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ELECTRIC RAILWAY PRACTICE ON THE CONTINENT OF EUROPE

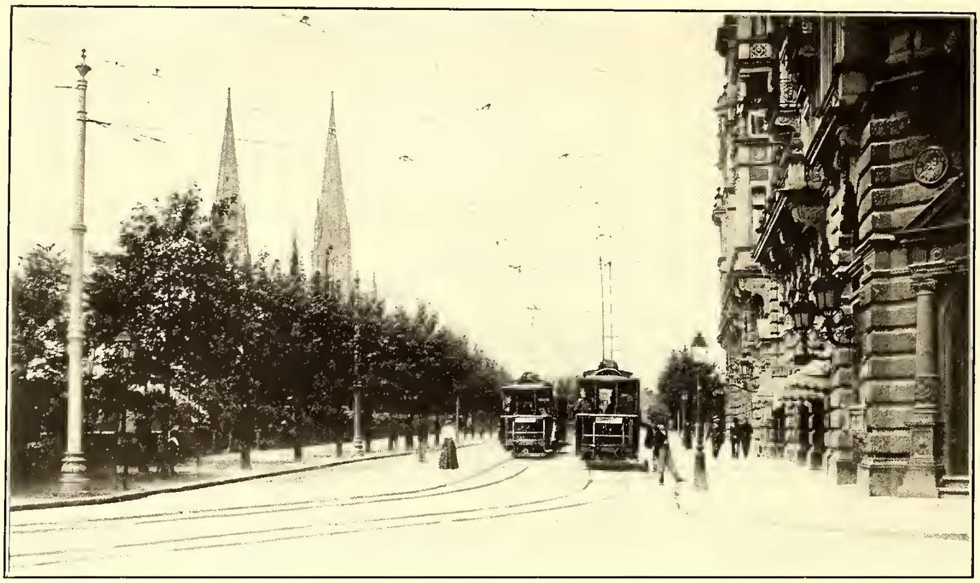
BY HEINRICH VELLGUTH

It is a bold undertaking to attempt to describe the electric railway practice in all of Europe, with its manifold and widely varying conditions, and no one must therefore expect to find a thoroughly exhaustive discussion of the subject in this series of articles. It is impossible for one person to obtain a comprehensive view of this great field, because, while it is not difficult for a person conveniently located to form a clear idea as to the conditions in his own country or immediate vicinity, he has to rely for the rest on the reports of companies constructing roads or his own personal friends in the street railway profession located in the several countries.

VIEW IN SPITTELMARKT, BERLIN

Some readers may even doubt that it is possible for any one person properly to survey and report on the conditions in his own country. This, however, does not apply strictly to the writer, who, as secretary of the Verein Deutscher Strassenbahn und Kleinbahn Verwaltungen, has at his disposal sources of information such as few in the profession can lay claim to. The street railway associations which exist in every large country are, above all other things, information bureaus of the first class on all matters pertaining to the industry, and of these the German association includes probably the widest extent of country of any in Europe. It is furthermore one of the oldest of such associations, and has had to deal at its early meetings with all kinds of motive powers and roads of every type, whether they be urban or suburban, freight, mine or mountain installations.

The fact, furthermore, that most of these different forms of roads were tried in Germany before other European countries had made any trials, and thus gained valuable experience, and that these roads were built by German firms, has induced nearly all European interests to ask the German association for information and to follow largely German designs, so that a German railway engineer should be well qualified to present a comprehensive picture of the entire situation, if such can be written at all. It was then only after a careful consideration of the facts here mentioned that the writer concluded to accede to the request of the STREET RAILWAY JOURNAL and write this article.



DOUBLE TROLLEY LINE IN STRASSBURG

First of all, the writer wishes to express his indebtedness to all, especially those not residing in Germany, who have so cheerfully provided him with valuable information. Several large German manufacturing companies and personal friends of the writer in other European countries deserve special mention.

As this article is intended for an American periodical, it might be advisable to give attention first to the conditions or practices which are universal throughout continental Europe and differ from those of America. Chief among other factors of this kind are: (1) The smaller traffic; (2) the far lower wages and the different labor conditions; (3) the small money unit; that is, the well-known "nickel," which is five cents in the United States and only one-quarter of that amount in Germany, and (4) the difficulties placed in the way of companies by the municipalities firstly, on account of their desire to insure safety by prescribing almost prohibitive conditions, and, secondly, because of their policy of extorting absurdly large fees for franchises and rights of all kinds, thus crippling the service.

Let us take up these points in detail: 1. No European (continental) city can show a traffic even approximating that which exists in New York, Chicago and other large American cities. Even Berlin, where one might expect very dense traffic, is far behind New York and other American cities of approximately the same size. But the traffic of Berlin is increasing enormously from year to year. The Grosse Berliner Strassenbahn alone, that is, without its leased roads, transported in 1900 236,300,000 passengers, against 306,300,000 in 1901, an increase of about 30 per cent.

DEVELOPMENT OF TRAFFIC IN GREATER BERLIN

	INDUSTRIAL EXHIBITION 1896		1897		1898		1899		1900	
POPULATION	2,203,000		2,269,000		2,345,000		2,414,000		2,485,000	
	Persons	Rides per Capita	Persons	Rides per Capita	Persons	Rides per Capita	Persons	Rides per Capita	Persons	Rides per Capita
Steam elevated road	90.00	40.76	87.75	38.6	93.56	39 55	95 00	39.3	97.53	39.7
Street railways	183.00	83.2	198.00	87.5	217.00	92.6	244.60	101.3	280.35	112.6
Omnibuses	38.00	17.2	44.00	19.4	54 00	23.00	75.00	30.9	80.57	32.4
Total	311.00	141.16	329 75	145.5	364.56	155.15	414.60	171.5	458.45	184.7

SUMMARY.—Increase in population, 1896-1900, 16 per cent. Increase in passengers: Steam elevated road 8 per cent, street cars 53 per cent, total 48 per cent. Increase in trips per capita: Steam elevated road (decrease) 1 per cent, street cars 35 per cent, total 31 per cent.

DEVELOPMENT OF TRAFFIC IN GREATER HAMBURG

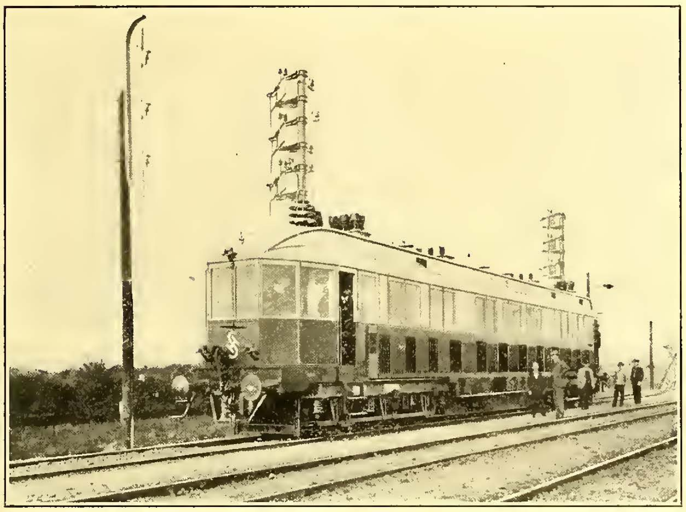
	1896		1897		1898		1899		1900	
POPULATION	823,865		846,929		865,828		885,189		904,631	
	Passengers	Rides per Capita	Passengers	Rides per Capita	Passengers	Rides per Capita	Passengers	Rides per Capita	Passengers	Rides per Capita
Street railways	73,929,436	89.7	84,957,742	100.3	89,697,051	103.6	95,757,733	108 2	102,641,383	113.6
City and suburban traffic on steam lines	6.728,000	8.2	7,158,000	8.5	7,588,000	8 8	8,018,506	9.1	8,355,000	9.2
Total on land	80,657,436	97.9	92,115,742	108.8	97,285,051	112 4	103,776,239	117.3	110 996,383	122.8
Steam roads	17,538,950	21.3	18,343,327	21.7	18,355,887	21.2	19,186,122	21.6	19,501,994	21.6
Total	98,196,386	119.2	110,459,069	130.5	115,640,938	133.6	122,962,361	138.9	130,498,377	144.4

SUMMARY.—Increase in population, 1896-1900, 10 per cent. Increase in passengers: On street cars 39 per cent, total 33 per per cent. Increase in trips per capita: On street cars 27 per cent, total 21 per cent.

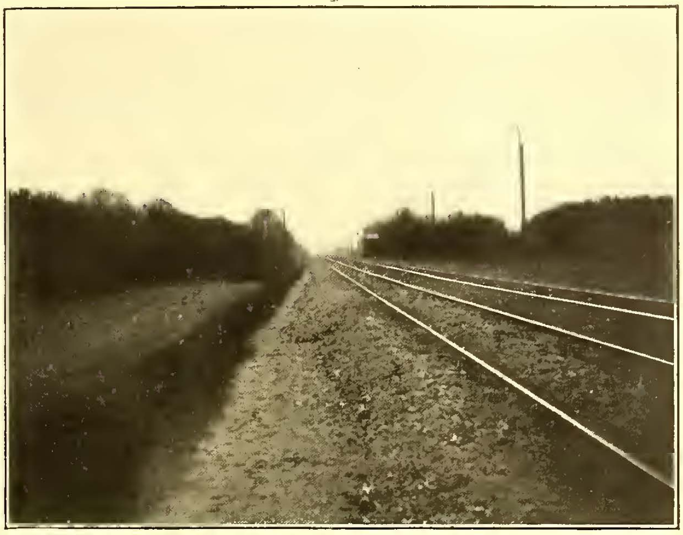
The traffic increase in Greater Berlin is shown by the table on the opposite page.

A similar table prepared for Greater Hamburg shows quite different results.

The receipts of the roads operated by the Grosse Berliner Strassenbahn in 1901 were 30,196,534 marks, against 27,580,968 marks in 1900; 76,674,000 car km were traveled.



EXPERIMENTAL HIGH-SPEED CAR, ZOSSEN LINE



TRACK CONSTRUCTION ON ZOSSEN LINE

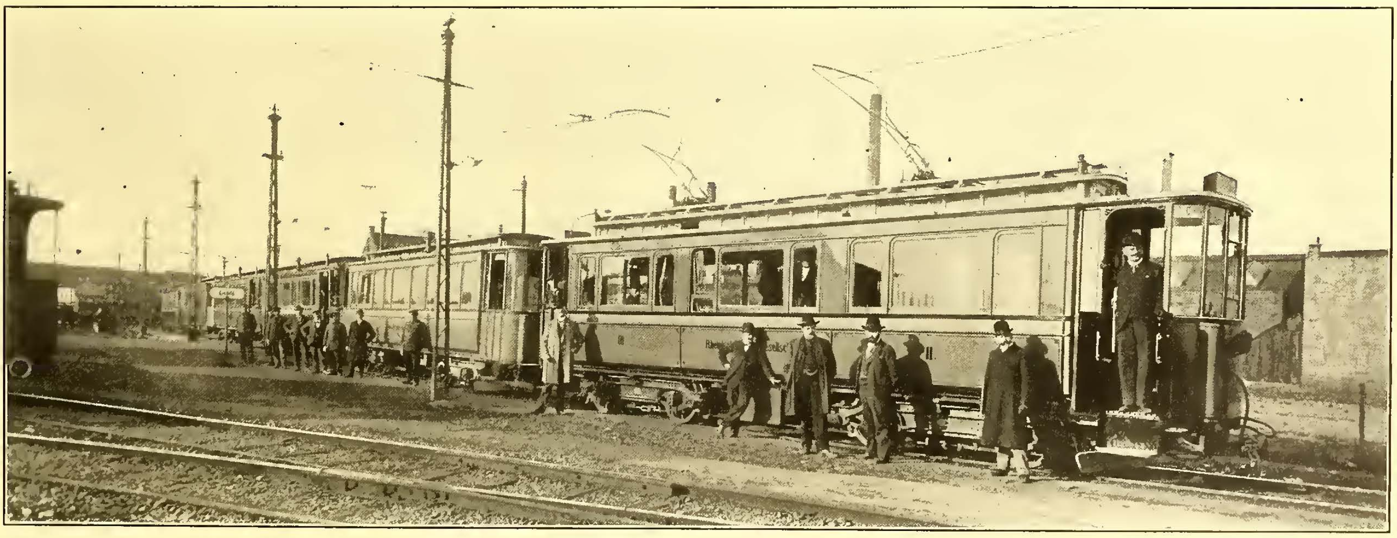
The receipts of the Grosse Berliner Strassenbahn only were 26,537,664 marks in 1901, the average daily receipts, therefore, 72,715 marks. Ten years ago they were about one-half, namely, 14,400,000, and in 1881, twenty years ago, not even one-quarter, namely, 6,600,000 marks.

The receipts of the Strassen-Eisenbahn-Gesellschaft, of Hamburg, amounted to the much smaller sum of 10,348,371 marks in 1901, against 9,803,892 marks in 1900, the mean daily receipts being 28,352 marks. The passengers transported in 1901 numbered 94,500,000, against 90,300,000 in 1900, an increase of 4.65 per cent, against 30 per cent in Berlin.

The following financial figures of the Hamburg road are very instructive and typical of the development of German street railways, as the company is one of the strongest in Germany. During the thirty-six years of its existence up to 1901 the average dividend has been 4.87 per cent, and the aggregate dividend payment has been 14,406,468 marks. During this time the city has received a percentage on the gross receipts, on a basis of 1 pfennig per ticket and 5 pfennigs on time tickets, amounting to 9,142,198 marks, or a sum equivalent to about 63 per cent of the dividends paid on the capital stock, in addition to enormous payments for pavements and widening of streets.

Naturally, little attention could be paid by the company to the demands of the public for lower fares in view of these payments, and the same condition of affairs holds throughout Germany. There are, in addition, other taxes, and many companies are required to pave the streets at a cost which runs into millions of marks. This money has to come indirectly from the public through fares paid; yet the ordinary citizen wonders why the company refuses to equip doubtfully profitable lines. Taxes feel especially burdensome in the years when no dividends are paid, as in 1892, the year of the cholera in Hamburg. That year the stockholders received nothing, but the State took 417,000 marks from the company by the 1-pfennig tax alone.

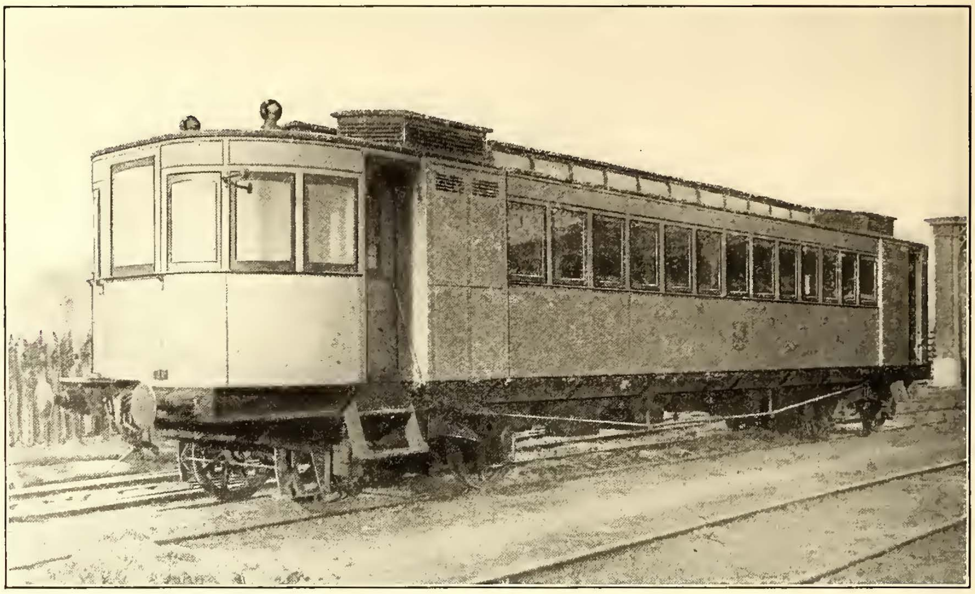
From the Berlin reports for 1900 some interesting conclusions may also be drawn. The Grosse Berliner Strassenbahn (omitting its auxiliary lines) had expended up to the close of 1900 for street cleaning and improvements, such as pavements, etc., a total of 75,000,000 marks, a very handsome sum, which explains why the fare has not been lowered.



DUSSELDORF-KREFELD ROAD WITH CARS WHICH RUN AT 60 KM PER HOUR

The custom, inaugurated centuries ago, that the business man should reside in close proximity to his place of business, and, if possible, in the same house, is still in vogue in most large continental cities with but few exceptions. This fact probably explains the slower traffic development in

SPALENTHOR, BASEL



ACCUMULATOR CAR OF THE BELGIUM STATE RAILWAYS TRUNK LINE SERVICE

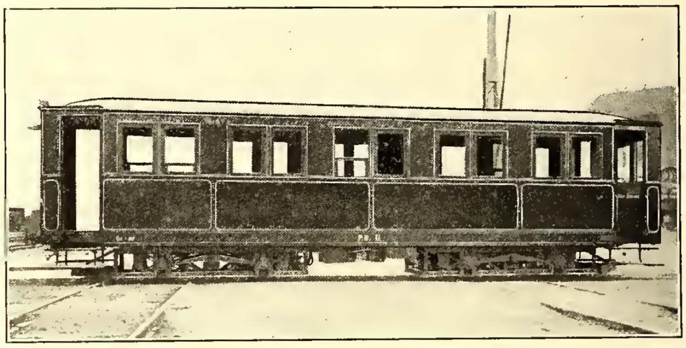
Germany as compared with England and the United States. The German city which most closely resembles cities in these countries is Hamburg, where the business center is distinctly separated from the residence portion. This has the advantage of increasing traffic, but the disadvantage of concentrating traffic during rush hours in one direction, crowded cars going one way and empty cars in the other.

As a road which has to cater to short-distance riders must run cars under short headway, a very small car has

SUPPLY TUBE CONDUCTOR AT FRANKFORT. THE VIEW SHOWS A CROSSING OF THIS OLDEST FORM OF TROLLEY SYSTEM WITH THAT OF THE MODERN BOW TROLLEY

been adopted in Europe. A car seating twenty passengers and with standing room for a few more is considered a large car, while most cars only seat sixteen or less. Another reason for using small cars is the impossibility of passing around the 15-m to 18-m curves in many streets with larger cars. There are places where cars have to pass through crowded streets which only measure 5 m between house walls. But more will be said about the cars farther on. To cope with the varying traffic conditions during the day extensive use is made of trailers, which are usually remodeled horse cars. New trailers have been built only in comparatively few cases.

And now as to the second point, namely, the lower wages paid in Europe. These have made it more economical in many cases to alter and repair old and worn-out cars and



ACCUMULATOR CAR, NARROW GAGE STEAM RAILWAY, LUDWIGSHAVEN, MUNDENHEIM

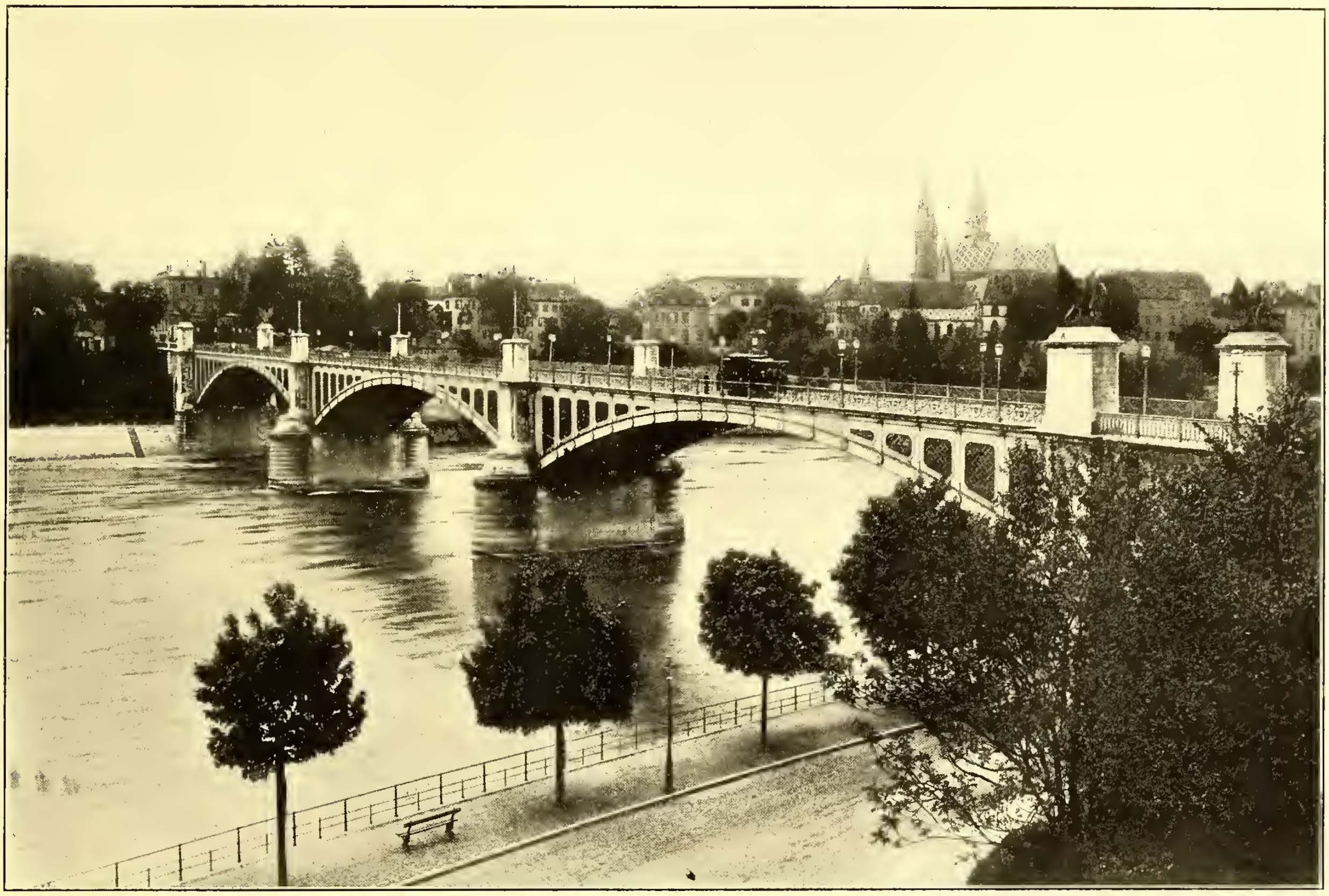
tracks than purchase new equipment. The lower wages also explain the smaller cars, as the conductor's wages are

OVERHEAD CONSTRUCTION IN FRANKFORT, SHOWING TELEPHONE GUARD WIRES

not such an important item of the expenditure as in the United States.

The third point mentioned as exercising an important influence on European traffic conditions was the small money unit. This precludes the possibility of a uniform fare, which would be very desirable. The European public often refer to the uniform American fare, saying that if it is possible in the United States it ought to be possible in Europe. It must be remembered, however, that the smallest piece of nickel money (copper money being used extensively only in China and being considered "unworthy") is 5 cents in the United States, against 5 pfennigs (1¼ cents) or 5 centimes (1 cent). While the European public admits that a uniform 5-pfennig fare is impracticable, they profess to see no reason for not having a uniform 10-pfennig fare. Although the expenses of an American road may be higher, 10 pfennigs is still less than one-half of 5 cents. For these reasons fares are proportioned according to "zones" traveled. It should be stated, however, that three or four average-sized roads (some small ones, but not a single large one) have successfully introduced the uniform 10-pfennig fare. The roads have a varying traffic, for the seats are occupied on an average by three sets of people during one trip. All other German roads which have tried the 10-pfennig fare have endeavored to return to the zone method wherever the cities permitted it. In all cases of this kind where the fare has been raised the road belonged to the city, but wherever it was owned by a private company the cities prohibited an increase in the fare. The result is that many of the roads are not earning a profit, and frequently are losing money. The only salvation for these properties is their purchase by the city, and this, fortunately for the companies, is the present tendency. Up to even a year ago many railway managers thought favorably of a uniform 10-pfennig fare, but the sentiment has changed, and those who adopted the plan are trying equally hard to abolish it, a task of considerably greater difficulty than its introduction. The result per car kilometer of the system where it has been introduced is very disappointing; on one road the receipts fell from 40 pfennigs to 35 pfennigs, on another from 35 pfennigs to 29 pfennigs, etc.; that is as much as 17 per cent in one year. The gross receipts were larger, but the increased traffic resulting from the reduction of fare required so much more rolling stock that the final result was a great disappointment. This was especially the case in towns where the street railways were the only means of transportation; that is, where other means of transportation were lacking, and the street railway companies had to carry passengers to the suburbs as well as within the city.

Some roads were even forced by the cities to introduce, in addition to a 10-pfennig fare, very low-priced commutation or time cards, permitting the holder to use them whenever convenient; these in some cases were sold for 60 marks or less per year for an 8-km distance. That a company must operate at a loss under such conditions is evident when we consider that if a person uses the road four times daily, or about 1500 times yearly, along the 8-km road back and forth, he travels 24,000 km for 6000 pfennigs, or ¼ pfennig per kilometer. In addition to this, most people owning such tickets use the road during rush hours, which compels the company to have a large reserve of cars and employees for use during these few hours. Scholar and workingmen tickets have frequently been sold for 3 marks per month. That such conditions are detrimental to a company is shown by the reports which have recently been made public. There is little hope for the roads which have agreed to such low fares with city authorities, while municipalities, having control over their own finances, have hurriedly gone back to higher fares when they operate the roads themselves.

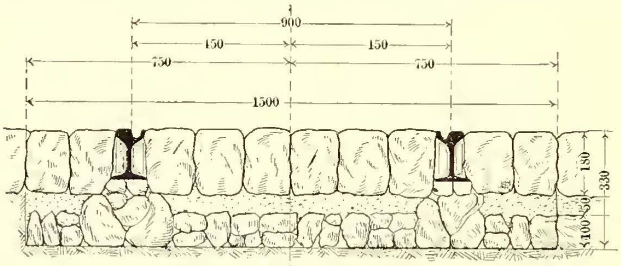


BASEL-WETTSTEIN BRIDGE

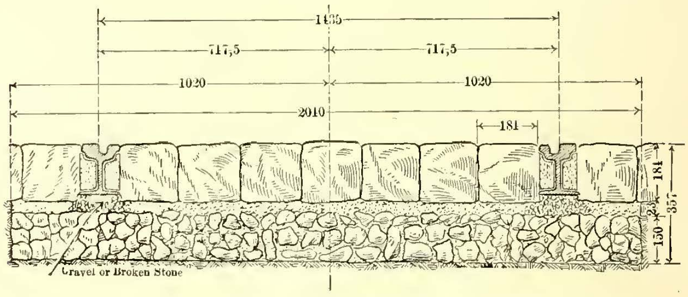
The fourth point is the extreme safety regulations prescribed by the cities and the æsthetic sense so highly developed in Europe which impose expensive methods of operation and construction altogether unwarranted by the extent of traffic. In addition, the personal views of the authorities and municipal bodies in regard to safety regulations have precluded the adoption of standard types of cars, etc., which are so essential for inexpensive installation and maintenance. Frequently a road has to equip each car with two or three kinds of safety devices, all serving the same purpose, and only required so as to satisfy the notions of two or three different authorities through whose territories the road passes. It is not at all uncommon to see a car equipped with three kinds of brakes, namely, hand brake, short-circuit and magnetic brake, and, perhaps, also a track shoe brake.

The æsthetic considerations often require expensive poles, with highly ornamented brackets, which sometimes, as on the Jungfernstieg, in Hamburg, cost about 10,000 marks completely installed. The same considerations made it possible for the accumulator companies to induce the authorities to prescribe accumulator service in fine residence districts by forbidding trolley poles within the city limits. This is especially true in France, for there especial attention is paid to everything which is tasteful. With great reluctance the Hanover Street Railway Company, forced by this sentiment, undertook to operate its system by accumulators. After having done so, the company unfortunately thought at first that the service was more satisfactory than it ultimately proved to be, and replied to the numerous questions as to the outcome of the experiment by saying that it resulted in a considerable saving. The consequences were that other roads which were compelled to use accumulator cars on account of this opinion were greatly embarrassed, and losses of millions of marks were entailed. That the first favorable opinion at Hanover was based on defective calculations has been since discovered by the directors of the Hanover Company, much to their disgust. Since then the Prussian Minister of Public Works has forbidden the use of accumulator cars in Berlin, Hanover and Hagen against the expressed wish of the cities, so that their fate is sealed, at least as far as Germany is concerned. The other roads which were drawn into this complication will probably have little difficulty in the future in doing away with accumulator cars. Other countries, especially France, have still a number of roads equipped with these cars. In Halle and Karlsruhe (Germany) they

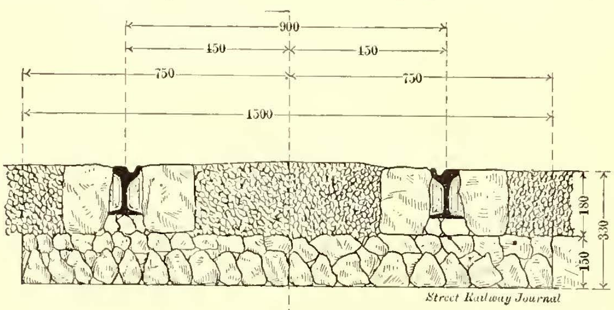
PIAZZA S. CARLO IN TURIN



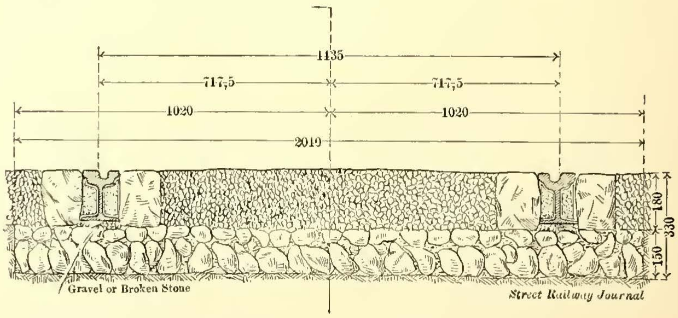
CROSS SECTION OF OLD TYPE OF TRACK CONSTRUCTION IN PAVED STREET



CROSS SECTION OF STANDARD TRACK CONSTRUCTION IN PAVED STREET IN EUROPE (WITH EXCEPTION OF GAGE LINE, WHICH DIFFERS)

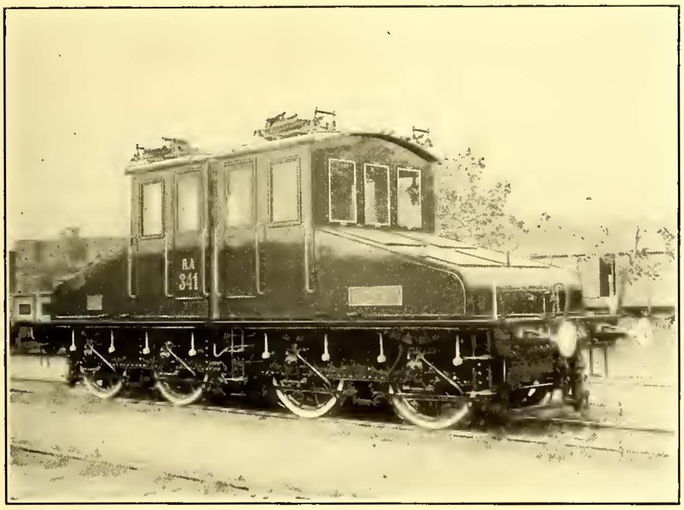


CROSS SECTION OF OLD TRACK IN MACADAM STREET



CROSS SECTION OF STANDARD TRACK IN MACADAM STREET IN EUROPE are still in use, because the university laboratories, where delicate instruments are housed, must not be disturbed by earth currents. In Strassburg, where a large university is located, the road was obliged to use a complete metallic circuit with two trolley wires. In a few cities the surface contact system was prescribed.

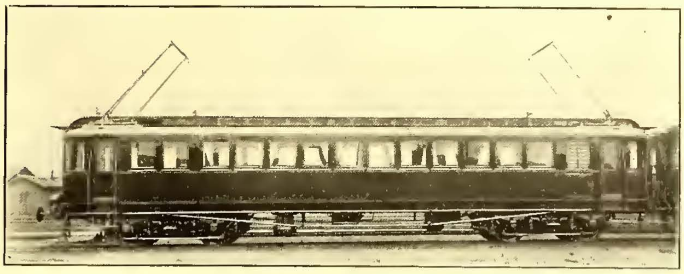
The worst feature of the entire situation is that European authorities seem to have entirely lost sight of the most important fact of all, namely, that the first duty of a street railway is the successful transportation of passengers. European authorities are particularly fearful of disturbing or interfering with local conditions, many of which are hundreds



ELECTRIC LOCOMOTIVE, VALTELLINA RAILWAY

of years old, and do not hesitate to express this feeling where the traffic question is involved. The writer returned to Germany in 1893, after a six months' trip through the United States, with the conviction that many methods in that country are well worthy of imitation; but he has finally come to the conclusion that the American will approach the European more as to his mode of living than vice versa, while so far as traffic conditions are concerned he wishes that the European will become imbued with a good dose of Americanism.

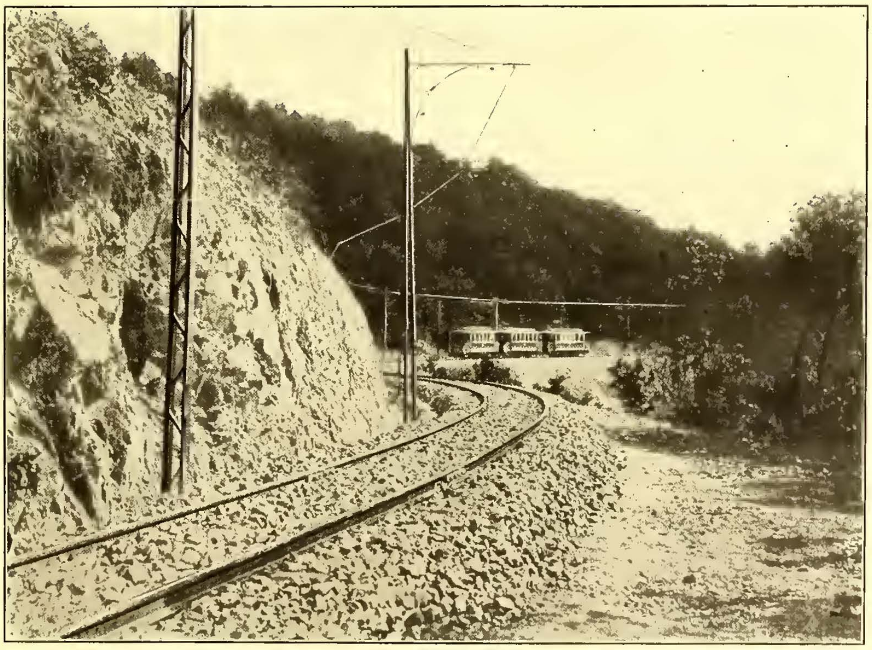
The majority of European street railway charters contain the clause that the companies must install any system or apparatus which has been found efficient and successful elsewhere when requested to make the change by the city authorities. In only a few cases is this clause modified by another stating that such a request can only be made if the change be consistent with ordinary business methods, namely, if it would not force the road into bankruptcy. This shows that a road can never be highly successful and pay large dividends, for as soon as this point is reached the authorities will demand the change to a conduit or accumulator system, or the installation of some other very expensive luxury. The sums paid by the companies for the maintenance of pavements and the cleaning of streets in German cities are enormous. Both are relics of the old street car days and relate to the space between the rails and from 25 cm to 60 cm outside the rails. Some roads were exempted from such duties when they introduced electricity because the cause—the horses—was removed, a motor car neither wearing nor soiling the pavement. As a substitute, the roads often volunteered to pay over to the city a part of their net earnings in case the latter exceeded 5 per cent or 6 per cent. The agreement is generally as follows: In case a 5 to 7 per cent dividend is declared, the authorities get 25 per cent of the surplus over 5 per cent; for a 7 per cent dividend the authorities receive 50 per cent, and so on for greater earnings. This payment is usually in addition to the percent-



MOTOR CAR, VALTELLINA RAILWAY

age on the gross receipts. This practice formed the subject of an able review by General Secretary Eduard Fuster, of the French Street Railway Association, in his recently published "Annuaire Général des Tramways de France," a book containing authoritative statistics in regard to all French roads. His words will be quoted in part when the writer discusses the street railways of France, although they are applicable to all European roads.

Another serious burden on street railway operation in Europe results from the fact that the telephone systems are usually owned either by the government or by the State which grants the franchise to the street railway company. The latter generally uses this circumstance to good advantage by imposing conditions on the street railway companies which result in those companies paying for the improvement in the construction of the telephone lines. The State not only requires the railway companies to install guard wires above and next to the trolley wires, which



TURKHEIM-DREIAHREN, INTERURBAN RAILWAY

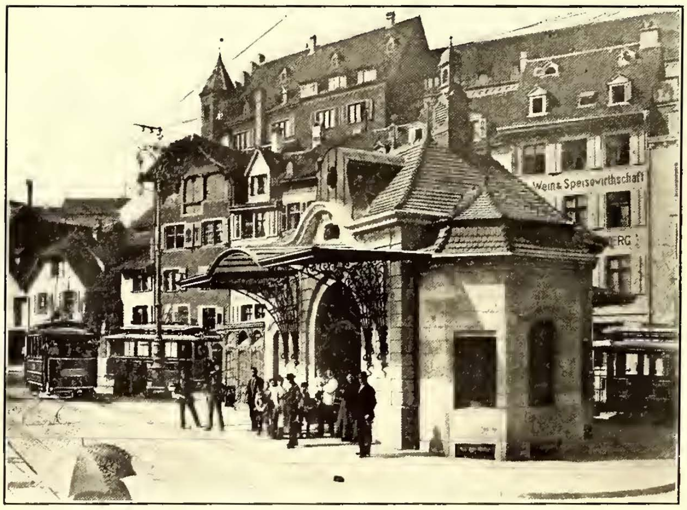
are frequently a complicated network, but also that a wooden lath be attached directly above the trolley wire for a guard; that the trolley pole must not carry current; that the trolley wheels shall be flanged on each side with hard-rubber bushings which are larger than the wheels themselves, and that the company furnish the telephone system with a metallic return wire for each single telephone line as soon as a disturbance is noticed thereon. This, of course, has not been necessary in countries where the telephone lines were operated by private companies. In such cases the latter had to make such changes as the advance in electrical engineering made necessary on account of the introduction of the electric railway.

During the last year, as the result of an extended series of experiments, which were, of course, conducted at the expense of the railway companies, the conclusion was reached that the best safety device was the insertion of fuses in the telephone circuits. These tests will not be continued in Germany, however, as the German courts have decided against the method in a decision rendered in January, 1902.

Although the railway companies have paid for everything of this kind which was demanded of them for the protection of telephone circuits, and for some companies this expense amounted to more than 1,000,000 marks, there have been three big fires in telephone central stations resulting from the telephone and railway wires coming in contact. In all three cases the courts either laid the blame on the telephone companies or the latter made no claim for indemnity. At Zurich, Switzerland, the damage amounted to over 1,000,000 francs and the telephone company was held to be at fault. At Dortmund, the cause was the carelessness of a workman who dropped a wire from the roof of a building on to the trolley wire. At Barmen, telephone linemen were suspending a telephone wire across an open field. They suddenly found an obstruction in the form of a trolley wire and threw their live telephone wire over the bare trolley wire, with the result that the telephone station was burned out. These incidents show that the elaborate guard-wire protection required by law is useless. If in any of the installations mentioned, however, fuses had been inserted, nothing would have happened except the blowing of the fuses.

All the peculiar conditions which have been mentioned here and others naturally determined the methods of construction of the various roads in Europe, whether these conditions related to track construction, cost of fuel or municipal ordinances. From an engineering standpoint, also, Europe has numerous types of construction which differ materially from the normal, such as mountain roads, three-phase roads, accumulator roads, conduit roads, suspended railways, button contact system roads, the oldest —the slotted tube trolley—and the newest—the rapid transit road of Berlin. There has been universal application of the balancing battery system on direct-current installations. This method results in a great saving in coal, especially for small roads and in mountainous regions, in some cases as much as 40 per cent. Even very large roads have used the method with much success. Besides equalizing the load, the battery furnishes before the beginning and after the close of the actual day's service current for the night trains, for it would hardly pay to run all the machinery for such light traffic. Of recent years these batteries have been of twice or even three times the capacity of those first used, for it has been shown that their installation was a good investment. More details in regard to this system will be found under the heading "Germany."

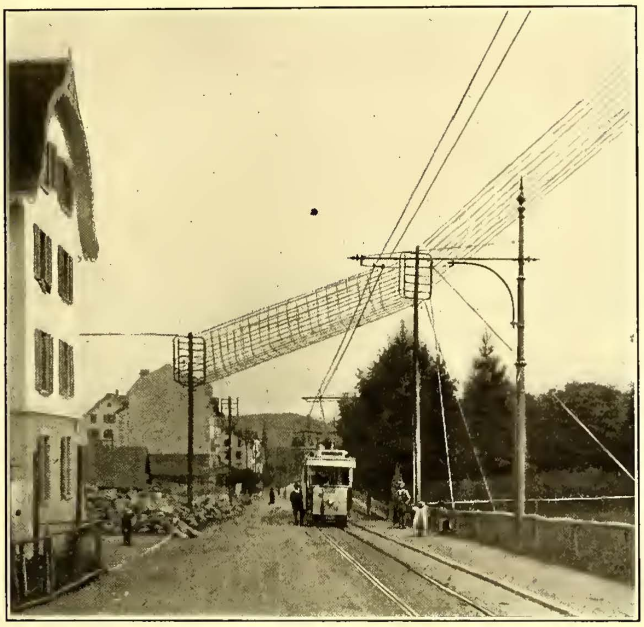
The most notable departure in European practice from American standards is in the use of the bow instead of the trolley wheel. During the last few years the former has grown steadily in favor, although it is not as generally used as the wheel. It is claimed on behalf of the bow trolley that it eliminates all danger of loss of contact and that there is no necessity for reversing the bow when the direction of the car is changed. Greater contact surface is afforded and much easier spans in curves are secured, which improves the appearance of the overhead construction and greatly decreases the cost of maintenance. In order to allow the bow to turn over automatically when the car changes its direction, the distance between the rail and the trolley line ought to be as constant as possible. European engineers who favor this form of construction say that there is no difficulty in doing this, and even many users of the trolley wheel favor the bow for higher speeds and heavier traffic where heavy currents are used. European street railway engineers have not, however, always favored the bow construction, and this may explain the fact that it is not more generally used at the present time. When the work of the re-establishment of electric railway systems in Germany (Bremen, 1890,) was undertaken, the trolley wheel had been fully developed in the United States and had been adopted as standard American practice. The bow trolley at that time had not been perfected, and in the crude form in which it was offered for consideration it very naturally made a poor impression in comparison with the trolley wheel. Since that time, however, many changes and improvements have been adopted, and in its present form it is favorably considered by the managers of many roads who had, however, adopted the trolley wheel. This favorable opinion has been strengthened by the knowledge that the defects imputed to the bow, especially the greater wear of the contact wire, were not well-founded; on the contrary, it is now claimed that commercial practice has



BASEL-BARFUSSERPLATZ, WITH WAITING STATION

THREE-PHASE RAILWAY, LUGANO

demonstrated the superiority of the bow construction in this particular. The change of opinion among engineers on this subject, however, comes a bit late, as many of the countries in which electric street railways have been built have already adopted the trolley wheel, and further extensions of these lines will undoubtedly be constructed to conform with the original installation, so that the cars now equipped with trolley wheels can be operated over the new lines; moreover, the bow patents will soon run out, and it is not expected, therefore, that any considerable advancement will be made in the meantime.



DEVICE FOR PROTECTION OF TELEPHONE WIRES IN LUCERNE

The slotted-conduit system (with complete metallic circuit) has been found satisfactory, but is only used in large cities where the traffic is very dense, where the difference in cost between it and a modern, first-class trolley construction is but slight, and where the installation may be expected to pay interest. In Europe it is, of course, only installed where the trolley has been forbidden. It is certainly preferable to the accumulator system, so far as short lines in the interior of cities are concerned. The system is extensively used in Buda-Pest, Berlin, Brussels and Paris, and on a small scale in a few other cities.

A very interesting departure from this system has recently been used in Berlin. It is well known that the Emperor, as owner of the street known as "Unter den Linden," has refused to permit the Grosse Berliner Strassenbahn to cross this street by means of its trolley system. The company was forced, therefore, to adopt some conduit system, as accumulators had been forbidden in Berlin. Siemens & Halske have solved the problem by attaching a "tail" to the car. This "tail" is a plow, and is hung beneath the car platform at the point where the trolley line ends. The stretch is 600 m in length, and at the end of it the plow, which is about 4 ft. long, is lifted out, detached and hung on an ornamental pole until a returning car takes it back. At both ends about six such plows hang on a pole. The time required to attach or detach the device is about fifteen seconds.

