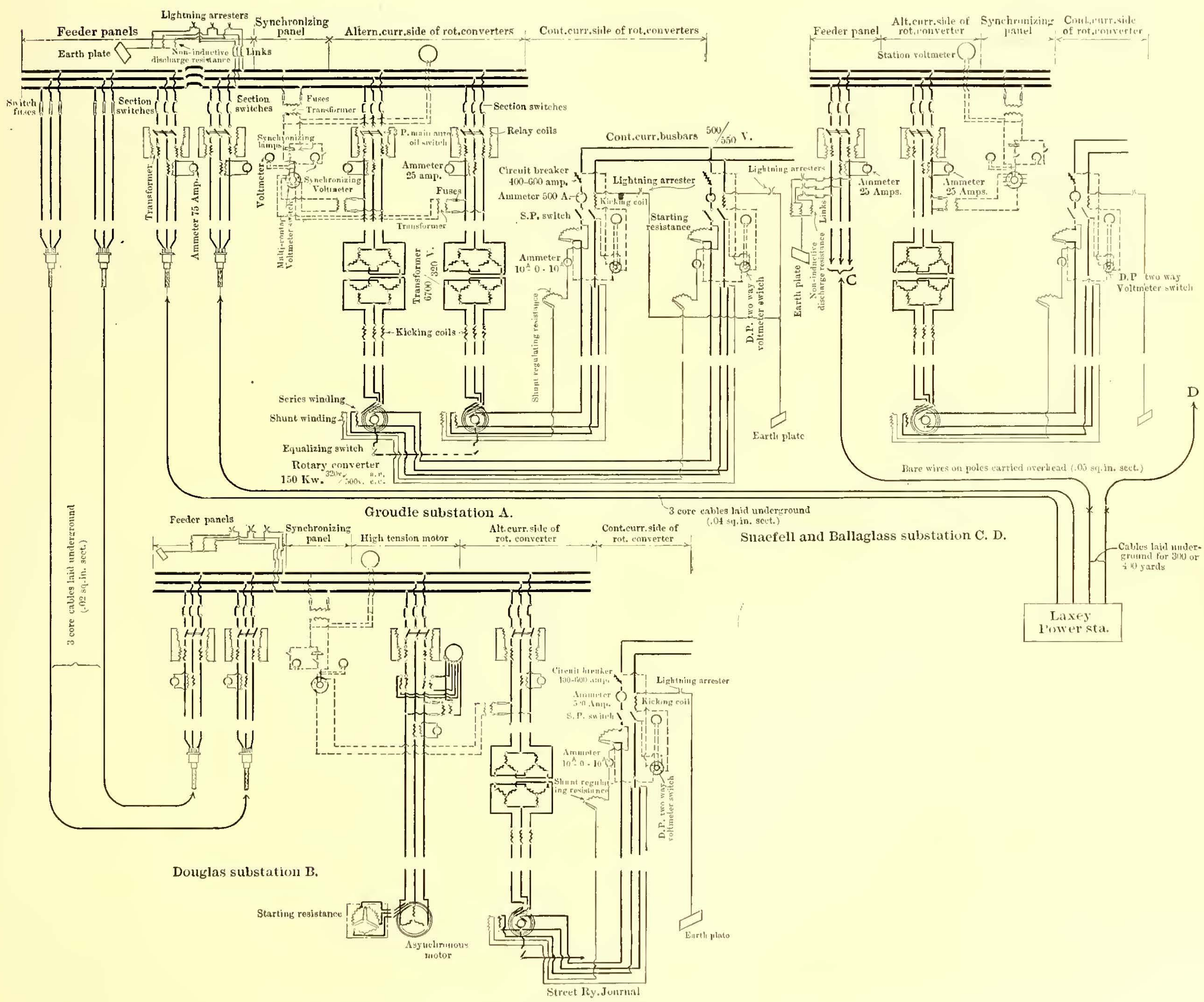


FIG. 13.—DIAGRAM OF SWITCHBOARD CONNECTIONS AT BALLAGLASS SUB-STATION

engine, as at Douglas, the pipe being of cast-iron. The pipes for the feed pump and injector, also in duplicate, were of cast-iron.

There was also erected at Laxey in 1898 a water-power plant

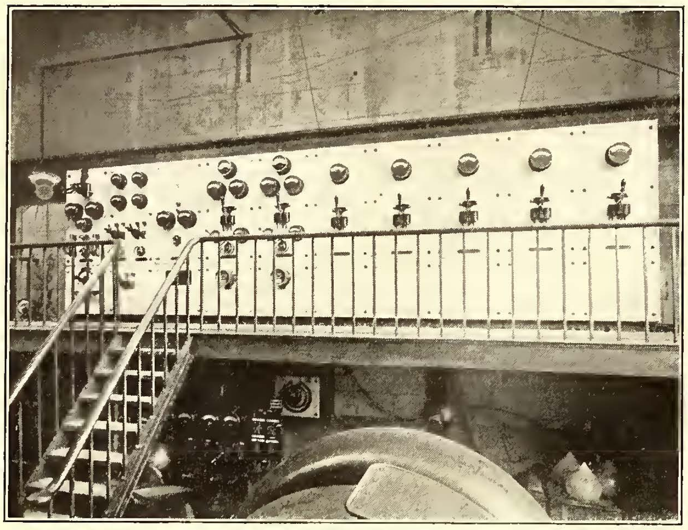


FIG. 11.—LAXEY SWITCHBOARD

which utilizes the fall of water in the Laxey River. The power house is situated on the banks of Laxey River, about 430 yds. below the steam-driven station. The building is of stone, and contains two Victor turbines, of the horizontal type, in one flume case, with shafts direct coupled. These turbines develop some 140 hp at 720 r. p. m.

The electrical generating plant consists of a combined

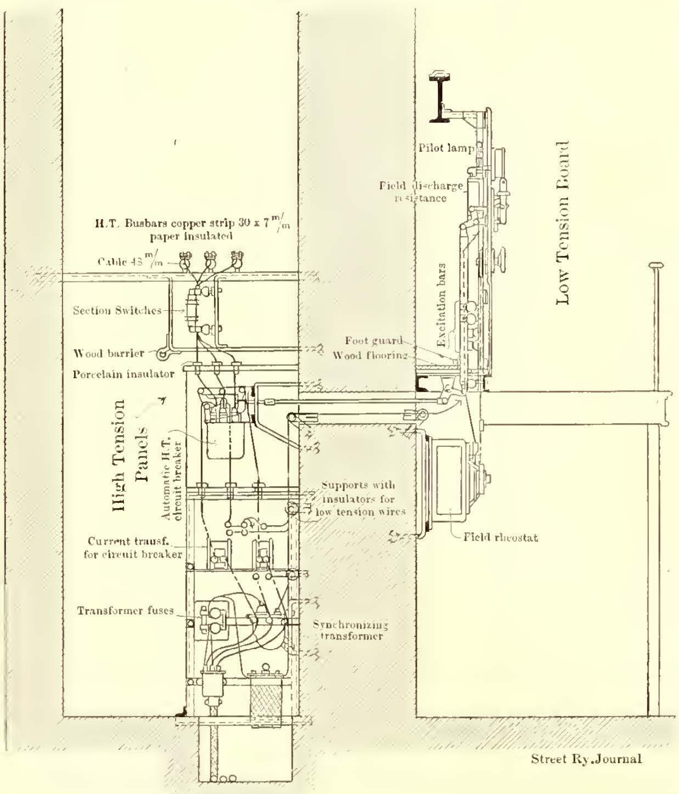


FIG. 14.—SECTION THROUGH ALTERNATOR PANEL AT LAXEY

bipolar dynamo and booster, the generator having an output of 160 amps. at 520 volts, and the booster 160 amps. at 100 volts to 200 volts. This combined machine is coupled direct to the turbines.

Two Lundell ¼-hp motors are used for opening and closing the gates, and are operated from the Laxey engine house. The weir across Laxey River is 42 ft. long and 4 ft. 6 ins. high. At one end are two masonry arches, 5 ft. wide and 9 ft. high, each fitted with a sluice gate with the necessary raising and lowering gear. The head race is constructed of masonry and concrete, and consists of 812 ft. of trench, 5 ft. wide, followed by 481 ft. of trench, 3 ft. 6 ins. wide, the depth being 4 ft. 6 ins. The head box is built of masonry, 8 ft. x 11 ft. x 7 ft. 9 ins. deep, from which the water is conveyed to the turbines by means of 820 ft. of steel piping, 3 ft. in diameter. The tail-race is 624 ft. in length, 10 ft. wide and 13 ft. 3 ins. below the turbine house floor.

The Ballaglass power station is situated 12½ miles from Douglas, and is a stone building like the other stations. In the boiler house there are two Galloway boilers, which measure 26 ft. x 6 ft. 6 ins. The condensing plant consists of two Ledward ejector condensers, with two centrifugal circulating pumps, direct coupled to a 10-hp E. C. C. electric motor of the enclosed type. The chimney, as in the case of the Douglas and Laxey power stations, is of iron, measuring 60 ft. in height and 5 ft. in diameter.

In the same building there is an accumulator room containing a battery of 260 chloride cells, having a capacity of 140 amps. for 6 hours, or 70 amps. for 12 hours. There is a coal store, 56 ft. x 31 ft. x 17 ft. high, adjoining the boiler house.

The engine room contains two Robb Armstrong horizontal

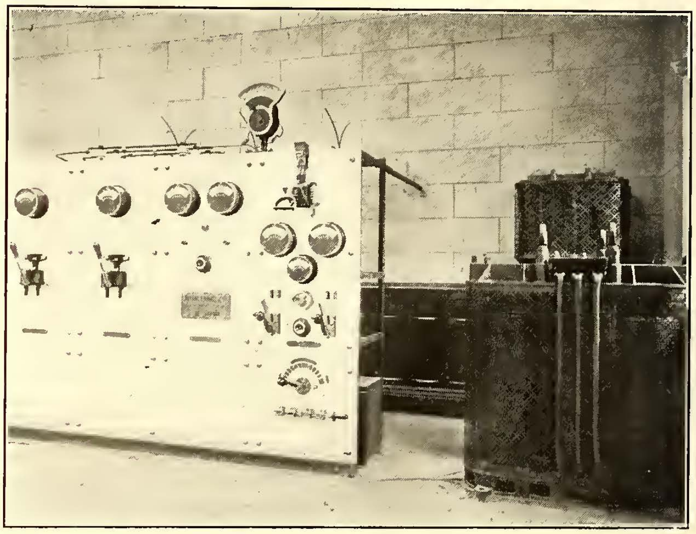


FIG. 12.—BALLAGLASS SWITCHBOARD

tandem compound engines, direct coupled to Mather-Platt multipolar generators. Both sets are precisely similar to the direct coupled set at Laxey. There is also a booster, consisting of one 500-volt motor, one 150-volt shunt generator for charging the accumulators, and one 150-volt series generator for raising the pressure on the additional feeder mentioned above.

The switchboard contains seven slate panels, each 7 ft. high and 2 ft. wide. There are two panels for the two generators, one for operating the booster and two for the accumulators, while the remainder are for circuits and testing purposes.

The rolling stock consisted of twenty-two motor cars, twenty-three trailers, one locomotive and twelve freight cars. Thirteen of the motor cars were fitted with two 25-hp motors, supplied by Mather & Platt, the other nine cars were equipped with four 20-hp E. C. C. motors each. Of the twenty-three trailer cars, eighteen held forty-four passengers each, four held fifty-six passengers each, and one held eighteen passengers. With the exception of the last, which was a closed saloon car, all the trailers were open cars. All cars, whether motor or trailer, were of the double-truck type. The twelve freight cars comprised eight open cars and four closed cars, each of 6 tons capacity. Each motor car was supplied with two circuits of five 16-cp lamps, and each of the nine trailers with one circuit of five lamps.

The company possesses five car sheds. No. 1 accommodates nine motor cars and has pits for six cars; No. 2 accommodates eight motor ears, No. 3 accommodates six motor cars, No. 4 accommodates fifteen trailers. There is also a car shed at Ramsey, close to the terminus, having accommodation for six cars.

Besides the supply of electric power for traction purposes the company also provide a certain amount of alternating current for public and private electric lighting. The requisite power is derived from two alternators in the Douglas station,

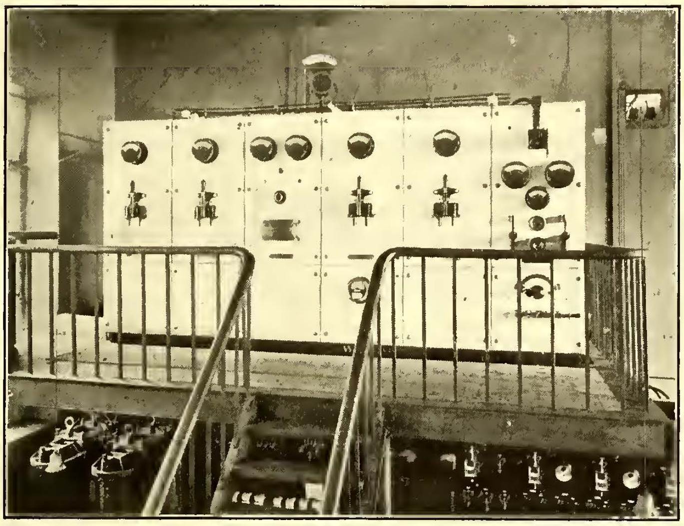


FIG. 17.—DOUGLAS SUB-STATION

one being steam driven and the other motor driven. At various points along the route from Douglas to Ramsey there are ticket offices and waiting rooms, etc.

We now come to the railway running from Laxey to the summit of the Snaefell Mountain.

This line comprises a double line, 4 miles 5 furlongs long, and 3-ft. 6-in. gage, and was constructed in 1895. It starts from Laxey Station, crosses the high road from Douglas to Ramsey, and thence goes up the valley of the Laxey River to the summit of Snaefell.

The track is laid with 56-lb. T-rails, and a center rail, which is used for braking purposes, weighs 65 lbs. per yard. The heaviest grade is 8½ per cent, the majority of the line being

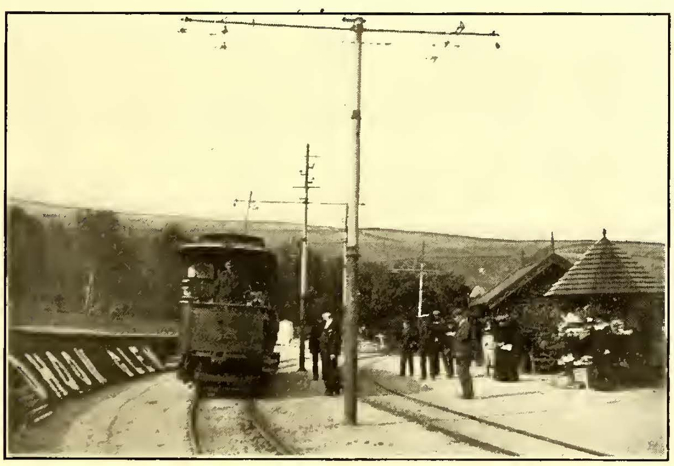


FIG. 16.—TYPICAL OVERHEAD CONSTRUCTION

at that slope. The rails are bonded with flat copper strip, riveted to the rails.

The line is equipped on the overhead system, No. 0 B. W. G. trolley wires being employed, which are hung from the bracket arms by means of "Ætna" bell insulators. Steel poles, measuring 6 ins. in diameter at the base and tapering to 3 ins. at the top, are employed. These are fixed in concrete foundations about 6 ft. deep.

The summit of Snaefell is connected with the car house at Laxey by overhead telephone wires carried on the tramway poles.

A 37-14 underground feeder cable connects the Snaefell power station with the accumulator station at Laxey, feeding into the overhead wire through feeder pillars placed every mile along the route. A similar cable joins the accumulator house with the Laxey power station, and is looped into the stationmaster's office at Laxey, at which point a small switchboard has been erected. These cables are of Callender's make, lead sheathed and armored.

The original Snaefell power station, erected when the line was an independent concern, is situated 2 miles 5 furlongs from Laxey. In the boiler house there were four Lancashire boilers, working at 120 lbs. pressure, and feed pump and injector. The stack, which is iron, is 60 ft. high and 5 ft. in diameter. A temporary coal shed, built of wood, adjoins the boiler house.

The engine house contains five horizontal compound engines, built by Messrs. Mather & Platt, indicating 120 hp each when

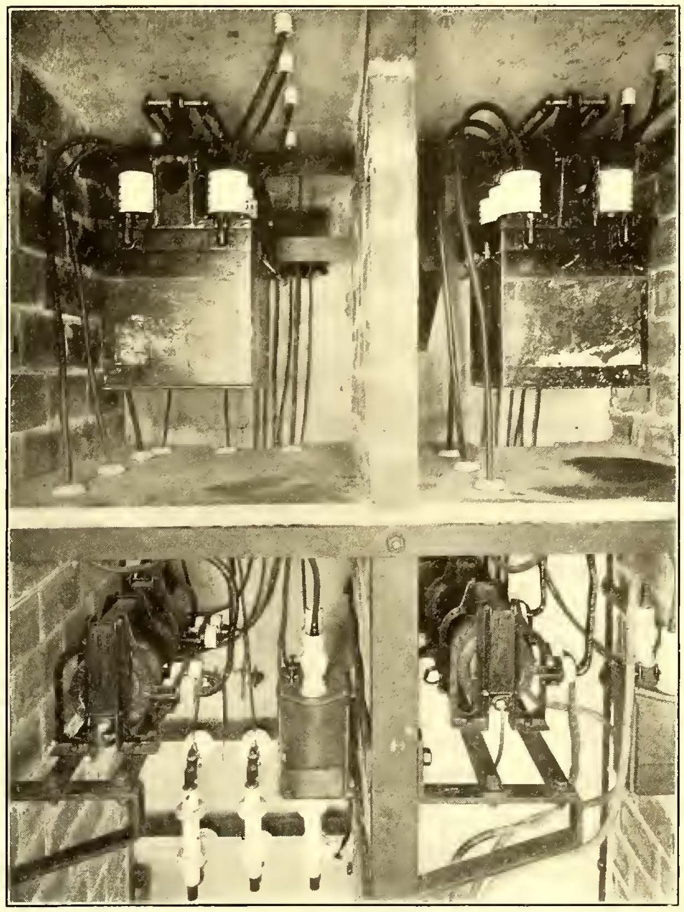


FIG. 15.—HIGH-TENSION OIL SWITCHES IN BRICK CELLS AT LAXEY POWER STATION

working at 120 r. p. m. The cylinders measured 20 ins., and 12 ins. in diameter by 16-in. stroke. Each engine drives a 60-kw Mather & Platt generator, by means of link leather belts.

A concrete tank, 29½ ft. x 19 ft., and 7¾ ft. deep, supplies the feed water. The tank is fed by a pumping station situated on the Sulby River. This building, which is of corrugated iron, contains one 4-hp vertical boiler, fitted with Galloway's patent cross tubes and one double-action plunger pump with engine attached, made by Tanges. This supplies water to the tank through a 2-in. iron pipe. The feed water is supplied to the boiler by a donkey pump attached to the side.

The car house is situated near the Laxey terminus, and has accommodation for six cars in two rows. Pits are provided for six cars.

The accumulator house was situated about 176 yds. up the line from the ear house, and is a wooden building containing

250 chloride cells. The capacity of the battery was 140 amps. for 4 hours.

The rolling stock consisted of six closed motor cars, built by G. F. Milnes & Company, each car being capable of seating forty-six persons. The motor equipment consisted of four 25-hp motors per car; the Hopkins current-collecting gear is used instead of the ordinary trolley.

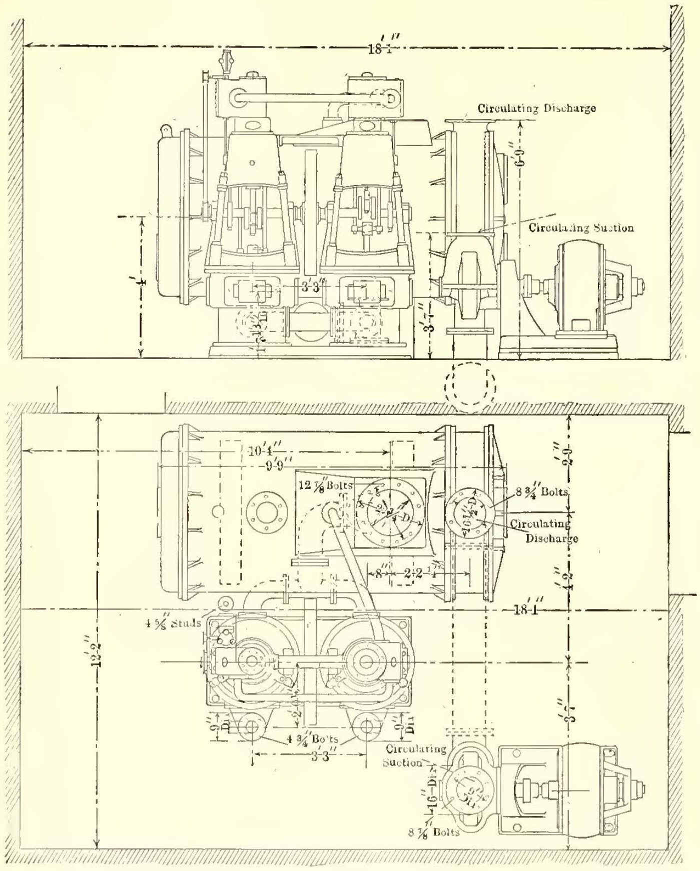


FIG. 18.—PLAN AND END ELEVATION OF CONDENSER PUMPS

There is a station at the summit of Snaefell, built of wood, and comprising waiting room, stationmaster's office and lavatories.

As mentioned above, the chief work of the new company on taking over the tramway from the liquidator has consisted in centralizing the power supply and dispensing with some of the numerous separate generating stations which were in existence at that time. New rolling stock has also been supplied, and the whole of the line has been generally overhauled and brought up to date.

The new generating plant, details of which are given elsewhere, consists of two 300-kw direct coupled sets for the existing station at Laxey, the steam being supplied by two Climax boilers. Two direct-acting feed pumps and a surface condensing plant have also been added. Some of the old plant will, for the present, at least, be retained, i. e., the Robb Armstrong and E. C. C. engine and generator and the three Lancashire boilers. The turbine-driven plant at Laxey will also be retained. There has also been installed at Laxey one 150-kw rotary converter, two static transformers and a new high-tension switchboard.

The sub-stations have been equipped as follows:

Groudle Sub-station.—Two 150-kw rotary converters, with static transformers and additions to the existing battery of accumulators at this station.

Douglas Sub-station.—One 150-kw rotary, with static transformers in the old power house.

Snaefell Sub-station.—One 150-kw rotary converter. The Ballaglass station has also been increased by the presence of two similar rotaries and a new high-tension switchboard.

These additions have enabled a considerable portion of the old, and in some cases obsolete, plant to be dispensed with. Thus at Laxey the original Galloway and Mather & Platt sets have been removed to make room for the new high-tension plant. The battery-charging booster for the Snaefell sub-station has also been taken out, since the abolition of the latter rendered its retention unnecessary. The space it occupied is now taken up by the rotary converter. The Douglas steam plant is now no longer used, but has not yet been disposed of. The original plant at Ballaglass remains unaltered.

As regards the rolling stock, thirteen of the old motor cars have been, or are being, provided with new four-motor equipments and Christensen air brakes, and nine other cars are also being supplied with four-motor equipments.

The Manx Electric Railway Company, since taking over the undertaking, has added four motors, four trailers, two light parcel vans (trailers) and one motor cattle car truck.

NEW PLANT AND EXTENSIONS

The chief additions to the generating plant have been made at the Laxey power station, where there have recently been installed two boilers, two direct coupled high-tension generating sets, two feed pumps, a surface condensing plant, one rotary converter, with two transformers for reducing the pressure, and the requisite switch gear for the new plant. Fig 2 shows the general arrangement of the present power station.