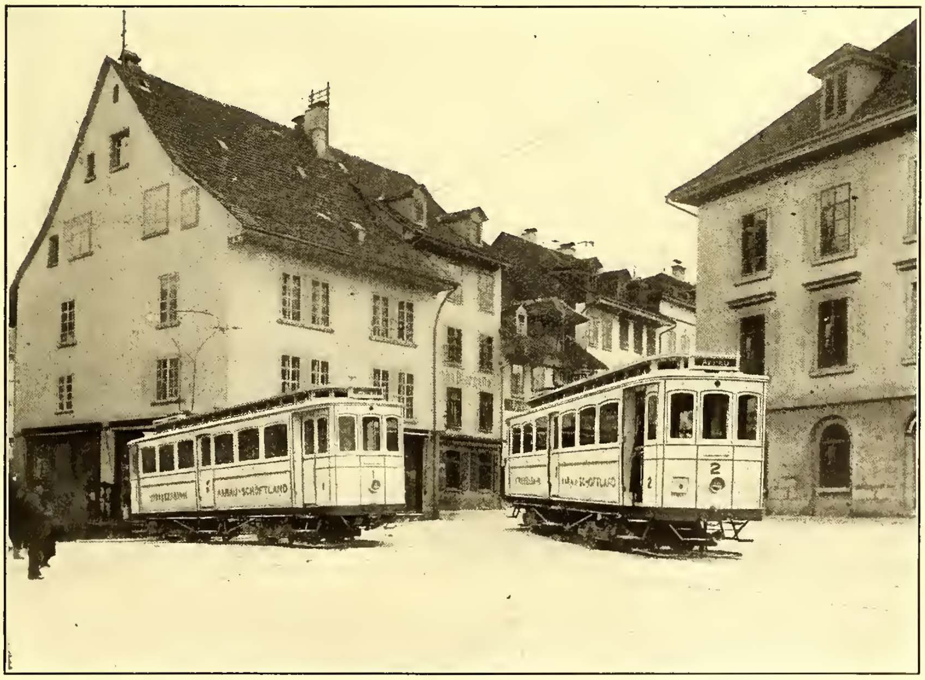
The button-contact system is in use on a few small systems in France, two or three different types being used. As yet nothing can be said in their favor as the result of the short time they have been in operation, and railway companies in general may congratulate themselves that present prospects are not favorable to an increased use of this system.

The accumulator system is mostly used on European railways now in the form of the so-called "mixed system." It is used generally in conjunction with the trolley and is employed in the interior of cities where the latter is not permitted. That the system is not a commercial success has already been stated. In Germany it will soon be extinct in all its phases, and in France, where the rest of the accumulator street railways are in operation, a similar fate awaits it.

Another type of accumulator service is that which has been installed on established steam railroads in order to make small headway between trains possible. It has been found here that if the traffic is too light to permit of the running of more than three or four steam trains per day hourly accumulator trains for passenger service can be run to advantage. For this purpose old steam railroad passenger cars have been equipped with accumulators, which are charged reasonably by an existing central station. In one case even new cars have been used. Experience has shown that while the service is cheaper than steam service, it was still cheaper to run single passenger cars propelled by benzine motors.

Such trials have been made in Belgium, in Italy and at Germany in Wurtemberg on a larger scale. The authorities of the latter State report as follows on the trial from April 1, 1899, to April 1, 1900. Three cars were tried, viz.:

1. Two-axle benzine motor cars with twenty-four seats.



VIEW IN AARAU, SWITZERLAND

2. Two two-axle Serpollet steam cars, one having thirty and the other forty seats.

3. One four-axle accumulator car with forty-four seats.

No. 1 traveled 43,800 km in 292 days. Cost of material (coal) was 4181 marks. Salary of motorman, 2634 marks; total, 6815 marks; so that each useful kilometer costs 9.55 pfennigs for material and 6.01 pfennigs for salaries, a total of 15.56 pfennigs. Repair cost 2883 marks, or 6.58 pfennigs per kilometer.

No. 2 car, seating thirty people, traveled in 196 days 23,595 km and consumed 65,375 kg. of coal, or 2.67 kg. per kilometer; 234 kg. of oil, or 0.01 kg. per kilometer; total fuel cost 1341 marks, or 5.37 pfennigs; repairs, 2138 marks, or 9.06 pfennigs per kilometer.

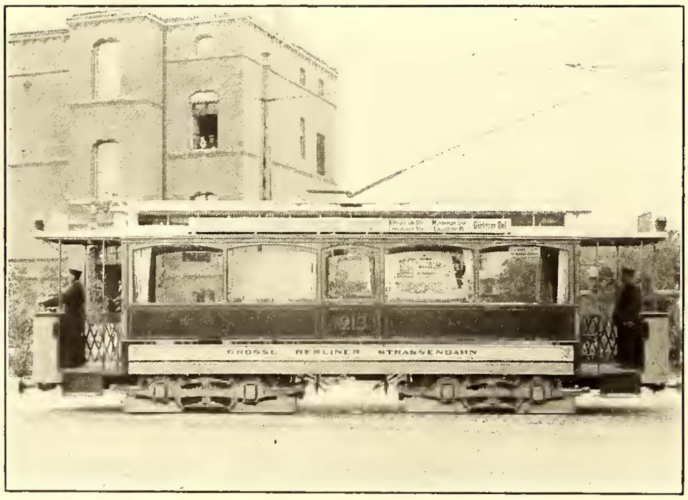
No. 2 car, seating forty people, traveled 7756 km in sixty-six days and used 3.26 kg. of coal per kilometer, 0.012 kg. oil per kilometer, or 6.34 pfennigs per kilometer; repairs, 4.37 pfennigs per kilometer.

No. 3, the accumulator car, traveled 8043 km, required 6873 kw-hours at 1632 marks; 34 kg. of oil, costing 21 marks, a total of 20.55 pfennigs per kilometer; repairs cost 4.44 pfennigs per kilometer.

Maintenance of batteries was undertaken by the firm furnishing the same, who received 8 pfennigs per kilometer, a total of 634 marks. Total maintenance cost 12.33 pfennigs.

The success of the accumulators is confined, therefore, to charging purposes in central stations, where they are indispensable.

It is necessary to say only a few words about municipal ownership of street railways. Out of a dozen municipal roads in Germany perhaps three have paid expenses or have made a slight profit. To-day, in the face of an expected deficit, the fares are higher than on roads owned by private companies elsewhere, because municipal operation



STANDARD DOUBLE TRUCK CAR OF THE GROSSE BERLINER STRASSENBAHN

is more costly. Statistics on this point have been published in the STREET RAILWAY JOURNAL, and the reader is particularly referred to a table presented last August.

Soon after the electric street railway companies had constructed their first lines, which were naturally those which promised the biggest returns, the municipalities regretted that they had not constructed these lines themselves so that they could pocket the receipts. From that time until the present there have been many illusions as to the cheapness of electric railway operation. The cities, in view of this misconception, often used force to compel the companies to sell their roads to them at a very low price, which they then equipped electrically. In no case did the results come up to the expectations. The taxpayers, who had to furnish the large sums of money for the purchase and equipment of the roads, were assured that the fares would be reduced, as well as the taxes. To-day, in the face of large deficits, the fares are increased, in fact, they are higher than on private roads, because municipal operation has proved more costly.

One of the chief points in the consideration of this problem is the choice of an efficient head who is able to deal with the continuously changing conditions. It requires a capable, resolute leader, who must be competent to assume great responsibilities, and this is seldom the case with municipal officers. The street railway superintendent must be a man of greater ability than those generally tempted by the small salary which the city pays. He is subordinate to the chief magistrate, who must, of course, receive a higher

BARMERBERGBAHN—STEEP GRADE IN LUISEN STRASSE

salary than the railway manager. This fixes the salary so low that cities cannot obtain or retain capable men.

In view of all these facts, the writer is of the opinion that the attempts to municipalize street railways have reached the point where the cities will lease their costly roads to private companies.

GERMANY

Whatever may be said about Germany in a general way has already been expressed in the introduction. The opinions there given on continental conditions, which were founded on German practice, have been strengthened by the information regarding other European roads collected by the writer for this article.

Werner von Siemens, the great physicist, was the first to apply electricity commercially to traction purposes. He

STATUS OF ELECTRIC ROADS IN GERMANY

	Length of Road			Length of Track			Motor Cars			Trailers			Total Capacity of Generators in Kw.			Central Station Battery Capacity in Kw.		
	Standard Gage	Narrow Gage	Total	Standard Gage	Narrow Gage	Total	Standard Gage	Narrow Gage	Total	Standard Gage	Narrow Gage	Total	Standard Gage	Narrow Gage	Total	Standard Gage	Narrow Gage	Total
	Km.	Km.	Km.	Km.	Km.	Km.												
In operation	1505 36	1429.82	2935.18	2734 32	1742.10	4476.42	5273	2763	8036	3703	1555	5258	85000	42000	127000	20000	1200	32000
Building or under construction	211.67	345.74	557 41	346.30	391 55	737.85	170	187	357	139	53	192	6200	3400	9600	200	1300	3300
Total	1717.03	1775 56	3492.59	3080.62	2133.65	5214 27	5443	2950	8393	3842	1608	5450	91200	45400	136600	22000	13300	35300

built a 2.5 km electric railway at Lichterfelde, a suburb of Berlin, the first electric road in the world. The current was sent through the two rails, each forming one pole of the circuit. It was impossible, on account of lack of insulation, to adopt pressures as high as those used at present. One hundred and sixty volts were employed, and even if the rails had been better insulated no one at that stage of electrical development would have thought of using a higher pressure. In this shape the small road of 1881 served its purpose and carried passengers until 1890 without being extended, because Europe was not yet ready for mechanical traction. The three cars seated sixteen persons each, and each car was equipped with one 10-hp motor. In 1890 the road was transformed into a trolley line, using a bow collector.

In April, 1884, Siemens & Halske opened another electric road in Frankfort-on-Main, built after another system. It was 6.7 km in length, had 6.9 km of track and ten motor cars, each with thirty seats and one 15-hp motor. The novel feature of this road was the method of transmitting the current. The positive and negative conductors were located at one side of the track in the form of two slotted tubes, in which the contact shoe slid. They were drawn along by the car to which they were connected by a flexible cable. The pressure was 300 volts. The tubes were ordinary gas pipes, ¾ in. to ⅞ in. in diameter, slotted on the under side and suspended from wooden poles by means of wires, the poles being placed every 30 m. The apparatus on this the oldest trolley road in existence still works splendidly and reliably. One of the accompanying engravings shows this road crossing the new Frankfort City Railway, the oldest and the most modern systems. A similar road was put in operation by the same firm in Vienna in 1883, on which a pressure of 350 volts was used.

In 1890 the Union Elektricitäts-Gesellschaft, then the Thomson-Houston Company's representatives, introduced the American trolley wheel, which had been perfected in the United States in the interval and had been successfully used in the States. The first German road thus equipped was that in Bremen, but others quickly followed. In 1894 the first Hamburg and in 1896 the first Berlin roads were thus equipped, and most German roads have adopted this system.

Several roads have introduced freight traffic, but these are not very numerous. The city doing the most in this respect is Hanover, with 1,375,000 freight car kilometers, the transportation of 253,000 tons and an income therefrom of 357,000 marks. The other roads transport freight to only a limited extent. Even in Hanover, for each freight car kilometer only .184 ton was transported and .19 mark was collected. Certainly a very unprofitable business.

All of the German street railways last year, including Hanover, covered 1,796,000 freight car kilometers, transporting 610,000 tons of freight and collecting therefor 716,000 marks, corresponding to .34 ton per car kilometer and an income of .85 mark per freight car kilometer.

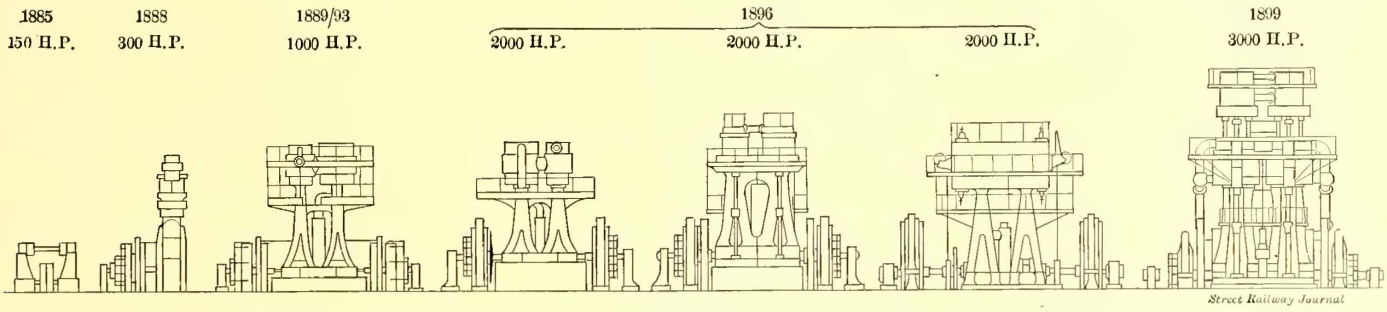
In addition to these street railways, the Dusseldorf-Crefeld road handles considerable freight. The table on the opposite page, which is taken from the *Elektrotechnische Zeitung*, gives the status of all the electric roads in Germany on Sept. 1, 1901.

The table indicates that nearly all the roads in the large

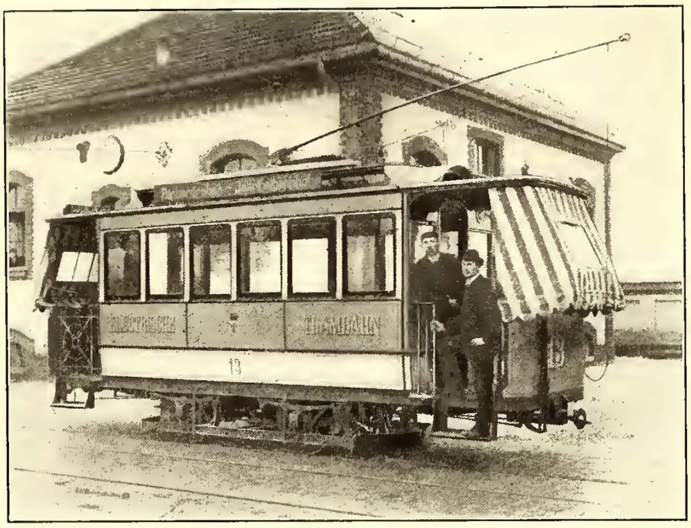
VIEW IN POTTSDAMERPLATZ, BERLIN

cities have the standard gage of 1.435 meters, or 4 ft. 8½ ins. This is shown by the relation of track length to road length and the number of trailers compared to that of motor cars. While on the 1505 km standard gage roads the generators have a capacity of 85,000 kw, the capacity is only 42,000 kw for 1429 km of narrow-gage roads; that is about half as much.

Before discussing the subject of standard-gage electric railways, it should be mentioned that there are in operation 1505 km length of road and 2734 km of track; that is, about 67 per cent of double track. The narrow-gage railways have only 12 per cent of double track, 8 per cent being used for depot track. For standard gage the capacity of the generators amounted to 85,000 kw, that of the station equalizing batteries 20,000 kw. The narrow-gage roads had generators of 42,000 kw capacity and station equalizing batteries of 12,000 kw. These proportions show that the operation of the latter roads is more difficult than those of standard



END ELEVATIONS OF ENGINES (DRAWN TO SCALE) USED IN THE BERLIN ELECTRIC POWER STATION FROM 1885 TO 1899 gage. Generally the capacity of the station storage batteries is understood to be the amount of electricity which can be given during one hour without overloading. The statistics from which this table is derived does not give the capacity of generators and batteries for several railways, but the writer has, with the aid of other statistics and his own observation, made out the given numbers for the generators out of the known operating effect, the capacity of



MOTOR CAR WITH ADJUSTABLE CANOPY FOR MOTORMAN AND CONDUCTOR IN MUNICH

the batteries being supposed to have the same proportions to that of the generators as on the other roads. There are equalizing batteries up to 4200 kw in one system at Berlin

In Germany there are no three-phase roads with the exception of the high-speed Zossen railway, on which the 200-km per hour experiments are now being made. On this road the three-phase current is delivered direct to the motors. There are several roads, however, using three-phase transmission with rotary sub-stations. The best ex-

TRUCK USED FOR HAULING STANDARD GAGE STEAM CARS ON A NARROW GAGE ELECTRIC LINE, MEISSENERSTRASSENBAHN

ample of this is the Hanover road, with its enormous suburban branches up to 40 km in length.

There are about eighteen municipal roads in Germany, the largest of which are at Frankfort-on-Main and Munich. Most of them are working at a loss.

The most extensive electric railway system of Germany, in fact the largest in all Europe, is that of the Grosse Berliner Strassenbahn, which controls the entire traffic of Berlin, with the exception of three small lines having a total of 53 km of tracks passing through 27 km of streets. As an extended descriptive article on this line was published in the July issue of the Street Railway Journal, an account will be given only of the improvements made during the last two years and the status of the company at present. At the close of 1900 the length of the company's lines was 309 km (length of streets), all of which was used for public traffic, and along these streets 547 km of track were laid. The company owned an additional 58 km of track, which was used for switching and depot purposes, making a total of 605 km. Nearly all of the lines of the company are electrically equipped, and at the close of 1901 only five out of the fifty-eight lines were operated by horses.

The rolling stock consisted at the close of 1901 of 2529 passenger cars, of which 372 were double-truck motor cars, including 178 accumulator cars, and 825 were single-truck motor cars, 77 being accumulator cars. The others were trailers or horse cars. All motor cars are equipped with two motors, a short-circuit brake and a Sperry electromagnetic brake, or a Standard air brake. The latter predominates on recent equipments. In 1901 the passenger cars traveled 65,662,000 car kilometers, of which the elec-

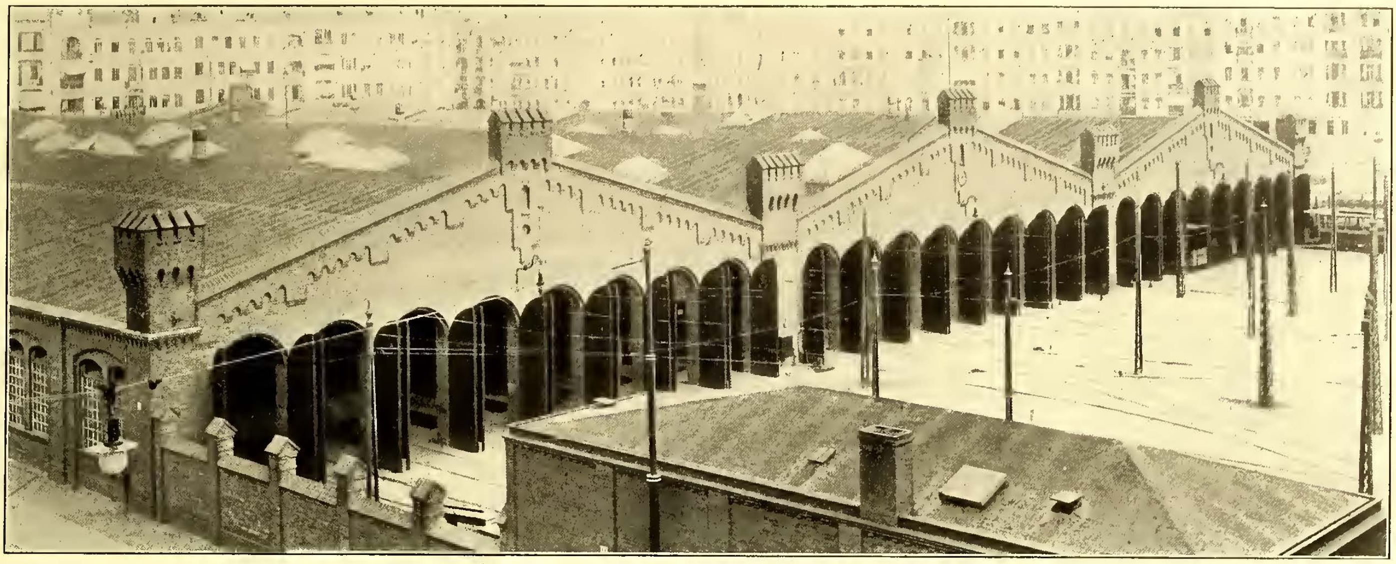
TYPES OF GENERATORS USED IN BERLIN ELECTRIC WORKS

Capacity in Kilowatts	Volts	Amperes	Revolutions per Minute	Type	How Connected to Engine	Station Where Located	Remarks
41	110	375	850	Edison	Belted	Markgrafen-strasse	Not used now
220	120	1800	182	Stationary field.	Direct	"	In operation
99	110	900	375	Edison	Belted	Mauerstrasse	Not used now
340	275	2600	70	Stationary field.	Direct	"	In operation
690	275	2500	105	18-pole revolving field......	"	"	"
860	3000	....	110	3-phase alternator........	"	Schiffbauer-damm	"
1000	275	3600	85	Shunt-wound continuous current	"	Luisenstrasse	"
3000	6000	....	83	3-phase alternator........	"	Moabit	"
3000	6000	....	83	3-phase 72-pole alternator...	"	Oberspree	"
5000	6000	....	83	3-phase alternator........	"	Oberspree-Moabit	In course of erect'n

CAPACITY OF BERLIN ELECTRIC WORKS WHEN COMPLETED

Name of Station	Hp. of Steam Engines	Capacity in Kw of Generators and Accumulators	Notes
Markgrafenstrasse..............	2,100	4,400	In operation
Mauerstrasse...	9,500	9,200	"
Spandauerstrasse-Rathausstrasse.	11,600	10,800	"
Schiffbauerdamm-Luisenstrasse.	16,600	12,700	"
Oberspree.......................	20,000	13,000	"
"	30,000	20,000	In course of erection
Moabit.........................	14,000	9,000	In operation
"	24,000	16,000	In course of erection
Total.......................	127,800	95,100	

tric cars traveled 55,602,000 car kilometers and the horse cars 10,060,000 car kilometers. The motor cars traveled 43,251,000 car kilometers and the trailers 12,351,000 car kilometers. A total of 282,800,000 persons were transported by these cars. All of these figures refer only to the Grosse Berliner Strassenbahn proper and do not include its controlled roads. The average consumption per motor car kilometer was 769 watt-hours. It cost 318,000 marks to maintain the accumulators in the cars, but, fortunately, bat-



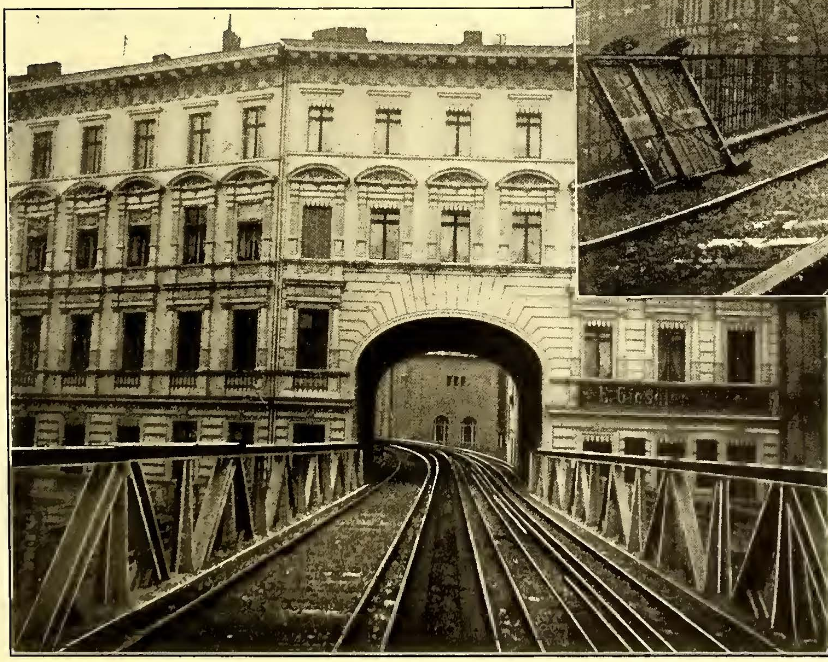
SCHONEBERG CAR HOUSE, BERLIN

tery cars have now been prohibited within city limits, all lines being changed to trolley or conduit.

At the close of 1901 the company had 7546 employees, who received 7,475,000 marks in wages during the year.

The passenger receipts for 1901 amounted to M 26,540,000, M 2,460,000 being for time cards; 240,885,000 persons paid 10 pfennig fares, and 41,910,000 traveled on time tickets, so that these latter tickets brought only about 6 pfennigs per passenger. For each kilometer of track, 1624 persons were transported daily; for each car kilometer, 4.31 persons, and for each trip, thirty-eight persons.

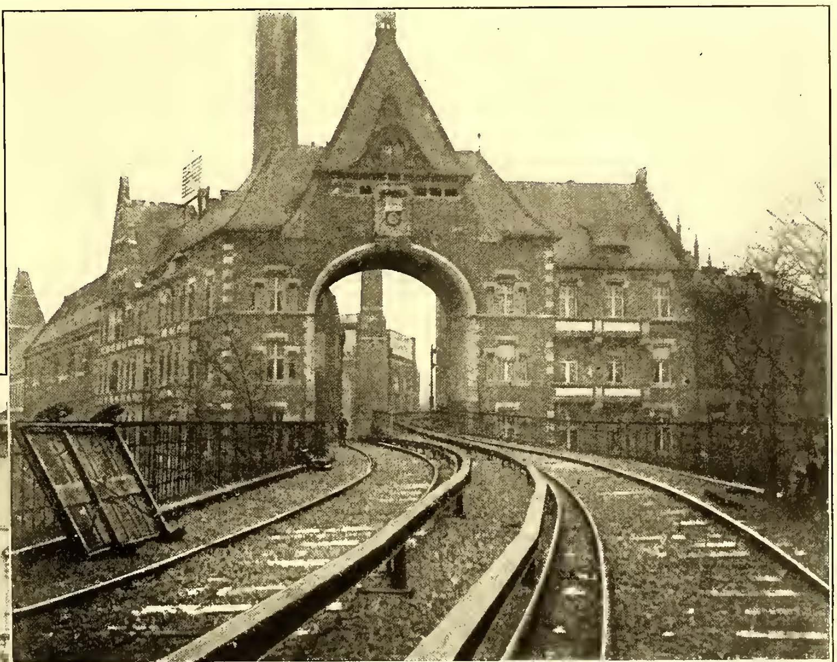
There is a pension fund for the employees, into which the latter paid 278,000 marks during 1901 and the company the same amount.



ELEVATED ROAD OF BERLIN, PIERCING A HOUSE USED FOR RESIDENCE PURPOSES

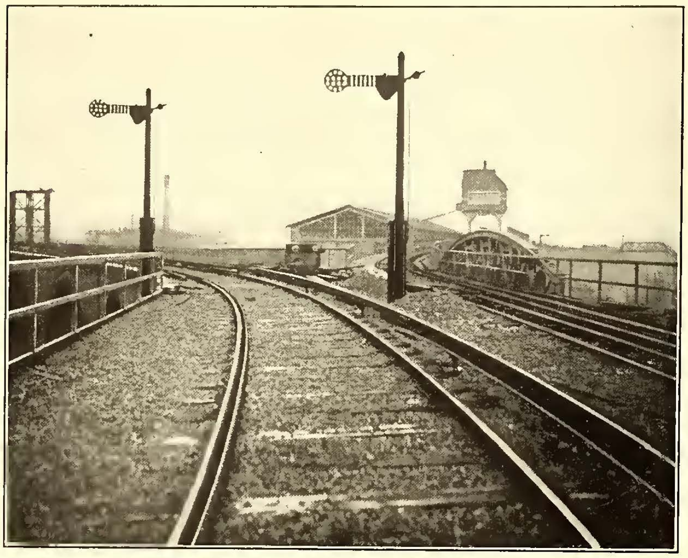
By its franchise the company is obliged to purchase all its current from the Berlin Electrical Works at 10 pfennig per kw-hour.

The Berlin Electrical Works, which supplies the current for the operation of the cars, is the largest on the continent. Its history is so typical of the formation and growth of many European electrical stations that the writer deems it proper to give a brief description of this large plant. It was established in 1883, after Edison, at Paris in 1881, had



ELEVATED ROAD IN BERLIN. THIS HOUSE WAS TORN DOWN AND REBUILT OVER THE TRACK

shown the world for the first time his new electric light. The city granted permission to the company in 1884 to lay cables through the streets, and two small central stations were built, in which there were six machines, each having a capacity of 150 hp. The first was started in 1885. After many extensions and negotiations with the city a maximum of 28,000 hp was contracted for in 1890. Large accumulator sub-stations were installed in 1898 In addition, motor-generators were set up in two more sub-stations, which were fed by 3000-volt three-phase current. As soon as this limit was reached the company had to refuse all further orders for current. This forced the city in 1899 to make a contract for 42,500 kw with the company and 37,000 kw with the suburban stations under the following conditions: The city comes into possession of the stations without payment

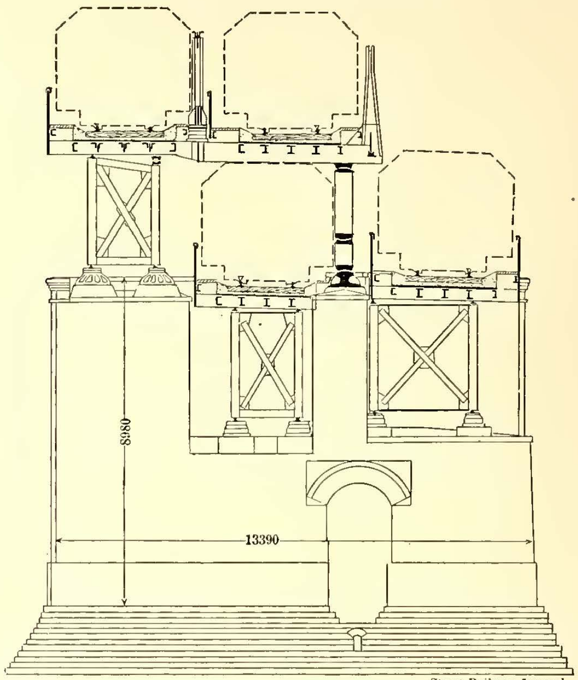


BLOCK SIGNAL USED ON THE BERLIN OVERHEAD AND UNDERGROUND RAILWAY

in 1915. The city is to receive 50 per cent of the net earnings above 6 per cent on the capital stock if the latter does not exceed 20,000,000 marks; but in case the capital is greater than this, the city is to receive 50 per cent of the net profits above 4 per cent on the capital.

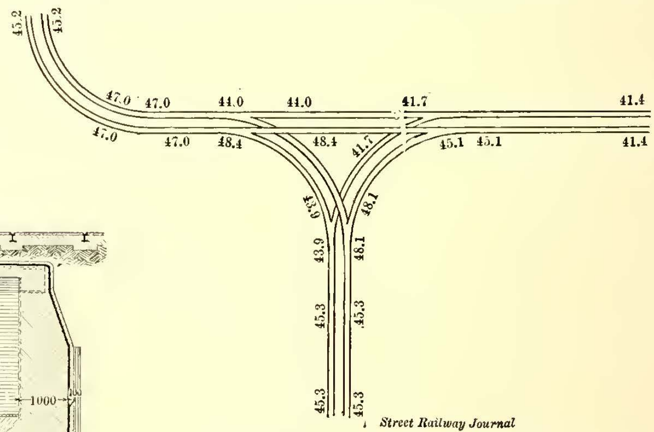
Naturally the work of extension was carried on as quickly as possible, as only sixteen and one-half years remained of independent existence.

Experience in this plant has shown vertical engines are a desirable type so long as they can advantageously be built in the form of twin-compound machines; but the recent 3000-hp vertical engines are so large that for three expansions two low-pressure cylinders had to be used, with a more than normal increase in attendance and repair cost. For this reason horizontal steam engines have been installed in the latest station. Poppet valves and super-

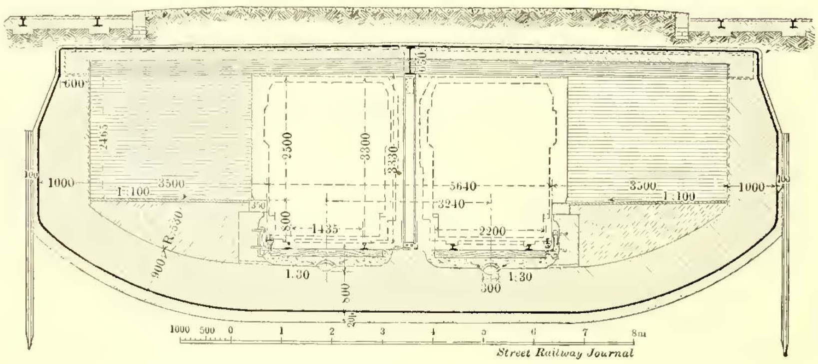


SECTION OF PORTION OF DOUBLE TRACK CLOSED Y, BERLIN ELEVATED AND UNDERGROUND ROAD

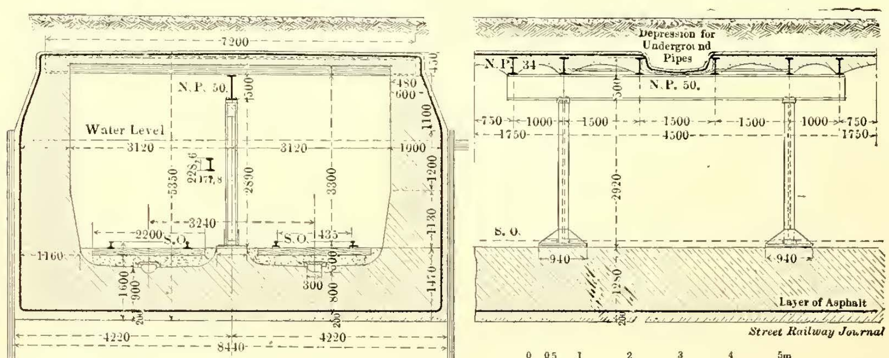
heated steam are in almost exclusive use. A popular form of fly-wheel is one cast in two parts only, the parts being



DOUBLE TRACK CLOSED Y, ELEVATED AND UNDERGROUND ROAD, BERLIN



SECTION OF UNDERGROUND ROAD, BERLIN, AT A STATION



CROSS AND LONGITUDINAL SECTIONS OF REGULAR TRACK, BERLIN

bolted together at the hub and rim.

The following data regarding the 3000-hp machines may be of interest: Diameter of high-pressure cylinder, 850 mm; diameter of intermediate-pressure cylinder, 1250 mm; diameter of two low-pressure cylinders, 1475 mm each; common stroke, 1500 mm; speed, 83 r. p. m. Each of the two frames belonging to one machine weighs 27,500 kg (casting), while the total net weight of a machine is 280 tons. The steam has a pressure of 14 atmospheres and is superheated to 320 degs. C. Each engine has a small twin engine for starting.

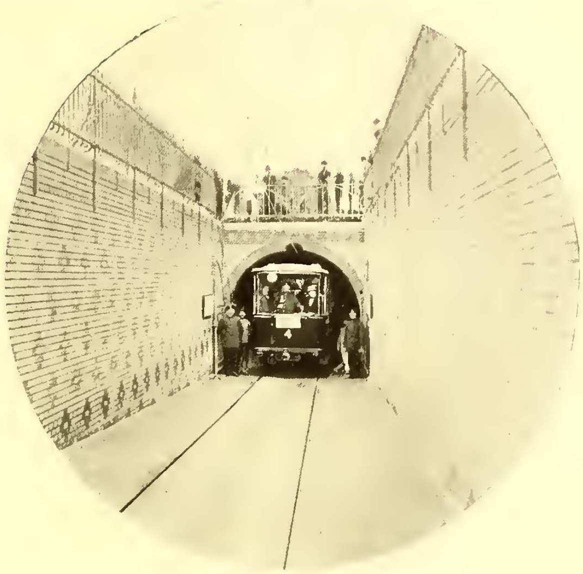
The 3000-kw, three-phase generators operate at 6000 volts. The rotor weighs 68.9 tons, has a diameter of 7.4 m and 72 poles. The stator weighs 70 tons and has a diameter of 8.6 m and is 1.2 m in width. The table on page 684 gives the types of machines and total output of the several stations of the Berlin Electric Works.

Superheated steam at 350 degs. C. is used satisfactorily in several of these stations.

ELECTRIC ELEVATED AND UNDERGROUND ROAD OF BERLIN

This interesting undertaking in the capital of Germany has been described to a greater or less extent in many of the technical papers, but as it has recently been put in operation and is well representative of the latest German practice, a few of the salient features will be given here. The franchise was awarded to Siemens & Halske in 1896 and the road was begun by them in the same year, but was later transferred to a separate operating company. The total length of the road at present is 10.1 km, and including the three terminal stations there are thirteen depots, the greatest distance between any two stations is 1.923 km and the shortest .454 km.

The width of streets between houses varies betweeen 31 m and 52 m. All streets on which the road is built are similar in section, that is, next to the houses is the sidewalk, then two roadways for vehicles and in the center a broad promenade for pedestrians. On this the viaduct is located, in the middle of the street. With one exception the shortest radius is 100 m, so that the cars can travel everywhere at full speed, the maximum being 50 km per hour. Of the entire 10.1 km distance, 1.7 km is built underground and the remainder is an elevated structure. On account of the



CAR ON RAILWAY UNDER RIVER SPREE, BERLIN

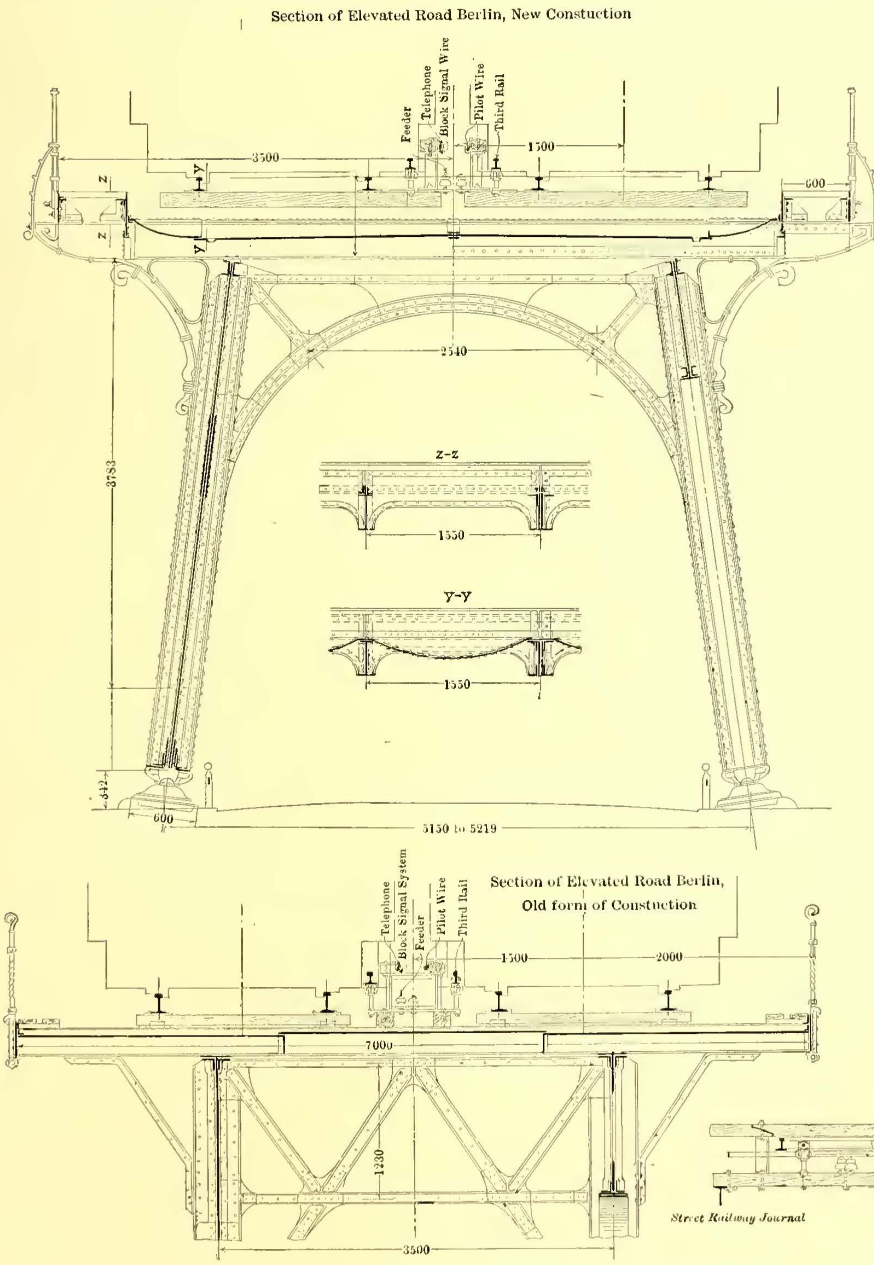
trolley lines the viaduct has a height of 4.55 m and the upper surface of the track is located 5.3 m above the street's surface. The underground section has a height of 3.3 m above the rails. In Budapest the height is only 2.75 m. Above this is the pavement, which varies between .9 m and 1.2 m in depth. The lowest point on the underground section lies 20 m below the highest point of the elevated road. The grades are moderate and are less than 1 per cent, except where the elevated and underground sections join, where they are 2.7 per cent and 3.1 per cent.

The entire viaduct is calculated to stand a pressure of 6 tons. The trains are made up of three cars, the first and last being motor cars and the one in the middle a trailer. They seat 120 persons, and there is standing room for a considerable number more. The average speed is 30 km per hour. The gage is 1.435 m. The height of the car body above the rail surface is 3.18 m and the width 2.3 m. A large series-parallel controller with train wire is used.

The line is double-tracked throughout. The distance between centers of tracks is 3 m on the elevated section and 3.24 m on the underground section, because on the latter there are supports between the tracks. The maximum distance of 1.2 m between the upper surface of the pavement and the lower surface of the cross-girders of the underground section was made necessary because it was intended to plant trees above the road, which required .7 m of earth.

The tunnel walls are made of concrete, the same as the foundation, and two-thirds of the tunnel lies below the level of ground water. For this reason the entire tunnel, including the roof, has been lined with three layers of sheet asbestos. The width of a station is 12.64 m, of which the two stairways occupy 3.5 m each. No elevators are employed.

Two forms of elevated structure are in use. The older type has the rails mounted



STRUCTURAL FEATURES OF BERLIN ELEVATED

directly on the iron girders by means of cross-ties, while the new construction has a complete broken-stone roadbed for the tracks. This method was adopted because the old construction created too much noise. The viaduct has a width between pillars of 12 m and 16.5 m.

On the old type of construction the rails are 180 mm high and weigh 42.7 kg. The new type requires the rails only to be 115 mm high and of 25.6 kg per meter weight, the head being 60 mm and the base 130 mm in width. The weight of the viaduct, as formerly constructed, is:

For a distance between pillars of 12 m, 1.2 tons per meter.
For a distance between pillars of 16.5 m, 1.4 tons per meter.
For a distance between pillars of 21 m, 1.8 tons per meter.

In the new construction the roadbed is laid on heavy 7-mm thick sheets of iron, which naturally increase the weight considerably. From each sheet the water is drained separately so that it cannot drip on pedestrians below. The weight here is 1.65 tons per meter. The cost per 100 kg of viaduct completely erected was from 28 marks to 32 marks.

The track triangle, or double-track closed Y, is undoubtedly the most interesting part of the undertaking. The road has three terminal stations, between all of which trains are run. As the headway on every line is 2½ minutes, it was out of the question to have the tracks cross each other on the same level. They therefore alternately pass over and under each other. The construction here consists principally of massive stone arches. Above the

MOTOR CAR AND TRAIL CAR ON CENTRALBAHN, HAMBURG

tracks a small switch tower is located and within the triangle is a car house, the floor of which is on a level with the third story of the adjoining houses.

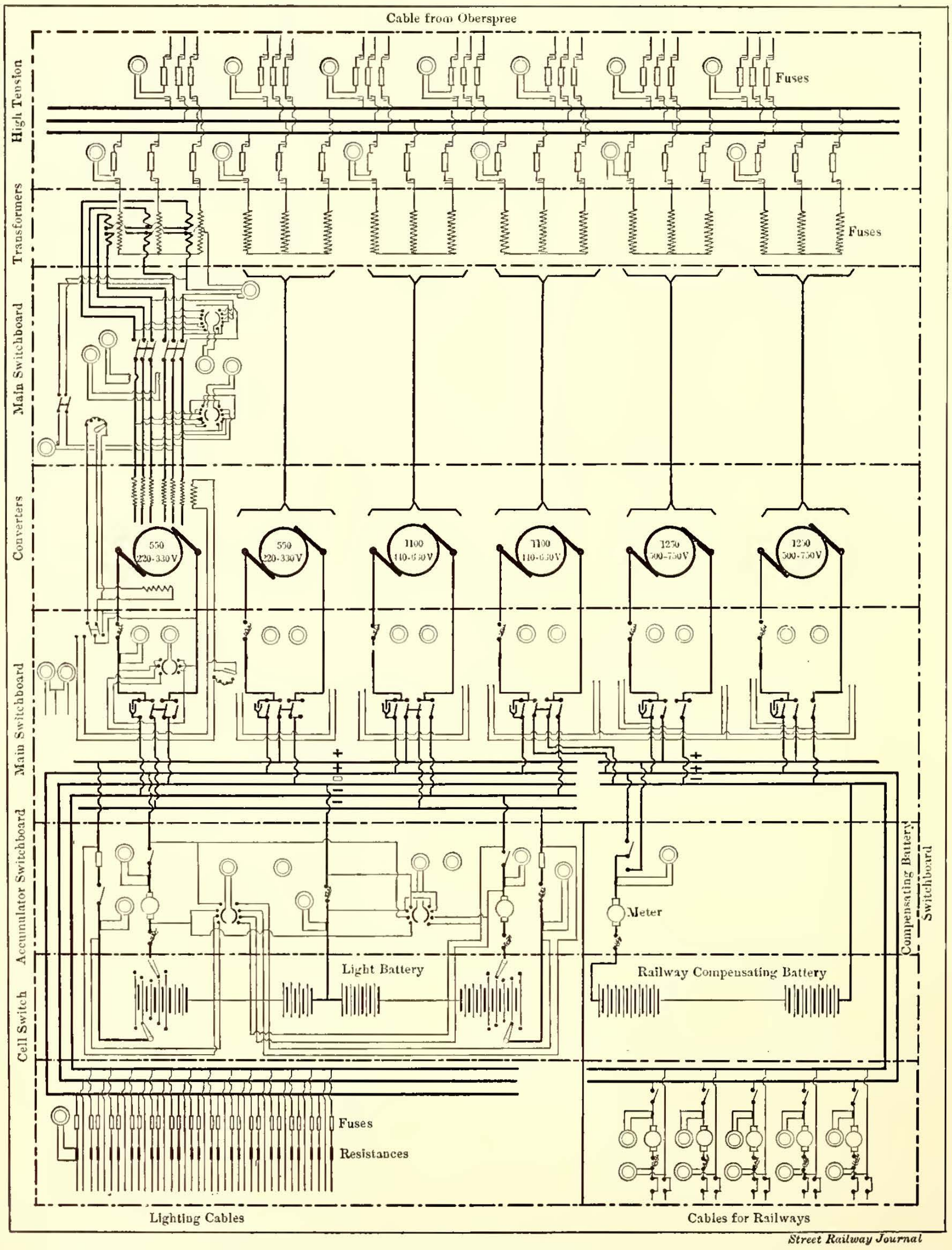


DIAGRAM OF CONNECTIONS, MARIANNENSTRASSE, SUB-STATION, THE BERLIN ELECTRICITY WORKS

The third rail is laid 1096 mm to one side of the track center. On the elevated structure it is 80 mm above the track surface and in the tunnel 50 mm higher. The rail has a cross-section of 3600 sq. mm and rests on hard-rubber insulators which are fastened to the ties at distances of 6 m apart. Wooden guard timbers, as shown in the cross-section, are located close to the third rails and 130 mm above them. Being in this position the workmen naturally step upon them. They are protected from accidental contact either with the third rail or live bare feeders just as thoroughly as though the latter were covered. These guard-rails are not used on the underground section because here the third rail is located outside of the main tracks next to the tunnel wall, and there are chambers about the same distance above the third rail into which the workmen can step.