The boilers are of the Climax type, supplied by B. R. Rowland & Company, this style of boiler being chosen chiefly on account of the small amount of floor space available, and the very simple design of the flues and chimney required for them. It was necessary to raise the roof of the boiler house in order to accommodate them, but this was a simpler matter than extending in any other direction. The boilers have a rated capacity of evaporating 12,000 lbs. of water per hour from and at 212 degs. F. in temperature. The heating surface of each is 3010 sq. ft., with 76 sq. ft. of grate area. The steam generators are of the water-tube type, each containing 420 tubes, 2½ ins. in diameter and 11 B. W. G. thick. About 500 sq. ft. of the heating surface of each boiler represents superheating. There is no economizer, but a coil of tubing is placed in the path of the

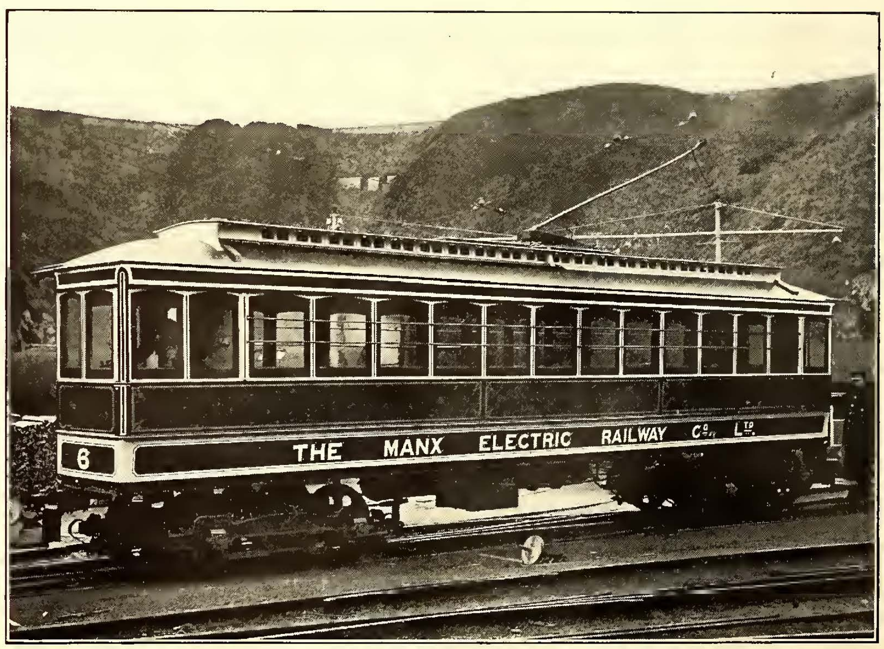


FIG. 19.—MOTOR CAR FOR MANX ELECTRIC RAILWAY

gases, directly over the tubes, and the boiler feed passes through this coil. The waste gases pass directly into a mild steel stack (each boiler has its own stack), 44 ins. in diameter and 75 ft. high. These stacks are made up in three sections,

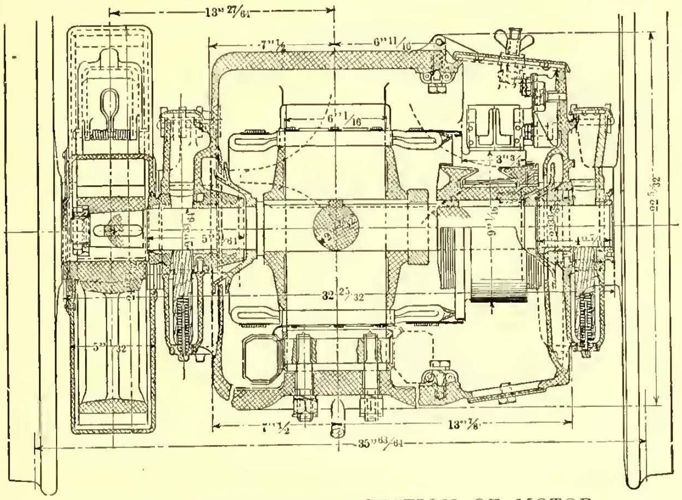


FIG. 20.—LONGITUDINAL SECTION OF MOTOR

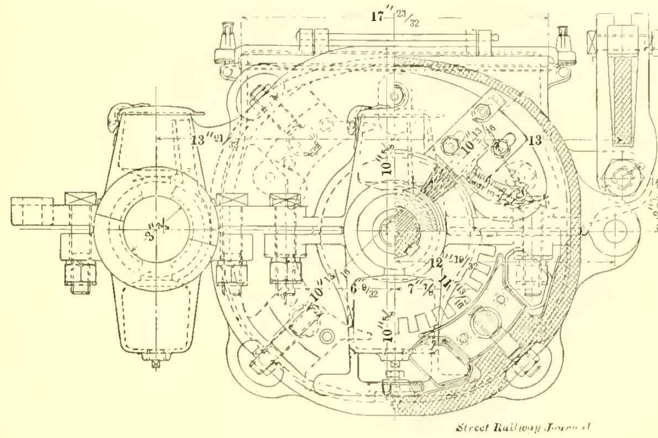


FIG. 21.—CROSS SECTION OF RAILWAY MOTOR

each 25 ft. long, the bottom section being constructed of plate ¼ in. thick, the center section 3-16 in. thick, and the top section ⅛ in. thick. The stack is stayed by steel wire guy ropes.

Each boiler consists of one central shell, bored to receive the tubes, which are so formed that both ends are expanded into the shell. Inside the shell there are a series of baffle plates, arranged to separate the water from the steam. On the top of the upper row of tubes there is a feed-water coil, one end connected to the water in the inner shell, and the other end connected to feed pumps. The whole rests on a cast-iron foundation plate, and is surrounded by a wrought-iron casing or jacket, lined throughout with patent fire-clay slabs, except the furnace, which is lined with firebrick.

The central shell is 11-16 ins. thick, 42 ins. diameter and 2 ft. 9 ins. high, composed of Siemens-Martin steel, welding quality, 60,000 lbs. tensile strength. The vertical seams of shell are welded, and the circumferential seams single riveted with ⅞-in. rivets. The wrought-iron bearer for the grate bars is fastened with ⅞-in. tap bolts. The central shell is securely fastened to the cast-iron base plate by four cast-iron sections around the bottom.

The heads in the central shell are ¾ in. thick, and of the same quality steel as the shell, pressed to radii equal to their respective diameters and single-riveted with ⅞-in. rivets. There are four baffle or separating plates of ¼-in. steel. The central shell has one manhole, 11 ins. x 15 ins., in the top head, and another of the same size in the shell below the grate bars.

The upper rows of tubes are arranged so as to form a superheater.

The jacket or casing is in four courses, with a canopy or bonnet on top. The lower course round furnace is ¼ in. thick, in four sections with four firing and ashpit doors. The dead plate which supports the firebrick and grate bars is of cast-iron, made in eight sections and bolted to the lower course. The furnace is lined with firebrick from the dead plate to the top of the lower course with 1-in. air space. The upper course is 2-16 in. thick in eight sections each, with 2-in. flange all around, lined with fire-clay slabs 3 ins. thick. There are cleaning doors in each course.

The main steam pipe, 6 ins. diameter, is secured to the shell by a flange with a special casting to receive two safety valves. There are two 3½-in. spring safety valves, Hopkinson make, designed to blow off at 165 lbs. Light iron gangways with hand rails encircle the boilers, so as to provide access to cleaning doors, etc. The diameter of the outside furnace casing is 12 ft., and that of the upper casing 11 ft. 6 ins. The height of the boiler to the top of the canopy is 23 ft. 1 in.

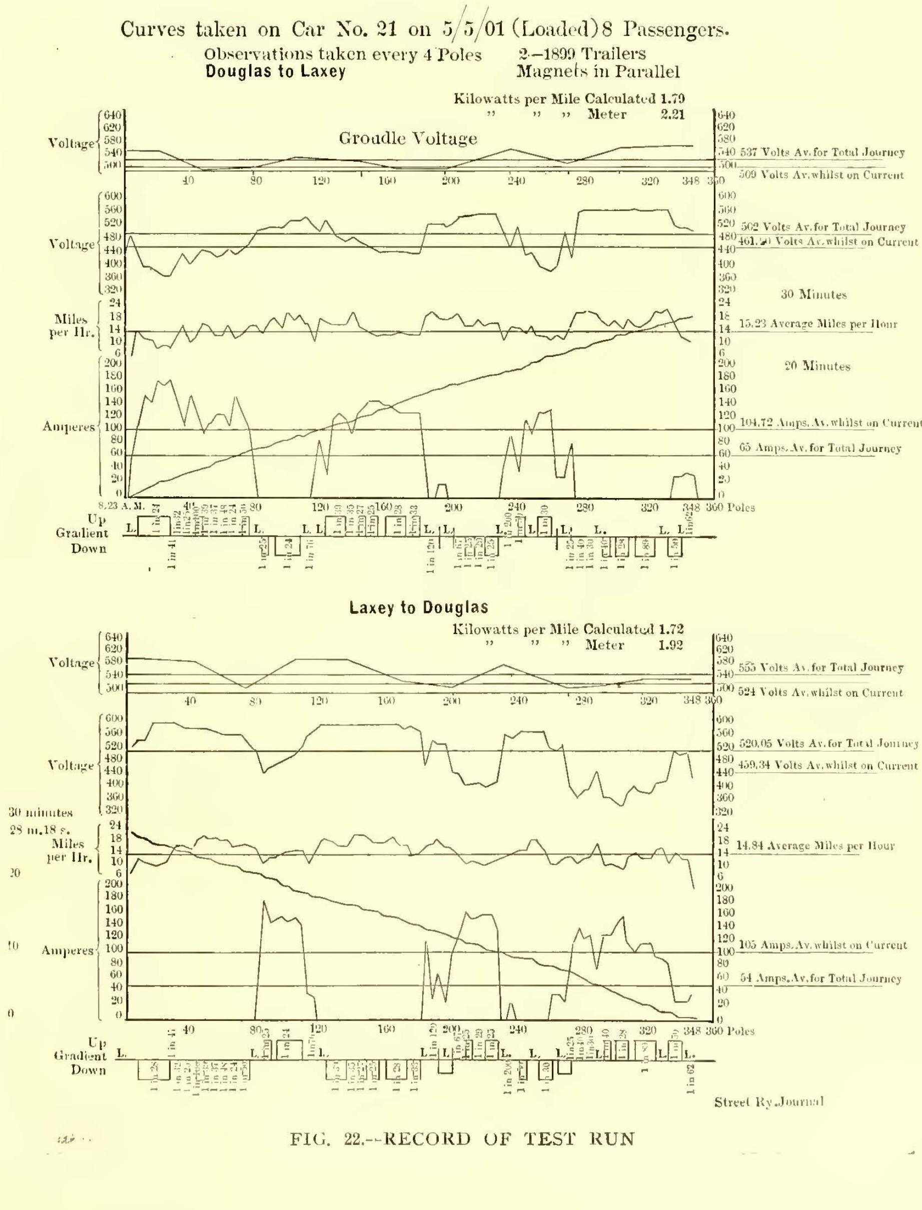


FIG. 22.—RECORD OF TEST RUN

The new generating sets, two in number, consist of high-speed engines direct coupled to high-tension alternators; they take the place of the Galloway sets originally installed. Figs. 3 and 4 show one of these sets.

The engines, supplied by Bellis & Morcom, are of the triple-expansion, vertical, high-speed enclosed type, designed to give the most economical results when working condensing, but capable of giving their full rated output when exhausting to the atmosphere, so that they will still continue to work satisfactorily should the condensing plant fail. The cylinders measure 12 ins., 17 ins. and 26 ins. in diameter by 13-in. stroke, and the normal speed is 375 r. p. m., with 155 lbs. steam pressure at the throttle. The shaft and the crank pins are all 5 ins. in diameter, and the total length of the bearings is 50 ins. The bearings are of gunmetal, lined with white metal. The flywheel is located next to the generator, and weighs 10,000 lbs. The speed is controlled by a centrifugal governor, which separates a throttle valve as well as the expansion gear. There is a steam separator attached to the engine bed. The cranks run in a bath of oil and water.

The generators were supplied by Witting & Eborall, who were the contractors for the electrical plant, and are of the three-phase revolving field type, with iron-clad armatures. The rated capacity is 300 kw at 7000 volts and 25 cycles, when running at 375 r. p. m., built by the Electricité et Hydraulique Company, of Charleroi, Belgium. A section of these machines, giving dimensions, is shown in Fig. 5. The frames stand upon heavy sole plates, mounted directly upon the foundations, and have no connection with the bases of the engines. The outer bearing is self-aligning and self-oiling by means of ring lubricators.

Each alternator is provided with a shunt-wound exciter, direct coupled to the shaft, each such machine being capable of providing sufficient current for the excitation of both generators simultaneously.

The steam consumption of these sets is guaranteed not to exceed the amounts given below when running condensing at 375 r. p. m. and 155 lbs. steam pressure at the throttle, using technically dry steam:

Full load, 18.5 lbs. per ehp-hour.
Three-quarters load, 19.2 lbs. per ehp-hour.
Half load, 21.0 lbs. per ehp-hour.

The full-load capacity of each set is 300 kw, with 20 per cent overload for two hours. Fig. 6 shows the two sets erected at Laxey.

The rotary converter and static transformer were likewise supplied by Witting & Eborall, as was also the switch gear. The rotary and transformers were made by Kolben & Company, of Prague. There are two static transformers supplying one rotary; the former are of the three-phase core type, the rated output of each being 75 kw. At present they are air cooled, but arrangements are being made for them to be oil cooled. With the secondary windings on a non-inductive load, the rated efficiency, after a full-load run of 6 hours, is as follows;

Full load, 97 per centt.
Three-quarter load, 96.8 per cent.
Half load, 96 per cent.

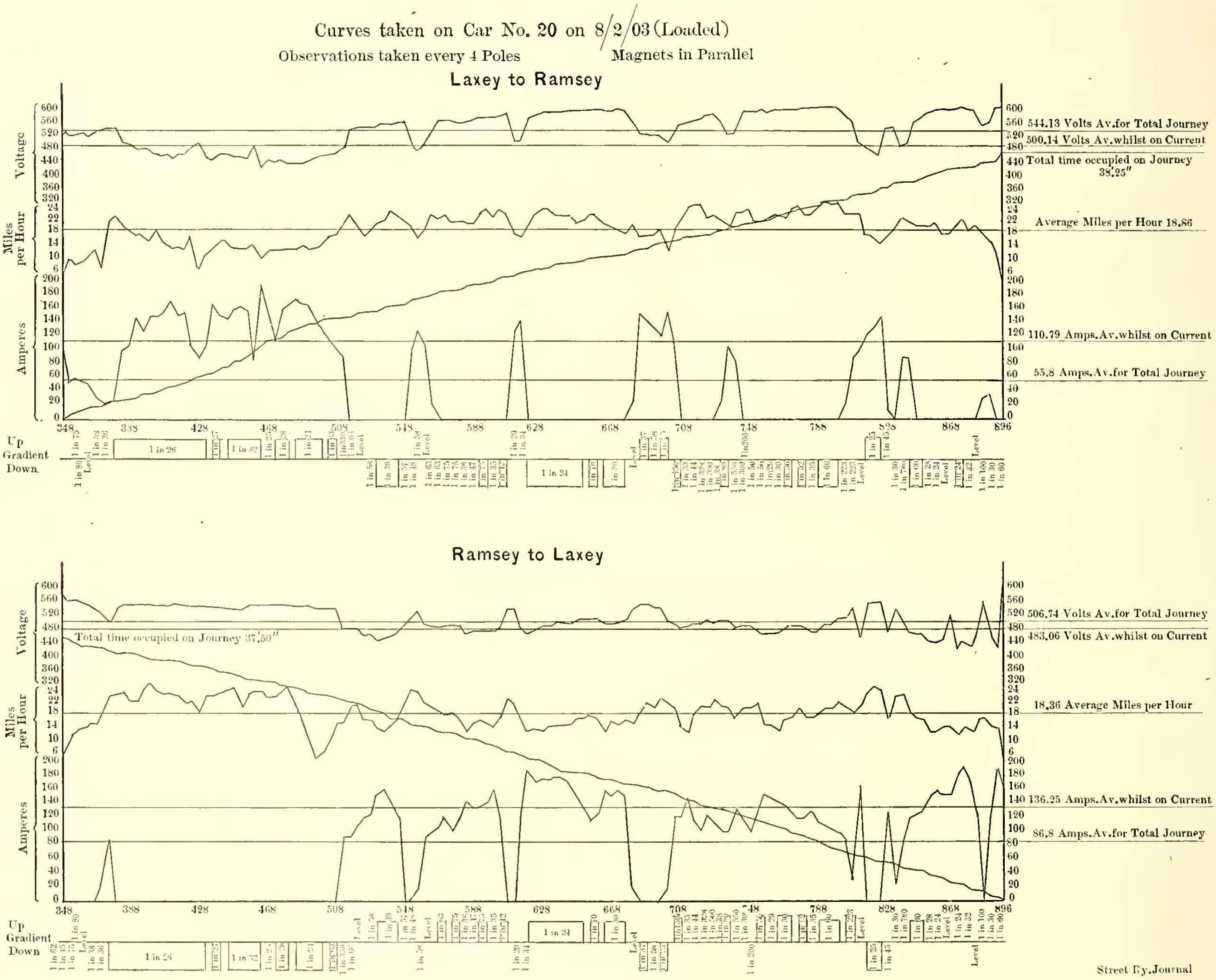


FIG. 23.—RECORD OF TEST RUN

The rotary is of the three-phase, six-pole type, and runs at a speed of 500 r. p. m. Fig. 7 gives overall dimensions. The guaranteed efficiency after a 6-hour run at full load is:

	Power factor 1 Per cent	Power factor 0.9 Per cent
Full load	94	94
Three-quarter load	92½	92
Half load	89½	89

The rotary can be operated either as a shunt machine or as a compound machine. In the former case hand regulation of the fields is employed in conjunction with the reactance coils which have been provided.

This rotary is precisely similar in every respect to the others distributed among the various other stations along the line. The machines are designed to be started up from the continuous-current side, the necessary current being obtained from the battery sub-station at Groudle.

The field magnet rings are of cast-iron with steel pole pieces bolted to the yoke ring, thus enabling a pole piece with its windings to be removed without disturbing the yoke ring. Damping coils are provided to prevent hunting. The armatures are drum wound, built upon a rigid cast-iron spider keyed to the shaft. Figs. 8 and 9 give different views of the two machines installed at Ballaglass station.

The addition of the above new plant at Laxey has necessitated the erection of a new switchboard for its proper control and operation. This switchboard is situated above the old low-tension board, and is provided with a gallery and flight of stairs leading down to the floor of the engine room. The gallery is about 8 ft. above the level of the floor.

The board itself consists of panels of white marble. Starting from the left-hand end the order of arrangement is as follows: Rotary converter panel (direct-current side), exciter panel, synchronizing panel, two alternator panels, one transformer panel and four feeder panels, two for Groudle, one for Snaefell and one for Ballaglass.

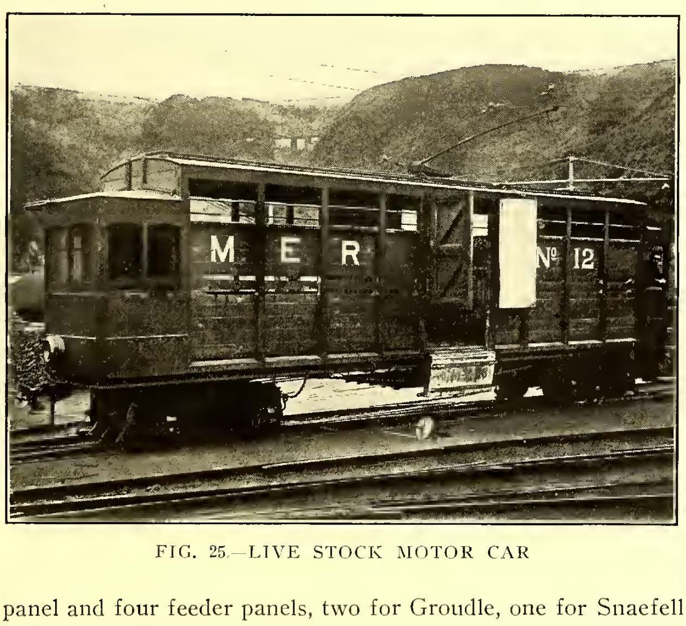


FIG. 25.—LIVE STOCK MOTOR CAR

The switchboard is mounted in a metal frame provided with lugs for making connection to earth.

Each high-tension generator panel contains:

One indicating watt meter.
One ammeter.
One volt meter.
One three-phase watt-hour meter.
One triple-pole, high-tension quick break switch.

The exciting-current panel contains;

One direct-current ammeter.
One switch with discharge resistance and pilot lamp.
One field regulating resistance.
One change-over switch, to enable either of the two exciters to be used for either or both alternator fields.

The exciter panels are fitted up with ammeter, double-pole switch, double-pole fuse and full regulating resistance. The synchronizing panel contains two voltmeters, one multiway voltmeter switch, and an Everett & Edgecumbe rotary synchronizer. Each of the high-tension feeder panels is provided with an ammeter, a high-tension triple pole quick-break switch and a lightning arrester. The high-tension transformer panel contains an indicating ammeter, and one automatic maximum current oil-circuit breaker.

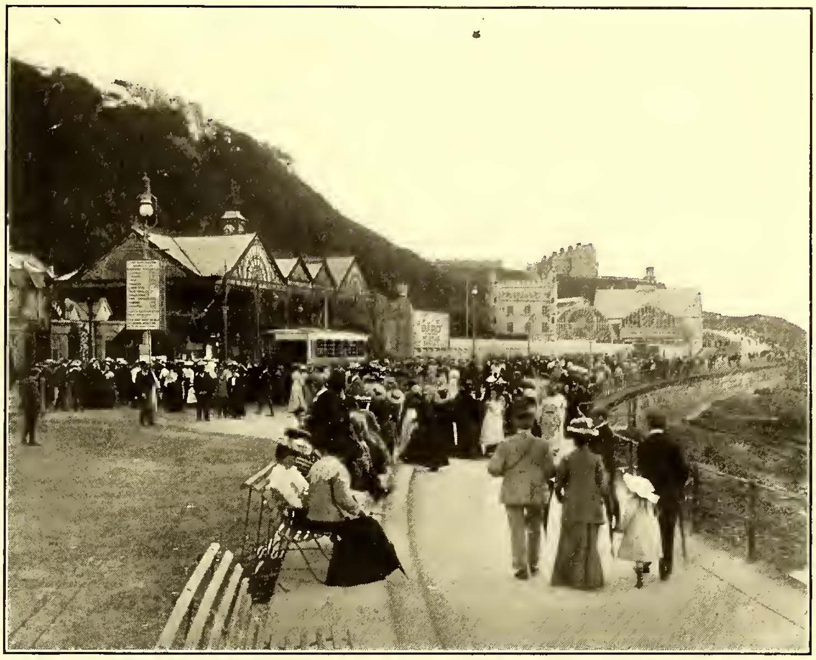


FIG 24.—DERBY CASTLE TERMINUS

On the rotary converter panel (direct-current side) there is mounted:

One I. T. E. laminated type circuit breaker.
One ammeter.
One paralleling voltmeter with zero in center of scale.
Two single-pole, quick break switches, kicking coil and lightning arrester.
One starting rheostat.
One equalizing switch.

For the field circuit there is an ammeter with the zero in the center of scale, a field regulating switch and field resistance. There is also a switch for changing over between shunt and compound running.

Fig. 10 shows diagrammatically the connections of the switchboard in the Laxey generating station. Fig. 11 shows a front view of the board.

The same type of switchboard has been used in the sub-stations as in the main power house. The only practical differences lies in the number of panels used, and, of course, no generator panels are required.

At the Ballaglass sub-station, where there are two rotary converters, two distinct and separate switchboards are employed, one for each machine, situated on opposite sides of the engine room. One of the switchboards is shown in Fig. 12. The two boards are absolutely identical in every respect. Each consists of four panels supported in an iron frame. The panels are arranged in the following order:

Feeder panel.
High-tension transformer panel.
Synchronizing panel.
Rotary converter panel.

Both boards are situated on a level with the floor, and not over the old low board as in the case both at Laxey and Douglas. The switchboard at Groudle, where there are also two rotaries, is not split up as at Ballaglass. The board comprises four feeder panels, two high-tension transformer panels, a synchronizing panel, and two rotary converter panels (direct current).

Diagrams of this and the remaining sub-station switchboards are given in Fig. 13.

Each of the high-tension lines is controlled by a three-pole oil switch, manufactured by the British Thomson-Houston Company. All these, together with the other high-tension apparatus, are situated in a special annex, which has been added to the engine and dynamo room in order to accommodate them. The two transformers and the reactance coils are also situated in the annex. The high and low-tension parts of the boards are absolutely separated, there being no high-tension apparatus or conductors either on the back or front of the operating panels. All the high-tension apparatus is arranged in compartments built into the walls of the annex.

The three-pole oil switches are worked by levers and links from the operating panels, and the voltmeters and ammeters are supplied by step-down transformers at low pressure.

No high-pressure fuses are provided; instead the three-pole switches are fitted with a circuit-breaking attachment worked by means of the low-tension relay mounted upon the corresponding operating panel, and supplied by a small series transformer. The switch can be arranged to open at any predetermined value of current, and is guaranteed to open a circuit at 10,000 volts on the severest short circuit that can take place.

On account of the character of these oil switches, which are also provided for use in connection with the high-tension side of the sub-station transformers, no switch gear has been provided between the secondaries of the transformers and the slip rings, which are thus directly connected. Synchronizing is done on the high-tension side in the usual way, thus saving considerable expense in cable and securing greater freedom from breakdown.

Any panel can be readily isolated, while the remainder of the board and the bus-bars are alive. Suitable section switches at all necessary points are provided for these purposes. An Everett-Edgecumbe rotary synchronizer is supplied in addition to the usual phase lamps. Fig. 14 gives a section through one of the alternator panels.

The switch gear at Douglas, Groudle and Ballaglass is in every way similar to that at Laxey, with the omission of the generator switch gear.

Fig. 15 is a photograph of a portion of the high-tension switch gear in the special annex at Laxey. Owing to the small space available the view obtained is somewhat forcshortened, but it shows the general idea of isolating each of the high-tension three-pole oil switches in separate brick cells.