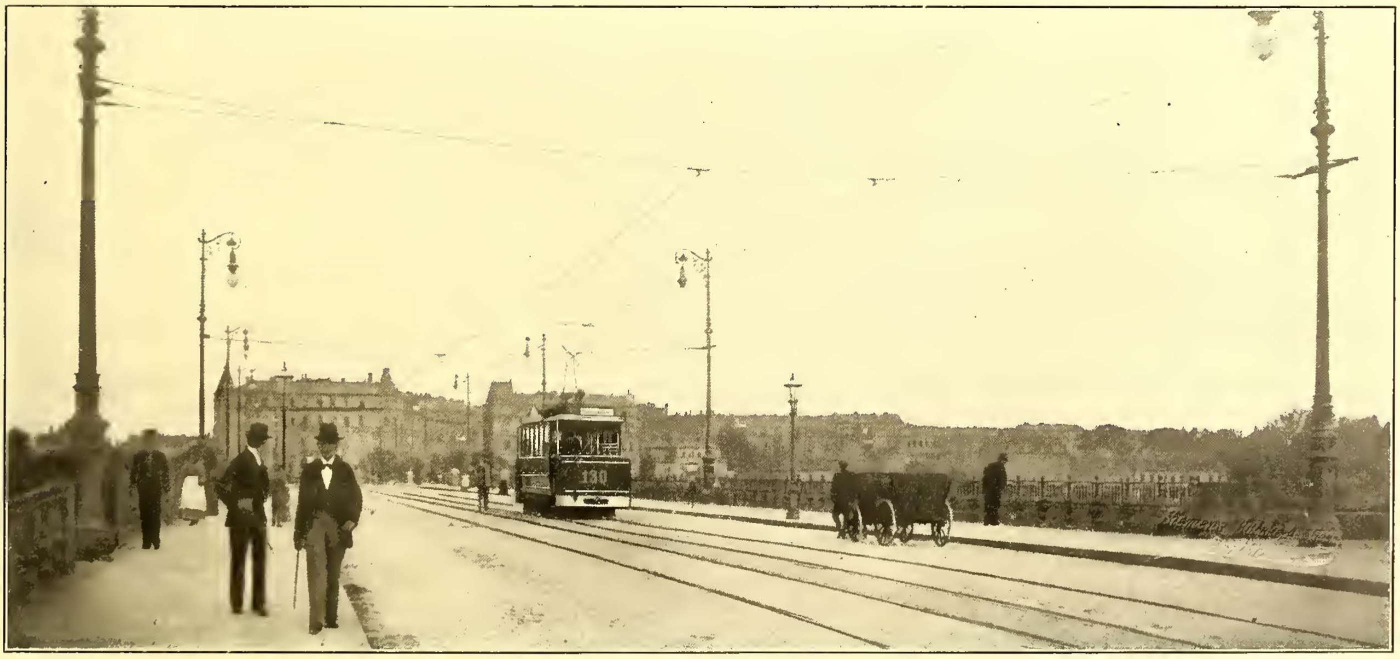
The feeders consist of bare flat copper strips set on edge and having a cross-section of from 1000 sq. mm to 1500 sq. mm. They are located between the guard timbers and are mounted on special insulators. Special lighting feeders, carrying 600 volts, are used. To protect falling telephone wires, 8-mm wires are fastened to the guard timbers and connected with the rails so that a fallen telephone wire will fuse immediately.

One of the interesting features is the crossing at one and the same point of a canal, an elevated road and a street; in other words, the crossing of four means of traffic—first the water, then the street, above that the steam long-distance road and above that the elevated road, whose viaduct spans all the others. The viaduct at this point breaks into a row of houses, entering them at the second story. The old buildings were torn down and a new one erected for this purpose. The house out of which the road emerges into the street, however, was not torn down, but simply broken through and lined

OVERHEAD GUARD WIRE CONSTRUCTION IN FRANKFORT

around the hole by an iron framework, as shown in the illustration.

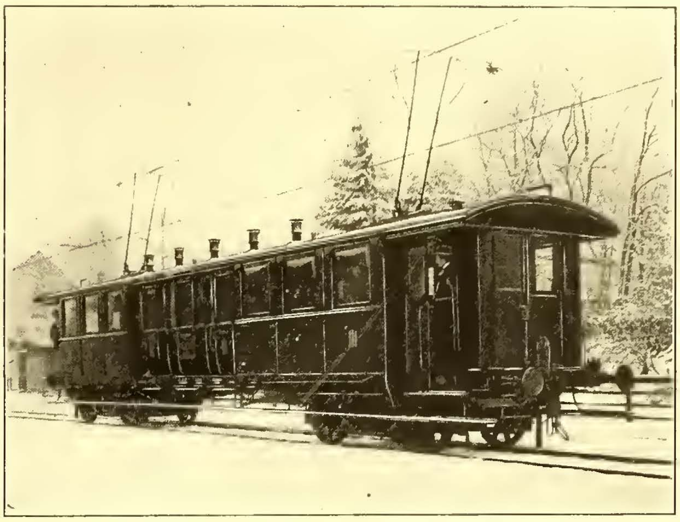
The rolling stock consists of fifty-six motor cars and twenty-eight trailers. The trailer is called the second-class and the motor cars third-class. Each car has four axles. The wheel base on the truck is 1.8 m, the body length is 9.3 m and the length over all, including the buffers, is 12.7



VIEW ON ALBERT BRIDGE IN DRESDEN

m. The seats are arranged longitudinally. There are two sliding side doors at each end of the car, each .8 m in width. Two of these, that is, those on the left side of the direction of travel, are closed up by improvised seats, which are removed to the other side when the car goes in the other direction. Passengers enter the forward door and leave the car through the rear door. At the two ends of the car are small doors which serve as danger exits in case of fire and through which passengers of one car may enter the adjoining one. The very wide center aisle serves for standing room. The trailers have forty-four seats and the motor cars thirty-nine seats. Each seat is 50 cm in width.

The motorman's platform is located at only one end of the car. Each motor car is equipped with three motors. Later, when more trailers are attached, a fourth motor will



MOTOR CAR, ISARTHAL INTERURBAN RAILWAY

be added. The maximum speed is 50 km per hour. The motors of each car are always connected in parallel, while those of the entire train may be connected in series. A block signal system is used.

The power station contains the condensers, feed and air pumps in the basement, the engines and generators on the ground floor level and the boilers and coal bunkers above. The steam is superheated to a temperature of 225 degs. C. Natural draft is used. The chimney being 80 m high is used by the military authorities for experiments in wireless telegraphy. There are three 800-kw units and a storage battery with a capacity of 900 hp-hours at a one-hour discharge rate.

The total installation cost about 25,000,000 marks. The cost per kilometer, therefore, including the power station, is less than 3,000,000 marks. In fact, for the elevated road, on straight sections, the cost was from 1000 marks to 1200 marks and for the underground section 2000 marks per meter.

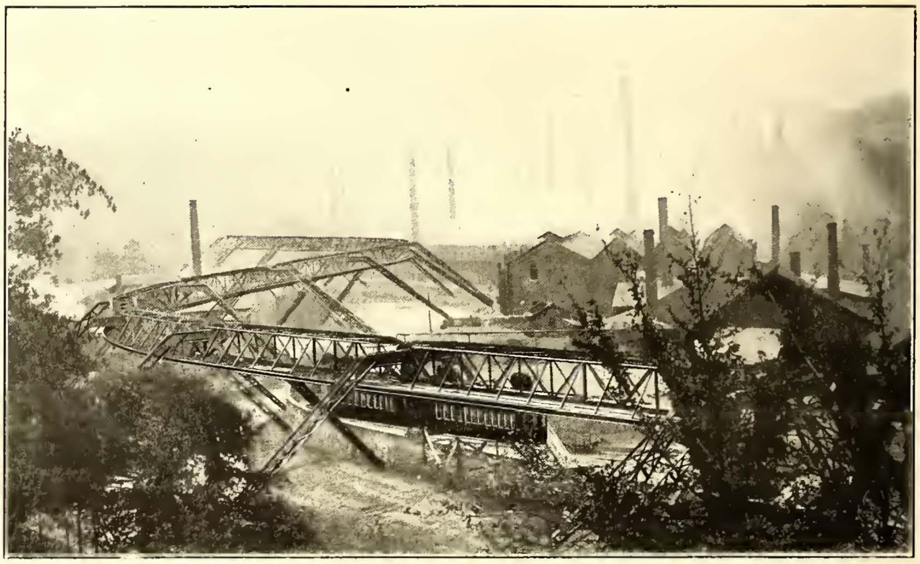
The diagram of connections in the sub-station is reproduced by permission from *Traction and Transmission.*

OTHER CITY TRAMWAYS

The next largest tramway system in Germany to the Grosse Berliner Strassenbahn is the Strassen Eisenbahn-Gesellschaft, of Hamburg, which uses the trolley exclusively. The organization and equipment of this were treated by the author of this article in a previous communication. The road is particularly interesting from the fact that it is one of the earliest trolley roads in Germany, the first among the large systems, hence its figures indicate what the actual expenses of a modern electric railway system are for a long period of time. It is found that a single-truck motor car weighing, empty, 7.6 tons and with a load of twenty-nine persons, uses just 550 watt-hours per car kilometer. This is paid for at the rate of 10 pfennigs per kw-hour, measured at the feeding points. The other expenses of operation, as shown by the books of the Hamburg Company, are presented in the table on this page.

EXPENSES OF HAMBURG COMPANY.

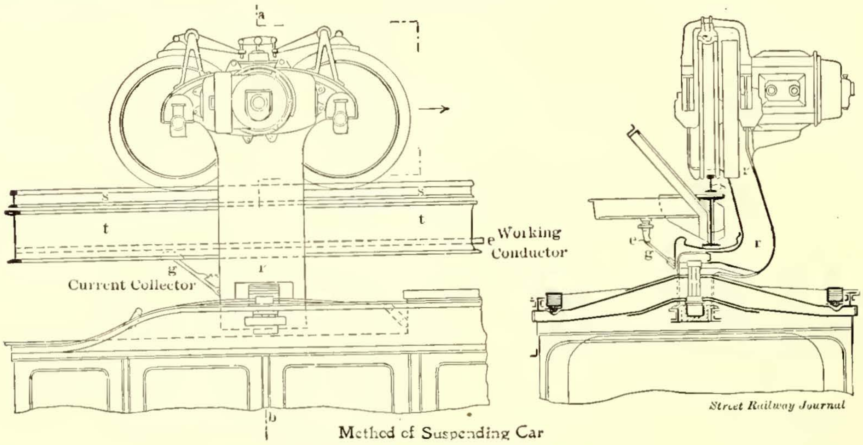
	Single-Truck Motor Car	Double-Truck Motor Car, Weighing 12 Tons, Load 39 Persons	Single-Truck Trailer, Weighing 2.8 Tons, Load 25 Persons
Expenses, including track repairs, salaries, maintenance of buildings, accidents, repairs, insurance, etc.	21.06 pfg.	26.34 pfg.	9.25 pfg.
Renewals (reserve)	2 40 "	2.97 "	1.73 "
Sinking fund (reserve)	3.32 "	4.72 "	1.86 "
Total	26.78 pfg.	34.23 pfg.	12 84 pfg.



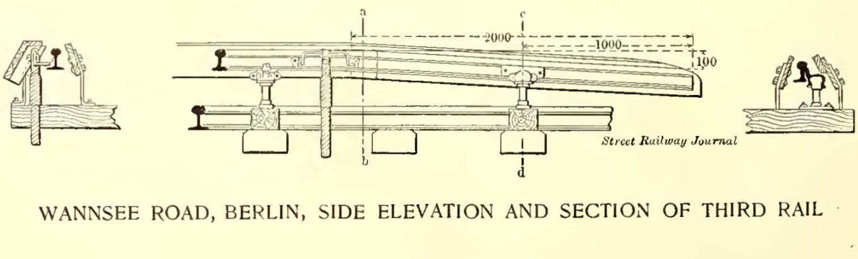
SUSPENDED RAILWAY AND TRAIN AT ELBERFELD

In addition to the Strassen Eisenbahn-Gesellschaft, there is in Hamburg the Hamburg-Altona Centralbahn, a small 7.5-km road built by Schuckert & Company, of Nürnberg. This road extends through the heart of the two cities and is on a dividend-paying basis.

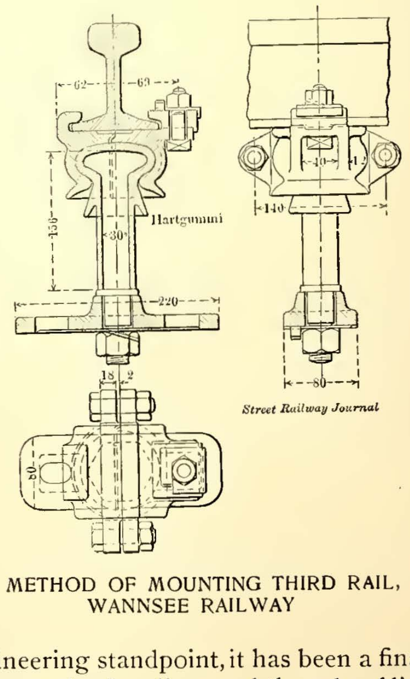
The Hanover street railway is also interesting, because it is one of the early large roads and covers a wide area around Hanover. It is, moreover, an excellent example of the modern tendency. Some of its lines extend 40 km out into the suburbs. This entire system has a total length of 160 km and receives current from six power stations, in some of which three-phase current is generated. The company also furnishes current for industrial, light and power purposes. The Hanover company is also one of the few German railway corporations which owns a large pleasure resort. It is in one of the suburban districts reached by its lines and is said to have cost about 500,000 marks. The company also does a considerable freight business. Part of the road is not equipped with the trolley, and accumulator cars are run over this section. While this road is of interest from an engineering standpoint, it has been a financial failure, and its long suburban lines and the sale of light and power current in suburban districts have not proved profitable. Trolley rollers, and not wheels, are used as current collectors.



BARMEN-ELBERFELD RAILWAY



WANNSEE ROAD, BERLIN, SIDE ELEVATION AND SECTION OF THIRD RAIL

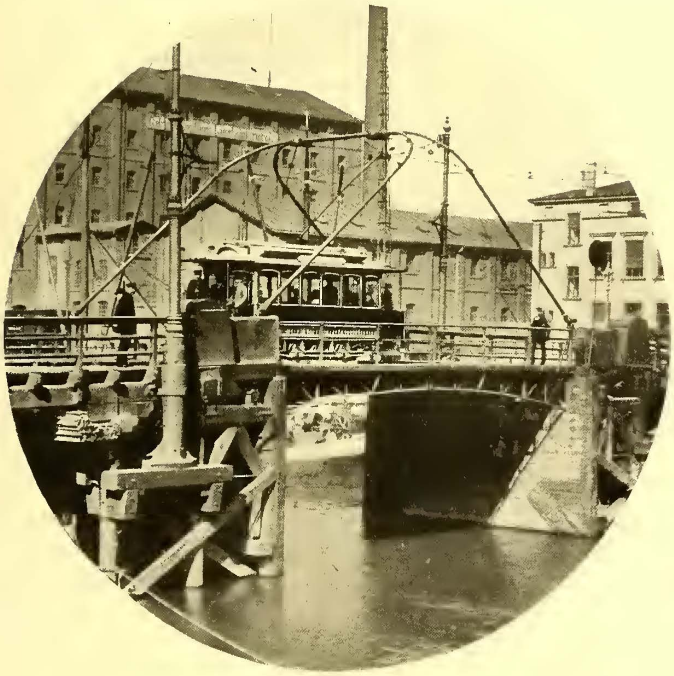


METHOD OF MOUNTING THIRD RAIL, WANNSEE RAILWAY

THE DUSSELDORF-KREFELD STREET RAILWAY

This is one of the most extensive interurban electric railways in Germany, and for this reason should be mentioned in this article. As, however, an excellent article on this road was published in the Street Railway Journal for August, 1899, a brief description will suffice here. The road is 22 km in length, is standard gage and was built to develop some real estate, according to a common American practice. The maximum grade is 2½ per cent and 600-volt direct current is employed, with floating accumulator sub-stations.

The company was not permitted to install overhead wires in the city of Düsseldorf, and therefore had to build 800 m of conduit and equip all motor cars with plows, although the city itself operates a trolley line in the same section of the city, but, then, that is a different proposition. As the illustration shows, rollers are used instead of trolley wheels. The double-truck cars, which measure 12.4 m over all, attain a speed of 60 km per hour and are equipped with two-roller trolleys, while the single-truck cars have only one roller, because they are used for local traffic and run more slowly. The motors are mounted directly on the axles without the use of springs, and each is of 60-hp capacity. The road transports considerable freight and was built by Siemens & Halske.



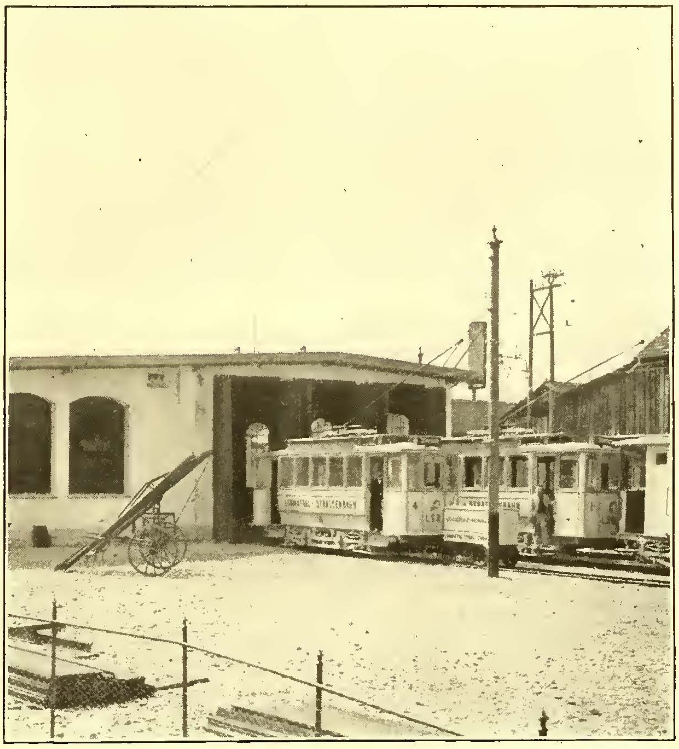
OVERHEAD WIRING ACROSS LIFT BRIDGE, DUISBURG

THE SUSPENDED RAILWAY AT ELBERFELD-BARMEN

This road, a view of which is published herewith, is familiar to most engineers through articles which appeared in the technical papers, including the Street Railway Journal, a year or a year and a half ago. The plan, as will be remembered, was to suspend the cars from one single rail, without any side guides or supports, so that in going around curves the centrifugal force would force the cars to assume an inclined position. As built, the cars seat thirty persons each, and there is standing room for twenty more. There are two trucks, being 8 m apart from center to center, on each car. A Westinghouse air brake and a hand brake are used, which brake on to the tops of the traction wheels. Two electrical methods are also used for braking purposes. The inventors of the system claim that the cars cannot be derailed, because the supporting hook embraces the track from below, leaving a free space of only 7 mm, so that the wheel cannot jump off. If, however, there should be an obstruction on the track, even if only the head of a rivet, there is some doubt as to the practical value of this derailment argument.

Only about 7.5 km of the originally planned total of 13 km of line is in operation, and up to date, a year and a half after the line was opened, only single motor cars, weighing loaded 16 tons, have been run. The speed of the cars is only 20 km to 22 km, although the inventors claim that with this system greater speed can be secured than by any other method on account of the ease with which curves can be traversed. The writer doubts this, especially as it has not been borne out by one and a half years' operation.

The road follows for the greater part the course of the Wupper River, which is from 15 m to 40 m in width, and along its shores the pillars of the elevated structure are set. The numerous curves have nearly all a radius of 90 m, but there is one of 30 m and one of only 8 m. The switching construction is highly interesting, but is not considered safe by the authorities, so that only empty cars are allowed to use it. For this reason there is no turnout on the line although one would have been desirable. In view of these conditions no branch lines are possible.



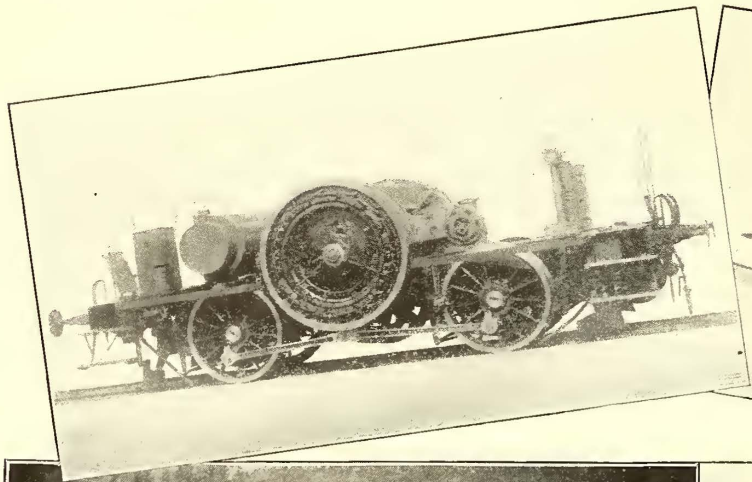
LIMMATTAL STRASSENBAHN

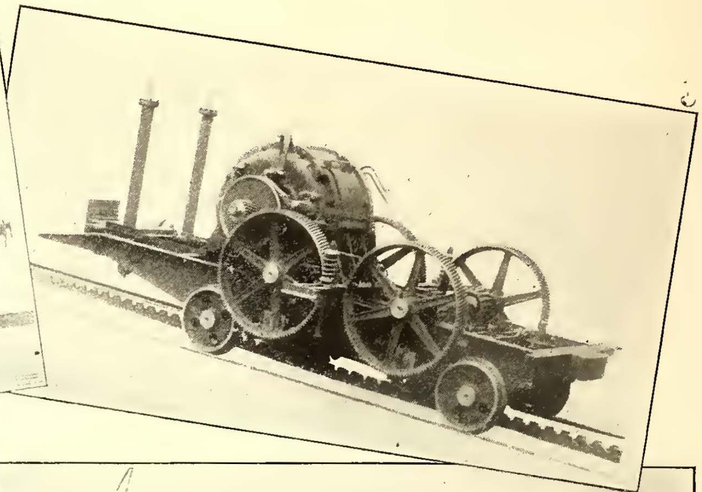
The writer does not believe that any more such roads will be permitted within cities, because pedestrians would not be protected from water and oil dripping from the system, no part of which is water-tight. The ordinary elevated construction is certainly more desirable and less noisy. It may be more expensive, but it is much more efficient. The suspended railway has the further disadvantage that trains cannot easily be run from it into an underground road, as might be desirable within city limits.

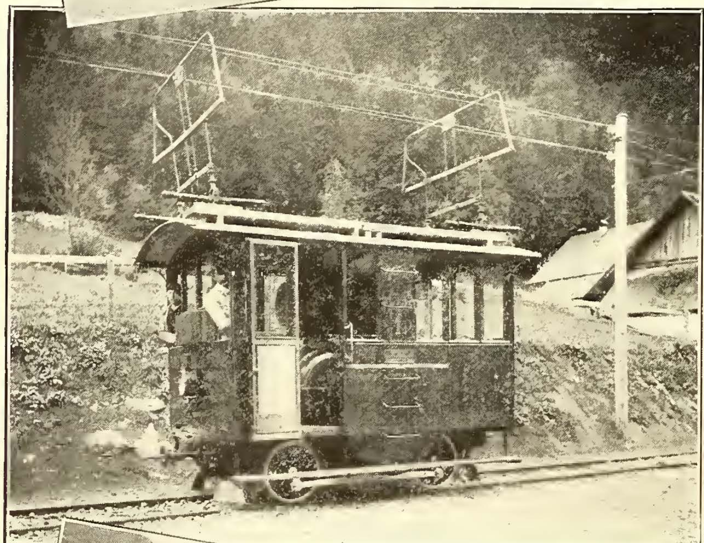
THE WANNSEE ROAD

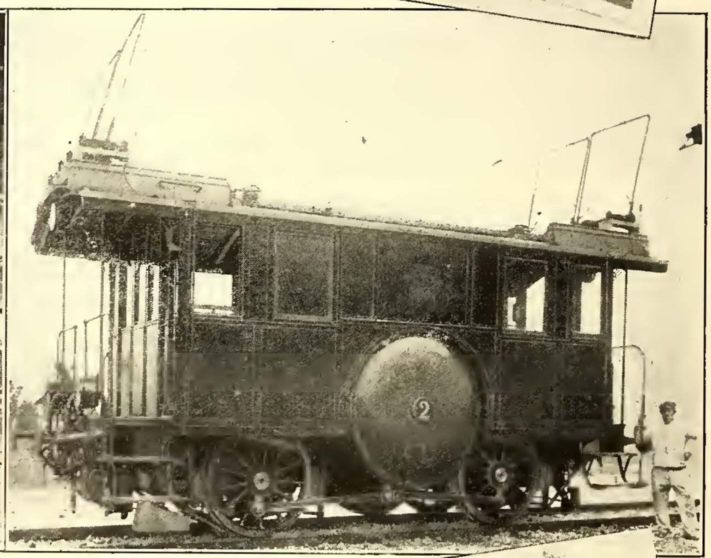
This interesting railway has also been described in the Street Railway Journal of August, 1899, but it comes within the scope of this article, and in order to make the record complete its main features must be mentioned. The road is owned by the State of Prussia and was formerly operated entirely by steam. It extends from Berlin to Wannsee, a distance of about 12 km, and is a part of the Berlin-Potsdam railway, the latter place being the residence of the Emperor. Siemens & Halske obtained permission a few years ago to equip one train on the road with electric power, and it has been in satisfactory operation ever since. It consists of ten cars, weighing without a load 193 tons and loaded 210 tons. The first and last cars are motor cars. Each motor car has three axles, so that there tons. The distances and running time between stations are as follows:

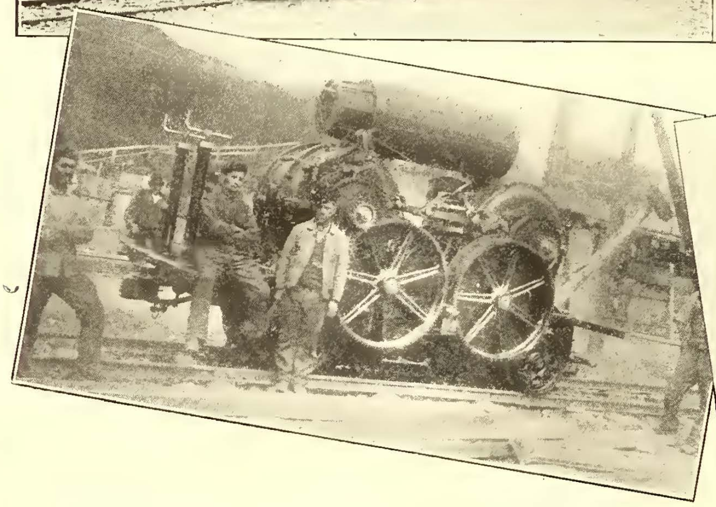
1.9 km	Running time,	$3\frac{1}{2}$	min.
2.78 "	"	"	$4\frac{1}{2}$	"
2.17 "	"	"	4	"
2.38 "	"	"	4	"
2 74 "	"	"	$4\frac{1}{2}$	"
11.98 "	"	"	$20\frac{1}{2}$	"

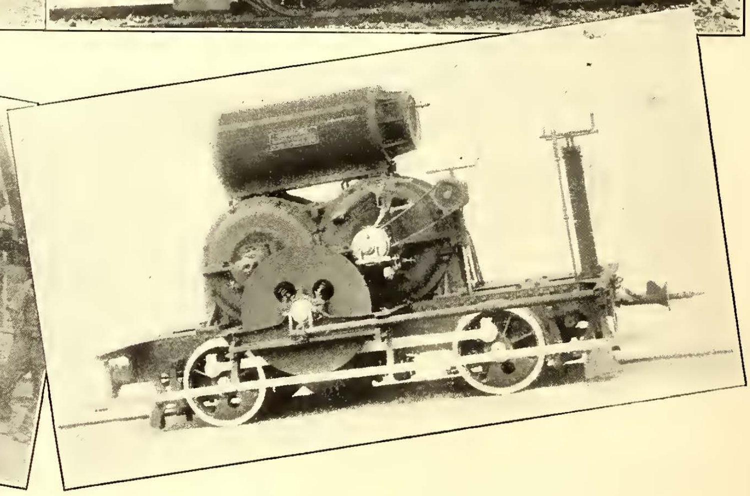












THREE-PHASE LOCOMOTIVE, BURGDORF-THUN RAILWAY
STANSSTAD-ENGELBERG THREE-PHASE LOCOMOTIVE
LOCOMOTIVE, JUNGFRAU RAILWAY

TRUCK OF THE GORNERGRAT LOCOMOTIVE
LOCOMOTIVE, BURGDORF-THUN RAILWAY
STANSSTAD-ENGELBERG ELECTRIC LOCOMOTIVE

are a total of six motors, which are mounted directly on the axle without gears and have a maximum capacity of about 125 hp each. The maximum speed is 55 km per hour. The acceleration at the start up to 40 km is .18 m per second. One motor car is equipped with a steam boiler for heating the train; that car weighs 33 tons, the other 30

The maximum current consumption of the train is 1200 amps. A motor, with its axle and wheels, weighs 3000 kg. At the start both motor cars work in series, but as soon as a speed of 40 km is reached the rear motor car is cut out of the circuit. A third rail is used. The installation is in constant operation.

SWITZERLAND

It is unfortunate that the Swiss authorities require so long a time for the compilation of their yearly railway statistics, because data about these roads become available in printed form only from one to two years after the events have taken place. If the Swiss statistics for 1900 were in existence this comparatively small land would make a far better showing with its highly interesting railways than is possible in the article which follows, as the author has at his disposal figures only up to the close of 1899.

Regardless of this, however, the development of the electric railways of Switzerland presents a remarkable picture, and this development has taken place under conditions which differ materially from those existing in other countries. The chief reason for this is the situation and topography of the country, far away from the coal districts, and including the romantic mountain ranges where few industries have been developed on a large scale. The one is a direct outcome of the other. On account of the high price for coal attempts were made many years ago to utilize the powerful and numerous water-powers of the country for the generation of electricity. As water-powers, however, are not always as conveniently located as steam plants may be, alternating and three-phase currents have been used for long-distance transmission, and to an extent which is simply astounding. Another important factor in the electrical development of the country has been that it contains two very progressive electrical concerns—the Oerlikon Maschinen Fabrik, of Zurich, and Brown, Boveri & Company, of Baden, Switzerland.

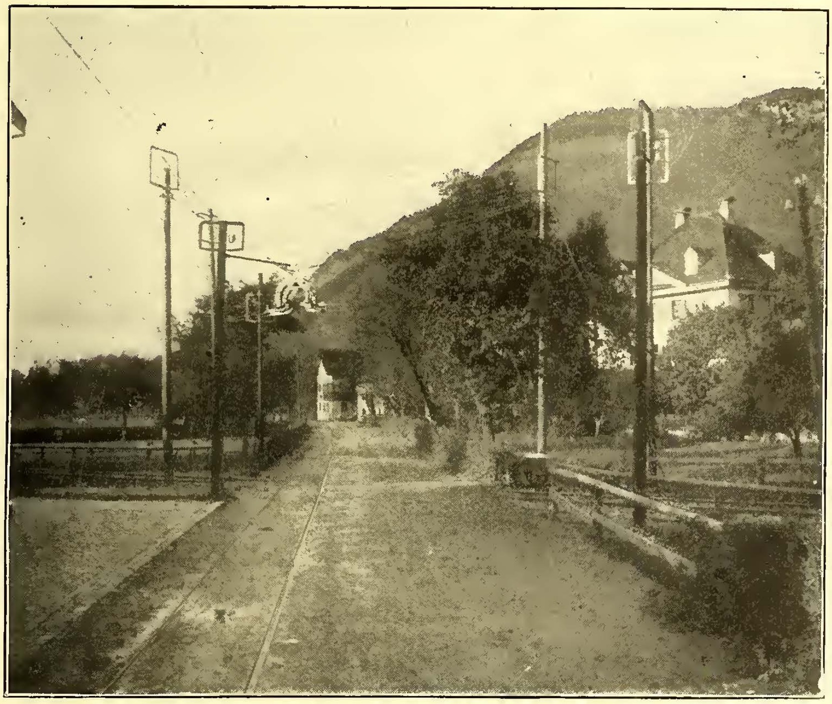
To offset the small number of ordinary manufacturing establishments and the resultant scarcity of freight service, there is the enormous tourist traffic, which is equaled by that in no other country in the world. And these tourists have money to spend—large amounts of it—and it is immaterial to them how much they have to pay for a short ride so long as they have an opportunity to go where they wish. This, however, is somewhat counteracted by the fact that this traffic extends over only about one-half of the year, as there is almost no traffic during the winter. Even if the fare charged is 5 francs for a 3-km trip or 18 francs for a trip of 10 km, there is still an enormous saving to the tourist. Many persons also are enabled to enjoy such tours only through these means, and a large part of the electrical railways of Switzerland are mountain railways.

At the close of 1899 nine cable roads were operated electrically, their total length being 10.21 km. The longest was 3.63 km (on the Stanserhorn) and the shortest the Zurich mountain road, being .17 km in length. These figures, as well as those given elsewhere in this article, unless otherwise stated, represent the streets covered and not the length of single track. The steepest grade is that of 63 per cent on the Stanserhorn road.

The greater part of the electrically operated roads are found within the cities. Statistics show that at the close of 1899 there were twenty-three such roads, having a total length of 154.18 km. This figure shows that there are no long street railways, which is explained by the fact that most of the cities are not very large and are crowded into valleys which are surrounded by high and steep mountains. The largest connected electric railway system is that of Geneva, and it is at the same time the only one on which a gage different from 1 m is used, namely, 1.445-m (or 4 ft. 8½ ins.). All other Swiss electric railways have a gage of 1 m. The older part of the Geneva railway, which has a total length of 15.36 km, was operated in 1899 with horses, steam and electricity and has a 1.445-m gage. The new construction, which was at once equipped electrically, has a 1-m gage and is 5.15 km in length. The next in extent is that of Zurich, which belongs to the city and is 19.11 km in length; 10.91 km are operated electrically, while the remainder was operated with horses and has a gage of 1.445 m. This was at the close of 1899, and it is quite probable that electricity has been introduced since that time.

Besides these roads, there are three other lines near Zurich which have a total length of 10.99 km, so that the total Zurich railway system had a length of 30.10 km at the close of 1899.

Basel has a system of street railways 11.41 km in length,

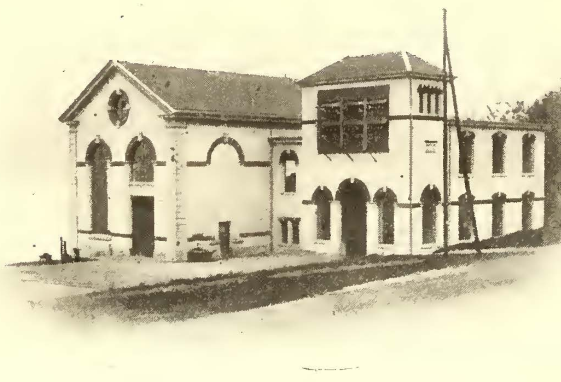


CROSSING OF THREE-PHASE LINE AND DIRECT-CURRENT LINE ON STANSSTAD-ENGELBERG RAILWAY, PROTECTIVE NETTING AROUND BARE FEEDER WIRE

AARAU-SCHOFTLAND, DIRECT-CURRENT RAILWAY

Lausanne 13.91 km, and, besides these, there are five other cities having railway systems of from 10 km to 11 km in length, while all others are smaller in extent.

One remarkable feature about the Swiss street railways is the long life of the franchises as compared with conditions prevalent in other European countries. Some of them



POWER STATION ON THE KANDER FOR THE BURGDORF-THUN THREE PHASE RAILWAY

extend to 1950 and a few even to 1975. In Germany, the longest time is fifty years, while in most cases, especially in large cities, it is considerably less. Under such conditions a sensible financial plan, especially in regard to a sinking fund, can be carried into effect.

The total length of all Swiss tramways at the close of 1899 amounted to 175.82 km, of which 154.18 km, or 88 per cent, are operated electrically. This is a large percentage for European conditions, especially in view of the fact that the figures were compiled two years ago, and the percentage is probably larger at the present time.

Nearly every road is single track, and only the two roads of Basel and Zurich, which are 11 km and 19 km in length, respectively, have about one-half of the system double-tracked (5 km and 10 km, respectively). Geneva has only 8.7 km of double track on a system which is 20 km in length.

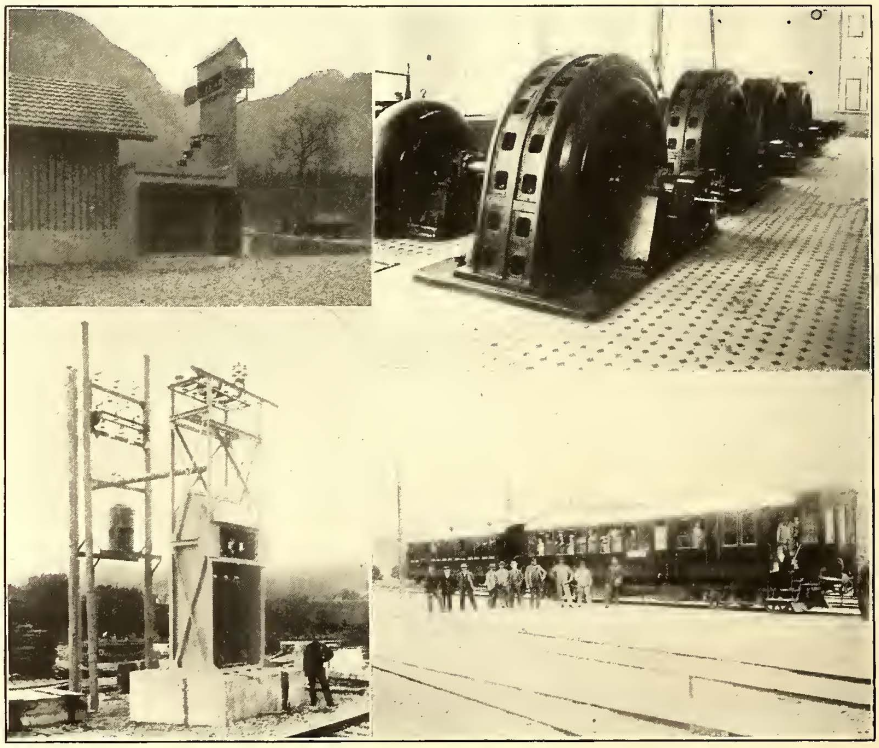
Except perhaps for the extensive use of turbines for the generation of electricity, the writer finds nothing which differs materially from current practice, unless it be the extensive telephone wire protection, as shown in the illustrations, and the three-phase railway at Lugano.

THE ELECTRIC RACK ROAD ON THE GORNERGRAT

A great many difficulties had to be overcome before this interesting road was finally completed. In 1890 the franchise was granted, and only during the summer of 1896 was the work on the road actually begun. The road starts at Zermatt at an elevation 1607 m above the sea level, then passes over a 24-m iron bridge spanning a rivulet, and then by means of many double curves and a maximum grade of 20 per cent it ascends the "Gornergrat." The curves represent 30 per cent of the total length, which is 9.2 km. There are three intermediate stations, which are from 2.5 km to 3 km distant from each other. These stations are located 1607 m, 1772 m, 2213 m and 2585 m above the sea level, and the terminal station on the Gornergrat is 3020 m above the sea level. At the time of its construction it was the highest road in Europe. The following comparative table may be of interest:

	Height at Starting Point	Height at Terminal Station.
UNITED STATES		
Pike's Peak Railroad (Colorado)	2,015 m	4,260 m
SWITZERLAND		
Vitznau-Rigi road	437 "	1,750 "
Arth-Rigi road	421 "	1,750 "
Pilatus road	441 "	2,066 "
Monte Generoso road	277 "	1,639 "
Wengernalp road	890 "	2,064 "
Schynigeplatte road	587 "	1,970 "
Glyon-Naye road	689 "	1,972 "
Rothhorn road	570 "	2,252 "
Gornergrat road	1,607 "	3,020 "

It goes almost without saying that the most difficult engineering problems had to be solved in the building of this road. As an example the following may serve: The entire roadbed was cut out of solid rock or is built on projections, and in driving a shaft only .35 m in depth for blasting purposes sometimes thirty chisels were broken. Tests show that the rock offered a resistance of 2070 kg per square centimeter. The work was normal up to a height of 2700 m, but when greater altitudes were reached the workmen could not work continuously owing to the so-called "mountain sickness." During the two years of building a total of 2400 workmen were employed. The illustrations show two portions of the road, one being a section of a tunnel and the other a place where the road passes along the side of the mountain. The smallest radius is 80 m; the



Transformer Station and Apparatus
Transformer Station with Automatic Circuit Breakers

Generators in Station, Kander
Motor and Trail Car, Making a Complete Train

BURGDORF-THUN EQUIPMENT

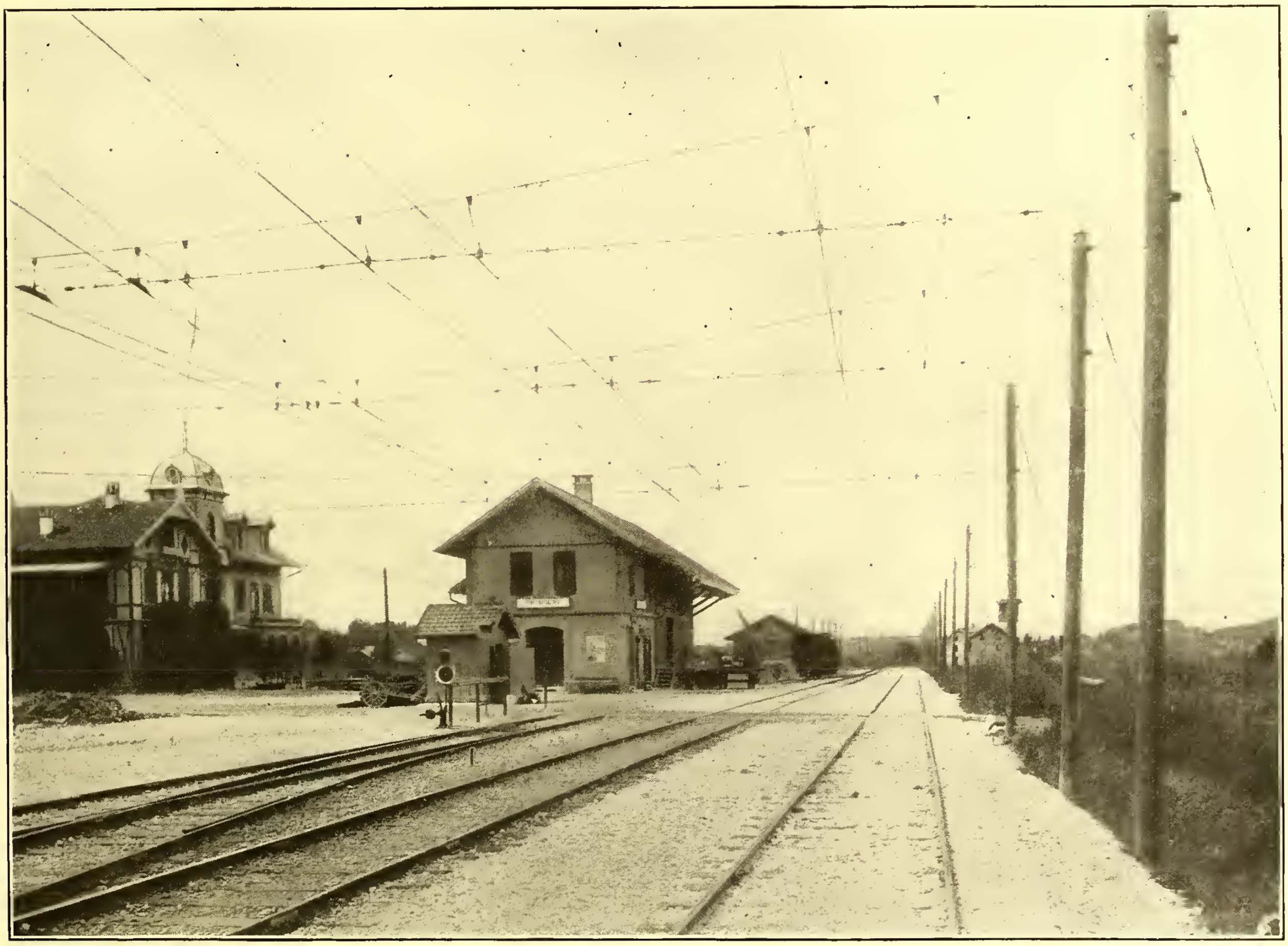
gage is 1 m. On a base having a width of 3.6 m a layer of broken stone to a depth of .3 m and a width of 3.2 m has been laid. The tunnels are 3.8 m wide and 4.5 m above the head of the rails. To gain some idea as to the cost of transporting material over the high altitudes without the use of railways, it might be stated that a cubic meter of building sand costs 62 francs at the lowest tunnel mouth.

On this road Vignole, or T-rail, weighing 20.6 kg per meter, 100 mm high, 90 mm width at base, 46 mm width of head and 8 mm width of web was used. There is only one 80-m radius curve, which simplifies the construction. The rack between the rails is of the Abt type and can sustain a pressure on the teeth of 6000 kg. As the speed is only 7 km per hour, the outer rails at curves are not raised.

The locomotive weighs 10.5 tons and is equipped with two three-phase motors, each of 90-hp maximum at a speed of 800 r. p. m. and 500 volts. Double-reduction gearing transmits the power of each motor independently to the rack-driving wheel, the ratio being 1 : 12. The constant speed for the up and down trips is 7 km per hour. The locomotive is equipped with two spindle brakes, the one operating on the left braking surfaces of the two rack-driving wheels and the other on the two right surfaces. to increase the tractive weight of the locomotive, the cars have a truck at one end only; the other end rests on the locomotive by means of extension sills. A fully loaded train weighs 28 metric tons (locomotive, 10.5 tons; two cars, 9.2 tons; 110 persons, 8.3 tons; total, 28 tons). Such a train requires 180 hp, 90 hp for each motor.

As the efficiencies of the motors are 91 per cent, the trolley line 85 per cent (average), the transformers 96 per cent, the feeders 95 per cent (minimum) and the generators 92 per cent, the turbine must furnish 255 hp for each train, and for two trains running at one time 510 hp.

The station is situated 2 km from the lower terminal station and contains three units of 250 hp each, consisting of Girard high-pressure turbines with horizontal shaft and a speed of 400 r. p. m direct-connected to the three-phase



BURGDORF-THUN THREE-PHASE RAILWAY—TURNOUT AND OVERHEAD WIRING FOR THREE TRACKS

There is also an electric brake, which is brought into play either by the motorman or automatically as soon as the 7-km speed is exceeded. The locomotive has two running axles. The motors are of the asynchronous, three-phase type with wound armatures and collector rings, and are arranged for the insertion of a resistance into the armature circuit. They start under full load. The motors have six poles, and with 40 p. p. s. the speed is 800 r. p. m. There is a double set of bow trolleys, so as to avoid interruptions at switching points.

The best brake is the three-phase motor itself, which at once acts as a generator during the descent as soon as the 7-km speed is exceeded. In this way a considerable amount of current is sent back over the line.

A closed passenger car holds sixty people, an open car fifty people, so that a maximum of 110 persons can be transported at one time. On account of the simplicity, and generators by means of elastic couplings. There are also two direct-current generators, which serve as exciters, driven by separate small turbines to reduce the speed variations. The twelve-pole revolving magnetic field is made ot cast steel, and at 400 r. p. m. the number of periods is 40. Current is generated at 5400 volts.

Three feeders lead to the transformers, located at 2 km, 5 km and 8 km from the lower terminal, which are of 180 kw each, and which reduce the voltage from 5400 volts to 540 volts. The trolley wires are 8 mm in diameter and are suspended from cross-wires 25 m in length. The rails are joined by means of Chicago rail-bonds and form the third conductor. The contact circuit is provided with air switches at all turnouts and stations. The one row of poles carries a telephone circuit along the entire distance.

It took only four weeks' time to install all the electrical and hydraulic machinery, inclusive of the pressure-pipe lines, which is certainly a remarkable performance in view of the difficult conditions and great altitudes. The electrical station and line equipment was furnished by Brown, Boveri & Company, of Baden, Switzerland.

The fare charged is very high, as might be expected on such tourist roads, which only do business during a short period each year. A single trip of 10 km costs 12 francs and an excursion ticket costs 18 francs. Five trips in each direction are made daily during the season.

BURGDORF-THUN ELECTRIC RAILWAY

This road is the longest of the four Swiss three-phase railways, being 40 km in length, and was opened in July, 1899. As this road has also been described in the STREET RAILWAY JOURNAL (December, 1899), a few of the main features only will be mentioned. The maximum grade is 2.5 per cent and the gage is standard, i. e., 1.435 m. The minimum radius is 250 m. There are fifteen stations, being a minimum distance of 1.23 km and a maximum distance of 4.27 km apart. Thirty-six per cent of the entire length of the road is on curves. The standard trains have a weight of 56 tons, but sometimes trains weighing 112 tons are run. The maximum speed is 36 km per hour.

The water-power plant is on the Kander, 10 km distant from the Thun end of the road. The voltage is 16,000, which is reduced to 750 volts for use on the line.

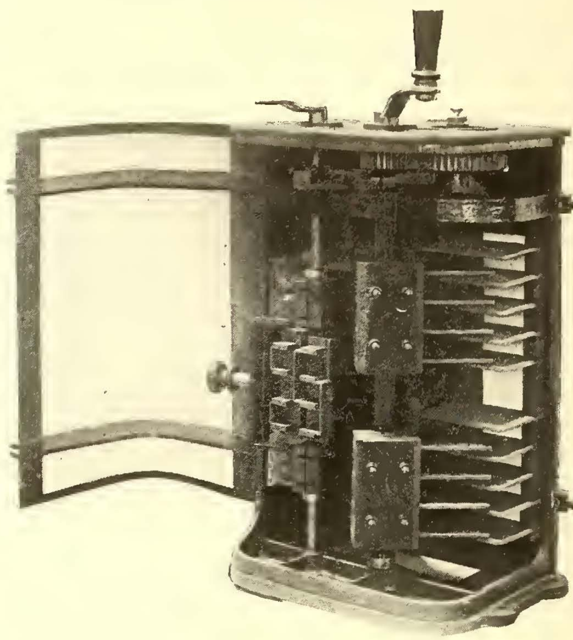
From the Kander central station to Thun the high-tension wires are carried on built-up iron poles, which are from 45 m to 50 m apart and are set in concrete.

There are fourteen transformers, located at an average distance of 3 km apart, the maximum being 3.4 km and the minimum 2.4 km. Each transformer is enclosed in an iron box casing and has a maximum capacity of 450 kw, which corresponds to the load of a double train. The windings are connected in star fashion. The so-called horn lightning arresters are used, having a spark distance of 18 mm. The wire leading to the track also serves as an earth connection of the transformer casing.

The trolley wires are 8 mm in diameter and are run in zigzag fashion, so that the bow-trolley contact wears evenly along its entire length. The wires are suspended 5.2 m above the tracks and have a sag of 35 cm, so that the lowest point is 4.85 m above the tracks except in the tunnels. As the cars carry four trolleys, one for each leg at each end of the car, insulated sections can be introduced at the overhead switches without interrupting the car circuits.

There are two two-axle locomotives, six four-axle motor cars, seven trailers for passenger traffic, three combination mail and freight cars, with twenty seats for passengers, and several freight cars. The locomotives are used principally for the transportation of freight. Their speed is 18 km per hour, which, by changing the gearing, can be increased to 36 km for the transportation of passengers. At a speed of 18 km a locomotive can draw a load of 100 tons, in addition to its own weight, up a 2.5 per cent grade. At 36 km 50 tons can be drawn. The motor cars will seat sixty-six persons, and can draw at a speed of 36 km a 20-ton trailer up a 2.5 per cent grade, the trailer seating an additional sixty to seventy people.

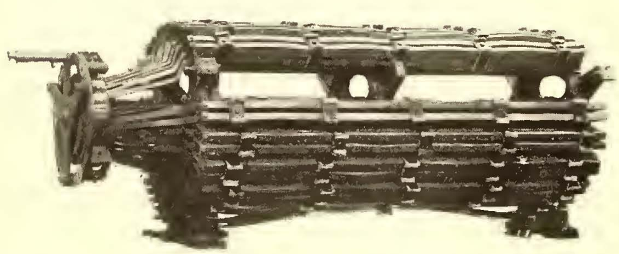
A special form of bow-trolley frame, as shown in the engravings, was adopted because each collector had to collect as high as 150 amps. The frames are constructed of gas pipe, steel wires being used for diagonal braces. The contact piece can be turned with ease and has a triangular shape (Greek delta), one face of which always bears against the wire. The life of the contact piece is about 4000 km.



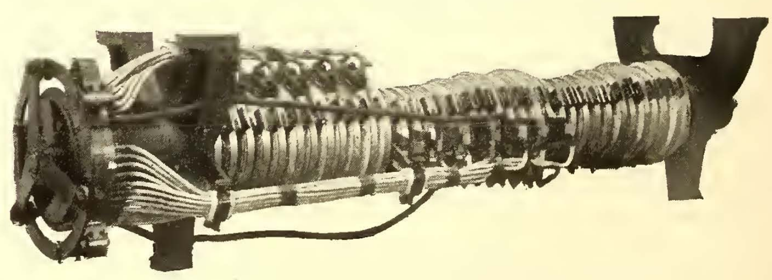
CONTROLLER FOR MOTOR CARS, BURGDORF-THUN RAILWAY

The locomotive is equipped with two motors, 150 hp, 750 volts, 300 r. p. m., one resistance, two controllers, four contact frames, one 18 kw, 750-100 volts transformer for lighting and heating, one lightning arrester, one air compressor driven by a 4-hp 100-volt motor, two 500-amp ammeters and one complete switchboard. The wheel base is 3.14 m, the length over all 7.8 m, diameter of driving-wheels 1230 mm, weight (empty) 29.6 tons, weight of electrical equipment 10 tons, weight of one motor 4 tons.

The motor cars have front and rear platforms. Each of the four axles is driven by a 60-hp 750-volt motor by means of gearing. The Westinghouse air brake is driven by a 4-hp 100-volt motor, receiving its current from a small 18-kw 750 volt to 100 volt transformer which is located under the car. The same transformer also furnishes current for lighting and heating the car. The wheel base of the truck is 2.2 m and the distance between the king-pins is 9.5 m. The mean duration of a maximum load on a transformer is about ten minutes. On account of this small demand the transformers are built very light. At no load the energy loss of the transformers is 2.5 kw, the maximum drop of pressure 10 per cent. At present only five trains are operated on the line at any time.



RESISTANCE FOR MOTOR CARS, BURGDORF-THUN RAILWAY



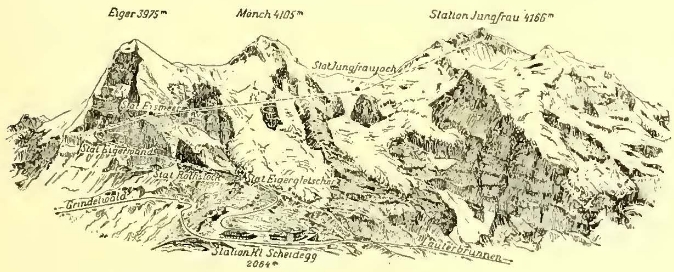
RESISTANCE FOR TWO 90-HP MOTORS, GORNERGRAT RAILWAY

The cost of the electrical installation, exclusive of the central station, was as follows:

Thirty-eight kilometer high-tension circuits from Thun to Burgdorf, inclusive of branch circuits to the fourteen transformers	F.140,000
Trolley line and track return, inclusive of 6-km double track at switches, including feeders, poles, insulators, wires, switches, lightning protectors, and erection	350,000
Fourteen 450-kw transformers, inclusive of small transformer houses	160,000
Station lighting and repair shops	20,000
Electric equipment of rolling stock, i. e., six motor cars, two locomotives, lighting and heating of cars	235,000
Reserve parts	30,000
Total	F.935,000

The fare for the entire 40-km trip is 2.05 francs and 2.90 francs (for two classes) and 3.30 francs and 4.60 francs, respectively, for the excursion trip.

The entire electrical equipment was furnished by Brown, Boveri & Company, of Baden, Switzerland.



SKETCH SHOWING COURSE OF JUNGFRAU RAILWAY

Accidents due to the use of high-tension three-phase and trolley three-phase currents have not been reported up to the present time, and it would appear as if the danger on the high-tension circuits may be absolutely removed by the exercise of care.

STANSSTAD-ENGELBERG ELECTRIC RAILWAY

This installation differs materially from the Gornergrat railway in having considerable freight traffic and also because of the entire length of 22.3 km only 1.5 km is rack but no tunnels, as is the case on the Gornergrat railway. As the track construction of the latter road has been minutely described it is not necessary to do so again in this case.

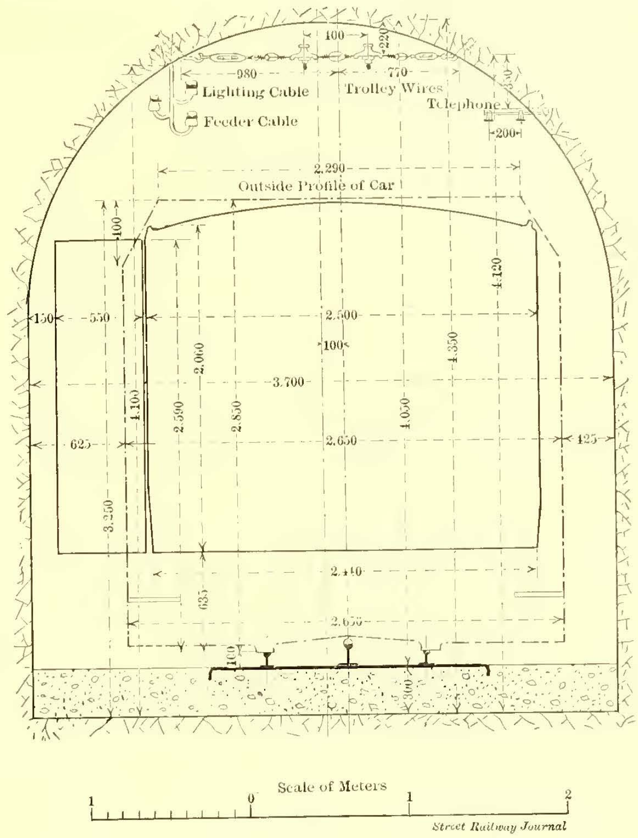
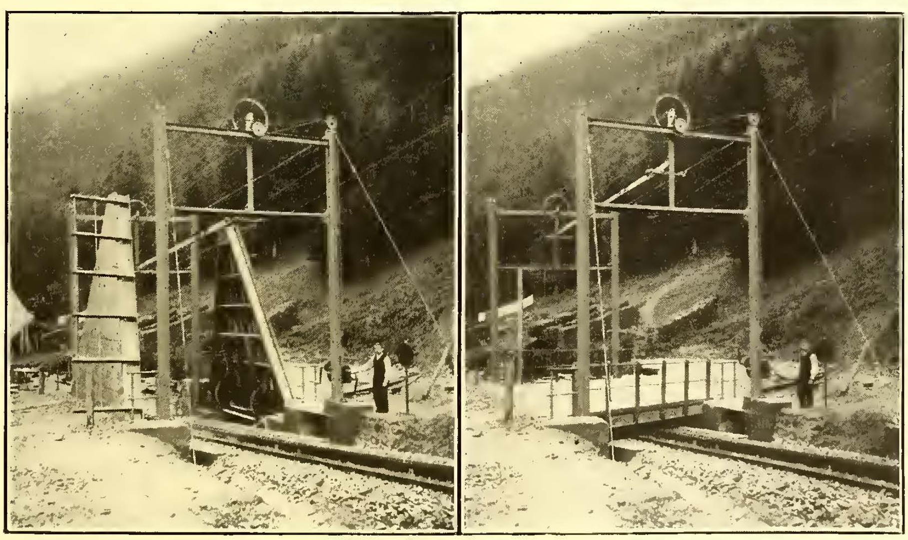


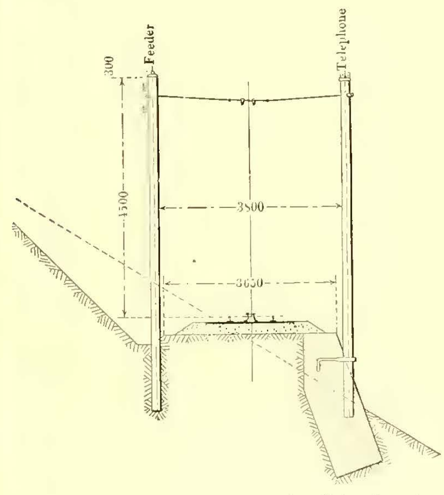
DIAGRAM SHOWING TUNNEL AT LAUTERBRUNNEN

Mention should be made, however, of a roadway drawbridge shown herewith which is only 2 ft. above the level of the roadbed and was necessary to keep the dust of the road out of the rack. The bridge is generally down, and only when a train approaches it is opened by hand. This requires one minute.



Open Closed

THREE-PHASE LINE, STANSSTAD-ENGELBERG; LIFTING BRIDGE FOR CROSSING OF HIGHWAY LINE AND RACK RAILWAY



CROSS SECTION OF TRACK ON SIDE OF MOUNTAIN, STANSSTAD-ENGELBERG

construction. Some particulars of the Stansstad line were published in the STREET RAILWAY JOURNAL for January, 1899, but the line has now been in operation for over three years, and a brief review of its construction and present methods of operation will be of interest.

The road was begun in 1897 and has several iron bridges

The rails used are of the Vignole type, are 10.5 m long, weigh 30 kg per meter and are laid on metal ties, there being eleven for each rail. The rack weighs 52 kg per meter. The smallest radius is 50 m.

The station could fortunately be located near the 1.5 km rack section, that is, near the point of greatest power consumption. In consequence most of the current is generated at the same pressure as is used on the trolley wires, namely, 750 volts, three-phase, and only for the last third of the railway is the current transmitted at high potential (5300 volts). This is accomplished by three single-phase transformers, each of 30-kw capacity. The central station is situated 4.3 km from one end of the road and 18 km from the other.

Water-power is the prime mover. Several sources of water supply are brought together in a 1000 cu. m basin, and from there are led through a 300-mm pipe line 1634 m in length to the station, where this great fall is utilized. There is room in the station for three generators, each coupled directly to a turbine, the shafts being horizontal. Each three-phase unit has a capacity of 180 hp. Two machines were installed at first. Their speed is 650 r. p. m., and each generator is excited by a small 12-hp exciter. Great care has been exercised in devising means to keep the speed of the turbines constant. Exciters and generators work in parallel, and the several sets are connected to common bus-bars, one of which is connected to the rails, and to the other two the trolley wires are connected through two-pole switches.

The two trolley wires are 7.5 mm in diameter, are suspended 4.5 m high and are carried by poles 6 m in length. By means of section insulators the entire road is divided into five sections, which may be fed independently. The 11-km high-tension line consists of two 3.5-mm wires, which are carried by separate iron poles 8 m high. The latter are placed 80 cm away from the trolley poles and are anchored toward the outside. At all streets, as well as telephone crossings, the high-tension wires are surrounded by a completely closed wire netting, as shown in the illustrations.

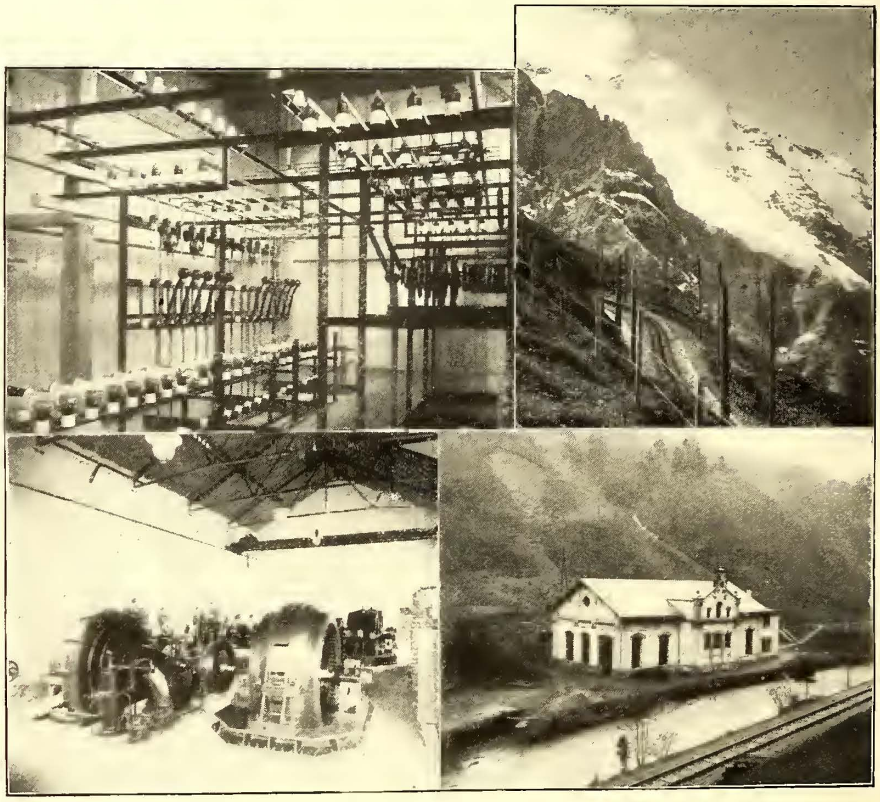
Fastened to the top of the poles is a telephone line which runs along the entire road. It consists of 2-mm silicon bronze wire, and is transposed every 100 m so as to eliminate the induction of the railway current. The high-tension line is protected by means of horn lightning arresters and the trolley line by Westinghouse arresters.

The rolling stock consists of three locomotives and seven motor cars. The latter are four-axle cars, 14 m long, weighing 14 tons, seating forty-six persons and having baggage room in addition. The forward truck carries two three-phase motors, each of 35 hp at 750 volts and 480 r. p. m., and each weighing 960 kg. They are mounted on springs and have a single-reduction gear which runs in oil. The rear truck has a gear brake which is operated from the rear platform. There is, furthermore, a hand shoe brake which operates on all eight wheels.

The current is collected by two double bow trolleys which are mounted on spring supports on top of the car. The maximum speed is 20 km per hour, which may be cut down by means of resistances. For lighting, the trolley pressure is reduced to 100 volts by a transformer located in the baggage room. For heating, there are fourteen heaters, seven being connected in series between the trolley wire and the rail.

The locomotives are constructed to be able to draw a fully loaded 15-ton motor car up hill or brake it going down hill along the 1.5-km rack section, which has a 25 per cent maximum grade, at a speed of 5 km; also to haul two 20-ton freight cars up a 5 per cent maximum grade on the ordinary track at a speed of 11.5 km. Each is equipped with two three-phase motors, each of 75-hp capacity at 650 r. p. m., and connected by separate gear-wheels having V-shaped teeth to a common pinion, which in turn drives an auxiliary axle. From this the motion is transferred by two symmetrically arranged pinions to the gear-wheel driving axle. This latter is hollow and is sleeved around the crank axle, which transmits the motion to the axle of the ordinary driving-wheels.

When on the rack section the motors drive the gear-wheel driving axle only, while the adhesion axles run idle and only serve as supports, while on the adhesion section, by a friction coupling, the motors are connected to the ordinary wheels and the gear-wheel mechanism runs idle. In running down grade the motors brake automatically by being turned into generators as soon as the speed exceeds the normal by 4 per cent.



High-Tension Switching Apparatus Power Station at Lauterbrunnen Mountain Curve, Jungfrau Railway

Interior Power Station at Lauterbrunnen Exterior of Power Station at Lauterbrunnen

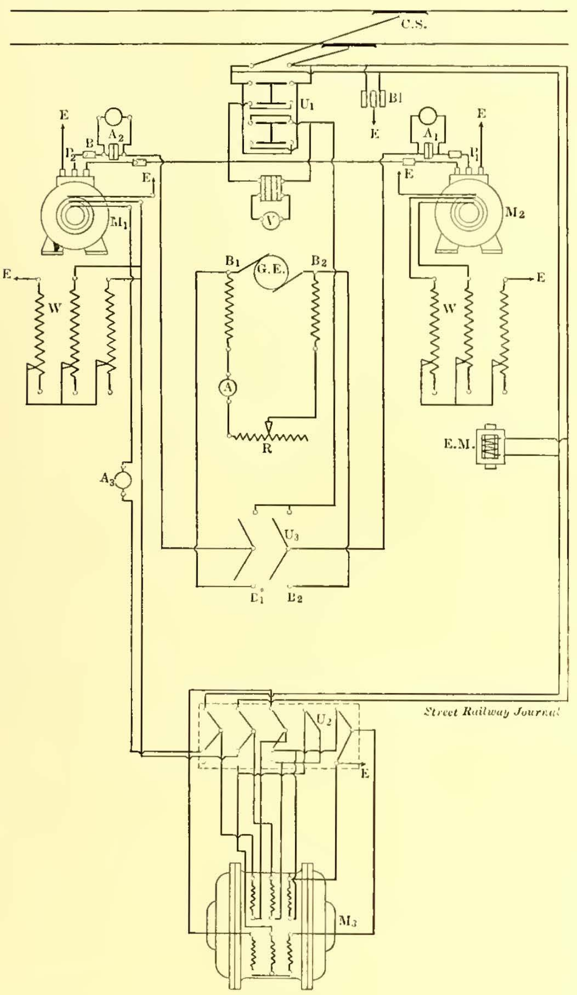
VIEWS OF JUNGFRAU RAILWAY EQUIPMENT

A motor car is capable of drawing a trailer weighing 10 tons (i. e., a total of 26 tons) up a 2.3 per cent grade at a speed of 20 km per hour. As soon as the grade reaches 5 per cent the trailer is dropped. The 16-ton car on such a grade requires from 80 hp to 90 hp. As soon as the car reaches the rack section the locomotive comes up from behind, but is not coupled to it, so that independent braking is possible in case the car and locomotive should separate. The power required to push the car up the 25 per cent grade is, for a total load of 26 tons and a speed of 5 km, about 150 hp. After reaching the top the motor car continues alone until the terminal station is reached. In going down hill the locomotive and motor car, having a total weight of 28 tons, send about 75 hp back into the line. The efficiency of the generators and turbines in the power house is 65.2 per cent when the load is normal and 69.2 per cent at a maximum load, which is a very creditable showing.

During the height of the season, ten to eleven trains are run daily. The fare for a single trip is 2.25 francs and 4.25 francs (two classes) and 3.70 francs and 7 francs for a return trip, the distance being 22.3 km. The electrical installation was furnished by Brown, Boveri & Company, of Baden, Switzerland.

THE JUNGFRAU MOUNTAIN RAILWAY

A third and highly interesting mountain rack railway operated by three-phase current is the Jungfrau railway. This road has also been briefly described in these pages, but further particulars are of interest. The road has its starting point at the "Kleine Scheidegg," situated 2064 m above the sea level, and runs along the edge of the mountain 2.015 km, including an 87-m tunnel. It will then traverse a 10.185-km tunnel (2 km of which has been completed), at the end of which the line will terminate, reaching an altitude of 4093 m. After leaving the train, passengers will be elevated through a distance of 73 m by means of a lift up to the summit of the mountain, 4166 m above the sea level. The grade will be 25 per cent along the entire road, with the exception of a 3.56-km section, which will be a 67 per cent grade. There are three branches to the 10.815-km main tunnel, which will terminate in the open air, always at intermediate stations, in order to give the travelers an opportunity to get a view of the wonderful scenery.



B1—Lightning arrester.
M1 M2—Motors for locomotive.
M3—Motor for air blast.
U1—Main switches.
U2—Switches for air-blast motor.
A1 A2—Ampere meter and resistance.
A3—Ampere meter for air-blast motor.
GE—Direct-connected motor.
W—Resistance for the motors on locomotive.
V—Voltmeter and resistance.
RN—Resistance for field of direct-connected motor.
B—Fuses.
CS—Method of contact.

DIAGRAM OF CONNECTIONS FOR JUNGFRAU LOCOMOTIVE

The construction of the tunnel is very interesting from an engineering standpoint, but would consume too much space to describe in detail in this article. It is interesting, however, to note that during the construction of the tunnel three-phase current is used for traction and power purposes to quite an extent. The motors receive the current direct from the trolley line, which carries 550 volts and which always follows the workmen. Fifteen, 20 and 30 hp three-phase continuous-current transformers are used for rock drills and a 12-hp three-phase motor for a ventilator. There is also a 550-volt to 200-volt transformer for heating purposes, furnishing current for the snow melter. The tunnel is 3.7 m in width, is 4.35 m in height and has a cross section of 14.6 sq. m.

Great care is taken in the construction of the roadbed and the laying of the rails, because repairs at such altitudes and in a tunnel are very costly.

Vignole T-rails 10.5 m in length, 100 mm high, 90 mm wide at the base, 46 mm wide at the head and weighing 20.6 kg per meter are employed. The rails are laid on prismatically shaped ties weighing 37 kg and closed at the two ends. They are 1.80 m long and are .5 m apart at the rail-joints and 1 m apart at other places. The gage is 1 m, but is 2 mm more at 150-m and 200-m curves and 4 mm more at the 100-m curves.

The Strub rack system has a broad surface at the top, which may be embraced by a clamp fastened to the car for braking purposes. The rack weighs 34 kg per meter. The complete superstructure weighs 125 kg per meter. The smallest radius in the open air is 100 m, in the tunnel 200 m and at switching points 80 m.

The power station at Lauterbrunnen covers an area of 617 sq. m. The turbine installation may be divided into three groups: The first consists of two Girard double turbines with the following data:

Fall, 35 m.
Quantity of water, 1430 liters per second.
Capacity, 500 hp.
Revolutions, 380.

Each turbine has a fly-wheel weighing 6000 kg and having a peripheral speed of 40 m. The second group consists of two horizontal radial turbines with the following data:

Fall, 35 m.
Quantity of water, 71 liters per second.
Capacity, 25 hp.
Revolutions, 700.

The third group consists of two Francis turbines:

Fall, 32.5 m.
Quantity of water, 2640 liters per second.
Capacity, 800 hp.
Revolutions, 380.

The turbines are connected to the generators by means of special couplings. They consist of two plates connected together by means of an elastic coupling in such a way that small variations in the location of turbine and generator shafts are equalized without disturbing the smooth operation in any way. Furthermore, this coupling serves as a good insulation between turbine and generator, which is very desirable in this mountainous country, where thunderstorms are so frequent.

There are three groups of generators, namely, two of 500 hp, two of 25 hp, direct current, and three of 800 hp. The alternating-current machines are of the inductor type, have stationary windings and rotating magnetic fields, which consist of a rotating cast-steel cylinder with two rings, each carrying six poles. At 380 r. p. m. the generators furnish 7000 volts at 38 p. p. s. At normal speed and load the generators have an efficiency of about 94 per cent, inclusive of the excitation, the load being a non-inductive resistance. The drop in pressure at uniform speed and excitation from no load to full load is:

With cos. $\Phi = 1.0$ .... 10 per cent.
With cos. $\Phi = 0.8$ .... 20 per cent.

In order to retain the pressure at 7000 volts with uniform speed the excitation must be increased 20 per cent between no load and a non-conductive full load, and if the latter consists of an inductive resistance (cos $\Phi = 0.8$) the excitation must be raised 50 per cent of the maximum excitation.

For lighting the station the pressure is transformed from 7000 volts to 86 volts. One village is lighted by means of the current generated at this station. The resistance seen in front of the switchboard in the illustration serves for heating the station.

Outside of the tunnel the high-tension feeders are supported by 12-m wooden poles 30 m apart, which also carry the testing and signal wires. The poles are embedded in concrete to a depth of from $1\frac{1}{2}$ m to 2 m. The circuit consists of three 7.5 mm hard-drawn copper wires, which are suspended on triple-petticoat porcelain insulators. Along the first portion of the tunnel the insulators are arranged as shown in the illustration, being cemented into the tunnel wall. After the 2.88 km point is reached the wires are carried in a cable.

At all stations two transformers are located, reducing the pressure from 7000 volts to 500 volts. The three iron cores arranged concentrically over the primary and secondary coils are placed in a vertical position next to each other and are covered on top and bottom by plates of laminated iron. The loss at full and overload is 3 per cent. The primary coils and secondary coils are each connected in parallel. Another transformer, reducing the pressure from 7000 volts to 200 volts, is used for lighting purposes.

The trolley wires, of hard-drawn copper, are 9 mm in diameter and are suspended on 6 mm steel wires 4 m above the top of the rails. In the tunnel the steel wires are carried on insulators which are attached to insulators cemented into the tunnel wall. The rails serve as conductors for one phase, and are therefore connected by 7-mm rail-bonds and cross-connected every 90 m.

The rolling stock consists of five locomotives, ten passenger cars and two freight cars. The locomotive in reality forms the rear truck of the motor car, but can also be used without the latter. The sills of the motor car are extended to the center of the locomotive, where they are suspended by springs on spring supports.

Three independent brakes insure safety during the car's descent. There is, furthermore, a device fastened to the upper running axle which can be made to grip the upper portion of the rack, which is designed expressly for this purpose, and the gear-wheel is thus prevented from leaving the teeth of the rack.

Two of the brakes are ordinary spindle shoe brakes and one is an automatic speed brake, which is operated by means of a centrifugal device. If the hand brakes are applied for a considerable distance the shoes are cooled by means of water. The diagram plainly shows the method of connections, which will be referred to later. The locomotive is equipped with two six-pole three-phase motors, which, at a pressure of from 450 volts to 550 volts at 750 r. p. m. and 38 periods, have a normal capacity of 120 hp each. The motor casing is of cast iron. The weight of the motor is 2100 kg. After three hours' running the temperature of no part of the motor exceeds 25 degs. C.

The no-load current for each motor at 500 volts is 25 amps, the no-load watt consumption is 4200 watts. At 120 hp, the efficiency is 92 per cent and the slip 1.5 per cent. The maximum current, i. e., at short circuit at 500 volts, is 800 amps. This gives a maximum torque of 360 kg per meter. The field and armature windings are connected in star fashion. The two ends of the rotating winding are connected to two collector rings, while the third end is connected directly to the iron wheels and thus to the rails. The current is collected from the rings by means of carbon brushes. The main dimensions of the motor are as follows: Diameter of core, 600 mm; air distance, 1.2 mm; thickness of iron, 240 mm; outer diameter of iron, 870 mm. The motors transmit their power by means of a gear-wheel with inclined teeth to an intermediate gear having a diameter of 1058 mm. The second transmission begins here, so that the total ratio becomes 1: 12.66 and gives the locomotive a normal speed of 7.7 km.

To the forward motor is coupled a continuous-current six-pole dynamo, which generates 150 amps and 25 volts at a speed of 700 r. p. m. This serves for the excitation of the motors during the descent, thus turning the motors into generators.

The resistances are divided for each motor and each phase into eight sections, which are connected to the eight segments on the controller. They have a total weight of 138 kg. To cool the coils, a small three-phase current motor driving a ventilator displacing 60 cu. m. of air per minute has been installed. This motor can be connected either to the trolley line direct or to the induced current in the motor, which has a pressure of about 200 volts.

There are two types of passenger cars, one which has but a single truck at one end, while the other end rests on the locomotive, and the other type equipped with two axles like ordinary motor cars. Strange to say, the former type is termed "motor car" in Switzerland, while the latter is called "trailer," although the former is a most helpless vehicle without the locomotive. The locomotive is always at the lower end of the train. The make-up of a train is usually a locomotive, a motor car and a trailer, seating a total of eighty passengers.

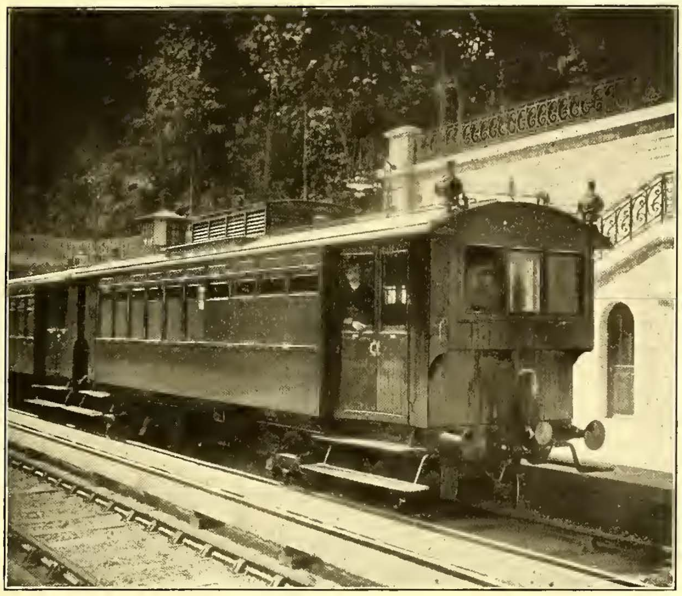
Each freight car weighs 2.6 tons and can transport a load of 8 tons. Its loading surface is 4 m x 2 m = 8 sq. m and the wheel base is 2.2 m. The cars are specially equipped for the transportation of long logs.

On account of its high altitude, there are but few days on which the summit presents a clear view of the surrounding country, which alone tempts the tourists to use the road. The traffic is therefore concentrated in a very short time when the rush is very great. At this time eight trains are run every day. A special sliding contact is used which does not have to be reversed at the end of the trip and which is concaved to give a broad surface of contact. The electrical equipment was furnished by the Oerlikon Company, of Zurich, with the exception of two of the locomotives, which were supplied by Brown, Boveri & Co. The illustrations published are those of Oerliken locomotives.

FRANCE

The electric railway industry began to make rapid strides in France in 1896. For the information contained in this series of articles, so far as it relates to European countries outside of Germany, the writer has been dependent on statistics and communications from the railway companies themselves or the builders of the roads.

Very complete statistics regarding French street railways fortunately appeared in France a short time ago, and were prepared by the secretary of the French Street Railway Association, who presents in his preface many interesting facts regarding French railways, and which are equally applicable to the conditions prevalent in other countries. The French law of 1880 carefully classified all transportation systems for purposes of regulation and defined the attitude of the government toward them. The term tramways is here used officially to designate not only street railways, but also certain classes of interurban steam railroads which connect small cities and villages and traverse territory which is not inhabited. Up to the end of 1900, 4223 km of such lines had been authorized. Of this number, the latter class of steam roads represented 2488 km of the total, while the actual city street railways were only 1735 km in length.



MULTIPLE UNIT TRAIN ON THE WESTERN RAILWAY OF FRANCE

In 1886 mechanical traction for tramways was not mentioned in the statistics. In 1887, of the total 720 km of railways, 158 km were operated by steam. In 1890 the first electric road was put in operation. It extended from Montferrand to Royat, was 7 km in length and cost the enormous sum of 293,000 francs per kilometer. In 1893 the second electric road, from Lyon to Sainte Foy, was put in operation with not quite 3 km of track. In the same year another 5-km road received a franchise. In 1895 a 25-km electric road was put in operation, and in addition five smaller roads, making a total of 34 km in length. Since then the progress has been so rapid that the writer must refer to the table below, which gives the state of the industry up to the close of 1900.

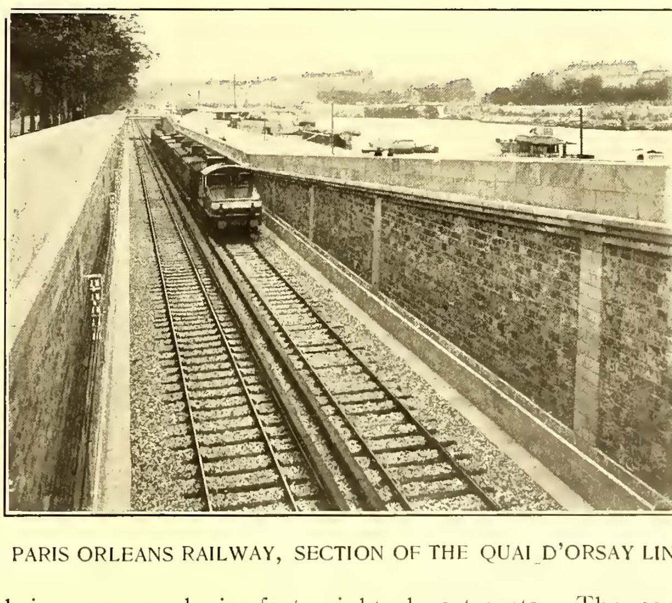
Referring to the table, it should be stated that, legally, the tramways are subdivided into several groups, which must be referred to, because the present statistics are arranged on this basis: (A) tramways for passengers and freight, with and without the state's guarantee; (B) tramways for passengers, baggage and parcels express; (C) tramways for passengers only. According to German and American methods of nomenclature, the first and a good part of the second class of roads would not be termed tramways in any sense. To make the table complete, however, all varieties of roads are enumerated under their respective classes.

The table shows that at the close of 1900 there were but very few horse car lines remaining, namely, only 5 per cent of the total length, while electric roads represent about one-quarter of all the tramways. The electric roads are of many types, including trolley, conduit, contact-button and accumulators, and the last three systems are in more extended use in France than any other European country. Every possible obstacle has been placed in the way of the trolley, the argument being a desire to preserve the beauty of the streets and insure safety. For this reason, probably, electric roads have not made such rapid strides in France as in Germany. We find only 788 km of roads on which electricity is the only motive power. On 611 km electricity, steam and horses are used in conjunction. The "all-electric" roads probably represent about 1100 km at the close of 1900.

LENGTH IN KILOMETERS OF FRENCH TRAMWAYS

Kind of Motive Power	Class A			Class B	Class C			Grand Total
	With State Guarantee	Without State Guarantee	Total		Seine Department (Paris)	Other Departments	Total	
Horses	1	3	3	9	..	133	133	145
Steam	1,965	393	2,358	60	..	17	17	2,735
" Serpellot	..	11	11	..	..	.	..	11
" stored	..	5	5	..	..	..	..	5
" smokeless	58	3	61	..	..	..	..	61
Compressed air	..	..	..	45	..	22	22	67
Electrical: trolley	..	113	113	154	.	495	495	762
" accumulators	..	..	..	..	..	4	4	4
Steam and horses	52	5	57	..	..	..	..	57
Compressed air and steam	..	40	40	..	.	..	.	40
Trolley and steam	..	..	.	..	..	31	31	31
" " " (smokeless)	..	..	..	..	..	35	35	35
" " horses	..	..	..	..	..	39	3	39
Electric system: Claret and steam	..	..	..	32	..	..	..	32
Electric system: Diatto and trolley	..	.	..	5	10	..	10	15
Electric system: Vedovelli and trolley	..	..	..	7	..	..	..	7
Steam (smokeless), accumulator and trolley	..	..	..	29	..	..	..	29
Electric conduit (cauiveau) / Trolley and horses	..	..	..	..	85	45	130	130
Steam, with and without smoke, accumulators and trolley	..	..	..	..	95	..	95	95
Horses, steam (Rowan, Serpellot, Purrey), compressed air, accumul'rs	..	..	..	..	220	..	220	220
Cable roads	..	1	1	..	2	..	2	3
Total	2,075	574	2,649	341	412	821	1,233	4,223

Of all systems, the trolley is most extensively used; there being 100 roads in forty-eight departments. The conduit (cauiveau in France) is used by five roads, the surface-contact system (Diatto, Claret and Vedovelli) on eight, accumulators on six, compressed air on seven, steam on eighty-six and horses on twelve.



PARIS ORLEANS RAILWAY, SECTION OF THE QUAI D'ORSAY LINE

Mr. Fuster remarks in his report that one result of this policy has been that when the trolley had finally to come in the various cities the roads were in large part equipped by foreign companies, who established agencies in France for this purpose.

What French managers themselves think about the advantages of electricity for railway service may be gathered from a speech by the president of the French Street Railway Association at a recent banquet of the International Street Railway Association. He said: "The progress of the electric railway is the best means of ameliorating the miserable situation within the interior of cities caused by the growing numbers of industrial workers who have to find their homes near their place of work. The concentration of population in large cities, which has been a characteristic of recent years, has been produced largely by the steam railroads, whose influence on population has been centripetal in its results; but the modern street railway has a centrifugal effect, and its extension will enormously reduce the great danger of congestion within cities."