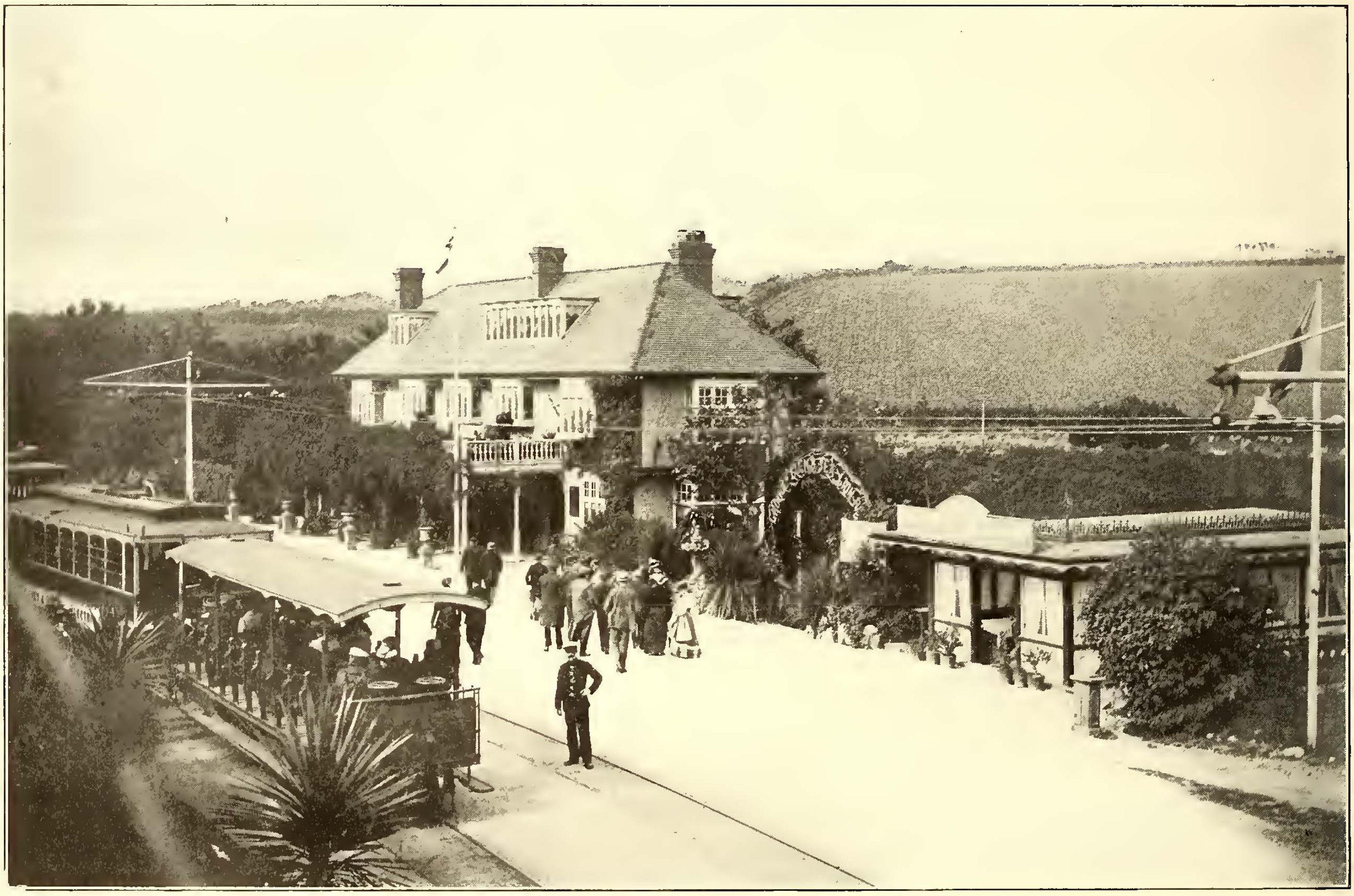


FIG. 27.—GROUDLE GLEN STATION

Fig. 16 gives a typical view of the overhead construction.

Fig. 17 shows the switchboard at Douglas, which, like the one at Laxey, is erected over the old low-tension board, and is reached by a stairway.

The arrangement of the high-tension feeders running from the Laxey power station to the other stations is as follows: There are four sets of feeders running from the central station, one going to Snaefell, a distance of 3 miles; one to Ballaglass, a distance of 5½ miles, and one to Grudle (4 miles), and thence to Douglas, 2 miles further on. The Snaefell and Ballaglass feeders each provide an area of .1086 sq. in. per phase. Between Laxey and Groudle there are two three-core cables, .04 sq. in. section, while the two extending from Groudle to Douglas are .02 sq. in. section.

The high-tension three-phase cables, before being laid, were subjected to test pressures of 20,000 volts alternating between conductors, and 12,000 volts alternating between any conductor and the lead sheathing. The low-tension single cables were required to stand 2000 volts alternating between the conductors and the lead sheathing of earth. The test pressures were applied for a period of 15 minutes, after the cables had been immersed in water for a period of 24 hours. After being laid in the ground the cables were tested with 70 per cent of the above pressures.

PIPING, VALVES, FEED PUMPS AND CONDENSING PLANT

All of the piping, valves, feed pumps and condensing plant were supplied by Babcock & Wilcox. The steam pipes are solid drawn with mild steel flanges. The pipe flanges are constructed of wrought-iron, attached to the pipes by riveting; in the case of the 7-in. and 8-in. diameter pipes the rivets being driven by hydraulic pressure. In the case of the 6-in., 4½-in., 2-in. and 1½-in. diameter pipes the flanges are fixed by fine screwed threads, the end of the pipe being afterwards expanded in. The copper piping is solid-drawn 15 B. W. G. thick, with heavy gunmetal flanges brazed on. The valves are of Glenfield & Kennedy's make, with cast-iron bodies and gunmetal working parts.

The steam pipes are covered with the Mica Boiler Covering Company's "mica" mats, the valves and fittings being covered with "mica" cement. All exposed cast-iron pipes are treated with one coat of Dr. Angus Smith's composition.

The feed pumps, two in number, are of the Weir standard construction, and were supplied by that firm. The cylinders measure 6 ins. and 8 ins., by 15-in. stroke, the pump being designed to deliver 2000 gals. of water per hour against a boiler pressure of 160 lbs. per square inch. Each pump is fitted with a relief valve and counter. The exhaust from these pumps is led through a coil of solid-drawn copper pipe, 2 ins. in diameter and 15 B. W. G. thick, located in the feed tank.

The condensing plant was supplied by Mirrlees & Watson, and consists of a surface condenser, a twin Edwards air pump, and a motor-driven circulating pump. The condenser has a cooling surface of 1800 sq. ft., and is designed to deal with 18,000 lbs. of steam per hour. The tubes are held in place in the brass tube plates by means of screwed ferrules with internal flanges, to prevent creeping. They are ¾ in. outside diameter, and are tinned inside and out.

The air pump cylinder measures 13 ins. diameter and 8-in. stroke, and the normal speed is 150 r. p. m. It is driven by an

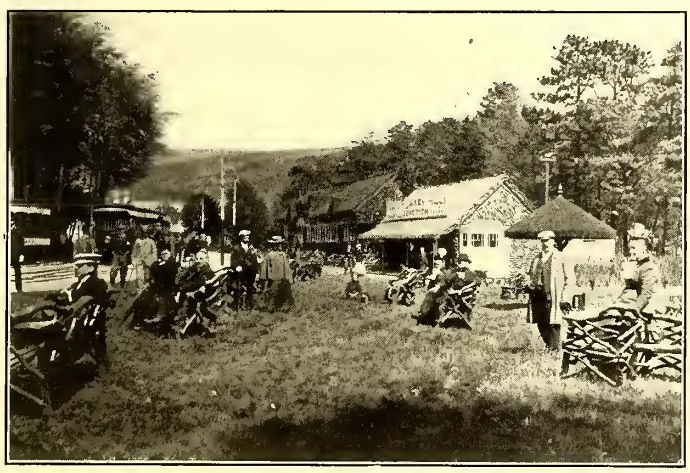


FIG. 28.—LAXEY STATION

inverted vertical cross-compound steam engine, having cylinders 4 ins. and 8½ ins. in diameter. The crank pin end of the connecting rod is made of solid gunmetal, lined with babbitt. The valve plates and valves are of gunmetal throughout, the valves themselves being of the Kingborn type.

The circulating water is handled by a centrifugal pump, and is designed to deal with 19,000 lbs. of steam per hour. The pump casing is of cast-iron, with Delta metal blades. The shaft is of similar material with solid gunmetal glands fitted with self-oiling arrangements. The motor driving this pump is of the semi-enclosed multipolar continuous-current type, designed to operate at an average pressure of 525 volts. The circulating water is taken from the turbine race through a cast-iron grating, and is returned to the race at a lower point after passing through the condenser. Fig. 18 shows the general lay out of the condensing plant.

The discharge from the condenser is 4-in. diameter cast-iron piping, ⅜ in. thick, and is taken to the river. The blow-off piping is 3 ins. diameter. The blow-off trench, cable trench and hot-well discharge trench are all covered with wrought-iron

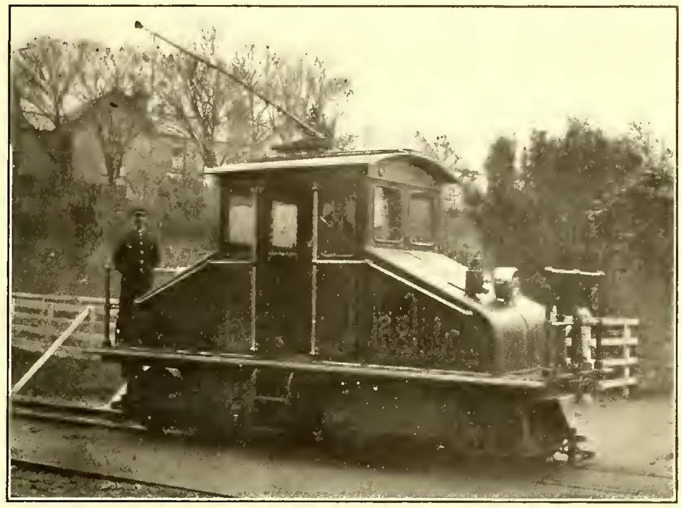


FIG. 26.—LOCOMOTIVE FOR MANX RAILWAY

chequered plating, 5-16 in. thick, with heavy cast-iron curb. These are 5¾-in. Geipel steam traps, with three-way cocks, so that they can be by-passed to the atmosphere when required.

ROLLING STOCK

The new single-deck open trailer cars, manufactured by Milnes & Company, are mounted upon double trucks, and have a seating capacity of forty-four passengers. The chief overall dimensions are:

Length of car over end framing, 28 ft. 6 ins.
Width over pillars, 6 ft.
Width inside pillars, 5 ft. 4 ins.
Width over steps, 6 ft. 9 ins.
Gage, 3 ft.

The side and end sills are of channel steel, 4½ ins. x 2 ins., with intermediate cross sills of pitch pine. The diagonal bracking between end sills and bolster is of oak. The under-frame bolster is of oak, firmly connected to the side sills, and oak blocks are provided to take the top center plates. The under-frame is trussed underneath by 1-in. diameter truss rods.

The floor is of Norway pine, with hard-wood wearing strips fitted between the transverse seats. The pillars are of American white ash, secured to the side sills by wrought-iron knees. The end framing contains two fixed windows on either side, with a sliding light in the center. One oil lamp is fitted at each end of the car, at diagonally opposite corners. There are eleven seats, each holding four, arranged transversely; the backs of the seats are reversible.

Running boards are arranged on either side of the car, with treads and risers of pitch pine, supported from side bars by hangers of angle-steel. These boards are fitted with a strip of non-slipping tread iron.

Fig. 19 shows one of the motor cars. They are painted in red and white colors, and the whole effect is most handsome and attractive.

The existing cars, thirteen in number, have been supplied with new equal wheel bogies by the Brush Electrical Engineering Company. The cars to which they have been fitted are of three types, the principal dimensions of which are given in the table below:

	1893 Type ft. in.	1894 Type ft. in.	1898 Type ft. in.
Overall length of underframe.......	34 9	34 8	35 5
Distance between truck centers......	23 8	23 8	23 8
Width of underframe over sills......	5 8	5 8½	5 4½
Width of underframe between sills..	5 4	5 4½	5 ½
Height of underside of sills from rail	....	....	2 5
Height of underside of floor from rail	....	....	2 8⅛
Radius of quadrants to center......	2 2¼	2 2¼	2 1½
Overall width of car body..........	6 6	....	....
Number of passengers..............	38	38	56

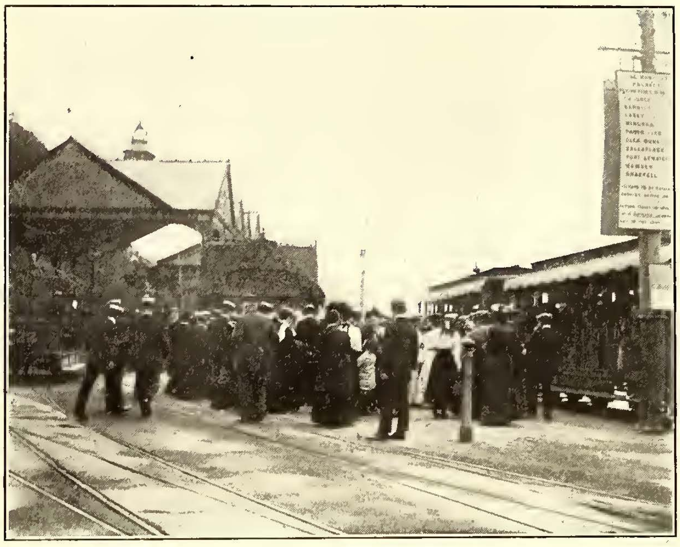


FIG .29.—DERBY CASTLE TERMINUS—DOUGLAS

The trucks are of the non-tilting, equalizing bar, swing-bolster type. The weight is doubly cushioned by two elliptical springs and spiral springs over each side box, and each truck is designed to take two d. c. railway motors, type T 11a, supplied by Witting Bros., manufactured by the Société Electricité et Hydraulique, of Charleroi. The swinging bolster is supported by four links, and rests on four conical coil springs, each having a movement of about 3 ins., so as to ensure a soft riding car body.

The wheels are of chilled iron, 30 ins. in diameter. The axles are of open-hearth steel, 3¾ ins. in diameter, and are required to be capable of being bent double, when cold, without flaw or fracture, and to resist a tensile stress of 65,000 lbs., with an elongation of 25 per cent on 8 ins.

The wheel seats on the axles are rough turned and white leaded before forcing the wheels on.

The motor cars have been fitted with Christensen air brakes, supplied by R. W. Blackwell & Company, Ltd. None of the trailer cars have as yet been fitted with air brakes, but the railway company has this matter under consideration. The existing arrangements, however, provide for the immediate and automatic setting of the trailer brakes, in the event of the coupling breaking. The same result would, of course, be obtained with air brakes on the trailer.

POWER MOTORS

The car motors, which have been supplied by Witting & Eborall, and are capable of exerting a minimum tractive effort of 520 lbs. at a speed of 15 m. p. h., and a minimum of 780 lbs. at 13 m. p. h., with wheels 30 ins. in diameter. They open from below. Figs. 20 and 21 show drawings of these motors.

The field coils are wound on formers, arranged so as to be readily removable and properly insulated with asbestos and rendered fireproof, and covered with varnished cloth and tape. Any coils likely to be subjected to the action of oil from the bearing are encased with lead. All connections taken through the motor case are brought through holes rendered watertight by means of rubber bushings. The armature is of the slotted drum type.

The controllers are of the ordinary standard series parallel type, with magnetic blow-outs and reversing and emergency stop connections. The reversing cylinder has five positions. The last position on either side is for the emergency brake, the motors being short circuited through a resistance and connected as generators.

The whole electric installation was designed by and carried out under the supervision of Messrs. Kincaid, Waller, Manville & Dawson.

The curves (Figs. 22 and 23), which accompany this article, show the power consumption on various portions of the line. During the year 1903 the aggregate number of passengers carried was 542,000, of which 230,000, or 42½ per cent, were conveyed during the month of August. Thirty thousand people made the journey to the top of Snaefell. Fig. 24 shows a crowd of holiday makers waiting to get on the cars at the Derby Castle terminus, Douglas, and gives a very good optical demonstration of the popularity of the line.

Fig. 25 gives an excellent view of the motor cattle truck, mentioned earlier in this description, and Fig. 26 shows (unfortunately, somewhat indistinctly) the electric locomotive which is used for hauling ballast cars and similar work. This locomotive was entirely constructed under W. Edmondson, the company's engineer, by the engineering staff in the workshops of the company. As all classes of merchandise and live stock are conveyed throughout the year, the locomotive and the cattle truck are kept pretty busy.

The time available was very short, for it was absolutely imperative that the work of reconstruction should in no way interfere with the running of the cars during the summer season. One of the conditions imposed upon the tenderers for the work was that sufficient progress should be made to enable the new units to be used for operating the summer traffic. In view of the amount of work to be done, the difficulties of transporting the machinery over hilly roads, and the very few appliances available in such an out of the way corner of the Kingdom, this condition was not easy of fulfilment, and the way in which the work was carried through reflects great credit upon all concerned. Tenders were invited at the beginning of February of last year, and within fourteen days from that time the contracts had been awarded. The generating units at Laxey commenced running on July 1, though the sub-station rotaries were not in running order till about three weeks later, owing to unavidable delays. Taking all the circumstances into consideration, we think that this very nearly constitutes a record for the rapid execution of the work.

FIG. 30.—DERBY CASTLE TERMINUS—DOUGLAS

Figs. 27, 28 and 16 show respectively the stations, booking offices, waiting rooms, etc., at Groudle, Laxey and Dhoon Glen. Figs. 29 and 30 give two views of the terminus at Douglas.

THE TRAMWAY SYSTEM OF BATH, ENGLAND

The ancient city of Bath, in Somerset, whose popularity as a health and residential resort is due to its far-famed medicinal waters and its baths, and also to the natural beauty of its surroundings, has just added a system of electric tramways to its other attractions. The population of the town is about 50,000.

The central portion of the city lies low, and the immediate outskirts are situated on rising ground, trending toward the surrounding hills. Walking is, therefore, a very tedious matter, and the electric cars now running have already proved a great boon. The new Bath system extends to within about 4 miles of the Bristol system, so that the interconnection of the two in the near future is quite probable.

The Bath Electric Tramways, Ltd., originated the project, and Geo. Hopkins & Son, of London, W. C.; Harper Bros. & Company, of London, E. C., and R. D. McCarter, of London, acted as engineers. The main contract for the tramways was awarded to Charles Chadwell, of London, S. W., and the track, together with the overhead equipment and the feeder cables, were laid and fitted by him. The British Westinghouse Electric & Manufacturing Company received the contracts for the erection and equipment of the generating station, a car house for forty cars, office buildings and the electrical equipment of the rolling stock.

VIEW IN BATH, SHOWING TYPE OF CARS AND POLES USED

LINES

The length of the lines now in operation comprises nearly 16 miles of standard gage single track, the total length of the routes being 12⅛ miles. The system consists of four routes, radiating from Southgate Street in the center of the city, two of them with short spurs, and one with an elongated loop. The extra mile authorized will go to form two loops in the city itself. The two longer of the four routes traverse the northern and southern districts respectively. The former runs due north to the church by Walcot Cemetery (this church forming the upper end of the loop referred to), and then follows the London Road northeast to Bathford. The southern line runs along Wells Road, and terminates opposite the Convalescent Home at Combe Down. The two other routes go to Weston and Tiverton, a short branch from the latter traversing the Oldfield Park district.

POWER STATION

The power plant is located on the River Avon, from which a good supply of water is obtained for feed and condensing purposes. Being very irregular in shape, much care was necessary to utilize the site to the best advantage. Much of it is made ground, in consequence of which the engine foundations had to be carried down nearly 30 ft., while the old river wall was found to be insecure and had to be rebuilt. The buildings consist of a boiler house, engine house and car house. The boiler house is 93 ft. long and 49 ft. wide, the engine and generator house being the same length, but 2 ft. wider. The car house is about 130 ft. long and 82 ft. wide. Over the street end of the car house are rooms for offices, etc., while at the rear end is a large basement, used as a repair shop. Eight tracks run the full length of the shed, an inspection and repair pit, 30 ft. long, being built in each track. The walls of the building are of brick. The engine room walls inside are of glazed brick to a height of 10 ft., and the roof trusses and the purlins for slating are entirely of steel. The engine foundations extend some 25 ft. to 30 ft. below the floor of the engine room, the floor being of concrete, finished with cement.

The steam plant comprises three Babcock & Wilcox tubular boilers, with a total heating surface of 9420 sq. ft., and each boiler is normally capable of evaporating 11,000 lbs. of water per hour, with a maximum of 13,000 lbs. per hour, the working steam pressure being 160 lbs. per square inch. Each boiler is fitted with a superheater having 339 sq. ft. of heating surface, sufficient to allow the steam produced by the boiler to receive a superheat of from 100 degs. to 120 degs. F. The economizer is of the Claycross type.

The feed water can be taken either from the River Avon or from the town mains. There are two feed pumps, one steam and one electrically driven. The former was built by J. P. Hall & Son, and is of the vertical slow-speed type. The latter is a Blake & Knowles three-throw pump, and is driven by a direct-current motor. The Hall pump is capable of delivering from 30 gals. to 45 gals. of water per minute, with a steam pressure of 150 lbs. per square inch and 100 degs. F. superheat against the boiler-working pressure of 160 lbs. The Blake &

Knowles pump has cylinders 5 ins. in diameter with 6-in. stroke, and can drive 2700 gals. of water per hour against the boiler

CARS PASSING THE BATH CITY MARKETS

pressure when running at 40 r. p. m. There are also two Blake & Knowles make-up pumps, each having a capacity of 300 gals. per hour.

The two Wheeler surface condensers have a combined cooling surface of 2820 sq. ft., and are capable of dealing with 28,000 lbs. of exhaust steam per hour, at normal load, and 35,000 lbs. for 1 hour as a maximum.

A Holly steam loop and gravity system is installed for taking care of the high-pressure drains. The water softener and purifier were furnished by Masson, Scott & Company. The former has a capacity of 300 gals. of water per hour, and the purifier a capacity of 1250 gals. per hour.

The main steam piping is 12 ins. in diameter, and the branches 6 ins., with 3-in. pipes to the pumps. The system is fitted with Hopkinson valves, and was supplied and fixed by the Sir Hiram Maxim Electrical & Engineering Company. The Holden & Brooke grease extractor is capable of dealing with 1500 gals. of condensed water per hour, and is fitted in the main exhaust pipe. The latter then passes on to the surface condensers.

Coal is conveyed from the railway trucks to the storage bins by "screw" conveyors, made by the Conveyor & Elevator Company, of Accrington. The bins have a capacity of 50 tons. A spiral coal conveyor brings the coal from the storage to the front of each boiler fire grate.

A Stothert & Pitt 15-ton electric crane, with a 50-ft. span, traverses the entire length of the engine room. The longitudinal travel is 175 ft. per minute, the cross-traverse 100 ft. per minute, and the hoist 6½ ft. per minute with full load, the total lift being 26 ft. The traveling, hoisting and traversing motors are 10 hp, 8 hp and 5 hp respectively.

The three Yates & Thom horizontal, tandem, single-crank, compound condensing engines have cylinders 15 ins. x 30 ins. in diameter and 36-in. stroke, and Corliss valves. They are of 320 hp each, and are capable of driving the 200-kw generators continuously at full load with 160 lbs. of steam, at 25 per cent overload for half an hour, and at 50 per cent overload momentarily. The engines give this output under both condensing and non-condensing conditions. Under condensing conditions and with the steam at 100 degs. F. superheat, the steam consumption at full, three-quarters and half-load does not exceed 15¼ lbs., 15¾ lbs. and 17 lbs. per hp-hour respectively.

The three 200-kw direct-current traction generators develop 500 volts to 550 volts. The armatures, which are pressed on to the engine shafts, are of the slotted drum type, with two circuit windings so arranged that the circuit will not become unbalanced by a displacement of 1-16 in. from the geometric center of the fields. The windings are arranged to give 500 volts at no load, and to over-compound to 550 volts, with a full load of 365 amps. The generators are capable of standing an overload of 25 per cent for half an hour, and one of 50 per cent for short periods. The 75-kw lighting and auxiliary traction set comprises a Westinghouse high-speed vertical, enclosed, two-cylinder, single-acting, compound engine, and a Westinghouse direct-

CAR HOUSE OF BATH TRAMWAYS

current railway generator. The high and low-pressure cylinders of the engine are 11 ins. and 19 ins. in diameter, respectively, and the stroke 11 ins. The generator has four poles, and gives about 150 amps. at from 500 volts to 550 volts, the set running at 300 r. p. m. The armature of the generator is pressed direct on to the extended crank shaft of the engine. The machine is compounded so as to give 550 volts with a full load of 136 amps. The machine will also carry a 25 per cent overload for half an hour, and a 50 per cent overload for a few minutes.

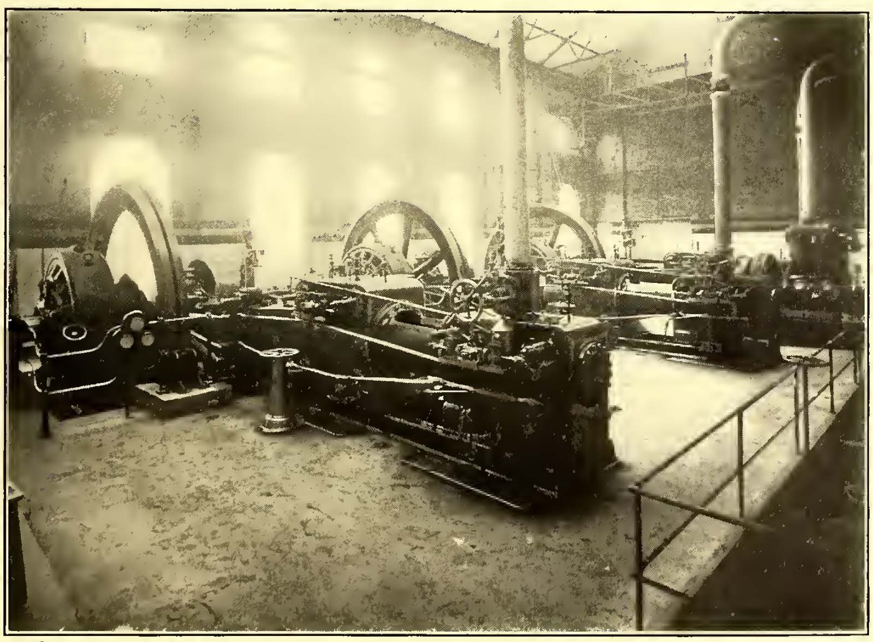
The two 15-kw boosters are four-pole machines, running at 575 r. p. m., the motor volts being 500 and the booster volts 50.

The main switchboard has thirteen white marble panels, 2 ins. thick, and is set in an angle-iron frame.

Some 900 ft. of double track are laid on 8-in. x 4-in. longitudinal sleepers in front of the hospital in Lower Boro Walls. The rails are cross-bonded about every 100 ft., the bonds being "Crown" 0000 B. & S. gage, with ⅞-in. nipples. These were supplied by the American Steel & Wire Company. The points are 8 ft. 6 ins. and 12 ft. long, and are chiefly of Hadfield's manganese steel, but some were supplied by the Lorain Steel Company. The crossings were supplied by, and the special track work done, partly by Hadfields and partly by the Lorain Steel Company. Wood paving is laid between the tracks in the center of the city, and granite sets and macadam with granite paving on the outlying portions.

OVERHEAD CONSTRUCTION

The overhead line is supported mostly on brackets (varying from 6 ft. to 22 ft. in length) on side poles; but in some parts of the city span wires with supporting rosettes are stretched from the fronts of the houses. The poles are in three pieces.



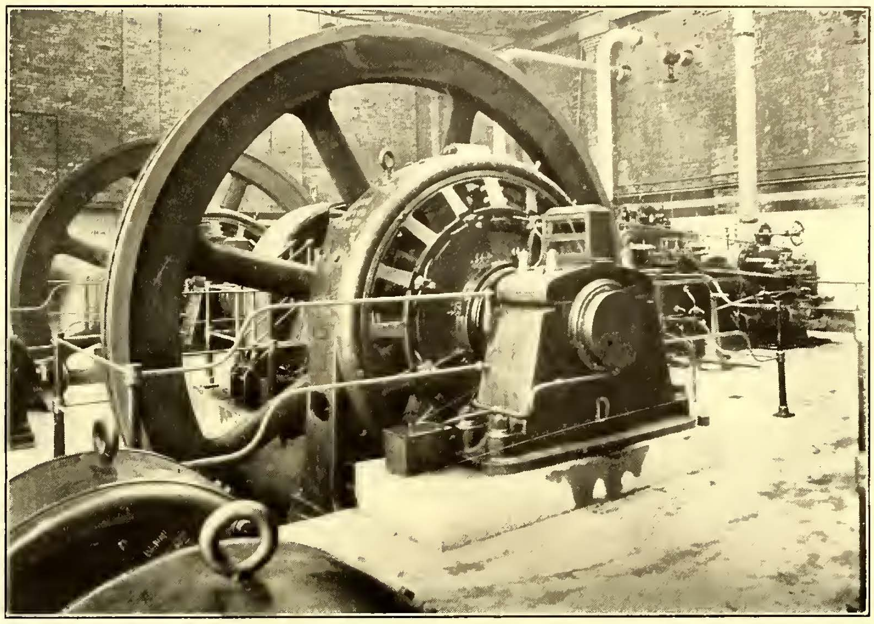
INTERIOR OF ENGINE ROOM OF BATH TRAMWAYS

The panels are divided as follows:

One each for the three large traction generators, one for the lighting set, one station-load panel, one Board of Trade panel, one each for the two booster sets, one for the station lighting panel, one for the yard and car house lighting, two for positive feeders, one for the negative main,

TRACK AND FEEDER CABLES

The thickness of the concrete bedding for the track is 6 ins. The rails are in 45-ft. lengths, and weigh 95 lbs. per yard, the width and depth of the groove being 1⅛ ins. and 1 in., respectively.



DIRECT-CONNECTED GENERATING SET, 200-KW CAPACITY

The fish-plates are 24 ins. long, and weigh 44 lbs. per pair, and the cup oval bolts measure 3½ ins. x 1 in., and stand 24 ft. high over all. There is no center-pole construction. The trolley wire is of hard-drawn copper 00 B. & S. gage. The guard wires are of galvanized steel in strands, and are earthed through the poles, every third one of which (in the guard-wire sections) is bonded to the rails.

The distributing system comprises some 7¾ miles of paper-insulated and lead-covered cables, furnished by the British Insulated & Helsby Cables, Ltd. There are 810 ft. of .2-sq. in., 141 ft. .25-sq. in. and 20,100 ft. of .3-sq. in. section. The return cables have a section of .6 sq. in., and comprise a length of 1 mile.

ROLLING STOCK

Of the thirty cars now running twenty-six are double-deckers and four single-deck combination cars. There is also one watering car. The double-deckers are 27 ft. long over collision fenders, and the single-deckers 28 ft. The trucks are of Milnes S. B. 60, four-wheel type, the wheel base being 6 ft. The wheels and axles were supplied by the British Griffin Company. The trolleys have swivel heads with graphite brushes. Each car is fitted with two 49-B 30-hp motors, No. 90 controllers and magnetic brakes, in addition to hand brakes.

In the rooms of the Rapid Transit Commission in New York there is on exhibition an elaborate model of a New York underground railroad station, brilliant with small electric bulbs. Looking through this the spectator will get a view back into a section of tunnel, equipped with tracks, signal appliances and lights, and with tiny electric trains at intervals. They will be exhibited at the St. Louis Exposition. In a big show case are various minerals and curios found below the surface of the city of New York by the subway builders, including cannon balls dug up in Elm Street, ancient coins found all along the line, and even a human skeleton.

THE FUSED STEEL-TIRED WHEEL

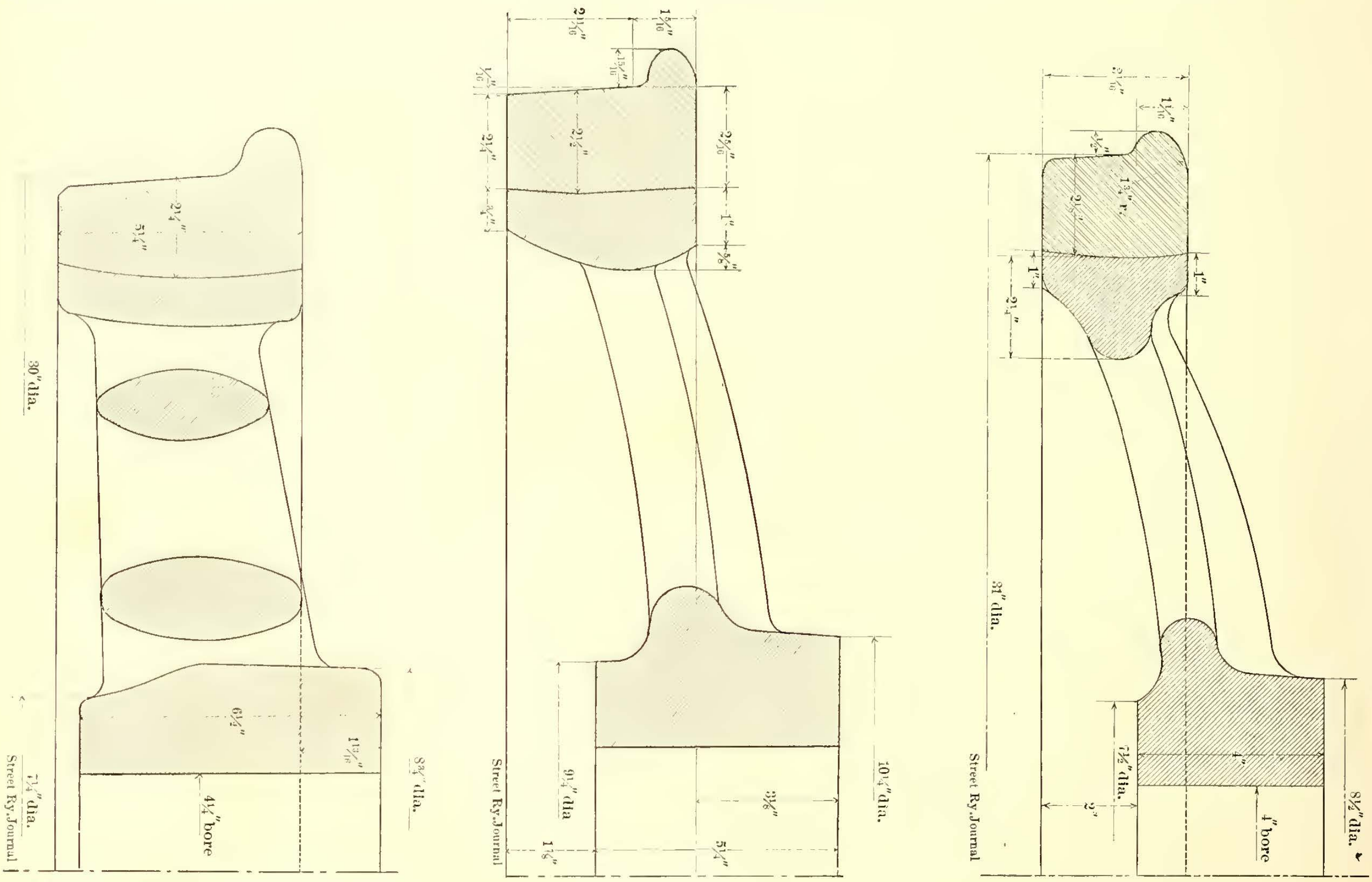
BY KNOX TAYLOR

The fused steel-tired wheel is typically an American production, and with the extension of high-speed interurban electric railways, is coming into quite general use for this class of service. In its manufacture a steel tire of the open-hearth, hammered, hot-rolled type is selected, such as that made by the Standard or Latrobe Steel Companies, of America, and Krupp, of Essen. The tire is heated to a mild heat, and placed in the wheel mould. Then, under proper conditions, the cast-iron to form the center of the wheel is poured into the mould at a high temperature. The casting forming the center of the wheel can be of either spoke or plate type, as may be preferred. When the center is cast against the tire in the manufacture of fused wheels, experience shows that the union between the cast-iron and the steel is an actual fusion or weld. This can be proved by breaking a wheel through the rim, when the appearance of the fracture will be similar to that shown in Fig. 1.

The fact that an actual fuse takes place can also be proved by taking a wheel and turning it down on a lathe through the point of the union between the cast-iron and the steel. If this is done, the chips which come off the wheel in the lathe will break in the cast-iron, a slight distance from the weld, showing that the weld is stronger than the cast-iron. In fact, in steam railroad service the tires of fused steel-tired engine truck, tender and car wheels have been worn down into the cast-iron so that the thickness of the steel at points in the tire was practically that of a sheet of paper, yet the tire did not loosen. Although this practice is not to be recommended it indicates the closeness and the strength of the union between the two metals.

The fused steel-tired wheel, of course, can only be re-tired by the manufacturer, who remelts the center and pours it into a new tire, and for this purpose the old wheel has only scrap value. On the other hand, the fused steel-tired wheel has certain advantages over the built-up steel-tired wheel, that is, a wheel fitted with a tire which is held to the center by some mechanical fastening, such as bolts, retaining rings, etc. The tire in the fused wheel is integral with the center, and there is no costly machine fitting of tire rings and bolts. A saving is thus effected in the manufacture of the wheel, and later, as well, in the equipment and labor necessary for repairs. The fused wheel is, therefore, stronger as the tire has added to its own strength the strength of the cast-iron which is underneath and a part of it. A tire held on in this manner cannot move around circumferentially or slip off, or expand away from the center when the tire is heated through brake-shoe action. More of the tire can, therefore, be put into wear than in any other type of steel-tired wheel.

FIG. 1.—FUSED WHEEL BROKEN TO SHOW APPEARANCE OF FRACTURES IN TIRE AND SPOKES



Manhattan Elevated Railway Co., New York — Schenectady Railway — New York City Railway Co.

FIGS. 2, 3 AND 4, SHOWING TYPICAL SECTIONS OF FUSED STEEL-TIRED WHEELS

A steel-tired wheel has a rim which can be made as thick as needed for any reduction in diameter in service that can be gotten conveniently out of a single wheel. It is perfectly feasible, so far as the manufacture of the wheel is concerned, to make it for a reduction in diameter of 4 ins. or more. Hence, the reduction in diameter, the greatest factor in the life of this type of wheel, is limited only by the equipment in which the wheel is mounted, and because of the thicker rims steel-tired wheels are considerably heavier than chilled iron wheels of about the same diameter.

The life of the steel-tired wheel is, roughly speaking, several times greater than that of a chilled iron wheel, depending upon the proper mounting oi the wheels, weight of the load, degree of speed developed, and upon local conditions, such as curvature of the track, and whether the track is clean or gritty, etc.

The fused steel-tired wheels are already extensively used on interurban service with the exposed T-rail track, and there is a tendency also to introduce them in strictly city service. In city service, while the speeds are not as great, the tread and flange are often restricted to comparatively small dimensions, which is as hard on the wheels as high speed. The wheels in city service, before the introduction of electricity, served only to carry and to stop the car, whereas, now, with electricity, the wheels are the medium through which the car is started as well as still carried and stopped. In addition to this new duty loads are heavier and speeds higher. It is not strange, in view of all this, that the possibilities of the iron wheel for many classes of service have passed through a repetition of what took place years ago when the steam roads changed from the chilled-iron wheel to the steel-tired wheel for use in most of their engine, passenger, sleeping and dining-car service.

The fused steel-tired wheel gives many advantages, which may briefly be summed up as follows: It is stronger and more secure, for it is not likely to fly to pieces, no matter how high the speed, heavy the load, rough the track and cold the weather.

It gives almost entire freedom from the spots in ordinary service, for even in severe service the steel is not likely to develop slide flats.

There is freedom from broken flanges in ordinary service, for even in severe service the steel flange is so strong that frequently the wheel is run entirely on the flange, without any damage to it, over tracks that were designed for a lower flange. It will also be found that there is no chipping on the front edge of the tread.

It insures longer life in the rest of the equipment, which is not racked by the jolting of flat wheels.

There is less noise, for with the steel-tired wheel the ringing sound that is heard with the chilled-iron wheel is muffled to such an extent that its absence is at once a noticeable feature of the equipment.

Greater traction is obtained, as the coefficient of friction between steel and steel is greater than between chilled cast-iron and steel. This means less power required to start and stop the car, and makes it possible to have a cleaner rail, as less sand is needed, and, consequently, there is less wear upon the rails, and ultimately less wear upon the wheels. In the city service a big factor in the wear is the dirt upon the rail.

The mileage that can be obtained from steel-tired wheels in interurban or city service is less than that which can be obtained in steam car service, where the wheels are not used as driving wheels, and where the stops are less frequent and the curvature in the tracks less.

The short life of the early steel-tired wheels used on city railroads in America was due largely to the softness of the material of which they were composed and partly to defective design. As regards the former, the standard practice is now to use the best hot-rolled hard steel, and in design it has been found that it is more easy to secure a satisfactory and long-lived flange section in a steel-tired than in a chilled-iron wheel. The reason for this is that with chilled-iron wheels it is necessary, to secure good results in casting, to have a special shape of fillet, whereas the flange of a steel-tired wheel can be turned to conform more closely with the contour of the rail.

Some typical sections of fused steel wheels, as manufactured by the Taylor Iron & Steel Company, of High Bridge, N. J., are shown in Figs. 2, 3 and 4, which represent three different classes of service. The first is the standard trailer wheel of the Manhattan Elevated Railway, which is 30 ins. in diameter and weighs 650 lbs. Fig. 3 illustrates the type of interurban fused steel wheel, as employed by the Schenectady Railway Company, with a weight of 688 lbs., and Fig. 4 is a lighter wheel for city service, in use in New York, weighing 475 lbs. The New York City Railway Company is equipping half of the cars on one of its important electric lines with this wheel, an innovation full of significance.

CAST-WELDED JOINTS

BY ALBERT B. HERRICK

The history of the cast-welded joint cannot be written without at least an allusion to the numerous discouragements and persistent efforts to perfect the joint made by both Falk and Hoffman, but the results of the experiments have been successful, and the joint is now applied to a great number of miles of railway in the United States. Engineers now thoroughly understand, as they did not five years ago, what is necessary in order that the weld formed at the joints of the rail will form a molecular integral connection between the casting and the rail itself. It has been found that the perfection of this weld does not so much depend on the composition of the cast metal, which is usually pig-iron, but in bringing the rail surface to a temperature so that it will amalgamate with the cast-iron surrounding it.

This temperature is attained in several ways. The usual method is to use a sufficient mass of metal around the joint so that the actual thermal units are sufficient to raise the temperature of the rail to the required point. Where a sand mould is used around the joint the sand chills the outside iron, and rapidly reduces the total heat in the cast joint, so the weight of the metal cast around the joint has to be increased until sufficient molten metal has been poured into the joint to effect the amalgamation required.

An expedient to reduce the mass of metal required, devised by Mr. Hoffman, is to put an iron sheath instead of a sand mould around the joint. This sheath, supported by the rail and against the joint, and the space between the sheath and the joint, is poured full of metal. This reduces the conduction of heat units from the mass of molten metal and allows an integral weld to be made with less weight of metal per joint.

Another expedient, devised by the Grand Rapids Railway Company, is to allow the metal to overflow the mould on the other side from the pouring side. In this way the temperature of the joint can be brought up to the required degree with a small mass of metal. The overflow is afterwards broken off and remelted again for other joints. This weld is made an inch or so below the head of the rail, a method which has the advantage of not bringing the head of the rail in such close contact with the molten metal and thus run the risk of annealing it.

The application of Dr. Goldschmidt's method of welding and producing what is known as the thermit joint has been successfully applied in Germany to the welding of rails, and it is to be hoped that we shall soon see applications of it in America. In this joint the mass of metal required is very much smaller, and the apparatus to produce the joint is not as cumbersome, nor does it seem that the opening of the pavement has to be as extensive as in the case of the cast weld.

It has been often assumed that all rails could be cast-welded, and this erroneous impression has caused a number of failures. Some rails have a composition which will anneal at the temperature attained with the welded joint and others will not. It seems to be a fact that those rails which are high in manganese and low in phosphorous are self-hardening, that is, they will harden again on cooling, but that a low-carbon rail will anneal under the heat of cast welding. This will cause a soft joint, which will soon be pounded to a flat joint by the passing over it of the wheels. For this reason, before deciding to lay cast-welded joints, it is desirable first to test the rail for its self-hardening qualities to determine whether it is of proper composition.

The cast-weld has been generally admitted, since 1898, to form an electrical connection between the rail ends, which, as a rule, is lower in resistance than an equal length of rail, provided the weight of the metal around the joint is two and one-quarter times that of the weight of rail per yard. But it should be remembered that the resistance will increase toward the end of a pour if the temperature of the metal is not maintained. Cast-welding the rail-joints of a track will not insure the permanency of its alignment, unless the rails are held in the pavement and concrete, so that no longitudinal motion of the rails can take place. In laying roadbed designed for cast-welding, therefore, it is essential that the grouting and concrete against the rail be satisfactorily applied, and well tamped immediately under the foot and around the web of the rail. It has also been found that in mixing this concrete a cement, high in lime, will produce a greater coherence between concrete and rail than ordinary cement will give. Experience has also shown that the best results in cast-welding have been obtained when the pavement has been laid complete except at the joints before welding, and then completed after welding. If the joints are cast on open track and the paving then laid, the difference in temperature between morning, noon and night is sufficient to warp the track, so that it is difficult, if not impossible, then to align it without cutting the rails.

Welding up special work, and welding the main track with the special work, are directions along which developments should be made in order that the electrical and mechanical continuity of the rail shall be insured.

Jumpers are often used to bond cast-welded track, but, as a rule, they are not put in with sufficient capacity. I have often found that the drop across special work was equivalent to 3000 ft. or 4000 ft. of adjacent welded track.

Breakage is largely a question of sub-ballast and pavement condition. It is largest in asphalt pavement and lowest with granite paving or toothing block set in concrete. In about 40 miles of the former class of pavement I have found 0.8 per cent breakages. I believe that the reason for breakages in asphalt is that the dark surface of the asphalt absorbs heat readily, which, in turn, is transmitted to the rail. The stress under which this rail is subjected on this type of pavement is also much larger than with the less absorbent granite block or brick. Wood pavement is hardly a pavement in which a cast-weld can be successfully applied, as there is no foundation to which to secure the rail to prevent longitudinal expansion, due to temperature changes. I have found that the number of broken cast-welded rail-joints averages about 2 per cent of the total. The points at which the welds are found most liable to break are at the end of tangents and at top of the grades. It may seem surprising, though, that I have found 8 miles of exposed track, laid with 40-lb. rail on ties, cast-welded with slip joints about every 1000 ft., where the breakage has not been over 4 per cent. This track has now been down three years.

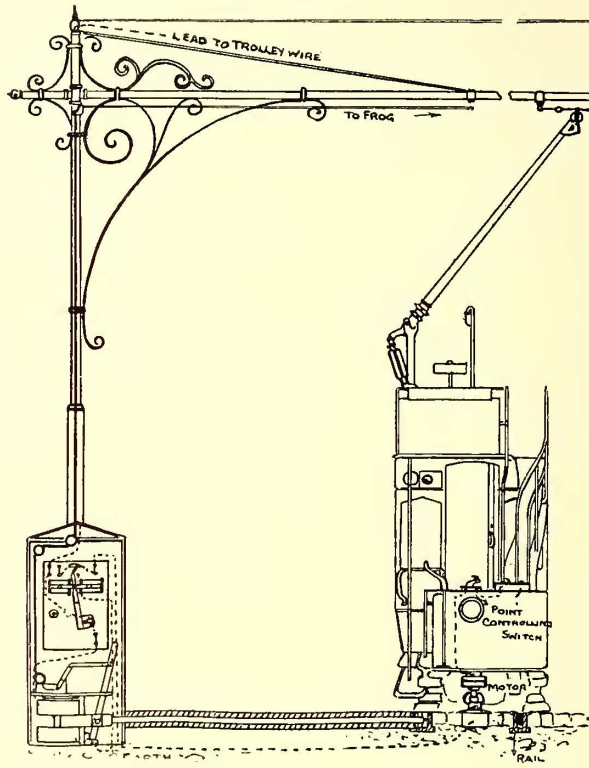
For the purpose of prolonging the life of a light rail in a paved street, cast-welding is certainly an electrical improvement, but to weld the joints for the purpose of improving the wearing qualities of the track is of doubtful mechanical and commercial value.

The Metropolitan West Side Elevated Railway Company, of Chicago, of which E. T. Munger is master mechanic, has adopted the plan of giving a bonus each month to the shop foreman who makes the best record during the previous month. In awarding this bonus, the amount of oil and various other supplies, and freedom from accidents to equipment due to neglect, are all taken into account. The competition between foremen to make the best record naturally results in considerable improvement, as the desire to make the best record is an even greater incentive than the bonus.

AUTOMATIC RAILWAY SWITCH

An automatic device for mechanically connecting and electrically operating the switches of electric railways on the overhead system is being manufactured by S. Dixon & Son, Ltd., of Leeds, England. The working parts of this apparatus are very simple and not at all liable to get out of order, being enclosed in a strong iron box of about the same dimensions as the ordinary street feeder box. This device has been in service on the Leeds City Tramways for over eighteen months, and is reported to be giving very satisfactory results.

The car is fitted up as follows: Two suitable water-tight controlling switches are fixed so as to be accessible easily to the motorman, one being placed at each end of the car, and a lead wire is taken from the main car circuit to one of the terminals of each switch. From the other terminals the circuit



DETAILS OF AUTOMATIC RAILWAY SWITCH

is continued through suitable fuses to one common permanent resistance, and then to a phosphor bronze slipper, or skate, suspended between the two motors in the center of the truck. This slipper is made adjustable from the inside of the car, and is raised normally 1½ ins. above the rail tread, and clears the crown of the paved track by ¾ in.

The iron street box used contains a powerful solenoid wound to suit the line voltage, having a core of suitable size and stroke to pull over both the track switch point and that of the overhead wire. The core is connected to the switch tongue by a suitable rod pivoted to it, and also to a lever projecting upward, so that when desirable, the points may be thrown over by hand. A suitable chain connected to this lever is carried to the overhead point, and adjusted so that the necessary movement is obtained at each, when the lever is thrown over either by hand or by the magnet.

The working of this magnet is controlled by an electrically-operated switch mounted in the same street box. The switch consists of two solenoids mounted with their axes in line, and having an iron core inserted in the central hole, which is slightly shorter than this hole, and is, therefore, sucked into one or the other according as the current energizes. To the center of this core, and mid-way between the two magnets, is pivoted a lever, forming the moving portion of the switch, and having insulated contacts upon it, so that when the iron core is attracted into one of the solenoids the switch is closed, and when attracted into the other the switch opens. The closing of this switch completes a circuit from the overhead line, through the large magnet to the rails, causing the core to be attracted and the track switch and overhead points pulled over. On the switch being opened, the core is released and the points resume their original positions by the tension of a powerful spring.

The current for working the solenoids of this switch is derived from the line as follows: At a position about 30 ft. short of the switching point an iron contact-plate, embedded in a granite insulating box, is fixed in the center of the track. The surface of this contact plate projects about ¾ in. above the road level, and is tapered off on all sides, so as to offer no obstruction to wagon traffic. This contact-plate is connected electrically to the "closing solenoid" of the main switch, above described, while from a similar plate, fixed some short distance past the points on the branch line, another wire is brought to the "opening" solenoid of the switch, thus cutting the current off and allowing the points to resume their normal position.

If the motorman desires to pass the junction without leaving the main line, he simply keeps his car switch on the "off" position, and the points above and below remain unaffected. Should he wish to turn into a branch line he must, on approaching the first contact stud, turn his switch to the "on" position. Current then flows from the line down the trolley, through the motorman's switch, safety fuse, permanent resistance to the slipper, through the iron contact-plate to the "closing" solenoid of the main switch, thus closing this switch, and the large magnet becoming energized pulls over the track and overhead switches.