Regarding French street railway finances, Mr. Fuster also presents some instructive figures, which are not given here because they relate to all tramways and the electric earnings are not separated from the others. But the conclusion may be derived from them that the financial results of the street railways in France have not been encouraging and the net return has been below the legal interest rate. The following table shows the percentages of operating expenses to receipts of the division C, that is, of the actual street railways:

PER CENT OPERATING EXPENSES TO RECEIPTS OF FRENCH TRAMWAYS

YEAR	Seine Department, Including Paris	Other Provinces	Grand Average
1890	90	73	83
1891	92	77.5	86
1892	96	80	90
1893	96	80	90
1894	90	79	85.5
1895	91	75	84
1896	89	72	82
1897	89	70	81
1898	88	69	80
1899	76	69	73
1900	80	73	77

Mr. Fuster regards this enormously high coefficient as very serious, believing that it shows either that the operating costs during 1900 were too high or that the recent regulations imposed on the railway companies by the government in regard to a prescribed minimum pay and maximum hours of labor for employees are too stringent. The latter is a more probable cause. The net profits during the Exposition year (1900) of the Paris roads was on the average not more than 9000 francs per kilometer. The dividends paid on the invested capital were as follows:

	1890-1899	1900
Class B	2.5 per cent.	.9 per cent.
Class C—Seine Department	3.7 "	4.9 "
" " Other provinces	5.8 "	4.0 "
" " Total	4.8 "	4.3 "
Class B and Class C together	4 4 "	3.6 "

Of the twenty-one of the largest roads in France, the stock of only six was quoted above par on the Exchange on June 30, 1900. They were roads whose gross receipts were equal to from 23 per cent to 46 per cent of their capital stock. According to Fuster, the cause of this condition is the rapacity of the municipalities, who no sooner secure one concession than they demand another, and the unfortunate wording of the French law, which puts these operating companies practically at the mercy of the local authorities. A few instances will suffice. The property of any street railway company in France can be condemned and purchased by the local authorities if authorized by popular vote. No company can refuse to build an extension to its system should the same be desired by the authorities, even if the company proves that such a line would be unprofitable. A number of roads have been compelled to erect their own power stations, although they could purchase current more reasonably elsewhere, solely that the station would revert to the city free of cost after the expiration of the franchise. When a street was to be widened the railway company was ordered to build a line through it, so that the company should pay all or most of the cost of the proposed improvement.

This extortion is not confined to the cities, but is practiced by the state as well. It obliges the companies to give free transportation to its postal and telegraph officials, as

TERMINAL STATION OF TOULON LINE

well as to soldiers, and the condition has actually been reached where all French telephone lines and return circuits are built at the expense of the street railway companies. A street railway, on the other hand, unlike a merchant, cannot re-establish its equilibrium after a deficit has been discovered by raising prices, so that, while nothing can be done to increase the income, more severe conditions are being constantly imposed. The payment to the state includes the ordinary taxes, as on real estate, doors and windows, patent taxes, rental for the use of streets, ticket and stamp boxes. Furthermore, the company defrays part of the expenses for the maintenance of the highways and pays for the telephone return circuits out of its own treasury, although these would be required whether the railway existed or not, on account of the other electrical circuits which are being constantly erected. To the cities the company must pay a percentage of the gross receipts and a graduated percentage of the net profits. The cities frequently designate the materials to be used for construction and repairs. Then there is the free transportation of official employees, which are very numerous in France, sometimes the free lighting of the streets and always the maintenance of street pavements. For example: The largest company of Paris, the Cie Générale des Omnibus de Paris (cars and omnibuses), paid in 1899 for each of its 34,000 shares 162 francs to the state and city before the stockholders received a dividend. The other imposts amounted to 1.8 centimes per passenger, or 10 per cent of the gross receipts, which amounted to 1.2 francs per car kilometer. Very "constant," Mr. Fuster calls one city, which also demands 6 per cent to 7 per cent of the gross receipts, but

PARIS-ORLEANS ROAD—LOCOMOTIVE WHICH HAULS TRAINS FOR A DISTANCE OF 3.8 KM FROM THE QUAI D' ORSAY TO THE CENTER OF THE CITY

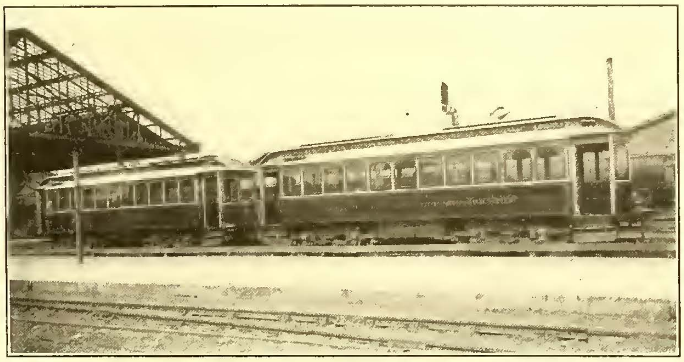
is willing to wait for payment until the dividend reaches the same amount.

Recently a number of cities governed by Socialists have prescribed to the railway companies a maximum working day of ten hours, minimum wages of 5 francs and a payment of an additional 6 per cent of the wages into the employees' insurance fund. This has increased the expenses of a prominent Paris street railway 30 per cent.

The conditions here described naturally undermine the financial foundations of street railways, so that the latter are forced to look for some means to relieve oppression rather than to improve traffic facilities. The writer has entered rather minutely into these conditions because they apply not only to France, but more or less to all of Europe.

In France, as in other countries, the most interesting electric railways are to be found in the capital. The situation in Paris is well described in a report by City Engineer Kortz, of Vienna, from which the following facts are taken:

A large part of the traffic of Paris is cared for by omnibuses and the remainder by the tramways. The Paris omnibus continues to flourish because the government will not permit trolley lines within the city limits, and imposes financial and other conditions that serve to prohibit the building of electric lines. In the suburbs, a complete network of trolleys has been established, and only on the most frequented streets of Paris are there conduit and accumulator cars, because it is only on such thoroughfares that the patronage will support them.



MULTIPLE UNIT TRAIN ON THE NEW FRENCH WESTERN RAILWAY BETWEEN PARIS AND VERSAILLES

There is a working agreement between the 100 lines of omnibuses and tramways, although they belong to different companies. The rate of fare within the city limits is uniformly 15 cents on the top of the bus or car, and 30 cents within the cars or on platforms, with the privilege of a single transfer ticket. The routes are arranged so that a single transfer will enable a passenger to travel from any point in the city to any other at a maximum fare of 30 cents.

One of the largest concerns is the Compagnie Générale des Omnibus, which operates eighty-one lines—forty-five omnibus and thirty-six tramway routes. The railway system includes 244 km of track, and the omnibus routes are 305 km in length.

The omnibus traffic of Paris has been very thoroughly developed, especially along those thoroughfares from the Madelaine to the Place de la République, where no street railways have been built. Here traffic starts at 7 a. m. and lasts until 12:30 a. m., and the headway between buses is from three to ten minutes. Between the hours of 8 a. m. and 9 a. m. and 6 p. m. and 7 p. m. there is much crowding at the terminal and transfer stations, and frequently 100 persons wait patiently half an hour for seats. In order to avoid confusion, the passengers, as they arrive at these depots, are given cards bearing numbers (differently colored cards being used for each line), and when a number is called by the conductor the person holding the card bearing it will be assigned to a seat. Only as many numbers are called as there are empty seats in the bus. Persons who have transfer tickets are assigned seats in like manner. A regulation compels each car and bus to start from the terminal stations with at least four empty seats, thus leaving a few seats for passengers who intend to board the vehicle at other points on the route. The new buses hold forty persons, sixteen inside and twenty on top and four on the rear platform.

The tramways of Paris represent probably the greatest variety in design and equipment to be found in any city of the world. There are a large number of horse cars, many ordinary steam locomotives, steam wagons of Rowan, the Serpollet automobile system, the fireless locomotive of Lamm-Frang, the compressed-air locomotive of Mekarski, electric accumulator cars, overhead trolley cars, the underground conduit and the surface contact systems, and, finally, the electric cable drive. The horse cars are now being superseded by electric cars.

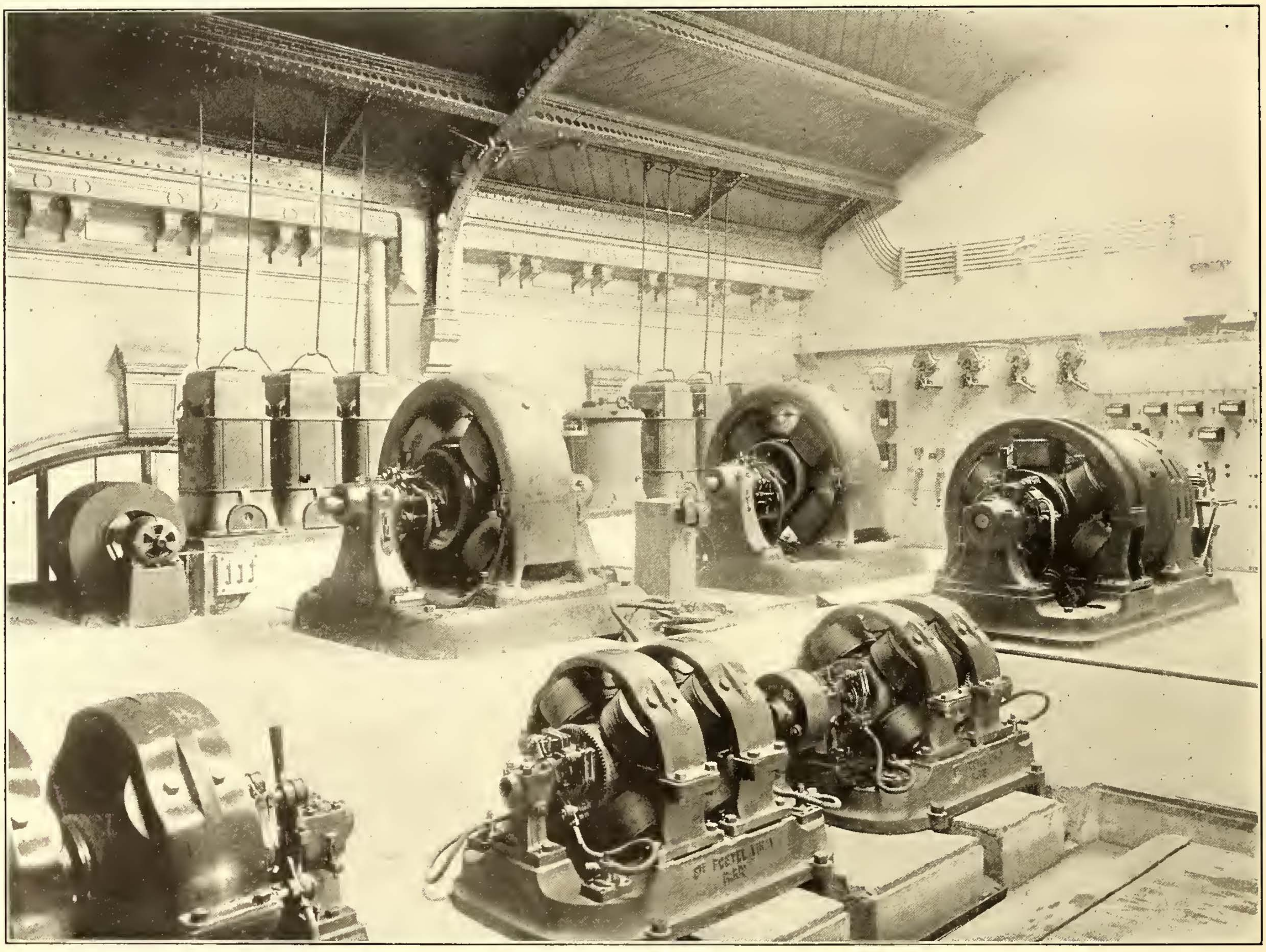
Overhead trolley lines are only permitted outside the city limits at present, and the regulations are very stringent. The gage must be 1.44 m; the width of the vehicle must not exceed 2 m, and the maximum height above rails must not be more than 4.6 m. On double-track lines, the space between two passing cars must be at least 50 cm. The pavement between tracks must consist of stone or wood, with concrete foundation 15 cm in thickness and extending 60 cm outside of the tracks. The street must also be paved between the two sets of tracks and 55 cm outside of the outer rail. In laying rails, provision must be made to allow a space of 2.6 m between the cars and the sidewalks for the convenience of other vehicles wishing to turn out.

The railway company maintains and cleans the pavement between the tracks and 55 cm on each side of the outer rail.

Mechanically propelled trains are limited to two cars, and their length must not exceed 25 m. The speed is limited to 20 km per hour, and at street crossings this must be reduced to 16 km. Every train contains twice as many second-class seats as first-class. The cars are heated in winter, and the apparatus for this purpose must be approved by the city. Where there are seats on top of the car a roof and a glass front must be provided to protect the passengers from the elements.

The company is required to pay each year a certain tax, or inspection fee, for the maintenance of the department which supervises the transportation facilities of the city. For the privilege of erecting waiting rooms at the terminal station the company pays 30 cents per car. No rental for the use of the streets is mentioned, but many regulations regarding the treatment of employees are in force; for instance, each employee receives ten days' vacation each year with full pay, and when performing periodical military duties he is paid by the company the same as if he were attending to business.

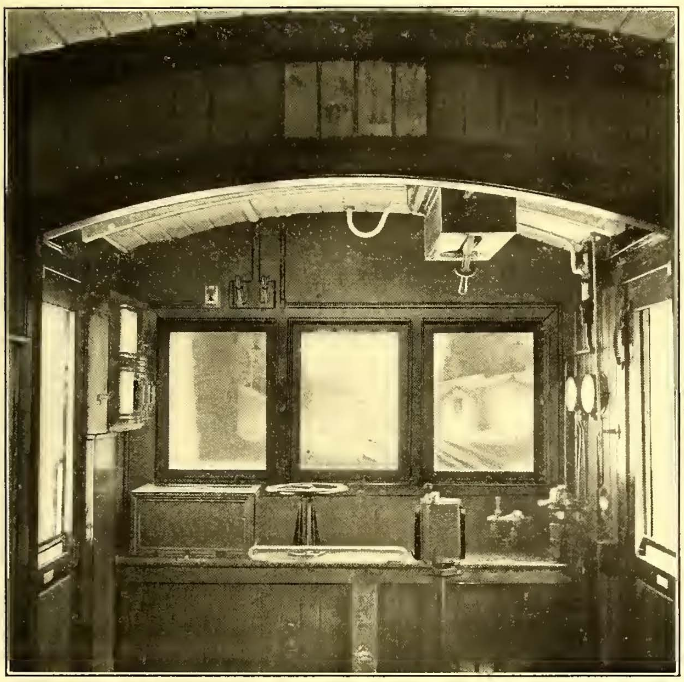
The following-named companies handle the principal traffic of Paris and vicinity: Compagnie Génerale des Omnibus, operating 124 km; Compagnie des Tramways de Paris et du Département de la Seine, operating 112 km, 82 km of which belong to the company; Compagnie Générale Parisienne des Tramways, 85 km; Compagnie des Tramways de l'Est Parisien, 136 km; Compagnie des Chemins de fer Nogentais, 52 km; Compagnie Electrique des Tramways de la Rive Gauche de Paris, 43 km. Several smaller roads are also operated. There are eleven companies operating seventy-seven lines, fifty-three of which have mechanical equipment.



PARIS-ORLEANS ROAD—SUB-STATION AT AUSTERLITZ

The Compagnie des Tramways de l'Est Parisien uses the overhead trolley outside of city limits and the Diatto surface-contact system within the city. The same arrangement has been adopted by the Compagnie Electrique des Tramways de la Rive Gauche de Paris. The contact systems, however, do not appear to be reliable. The button which should drop down and open the circuit after a car passes sometimes becomes stuck and remains electrified; in this way many horses have been killed. Another serious objection is the fact that the pavement around the buttons wears away after a while and the protruding buttons greatly impede ordinary traffic.

Compressed-air cars are being rapidly replaced by electric equipments. Electric accumulator cars are generally equipped with rapid-charging batteries. The charging is accomplished at the terminal stations after each trip and requires from nine minutes to twelve minutes. In order to avoid the objectionable odors penetrating the interior of the cars, and to prevent the spilling of the acid on the car floors, experiments are being made with the view of entirely enclosing the batteries while in service. Along the sides of the car glass windows have been placed in front of the battery compartment, and the batteries may thus be observed at any time. The accumulator cars are equipped with the Westinghouse automatic air brake. The compressed air is carried in a reservoir on the car The over-



VIEW IN CAB ON WESTERN RAILWAY OF FRANCE

head and underground trolley cars are equipped with electromagnetic and hand brakes. Generally, one trailer is attached to each motor car, but the compressed-air cars running between Lonore and Versailles and Lonore and St. Cloud often have three or four trailers attached, so that one train has carrying capacity for 200 persons.

The Paris passenger cars are usually heated by means of hot water bottles, which are replenished at the terminal stations. The Compagnie Génerale des Omnibus has heated all its horse cars and trailers since 1898 by means of the Fabre slowly burning coal briquettes. These are placed in sheet-metal boxes which are so arranged that air is freely admitted and gases are emitted through apertures in the car body to the outer air. The Rowan and Serpollet cars are heated by means of exhaust steam. On the St. Germain road the cars are heated by means of thermophor. The Compagnie Générale Parisienne des Tramways heats its cars by circulating hot water through U-shaped vessels, arranged under the car floor, the water being heated by a small stove carried under the platform. This system has been in successful operation since 1897. The horse cars are generally lighted by petroleum lamps; the Serpollet automobiles and trailers use electricity supplied by a small storage battery beneath the steps and the forward platform of the trailer.

During the Paris Exposition 197 km of new roads were projected, and a part of these are now in operation. Cars on these lines must be operated by mechanical means, but compressed air is forbidden within the city limits. The underrunning trolley system has been adopted. The concreted conduit is not always built directly under the car, however; by placing it at switches between the lines very wide conduit openings are avoided. This necessitates the use of a shifting contact-shoe on the motor car.

Engineer Broca, the director of one of the largest systems, declares that, with the exception of the overhead trolley system, which is forbidden within Paris, the storage battery cars have been the most economical to operate, and that this system possesses an advantage in being able to use existing tracks without alterations. This view, however, is not shared by other engineers.

THE PARIS-VERSAILLES RAILWAY

The mutiple-unit system has been introduced by the Compagnie des Chemins der Fer de l'Ouest between Paris and Versailles. A considerable portion of this road was opened last year. It is proposed to extend the line through a tunnel 3550 m long. There is a constant grade from Paris to Versailles, but through the tunnel it will not be as great as at other points along the line.

Three transformer stations have been established to reduce the current to 500 volts from 5000 volts, at which it is generated by three-phase machines at the Monlineaux central station. A third rail is employed, which is placed between the double tracks 600 mm from the inner rail and 200 mm above it. The rails weigh 46.25 kg per meter, and are 18 m in length. They rest on cast-iron supports, which are fastened to wooden insulators. These are attached to the extended sleepers every 3 m to 4 m. The conducting rails are painted red, so that they may be easily recognized. The road was equipped by the Société de Locomotion Electrique, which introduced some methods that were novel to European practice. The rails were cut and bent, the insulating timbers cut and saturated with insulating material, and the rail-joints constructed in a nearby workshop. The actual work of laying the rails was done by what is described in France as a "flying" shop, consisting of a steam locomotive, a 45-hp dynamo, several cars fitted with machines, lamps, etc., and twenty-five rails, weighing 21 tons.

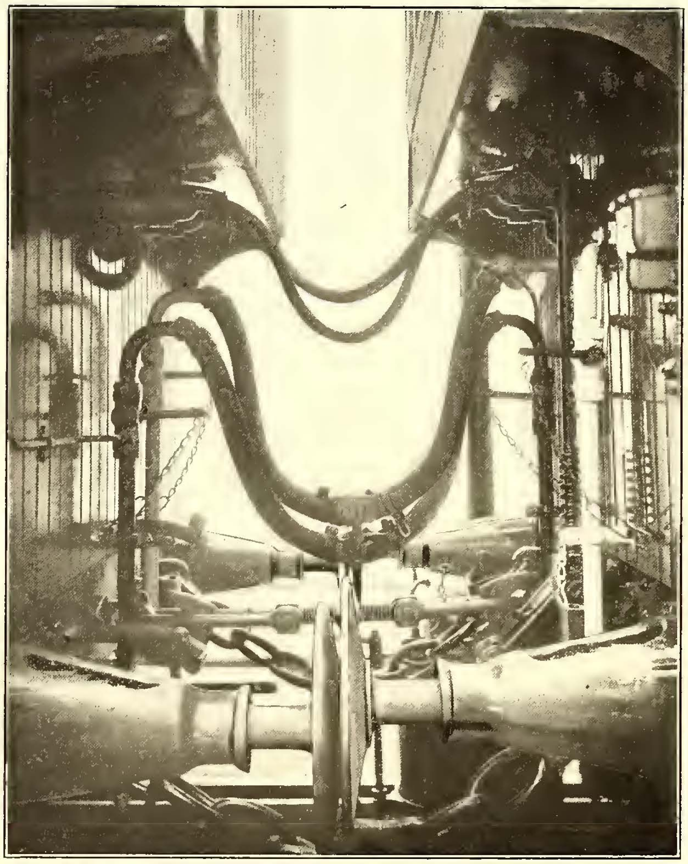
The power station has a total capacity of 7200 kw, and furnishes current for lighting depots and operating the shops, pump works and drawbridges, as well as the railway cars. The equipment includes six four-cylinder, triple-expansion high-pressure engines of 1700 hp each. The fly-wheel weighs 20 tons and is 7100 mm in diameter. Three other tandem compound engines have fly-wheels weighing 25 tons. These have a diameter of 6500 mm. There are two condensers for each machine, placed directly behind the two cylinders. The dynamos were furnished by the Westinghouse Company. The armature frame weighs 38 tons and is so arranged that repairs and inspections can be made with ease. The revolving magnetic field, which weighs 18 tons, has thirty-eight poles and makes 80 r. p. m.

The 5000-volt three-phase current generated in this station is led to three transformer stations by triple-armored cables, the insulation consisting mainly of paper.

Each station has four rotary Thomson-Houston converters of 300 kw capacity, each operating at 5 r. p. m. Each rotary is fed by three 110-kw transformers, connected in delta. The rotaries are operated by motor generators, consisting of an induction motor and a 40-kw, 500-volt, 80-amp. direct-current generator. The speed is 750 r. p. m. Two of the transformer stations are furthermore equipped with three 60-kw motor generators, the third with 12-kw motor generators.

METROPOLITAN RAILWAY

The lines of this system, which have been described in detail in the Street Railway Journal, will be 64.7 km in length when completed. This road has no connection with other railway systems, and a uniform fare has been adopted. It is owned by the city, which has leased it for operation to a company for a period of thirty-five years. The lessee has been obliged to furnish the rails, build the roadbed, cars, depot equipment and electrical apparatus.



The upper cables are for the electric connection; the one below is the air-brake hose; the train coupling and train chains are below.

COUPLING BETWEEN CARS ON MULTIPLE UNIT TRAIN

The tunnel cost 165 million francs, and the remainder of the road about 50 million francs.

The franchise term begins as soon as the last section is finished, which will probably be in April, 1911. Seven years later the city may request that the operation of the road be turned over to it, under certain conditions, and on the expiration of the franchise the entire property passes into possession of the city.

The third-rail system is here employed. Of the total 65 km, 45.5 km are in tunnels, 9.1 km open cut and 10.4 km on viaducts.

The station platforms are 4 m in width and 75 m long, thus enabling trains of eight 9-m cars to load at one time. The Vignole rails are 15 m long and weigh 52 kg per meter.

The first section, opened on July 19, 1900, between Porte de Vincennes and Porte Maillot, 10.6 km long, has twenty-five stations along this section, the average distance between them being 625 m. This entire section, which is the most important branch of the road, is built in a tunnel. There are no depots above the street surface. Steep stairways lead to the tunnel, and are covered by glass roofs. The platforms are located about 3 m below the street surface. The central station, located at Bercy, contains five 1500-kw units. Direct current is generated for nearby sections, and 5000-volt three-phase current for distant ones, which is transformed into direct current at the sub-station in the Place de l'Etoile.

The headway between trains is three minutes. The trains are made up of a motor car and three to four trailers. The stations are indicated by electric signals, which display the name of the next station as soon as one is passed. The motor cars are equipped with two Westinghouse 100-hp motors. They will seat thirty persons, and there is standing room for twenty more. The maximum speed is 36 km per hour. The fare in the first-class is 25 centimes and in the second-class 15 centimes.

The city receives within sixty-five years 33 per cent of the gross receipts of the road. Should the number of passengers carried per year exceed 140,000,000 this figure is increased, according to a scale agreed upon. The receipts from Jan. 1 to April 30, 1901, amounted to 2,690,344 francs, although during three days in January the road was at a standstill, on account of a strike. At 33 per cent the city would receive 2,660,000 francs per year and more than 7 per cent interest on the invested capital for this first section. The paid-in capital of the company could draw an interest of 6 per cent. The other sections will probably not yield such good results at the start. The traffic on the main section of the road is 4,200,000 persons per kilometer, as compared with 3,000,000 on the London Underground road, 2,800,000 on the Berlin City road and 3,150,000 on the Manhattan Railway of New York. The average receipts per passenger is 17.3 cents, the operating cost is 42 per cent of the receipts. The company, therefore, only retains 25 per cent of the gross returns. It is expected to reduce the operating cost to 33 per cent. as soon as the new three-phase power station is in operation. The receipts of the tramway and omnibus companies have been reduced 1.5 million francs between Jan. 1 and April 30, 1901.

EXTENSION OF ORLEANS RAILWAY

This important steam-railroad company desired to move its terminal station at Quai d'Austerlitz into the city, and the exposition offered a splendid opportunity to accomplish this task. The extension is 3.8 km in length, and runs along the Seine River, going around bridge supports in curves of 200 and 150-m radii. The tracks are on the same level as the Seine, and ground water has to be continually pumped out. For 450 m the extension is a tunnel road, and a part open-cut, while the last section is in a gallery under the pavement, opened toward the river front, thus admitting light.

The new depot is an imposing structure, and contains sixteen tracks, twelve having separate platforms. The latter are connected with the waiting rooms by seventeen stairways, fifteen elevators, nine inclined platforms and two traveling belts for freight. A hotel with 350 rooms is connected with the depot. The traffic is very heavy, 150 trains running daily between Austerlitz and Ortay.

The power station contains two units, consisting of 1500-hp engines and 1000-kw generators, producing three-phase current at 5500 volts. The 1500-hp engines are the 4-cylinders, triple-expansion Corliss type, and operates at 75 r. p. m. The fly-wheels weigh 35 tons each. The 1000-kw dynamos are of the A. T. B. type, with forty poles. They will carry an overload of 25 per cent half an hour, and an overload of 50 per cent five minutes. The efficiencies are 95 per cent at full load, 94 per cent at three-quarters load, and 92.5 per cent at one-half load.

The current is transformed to 550 volts direct in two transformer stations at the terminals. Each sub-station is equipped with two 250-kw motor-generators, six 90-kw stationary transformers, two electric ventilators for the transformers, and one storage battery.

The latter serves for traction purposes, for furnishing current to the road at night, and for lighting purposes when the generators are shut down. Each sub-station contains 260 cells, capable of furnishing 1100 amps. Each cell, containing eighteen positive and nineteen negative plates, weighs 350 kg.

There are eight locomotives, similar to those at Lockport, N. Y., each being capable of drawing a 300-ton train up an 11 per cent grade in seven minutes over a distance of 3.8 km. Each locomotive is equipped with four G. E.-65 125-kw motors, transmitting power directly to the axles. The efficiency of the equipment when taking 300 amps. is 86 per cent. The locomotive is equipped with air brake and air whistle.

The third-rail system is used, but at the car sheds the overhead trolley is used. For this reason the locomotive is equipped with three contact shoes in front and three in the rear and a trolley collector. There is also an experimental multiple-unit train controller equipment in service on two cars.

The cars are built for a speed of 80 km to 100 km. They weigh, without equipment, 12.7 tons, and measure 12.45 m over all. The cars contain eighteen cross-seats, and four longitudinal benches, seating a total of forty-four persons. Brill trucks are used, and an 80-hp G. E. motor is mounted on each axle. The two motors on a truck are permanently conected in parallel, while the two groups of motors can be connected in series and parallel.

HOLLAND

After considering the development in Germany, Switzerland and France, one is liable to overestimate the progress that has been made in European countries. It would be unwarranted to take these countries as a standard for the entire continent, as many other countries are very backward, and in some there has been very little work done along these lines.

On account of its small industrial development, for instance, Holland has but few electric railways, and it is not to be expected that it will make rapid strides in this direction. Not even the celebrated seaport, Rotterdam, has an electric railway. There are a total of four roads if we include a section which belongs to a German road extending into Holland.

The section just referred to, which is a suburban road, was opened in January, 1896, and is operated by an overhead trolley.

The Haarlem Street Railway, having 16.2 km of single track, was opened in July, 1899, 5.4 km being suburban road and 10.8 within the city limits. Although it is the largest electric railway in Holland it is a single-track system.

The Amsterdam Railway is 4.8 km in length, 3 km of which is double track. It was opened in August, 1900, and is a city road.

The railway in the royal town of Haag-Scheveningen is 10.255 km in length, of which 9.488 km is double track. When the queen is at this resort in summer, and the traffic is heavy, storage batteries are employed, but in winter horses are used. The electric cars were installed in August, 1900. The gage is 1.435 m.

CONCLUSION

The writer acknowledges his indebtedness to all who have assisted him by furnishing data and photographs, thereby making this series of articles possible. As the series was to be in no way an advertising or commercial project the names of electrical firms were only mentioned incidentally, and the assistance received is all the more appreciated. The articles simply are technical descriptions of Continental European street railway systems of to-day, and an explanation of the conditions under which they operate. Another installment may be expected very shortly.

International Tramway Congress

Arrangements for the twelfth International Tramways and Light Railways Congress, which will be opened in London, Monday, June 30, and continued five days, have been completed and the provisional programme has been announced. Only members of the association will be admitted to the meetings, which will be held in Agricultural Hall, Islington. The committee of arrangements has established headquarters at De Keyser's Royal Hotel, on the Thames embankment, near Black Friar's Bridge, London, which will be kept open until after the close of the Congress. Reading rooms and meeting rooms for the committees will be provided.

The first formal session of the Congress will be held on Tuesday morning, and will be opened by Sir C. Rivers Wilson, president of the Tramways and Light Railways Association. In the evening the conversazione of the Institution of Electrical Engineers will be held in the Natural History Museum, to which members of the Congress will be invited. Formal session of the Congress will also be held on Wednesday, Thursday and Friday mornings. The afternoons of these days will be devoted to the inspection of power houses and points of special interest to the delegates, and excursions will be arranged for those who desire to visit points of interest in the vicinity of the city. On Friday evening a banquet will be given in honor of the foreign members by the Tramways and Light Railways Association.

On Saturday, July 5, it is proposed to invite the foreign visitors, who remain in London, to one of the industrial centers, probably Wolverhampton, where they will have an opportunity to study English methods of manufacture. An invitation has been extended by the Dublin Tramways Company to members of the Congress to visit the interesting power plant of that concern, and arrangements will be made for taking those who desire to make this trip to Dublin on Sunday, July 6. Invitations have been received from most of the large electrical power stations of London and vicinity, and arrangements have been made to have the delegates visit many of these plants, including the City & South London Electric Railway, the Central London Electric Railway and Waterloo & Baker Street Electric Railway, which are known as the Tube Systems; the London United Tramway's trolley plant and the London County Council Tramway's conduit system, the latter of which is in course of construction.

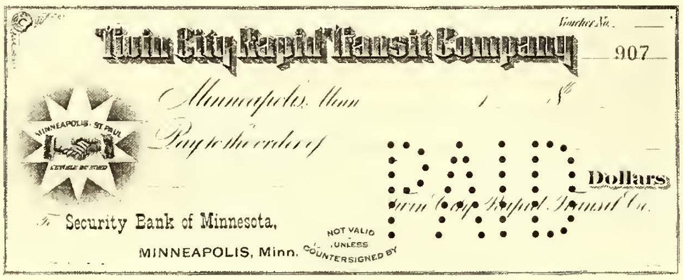
The Second International Tramways and Light Railways Exhibition, which will be held in conjunction with the Congress, promises to be an interesting event. It will be opened to the public on July 1, and continued until July 12. The list of exhibitors includes 160 of the largest manufacturing and construction companies of England and the Continent, and it is promised that the latest designs in European electrical apparatus will be shown. The fact that not only the International Congress, but a large number of smaller tramway associations will meet in the same building during the time for holding this exhibition, will lend interest to the occasion.

STREET RAILWAY ACCOUNTING

CONDUCTED BY J. F. CALDERWOOD, COMPTROLLER TWIN CITY RAPID TRANSIT COMPANY AND MEMBER INSTITUTE OF SECRETARIES OF LONDON

From the Bank to the Payee, with the Disbursements of the Twin City Rapid Transit Company

In the May issue we illustrated the methods of handling the receipts of the Twin City Rapid Transit Company—"From the Passenger to the Bank." In this article we will explain the method employed by the company in disbursing its funds, or "From the Bank to the Payee," and reproduce some of the forms, used in these transactions and in compiling the records.



FORM A

As previously stated, the entire passenger and miscellaneous receipts of the company are deposited in the bank each day to the credit of the company. All payments are made by check, requiring two signatures (Form "A"), and only on approved voucher with three signatures (Form "B"). The treasurer has an individual working capital of $2,000 in cash. With this he supplies the necessary change for the different starters' stands where the conductors are supplied with their change, and he also pays small emergency items for the company. This cash is charged directly to the treasurer, and he at all times has either the cash on hand or small memorandums which make the total of $2,000. When he has accumulated any considerable number of petty memorandums he turns them over to the auditor, and a voucher is drawn in his favor, which makes $2,000 good.

Please date, sign and return this Voucher at once. Do not detach any papers.

TWIN CITY RAPID TRANSIT CO.

Dept. No. ______
To ______ Dr. Aud. No. ______ Month ______
Address ______ Minneapolis, Minn., ______ 190__

Distribution				Date						

CORRECT: AUDITED: APPROVED:
AUDITOR. GENERAL MANAGER.

RECEIVED of the TWIN CITY RAPID TRANSIT COMPANY, ______ DOLLARS
IN FULL FOR ABOVE ACCOUNT.
DATED ______ 190__

FORM B

The treasurer keeps no regular cash book. When cash is received by him he gives a receipt (Form "C") in triplicate—original and two carbons. The original is delivered to the payee, one carbon to the auditor and the third remains in his receipt book. The treasurer deposits the amount received in the bank each day. The treasurer keeps a treasurer's record (Form "D"). There are two of these records in use, one for each alternate month. When the treasurer has completed his last entry for April he turns over the treasurer's record to the auditor and begins May business on his other record. The auditor receives from the bank the canceled checks and pass books of the treasurer, which he carefully audits, and from the data on the carbon copies of the treasurer's receipts given makes a distribution of the miscellaneous receipts, together with the passenger receipts, proves the balances and turns the treasurer's record over to the bookkeeper to be posted in the ledger. The treasurer's report is made on Form E.

TWIN CITY RAPID TRANSIT CO. No. 1399
TREASURER'S RECEIPT.

MINNEAPOLIS, MINN., ______ 190 .

Received from ______ $ ______
______ Dollars
For ______

ASS'T TREASURER

FORM C

TREASURER'S REPORT.

DAILY STATEMENT OF RECEIPTS AND DISBURSEMENTS

______ 190__

Balance in Bank last Statement,		
190 , Deposit Earnings, 190 .		
190 , " Miscellaneous, .		
Disbursements, 190 .		
Balance in Banks, 190 .		

BANK	DEPOSIT	BALANCE
TOTAL.		

CHECKS DRAWN				AMOUNT
CHECK NO.	BANK	VCHR. NO.	IN FAVOR OF WHOM	
			TOTAL.	

Correct,

Approved,

TREASURER.

FORM E

We believe that depositing the passenger receipts each day in their entirety, also the miscellaneous receipts promptly, making disbursements only by check and voucher, you minimize the work and responsibility of the treasurer and safeguard the company's interests. Our treasurer also fills the position of paymaster. The details of this position we will treat later on.

Treasurer's Daily Record for.................190.....

APPROVED VOUCHERS PAID							BANK BALANCES							MISCELLANEOUS			
Check No.	Date Mo.	Date Dy.	IN FAVOR OF	No.	B'k	Amount	Sec. Bank	Nat. B'k Com.	Mer. Nat Bank	J. K. Tod & Co.			Total	Rep No	ACCOUNT	Folio	Amount

FORM D

Requisites

The underlying principles in street railway economics are: First, an up-to-date system of accounting; second, the supervision of the accounts by a modern accountant; third, a management that appreciates the necessity of the foregoing, and to that end will give hearty co-operation and support.

The evolution wrought in the methods of street railway accounting in the last five years has been little less than marvelous. For the transition from a condition of chaos to that of a uniform classification of accounts we are indebted to the great work of the Street Railway Accountants' Association of America, which has laid the fundamental principles for a system of uniform classification of the various items of expense and revenue, making it possible to compare one period with another intelligently and one system with another profitably.

Every system has peculiar conditions which necessitate a variation in the methods of collecting data and the keeping of auxiliary records, so that in the final summing up all will harmonize under the standard classification.

It is in the act of bringing about the adaptation of a system to the conditions that the skill of the accountant is brought to a test.

We earnestly solicit suggestions and ideas on any feature of accounting as applied to street railways. It is by the exchange of ideas, based on the application of the principles to the varying conditions, that we will all in the end reach a greater degree of perfection in the science of accounting.

National Order of Chartered Accountants

The investment interests of this country, as well as the highest interests of the accounting profession, require the protection of a national organization of chartered accountants. The qualifications demanded by this organization should be high not only in professional knowledge and skill, but in honesty and general ability, and especially high and strict in its standard of professional ethics.

The certificate of a chartered accountant attached to an investigation of the affairs of any corporation should be beyond suspicion. The findings of the accountant should be far-reaching and impartial and beyond the taint of influence, and they should have the weight in the investment world that judicial findings have in a court of law.

The proper function of the accountant is that of financial judge or referee, and not that of special pleader or pettifogger; and we need the National Order of Chartered Accountants to give an impetus and a goal to this high and right professional ideal. When the professional ideal has once found concrete recognition through this chartered order the world of corporation management will be compelled to rise to the situation, for the best class of investment securities will naturally seek the highest standard of accounting, and other investment propositions will be compelled by competition to follow suit.

When once the accounting profession is able to furnish the investment world the gilt-edge service of a National Chartered Accountant the investors themselves will do the rest. Capital seeks the safest and soundest investment proposition. Money goes to the investment that can make the best and most reliable report The value of the report upon the soundness of the investment depends upon the standing of the accountant for integrity, ability, and for fearless and searching analysis. The accounting profession, in its fight for high accounting standards, will therefore have the substantial co-operation of the investor and thereby in the end the hearty support of the intelligent corporate manager and promoter. The national organization is the first preliminary.

The Street Railway Monthly Report

BY C. NESBITT DUFFY,
Auditor, Chicago City Railway Company.

In response to your request to contribute to the columns of the Street Railway Journal's Accounting Department, I offer some suggestions, embodying ideas growing out of my own experience and practice, as to the preparation, scope and arrangement of the monthly report.

PREPARATION

In anticipation of and preparatory to the monthly report the books should be closed at the earliest possible date that will admit of all transactions of the company affecting the accounts being brought into the books.

It should be clearly understood, and this point can not be too strongly emphasized, that the monthly closing of the books should be as complete and thorough as possible, just as the yearly closing of the books is or ought to be.

All asset and liability accounts of the general ledger should be carefully examined, if possible verified, except as to inventories, and all necessary adjustments should be made as would be made in the final closing of the books for the year.

By following this principle the books will correctly and fully set forth the true condition of the affairs of the company. It may be said, in passing, that the books could be closed weekly, or for that matter daily, or not at all, by following the "going" principle of the perpetual balance sheet system of our friend Mr. Kittredge, which he has so ably expounded and advocated in the columns of the Street Railway Journal.

Whatever may be the practice in vogue the principle laid down should be closely adhered to; the balance sheet should contain all of the transactions entering into the accounts of the company, everything in any way affecting the income, assets or liabilities should be taken care of, and all known liabilities as well as all known assets should appear on the balance sheet.

In order to facilitate the closing of the books and gain time a schedule of regular general journal entries should be prepared in skeleton form, as this will be of material assistance and can be used from month to month.

From this schedule the general journal can be written up, posted into the general ledger and a partial trial balance taken off immediately after the close of the month. This trial balance will cover all transactions ending with the month dealt with except the following:

1. Distribution and charge of pay rolls.
2. Distribution and charge of material and supplies.
3. Distribution and charge of audited vouchers.

It is hardly practicable or reasonable to expect the figures for these entries before the seventh day of the month, but that should be the time limit, as any well-organized accounting department of a street railway company should always have its books for the month closed by that date.

By having the general journal written up, posted and a partial trial balance taken off at the earliest possible moment, as previously explained, it is a comparatively easy matter to take care of the entries growing out of the transactions of the three propositions referred to above, in order to finish the work of journalizing and posting for the month and complete the monthly trial balance.

In this connection it should be understood that the monthly closing of the books outlined above contemplates dealing with the transactions of the company in a summarized or concrete form only, without regard to details; therefore the general ledger accounts should be arranged with that end in view. Ordinarily from fifty to one hundred accounts will be sufficient for the general ledger; the detail accounts should be taken care of in subsidiary ledgers. The general ledger and the balance sheet therefrom should deal with the assets and liabilities, the income, profit and loss, and surplus, and the totals only of such accounts as operating expenses, construction and equipment, special accounts (reconstruction accounts—extraordinary expenditures—reserve fund charges), material and supplies, accounts payable, accounts receivable, etc. The details of such accounts should appear on the subsidiary ledgers.

The advantages of this plan are that it materially reduces the labor of closing up the books, drawing off the trial balance and making up the balance sheets, and in addition presents quickly the results of operation for any given period as well as a statement of the condition of the company in a condensed and comprehensive form, that will find favor with the average director or stockholder, as such information as directors or stockholders usually desire or expect will be fully set forth.

By this method the main walls and roof of the structure are built first, resting on a solid foundation, the completion of the building following in detail the plans and specifications drawn (the classification of accounts of the company) being accomplished later.

SCOPE AND ARRANGEMENT

The monthly trial balances having been drawn off, the next step is the compilation of the monthly report.

This report should exhibit in a comprehensive and explicit manner the condition of the affairs of the company and the results of the operation of the road.

In preparing the monthly report it will be found advantageous to segregate it or arrange it in sections as follows:

A. Report for directors.
B. Report for president.
C. Report for general manager.
D. Report for heads of departments.

A. *Report for Directors.*—This report need not be anything more than a condensed comparative statement of earnings and expenses, capital expenditure charges, extraordinary expenditure charges, reserve fund charges, percentage of net income to capital stock, percentage of ex-

EXHIBIT A

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR DIRECTORS, MARCH 31, 1902

Earnings and Expenses	March 1902	March 1901	March Increase	March Decrease	3 Months 1902	3 Months 1901	3 Months Increase	3 Months Decrease
Total gross earnings.								
Total expenses.								
Net income.								
Dividend charges.								
Surplus.								
Deficit.								
Capital expenditure charges.								
Extraordinary expenditure charges.								
Reserve fund charges.								
Percentage of Net Income to Capital Stock								
On $18,000,000.								
TABLE OF PERCENTAGES								
Expenses to Total Gross Earnings								
Operating expenses (all expenses except taxes and interest).								
Operating expenses and taxes (all expenses except interest).								
TABLE OF PERCENTAGES								
Expenses to Passenger Receipts								
Operating expenses (all expenses except taxes and interest).								
Operating expenses and taxes (all expenses except interest).								
Details of Total Gross Earnings								
Passenger receipts.								
Chartered cars.								
Income from mail service.								
Income from newspaper car service.								
Income from advertising.								
Income from rent of land and buildings.								
Income from rent of tracks and terminals.								
Income from interest on deposits.								
Income from miscellaneous sources.								
Total gross earnings.								
Details of Total Expenses								
Operating expenses.								
Taxes.								
Interest charges.								
Total expenses.								
Passenger receipts per day.								

penses to earnings, details of total gross earnings, details of total expenses, and passenger receipts per day. It should be in the hands of the directors not later than the tenth day of the month. The income, profit and loss, and surplus account, and the general balance sheet, in full or condensed, may be included or not, according to custom and conditions. It is not customary to include them in the reports for the directors of the Chicago City Railway Company.

This report may be a printed blank form, the figures being inserted with pen and ink or with typewriter, or the report may be drawn up in typewriter form on a blank piece of paper. The advantages of the latter plan are that a number of copies in carbon can be made at once, thereby saving time and clerical work. The four forms of reports already referred to, A, B, C, D, of the Chicago City Railway Company are drawn up in typewriter form on a blank piece of paper, with carbon copies. A copy of the report for directors of the Chicago City Railway Company is submitted; it is a typewritten report, on 17-in. x 20-in. paper. (See Exhibit A.)

B. *Report for President.*—The report for the president should be prepared for the purpose of submitting it to the board of directors at the regularly monthly meetings, and ought to be full and complete in every particular, except with respect to details that should be dealt with only in the report for general manager, which report will be referred to and explained further on. The president's report should contain the following:

1 Review of the condition of the affairs of the company and the results of the operation of the road.

2. Income, profit and loss, surplus account.

3. General balance sheet.

4. Condensed general balance sheet.

5. Analysis of general balance sheet.

6. Increases and decreases in general balance sheet.

7. Cash statement.

8. Capital expenditure charges, extraordinary expenditure charges, reserve fund charges, in detail.

9. Comparative statement of earnings and expenses.

10. Comparative statement of operating expenses.

11. Maintenance statistics.

12. Cost of producing power, details of production of power.

13. Classification of pay rolls by departments.

14. Traffic statistics.

This report of the Chicago City Railway Company, prepared by the auditor, should be in the hands of the president on the fifteenth day of the month, if necessary, in no event later than the twenty-second day of the month, according to the date of the monthly meeting of the board of directors, the third Monday in each month.

The report is typewritten on onion skin paper, 8½ ins. x 13 ins., in an original and two carbon copies, and usually covers about fifty pages. The three copies are available for use at the meetings of the board of directors and are afterward disposed of by the president, general manager and auditor, each retaining one copy.

The different subject-matters of this report, as previously set forth in detail, are self-explanatory; no attempt will be made to discuss them at length, as that would be a task equal to the preparation of the report itself, but a few remarks on some of the features of the report may not be out of place and may prove of interest.

The review of the condition of the affairs of the company and the results of the operation of the road are intended to be a complete digest and analysis of the figures of the report; in other words, the story of the figures. This story should be presented in a brief, concise but comprehensive form; its purpose is to lay before the president and board of directors the principal features of the report and the facts and figures in connection therewith.

In drawing up this story the following are some of the more important matters that should demand special attention:

Increases and decreases in the general balance sheet.

Cash statement.

Capital expenditure charges, extraordinary expenditure charges, reserve fund charges.

Comparative statement of earnings and expenses.

Comparative statement of operating expenses.

Pay rolls.

Statistics.

"Bookkeeping" has been defined as the "how" and accounting as the "why." Applying this to the subject-matter under discussion, every phase and condition met with affecting the results attained, as reflected in the figures presented, should be thoroughly analyzed and fully

EXHIBIT B

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902

INCOME, PROFIT AND LOSS, SURPLUS—JANUARY 1-MARCH 31, 1902

INCOME

EXPENSES		RECEIPTS	
Operating expenses.		Passenger receipts.	
Taxes.		Chartered cars.	
Interest on floating debt.		Income from mail service.	
Interest on employees' deposits.		Income from newspaper car service.	
Interest on real estate mortgages.		Income from advertising.	
Miscellaneous interest.		Income from rent of land and buildings.	
		Income from rent of tracks and terminals.	
Total expenses.		Income from interest on deposits.	
Balance carried down to profit and loss.		Income from miscellaneous sources.	

PROFIT AND LOSS

Dividends.		Balance carried down from income.	
Balance carried down to surplus account.			

SURPLUS

Balance March 31, 1902, as per general balance sheet.		Balance carried forward from Jan. 1, 1902.	
		Balance carried down from profit and loss.	

explained, so that the "why" may be clearly understood. This is the vital feature of the report.

The form of income, profit and loss, and surplus account is shown. It does not differ from the ordinary or

Cars operated.
Total car miles run.
Total car hours run.
Passengers carried.

EXHIBIT C

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902

GENERAL BALANCE SHEET—MARCH 31, 1902

ASSETS

(1) Construction and equipment.
(2) Horses.
(3) Cables (in service).
(3) Cables (in stock).
(3) Material and supplies.
(3) Coal.
(4) Investments.
(5) Bills receivable.
(5) Accounts receivable.
(6) Cash.
(6) First National Bank (dividend account deposit).
(6) Track rental paid in advance.
(6) Insurance paid in advance.
(6) Taxes paid in advance.
(7) Special accounts.
(7) Suspense accounts.

LIABILITIES

(1) Capital stock.
(2) Surplus.
(3) Reserves.
(4) Bills payable.
(4) Accounts payable.
(4) Audited vouchers.
(4) Pay rolls.
(4) Unclaimed wages.
(4) Passenger tickets outstanding.
(4) Unpaid dividends.
(4) Real estate mortgages.
(5) Interest on real estate mortgages accrued.
(5) Interest on floating debt accrued.
(5) Accrued interest on employees' contract deposits.
(5) Accrued interest on employees' savings deposits.
(5) Insurance accrued.
(5) Taxes accrued.
(6) Employees' contract deposits.
(6) Employees' badge and tool deposits.
(6) Employees' savings deposits.

NOTE. The numbers in parentheses indicate the number of the classification under which the account has been classified on the condensed general balance sheet.

usual form and is simply exhibited in order to show that the balance of income is carried into profit and loss, and from profit and loss into surplus. (See Exhibit B.)

The form of general balance sheet is presented in order

Passenger receipts per mile of track, per car, per car mile, per car hour.

Operating expenses per mile of track, per car, per car mile, per car hour.

EXHIBIT D

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902

CONDENSED GENERAL BALANCE SHEET

ASSETS

(1) Property and plant.
(2) Horses
(3) Material and supplies, cables and coal.
(4) Investments.
(5) Accounts receivable.
(6) Cash assets.
(7) Suspense accounts.

LIABILITIES

(1) Capital stock.
(2) Surplus.
(3) Reserves.
(4) Current liabilities.
(5) Accrued liabilities.
(6) Deposits.

to show the arrangement of the general ledger accounts and also the classification of same, as condensed on condensed general balance sheet. (See Exhibit C.)

The form of condensed general balance sheet is exhibited in order to show the thirty-six general ledger accounts condensed into thirteen accounts. (See Exhibit D.)

The form of analysis of the general balance sheet is submitted in order to demonstrate how the investment of capital stock, surplus and reserves, as it stands on the books, is shown. (See Exhibit E.)

The several forms of the comparative statement of earnings and expenses are exhibited in order that the special features of each may be understood. (See Exhibits F, G, H, I.)

The statistics include the following:

Car miles by lines (there are twenty-five lines and 173 routes operated by the Chicago City Railway Company).

Passenger receipts by lines.

Miles of track operated.

C. *Report for General Manager.*—This report of the Chicago City Railway Company is drawn up in typewritten form on onion skin paper, 17 ins. x 20 ins., in an original and two carbon copies, one for the general manager, one for the president, and one for the auditor, usually covers about twenty-two pages, and should be completed by the twenty-fifth day of the month.

The report deals with operating expenses exclusively, the intention being to present such details, statistics and data as will exhaustively and comprehensively reflect every phase and condition of the operating expenses during the period under consideration.

This report should contain the following:

1. Itemization of operating expenses.
2. Subdivision and itemization of pay rolls.
3. Distribution and charge of pay rolls.
4. Table of operating expenses.
5. Details of cost of producing power, details of production of power.
6. Operating expense statistics.

7. Analysis of itemization of operating expenses.

The itemization of operating expenses is the subdivision of the operating expense accounts, of which the Chicago City Railway Company has fifty-one, owing to electric, cable and horse operation, first into 173 items and then into 230 subsidiary accounts; pay roll charges (wages and salaries) being separate from other charges (material, supplies, tools, expenses).

The subdivision and itemization of pay rolls is the classification of the pay rolls, first into departments, of which the Chicago City Railway Company has eleven, and then into occupations, numbering in all sixty-nine, showing the total number of employees by occupations and departments and the total amount of wages and salaries by occupations and departments.

The distribution and charge of pay rolls explains itself.

EXHIBIT E

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902

ANALYSIS OF GENERAL BALANCE SHEET

Property and Plant

Construction and equipment.		Capital stock.	
		Surplus and reserves.	
	———		———

Property Accounts

Horses.		Surplus and reserves.	
Material and supplies, cables and coal.			
	———		———

Investments

Investments (in detail).		Surplus and reserves.	
	———		———

Current Assets and Liabilities

Accounts receivable.		Current liabilities.	
Cash assets.		Accrued liabilities.	
Suspense accounts.		Deposits.	
		Surplus of current assets over current liabilities.	
	———		———

ANALYSIS OF SURPLUS AND RESERVES MARCH 31, 1902

Surplus and Reserves

Property and plant.		Surplus.	
Property accounts.		Reserves.	
Investments.			
Surplus of current assets over current liabilities.			
	———		———

EXHIBIT F

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902

COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES

Earnings and Expenses	March 1902	March 1901	3 Months 1902	3 Months 1901
Total gross earnings.				
Total expenses.				
Net income.				
Dividend charges.				
Surplus.				
Deficit.				
Capital expenditure charges.				
Extraordinary expenditure charges.				
Reserve fund charges.				
Percentage of Net Income to Capital Stock				
On $18,000,000.				
TABLE OF PERCENTAGES				
Expenses to Total Gross Earnings				
Operating expenses (all expenses except taxes and interest).				
Operating expenses and taxes (all expenses except interest).				
TABLE OF PERCENTAGES				
Expenses to Passenger Receipts				
Operating expenses (all expenses except taxes and interest).				
Operating expenses (all expenses except interest).				
Passenger receipts per day.				

The table of operating expenses shows the operating expenses as follows:

Rank (the numerical position of each account by reason of its total, the smallest in amount would rank fifty-one, the largest in amount would rank one).

Percentage (the percentage that each account bears to the total).

Percentage of passenger receipts (the percentage that each account bears to the total passenger receipts).

Cost per car mile, cost per car hour (the proportion that each account bears to the total cost per car mile or the total cost per car hour).

The details of cost of producing power and details of production of power cover in detail the operation of the

EXHIBIT G

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902
COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES

Earnings and Expenses	March 1902	March 1901	3 Months 1902	3 Months 1901
Gross earnings from operation.				
Operating expenses.				
Net earnings from operation.				
Income from other sources.				
Gross income.				
Deductions from income.				
Net income.				
Total gross earnings.				
Total gross earnings per mile of single track.				
Total expenses.				
Total expenses per mile of single track.				
Investment				
Capital stock.				
Total investment.				
Total investment per mile of single track.				

EXHIBIT H

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902
COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES

TABLE OF PERCENTAGES	March 1902	March 1901	3 Months 1902	3 Months 1901
Percentage of operating expenses to total gross earnings.				
Percentage of taxes to total gross earnings.				
Percentage of interest charges to total gross earnings.				
Percentage of net income to total gross earnings.				
Percentage of net income to capital stock ($18,000,000).				
Percentage of total gross earnings to total investment ($18,000,000).				
Percentage of operating expenses to passenger receipts.				
Percentage of operating expenses and taxes to passenger receipts.				
Percentage of total expenses to passenger receipts.				

EXHIBIT I

CHICAGO CITY RAILWAY COMPANY—MONTHLY REPORT FOR PRESIDENT—MARCH 31, 1902
COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES

Details of Total Gross Earnings	March 1902	March 1901	3 Months 1902	3 Months 1901
Passenger receipts.				
Chartered cars.				
Income from mail service.				
Income from newspaper car service.				
Income from advertising.				
Income from rent of land and buildings.				
Income from rent of tracks and terminals.				
Income from interest on deposits.				
Income from miscellaneous sources.				
Total gross earnings.				
Details of Passenger Receipts				
Electric.				
Cable.				
Horse.				
All.				
Details of Total Expenses				
Operating expenses (all except taxes and interest).				
Taxes (estimated and apportioned).				
Interest on floating debt (apportioned).				
Interest on employees' deposits.				
Interest on real estate mortgages.				
Miscellaneous interest.				
Total expenses.				

power plants; the Chicago City Railway Company operates five power plants, two electric, three cable.

The operating expense statistics embrace the following:

Maintenance of way per mile of single track.

Maintenance of track and roadway per mile of single track.

Maintenance of electric line per mile of single track.

Maintenance of cable track and conduit machinery per mile of single track.

Maintenance of cables per mile of single cable track.

Maintenance of cars per car (trucks and truck parts, car bodies, car fixtures and trimmings, car painting, separate).

Maintenance and operation of electric equipment of cars per equipment (maintenance and operation separate, motors and motor parts, trolleys and trolley parts, car wiring, separate).

Maintenance and operation of grips per grip (maintenance and operation separate).

Lighting, cleaning and heating cars per car (exclusive of cost of current, each item separate).

Cleaning, sanding and sprinkling tracks per mile of single track.

Feed and keep of horses per horse.

Pay roll charges (wages and salaries) and other charges (material, supplies, tools, expenses) are shown separately in all of the above.

The analysis of itemization of operating expenses is the story of the figures of the operating expense accounts in detail. Each item and each subsidiary account is analyzed and all facts in connection therewith obtainable submitted for the information of the management.

The idea of having the operating expenses subdivided into 173 items and 230 subsidiary accounts is to furnish that many additional channels of information to draw from. This subdivision of the operating expense accounts could be made greater or less, as would be found desirable or necessary.

D. *Report for Heads of Departments.*—This report of the Chicago City Railway Company is prepared in typewritten form, on 17-in. x 20-in. paper, in two copies, an original and one carbon. The original copies go to the heads of departments, the carbon copies are retained by the auditor.

The report is drawn up in sections, by departments, from the report for general manager, and should be completed by the twenty-eighth day of the month.

The accounts that each department head, respectively, has jurisdiction over and is held accountable for or affected by are submitted to each department head, so that he may know how the expenses of his department are running.

The reports are made up for the following departments:

Maintenance of way and structures.

Power plants.

Repair shops.

Operation of cars (by divisions, five divisions in all, five division superintendents in charge).

In the department of operation of cars the reports contain not only the expenses by divisions, but the car miles by lines, the passenger receipts by lines, and the passenger receipts per car mile by lines for the month and period dealt with.

Watered Stock

Not Webster, but an analysis, defines "watered stock" as the increase of capital stock without the acquisition of additional property or the investment of cash.

This adjustment of capital stock by the addition of watered stock is gaged by the earning capacity of the organization, present and prospective. A reorganization of a company may mean an adjustment of its capital stock to its earnings that are applicable to dividends on stock. Organizers and promoters have taken advantage of the possible phenomenal increase in gross earnings of street railway properties and a marked decrease (often fictitious) in the cost of operation, affording an opportunity to "water the stock" in order to keep the surplus applicable to dividends normal. In this respect the bookkeeping and financiering of these street railway properties will not bear the lime-light of either method or purpose.

Safeguard of Companies

The safeguard of a corporation is the vigilance of its stockholders.

In a corporate body, all power emanates from the stockholders. A high degree of organization is necessary in all industrial, commercial and transportation organizations or corporations by reason of close competition and the existence of a complex state of modern civilization.

The stockholders select a certain number as directors and delegate to them such powers as are necessary for the conduct of the business. These directors choose certain others as officers, and to them are delegated specific duties for the purpose of conducting the business in its many details, and thus we have an efficient organization.

There seems to be a lack of appreciation on the part of the stockholders that it is not only their right, but duty, to see to it that the directors and officers honestly perform their duties to the highest degree of efficiency. The stockholders should assemble periodically and review the acts of their directors and officers. That a board of directors and officers get certain or gratifying results is not sufficient. The acts and results of a corporate body should be carefully reviewed and freely discussed periodically by the stockholders and the directors and officers given to understand that they are amenable to the stockholders at all times for their acts. There is a great danger in any tendency which makes for the removal of power from its ultimate sources, or that makes it difficult for those who have the right to demand from its officers and directors a full account of their stewardship. In this day of great combinations, mergers and industrial organizations, there seems to be an increasing appreciation on the part of stockholders of their rights and duties. We believe that greater vigilance and activity on the part of stockholders in asserting their rights would stimulate a greater appreciation on the part of directors and officers of their duties and responsibilities

H. C. Mackay, in the May issue, contributed a very able article on the question of "reserve fund." There will come a time in the life of every street railway corporation when it will reach its limit in adding to its capital accounts for expenditures, and can no longer, as many of them are at the present time doing, under the cloak of reorganization, charge to capital account items that are nothing more or less than renewals. The time will come when they will be obliged either to charge these expenditures against revenue or "reserve fund." Mr. Mackay's article presents food for thought for those who want to make their investments in street railway securities both permanent and profitable. There is no class of legitimate investments that presents so many contingencies as a modern electric street railway proposition, with its ever-changing conditions and improvements in the methods of electrical mechanism and its application and the occupancy of streets and public highways under a franchise or lease at all times subject to the rules and regulations of local and State legislative bodies.

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NOTICE.

Papers and correspondence on all subjects of practical interest to our readers are cordially invited. Our columns are always open for the discussion of problems of operation, construction, engineering, accounting, finance and invention.

Special effort will be made to answer promptly, and without charge, any reasonable request for information which may be received from our readers and advertisers, answers being given through the columns of the Journal *when of general interest, otherwise by letter.*

Street Railway news and all information regarding changes of officers, new equipment, extensions, financial changes, etc., will be greatly appreciated for use in our news columns.

All matters intended for publication in the current issues must be received at our office not later than Wednesday of each week.

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It must be admitted by steam railway managers that the electric railway has been remarkably successful in developing the freight and package express business along the interurban trolley lines, and that in many cases it has not only secured its share of patronage, but it has in many places opened new fields of operation and built up a profitable business where the steam lines could find no inducement to enter. Two notable instances of this character are furnished in the operations of the Chicago, Harvard & Geneva Lake Railway and the Cleveland & Eastern Railway. The former, which is operating in Wisconsin, has developed considerable freight business in an average farming community without any reference to city traffic or patronage from manufacturing centers. There are many other sections in which similar service could be established with advantage and made to yield very fair profit upon the investment, and the returns would be much more satisfactory from an investor's view point than those of many steam railroads operating under similar conditions. It is worthy of note that this trolley system works in harmony with the steam lines, and that passengers and freight are exchanged.

The Cleveland & Eastern Railway departed from the usual practice of paralleling established steam lines, and entered a territory that was badly in need of transportation facilities, although in the immediate vicinity of Cleveland. Lines were built through a farming country that was almost entirely isolated; in fact, the residents of this district found it more convenient to go to Pittsburgh, a hundred miles away, than to visit Cleveland, which was only a comparatively short distance from them. Many small hamlets in this territory are touched by an iron ore line running north and south, but this was all the service they had, and as much better communication could be obtained with Pittsburgh, traffic had been diverted in that direction. The electric line brought relief to the residents of the district, and opened a direct channel for trade with Cleveland.

It is an established fact, supported by the experience of both of these roads, that the electric system is favored by the farmers, all things being equal. This is attributed to the natural antipathy of the average farmer to railroad corporations. But other factors enter into the problem. The attention which the smaller concern can give to details and the advantages of quick connections are not lost on the farmer who wishes to place his stock on a rising market.

Some months ago we took occasion to call attention to the practice regarding overhauling and inspecting motors. Some roads make it a practice on all cars to do all this work from the pit. Motors are taken out from beneath and armatures are removed from below as far as trucks will permit. Other roads take the trucks out from under the cars and do all work from above as far as possible. With double-truck cars, which are now becoming so common, it becomes much easier and more natural to remove the trucks from under the cars for inspection and repairs of both motors and trucks. Nevertheless some roads with double-truck equipment do everything possible from beneath, and make no provisions for working from above, save when the trucks are out from under the car. As long as practice is so divided as to the methods of overhauling, whether from above or beneath, it would be unwise to condemn either method, because both have the sanction of so many good master mechanics, and, indeed, on some roads both methods are in vogue. A master mechanic of wide experience, who has had exceptional facilities for observing the operation of both methods, remarked that while it was true that practice was divided as to the inspection and overhauling of motors in the pit as against taking the trucks out from under the car and overhauling and inspecting the motors from above, it seemed to him that, as far as modern double-truck cars were concerned, there was no question as to which was the sensible method. It was all very well, he thought, for the superintendent or master mechanic to sit in his office and figure on the number of operations required to inspect and clean a motor from the pit as compared with taking the trucks out from under the car and working on the motor from above, but anyone who had ever done pit work himself knew that this did not half cover the case. He believed that no man would do a thorough job of cleaning and inspection when working by the light of a portable incandescent lamp with his head under a truck frame looking up into dirty machinery that was liable at any moment to fill his eyes with dust. He reasoned with much truth that under such conditions something was sure to be slighted, and to get good results the truck must be run out from under the car so that the men could do their work with some degree of comfort, and with something more than portable drop-lights to enable them to see what they were doing. In this connection he criticised the tendency which has been noticeable the last few years to design motors which could only be opened for inspection from below unless they were removed from the truck and turned over. If the trucks are to be taken out from under the cars, motors should be designed to open from the top to expose the armature and the commutator without removing the motor from the truck. These contentions, undoubtedly, contain much truth in them, and they are backed by years of experience as a master mechanic of large roads. With double-truck equipments, which are becoming the standard on an increasing number of roads the tendency is constantly toward removing the trucks from under the cars whenever work is to be done on them. With proper provisions for hoisting motors out of trucks it is, of course, not a long operation to remove a motor from a truck, but it saves some work to be able to open up a motor without removing it when the truck is standing uncovered on the floor. Of course, all will not agree with the views advanced by our friend whose opinions we have quoted so freely, but these suggestions should be taken into consideration in ordering new double-truck equipments. As to the character of work done by the repair men when working over a truck on a well-lighted floor as compared with work in the pit from underneath, the verdict is unanimously in favor of the more comfortable and more rational method of performing the work.

The extended article published elsewhere in this issue on street railway traffic conditions on the Continent of Europe will, we are confident, prove of the utmost interest to railway managers both in America and abroad, and will be found worthy of the large amount of space devoted to it. The author, as secretary of the German Street Railway and Light Railway Associations, has had excellent opportunities for obtaining a close insight into electric railway conditions and practice not only in Germany, but also in other European countries, and, being engaged in railway operation himself, can appreciate the practical requirements of every-day service and the extent to which every-day conditions modify purely theoretical desiderata.

Although American apparatus is now used widely throughout Europe, and although American methods of railway construction are studied by foreign railway engineers more closely than are those of other countries, it would be erroneous in the last degree to assume that no valuable lessons are to be derived from a study of the results secured abroad. The first commercial electric railway in the world was put in operation in Germany, and in many branches of electrical work, as well as in other directions of scientific research, that country has taken a leading position. The practical development of the trolley system was so long delayed in Europe by absurd municipal regulations, which still hamper its natural growth there, that it had finally to be adopted almost bodily from America; but in other directions, particularly in three-phase traction, Europe as a whole, and certain parts of it in particular, have gone considerably farther than has this country.

There are a number of reasons for this difference in electrical engineering development in the two continents, but chief among them are the high price of coal, the cheapness of labor, the comparatively small size of the installations and the municipal regulations already referred to. The first consideration has had an important bearing on power station design and has resulted in many economies in station operation, such as super-heaters, waste-heat engines, etc., which are rarely or never used on this side of the Atlantic in railway work. It also lead to the early and widespread adoption of storage batteries for stations. The lower cost of labor, in turn, has made experimental, and consequently special, apparatus cheaper in America, and, compared with standard apparatus, very much cheaper, for the labor-saving appliances, the automatic machine tools and the many devices which bring down the cost of manufacturing in America are still comparatively rare in Continental shops. The comparatively small size of the electric railways and the governmental regulations in restriction of the trolley have both in turn acted as a stimulus for investigations along certain lines, the former, because failure was not very costly and the latter because the most obvious and desirable method was prohibited. American managers have never balked at a large expenditure of money if it promised a durable improvement or economy, but the very fact that they have been allowed a comparatively free hand in the equipment of their own systems, and that the standard trolley system has proved so satisfactory, has acted as a bar to the adoption of untried methods which would take time to standardize and in the end, if successful, prove little, if at all, better than that which was immediately available.

Mr. Vellguth points out how these differences in environment have lead to differences in practice; yet these differences are not so great as one might expect to find and far less than exist in steam railroad service in the two continents. The fact that there are no radical divergences in principle between the two continents makes the study of one set of methods of value to those who practice the other.

In certain directions, as in three-phase traction, European practice has lead American, though how important this system will be in future traction service will not be discussed here. Certain it is that the three-phase roads now in operation in Europe are very satisfactory for the work for which they are intended, and the leading engineers there are thoroughly imbued with their merits for long-distance, high-speed service.

Conditions of Export Trade

From time to time one hears some concern expressed as to the maintenance of the recent high level of American export trade, and late statistics have been assumed to show that the remarkable demand exhibited for our product during the last two or three years was a mere spurt. A more careful and sober inquiry does not justify these pessimistic views. There is, in reality, little difference in the bulk of exported manufactures, while lower price and the falling off in agricultural produce would fairly account for the slightly smaller trade balance in our favor. In fact, the classified returns for April, just to hand, demonstrate that of our exports in that month 36.54 per cent were of manufactures, as compared with 29.15 per cent in April, 1901. This is a striking gain of over 7 in the percentage; while of our imports that month, not less than 49.93 per cent were of raw materials for manufacture or partially manufactured material. We can see nothing temporarily discouraging or permanently bad in such cheerful figures.

There is, however, an aspect of the case that does not reveal itself in these statistics, but one which is familiar to our readers, namely, the actual diminution of exports caused by the establishment of large factories abroad to make goods previously shipped in notable quantities from this country. A change of method like that must obviously prevent any rapid expansion of figures in the departments affected by the creation of American centers of industry on foreign soil; and while we are not in possession of the data—which would in any event be extremely difficult to collate—it is evident that the growth of manufactured export in electric and street railway classes would be larger but for the natural and inevitable check referred to.

While this tendency to plant American factories near the points of large consumption, with foreign capital and under foreign management, is likely to continue, we can only welcome it as a sign of greater international intercourse and of a reduction of all practice to uniformity, which in the long run makes not only for the welfare of the purchaser, but for the benefit of the producer in biggest volume. It is the fact that, while some areas of supply have been restricted by the operation of the causes named, in general the market for American street railway apparatus is appreciably larger than when our efforts to promote it were first made, for electric traction is now one of the dominant needs in each of the four quarters of the globe. This means not merely equal opportunity for the larger machinery built in Europe and on this continent, but a better chance than ever for the long list of miscellaneous parts and supplies without which no trolley road can be equipped or maintained. But such goods must be made universally known and be so standardized in quality, size and applicability that the largest orders can be at once filled with that promptitude for which our European friends so often compliment this country. The one great fact to be borne in mind is that eternal vigilance is the main item in holding and extending the export market already secured by the earlier efforts and the persistent publicity thus far brought to bear.

Results of the Zossen Tests

It is with great pleasure that we are able to present to our readers the results of the preliminary high-speed tests on the Zossen line. It is especially fortunate that they became available at this particular time, just when the whole question of train resistances had been reopened in our columns last month. The curves showing the experimental values of the air resistance are exceedingly instructive, and will well repay careful study, especially the one indicating the points obtained from the full series of tests with the Siemens & Halske car. Without entering into a detailed discussion of the records it should be noted that these results indicate for the relation between normal air pressure and speed approximately $p = .0027 V^2$. The experiments show distinctly that the pressure varies with the square of the speed, but with a much smaller coefficient than was assumed by the older formulæ, long discredited and now disproved, which are cited by Mr. Davis in his discussion of the subject this month. The coefficient is, however, much larger than that obtained by Crosby with whirling bodies some ten years ago, indicating that his experiments were probably vitiated by "mit-wind" which is likely to affect any work by that method.

The second important fact brought out by the Zossen tests was that the tractive coefficient at about 75 miles per hour was certainly no greater, and probably materially less, than at a speed as low as 12 miles per hour. This result is absolutely confirmatory of the position which we took last month, and indeed have often reiterated in referring to the subject. The same fact has often appeared in results obtained from locomotives, and the late Mr. Barnes, who had made a special study of the subject, used to contend that at very high speed a marked steadying action took place, which gave smoother and easier running with respect to minor irregularities. We regret that the results now obtained do not include the track resistances at various intermediate speeds, for there is some probability, as we have before intimated, that they may show higher values than those obtained at either extreme. In any event a decreasing or uniform value of tractive resistance explains the fact that formulæ like those of Sinclair, Barnes and Vauclain, which contain only the first power of V, still give results close to the experimental facts within the range of rather high speeds for which these formulæ were designed. Certain it is that they give at high speeds results much more closely in accordance with fact than any of the older formulæ, which were based on lower speeds and antiquated track conditions, although being based on trains they give low values for the resistance of a single car. The power actually taken to drive the experimental cars at speeds between 90 and 100 miles per hour ranged from 840 hp to 950 hp, and it should be remembered that at these speeds the track was giving serious trouble, so that the tractive coefficient was probably quite abnormal.

We shall await with great interest the detailed results of the tests with respect to power consumption and tractive effort, but enough has already been made public to assure us of the welcome fact that electric trains at the high speeds in question actually require vastly less power than would be indicated by the "B & L" formulæ which aroused so much discussion last month. The probable errors which we pointed out at the time are fully confirmed as errors by the results at Zossen, and it now appears that instead of a single car at 100 miles per hour taking an amount of energy so great as to be virtually impossible, it takes an amount that is entirely practicable. Nevertheless, we have always taken the position that, as Mr. Davis indicates, the train is a unit vastly preferable from the standpoint of output, and offers the only proper solution of the high speed problem. The one critical point is the character of the track, and evidently this is the direction in which to look for the improvements necessary to make high-speed electric trains an operative success.

The Zossen results, so far as they have gone, are highly satisfactory to the advocates of high-speed electric traction, and we hope they will not suppress, but rather stimulate, further investigation. There is much work to be done. The effect of cross wind and head wind must be studied, the relation of the track construction to the resistance must be investigated, and the braking problem must be worked out to a successful conclusion. It is, however, of great assistance to have accurate values of the air resistance and confirmatory evidence of the steadiness of the tractive resistances so long, at least, as the track remains in good condition.

Automatic Block Signals for Electric Railways

The advance of electric traction into the field of steam road suburban service and the increasing number of high-speed interurban lines operating on both single and double track make it opportune to call attention to the need for development of automatic block signal systems suited to this class of heavy electric railway service. It is not to be supposed that any block signal system can take the place of eternal vigilance on the part of motormen and conductors, but an efficient system of this kind may greatly assist in the working of the road and add to the safety with which trains can be operated. Much costly experimental work has already been done in developing block signals for electric roads, yet much more remains to be accomplished. We would not for a moment belittle the work already completed or in process, but we do wish to speak a word of encouragement to those who are endeavoring to evolve automatic block signal systems which will be entirely suited, both in cost and operation, to the conditions of present high speed and electric interurban lines. as well as to steam railroad suburban lines electrically equipped. It is true that the latter class of service is as yet undeveloped and that this application is more a question of future demands than present requirements. So far no actual demands have been made for signals in this service, yet it does militate somewhat against electric traction in the minds of steam railroad officials that few automatic block signal systems are being offered which would be at all suited to the conditions which arise when a steam road is changed to electric traction.

All block signal systems so far put in operation can be classified under two general heads; first, those dependent on the operation by the train of some kind of a track instrument or trolley instrument at a given point; second, those dependent upon track circuits. The first class is the oldest both in steam and electric railway practice. The first automatic block signals used on steam roads depended upon the deflection by the wheels of a train of a track instrument at the beginning of each block. The deflection of this instrument set the signal at the entrance to that block to "danger" position. When the train passed on out of the block it deflected another track instrument which established circuits, putting the signal at the entrance of the block again to safety position. All the automatic block signal systems so far used for surface electric railways have depended upon the instruments in the overhead line, operated by the passage of the trolley wheel. In the case of electric roads, of course, power for operating the signals or lighting signal lamps is obtained from the trolley circuit. In the case of steam roads, primary batteries were necessarily used. Any block signal system dependent upon the operation of track or trolley instruments has certain defects which do not exist with systems dependent upon track circuits. With the track-circuit system used on steam railroads, the blocks are composed of continuous bonded sections of track, and each block is insulated from the adjoining blocks by insulating rail-joints. A potential difference of one volt is maintained by a gravity battery between the two track rails of a block. The presence of a train, or even a single pair of wheels on a block, short circuits the battery and lets the signals fall to danger. A broken rail, or an iron bar resting across the tracks, has the same effect, and it makes no difference whether a portion of a train has passed out of the block or not; the signal governing the block will not go to safety until all the wheels of the train are off the block. In any system dependent on track or trolley instruments it is possible for the instrument at the exit of the block to be operated and clear the signal when the block is in reality not clear, as, for example, when two cars are closely following each other under special orders or where one car has entered a block against the danger signals before the car ahead has left it. Of course, with motormen properly observing rules, the danger of this kind is very small, and, in fact, as we said at the beginning of this article, it makes no difference how efficient the block signal system is, there must be discipline upon the part of the motormen and strict observance of the rules in order to make it efficient. However, the desirable features of the track-circuit plan have resulted in an almost universal adoption of track circuits by steam roads for automatic block signals. It is much to be regretted, in view of the simplicity and efficiency of the automatic block signal systems which have been developed on steam roads, that such systems are not suited to heavy electric railways, because if they were it would save much of the inventive and experimental work that must be done when electric traction enters the field of high-speed suburban and interurban service on steam roads. The essential difficulty is that the foundation of automatic block signaling on the steam roads of America to-day is the track circuit, which makes use of easily disturbed electrical conditions existing between the rails of the track. On account of the low insulation resistance between the rails of a track on the surface track circuits can only be satisfactorily maintained on steam roads by using a low-voltage battery of high internal resistance, the custom being to use two cells of gravity battery in multiple. If an electric road were to try track-circuit signaling, while still using the track as a return, one rail of the track must be divided up into blocks insulated from each other, leaving only one rail available as a return conductor. In order to prevent interference with the signals by any difference of potential set up by the flow of the return current used in train propulsion voltage considerably higher than one volt or two volts must be used. While a system of this kind is successfully used on the Boston Elevated, as recently described in these columns, it is, of course, not desirable to give up the value of one track rail as a return conductor, especially on surface roads which have no elevated structure to bond to; and, furthermore, it has not been established by trial that the maintenance of a sufficiently high voltage on the track circuit with rails laid on the surface would be free from objections. If it should be found that the track circuits are utterly impracticable for surface lines there is still the alternative of track-instrument systems.

One possible scheme of block signaling on electric roads which has been proposed in a general way by a number of writers, but which has never been worked out in practice, is that of having the block signal system governed by the current supply. The general idea of this is to divide the third rail into sections insulated from each other, each section constituting a block. The presence of a train on one section would act either to set danger signals at the beginning of the block or to cut off current entirely from the preceding block through the medium of a relay in the feeder supplying the block to be protected. This could only be accomplished with safety on a third-rail system, where the contact shoes would always be on the rail and where each car would take sufficient current from the line at all times, even when the motors were not running, so that it would operate a relay inserted in the feeder circuit supplying its section of the third rail. This would not be feasible with a trolley road because of the possibility of the trolley being off the wire and leaving the car unprotected by any block signals at the very time when it might need it the most. Considerable experimental work would have to be done to bring such a system to a commercial state as just outlined, and it would not conform to the rules adopted by American steam railroads governing signals, in that it would require the presence of current in the feeder supplying a block before the signal would be allowed to go to danger at the entrance to the block. American railroad rules require that in the event of any defect or failure of any part of the signal system to operate the signal shall go to danger by gravity and shall not depend upon positive operation of some force to put it in the danger position.

Polyphase Railway Working

Two important papers, read at the recent meeting of the American Institute of Electrical Engineers on this subject, are of particular interest to those engaged in solving the problems of long interurban service and the substitution of electricity for steam on existing roads. Naturally, manufacturers are well contented to let a good thing stay undisturbed, and they will have a very logical and forcible argument against the innovation, so far as street railway service goes, in the desirability of a uniform practice on electric roads, yet the polyphase specter will not down. We believe that it will be laid, if at all, only by a thorough and unbiased study of its merits on a practical scale. We do not believe that it will prove an important factor in street railway systems for cities, but it is the part of wisdom to consider the features of the system, and to study in particular the points in which it differs from present American practice.

De Muralt's paper dealing with the European roads already in operation is full of valuable information. The general impression which it leaves upon the mind is that the roads operated by polyphase motors have demonstrated that the system is thoroughly reliable and practical, at least for certain classes of work, but the fact that of the half dozen roads described only one belongs fairly to the tramway class forcibly suggests that polyphase working finds its least advantageous field in ordinary street railway work. It seems to us that the chief objections to the system lie not in the character of the apparatus, which is excellent, nor in the difficulty of speed regulation, which can be as readily obtained as in a simple motor equipment of the ordinary kind; but in the necessity for a double trolley, and in the inconveniences of a nearly-fixed general speed.

A double trolley in any form and for any purpose is an unmitigated nuisance. It stands condemned by the whole body of practical railway men who have used it on street railways. In the larger field of electric railroading the objections to it are not so important, but it seems to us that for ordinary tramway work polyphase motors will have a hard road to travel unless they can shed the extra trolley.

As to the other count in the indictment, induction motors, while perfectly capable of speed regulation, constantly tend to run at nearly synchronous speed, so that it is difficult to obtain the reserve speed necessary for making up lost time so as to preserve a uniform schedule. One could run ordinarily at reduced speed with some considerable loss of energy, but the question of making up time is serious with any form of induction motor. Of course, in interurban and some special railway service, traffic is relatively steady; as regards the call for unusual delays there would be less inconvenience from this cause, and it is in this larger work that polyphase motors have the best chance.

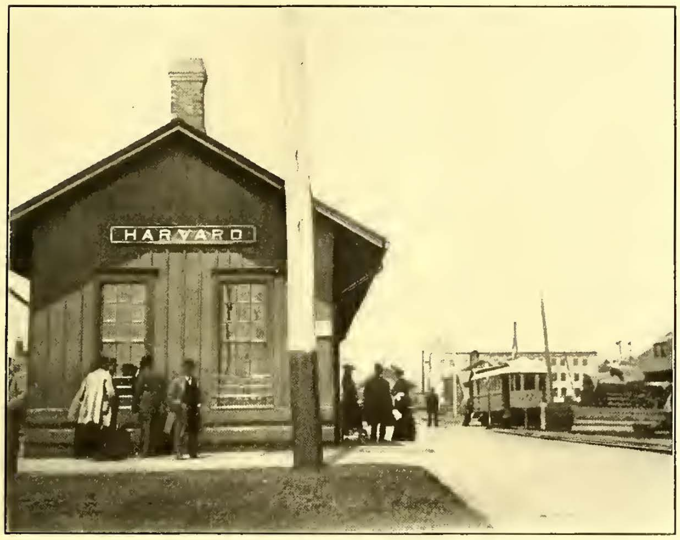
It is for just such cases that the advantages of the polyphase distribution are most conspicuous. Whenever a large amount of energy must be distributed over a long line the feeder copper becomes very burdensome. In splitting up the line into sections fed from the sub-stations there is a very great saving, for the feeder copper is very nearly inversely as the square of the number of sections. There is besides no doubt that the motors, if polyphase, can with entire success be wound for double the voltage that is permissible in a motor having a commutator, so that here again is a possible large saving. The tests on the Burgdorf-Thun line show clearly that good results can be obtained with simple rheostatic control, but for severe acceleration something more is needed, and in the Valtellina system Ganz & Co. have placed reliance on the so-called concatenated control, in which the secondary of one motor feeds the primary of another.

Mr. Danielson, in a very interesting paper, presents several modifications of this system, made with a view of getting easy control of speed over a wide range. The general principle is to employ two or more induction motors with different numbers of poles, so as to get what is practically a change of frequency in the subordinate member of the concatenation. There is no doubt that one can get a wide range of regulation by this device, and Mr. Danielson figures out that such a combination will give substantially as good results in acceleration as are obtained with continuous-current motors. The scheme is certainly highly ingenious, but, to the lay mind at least, it suggests frightful complication, both in the controller and in the car wiring. It is not many years, however, since series-multiple control was rejected for the same reason, and we should really like to see Mr. Danielson's device tried on a practical scale. For many purposes the simpler control used on the European roads seems adequate to do the work, and from all accounts it actually does perform thoroughly well.

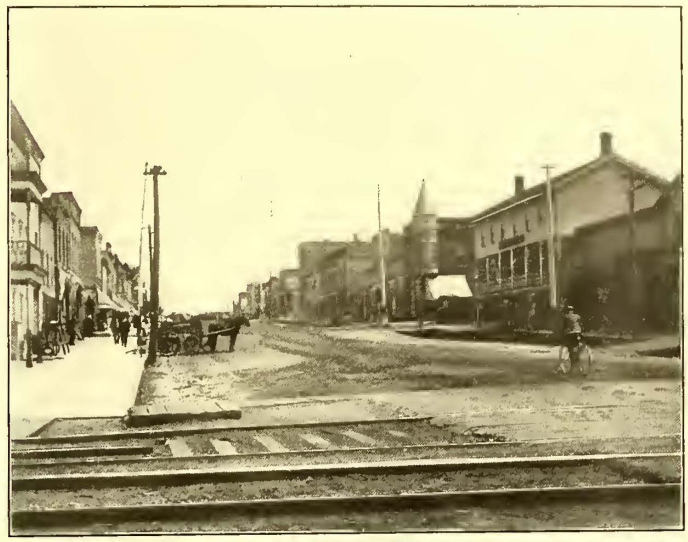
We do not desire to take a radical position in this matter of polyphase traction, and we certainly appreciate the advantages that have accrued to the art of electric traction from the thorough development that standardization has brought to our present apparatus. But we cannot be blind to the fact that the Continental engineers have rapidly been putting polyphase traction into a useful and practical state for many purposes. The litigation of last year over the "Inner Circle" showed very plainly that polyphase traction must be reckoned with in the very near future, and while the London decision may have shown sound judgment, under the conditions to be met, it cannot be considered as having definitely put polyphase methods out of the game. The subject ought to be taken up and thoroughly studied by our American engineers in the light of the foreign results. Our cheaper copper and more costly apparatus result in conditions of economy radically different from those found abroad, and the possibilities and limitations of polyphase railway working in this country ought to be investigated most carefully. It will not do to let the matter rest.

Freight Business on the Chicago, Harvard & Geneva Lake Railway

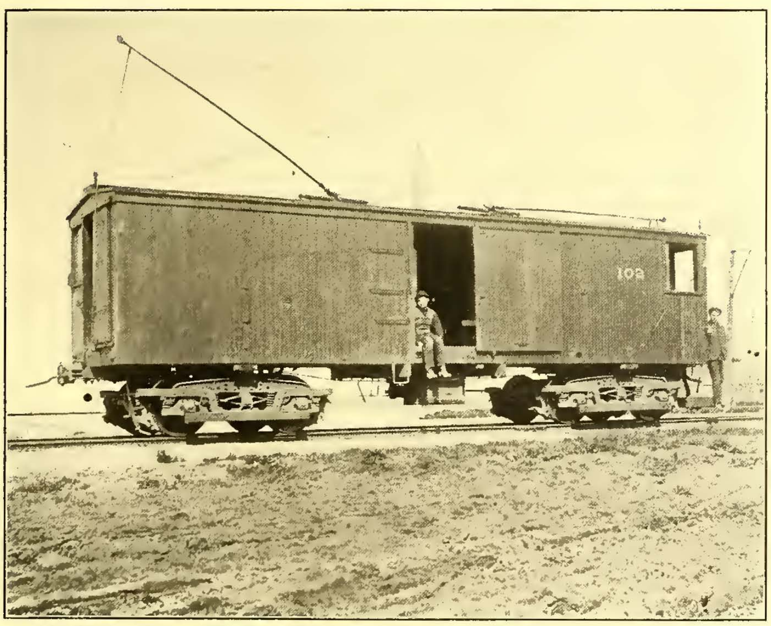
Inquiries have recently been made by those interested in the building of electric interurban roads as to what amount of freight business could be obtained from an average farming community, leaving out of account city traffic and patronage from factories along the line. In this connection, also, the question has come up as to how far interchange of freight business with steam roads can be carried on and whether it is practicable to load the majority of farm products directly in the steam road freight cars at sidings along the electric road. As a partial answer to some of these questions an investigation of the freight business which has been carried on for nearly three years by the Chicago, Harvard & Geneva Lake Railway may prove of value as indicating what may be expected under similar circumstances elsewhere as to the volume and kind of business.

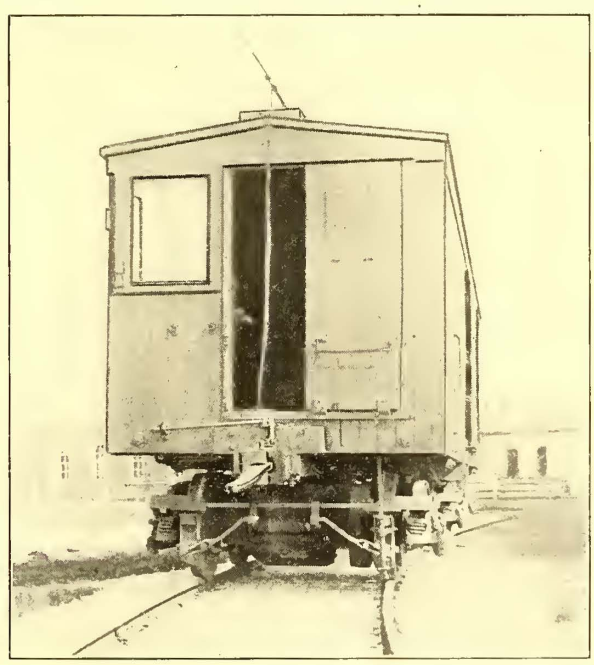


CONNECTION WITH CHICAGO & NORTHWESTERN AT HARVARD



MAIN STREET OF HARVARD





FREIGHT MOTOR CARS ON CHICAGO, HARVARD & GENEVA LAKE RAILWAY

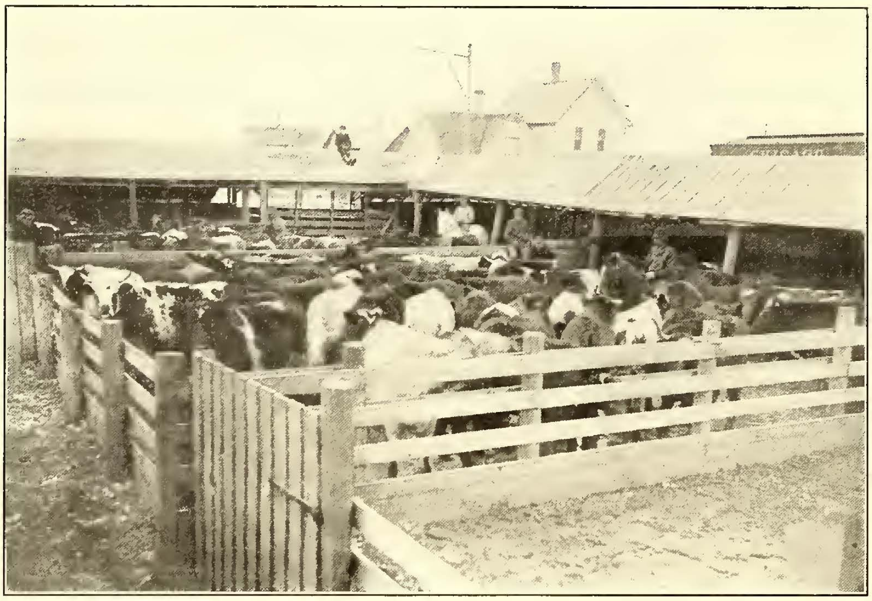
Figures from this road are of value not because the road's earnings are anything enormous either from freight or passenger business, but because there is so little along the line of the road as regards freight production which differs from average conditions existing in many communities throughout the Central States which are devoted almost entirely to farming. Another thing which makes the experience of this road especially valuable to others is that it probably carries on interchange of business with steam roads to a greater extent than any other electric road in the country. This holds true both as to freight and passenger business. Tickets are sold through from any point on the Chicago, Harvard & Geneva Lake Railway to those on the Chicago & Northwestern Railroad or the Chicago, Milwaukee & St. Paul Railroad. The greater part of the freight received and delivered by the Chicago, Harvard & Geneva Lake Railway is handled in the steam road freight cars, which are hauled directly from the steam road to the rural siding at which delivery is made, thus doing away with all transfer of freight from steam to electric cars.