The car having passed the switches comes to the second contact-plate placed on the branch track. As the motorman's switch is still closed, a similar current flows through this plate to the "opening" solenoid, cutting the current off the large magnet, thus allowing the switches to resume their normal position. Provision is also made for mechanically releasing the main switch referred to from the outside of the street box by inserting a specially constructed key, which displaces the pivoted lever of the switch when it has been operated by a main route car.

Should a main route motorman inadvertently operate the points, he can, upon discovering his mistake, immediately put his car-point switch to the "off" position, reverse the motor controller, and back out; then the conductor can release, by the key referred to, the main switch in the street box, which will, of course, release the points.

VERTICAL MOTOR-GENERATOR SETS

A short time ago the Lend-Gastein (Austria) branch of the Neuhausen Aluminum Industrie Gesellschaft was equipped completely with electrical apparatus furnished by the Oerlikon Company, of Oerlikon, near Zurich, Switzerland. The most interesting feature of this installation is the use of vertical motor-generator sets, of which there are six in all. This type was chosen owing to the satisfactory service given by the vertical generators used in connection with the turbines in this plant. It was found that the vertical arrangement permitted the machinery to be handled with greater ease, and that the carbon and copper dust from the brushes fell directly downward and could not get into the armature windings.

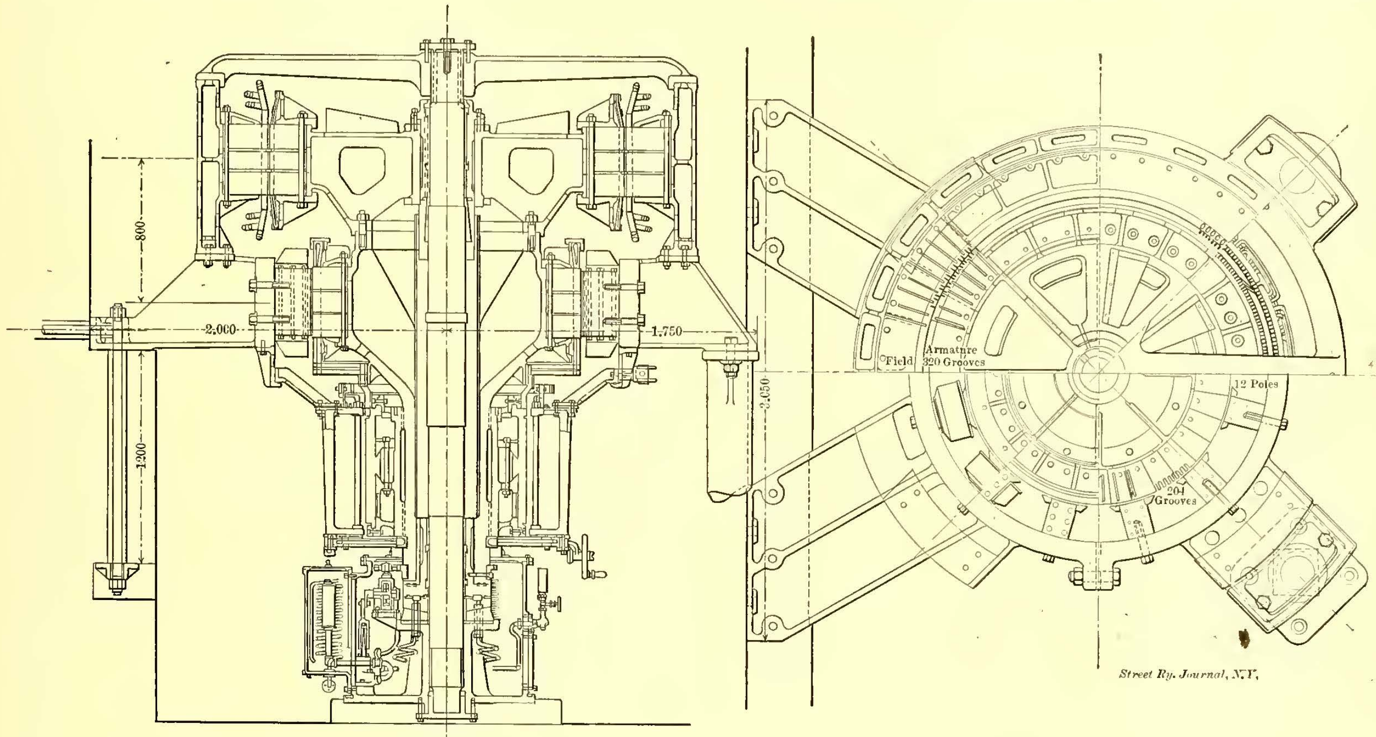


FIG. 1.—DETAILS OF VERTICAL MOTOR GENERATOR SET

The motors of each set are of the synchronous type, built to give 1000 hp at 10,000 volts, 45 cycles, 340 r. p. m. The 160-volt direct-current generators are each of 560-kw capacity.

The generator field is made of cast-iron. The motor armature is placed directly above the field of the generator, and is enclosed by an iron frame, cast in one piece.

The rotors of both machines are screwed to each other and revolve around the stationary shaft, which is lubricated from the oil-cup shown at the top of the shaft, in Fig. 2. The total weight of the rotors is about 14 tons. This weight is taken up by a spur foundation, located beneath the commutator of the generator. The stationary cast-steel spur plate is frustum-shaped, and rests in a cast-iron pan. The shell of the lower foundation, which is built in the commutator, has a flange at its bottom resting on the spur plate. Both the spur plate and flange have a circular groove for taking up the oil after it has been pumped through the machinery, under a pressure of 10 atmospheres. The entire supporting foundation, including the pumping machinery, is built in a cast-iron housing completely filled with oil, so that lubrication is ensured even if the pump fails.

The oil is kept cool by a spiral copper pipe, which conveys cold water through it.

The generators have twelve poles each and are shunt wound. The armature core is cooled by two ventilating slits. It contains 204 open slots for the windings, each slot containing four insulated copper wires. The connection between the armature winding and the commutator is made according to a new system devised by the Oerlikon Company, consisting in the use of copper forks, each of which combines two commutator laminations, separated from each other by twice the polar division, with the corresponding armature winding. The commutator consists of 408 segments of hard-drawn copper, insulated from each other by mica plates. All insulating rings in the interior of the commutator are also of mica. The twelve poles which carry the shunt windings are built of soft sheet-iron, and are

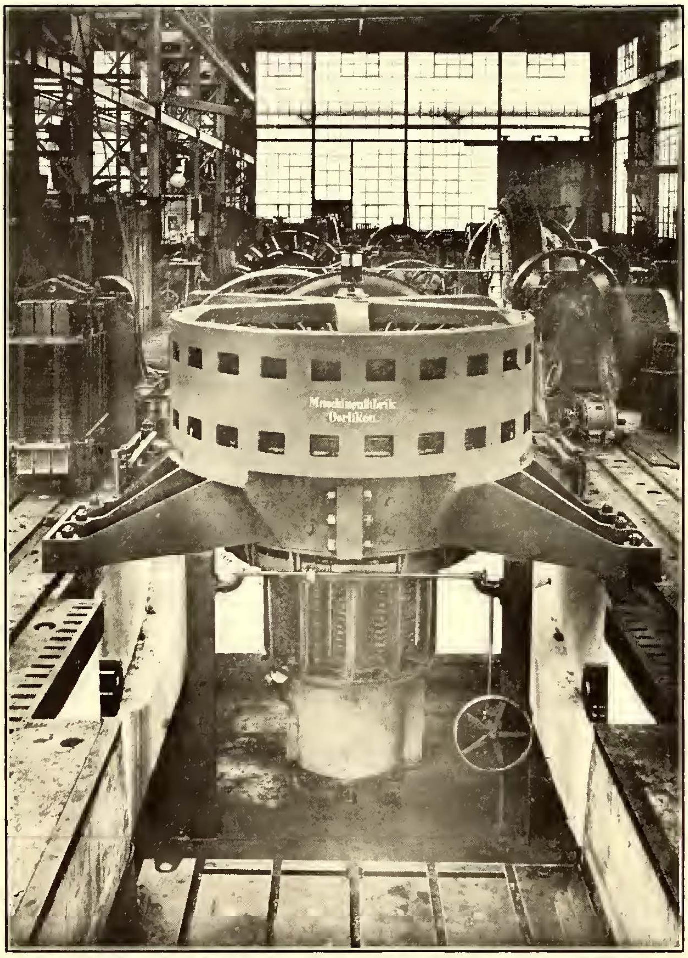


FIG. 2.—VERTICAL MOTOR GENERATOR SET, WITH FRAME

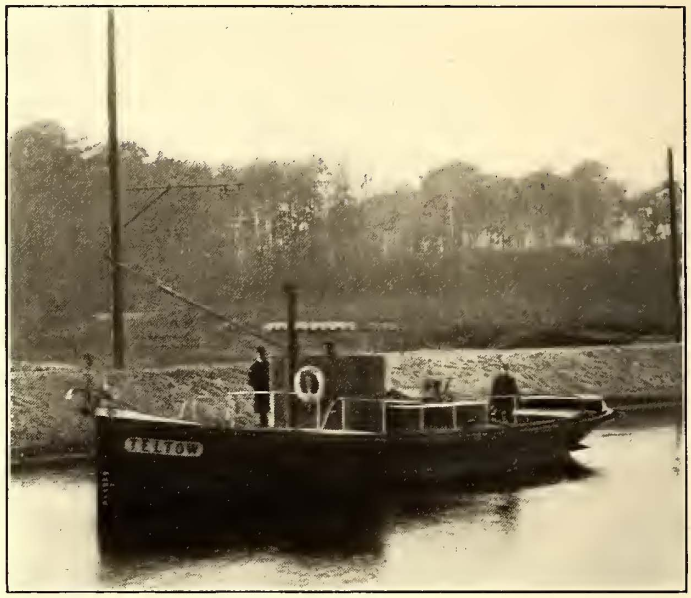
screwed to the field frame. Corresponding to the twelve poles the brush holder has twelve brushes, each of which is furnished with eleven carbon tips. These brushes are arranged so that all of them can be raised simultaneously when it is necessary to clean or true the commutator.

The motor has sixteen poles. The high-tension winding is laid in 192 slots, each containing eighteen series wires, insulated from each other by mica sheets. The rotor of the motor has a short-circuited winding.

ELECTRIC HAULAGE ON THE TELTOW CANAL

Some interesting experiments with electric boats and electric locomotives for hauling canal boats have been carried out recently on the Teltow Canal, Germany, under the joint auspices of the Teltow Canal Building Management and the Siemens-Schuckert Company. The locomotive and boat used for these tests are shown in the accompanying illustrations.

The boat is furnished with a 220-cell accumulator battery, but also has a 40-ft. trolley pole for taking current from one of the overhead wires placed along the canal bank. The second overhead wire is used for the return current. The locomotive is also arranged to send its return current through the second



ELECTRIC TUGBOAT ON THE TELTOW CANAL

overhead wire, as ground return would cause serious disturbances at the nearby Potsdam magnetic observatory.

The locomotive has a framed truss over which the hauling

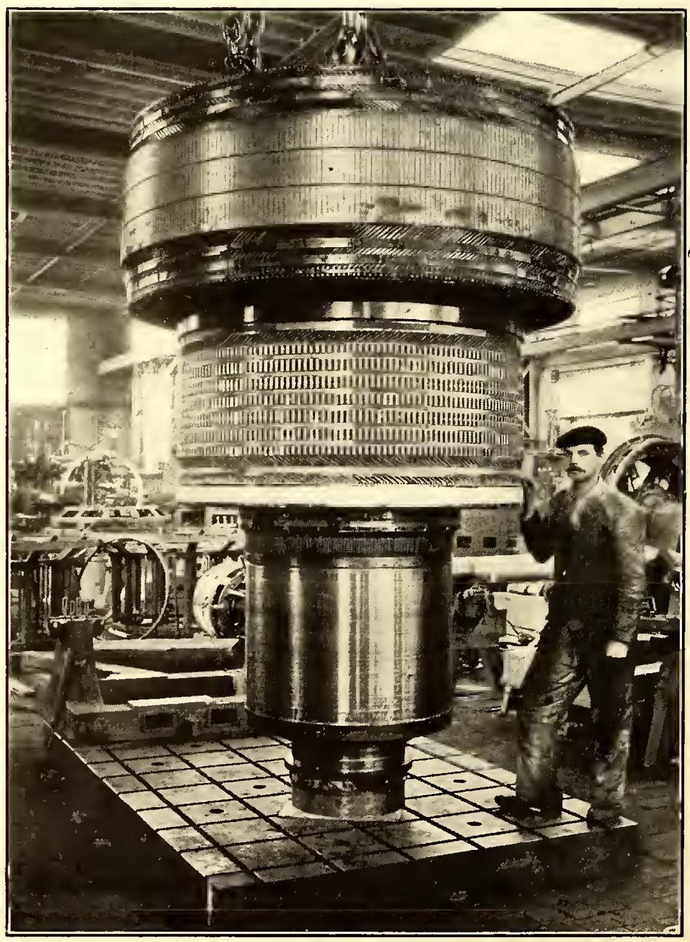


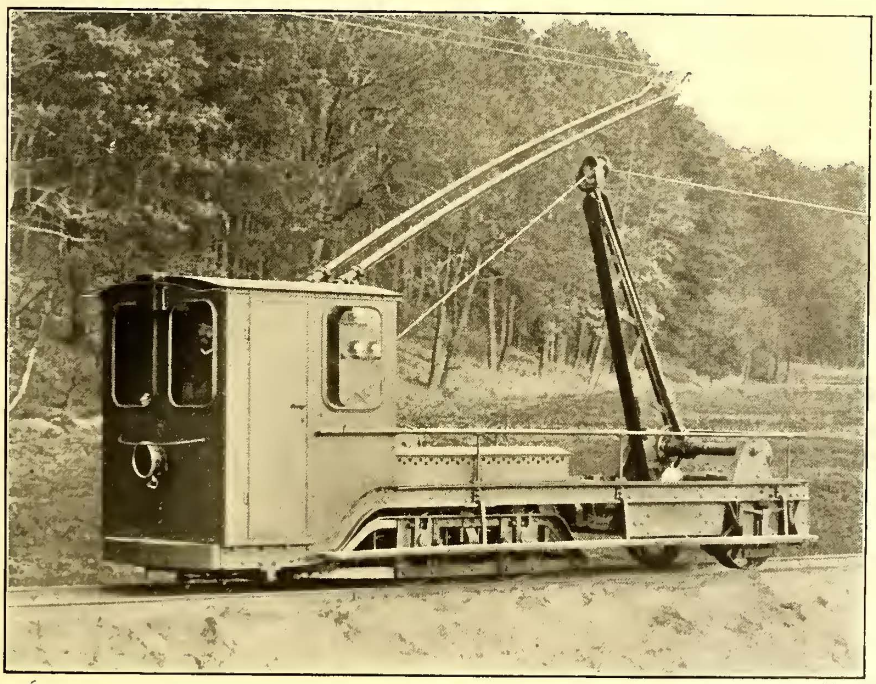
FIG. 3.—VERTICAL MOTOR GENERATOR SET, WITHOUT FRAME

rope passes. This truss is movable and may be raised so high that the rope will not interfere with any boats that may be lying along the canal bank. The locomotive is also furnished with a rope drum, on which the hauling rope is wound or unwound by an electric motor. Besides this motor there are two others, one for raising and lowering the truss and the second for running the locomotive. All of the controlling apparatus is mounted in the motorman's cab.

At a recent test this locomotive hauled four scows, weighing 1450 metric tonnes (2205 lbs. per tonne), at 2.7 miles (4.35 km) an hour. The tractive effort at starting was 2205 lbs. (2000 kg) and during the trip averaged 1102.5 lbs. (1000 kg). The power required was 19.075 kw. During the second trip the total weight hauled was 1250 tonnes, the tractive effort 1984.5 lbs. (900 kg), the speed 2.6 miles (4.3 km) an hour, and the total power 16.275 kw. At a third trial the weight hauled was 1000 tonnes, the tractive effort 2095 lbs. (950 kg), and the power required 19.635 kw.

The tugboat is about 60 ft. long and 12.5 ft. wide. It is fitted with three screws, each operated by a 20-hp motor, running at 600 r. p. m. The speed of the screws, however, may be varied within wide limits. The motors are operated at 500 volts to 600 volts when using the overhead current, and at 400 volts to 450 volts when the accumulator battery is employed. The speed is not regulated by using resistances but by cutting motors in or out of the circuit and making different parallel and series connections. Under test it was found that the power required to operate the boat when running at 7.8 miles (12.5 km) per hour without load is 34 kw. On another occasion, when handling a load of 454 tonnes at 3.2 miles (5.2 km) per hour, the power required was 43 kw.

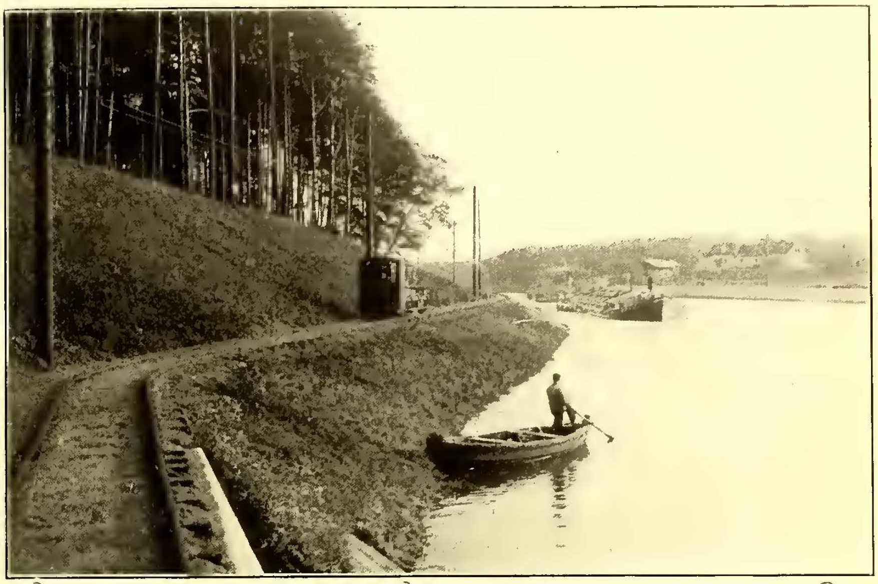
It will be seen from these figures that the efficiency of the boat is lower than that of the locomotive. The main reason for this difference is that the screws are too small to secure the best results. However, as the boats will only be used for short distances the problem of economic electric canal transportation is not seriously affected by this fact. The tests made thus far have proven very satisfactory. It is apparent from the foregoing that this subject is being seriously considered in Germany, and it is to be hoped that further reports will be forthcoming at an early date.



ELECTRIC LOCOMOTIVE USED ON THE TELTOW CANAL

AIR BRAKE FOR ELECTRIC RAILWAYS

The accompanying illustrations and description relate to a new air brake placed on the market recently by the Philadelphia Air Brake Company, of Philadelphia, Pa. While, in general, this apparatus involves no radical departure from standard practice, it possesses a number of special features tending toward lower first cost and economy in operation. The particular improvements which extensive tests have shown to be most advantageous are the duplex jam cylinder and the automatic cut-off, both of which will be described in detail hereafter.



VIEW ALONG THE TELTOW CANAL

Fig. 1 shows the complete motor and air compressor, consisting of a series-wound multipolar motor connected to a steel crank shaft by high-speed worm and gear. The gear is placed in the center of the crank shaft, operating two single-acting plunger pistons through connecting rods. This arrangement naturally gives the best transmission results, as the source of power is in the center of the work. It also greatly simplifies the scheme for oiling, as the moving parts all work in the same compartment, which is kept partially filled with oil and is completely enclosed.

The suction and discharge valves are arranged in the cylinder heads, so as to be easily accessible for inspection and grinding. The four valves (two suction and two discharge) are exactly alike and interchangeable.

The use of worm and gear running in oil reduces to a minimum the noise made by the compressor. The bearings are extra long, and fitted with oil-carrying rings. The pinion end of the armature shaft is fitted with two bearings, one either side of the worm, thus eliminating any chance of a bent armature shaft as well as doubling the bearing surface of the shaft. The motor and pump may be placed inside the car under one of the seats, or suspended underneath the car. In the latter case a dust-proof box is provided. This box is arranged so that the entire motor may be removed together with the bottom of the box by the removal of four bolts, or any part of the motor can be inspected through doors in the sides.

Fig. 2 shows the top field and armature of the motor removed.

Close inspection of this illustration will show the ease with which the several parts may be removed for renewal or repairs.

The automatic cut-off with cover removed is shown in Fig. 3. The cut-off is so designed that it stops the compressor motor

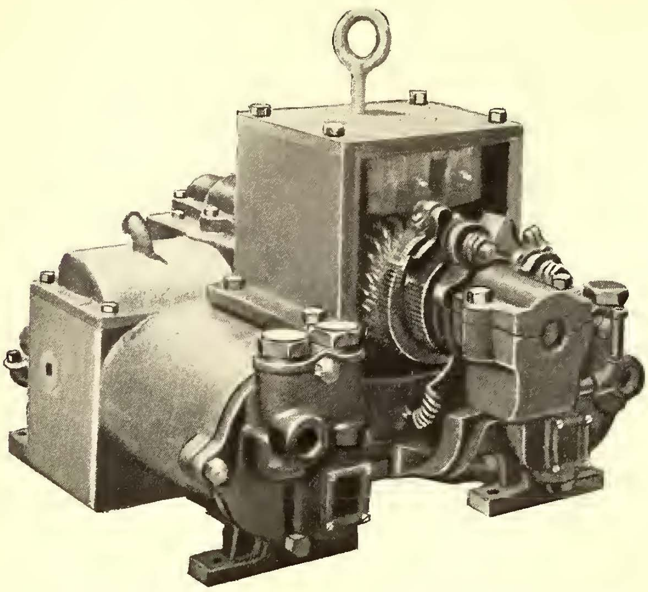


FIG. 1.—COMPLETE MOTOR AND AIR COMPRESSOR

when the pressure in the main reservoir reaches the maximum for which it is set and starts the motor when the minimum pressure is reached. The cut-off is very simple in design, having but two moving parts, that is, the diaphragm, operating the magnet contact, and the magnet armature, operating the motor

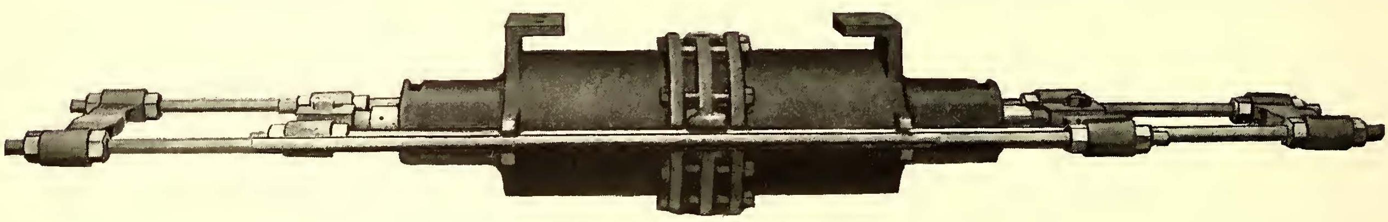


FIG. 4.—DUPLEX JAM CYLINDER

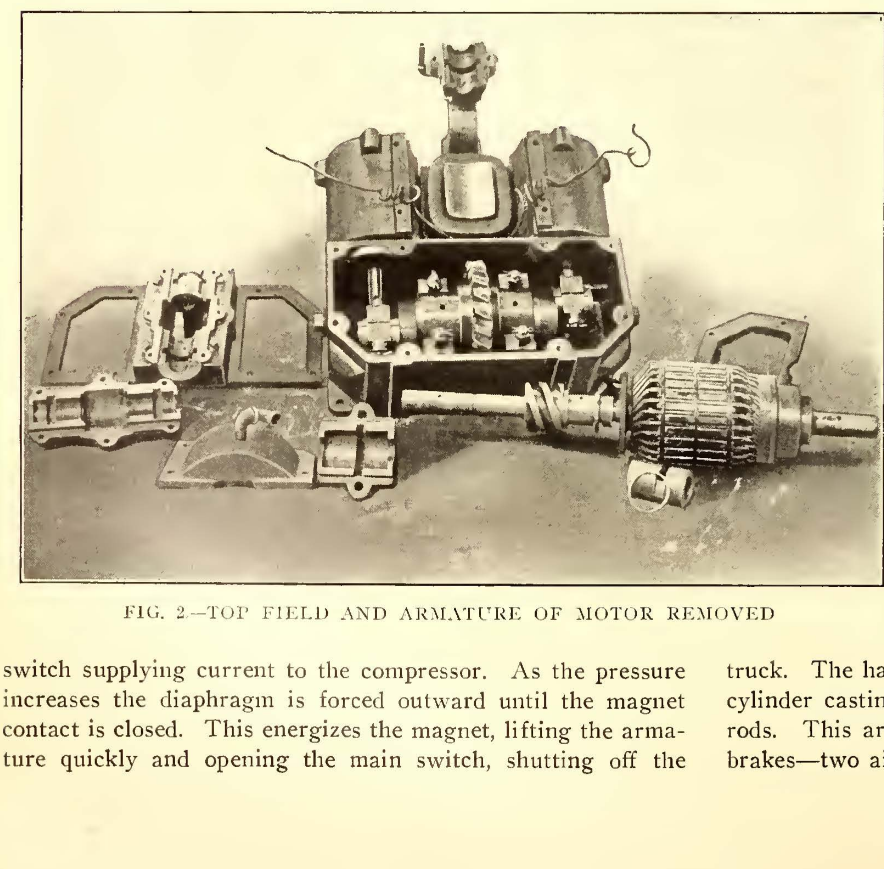


FIG. 2.—TOP FIELD AND ARMATURE OF MOTOR REMOVED

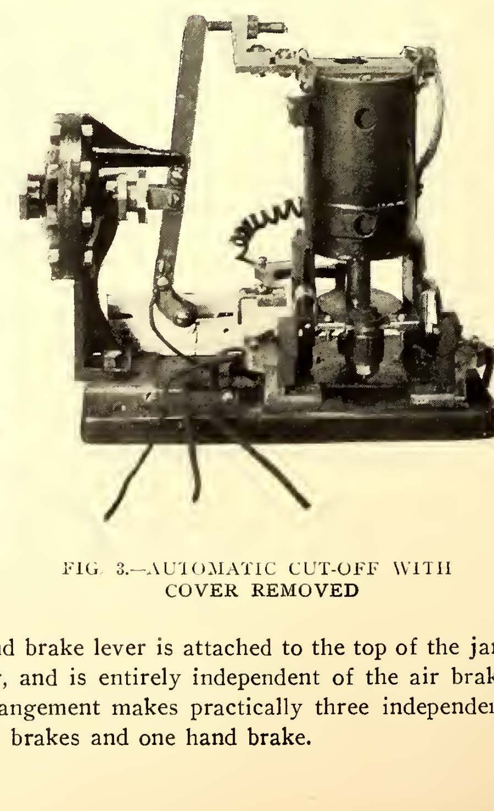


FIG. 3.—AUTOMATIC CUT-OFF WITH COVER REMOVED

switch supplying current to the compressor. As the pressure increases the diaphragm is forced outward until the magnet contact is closed. This energizes the magnet, lifting the armature quickly and opening the main switch, shutting off the current to the compressor. As the armature is drawn up the magnet contact is broken and the armature is held up by a pawl. The magnet is only in circuit during a portion of the upward travel of the armature, and for so short a period of time that the coil is never in service long enough to burn out or even warm. As the pressure against the diaphragm decreases to the minimum the pawl holding the armature drops by gravity to the first position, closing again the motor switch and starting the compressor.