The road has 10.5 miles of main line and 1.5 miles of siding. Its southern terminus is at Harvard, on the Chicago & Northwestern Railroad, near the northern border of Illinois. This division of the Northwestern road forms its main line between Chicago, St. Paul and Minneapolis. Running north from Harvard 8.5 miles the electric road crosses the Chicago, Milwaukee & St. Paul Railroad and then runs 2 miles northeast to the southern edge of Lake

Geneva, one of Wisconsin's choicest lakes and an aristocratic summer resort. Out of a total yearly business of about $20,000 fully one-third, or $6,666, is income from freight. The population along the line is as follows:

Harvard	2,500
Big Foot Prairie	100
Walworth	600
Fontana, on Lake Geneva	300
Farmers, tributary to line	500
Total population	4,000

or about 380 people per mile of track.

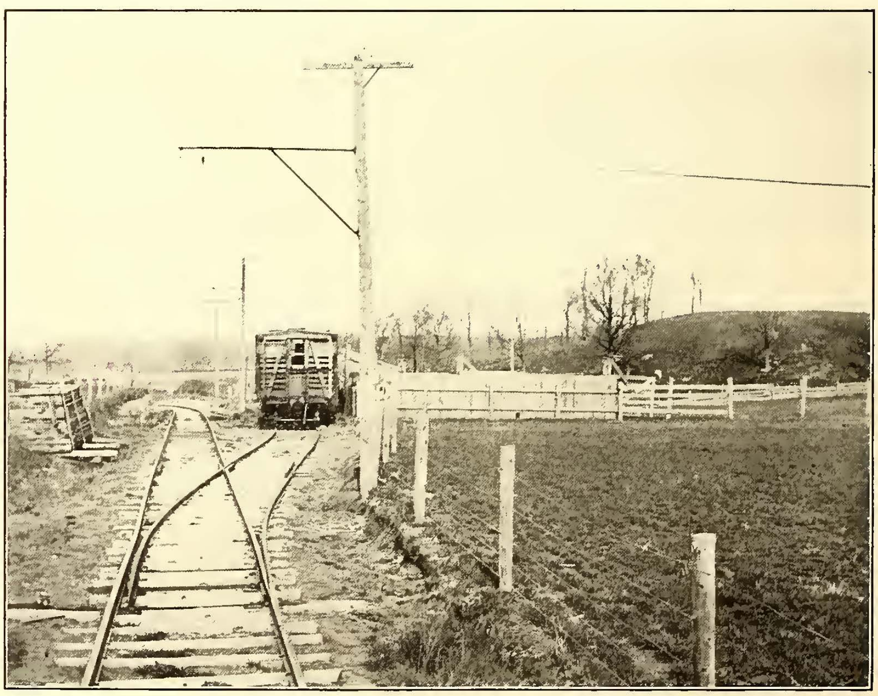


WALWORTH STOCK YARDS ON THE CHICAGO, HARVARD & GENEVA LAKE RAILWAY

The freight earnings come to about $635 per mile of track per year. When freight is handled by the carload, the Chicago, Harvard & Geneva Lake Railway charges $5 per car for every car delivered from a steam road to any point along the line. Last year about 1000 carloads of freight were handled in this way at $5 a car. Piece freight is handled on a one-rate plan between any two points on the Chicago, Harvard & Geneva Lake Railway at 5 cents per hundred pounds. No piece of baggage or single shipment of freight is taken for less than 10 cents, though baggage of passengers going through to or from steam road points is checked free. In carload lots on both of the steam roads which this electric road intersects the freight rate is the same to any point on the electric road that it would be to Harvard on the Northwestern road or Walworth, on the Chicago, Milwaukee & St. Paul, from any point on either of these steam roads. One freight motor is kept in service all day, with a crew of two men. This motor car is made from a steam road freight car body mounted on McGuire trucks which were designed for elevated service and equipped with two G. E.-57 motors. This freight car has windows in each corner for the use of the motorman and a controller at each end. This motor car hauls from one to four steam road freight cars and carries piece freight. Some of the latter freight is also carried in the baggage compartment of the passenger cars. There are six freight sidings along the road, not including the company's own yards. In summer, refrigerator cars are run twice a week from the Chicago & Northwestern Railroad for the benefit of the three creameries on and near the line of the electric road. This saves these creameries a long haul in the hot sun to the steam roads. Last winter 3000 tons of ice were hauled from Lake Geneva for local use along the road. The company receives $500 per year for hauling mail two trips each way the entire length of the road. After June 1, 1902, an aditional service of one trip each way over the 2 miles between Walworth and Lake Geneva will be given.

Live stock shipments form an important part of the company's freight business and account for the large number of carload lots of freight delivered to the steam roads. When the road was first built the only steam road connection it had was with the Chicago & Northwestern Railroad at Harvard, its southern terminus. Later the Chicago, Milwaukee & St. Paul Railroad built through Walworth. This town had formerly been served only by the electric road and had grown from 300 to 600 people in a space of two years, due to the building of the electric line. As the building of the Chicago, Milwaukee & St. Paul Railroad through Walworth gave a direct steam road connection from that town to Chicago it was feared that it would have a disastrous effect on the business of the electric road originating in the vicinity of Walworth. It is interesting to note, however, that the electric road has held its own in spite of this competition and that 85 per cent of the live stock freight business out of Walworth is handled by the electric road instead of being shipped directly over the Chicago, Milwaukee & St. Paul Railroad.

The whole secret of this is in the better accommodation for shippers which the electric road is able to offer. In one case the electric road has put in a siding for the stock yards of a private shipper a short distance from Walworth. In the town of Walworth itself are the yards of both electric and steam railroad companies. The rate to shippers being



PRIVATE STOCK YARD ON LINE OF CHICAGO, HARVARD & GENEVA LAKE RAILWAY the same by either the electric or steam roads, the great majority go to the electric road stock yard because of better accommodations. The stock yards of the electric road are near the shops and power house and are supplied with both hot and cold water and electric light. The hot water is especially appreciated by shippers who wish to give their stock a warm bran mash before shipment. Then, too, there are other small points which the shippers appreciate very much. There are always enough employees around the company's shop and yards so that a man or two can be spared to help the shipper in case of necessity and to see that his wants are attended to. It is manifestly impossible for a steam road with a single agent to do anything of this kind for shippers, and yet under the circumstances it costs the electric road little to do it. Steam roads haul stock into the Chicago stock yards in from three to four hours from the time of leaving Harvard or Walworth. The electric road makes it a point to keep stock cars always available for evening shipments on short notice and has arc lights at the yards. When a shipper's agent in Chicago wires that the market on the following day will be good, this message is received by the manager of the road and immediately telephoned to the shipper, who can load his stock in time for the stock train leaving Harvard at midnight. From the experience of this road it is evident that an electric road, the manager of which makes it a policy to accommodate shippers in every way possible and to cultivate their good feeling, can rely on capturing a large share of the business of the country through which his road runs and that stockmen will not drive to a steam road stock yard when an electric road is near. It has nothing to fear from long drives to steam road stock yards and freight depots if the shippers are well treated. It is in the matter of conformity to the wants of shippers and travelers that the electric road has always excelled, and when well managed this will always be true from the nature of the case, because the organization of the steam road and methods of operation do not permit of such frequent service or attention to the individual wants of shippers as would be possible on an electric road.

Although this article has been devoted mainly to the freight business, it may not be amiss to mention some of the other principal points about the road. The equipment consists of two freight motor cars, each having two G. E.-57 motors; four passenger cars, each equipped with two G. E.-1000 motors, and one fast passenger car equipped with two G. E.-57 motors geared to 40 miles per hour. This latter motor equipment is put under a snowplow in winter. The freight motor car, with its crew of two men, is kept in service during the day, and, when necessary, in the evening, the year round. One passenger car, with a crew of two men, is kept in service all day during the winter months. In the summer this road offers one of the easiest means of reaching Geneva Lake from Chicago in connection with either of the two steam roads, and, in fact, this is the only railway line going to the water's edge of Lake Geneva, the grades down to the lake being so severe that no steam road has ever built directly to the lake. In the summer, therefore, to accommodate the Lake Geneva travel, much of which consists of regular patrons who have cottages on Lake Geneva and do business in Chicago, the service is increased. Two cars are kept running the entire length of the line, from Harvard to Geneva Lake, and one car between Walworth and Geneva Lake. The cash-fare rates are as follows:

Harvard to Oak Grove, 3.75 miles	$0.10
Harvard to Big Foot Prairie, 5 miles	.15
Harvard to Walworth, 8.5 miles	.20
Harvard to Fontana on the Lake, 10.5 miles	.30

After June 1 the rate from Harvard to the lake is to be 25 cents. Commutation tickets consisting of forty 5-cent rides are sold. Only four coupons are taken from such a ticket for a trip from Harvard to the lake. Steam roads sell tickets from Chicago to Geneva Lake and return by way of the Chicago, Harvard & Geneva Lake Railway. There is also a commutation ticket sold between Chicago and Lake Geneva upon which a person can reach Chicago from the lake either by the way of the electric line or by a steam road in connection with the Chicago & Northwestern. One coupon on this ticket reads by the way of either line. The roads named on this optional coupon are credited with the tickets which they collect. From Harvard to Walworth the right of way is along one side of the highway. This highway is much better now than in former days, owing to the absence of heavy teaming, which was done away with after the electric road was built. The franchise is for fifty years.

The force required to operate the road, except during the summer passenger business, consists of one manager, two engineers, one fireman, one electrician, one helper, one trackman, two motormen, one passenger conductor and one freight conductor. The road is managed by Herbert T. Windsor, formerly of the Chicago office of the General Electric Company. L. S. Owsley, of Chicago, is president and H. H. Windsor, of Chicago, secretary.

Association Meetings at the World's Fair

It is proposed to invite the American Street Railway Association to hold its meeting in St. Louis in 1904, and furnish the organization facilities for a large gathering.

At the recent annual convention of the National Electric Light Association, in Cincinnati, considerable interest was manifested in the importance of the association taking an active part in stimulating a prominent and important display of electrical apparatus and appliances at the international exposition to be held in St. Louis in 1904, which culminated in the unanimous adoption by the convention of a resolution presented by James I. Ayer, of Boston, which provided that the annual meeting of 1904 be held on the grounds of the Louisiana Purchase Exposition Company at St. Louis.

Action was taken by the National Electric Light Association to hold the 1904 meeting in St. Louis, for the reason that the members are convinced that much better working exhibits will be forthcoming if the electrical manufacturers understand that the operating companies are thoroughly interested in having electrical apparatus exploited on a large scale. The co-operation of the American Street Railway Association, it is estimated, would result in attracting a still larger number of exhibitors, and would really solve the problem of getting a proper representation of these interests in the electrical department.

On Oct. 1, 1901, 113 German cities, against 99 in 1900, had electric traction, with a total length of roads of 1940 miles, equal to 2844 miles of single track. The total capacity of the generating machinery in use for traction was 108,021 kw, as against 76,600 kw in 1900, excluding storage batteries. The increase in the use of storage batteries was still greater; their power was 25,531 kw at the end of October, 1901, as against 16,890 in 1900. Of the total of 2844 miles of single track, only 445 miles are owned by the municipalities, but even this is in part rented to private companies. The Berlin-Zossen Railway is the only private railway included in the foregoing figures.

Train Resistance

BY W. J. DAVIS, JR.

The communication from Messrs. Lundie, Bell, Dodd and Wille in the May 3 issue of the Street Railway Journal on the subject of train resistance in general and the formulæ offered as the results of the Buffalo & Lockport tests in particular, were read by the writer with deep interest and appreciation of the suggestions and information given. In view of the friendly criticism provoked the writer feels that additional explanation of the derivation and limitations of his formula may not be out of place. It must be remembered that as the maximum speed obtained in the Buffalo & Lockport tests did not exceed 60 miles per hour it cannot be assumed that the constants obtained can be applied with accuracy for speeds greatly exceeding this value until verified. To the writer's knowledge, all of the published data on train resistance at high speeds is the result of tests taken with steam locomotives hauling trains of standard steam railroad passenger coaches. The Buffalo & Lockport tests were made under similar conditions, except that an electric locomotive was used instead of a steam locomotive.

It may be interesting to compare some of the best-known

(1) Wellington. $f = 4 + .005V^2 + (.28 + .03n)\frac{V^2}{T}$

(2) Eastern Ry., France. $f = 3.6 + .45V + .0019\frac{AV^2}{T}$

(3) D. K. Clark. $f = 7.14 + .00525V^2$

(4) *Engineering News*, 1894. $f = 2 + .25V$

(5) Baldwin Locomotive Works. $f = 3 + .167V$

Where f = resistance in lbs. per ton.

V = velocity in miles per hour.

T = weight of train in tons.

n = number of cars in train.

A = cross section of car in square feet.

It will be observed that none of these formulæ, with the exception of Wellington's, takes into consideration the number of cars forming a train or the cross-sectional area of the car. In making comparison therefore with the Buffalo & Lockport formula it is necessary to approximate these values by assuming type of car and engine representing average practice. Suppose we take a five-unit train made up of four cars weighing 45 tons each, with 110 square feet cross-sectional area and hauled by 80-ton locomotive, making total weight of train 260 tons. Formula (3) in the May issue, obtained directly from Buffalo & Lockport tests, has been given as

$$f = 4 + .13V + \frac{.004AV^2}{T}\,[1 + .1(n - 1)]$$

Substituting the above value we obtain the following results at a speed of 60 miles per hour:

B. & L. formula	20.3 lbs. per ton
Wellington	27.9 " "
Eastern Ry., France	33.5 " "
D. K. Clark	26.0 " "
Engineering News, 1894	17.0 " "
Baldwin Locomotive Works	13.0 " "

It will appear from the foregoing that the values given by the Buffalo & Lockport constants, instead of being high, are considerably less than the values obtained from the formulæ of D. K. Clark, Wellington and Eastern Railway, of France, but are rather higher than the Baldwin Locomotive Works and *Engineering News* formulæ. The latter, however, contain no quadratic function of the velocity, and for this reason, while approximately correct at low speeds, are inaccurate in high-speed work.

The formula has also been checked up from time to time with published results of isolated engine trials and performances. As an example taken at random, the *Railroad Gazette* of Nov. 1, 1901, gives some tabulated results of the performance of a New York Central class I engine hauling the Empire State Express from New York to Albany. The train was made up of one composite car, two coaches and one parlor car, having weight, with passengers and baggage, of 208 tons. The locomotive weighed 88 tons, making total weight of train 296 tons. Assuming the cross-section of the cars to be 115 sq. ft., and taking the engine efficiency at 90 per cent, the following tabulated results are obtained:

Card No.	Speed M. P. H.	Total I. H. P.	Train Resis. lbs. per Ton	Train Resis. lbs per Ton by B. & L. Formula
3	60	1,138	21.8	19.6
4	65	1,337	23 7	21 6
6	72	1,331	21.1	24.6
8	64	1,101	19.7	21.2

In the Buffalo & Lockport tests none of the coaches were of the vestibuled type, and the outline of the electric locomotive was such that it and the car following presented practically a flat surface to the wind. Verification of the law that the wind pressure varies as the square of the velocity was obtained, not from a single run, but from six independent trials requiring more than forty observations. Four of these runs, where the wind was very light and normal to the track, gave each a coefficient within a few per cent of .004. In the remaining runs the wind was gusty, and the tests were rejected on this account; but they also showed the increase in wind pressure to be proportional to the square of the velocity for speeds below 60 miles per hour.

The usual type of interurban electric car is vestibuled at both ends, and consequently presents a partially rounded or wedge-shaped end to the direction of motion. In applying the formula obtained from the Buffalo & Lockport tests, therefore, to this type of car it was thought to be approximately correct to reduce the constant "d" to .0035. This may prove to be too high, and from the viewpoint of the engineer and the promoter it is to be hoped that it is so. A conservative attitude with regard to motor and power-station capacity impels the writer to favor this value until proven high by a number of tests taken under widely varying conditions.

It seems to be the general opinion that there is a woful lack of data which may be applied universally to high-speed traction with single cars having vestibuled fronts, or even to short trains of two or three cars where the maximum speed exceeds 40 miles per hour. The results of the Buffalo & Lockport tests were so striking and conclusive in their general character, and appeared so threatening to the successful and economical operation of single cars at speeds above 60 miles per hour or 75 miles per hour, that it was with the hope of arousing the attention of electric railway engineers to the gravity of the subject, as well as to the importance and value of more data, that the modified results of the Buffalo & Lockport tests were published.

Unfortunately, most of the early interurban electric roads follow highways or river bottoms, and on this account abound in grades and curves. To the writer's knowledge, there is no electric road in the country now operating which can offer a continuous stretch of 10 miles to 12 miles of practically level tangent track backed up with sufficient station capacity and adequate third-rail construction to permit accurate tests of trains of three or more cars at speeds approaching 75 miles per hour to 80 miles per hour. There are several such roads under construction, however, and

STREET AND ELEVATED RAILWAY MILEAGE, CARS AND CAPITALIZATION IN UNITED STATES AND CANADA.

COMPILED FROM THE STATISTICS OF THE VARIOUS PROPERTIES CONTAINED IN "AMERICAN STREET RAILWAY INVESTMENTS," EDITION OF 1902.

STATES.	No. of Roads.	Electric Railways. Track Mileage.		Electric Railways. Motor Cars.		Electric Railways. Trail Cars.		Cable Railways. Track Mileage.		Cable Railways. Grip Cars.		Cable Railways. Trail Cars.		Horse Railways. Track Mileage.		Horse Railways. Cars.		Miscellaneous Railways. Track Mileage.		Miscellaneous Railways. Cars, Engines, etc.		Total Railways. Track Mileage.		Total Railways. Cars.		Capital Stock. Total.		Capital Stock. Increase for Year.	Funded Debt. Total.		Funded Debt. Increase for Year.	Capital Liabilities. Total.		Capital Liabilities. Increase for Year.	STATES.
	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901	1900	1901		1900	1901		1900	1901		
New England States.																																			**New England States.**
Maine	22	278	329	407	426	54	59							3	3	4	4					281	332	465	489	$3,902,148	$4,080,348	$187,200	$4,326,000	$5,009,519	$683,519	$8,228,148	$9,098,867	$870,719	Maine
New Hampshire	11	121	159	170	206	33	34															121	159	203	240	1,533,300	4,237,000	2,703,700	1,009,500	2,818,500	1,809,000	2,542,800	7,055,500	4,512,700	New Hampshire
Vermont	10	91	91	85	94	12	2															91	91	97	96	1,277,600	1,765,124	487,524	1,006,600	1,345,000	338,400	2,284,200	3,110,124	825,924	Vermont
Massachusetts	119	1,968	2,309	6,214	6,997	2,676	2,676							5		12						1,973	2,309	8,902	9,673	48,971,168	54,069,933	5,098,765	34,373,000	34,312,500	*60,500	83,341,168	88,382,433	5,038,265	Massachusetts
Rhode Island	10	283	316	583	753	56	93															283	316	639	846	16,202,000	16,072,000	770,000	2,862,400	5,719,700	2,857,300	19,064,100	22,691,700	3,627,300	Rhode Island
Connecticut	28	503	527	1,028	1,052	104	88															503	527	1,132	1,140	13,164,940	23,772,940	10,608,000	10,802,800	15,557,000	1,754,200	23,967,740	39,329,940	15,362,200	Connecticut
TOTAL	200	3,244	3,731	8,487	9,528	2,935	2,952							8	3	16	4					3,252	3,734	11,438	12,484	85,051,156	104,906,345	19,855,189	54,380,300	64,762,219	10,381,919	139,431,456	169,668,564	30,237,108	TOTAL.
Eastern States.																																			**Eastern States.**
New York	121	2,194	2,608	8,498	11,463	538	676	54		760		200		112	110	1,097	1,025	a194	a194	2,272	2,717	2,554	2,912	13,365	15,881	222,065,607	276,011,467	53,945,860	228,883,049	245,683,434	16,800,385	450,948,656	521,694,901	70,746,245	New York
New Jersey	57	787	838	1,711	1,750	186	146							11	9	34	39					798	847	1,931	1,935	46,193,800	79,925,180	33,731,380	50,003,628	64,702,500	14,698,872	96,197,428	144,627,680	48,430,252	New Jersey
Pennsylvania	176	2,117	2,472	5,930	6,308	490	444											2	3	26	23	2,119	2,475	6,446	6,775	145,673,296	168,921,116	23,247,820	94,605,646	138,743,685	44,138,139	240,278,942	307,664,801	67,385,859	Pennsylvania
Delaware	6	62	62	96	108	2	2															62	62	98	110	1,320,000	1,920,000	600,000	875,000	900,000	25,000	2,195,000	2,820,000	625,000	Delaware
District of Columbia	6	227	239	943	955	125	25															227	239	1,068	980	24,400,000	28,205,000	3,805,000	21,930,000	19,920,000	*2,010,000	46,330,000	48,125,000	1,795,000	District of Columbia
Maryland	6	390	442	1,222	1,256	353	356															390	442	1,575	1,612	24,360,806	30,404,000	6,043,194	36,193,000	51,698,694	15,505,694	60,553,806	82,102,694	21,548,888	Maryland
Virginia	17	248	300	378	493	58	56														4	248	300	456	553	7,831,250	9,856,250	2,025,000	10,599,000	14,829,500	4,230,500	18,430,250	24,685,750	6,255,500	Virginia
West Virginia	9	105	148	154	198	31															11	105	148	185	209	3,348,000	3,603,000	255,000	3,809,000	3,684,000	*125,000	7,157,000	7,287,000	130,000	West Virginia
TOTAL	398	6,130	7,100	18,952	22,531	1,783	1,705	54		760		200		123	119	1,131	1,064	196	197	2,298	2,755	6,503	7,125	25,124	28,055	475,192,759	598,846,013	123,653,254	446,898,323	540,161,813	93,263,500	922,091,082	1,130,007,826	216,916,744	TOTAL
Central States.																																			**Central States.**
Michigan	31	823	961	1,347	1,642	204	164							2	2	2	2	2		6		827	963	1,550	1,808	24,354,000	32,703,400	8,349,400	23,082,000	55,325,000	32,243,000	47,436,000	88,028,400	40,592,400	Michigan
Ohio	81	1,823	2,107	3,223	4,052	498	240	19	7	110	72							8	2	3	3	1,850	2,116	3,834	4,367	87,341,300	124,655,350	37,314,050	41,717,700	64,339,000	22,621,300	129,059,000	188,994,350	59,935,350	Ohio
Indiana	29	678	804	671	923	308	213							7	7	13	13					685	811	992	1,149	17,323,600	24,233,600	6,910,000	26,629,000	26,813,500	184,500	43,952,600	51,047,100	7,094,500	Indiana
Kentucky	12	226	222	488	535	240	257							5	3	25	6					231	225	753	798	8,196,900	7,596,900	*600,000	7,123,300	8,263,300	1,140,000	15,320,200	15,860,200	540,000	Kentucky
Wisconsin	19	405	405	580	580	211	211															405	405	791	791	10,781,500	10,795,500	14,000	11,039,050	12,267,050	1,228,000	21,820,550	23,062,550	1,242,000	Wisconsin
Illinois	55	b1,664	b1,724	3,060	4,000	2,861	2,861	82	82	627	708	700		17	18	21	16	10	10	142	99	1,773	1,834	7,411	7,684	151,604,160	158,791,060	7,186,900	89,767,900	93,189,900	3,422,000	241,372,060	251,980,960	10,608,900	Illinois
Minnesota	8	324	351	773	781	304	304							3	3	3	3					327	354	1,080	1,088	26,115,495	23,625,495	2,490,000	12,076,000	13,726,000	1,650,000	38,191,495	37,351,495	*840,000	Minnesota
Iowa	23	333	378	377	410	183	188							9	9	9	9					342	387	569	607	11,543,000	13,398,000	1,855,000	5,392,000	6,624,000	1,232,000	16,935,000	20,022,000	3,087,000	Iowa
Missouri	20	676	829	1,396	2,240	860	284	54	38	183	211	210		10	10	13	13					740	877	2,662	2,748	46,006,300	53,479,600	7,473,300	55,168,000	63,555,000	8,387,000	101,174,300	117,034,600	15,860,300	Missouri
TOTAL	278	6,952	7,781	11,915	15,163	5,669	4,722	155	127	920	991	910		53	52	86	62	20	12	151	102	7,180	7,972	19,651	21,040	383,266,255	449,278,905	66,012,650	271,994,950	344,102,750	72,107,800	655,261,205	793,381,655	138,120,450	TOTAL
Southern States.																																			**Southern States**
North Carolina	8	45	45	82	82	14	14							2	2	3	3	2	2		2	49	49	99	101	1,116,000	1,465,600	349,600	666,500	1,075,000	408,500	1,782,500	2,540,600	758,100	North Carolina
South Carolina	5	59	69	85	102	35	30							8	3	6	6					62	72	126	138	1,962,000	2,012,000	50,000	2,950,000	3,028,000	78,000	4,912,000	5,040,000	128,000	South Carolina
Georgia	12	261	274	358	439	34	26							11	11	9	9					272	285	401	474	5,741,400	14,911,400	9,170,000	9,564,000	19,823,000	10,259,000	15,305,400	34,734,400	19,429,000	Georgia
Florida	7	52	54	55	55	12	12							5	6	4	4	9	9	20	18	66	69	91	89	1,131,000	1,131,000		654,300	904,300	340,000	1,785,300	2,125,300	340,000	Florida
Alabama	11	159	180	265	295	54	56							7	7	14	7	36	20	62	43	202	207	395	401	3,585,000	8,755,000	5,170,000	4,702,000	6,892,000	2,190,000	8,287,000	15,647,000	7,360,000	Alabama
Mississippi	4	21	25	31	39	8	2							9		14						30	25	53	41	506,500	685,500	179,000	518,000	630,000	112,000	1,024,500	1,315,500	291,000	Mississippi
Tennessee	13	254	257	398	392	111	110											12	17	15	21	266	274	524	523	9,625,000	9,625,000		7,765,000	7,765,000		17,390,000	17,390,000		Tennessee
Louisiana	9	197	207	514	554	52	52							9	9	14	14					206	216	580	620	10,245,100	16,095,100	5,850,000	9,604,000	12,354,000	2,750,000	19,849,100	28,449,100	8,600,000	Louisiana
Arkansas	7	44	44	94	99	32	26							8	8	11	11	25	25	9	10	77	77	146	146	1,038,800	1,170,500	131,700	1,114,800	1,159,500	44,700	2,153,600	2,330,000	176,400	Arkansas
TOTAL	76	1,092	1,155	1,882	2,057	352	328							54	46	75	54	84	73	106	94	1,230	1,274	2,415	2,533	34,950,800	55,851,100	20,900,300	37,538,600	53,720,800	16,182,200	72,489,400	109,571,900	37,082,500	TOTAL
Western States.																																			**Western States.**
South Dakota	2													11	11	8	8					11	11	8	8	100,000	100,000					100,000	100,000		South Dakota
Nebraska	7	152	152	208	306	97	95							22	22	21	21					174	174	326	422	6,377,500	6,377,500		2,410,000	2,455,000	45,000	8,787,500	8,832,500	45,000	Nebraska
Kansas	10	106	112	88	108	56	63							18	15	24	22					124	127	168	193	2,345,000	2,705,000	360,000	1,165,000	1,325,000	160,000	3,510,000	4,030,000	520,000	Kansas
Texas	19	273	310	352	436	78	65							28	17	50	28					301	327	480	529	6,176,000	8,886,000	2,710,000	5,234,000	8,475,000	3,241,000	11,410,000	17,361,000	5,951,000	Texas
Colorado	8	232	234	277	377	172	82							2	2	2	2	79	77	95	84	313	313	546	545	8,205,000	8,205,000		9,064,000	9,214,000	150,000	17,269,000	17,419,000	150,000	Colorado
Montana	4	61	61	70	71	12	17															61	61	82	88	2,120,000	2,120,000		1,381,500	1,546,500	165,000	3,501,500	3,666,500	165,000	Montana
Idaho	1	4	4	2	2																	4	4	2	2	54,000	54,000					54,000	54,000		Idaho
Utah	3	97	97	101	101	26	26											8	8	2	2	105	105	129	129	1,606,000	3,400,000	1,794,000	1,190,000	1,263,000	73,000	2,796,000	4,663,000	1,867,000	Utah
Washington	11	191	199	230	200	47	143	22	26	62	61	15									15	213	225	354	419	11,550,000	11,815,000	265,000	7,435,000	7,960,000	525,000	18,985,000	19,775,000	790,000	Washington
Oregon	8	128	138	175	214	46	36	2	2	16	16	6	36		3		2	14	6	30	9	144	149	273	313	2,718,300	3,067,000	348,700	2,525,000	5,173,000	2,648,000	5,243,300	8,240,000	2,996,700	Oregon
California	35	652	969	900	1,047	172	199	97	86	588	539	40		51	39	143	140	27	27	79	71	827	1,121	1,922	1,996	46,483,690	68,385,190	21,901,500	25,652,000	46,414,000	20,762,000	72,135,690	114,799,190	42,663,500	California
Arizona	2		11		10		7								3		4						14		21		75,000	75,000		25,000	25,000		100,000	100,000	Arizona
TOTAL	110	1,896	2,287	2,403	2,872	708	733	121	114	666	616	61	36	132	112	248	227	128	118	206	181	2,277	2,631	4,290	4,665	87,735,490	115,189,690	27,454,200	56,056,500	83,850,500	27,794,000	143,791,990	199,040,190	55,248,200	TOTAL
United States	1,062	19,314	22,063	43,630	52,151	11,445	10,440	330	241	2,346	1,607	1,171	36	370	332	1,556	1,411	428	400	2,761	3,132	20,442	23,036	62,918	68,777	1,066,196,460	1,324,072,053	257,875,593	866,868,673	1,086,598,082	219,729,409	1,933,065,133	2,410,670,135	477,005,002	**United States**
Canada	41	737	755	1,717	1,902	420	355											32	30	92	73	769	794	2,220	2,330	26,119,255	26,848,100	728,845	13,078,538	15,088,538	2,010,000	39,197,793	41,936,638	2,738,845	**Canada**

NOTATIONS.—*a* includes 178 miles of elevated track, 68 in Brooklyn and 110 in Manhattan and the Bronx. *b* includes 120 miles of elevated track in Chicago. * Indicates decrease.

one of them, where the highest possible speed and very heavy service is demanded and justified by the traffic, will have a stretch of 15 miles of almost perfectly level double track free from turnouts and switches which require slowing down, will be laid with 90-lb. rail and have sub-stations of 1000 kw rated and 2000 kw momentary capacity located at an average of 9 7 miles apart. The General Electric Company is now making arrangements through the kindness of the owners to conduct a series of exhaustive tests on this road at the highest speeds within the capacity of track and equipment and under various conditions of shape of cars, number of cars forming a train, etc. It may be several months before these tests can be made and published, and if other engineers in the meantime have an opportunity to add in any way to our present information the data will be gratefully received.

Special Tests vs. Commercial Practice

CHICAGO, May 19, 1902.

EDITORS STREET RAILWAY JOURNAL:

Regarding the discussion started in the May 3 issue of the STREET RAILWAY JOURNAL on the figures on train resistance given by W. J. Davis, Jr., I am reminded of a story which is told of a distinguished American inventor who has a well-developed sense of humor along with an ability to go at all problems in the easiest and most practical way. This inventor, so the story goes, had in his employ some expert mathematicians noted more for their ability to juggle with equations than for their practical ideas. The inventor rushed in upon these gentlemen one morning with a vessel of very peculiar and irregular shape and asked to know the cubic contents. The mathematicians set to work with caliper and pencil, and along toward night, after a day of strenuous labor, they were able to triumphantly announce the result. "Yes, that's correct," said the distinguished inventor. The calculators were somewhat astounded at the assurance with which the inventor spoke and were beginning to wonder if their employer had been brushing up on higher mathematics and lightning calculation on the quiet, when one of their number, in an awed voice, asked how he had obtained his result single handed so quickly. "Oh, that's easy," he replied; "I filled the thing with water and then measured the water in a graduated tube."

Now, after reading the mathematical discussions on train resistance which appeared in connection with Mr. Davis' article, I could not help thinking along the line suggested by Mr. Dodd that the best way to determine train resistance of electric motor cars is to make use of the numerous figures on power consumption obtainable in every-day service from high-speed interurban cars before going through further mathematical gymnastics in regard to the matter. Enough high-speed runs have been made by electric cars in the neighborhood of 60 miles per hour, so that there ought to be no great alarm lest the train resistance with electric traction soon reach a prohibitive figure. Indeed, some of us have a strong suspicion that if the results given by Mr. Davis as obtained by the coasting method were checked with the readings of an ammeter and voltmeter on the same locomotive, taken just before current was cut off, there would be a great discrepancy. We have on an electric car such easy means of obtaining, within a fair range of commercial accuracy, the power required to propel a car at different speeds that it would seem that the best evidence to introduce in a case of this kind would be from the car tests of numerous roads now operating at high speed. It is safe to say that if electric car resistance had been found to be abnormally large on our present roads operating at 50 miles per hour to 60 miles per hour a halt would have been called on higher speeds before this. As one of the figures which has been obtained in practice (and which I believe corresponds fairly well with results elsewhere) the test on the Lake Electric Railway, published on page 611 of the May 17 issue, is worth considering. Here a car weighing, loaded, 36 tons made 4.84 miles on level track in 4 min., 10 sec., taking 12 kw-hours, 2480 watt-hours per car mile, 69 watt-hours per ton mile. Of course, special tests are to be considered as of more weight than any single common commercial measurements, but when special tests do not agree with the general average results of commercial tests there is at least good reason for inquiring further into the possible errors in the special tests. As intimated in your editorial, there are chances for error in the coasting method, which leave the results obtained by Mr. Davis open to question, and this is especially true since they do not seem to agree with power consumption figures obtained in practice.

C. R. JAMES.

Mileage, Car and Capitalization of Street Railway Companies in the United States and Canada in 1901

The accompanying table of street railway mileage, cars and capitalization in the United States and Canada for 1901 has been compiled from the 1902 edition of "American Street Railway Investments." An examination of the table shows that the total mileage of track in the United States has been increased during the year 2594 miles, making a total for 1901 of 23,036 miles. The increase in capital liabilities is $477,605,002. Each geographical division of the country shows an increase for the year both in mileage and in capital liabilities. The New England States added 482 miles, an increase of 18.59 per cent, with an increased capitalization of $30,237,108, or 6.33 per cent. The increase in the mileage of the Eastern States and in the capital liabilities is larger in volume, as well as in proportion, than that of any other section. The extensions amounted to 922 miles, which was 35.54 per cent, while the increase of capitalization amounted to $216,916,744, or 45.41 per cent. The Central States rank next, with an increase of 792 miles, an equivalent of 30.53 per cent. The capitalization was raised by $138,120,450, or 28.92 per cent. The Western States increased their mileage 354, which was an addition of 13.64 per cent, and their capital liabilities $55,248,200, which was 11.57 per cent. In the Southern States, the increase was only 44 miles and 1.70 per cent, but the capitalization was increased $37,082,500, which was equivalent to 7.77 per cent. The Canadian systems added 18 miles during the year and increased their capitalization $2,738,845.

The year covered by these statistics witnessed the last of the cable lines in New York City changed into the conduit trolley system, thus completing the abandonment of the old cable system of 56 miles throughout the city and the substitution therefor of a modern electric equipment. Although the mileage of the New York elevated railways is still counted in the miscellaneous, or steam group, a large portion of the system is now operated electrically. On the Second Avenue line the steam locomotives have been discarded entirely, and on Third Avenue more than 50 per cent of the traffic is handled by the electric system. It is expected that the transformation of the entire elevated railway system of New York will be completed within the present year, thus making the largest third-rail multiple-unit electric railway system in the world. The official opening of the elevated system of Boston, which is operated by electricity, was the most important event in New England during the year.

Results of Tests for Air Resistance on the Berlin-Zossen Experimental High Speed Line

The great interest which has been growing for all experiments on high-speed electric railroading for the last decade has become largely concentrated upon the trials during the tests made in Germany last fall. While a great many experiments have been made in high-speed working, there has never been anything undertaken of so thorough a nature as the work of the so-called Studien Gesellschaft für Schnellbahnen, which was organized at Berlin on Oct. 10, 1899. This company, as already mentioned in these pages, is composed of representatives of a number of the leading German technical societies and electrical manufacturing companies, and is backed by royal favor and large financial interests. The right to secure the use of the military road between Marienfelde and Zossen, near Berlin, for experiments, and the necessary capital of some $180,000 being appropriated, two cars were built by two of the leading continental manufacturers and the tests were attempted. While the rolling stock operated with perfect satisfaction in every way, it was found that at a speed above 100 miles an hour the track construction became the limiting feature, and the experiments had to be abandoned until heavier rails and better ballast had been substituted for the present line.

The results of these experiments, as far as carried out, have been carefully kept from the public, and but little is known of the actual data which was obtained. The paucity of knowledge on actual train resistance, particularly that due to the air, make this data of exceptional interest, and through the courtesy of the engineers the accompanying curves are published for the first time, showing the relation between air pressure and speed. It was originally intended to obtain speeds of 200 km (125 miles) per hour or over, but up to the speeds actually obtained the curves show that the wind pressure does not vary as the linear function of the speed, but as approximately the square of the speed. Whether this relation will obtain at higher speeds will remain for subsequent tests to determine.

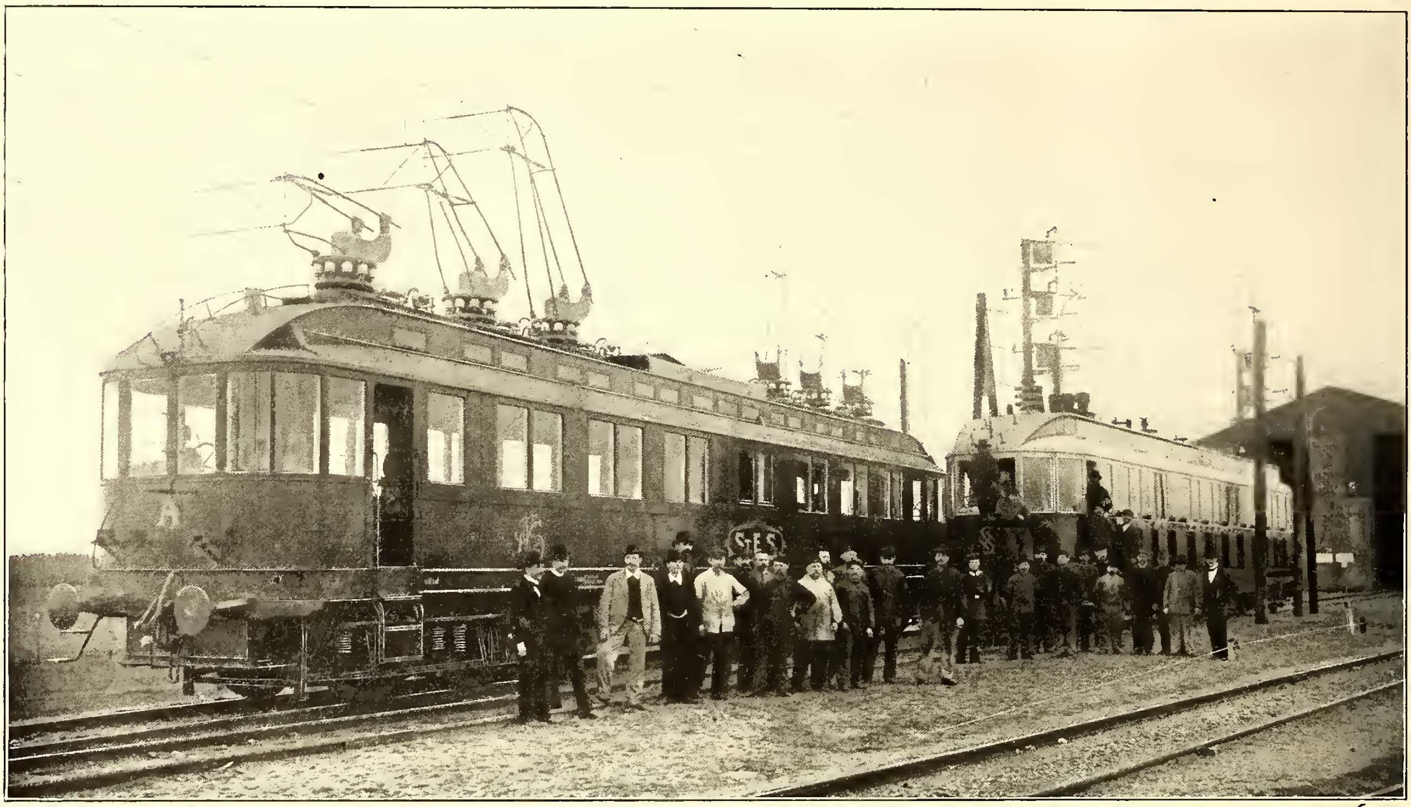


FIG. 1.—THE EXPERIMENTAL CARS USED IN BERLIN-ZOSSEN EXPERIMENTS

The cars have a seating capacity of fifty persons, and, according to the conditions of the test, were to be no larger in width and height than the standard Prussian State Railway car. The trucks are of normal gage, with three axles, each able to support a maximum load of 16 tons per axle, inclusive of the passenger load. Three-phase current was used, with 10,000 volts to 12,000 volts on the line. This current was transformed on the cars by static transformers and supplied to the motors, which were directly on the axles, no reduction gearing being employed. One of the two cars used was supplied by the Siemens & Halske Aktien Gesellschaft and the other by the Allgemeine Electricitäts Gesellschaft.