As the cut-off works by gravity the closing of the motor switch is positive under any conditions, and is not dependent upon magnet or spring. In case of any accident to the cut-off

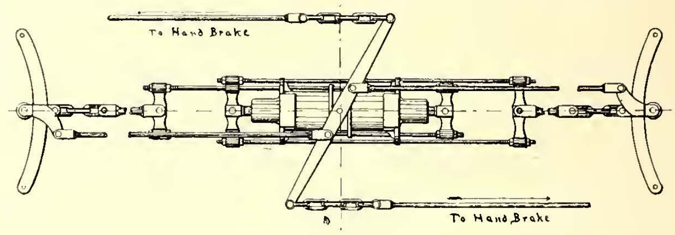


FIG. 3.—DUPLEX JAM CYLINDER, SHOWING HAND BRAKE CONNECTIONS

the compressor is left running and the air brake can be operated by use of the hand switch on the platform.

The duplex jam cylinder is shown in Figs. 4 and 5. By the use of this double cylinder, one end is connected to each end of the car. All the equalizing between the two trucks is accomplished by the use of compressed air, instead of a complicated system of levers, as in present practice. The cylinder is placed exactly in the center of the car, allowing a straight pull to each truck. The hand brake lever is attached to the top of the jam cylinder casting, and is entirely independent of the air brake rods. This arrangement makes practically three independent brakes—two air brakes and one hand brake.

PNEUMATIC STATION INDICATOR FOR SUBWAY AND ELEVATED SYSTEMS

The accompanying illustrations show a novel and ingenious type of pneumatic station indicator now being tested on one of the cars of the Interborough Rapid Transit Company, of New York, and invented by Ernest K. Adams, of this city. In the engravings, Fig. 1 is a cross-section of the car with the indicator mounted therein, and Fig. 2 a longitudinal section of the same. The system primarily consists in placing a double indicator in the center of the roof of the car, where it can readily be observed from nearly every seat within. The indicator is operated by compressed air from the platforms of the car by means of a lever. A movement to the right of this lever causes the printed strip within the indicator to travel suitably for an uptown trip, and conversely when the lever is thrown to the left to move correspondingly with a down-town run. The air for the system is supplied by a small automatic compressor, which is located under the car. In certain cases the compressed air may be obtained directly from the reservoir that supplies the brake system. To advance the indicator one station, about 1 cu. ft. of air, at 50 lbs. pressure per square inch, is required. The lever of the controller for this operation need be held at on side but for several seconds. When the equipment is employed on a route with branch lines, and it is occasionally necessary to pass over a number of station names on the printed strip, a movement of a controller lever suffices to quickly accomplish the function. Two stamped metal flaps, having the words "Next Station" raised thereon, are hinged to the sides of the indicator, and when for any reason it is not desired to operate the indicator system, these flaps may be made to cover the station names appearing at the indicator openings. In Fig. 2 the air conduits for the equipment have been carried along the roof of the car, and the indicator secured to it; but, of course, if preferred, the air conduits may be run within the car, and the indicator supported by brackets from the sides of the car.

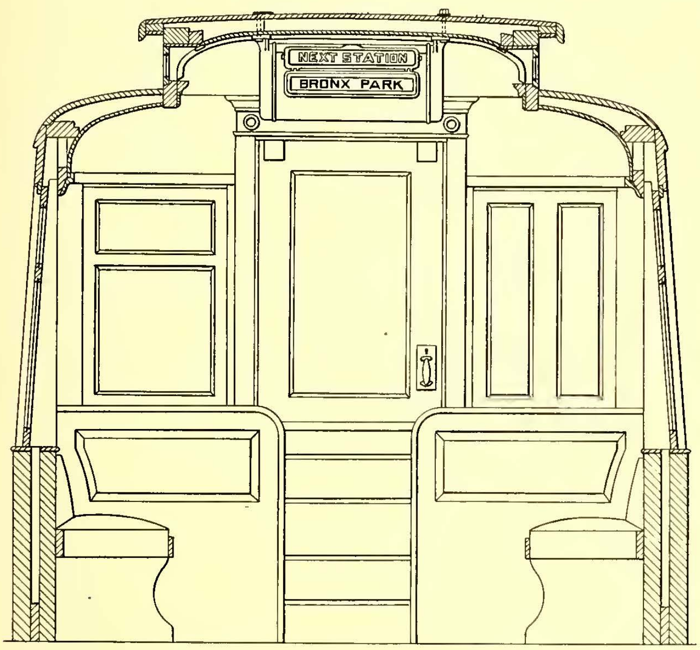


FIG. 1.—CROSS SECTION OF CAR, WITH PNEUMATIC STATION INDICATOR

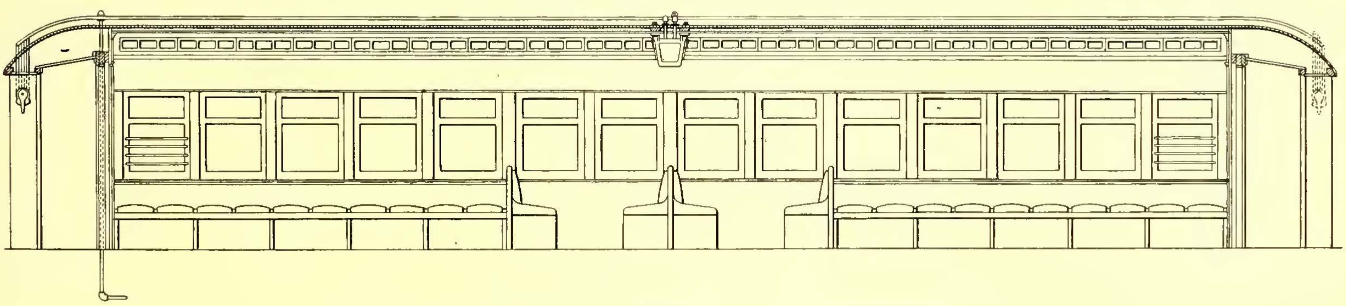
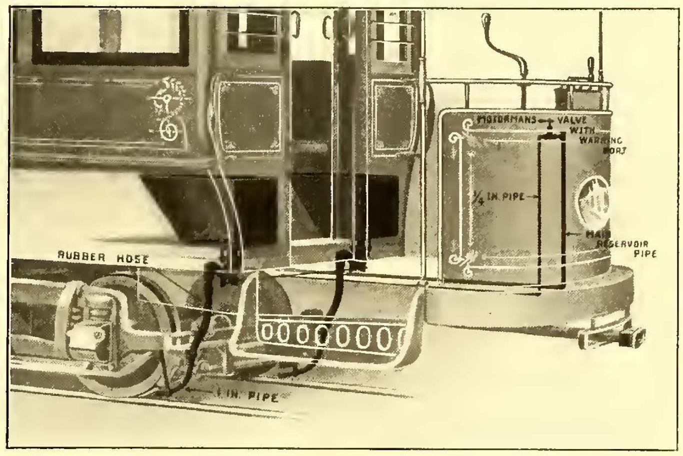


FIG. 2.—LONGITUDINAL SECTION OF CAR WITH INDICATOR

The application of compressed air to station indicators is claimed to be more flexible and safer than electricity, particularly if the 500-volt current in the car is employed for the purpose. If desired, however, the indicator can be run by an electric motor. The indicator may be also mechanically operated.

PNEUMATIC SANDER

The accompanying illustration shows one of the several sanding devices made by the American Locomotive Sander Company, of Philadelphia and Chicago, for electric cars using air brakes. The device shown is extremely simple in its application to old equipments, and it is claimed that it will effect quite a large saving in sand over other methods. It consists essentially of two traps placed underneath the sand-box. From each trap a rubber hose connects with a 1-in. iron pipe. This latter pipe is fastened securely to the truck, the rubber hose allowing the car to swing around curves without interfering with any of the rigid connections.



ARRANGEMENT OF PNEUMATIC SANDER ON CAR

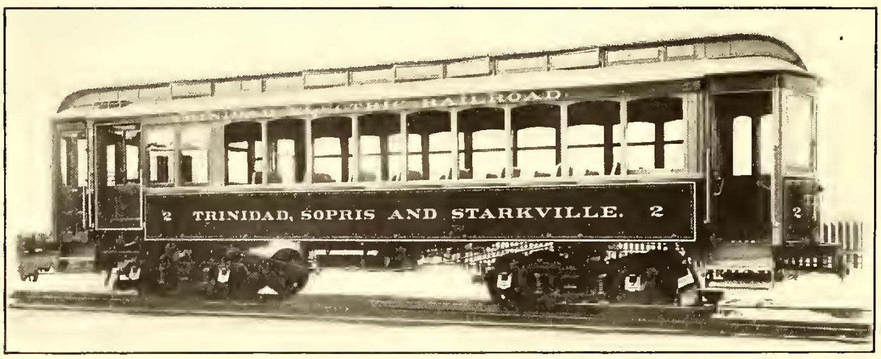
The air supply is taken from the main reservoir from which it passes through the motorman's valve with warning port to the traps. The sand is then lifted from the traps and blown between the tread of the wheel and the rail. The operating valve in the cab is fitted with a warning port, and is so constructed that when the sander is in operation the warning port keeps up a continuous whistle. Should, however, the motorman wish to stop the whistle and still desire to keep the sander in operation he can do so by simply pressing on the valve placed in the end of the operating valve handle.

This sander is arranged to operate with fairly coarse sand, but the best results will be obtained, of course, from sand that has been screened and dried. The manufacturer of this device recommends that the sand be screened through a sieve of No. 14 wire and four-mesh per inch.

It has been demonstrated that, compared with gravity sanding arrangements, pneumatic sanders effect a great saving in the amount of sand used, besides being more reliable. The manufacturer of this pneumatic sander claims that it easily effects a saving as high as 70 per cent. The fact that the sand is blown directly under the tread of the wheel makes it possible to start a car on slippery rails without any trouble, and when used in conjunction with the brake it can be brought to a standstill very quickly, thus avoiding costly accidents.

CARS FOR NEW LINES AT TRINIDAD, COL.

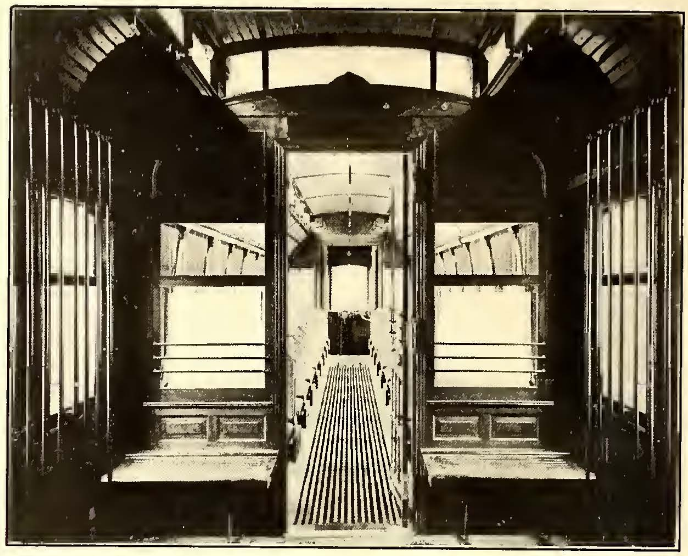
The American Car Company, of St. Louis, has furnished five semi-convertible cars of the Brill patented type to the Trinidad Electric Railroad, of Trinidad, Col. Three of the cars have bodies 20 ft. 8 ins. long, and are mounted on 21-E trucks. The other cars have baggage compartments, are 34 ft. over the bodies, and are mounted on the American Car Company's M. C. B. trucks, 14-B-1. The shorter cars are for use at Trinidad, and the larger cars are intended for interurban service between Trinidad, Sopris and Starkville, these three towns forming the vertices of a triangle, the distance between each point being about 5 miles. Trinidad is one of the most important mining centers of the State, and is in the vicinity of the celebrated Raton coal fields; it is also the junction of three important steam lines. The country traversed by the interurban line is thickly populated, and both systems, which have just been opened, will meet, doubtless, with success.



COMBINATION CAR FOR TRINIDAD ELECTRIC RAILROAD

The dimensions of the shorter cars are as follows: Length over end panels, 20 ft. 8 ins., and over crown pieces, 29 ft. 8 ins.; from panels over crown pieces, 4 ft. 6 ins.; width over sills, including panels, 8 ft. 1 in.; width over posts at belt, 8 ft. 3½ ins.; from center to center of side posts, 2 ft. 8 ins.; thickness of corner posts, 3¾ ins., and side posts, 3¼ ins.; sweep of posts, 1¾ ins. The side sills are 4 ins. x 6¾ ins., with 12-in. x ⅜-in. plates on the insides; size of end sills, 5¼ ins. x 6¾ ins.; width of aisle, 23 ins. The distance from rail-head to platform-step tread is 14⅞ ins.; from step to platform, 12¾ ins. The seats are 36 ins. long and accommodate twenty-eight passengers. The wheel base of the trucks is 7 ft. 6 ins.; diameter of wheels, 33 ins.

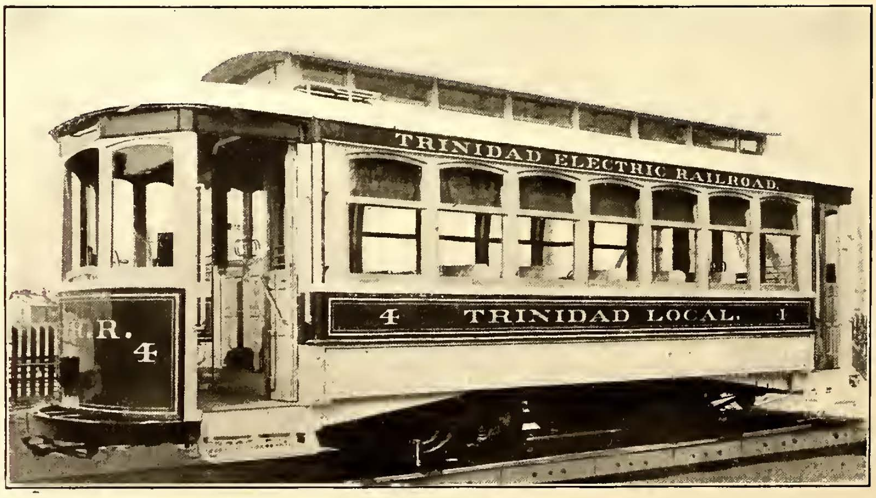
The combination passenger and baggage cars are 34 ft. over end panels, and 43 ft. over crown pieces; from end panels over crown pieces, 4 ft. 6 ins.; width over sills, including sheathing, 8 ft. 4 ins.; distance between center posts, 2 ft. 8 ins.; size of side sills, 4½ ins. x 7¾ ins., and end sills, 5¼ ins. x 7¾ ins.; sill plates on the inside of side sills are 12 ins. x ⅜ in. The side posts are 3¼ ins. thick, and the corner posts 3¾ ins. The cars are seated for thirty-six passengers, and the baggage compartments are furnished with folding seats for smokers. The seats are of the walk-over type, and are 36 ins. long, leaving the aisle 23½ ins. wide. The illustration of the larger car illustrates the open appearance when the windows are raised into the roof pockets. The height of the step from the rail-head is 13⅝ ins., and the distance of steps 11 ins. The trucks have a wheel base of 6 ft., and have 33-in. wheels. All the cars are handsomely finished in cherry with ceilings of birch. They are equipped with sand-boxes, angle-iron bumpers, "Dedenda" gongs and radial draw-bars of Brill manufacture.



INTERIOR OF TRINIDAD COMBINATION CAR

NEW CARS FOR MONTREAL

The Montreal Street Railway has appropriated $300,000 to be utilized in the construction of fifty new cars, to be built at the company's own shops. The new cars will be of the semi-convertible type, 40 ft. over all, and 30-ft. body. The doors will be at the side of the cars, making them of the accelerator type. Then, again, the platforms on the new cars will be 5 ft. wide instead of 3 ft. 8 ins., as at present.



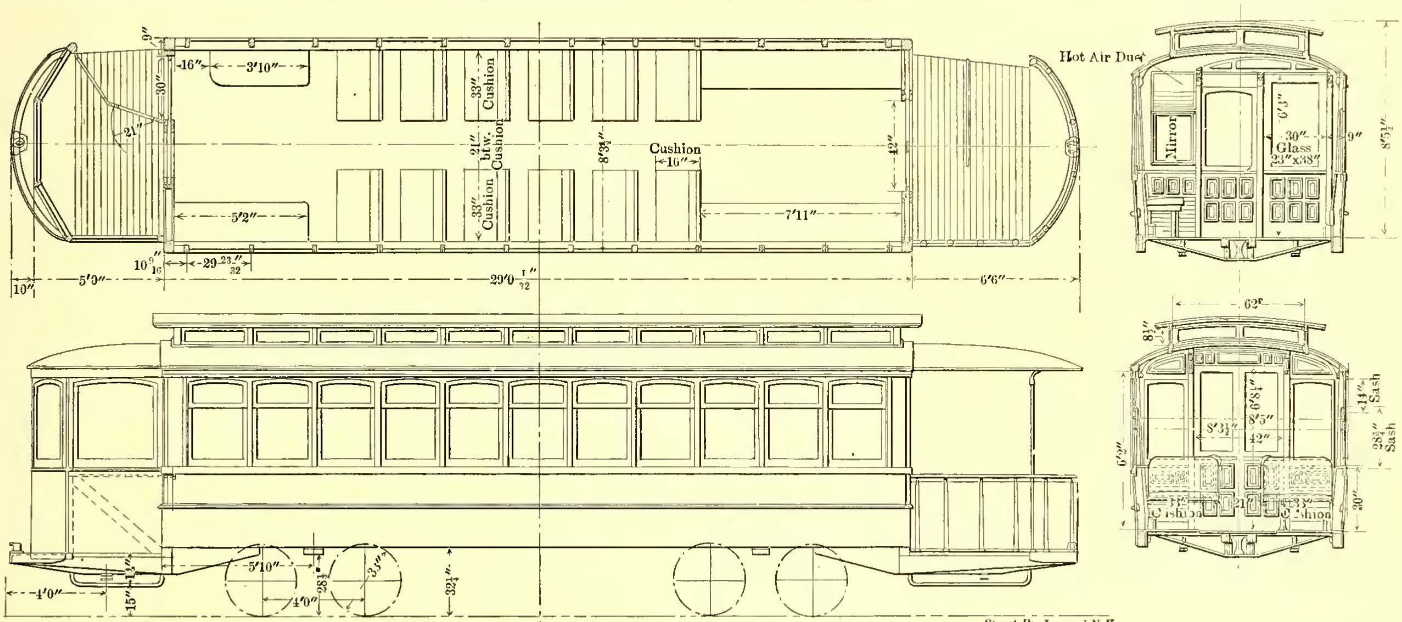
LOCAL CAR FOR TRINIDAD ELECTRIC RAILROAD

NEW CARS FOR DETROIT

The J. G. Brill Company has completed lately for the Detroit United Railway Company an order for fifty cars like the one shown in the accompanying illustrations. The cars are for use on the city and suburban lines of Detroit, and include features which particularly adapt them to the conditions met with in that city.

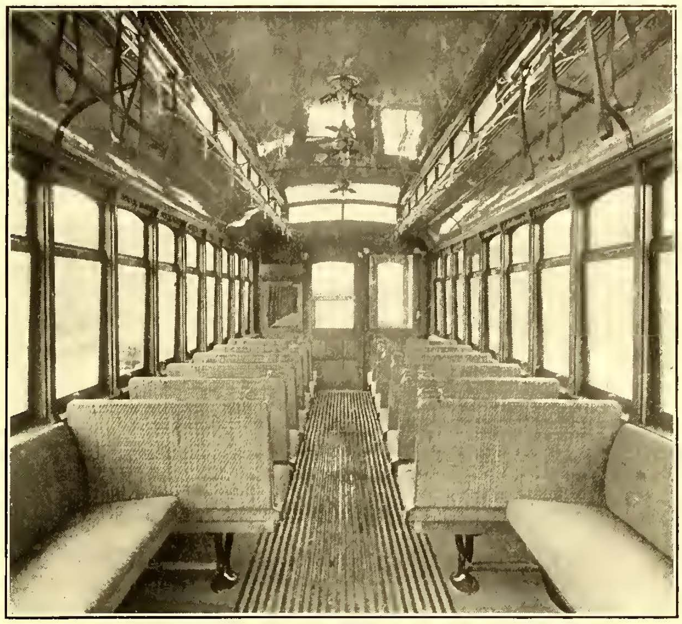
The seating arrangement was planned carefully to utilize the floor space so that forty-three passengers may be seated, only one less than with the usual cross-seat arrangement of the entire car, and providing standing room for a larger number of passengers. The clear space from the rear door to the cross-seats is a trifle over 8 ft., and between the longitudinal seats 4 ft. 6 ins. This ample space, together with the fact that the rear platform is of the Detroit type and is divided by a railing which prevents obstruction, enables passengers to move freely in and out, minimizing the length of stops, thus adapting the car to short headway and to service on busy lines. The forward end of the car is provided with a single sliding door in the right-hand corner, of the Brownell semi-accelerator type, of which the builders are licensees. This arrangement permits the use of a diagonal partition with swinging door and extending from the inner door post of the car end to the vestibule corner post. The motorman has a commodious vestibule, or cab, and is free entirely from distraction by passengers. The heater is placed in the corner of the vestibule at the paneled side.

The interiors are handsomely finished in quartered oak, with



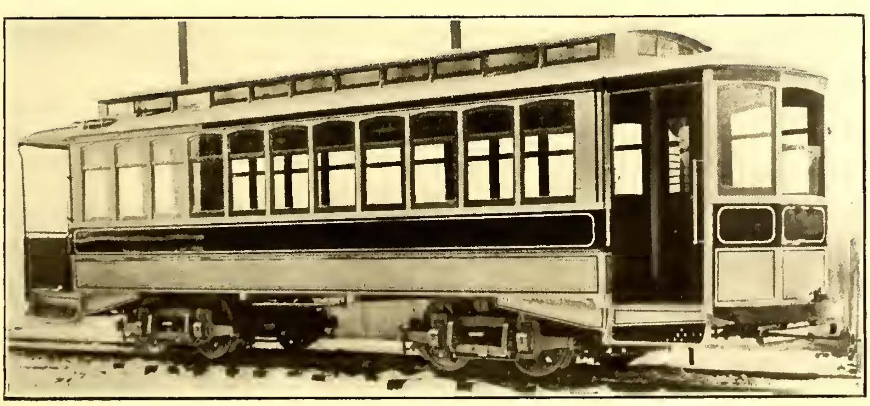
CONSTRUCTION DETAILS OF DETROIT CAR

bird's-eye maple ceilings, simply decorated. The lower sashes are arranged to drop into wall window pockets; the pocket openings are closed with hinged covers. The upper sashes are stationary. The seats, which are placed transversely to the car are 33 ins. long and have stationary backs. The aisle is



INTERIOR OF DETROIT CAR

21 ins. wide. The door at the forward end has a 30-in. opening, and the mutually-operating double doors at the rear end have a 42-in. opening. The width of the monitor deck, measured between the vertical faces of the ventilator posts, is 5 ft. 2 ins. The cars have a double flooring, with the interspace filled with mineral wool, which serves the double service of deadening the sound of the trucks and keeping out the cold.



DETROIT CAR FOR URBAN AND SUBURBAN SERVICE

The length of the cars over end panels is 29 ft., and over vestibule sheathing, 41 ft. 1 in.; width over side sills, including panels, 8 ft. 1 in., and over posts, including drip rail, 8 ft. 5 ins. The side sills are of long-leaf yellow pine, 4 ins. x 7¾ ins., with 12-in. x ⅜-in. steel plates on the inside. The end sills, of white oak, are 5¼ ins. x 6⅞ ins., and the center cross joists, 4½ ins. x 5½ ins.; thickness of corner posts, 3¾ ins., and of side posts, 2¼ ins.; sweep, 1¾ ins. The trucks are Brill No. 27-F, with 33-in. wheels and 4½-in. axles. Two 55-hp motors are used per car, both being on the rear truck.

TRANSIT PROPOSALS TO NEW YORK COMMISSION

The session of the Rapid Transit Commission of New York, held on Friday, Feb. 26, was especially significant, because of the important proposals that were made for the extension and improvement of the city's transportation facilities. Three distinct and separate projects were outlined—the plan of the New York City Railway Company to build, at a cost of $40,000,000, a subway down Lexington Avenue, Broadway and William Street to the Battery, and returning under Eighth Avenue and Thirty-Fourth Street to a junction with the main line; Chief Engineer Parsons' plan for extending the Brooklyn branch of the subway from Flatbush and Atlantic Avenues, Brooklyn, through to the Willink entrance of Prospect Park, to facilitate the running of subway trains from The Bronx to the beaches without change of cars; Mayor McClellan's plan for a Williamsburg Bridge terminal at the Bowery and Delancey Street, to be built within eighteen months.

Of these plans the most important undoubtedly is that of the New York City Railway Company. The company proposes, if terms not too onerous can be secured, to build an underground road from the Battery, on the West Side, to Thirty-Second Street, and eventually, perhaps, beyond the Harlem; and, on the East Side, under Lexington Avenue north from Fifteenth Street and south from Fifteenth Street under Broadway, with connecting links under Thirty-Fourth and Chambers Streets, and an extension from Chambers Street under William Street to the Battery. There would thus be provided a belt line enclosing a large section of the lower part of the city, with east, central and west continuations where they are greatly needed. The chief attractions of this scheme are its provision of free transfers over the company's surface system. The plans have been submitted to a committee composed of President Orr, Controller Grout and Charles Stewart Smith, with instructions that a public hearing be ordered.

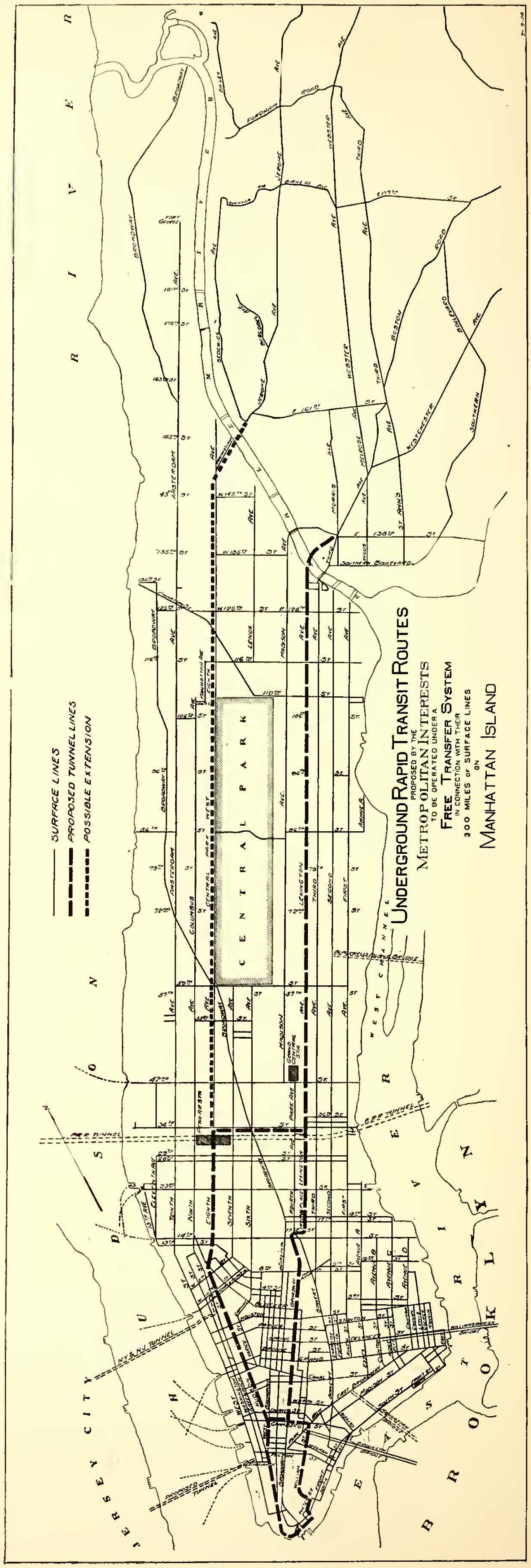
Mr. Parsons' plan, as previously outlined, provides for the extension of the Interborough Rapid Transit Company's line from the intersection of Atlantic and Flatbush Avenues, Brooklyn, the original Brooklyn terminus, under Flatbush Avenue to the Prospect Park Plaza. Mr. Parsons in his report, however, suggested that instead of ending there the Brooklyn tunnel should be extended to the Willink entrance of Prospect Park and beyond to Malbone Street, where connection could be made with the Brighton Beach and Coney Island railroad lines, providing an unbroken line of communication from the northern end of The Bronx to the seashore. The plan was referred to the committee previously delegated to consider the New York City Company's offer.

Mayor McClellan announced that trolley cars would be in operation across the Williamsburg Bridge before long.

MEETING OF THE EXECUTIVE COMMITTEE OF THE AMERICAN STREET RAILWAY ASSOCIATION

A meeting of the executive committee of the American Street Railway Association was held at the Waldorf-Astoria, New York, on Feb. 29 and March 1. There was a large attendance, the following members of the executive committee being present: Messrs. Ely, Foster, Grant, Shaw, Penington, Hutchins, Rogers and Smith.

One of the principal subjects discussed was, of course, that of the next meeting place of the Association, which, at the last meeting, was left open, subject to appointment by the executive committee. A number of cities were considered, and considerable progress was made in selecting a meeting place. No absolute decision was reached, however, at the meeting in New York. The decision of the committee in this respect and also as to the date of the meeting and the programme will be announced in these pages as soon as it is made public.



LONDON LETTER.

(From Our Regular Correspondent.)

One of the most novel schemes in the history of light railway enterprise in England is proposed to be carried out in the Forest of Dean, namely, construction of a three-rail track of line, 12 miles long, from Cinderford to Lydney on the Severn. The track constituting the middle and outer rails—a narrow-gage one—is to be used for passenger traffic and the two outside rails as a broad-gage line for mineral traffic. Owing to the high gradients from Cinderford to the Severn, no motive power, it is estimated by the engineers, will be needed to draw the trains, while it is proposed that the power necessary to make the return journey to Cinderford be obtained by utilizing the force of the tides of the Severn for the generation of electricity. The scheme has excited a good deal of interest in the Forest of Dean, and at a public meeting recently held it was decided to support it.

A storm of indignation has been raised in the district by the proposal of the London County Council to continue the present Hampstead Road tramway service which terminates at Euston Road along Tottenham Court Road as far as Oxford Street. The argument put forward by the tradesmen of the thoroughfare is that the tramway is unnecessary, that it would lead to "nowhere," and that at present the "tube" and omnibuses are sufficient for the needs of the locality. Statutory consent to the tramway has been given the London County Council by the St. Pancras Borough Council. When, however, the bill comes before Parliament it will be strongly opposed by the Holborn Borough Council, which declares that that portion of Tottenham Court Road which forms the boundary of their district is not sufficiently wide to admit of a double line of trams, and so, in spite of all efforts, London continues to be about the worst city in the world as far as electric transportation is concerned.

At a recent meeting of the Leicester Tramways Committee it was decided that Mr. T. Robert Smith, A. M., Inst. E. E., should be appointed resident electrical engineer to the new undertaking. The salary will be £250 a year, rising to £350.

The Walthamstow Urban Council has just placed the contracts for the construction of an electric tramway system, which, when completed, will connect the growing towns of Walthamstow, Tottenham and Leyton, besides establishing direct communication between Northeast London and Epping Forest. The contracts have been given two British firms—W. T. Henley's Telegraph Works Company, of Greenwich, for permanent way and overhead equipment; and F. Suter & Company, of London, for the dynamos, gas plant, etc.—the total of the two contracts being £96,611.

The proposal to connect Dundee more directly with the Highlands than by way of Perth has been more than once seriously considered, but has never got any further. It has now been brought up in view of the scheme for forming a water power electricity generating station in the Highlands. If this proposal is carried out an effort will likely be made to find a market for the current in Perth and Dundee. In that case it can either be brought to Dundee via Perth or direct from Stanley. It is considered that an electric railway could be worked along the route of the cable, and thus accomplish a project which has long been considered a very desirable part of the city's railway system.

The East London & Lower Thames Electric Power Company is promoting a bill of far-reaching importance. The bill, which provides for incorporation, will also empower the erection of generating stations and works, and the supply of electricity in an extensive area in the counties of London and Essex, including the metropolitan boroughs of Hackney, Bethnal Green, Stepney, Poplar, Deptford, Woolwich, Greenwich and Bermondsey; Ilford, Woodford, Wanstead, Leyton, Barking, Romford, East Ham and West Ham. The proposed capital of the company is £2,000,000, with borrowing powers.

The electrical "tubing" of London, which proceeds apace, is making an inevitable impression upon the suburban fares of the existing trunk lines. The District was the first to lead the way, other companies have followed, and now the Great Northern announces a general reduction of its ordinary suburban fares after Feb. 1. It is also inaugurating third-class season tickets between stations in the suburban districts and King's Cross and the City, with facilities for passengers to use the intervening Metropolitan stations without extra charge.

An important railway scheme will be promoted in this session of Parliament. The North Yorkshire Dales Railway Bill seeks power for the construction of a greater length of heavy electric railway, as distinguished from light railways or tramroads, than has ever been authorized in one scheme by the Legislature. The proposed line is to run from Hellifield to Scorton, and, according to the proposals, its ability to serve the Northern dales will be enhanced by the fact that junctions are proposed with the steam lines of the leading railway companies now running through the district. The railway will be no less than 51¼ miles in length and almost entirely double track, and will be provided with all the usual equipment in the way of stations, signaling, etc. The estimated cost of construction, including land, stations, bridges, earthworks, etc., but apart from electrical equipment, is £886,581, and the capital of the company to be incorporated by the bill is £960,000, besides borrowing powers to the amount of £450,000. The promoters of the scheme are Messrs. T. J. Harrison, J. W. Lodge, A. Lupton,, J. C. Winn and M. D. Wyvill.

The growth of tramways in the United Kingdom is shown by the following figures taken from the blue-book on the subject published recently:

	1878	1903.
Miles of lines open	269	1,772
Passengers carried	146,001,223	1,681,948,655
Capital expended	£4,207,350	£41,656,597

Under the draft provisional order which has been deposited at the Scottish office by the Glasgow & Southwestern Railway Company, power is sought to construct about 6 furlongs of new lines, and to widen about 4½ miles of their existing lines. Power is also sought to enable the company to "at any time work by electrical power the traffic on their railways or any part thereof, or any railways in connection therewith, now worked or used by them, or any railways hereafter to be constructed."

The London County Council has had under consideration for some time the tenders for the supply of four 300-kw. three-phase generators for its new Greenwich power house, to be coupled to the Musgrave engines recently ordered. It has now decided to give this contract to the Electric Construction Company, Limited, of London and Wolverhampton, for the sum of £29,600, though there were lower bidders. The design submitted by this firm is for a complete fly-wheel alternator, built up with steel plates, and is very suitable for high speeds, while the construction proposed is the safest known for withstanding centrifugal strains.

Mr. Henry W. Clothier, whose association with H. T. switchgear designs is well known, has resigned as manager of the estimating department of Ferranti, Limited, to take up the development of the business of Walker & Hodgetts, Limited, of Salford. Mr. Clothier joined Messrs. Ferranti, Limited, in 1894, and has the record of having designed the first oil-break switch put to commercial use in England. He was chief assistant to Mr. Ferranti in the design of switchgears, etc., to the end of 1890, when he was offered an appointment as commercial manager for the switch department. At the commencement of 1903 the management of Messrs. Ferranti, Limited, was reorganized, and he was appointed to the position he has recently given up. Walker & Hodgetts were initiated in the year 1898, and became a limited liability company in 1900. They are known as makers of C. C. dynamos and motors, their clientage hitherto being chiefly colliery companies, theaters, and other users of lighting and power installattions. They have made a specialty of electric haulage and mining machinery. Mr. Hodgetts will in future manage the works and attend to the design of motors and dynamos, in which class of work he has specialized for a number of years. It is now the intention of Walker & Hodgetts to promote the interest of the existing motor and dynamo section, and to inaugurate a special department for the manufacture of switchgears for use in central stations, collieries, etc.

London County Council will ask Parliament this session to sanction tramway extensions costing £1,729,845, including £657,300 for the widening of streets. The Highways Committee has recommended the Council to give statutory notice of an intention to compulsorily acquire the London Southern Tramways system. Some delay has been caused by the indecision of the Lambeth Borough Council. The Finance Committee, reporting upon the financial aspects of the purchase, state that the total capital outlay involved in this proposal is about £393,000 gross, or, after deducting the value of recoupment in connection with the street widenings, £385,000 net. These figures, however, include no part of the cost of the generating station for supplying electrical energy.

The Torquay Tramways Bill has passed the Standing Orders stage on the consent of the corporation being proved. The total length of tramways contemplated is just over 8 miles, at an estimated cost of £87,000. To start with, 5 miles of lines will be laid, viz., from Castle Circus to Tor railway station; from Castle Circus to the south pier, and from Castle Circus to St. Marychurch Townhall; and it is stipulated that these three lines shall be open for public traffic before the expiration of eighteen months from the passing of the Act, probably about next July.

A. C. S.

PARIS LETTER

(From Our Regular Correspondent.)

Affairs of the Metropolitan, as usual, continue to occupy a very great deal of public attention. At a recent sitting of the Municipal Commission appointed for watching the City interests in the Metropolitan schemes, and at which the State Council and the Prefect of Police of Paris were represented some few unimportant modifications were approved concerning the lines in operation and projected. The principal improvement is to give two entries and exits to all stations to be constructed and to transform several already finished, notably the Palais Royal Station, the most frequented of line No. 1.

Line No. 3 (Courcelles-Menilmontant) is completely finished beween the Avenue de Villiers and the Place Gambetta. The Metropolitan company, to whom the tunnel has been delivered expects to inaugurate the line in July. The trains will consist of six cars, larger and better ventilated than existing cars on the lines now opened, and will be mounted on bogie trucks. The equipments will be furnished by the French Thomson-Houston Company, which has recently taken the order for 90 equipments. The six-car trains will each consist of 3 motor-cars and 3 trailers, and the equipments will be of the Type M, modified by having contractors and reversers mounted in the motorman's cabin instead of beneath the car; the cabin is constructed entirely of metal. At the present moment tests are being made with bogie trucks, of which the corners are rounded on account of sharp curves. The motor cars will measure about 11 meters in length over all.

The list of accidents on the Metropolitan is not yet closed. Small outbreaks of fire are pretty constant, but are immediately extinguished. The third rail, however, still gives trouble owing to defective insulation; no permanent insulators have yet been adopted to replace the defective ones, which have given rise to a number of short circuits and incipient outbreaks of fire.

The inquiry regarding the catastrophe of last August on the line No. 2 has just been closed, and responsibility is attached by the commission to the traction manager as well as the employees of the burned train.

In spite of the unfinished condition and the recent bad luck of the Metropolitan, it is growing in public favor, and its managers should feel encouraged in their progressive policy by the favorable figures reported. These latter have been remarkably good in January last, surpassing the then record (April, 1903) by frs. 34,840, and surpassing January, 1903, by frs. 419,000.

For the second 10 days in January, 1904, the company showed 3,202,724 passengers and frs. 556,382 receipts.

The corresponding figures for the Compagnie Generale des Omnibus show a decrease. On the other hand, the Compagnie Generale Parisienne des Tramways report an increase of frs. 18,000 for January, 1904, over January, 1903.

As regards now the departmental tramways and their operation in 1904, statistical data is available in the Journal Officiel, from which is abstracted the following: The tramway lines in the Seine Department, guaranteed by the State, show an increase in receipts equal to frs. 16 per share, a decrease in expenses of frs. 14 per share, giving a net profit equal to frs. 63 per share. As regards lines not guaranteed, the net product has increased by frs. 174 per share. The net increase per kilometer for tramways in this department is about frs. 163, and in other departments the average attains frs. 577 increase per kilometer.

The eastern suburbs of Paris have been deprived of their one means of transport and communication with Paris. This was due to the strike on the Est Parisien. Out of 1200 employees 1125 went on strike on Jan. 30. The strikers, as usual, prevented cars from running and the usual consequences of the strike occurred. The questions at issue concern the hours of work and have nothing to do with the wages. Formerly the cars ran 18 or 19 hours a day, and in consequence there was a day and night shift. A constant schedule was run. The company, in response to demands from the public, doubled the service at the rush hours morning and evening, and reduced the number of cars running in midday. This interfered with the usual habits of the men and broke their 9-hour day into two shifts, hence the reason for determining to go on strike.

The strike was referred to arbitration and a temporary peace was made. Higher wages were paid by the company for extra hours of service, and two monthly holidays were given instead of one. The company, moreover, agreed to introduce a system similar to the original arrangement. The strike caused immense inconvenience to the district served by this company, and even yet all questions are not settled, although service has been resumed in a general way.

IMPORTANT CHANGES IN AN INDIANA RAILWAY

The owners of the Fort Wayne Traction Company have voted to change the name of the company to the Fort Wayne & Wabash Traction Company, so as to include the interurbans running to Logansport and Lima, Ohio, which the company has recently acquired. George F. McCulloch, president of the Indiana Union Traction Company, has disposed of his interests in Fort Wayne and other northern Indiana lines, and the real heads of the traction lines in Fort Wayne and vicinity now are Messrs. Morgan, Jones, Taylor and Wanamaker, of Philadelphia; James Murdock, of Lafayette, and H. C. Paul and F. B. Flemming, of Fort Wayne. These capitalists own, besides the city lines in Fort Wayne, Wabash, Logansport and Lafayette, the Wabash & Logansport Interurban line, the Wabash River Traction line and the Rochester & Northern Traction line. The Fort Wayne & Wabash Traction Company will control all the large traction lines in Northern Indiana. Under the new arrangement lines will be extended and interurban service begun between Elkhart, St. Joseph, Fulton, Marshall and Kosciusko counties.

PROPOSED ELECTRIC RAILWAY BETWEEN PHILADELPHIA AND ATLANTIC CITY

The Delaware River & Atlantic Railroad Company, which was incorporated some years ago for the purpose of building an electric railway between Philadelphia and Atlantic City, has at last let the contract for building the road to the Delaware River & Atlantic Construction Company, and the work is to be completed by May 1, 1905. P. B. Shaw, owner of the controlling interest in a number of railway and lighting plants, is the president of the construction company, and Wilbur F. Sadler, Jr., of Trenton, N. J., is the general manager.

The railroad company has completed the purchase of a private right-of-way, 100 ft. wide, between the Delaware River, at Gloucester, and Florida and Atlantic Avenues, Atlantic City, and, according to present plans, four tracks will be laid, with 100-lb. rails. Owing to the abolition of all grade crossings, the amount of earth to be used in filling in will reach a total of more than 2,840,000 cubic yards, and there will be 60 bridges, costing over $500,000 for the structural work alone.

The main power house will be located at Gloucester City, on account of the low price of coal at tidewater, and the power will be distributed to half a dozen or more sub-stations along the 52 miles of road. The plans provide for turbine engines aggregating 25,000 hp, and there will be sufficient room to accommodate twice this amount of equipment. The method of feeding the current to the cars has not been definitely determined.

On the Philadelphia end of the line most elaborate preparations have been made for the handling of the passenger traffic. Some time ago the Delaware River & Atlantic Railroad Company purchased the land on Delaware Avenue, between Market and Chestnut Streets, adjoining the ferry houses of the Pennsylvania and Philadelphia & Reading Railway Companies. The Gloucester Ferry Company's six boats, franchises, stocks, bonds and real estate have also been purchased by the Delaware River & Atlantic Railroad Company. Additional ferry-boats of the double-deck type, patterned after the Pennsylvania Railroad Company's West Twenty-Third Street, New York, boats, will be purchased. The Ferry Company owns a terminal at South Street, Philadelphia, and an 850-foot frontage at Gloucester City.

The cars will be of the Pullman type, equipped with four 250-hp motors, and will be capable of attaining a maximum speed of 100 m. p. h. As there will be no grade in excess of 1 per cent, and no curve in excess of 1 degree, excepting at terminals, it will be possible to maintain a speed of about 75 m. p. h. It is stated by one of the officials that the time will be 1 hour from Philadelphia to Atlantic City, or vice-versa, including the ferry trip. The fare will be $1 instead of the $1.75 charged by the steam railroads; tickets will be unlimited, and cars or trains will be run every 15 minutes from 6 a. m. to 12 midnight, daily. The road will also haul freight, express and mail. All the principal trains, passenger and freight, will be run through the 52 miles without a stop.

The field for business is a peculiar one. The Philadelphia & Reading and Pennsylvania Railroads, according to their reports, carried 18,600,000 passengers between Camden and Atlantic City last year, and were even then unable to handle all the excursion business offered. There have been more than 300,000 visitors in Atlantic City on a single Sunday.

The Delaware River & Atlantic Railroad Company is understood to have expended about $3,000,000 in purchasing the ferry business, rights of way, etc., including the $104,000 paid to the State of New Jersey for the charter.

NEW REPAIR HOUSE

The Dittrick & Jordan Electric Company, of Cleveland, has been incorporated by the members of the firm of Dittrick & Jordan, that city, who for the past two years have been doing general electric railway repair work. Until a short time ago the company had been doing business on a small scale, but lately it has been found necessary considerably to increase the factory space and equipment to take care of the growing business. Mr. Dittrick, who is in active charge of the company's shop, was for a number of years in charge of electrical repair work at the shops of the Cleveland City Railway Company, where he gained a wide, practical knowledge of the requirements for high-class repair work. Mr. Jordan has had wide experience as an operating man, having formerly been division superintendent of the Detroit United Railway and later superintendent of the Cleveland, Painesville & Eastern Railway. The company's shop is well equipped, and it is the intention to carry a large stock of repair parts on hand for immediate shipment. The company was probably the first in the country to use micanite coils for armatures, and the success of this innovation is well known. In selling coils the company makes a practice of soaking them just before shipment. For facilitating prompt deliveries on Western work the company has established a branch shop at Leavenworth Kan., where a full line of coils will also be carried. The company numbers among its regular patrons some of the foremost interurban and city roads.

DISCLOSURES MADE AT THE TRIAL OF THE PHILADELPHIA ACCIDENT FAKIR

The trial in Philadelphia, a few days ago, of Frederick Seymour, alias Francis Irving and John Harte, whose arrest as the result of a bogus accident claim against the Philadelphia Rapid Transit Company was noted in the Street Railway Journal of Feb. 13, brought to light a swindling scheme said to involve sixteen persons, four of whom are physicians. Besides the alias Harte, Seymour appears to have been known at one time or another as J. J. Galbraith, J. Samuel Gordon, Edward Williams and Edward J. Tooney, and under all of these names, with the assistance of his accomplices, brought action for damages against public service companies in four different States. This he confessed when arraigned in court, but gave the name of only one of his confederates in crime. It is said that the other persons who operated with him are known to the Rapid Transit Company, and that they will be arrested very soon.

In the swindle against the Philadelphia Company Seymour was assisted by one Beatrice Graham, said to be a chorus girl playing in New York. The actress, who had been passing as Seymour's wife for three years, said she had been injured while a passenger on a trolley car in Philadelphia. Her claim against the company was for $5000. Seymour says that about a month ago he read an account of an aceident at Ninth Street and Girard Avenue, Philadelphia, and that he then arranged with Miss Graham to say that she had been a passenger and had been injured. She went to bed at New York City and a claim for damages for personal injury was then presented. In court Seymour admitted that the woman was not in Philadelphia on the day of the accident. On Nov. 8, 1903, Seymour himself, under that name, was at the Bingham House, Philadelphia, and put in a claim for injuries said to have been received while attempting to board a Chestnut Street car at Twentieth Street. On Jan. 14, as J. Samuel Gordon, stopping at Green's, he attempted to board a car at Nineteenth and Chestnut Streets, and was thrown down. It is said that the conductor of this car recognized Gordon as Seymour and reported the case to the company.

Seymour, together with other members of the gang, so successfully worked a fake against the Public Service Corporation of New Jeresy that they secured $65 in payment of a claim against that company. Later, however, the discovery was made by the company that it had been swindled. An investigation followed, and Daniel, one of the members of the gang, confessed. It seems that this same Daniel, in January, collected $100 from the Brooklyn-New York Ferry Company for reputed injuries to his wife in a ferry-boat collision. It was also admitted by Seymour on the stand that he, under the name of J. J. Galbraith, presented a claim against the Fair Haven & Westville Company, of New Haven, Conn.

Judge Wiltbank, before whom Seymour was tried, sentenced the offender to two years in the Eastern Penitentiary.

PHYSICAL TESTS BY THE BROOKLYN COMPANY

The Brooklyn Rapid Transit Company is subjecting all its motormen to a rigid physical examination. About thirty men are being called daily by the company to pass muster before its physicians. A thorough test is made of the men's eyesight, while an examination is also made of the general physical condition. Every motorman is thoroughly examined before he is engaged by the company, but some of the men have now been in the service for over fifteen years. It is to insure itself that these men are equally as capable now as when first assigned to duty that the tests are being made. Last summer the company conducted a series of eyesight tests. Of a hundred men who were inspected at that time only one failed to pass. There are at present about 400 motormen on the elevated system and 1700 on the surface lines. In summer there are perhaps 2500 in all, as the company takes on several hundred extra men at that time.

CONTRACT FOR SECOND CRAWFORDSVILLE-INDIANAPOLIS LINE

A contract has just been signed by the Consolidated Traction Company, of Indianapolis, Ind., with Westinghouse, Church, Kerr & Company, to construct and install completely the electric and mechanical equipment for the Consolidated Company's road between Indianapolis and Crawfordsville. The engineering work is to begin as soon as the weather permits, and the work of building the power house at Crawfordsville is to begin about the middle of next month.

The traction company has been working for about eight months on the grading, culverts, bridges and fences along its way, and this work is practically completed. It has not yet been decided whether the overhead or the third-rail system will be adopted, but the conditions are almost ideal for the use of the third-rail system, as the way is practically a straight line from Indianapolis to Crawfordsville, with only slight grades at any points, with a private right-of-way the entire distance and with only sixty-two road crossings in its 43 miles, outside of this city's limits. The only railroad crossing is at New Ross.

The work of building the road will be pushed as rapidly as possible, and it is thought that it will be completed this year. The principal towns through which the road will pass are Clermont, Brownsburg, Pittsboro, Lizton, Raintown, Jamestown, New Ross and Limmsburg. The road will begin with an hourly passenger service, and it is the intention to pay considerable attention to the freight business.

THE NEW POWER PLANT OF THE EVERETT RAILWAY & ELECTRIC COMPANY

Material is being shipped to Lake Isabel, 32 miles east of Everett, Wash., for the early beginning of work on what is known as the May creek power plant, by the Everett Railway & Electric Company. The plant is designed to furnish 15,000 hp, to be carried to Everett for street railway, lighting and power purposes, and the plant will be unique in that the head of water will be the greatest in the United States.

The intake for the 32-in. steel pipe will be 30 ft. below the surface of Lake Isabel. The pipe will be carried 12,000 ft., with a fall in that distance of 2500 ft. The total distance will be shortened by 4000 ft. if the company determines to tunnel a granite hill lying between the lake and site for the power house.

Owing to the enormous pressure special steel pipe has been ordered. Toward the nozzle the pipe decreases in diameter to 20 in. The diameter of the nozzle itself will be about five-eighths of an inch. A wheel of the Pelton type will be used. Later, when additional power is needed, another stream and wheel will be installed. The pressure on the steel pipe is 1100 lbs. to the sq. in., and the speed of the water leaving the nozzle is 25,000 ft. per minute.

The cost of the plant will be about $600,000, and it will take the place of a fine steam plant built two years ago. The outlet of Lake Isabel will be dammed, thus storing enough water for a six months' run. This is in a precautionary measure. May Creek is not large, but is a tumbling mountain stream flowing into the lake, and is never dry.

The company is now building roads to the lake, which is a little more than a mile from the Great Northern tracks. The country is so rough that a roundabout route must be taken.

ST. LOUIS COMPANY'S LOAN

It is reported in financial circles that the loan desired by the St. Louis Transit Company has been secured. It is stated that this has been done by either selling or giving as collateral $8,000,000 of the $20,000,000 issue of improvement bonds authorized at the last meeting of the stockholders. These bonds have not been sold up to this time.

Murray Carleton, president of the company, said that the negotiations for securing the loan were progressing favorably, but had not yet been closed. The money is wanted to discharge obligations resulting from the large amount of work made necessary by the Fair, and to meet large payments which come due March 15.

A large force is at work building the World's Fair terminals, and General Manager du Pont says that the work will be pushed to an early completion. Some grading and excavation have been done, but now is the first time that a large force could be profitably employed. The ground has thawed enough to permit active work, and on some of the prepared ground tracks have already been laid. Mr. du Pont is confident that the terminals will furnish all the facilities required and that they will be in readiness for the first crowds.

THE CONNECTICUT RAILWAY AND LIGHTING COMPANY SECURES POWER FROM THE NEW MILFORD COMPANY

The Connecticut Railway & Lighting Company has entered into a 30-year contract with the New Milford Power Company for power for its trolley systems, electric light and power business in Waterbury and New Britain. This contract calls for a minimum payment to the New Milford Power Company, when the plants are completed, of $129,600 per year. These payments are to be graduated during the first eighteen months in the following manner: Minimum payment for the first six months to be not less than $37,240; for the second six months, $46,480; for the third six months, $55,720, and thereafter during the entire term of thirty years the sum of $129,600 per year .

The New Milford Company, operating under a special charter granted by the Legislature of Connecticut in 1893, has acquired and is the owner of the valuable water powers at Bulls Bridge, Gaylordsville and Boardman's Bridge, Conn., on the Housatonic River, and the lands necessary for its use along the river on both sides, for a distance of about 10 miles. It has constructed a dam of solid concrete masonry at Bull's Bridge, on rock foundation, and built a canal over 11,000 ft. in length, giving a fall from the terminus of the canal of 115 ft. A power house has been constructed entirely of masonry and steel, and there are six hydraulic machines and six generators installed and in operation. The capacity of the plant, as rated at the wheels, is 10,500 hp, which power is being delivered at Waterbury for the trolley systems.

This means that the plant already installed has capacity to supply the amount required for the third period or at the rate of $111,000 per year. Plans are now being matured to construct an auxiliary plant at Boardman's Bridge, and also to enlarge the present development by making use of part of the surplus water. The canal has been constructed with sufficient capacity to carry 50 per cent additional water.

SUPREME COURT DECIDES IN FAVOR OF JERSEY CITY

The Supreme Court has just given judgment on demurrer to Jersey City against the Jersey City & Bergen Railroad Company, the Consolidated Traction Company and the North Jersey Street Railway Company and the Bergen Company, lessee, being all the street railway companies using the streets of Jersey City. The suit of the city was to compel the Public Service Corporation, which controls the companies, to pay a license of $10 per car to the city. At the time of the granting of authority to use the streets, the city of Jersey City did so upon condition that the company pay an annual license fee of $10 per car. The companies accepted the condition and then an ordinance containing the license clause was passed, but as soon as the road had been installed the Supreme Court set aside the ordinance. The court holds that the company is bound by its contract with the city. The license fee of $10 per car has not been paid since 1868. The fees now amount to many thousands of dollars long past due, and the companies will be compelled to pay $10 upon each car annually in future.

ANNUAL REPORT OF LOUISVILLE COMPANY

The annual meeting of the Louisville Railway Company was held a few days ago. Directors were re-elected and the operating report for the year just ended was presented. This report shows as follows:

Gross earnings		$1,941,599
Operating expenses	$1,050,125	
Taxes for year	150,000	
Interest on debt and dividend on preferred stock	482,785	
Depreciation on equipment	50,000	
Set aside on account of judgment for back taxes	30,000	1,762,911
Net earnings		$178,688
From which deduct dividend on common stock of 5 per cent		175,000
Net balance		$3,688

For the purpose of comparison the summarized reports of 1903 and 1902 are appended:

	1903	1902
Gross earnings	$1,941,599	$1,771,887
Operating expenses	1,050,125	1,127,716
Net earnings	$891,474	$644,171
Fixed charges	712,786	333,880
Net income	$178,688	$310,291
Dividends	175,000	300,000
Surplus	$3,688	$10,291

PROPOSED NEW POWER STATION FOR NEW ORLEANS

The construction of a new power house station for the New Orleans (La.) Railways Company is proposed. The ultimate capacity of the proposed plant will be 20,000 hp. An equipment capable of developing 7000 hp is to be installed, in the first instance. Sanderson & Porter, 52 William Street, New York, are the consulting engineers for the New Orleans company.

DETAILS OF NEW YORK BRIDGE PLANS

With the approval of Mayor McClellan to the general features of the plan, Bridge Commissioner Best, on Saturday, Feb. 27, made public the details of the proposition framed by Chief Engineer O. F. Nicholls to connect the Brooklyn and Williamsburg Bridges. It involves the erection of an elevated road from Worth and Centre Streets, where the proposed Brooklyn Bridge terminal would end, to run to the Bowery and Delancey Street, at which point it would connect with the proposed elevated road terminal from the Williamsburg Bride. This connection, it is estimated, would cost $2,000,000 for the land, and about $1,000,000 for the construction of the elevated connection.

The proposed extension of the Williamsburg Bridge elevated structure will run over the widened Delancey Street to the Bowery, and there, by having the structure high enough to cross over the Third Avenue elevated tracks, the connection with the road running from the Brooklyn Bridge could be effected. It is proposed to have a large station at the Bowery and running two blocks west toward Mott Street.

The Williamsburg Bridge extension is figured to cost about $8,000,000, including the widening of the street, to which the city will take title May 1. The Brooklyn Bridge terminal, proposed to relieve the bridge crush, will cost $6,000,000, including the terminal building from the bridge to Duane Street, with a three-story office building on top, bringing the total height to a level with the Hall of Records. The switch yards would run to Worth Street, where the connecting railroad would meet it.

MEXICO CITY SYSTEM TO BE EXTENDED

The Mexico Electric Tramways, Limited (known as the Wernher-Beit system), proposes to considerably extend its lines in Mexico City, which are now including those running in the suburbs, some 120 miles in length. The company has filed an application with the Department of Public Communications for authorization to build a line from Nino Perdico, on the south, to Los Angeles on the north side, thus forming a complete circuit across the city.

REORGANIZATION TALK IN CHICAGO

In connection with the retirement of R. R. Govin from the receivership of the Chicago Union Traction Company, Mr. Govin announced that persons controlling the Chicago Union Traction Company, who also have large stock interests in the North Chicago and West Chicago Street Railroad Companies, had concluded to take steps to bring about the reorganization of the Chicago Union Traction system. As many of those interested are desirous that Mr. Govin should represent them, and as his duties and obligations as receiver might hamper him, it seemed wise to him that he should ask the court to relieve him from the position as receiver. Mr. Govin says that any scheme of reorganization, in a measure, rests upon the litigation now in the courts The hearing of the ninety-nine-year case is now being held.

MORE NEW CARS FOR KANSAS CITY

The Metropolitan Street Railway Company, of Kansas City, Mo., has ordered thirty-five more new cars of the St. Louis Car Company. These cars are to be similar to the standard cars of that company, described in the STREET RAILWAY JOURNAL of June 27, 1903, except that they will be mounted on St. Louis No. 47 short wheel-base trucks, instead of the Brill trucks mentioned in that article.

THE McGUIRE-CUMMINGS MANUFACTURING COMPANY

The McGuire-Cummings Manufacturing Company, of Chicago, has recently been organized to take over the business of the McGuire Manufacturing Company. This reorganization is practically a consolidation of the McGuire Manufacturing Company and the Globe Iron Works, both of Chicago. The Cummings mentioned in the new company's title is John J. Cummings, president of the Globe Iron Works.

The Globe Iron Works has a factory located on the north side, Chicago, where it makes a number of iron specialties. The consolidation will add to the manufacturing facilities of these companies.

PERSONAL MENTION

Mr. C. A. SEARS has resigned as electrician of the Puget Sound Electric Railway, of Tacoma, Wash., and Mr. R. J. McClellan has been appointed as his successor.

MR. JAMES A. GREER, for several years connected with the Weber Rail Joint Company, of New York, has recently been advanced to the position of assistant general manager of the company.

MR. A. C. HARRINGTON, formerly manager, purchasing agent and superintendent of the Erie Rapid Transit Street Railway Company, of Erie, Pa., has been appointed superintendent of the Columbus, London & Springfield Railway Company, of Columbus, Ohio.

MRS. W. F. KELLY, wife of W. F. Kelly, general manager of the Oakland Transit Consolidated Railway Company, and the San Francisco, Oakland & San Jose Railroad Company, died at her home in Oakland, Cal., on Feb. 14. Mr. Kelly, who is widely known throughout the country among street railway men and an eleven-year-old son survive her.

MR. CHARLES THRASHER, who has been elected vice-president and general manager of the New York & Long Island Traction Company, is an extremely young man for such an important position. He received his training on the Mandelbaum roads in Ohio, having been auditor of the Western Ohio Railway, and later of the Cincinnati, Dayton & Toledo Traction Company. He was sent to the Long Island road last year, and has been in charge of the operation of the road since that time.

THAT the late Senator Hanna was extremely popular with all the officials and department heads of the street railway companies with which he was connected is attested by the kindly resolution of sympathy drawn by the employees of the Cleveland Electric Railway, and the tribute made to the Senator's memory by Mr. George Mulhearn, for thirty-one years general superintendent of the Cleveland City Railway Company, of which Mr. Hanna was president. Mr. Mulhearn said: "I have lost my best friend. In all the years that I knew Mr. Hanna I never heard a harsh word pass his lips, nor an appeal for help refused. His men always turned to him in trouble, and he was never too busy to listen to their grievances and to right their wrongs. * * * He was one of the most consistent friends of labor in America, and workingmen were just beginning to realize it at the time of his death.

MR. CHARLES T. CHAPIN, for many years the president of the Rochester Car Wheel Works of Rochester, N. Y., which position he filled with conspicuous ability, has been elected vice-president of the National Car Wheel Company, which is a consolidation of four important plants, viz: The Rochester Car Wheel Company, Rochester, N. Y.; Keystone Car Wheel Company, Pittsburg, Pa.; Maher Wheel & Foundry Company, Cleveland, Ohio, and the Cayuta Wheel & Foundry Company, Cayuta, Pa. The list of officers for the new company are as follows: C. V. Slocum, president, Pittsburg, Pa.; Charles T. Chapin, vice-president, Rochester, N. Y.; C. A. Maher, secretary, Cleveland, Ohio, and William T. Goodnow, treasurer, Cayuta, Pa.

MR. C. D. BALDWIN has recently been appointed purchasing agent of the United Railroads, of San Francisco, to succeed Mr. A. K. Stevens, who has been made claim agent of the company, the former claim agent, Mr. E. E. Gates, having resigned to take up private law practice. Mr. Baldwin formerly was purchasing agent for the Jersey City, Hoboken & Paterson Railway Company, and more recently held a similar position with the Public Service Corporation, of New Jersey, at Newark, N. J. Another change in the personnel of the United Railroads is the appointment of Mr. H. H. Lynch, formerly superintendent of construction and road engineer, as consulting engineer of the company. Mr. Warren C. Lane has been made engineer of maintenance of way, assuming Mr. Lynch's duties, the title of superintendent of construction being abolished.

MR. GEORGE A. STANLEY, of Cleveland, who, as previously noted in the STREET RAILWAY JOURNAL, has been elected president of the New York & Long Island Traction Company, is prominently identified with the Andrews-Stanley interests, which control the Cleveland Electric Railway, the Utica & Mohawk Valley Railway and the New York & Long Island Traction Company. Mr. Stanley is purchasing agent for the Cleveland Electric Railway Company, and has had a wide experience in electric railroading. The New York & Long Island Traction Company has about 22 miles of road in operation, and has secured all the franchises necessary for building an 18-mile extension. Its lines will connect with the Kings County elevated line of the Brooklyn Rapid Transit Company at the city line in Brooklyn, and with the surface lines of the Brooklyn company at Jamaica, thus giving ready access to Brooklyn and New York.

G. A. STANLEY

MR. WILL H. BLOSS, heretofore chief engineer and roadmaster of the Indiana Union Traction Company, has resigned and accepted a position with the Paige Iron Works, of Chicago, which is the switch and crossing department of the Buda Foundry & Manufacturing Company. Mr. Bloss will represent the Paige Iron Works, traveling from the Chicago office, and will give especial attention to the increasing of the urban and interurban work of this company. His connection with the Indiana Union Traction Company covers a period of five years, starting in when the line was being built between Anderson and Indianapolis. Mr. Bloss will look after the outside matters heretofore cared for by Mr. E. S. Netherout, chief engineer of the Paige Iron Works. Mr. Netherout, who has been with the company for over twelve years, will spend most of his time directing the sales from the Chicago office and looking after the engineering of the company.

MR. W. A. McGUIRE, president and general manager of the McGuire Manufacturing Company, died in Chicago, Feb. 20. Mr. McGuire was one of the most prominent and successful manufacturers of street railway apparatus in this country, and was personally the patentee of a great many of the appliances which he manufactured. He was a resident of Chicago, but also had large manufacturing interests in England where the McGuire apparatus was almost, if not quite, as well known as in this country. Mr. McGuire was very successful in his enterprises and might have retired a number of years ago but for the great personal interest and pride which he took in the companies which bore his name. He had recently, however, decided to retire from active business, and only last week disposed of his interests in the McGuire Manufacturing Company to several gentlemen, prominent among whom is Mr. W. J. Cooke, who for a long time has been vice-president of the company, and who has always had charge of its selling interests.

TABLE OF OPERATING STATISTICS

Notice.—These statistics will be carefully revised from month to month, upon information received from the companies direct, or from official sources. The table should be used in connection with our Financial Supplement "American Street Railway Investments," which contains the annual operating reports to the ends of the various financial years. Similar statistics in regard to roads not reporting are solicited by the editors. * Including taxes. † Deficit. *a* Including all lines operated.

Company	Period	Total Gross Earnings	Operating Expenses	Net Earnings	Deductions From Income	Net Income, Amount Available for Dividends
AKRON, O. Northern Ohio Tr. & Light Co	1 m., Jan. '04	59,607	37,098	22,509	22,467	43
	1 " " '03	58,787	34,843	23,944	20,966	2,978
ALBANY, N. Y. United Traction Co.	3 m., Dec. '03	418,140	288,013	130,127	76,147	53,979
	3 " " '02	398,667	262,482	136,185	71,672	64,512
AURORA, ILL. Elgin, Aurora & Southern Traction Co.	1 m., Jan. '04	34,694	22,309	12,385	9,256	3,129
	1 " " '03	33,254	21,301	11,953	9,216	2,736
	7 " " '04	276,955	162 339	114,616	64,374	50,242
	7 " " '03	257,131	147,012	110,120	63,514	46,606
BALTIMORE, MD. United Railway & Electric Co	12 m., Dec. '03	5,571,003	2,554,241	3,016,762	2 708,030	308,732
	12 " " '02	5,094,680	2,252,133	2,842,547	2,637,115	205,432
BINGHAMTON, N. Y. Binghamton Ry. Co	1 m., Jan. '04	16,764	10,812	5,952	------	------
	1 " " '03	16,417	11,586	4,831	------	------
	7 " " '04	144,951	75,003	69,949	------	------
	7 " " '03	133,035	75,052	57,983	------	------
BUFFALO, N. Y. International Trac. Co.	1 m., Dec. '03	325,464	190,072	135,392	134,365	1,027
	1 " " '02	309 871	169,957	139 914	132,822	7,092
	6 " " '03	2,174,765	1,164,777	1,009,988	796,444	213,543
	6 " " '02	1,923,689	999,654	924,035	774,555	149,480
CHICAGO, ILL. Chicago & Milwaukee Elec. Ry. Co	1 m., Jan. '04	18,987	10,812	8,175	------	------
	1 " " '03	12,035	6,571	5,465	------	------
Metropolitan West Side Elevated R. R. Co	1 m., Jan. '04	174,240	------	------	------	------
	1 " " '03	174,795	------	------	------	------
South Side Elevated R. R. Co	1 m., Jan. '04	135,781	------	------	------	------
	1 " " '03	134,287	------	------	------	------
CINCINNATI, O. Cincinnati, Newport & Covington Light & Traction Co	1 m., Dec. '03	108,419	* 59,488	48,932	21,413	27,518
	1 " " '02	100,587	* 53,950	46,638	23,886	22,752
	12 " " '03	1,224,352	*700,962	523,390	252,760	270,630
	12 " " '02	1,103,995	*610,445	493,551	255,873	237,677
CLEVELAND, O. Cleveland & Southwestern Traction Co	1 m., Jan. '04	27,852	22,557	5,294	------	------
	1 " " '03	26,949	19,615	7,334	------	------
Cleveland, Painesville & Eastern R. R. Co	1 m., Jan. '04	11,740	9,024	2,716	------	------
	1 " " '03	12 158	7,971	4,187	------	------
DETROIT, MICH.	1 m., Jan. '04	311,440	226,103	85,337	88,067	† 2,730
	1 " " '03	321,145	195,938	125,207	81,156	44,051
FORT WORTH, TEX. Northern Texas Traction Co	1 m., Jan. '04	37,880	25,468	12,412	9,583	2,828
	1 " " '03	29.950	16,313	13,637	8,933	4,704
	12 " Dec. '03	465,394	261,357	204,037	111,371	92,667
	12 " " 02	269,116	123,682	145,433	5,852	139,582
HANCOCK, MICH. Houghton County St. Ry. Co	1 m., Dec. '03	13,756	12,008	1,748	2,697	†949
	1 " " '02	13,800	11,105	2,695	2,604	91
	12 " " '03	189,404	122,840	66,564	34,933	31,631
	12 " " '02	170,710	112,412	58,297	31,250	27,047
HARRISBURG, PA. Central Pennsylvania Traction Co	1 m., Jan. '04	36,158	37,221	†1,063	------	------
	1 " " '03	38,352	26,414	11,938	------	------
HAZLETON, PA. Lehigh Traction Co	1 m., Jan. '04	10,017	7,798	249	------	------
	1 " " '03	9,674	9,323	351	------	------
HOUSTON, TEX. Houston Electric Co.	1 m., Dec. '03	29,707	24,956	4,752	8,109	†3,358
	1 " " '02	30,418	24,973	5,444	6,250	† 806
	12 " " '03	416,124	272,564	143,559	84,657	58,903
	12 " " '02	360,018	210,772	149,246	------	------
JACKSONVILLE, FLA. Jacksonville Electric Co	1 m., Dec. '03	21,424	15,606	5,818	3,170	2.648
	1 " " '02	18,115	12,650	5,466	2,917	2,549
	12 " " '03	248,650	165,942	82,707	36,403	46,304
LIMA, O. Western Ohio Traction Co	1 m., Jan. '04	14,154	8,850	5,304	------	------
	7 " " '03	142,374	70,240	72,134	------	------
MILWAUKEE, WIS. Milwaukee El. Ry. & Lt. Co	1 m., Jan. '04	259,413	139,552	119,862	74,719	45,143
	1 " " '03	244,469	129,402	115,067	71,098	43,969
MINNEAPOLIS, MINN Twin City Rapid Transit Co	1 m., Jan. '04	331,412	156,502	175,911	70,019	104,891
	1 " " '03	311,838	148,575	163,263	60,900	102,362
MONTREAL, QUE. Montreal St. Ry. Co	1 m., Jan. '04	183,708	131,487	52,221	16,482	35,739
	1 " " '03	172,143	110,611	61,532	18,516	45 016
	4 " " '04	769,136	486 837	282,299	68,848	213,451
	4 " " '03	703,788	424,576	279,213	65,990	213,222
MUNCIE, IND. Muncie, Hartford & Ft. Wayne Ry. Co	1 m., Jan. '04	11,569	6,387	5,182	------	------
	2 " " '04	24,307	11,780	12,527	------	------
NEW YORK. Interborough Rapid Transit Co	3 m., Dec. '03	3,743,308	1,396,395	2,346,913	1 596,579	750,334
	9 " " '03	10,124,323	4,006,105	6,118,218	2,949,617	3,168,601
New York City Ry. Co. *a*	6 m., Dec. '03	11,864,837	5,777,619	6,087,218	6,028,133	59,085
	6 " " '02	11,595,620	5,826,173	5,769,447	5,840,106	†70,659
PEEKSKILL, N. Y. Peekskill Lighting & R. R. Co	1 m., Jan. '04	8,643	5,735	2,908	------	------
	1 " " '03	8,015	5,472	2,543	------	------
PHILADELPHIA, PA. American Railways	1 m., Jan. '04	99,624	------	------	------	------
	1 " " '03	89,978	------	------	------	------
	7 " " '04	852,220	------	------	------	------
	7 " " '03	729,905	------	------	------	------
ROCHESTER, N. Y. Rochester Ry. Co	1 m., Jan. '04	113,454	70,865	42,589	26,125	16,464
	1 " " '03	101,912	54,520	47,392	25,586	21,806
ST. LOUIS, MO. St. Louis Transit Co.	1 m., Jan. '04	565,098	------	------	------	------
	1 " " '03	527,870	------	------	------	------
SAO PAULO, BRAZIL. Sao Paulo Tramway, Light & Power Co., Ltd	1 m., Jan. '04	120,000	36,000	84,000	------	------
	1 " " '03	102,587	32,019	70,568	------	------
SYRACUSE, N. Y. Syracuse Rapid Transit Co	1 m., Dec. '03	73,649	43,067	30,582	20,245	10,337
	1 " " '02	67,405	36,804	30,600	19,025	11.575
	6 " " '03	424 644	239,156	185,488	121,705	63,782
	6 " " '02	371,733	203,067	168,666	114,150	54,516
TERRE HAUTE, IND. Terre Haute Elec. Co.	1 m., Dec. '03	45,524	34,405	11,119	9,480	1,639
	1 " " '02	35,378	27,684	7,693	6.414	1,279
	12 " " '03	474,250	312,084	162,167	87,385	74,782
	12 " " '02	327,957	265,355	62,602	76,165	†13,563
TOLEDO, O. Toledo, Bowling Green & Southern Traction Co	1 m., Jan. '04	19,747	15,379	4,368	------	------
	1 " " '03	20,791	13,845	6,946	------	------
Toledo Rys. & Lt. Co.	1 m., Jan. '04	137,517	73,806	63,711	41,312	22 399
	1 " " '03	125,494	62,396	63,097	39,458	23 639