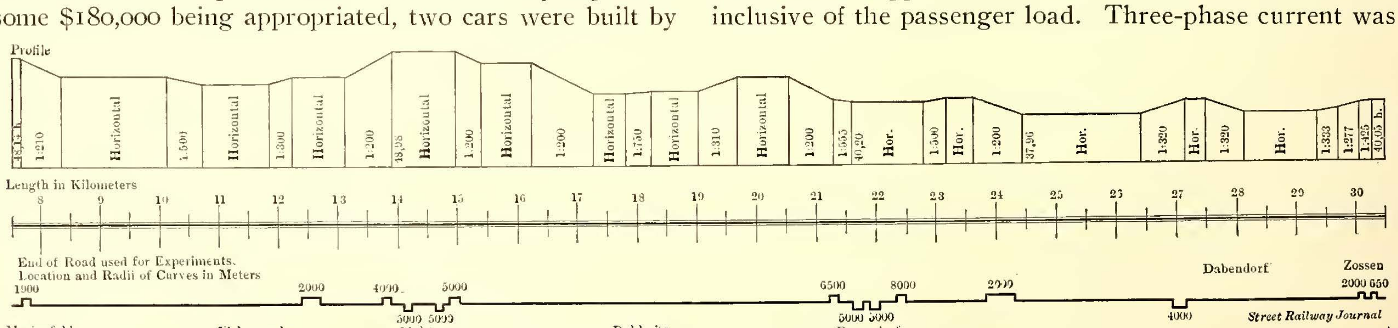


FIG. 2.—PLAN AND PROFILE OF BERLIN-ZOSSEN EXPERIMENTAL LINE

The military road extending from Marienfelde, a suburb a few miles to the south of Berlin, to Zossen, which was put at the disposal of the society for this purpose by the government, is 23 km (14.3 miles) long and runs almost directly south from Marienfelde. It is level and has only a few curves, as will be seen from the plan and profile in Fig. 2. The road is not used for passenger traffic, so that

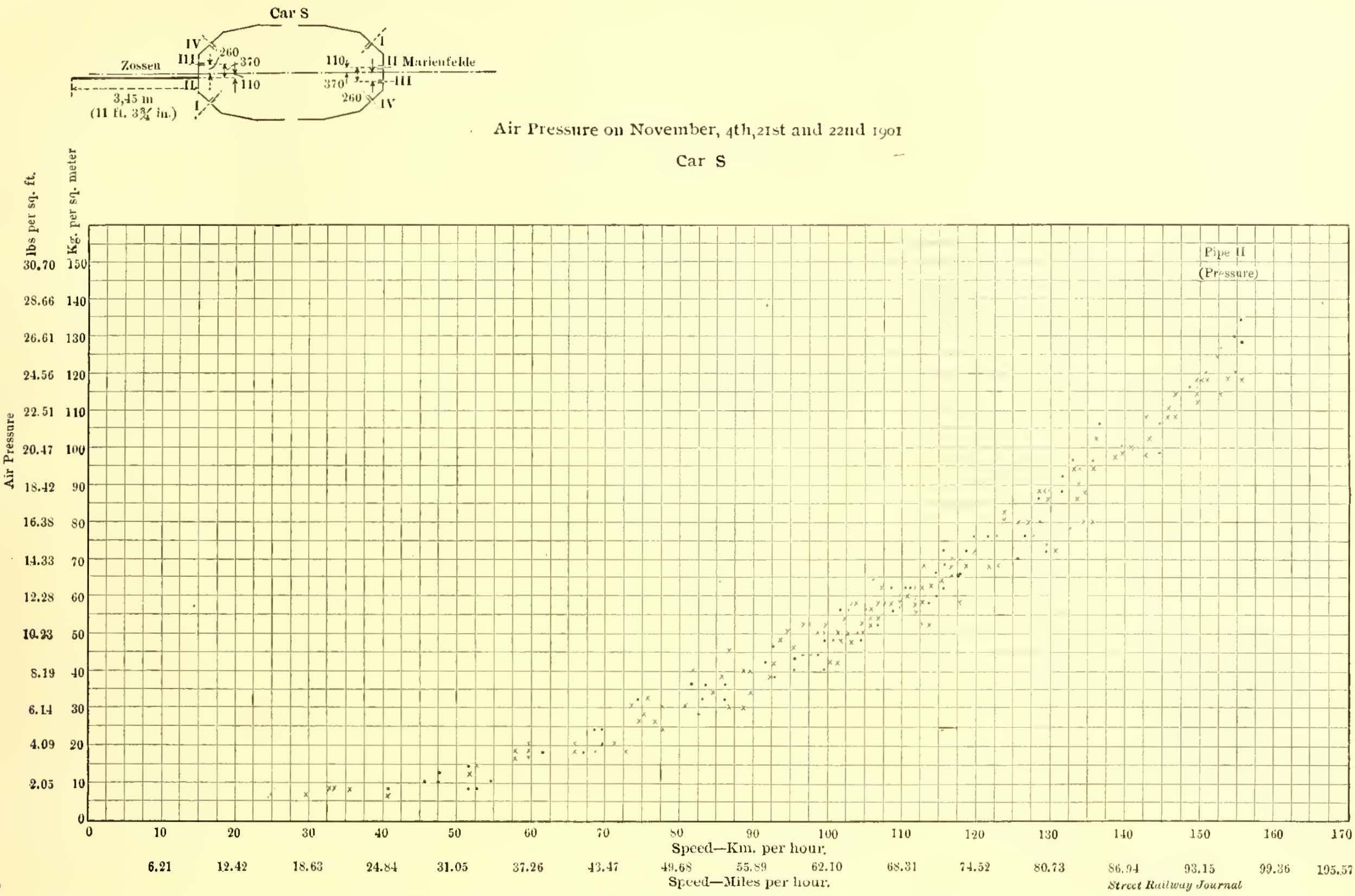


FIG. 3 —WIND RESISTANCE TESTS ON THE BERLIN-ZOSSEN LINE

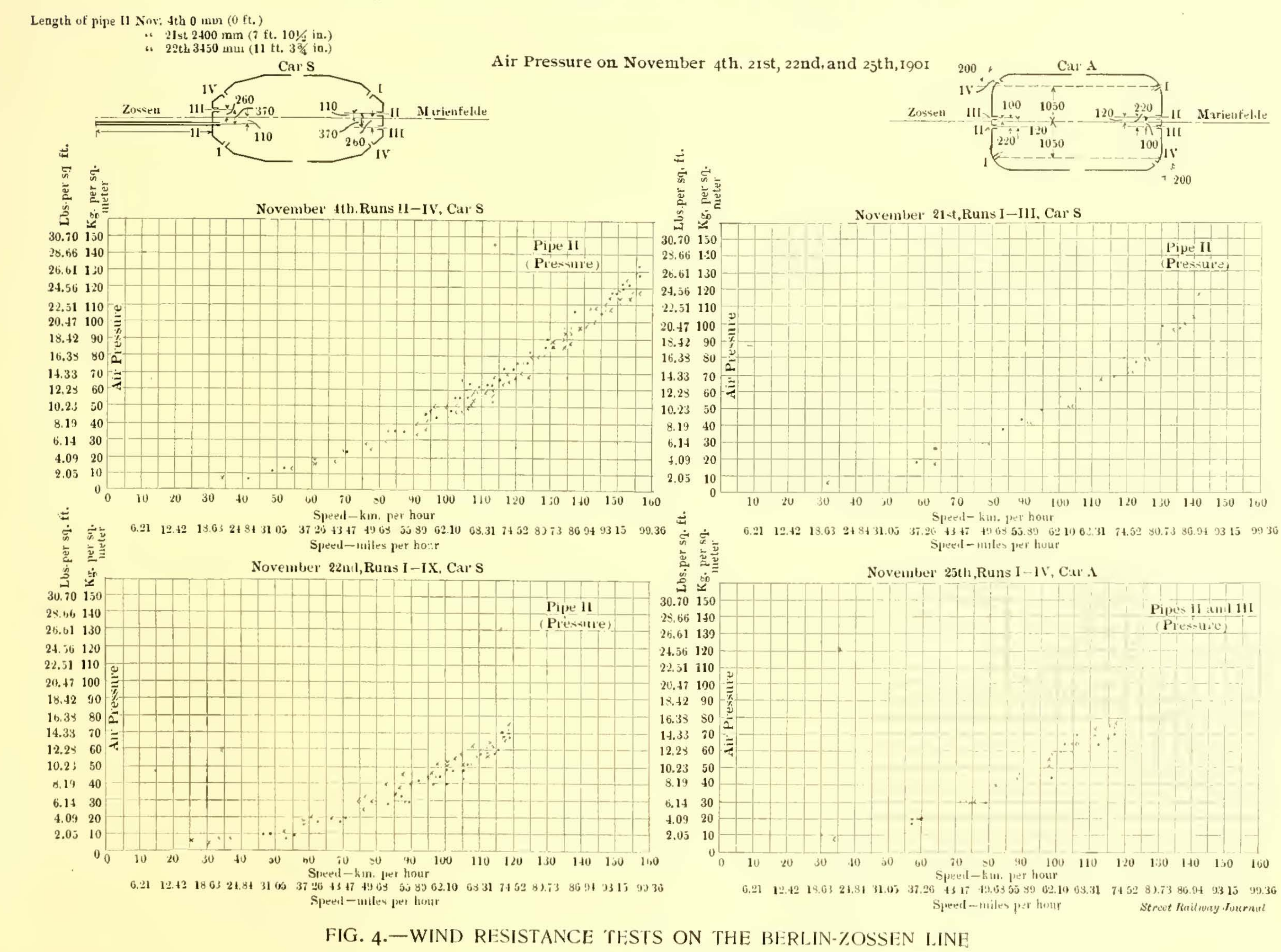


FIG. 4.—WIND RESISTANCE TESTS ON THE BERLIN-ZOSSEN LINE

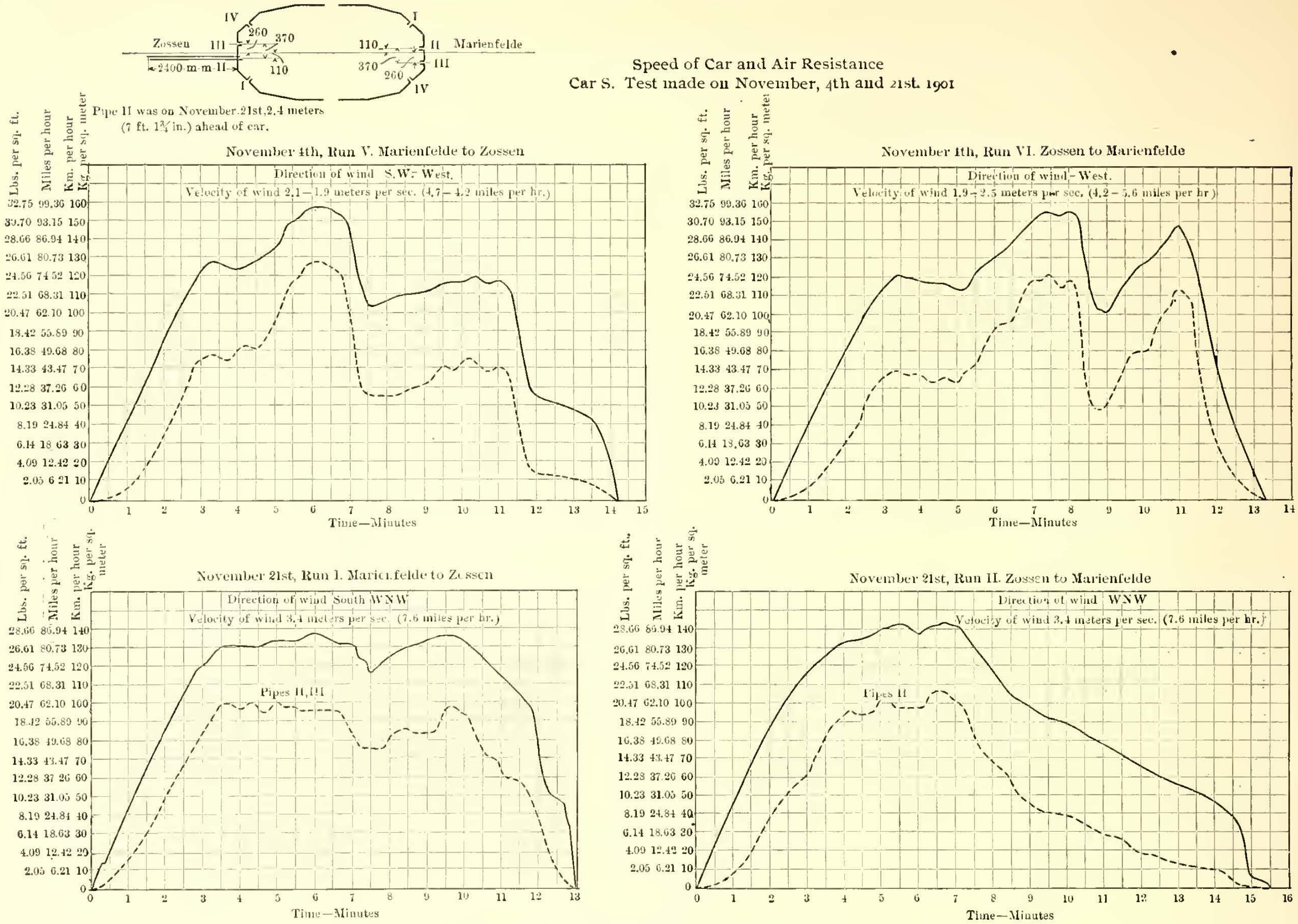


FIG. 5.—WIND RESISTANCE TESTS ON THE BERLIN-ZOSSEN LINE

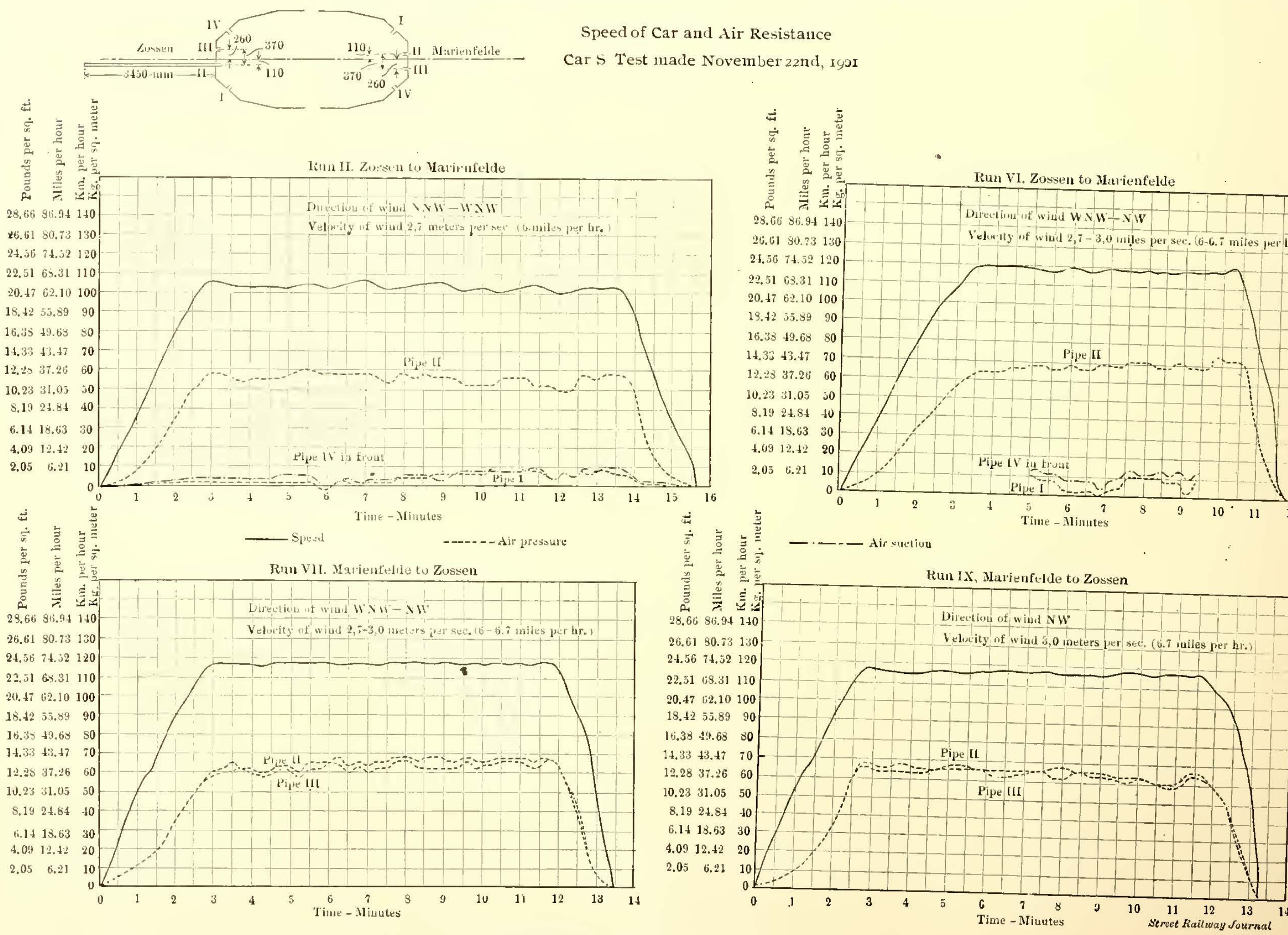


FIG. 6.—WIND RESISTANCE TESTS ON THE BERLIN-ZOSSEN LINE

the tests could be carried on without interference from other trains. The track, which after two or three months' tests was found to be too light to stand the strain of cars running at the speed proposed, is now being strengthened. At 60 km (37 miles) to 80 km (50 miles) per hour very little trouble was experienced with the track, but at 100 km (62 miles) to 120 km (74 miles) per hour the cars oscillated badly.

The original track construction consisted of rails weighing 32 kg per meter (64 lbs. per yard), partly on metal but for the most part on wooden ties laid in sand. It is interesting to note that the section using metal ties, which was near the station, proved entirely too rigid, and wooden ties will be used exclusively in the new work. The new rails will weigh 42 kg per meter (84 lbs. per yard) and will have a head 70 mm (2.75 ins.) broad, with an 18-mm (.7 in.) web and a height of 150 mm (5.9 ins.). They will be laid on oak ties, of which there will be eighteen to a rail length of 15 m, and the road will be ballasted to a depth of about 200 mm (7.9 ins.). The angle-plates will be 600 mm (23.6 ins.) in length and will have six bolts each. Tie-plates will be used under the rails. The cars used in the test differed somewhat from each other, the main points of difference being in the shape of the ends, which in the Siemens & Halske car were somewhat pointed, while the ends of the Allgemeine Electricitäts Gesellschaft car were flat with rounded corners. The current-collectors also differed in form. Those in the Allgemeine Electricitäts Gesellschaft car were on separate frames, three at each end, while the Siemens & Halske car had a single upright standard at each end to carry the sliding contact. These points of difference are well shown in the accompanying engraving, which is from a hitherto unpublished photograph.

The Allgemeine Electricitäts Gesellschaft car was designated as "Car A" and the Siemens & Halske car as "Car S." The equipment of Car A consisted of four motors having a normal output of 250 hp with 750 hp maximum, or a total normal output of 1000 hp and 3000 hp maximum for the car. These motors were carried on a hollow sleeve around the axle, which was attached to the wheels by a set of springs on each side. The motors were mounted on the outside axles of the six-wheel trucks. A single controller was used, placed in the center of the car and attached mechanically to the operating controllers at each end of the car, one of the requirements of the test being that the car should be operated from either end. Static transformers were placed under the car, and for starting and regulating liquid rheostats were employed. The equipment of Car S consisted of four motors, likewise placed on the outside axles of the trucks, with a normal output of 250 hp when running at full speed and a maximum of 750 hp at starting. The transformers were placed under the car. The resistances were made of sheet metal and placed along the side of the car body between the windows and the side sills. They were contained in boxes constructed from angle iron, which was bolted to the car girders. One main controller was used in the center of the car, operated by compressed air from the motorman's controllers, which were placed in each cab at the ends of the car. The voltage used upon the motors on Car A was 435 volts and that on Car S was 1150 volts.

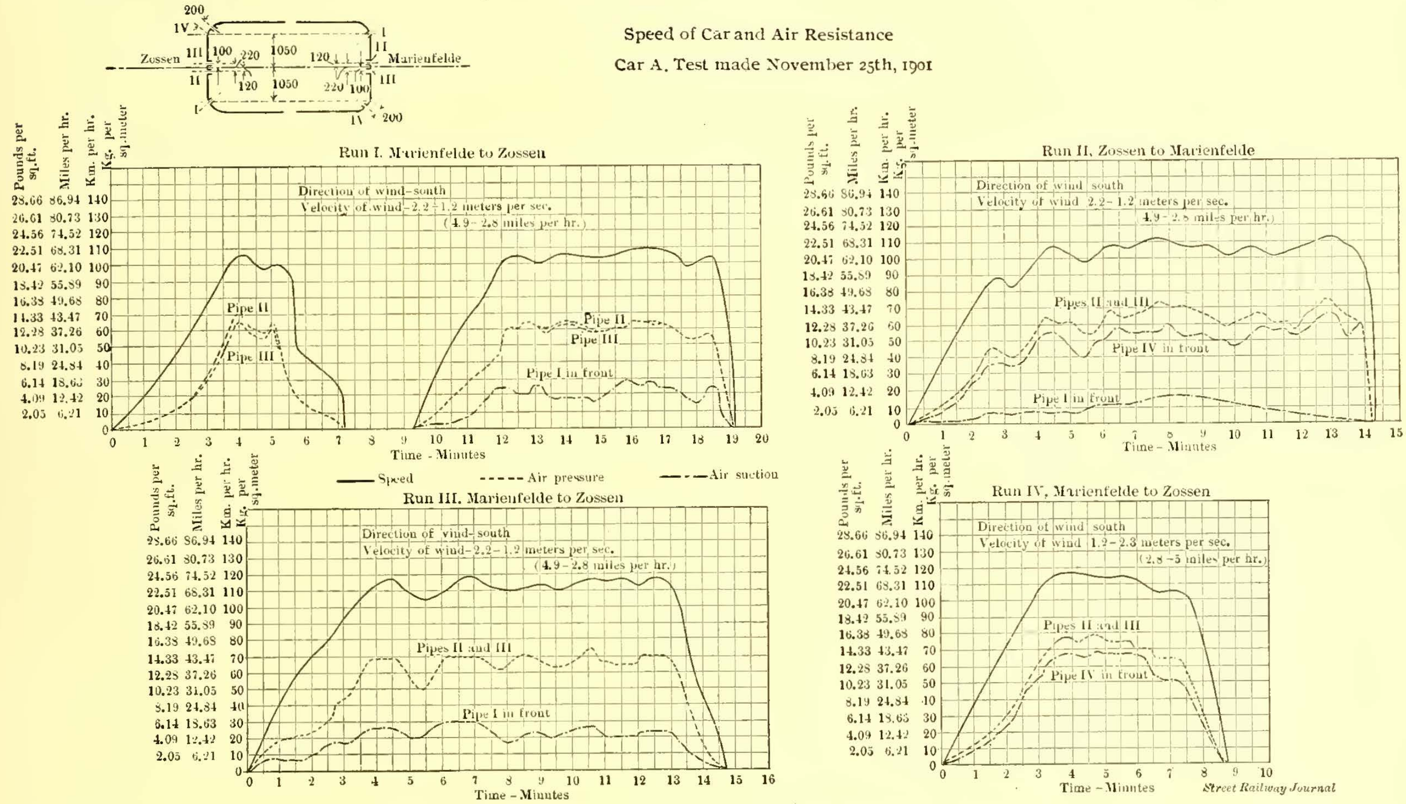


FIG. 7 —WIND RESISTANCE TESTS ON THE BERLIN-ZOSSEN LINE

As soon as the track is strengthened, which will be in the late summer, the tests will be resumed. In the meantime the data secured from the tests already made are being collated by the Studien Gesellschaft, whose report is soon to be made public. It is therefore only through the courtesy of the officers of the company that some of the most important results concerning air resistance derived from the tests can here be presented.

An ingenious method was adopted for measuring this pressure. Pipes of different diameters and at different angles were passed through the ends of the cars and were led to pressure gages whose readings were recorded at different speeds. These readings, reduced to a basis of kilograms per square meter and pounds per square foot, are plotted on the charts herewith. One pipe (Pipe II.) was arranged so that it could be extended to various distances in front of the car, as indicated in the charts, which also show the location and diameter of all the pipes. The final chart indicated herewith as Fig. 3, shows that the resistance is a function of V^2.

Figures on the total train resistance are not yet available, but will be published in an early issue of this paper. It might be said, however, that the total motor output required by the 90 ton to 92 ton cars was from 840 hp to 950 hp for speeds varying from 145 km to 160 km (90 miles to 106 miles) per hour, indicating a total coefficient at these higher speeds of about 25 kg to 26 kg per metric ton (50 lbs. to 52 lbs. per ton of 2000 lbs.), At 18 km to 20 km (11.2 miles to 12.4 miles) per hour the traction coefficient was about 4 kg to 5 kg per metric ton (8 lbs. to 10 lbs. per ton of 2000 lbs.). It might also be added that when running at 120 km (74.6 miles) per hour, if the current was shut off, the car coasted from station 13 to station 22.5 (see plan), or 9.5 km (5.9 miles). This, however, was with the current-collectors on the wire, which amounted to about 1 kg (2 lbs.) per ton, so that the rail resistance was 3 kg to 4 kg (6 lbs. to 8 lbs.) per ton.

Comparisons of Gross Receipts for 1900 and 1901

The accompanying tables, which have been carefully compiled from statistics presented in the American Street Railway Investments for 1902 (just published), give the gross receipts of 246 railway companies, arranged in five groups. The first group contains thirty-five properties, each having received in 1901 gross receipts amounting to $1,000,000 or over; second, seventeen properties, showing gross receipts of between $1,000,000 and $500,000; third, sixty-nine properties, between $500,000 and $100,000; fourth, sixty-three properties, between $100,000 and $50,000, and fifth, sixty-two properties, between $50,000 and $25,000. The average rate of increase of the receipts in 1901 over 1900 is, in the first group, 8.3 per cent; in the second group, 14.4 per cent; in the third group, 12.6 per cent; in the fourth group, 13.4 per cent, and in the fifth group, 19.1 per cent. The general average increase for 1901 over 1900 for the 246 companies compared is 9.3 per cent.

The prosperous condition of the country during the year has been reflected in the earnings of the street railway companies, as well as in the number of extensions to existing properties and new roads which have been built. Many of the latter have been of the interurban type, and with the introduction of polyphase apparatus longer roads have been built and projected than ever before. On many of these, particularly in the Middle West, high speeds are being secured, and some are employing the third-rail system of traction on the sections built on private right of way.

Some particularly interesting developments, which are noted in this review and are emphasized in these tables, may be mentioned in passing. The modern tendency toward consolidation has been exemplified in the city of Atlanta, where two companies, which for some years have been active rivals for the transportation and lighting business of the city, have been united.

The principal event in Boston was the official opening of the elevated railway system, which is operated by electricity. The success of the subway has become so marked that another subway is under construction to East Boston, and plans are under consideration for materially improving the rapid-transit system of the city by the construction of additional subway routes. The consolidations of the sub-companies of the Massachusetts Electric Companies have resulted in the practical absorption of all the interurban and city lines controlled by these companies into two main companies. Many of the lines to the west of Boston which have not been included in the scheme of the Massachusetts Electric Companies, whose operations have been confined mostly to the territory north and south of the city, have been united under the title of the Boston Suburban Electric Companies, the form of whose organization is very similar to that of the Massachusetts Electric Companies.

The traffic returns of the street railway system of Buffalo and Niagara Falls are larger than usual, owing to the influence of the Pan-American Exposition, which was held in that city during the year. The improvements made in track construction and power requirements by the International Traction Company previous to the fair will remain adequate for the requirements of the company for some time.

The claim of the city that several important franchises in Chicago expire within a few years has been steadfastly opposed by the street railway companies. Just outside of Chicago, work is being completed on one of the most ambitious schemes of high-speed electric railroading which has yet been attempted. This is to connect the city of Aurora, Ill., by way of Elgin. The line has been constructed especially to attain high speed.

Two important events connected with the street railway interests of Cleveland are the extension in every direction of the interurban systems centering in Cleveland, and including the completion of a through electric line under one management as far as Port Huron, Mich., and the embarrassment, announced early in 1902, of the Everett-Moore Syndicate, which had taken a prominent part in the development of interurban railways, including the establishment of the line already mentioned. The report of the financial trouble was at first construed as having been brought about through the failure of its electric railway enterprises, but the reports of the Bankers' Committee, which has had the finances of the syndicate in charge, indicate that, so far as the electric railway properties were concerned, the results were profitable.

Detroit, like Cleveland, has for several years been an important interurban railway center, and the extensions and new roads which have been built in Southern Michigan during the last year have directed particular attention to the city and its interurban railway enterprises. Several of the latest electric roads which have been built in the western part of the lower peninsula have been equipped with the third rail and are representatives of the latest development in high-speed electric railroading. These roads have been extended now so as practically to cross the State, a distance of about 200 miles.

The city of Pittsburgh exhibits another striking example of the modern tendency in street railway operation to unite in the hands of a single company all of the street railway lines. This has been done under the name of the Philadelphia Company, which now controls all the lines of both the United Traction Company and the Consolidated Traction Company, as well as of several lighting, gas and other public service corporations.

The United Railways of San Francisco during the last year secured possession of the San Francisco & San Mateo Railway, the Sutro Railway and the Sutter Street Railway, and early in 1902 of the Market Street Railway, of San Francisco, thus coming into possession of most of the transportation systems of the city. San Francisco was one of the last of the cities of first importance in the country in which the transportation system was divided among several owners, but by the new consolidation, which has been carried out with Eastern capital, has now followed the lead established in Eastern communities.

It will be seen, therefore, that the year has witnessed many important changes in the large street railway properties, along with the expansion in the volume of business.

COMPANIES HAVING GROSS RECEIPTS FOR 1901 OF OVER $1,000,000.

NAME OF COMPANY.	1900.	1901.
Metropolitan Street Ry. Co., New York	$14,437,134	$14,720,767
Union Traction Co., Philadelphia, Pa.	13,249,819	13,431,680
Brooklyn Rapid Transit Co. (all controlled companies), Brooklyn, N. Y.	11,768,550	12,135,559
Boston Elevated Ry. Co., Boston, Mass.	10,236,994	10,869,495
Manhattan Ry. Co., New York	9,969,900	10,253,271
Chicago Union Traction Co., Chicago, Ill.	8,345,748	8,158,810
Chicago City R. R. Co., Chicago, Ill.	5,543,179	5,900,271
St. Louis Transit Co., St. Louis, Mo.	5,469,207	5,783,912
Massachusetts Electric Companies (all controlled companies), Boston, Mass.	5,518,837	5,778,133
United Ry. & Electric Co., Baltimore, Md.	4,304,933	4,718,295
North Jersey Street Ry. Co., Jersey City, N. J.	3,992,067	4,172,647
Consolidated Traction Co., Pittsburg, Pa.	2,737,938	3,279,189
International Ry. Co., Buffalo, N. Y.	2,621,375	3,202,202
Twin City Rapid Transit Co., Minneapolis, Minn.	2,839,355	3,173,976
Detroit United Ry., Detroit, Mich.	2,589,836	2,942,238
Boston & Northern St. Ry. Co., Boston, Mass.	1,945,415	2,758,702
Providence-Pawtucket-Rhode Island Suburban Ry. Co., Providence, R. I.	2,382,258	2,702,383
Third Ave. R. R. Co., New York	2,155,461	2,655,725
Milwaukee Electric Ry. & Light Co., Milwaukee, Wis.	2,220,698	2,442,342
Cleveland Electric Ry. Co., Cleveland, O.	2,061,505	2,296,898
United Traction Co., Pittsburg, Pa.	1,816,686	1,958,115
Old Colony Street Ry. Co., Brockton, Mass.	618,705	1,932,097
Montreal Street Ry. Co., Montreal, Que.	1,769,905	1,900,680
Jersey City, Hoboken & Paterson Ry. Co., Hoboken, N. J.	1,803,287	1,859,931
Metropolitan West Side Elevated Ry. Co., Chicago, Ill.	1,628,737	1,753,313
Toronto Ry. Co., Toronto, Ont.	1,501,001	1,661,108
Louisville Ry. Co., Louisville, Ky.	1,520,514	1,617,059
Denver City Tramway Co., Denver, Col.	1,302,290	1,507,293
Coney Island & Brooklyn R.R. Co., Brooklyn, N. Y.	1,393,732	1,471,268
South Side Elevated R. R. Co., Chicago, Ill.	1,286,636	1,362,231
United Traction Co., Albany, N. Y.	1,318,902	1,340,208
Toledo Railways & Light Co., Toledo, O.	1,125,187	1,311,084
Capital Traction Co., Washington, D. C.	1,124,434	1,251,360
Worcester Consolidated Street Ry. Co., Worcester, Mass.	710,023	1,031,235
Rochester Ry. Co., Rochester, N. Y.	936,341	1,000,259
Total... { 29 companies in 1900 / 35 companies in 1901 }	$133,246,589	$144,333,736

COMPANIES HAVING GROSS RECEIPTS FOR 1901 BETWEEN $1,000,000 AND $500,000.

NAME OF COMPANY.	1900.	1901.
Union Ry. Co. of New York City, N. Y.	787,170	919,131
American Railways Co., Philadelphia, Pa.	603,606	844,297
Cincinnati, Newport & Covington Ry. Co., Cincinnati, O.	783,588	819,206
Lake Street Elevated R. R. Co., Chicago, Ill.	757,955	786,462
New Orleans & Carrollton R. R. Co., New Orleans, La.	708,575	762,718
Springfield St. Ry. Co., Springfield, Mass.	686,050	753,810
Union Traction Co. of Indiana, Anderson, Ind.	447,616	752,524
Hartford Street Ry. Co., Hartford, Conn.	682,936	745,173
Forty-Second Street, Manhattanville & St. Nicholas Ave. Ry. Co. New York City, N.Y.	519,424	701,177
Pittsburg & Birmingham Traction Co., Pittsburg, Pa.	632,455	661,927
Fair Haven & Westville R.R. Co., New Haven, Conn.	591,801	644,528
United Power & Transportation Co., Philadelphia, Pa.	594,625	632,475
Syracuse Rapid Transit Ry.Co., Syracuse, N.Y.	552,403	621,299
Northern Ohio Traction Co., Akron, O.	425,886	617,011
Scranton Ry. Co., Scranton, Pa.	589,342	614,022
Dry Dock, East Broadway & Battery R. R. Co., New York City	638,943	588,540
Washington Water Power Co., Spokane, Wash.	503,906	556,998
Total, 17 companies	$10,506,281	$12,021,298

COMPANIES HAVING GROSS RECEIPTS FOR 1901 BETWEEN $500,000 AND $100,000.

NAME OF COMPANY.	1900.	1901.
New York & Queens County Ry. Co., Long Island City, N. Y.	$468,447	$494,301
West End Traction Co., Pittsburg, Pa.	394,661	493,865
Central Crosstown R. R. Co., New York City.	619,213	482,471
Portland R. R. Co., Portland, Me.	413,512	477,598
Sacramento Electric, Gas & Ry. Co., Sacramento, Cal.	376,970	419,781
Camden & Suburban Ry. Co., Camden, N. J.	347,948	411,002
Thirty-Fourth Street Crosstown Ry. Co., New York City, N. Y.	342,711	397,949
Harrisburg Traction Co., Harrisburg, Pa.	343,508	393,771
Monongahela Street Ry. Co., Pittsburg, Pa.	285,094	356,293
Fonda, Johnstown & Gloversville R. R. Co. Gloversville, N. Y.	318,940	344,927
Trenton Street Ry. Co., Trenton, N. J.	314,651	337,217
Ottawa Electric Ry. Co., Ottawa, Ont.	315,022	313,171
Holyoke Street Ry. Co., Holyoke, Mass.	262,487	303,666
Chester Traction Co., Chester, Pa.	297,132	295,915
Winchester Avenue R. R. Co., New Haven, Conn.	278,891	288,791
Utica Belt Line Street R. R. Co., Utica, N. Y.	245,183	281,224
Union Street Ry. Co., New Bedford, Mass.	249,640	272,895
Conestoga Traction Co., Lancaster, Pa.	241,583	270,533
Halifax Electric Tramway Co., Ltd., Halifax, N. S.	232,766	251,644
Cleveland, Elyria & Western Ry. Co., Cleveland, O.	179,697	249,260
Elizabeth, Plainfield & Central New Jersey Ry. Co., Elizabeth, N. J.	201,123	236,082
Lewiston, Brunswick & Bath Street Ry. Co., Lewiston, Me.	222,364	221,532
Atlantic Coast Electric R. R. Co., Asbury Park, N. J.	268,802	220,661
Richmond Traction Co., Richmond, Va.	203,057	218,569
Schenectady Ry. Co., Schenectady, N. Y.	110,382	215,962
Staten Island Electric R.R. Co., Staten Island, N. Y.	204,049	214,063
Newport & Fall River Street Ry. Co., Newport, R. I.	128,654	213,129
Manchester Street Ry. Co., Manchester, N. H.	173,004	212,138
Johnstown Passenger Ry.Co., Johnstown, Pa.	169,784	204,286
Binghamton Ry. Co., Binghamton, N. Y.	176,210	204,079
Southwest Missouri Electric Ry. Co., Webb City, Mo.	213,865	203,630
Fitchburg & Leominster Street Ry. Co., Fitchburg, Mass.	178,644	196,544
Yonkers R. R. Co., Yonkers, N. Y.	177,394	189,503
Erie Electric Motor Co., Erie, Pa.	176,098	185,847
Westchester Electric R. R. Co., New York	163,932	185,285
Wilkinsburg & East Pittsburg Ry. Co., Braddock, Pa.	35,962	183,787
Twenty-Eighth & Twenty-Ninth Sts. Crosstown R. R. Co., New York	182,932	177,370
Interstate Consolidated Street Ry. Co., North Attleborough, Mass.	176,032	174,701
Pottsville Union Traction Co., Pottsville, Pa.	142,466	173,209
Cleveland, Painesville & Eastern R. R. Co., Cleveland, O.	141,112	164,971
Lincoln Traction Co., Lincoln, Neb.	132,996	163,634
Southern Ohio Traction Co., Hamilton, O.	140,542	154,787
Beaver Valley Traction Co., Beaver Falls, Pa.	59,469	147,992
Staten Island Midland R. R. Co., Staten Island, N. Y.	139,345	144,814
London Street Ry. Co., London, Ont.	119,109	141,846
Camden, Gloucester & Woodbury, N. J.	140,225	141,074
Roxborough, Chestnut Hill & Norristown Ry. Co., Philadelphia, Pa.	124,103	136,073
Lehigh Traction Co., Hazleton, Pa.	115,332	133,812
Northampton St. Ry.Co., Northampton, Mass.	107,243	133,429
Meriden Electric R. R. Co., Meriden, Conn.	121,939	133,154
Newton St. Ry. Co., Newton, Mass.	120,338	129,750
Alton Ry., Gas & Electric Co., Alton, Ill.	106,575	128,894
Montreal Park & Island Ry. Co., Montreal, Que.	123,722	128,678
Schuylkill Traction Co., Girardville, Pa.	98,101	128,359
Altoona & Logan Valley Electric Ry. Co., Altoona, Pa.	103,337	127,263
Hartford, Manchester & Rockville Tramway Co., Hartford, Conn.	115,271	126,811
Suburban Rapid Transit Street Ry. Co., Pittsburg, Pa.	38,249	126,577
New Castle Traction Co., New Castle, Pa.	137,493	122,180
Dartmouth & Westport Street Ry. Co., New Bedford, Mass.	104,637	119,545
Milford, Holliston & Framingham Street Ry. Co., Milford, Mass.	121,708	118,029
Haverhill & Amesbury Street Ry. Co., Haverhill, Mass.	115,660	116,396
Holmesburg Tacony & Frankford Electric Ry. Co., Philadelphia, Pa.	107,467	112,139
Fairmount Park Transportation Co., Philadelphia, Pa.	112,305	111,576
Jamestown Street Ry. Co., Jamestown, N. Y.	105,387	110,716
Exeter, Hampton & Amesbury Street Ry. Co., Exeter, N. H.	75,028	105,298
New Jersey & Hudson River Ry. & Ferry Co., Hackensack, N. J.	88,895	103,589
Consolidated Street R. R. Co., Macon, Ga.	100,379	101,190
Hoosac Valley Street Ry.Co., No. Adams, Mass.	98,511	100,803
Philadelphia & West Chester Traction Co., Philadelphia, Pa.	98,910	100,166
Total, 69 companies	$13,126,198	$14,780,196

COMPANIES HAVING GROSS RECEIPTS FOR 1900 BETWEEN $100,000 AND $50,000.

NAME OF COMPANY.	1900.	1901.
Ithaca Steeet Ry. Co., Ithaca, N. Y.	101,548	99,552
Orange County Traction Co., Newburgh, N.Y.	93,456	97,976
Woonsocket St. Ry. Co., Woonsocket, R. I.	81,382	97,692
City Passg'r Ry. Co. of Altoona, Altoona, Pa.	88,982	95,980
Citizens' Electric Street Ry. Co., Newburyport, Mass.	76,848	95,696
Norwich Street Ry. Co., Norwich, Conn.	84,442	95,378
Williamsport Passenger Ry. Co., Williamsport, Pa	88,730	93,780
Elmira Water, Light & R. R. Co., Elmira, N.Y.	75,700	92,121
Easton Trasit Co., Easton, Pa.	151,167	91,945
Parkersburg & Interurban R.R. Co., Parkersburg, W. Va.	80,983	91,472
Cleveland & Eastern Electric R. R. Co,, Cleveland O.	62,893	90,390
Rockland, Thomaston & Camden St. Ry. Co. Rockland, Me	79,845	90,193
Glens Falls, Sandy Hill & Ft. Edward St. Ry. Co., Glens Falls, N. Y.	73,707	90,007
Poughkeepsie City & Wappinger's Falls Electric Ry. Co., Poughkeepsie, N. Y.	85,003	89,163
Pittsfield Electric St. Ry. Co., Pittsfield, Mass.	79,953	87,071
Commonwealth Ave.St.Ry.Co., Newton, Mass.	79,518	85,010
Schuylkill Valley Traction Co., Norristown, Pa.	78,514	84,720
Auburn City Ry. Co., Auburn, N. Y.	76,680	84,633
Orange & Passaic Valley Ry.Co., Orange, N.J.	76,850	82,895
Niagara Gorge R. R. Co., Niagara Falls, N.Y.	61,588	82,160
Syracuse, Lakeside & Baldwinsville Ry. Syracuse, N. Y.	68,600	81,096
Delaware Co. and Philadelphia Electric Ry. Co., Philadelphia, Pa.	82,421	77,913
Portsmouth, Kittery & York Street Ry. Co. Portsmouth, N. H.	71,180	76,798
Bridgeton & Millville Traction Co., Bridgeton, N. J.	68,706	75,832
Milford, Attleboro & Woonsocket Ry. Co., Milford, Mass.	42,131	75,464
Danbury & Bethel St. Ry. Co., Danbury, Conn.	69,955	74,434
Natick & Cochituate St. Ry.Co., Natick, Mass.	68,812	72,224
Springfield & Eastern Street Ry. Co., Palmer, Mass.	39,774	72,169
Concord St. Ry. Co., Concord, N. H.	64,468	70,275
Kingston City R. R. Co., Kingston, N. Y.	66,668	70,093
South Middlesex St. Ry. Co., Natick, Mass.	63,451	69,425
Portland & Yarmouth Electric Ry. Co., Portland, Me.	55,096	69,382
Bristol & Plainville Tramway Co.(of the Conn. Ry. & Light Co.), Bristol, Conn.	65,062	69,086
La Crosse City Ry. Co., La Crosse, Wis.	61,527	68,296
Bangor Street Ry. Co., Bangor, Me.	65,171	67,155
New London St. Ry. Co., New London, Conn.	55,925	65,283
Newton & Boston St. Ry. Co., Newton, Mass.	80,667	64,912
Shamokin & Mt. Carmel Electric Ry. Co., Shamokin, Pa.	44,918	64,183
Sanford & Cape Porpoise Ry. Co., Sanford, Me.	47,013	64,094
Geneva, Waterloo, Seneca Falls & Cayuga Lake Traction Co., Geneva, N. Y.	62,117	63,912
Tarrytown, White Plains & Mamaroneck Ry. Co., White Plains, N. Y.	49,700	62,261
Warren, Brookfield & Spencer St. Ry. Co., Brookfield, Mass.	61,568	61,264
Woronoco Street Ry. Co., Westfield, Mass.	54,772	61,091
Wellesley & Boston St.Ry.Co., Newton, Mass.	59,085	60,809
Syracuse Suburban R. R. Co., Syracuse, N.Y.	62,953	60,747
West Side St. Ry. Co., Elmira, N. Y.	59,148	59,289
Marlborough St.Ry.Co., Marlborough, Mass.	54,041	59,103
Stamford St. Ry. Co., Stamford, Conn.	51,795	58,768
Burlington Traction Co., Burlington, Vt.	57,435	57,963
Worcester & Webster Street Ry. Co., Worcester, Mass.	51,581	56,563
People's Tramway Co., Putnam, Conn.	30,895	56,180
Black River Traction Co., Watertown, N. Y.	51,370	55,084
Tamaqua & Lansford Street Ry. Co., Lansford, Pa.	43,899	54,679
Amsterdam St. R. R. Co., Amsterdam, N. Y.	50,258	54,658
Gardner, Westminster & Fitchburg Street Ry. Co., Gardner, Mass.	46,723	54,137
Herkimer, Mohawk, Ilion & Frankfort Electric Ry. Co., Mohawk, N. Y.	51,202	53,727
Newtown Electric St. Ry. Co., Newtown, Pa.	36,445	53,713
Bangor, Orono & Oldtown Ry.Co., Bangor, Me.	50,587	53,656
Stillwater & Mechanicsville St. Ry. Co., Stillwater, N. Y.	52,455	53,379
Chippewa Valley Electric Ry. Co., Eau Claire, Wis.	45,408	53,077
Olean Street Ry. Co., Olean, N. Y.	48,700	52,018
Wilmington St. Ry. Co., Wilmington, N. C.	50,398	51,856
Norton & Taunton Street Ry. Co., Norton, Mass.	49,059	51,341
Total, 63 companies	$3,990,928	$4,525,223

COMPANIES HAVING GROSS RECEIPTS FOR 1900 BETWEEN $50,000 AND $25,000.

NAME OF COMPANY.	1900.	1901.
Seattle & Renton Ry. Co., Seattle, Wash.	40,965	49,601
Port Chester St. Ry. Co., Port Chester, N. Y.	31,593	49,078
Camden & Trenton Ry. Co., Camden, N. J.	12,177	48,717
Middletown-Goshen Electric Ry. Co., Middletown, N. Y.	46,831	48,707
Van Brunt St. & Erie Basin R.R.Co., Brooklyn.	50,251	48,258
Cleveland & Chagrin Falls Elec. R. R. Co., Cleveland, O.	49,646	47,976
Newark & Hackensack Traction Co., Rutherford, N. J.	27,692	47,393
Meriden, Southington & Compounce Tramway Co., Meriden, Conn.	39,055	46,617
Fulton St. R. R. Co., New York City	46,147	45,921
Chillicothe Electric R. R., Light & Power Co., Chillicothe, O.	44,301	45,900
Bradford Electric St. Ry., Co., Bradford, Pa.	37,875	45,300
Union Electric R. R. Dover, N. H.	42,347	45,235
Waterville & Fairfield Ry. & Light Co., Waterville, Me.	43,559	45,062
Greenfield & Turners Falls St. Ry. Co., Greenfield, Mass.	39,984	44,865
Allentown & Kutztown Traction Co., Allentown, Pa.	21,262	43,601
Oil City St. Ry. C., Oil City, Pa.	40,710	43,241
Torrington & Winchester Street Ry. Co., Torrington, Conn.	42,413	42,921
Biddeford & Saco R. R. Co., Biddeford, Me.	31,572	42,799
Olean, Rock City & Bradford R.R. Co., Bradford, Pa.	32,522	42,654
Washington Electric St. Ry. Co., Washington, Pa.	34,532	42,496
Warren Street Ry. Co., Warren, Pa.	30,179	41,904
Saratoga Traction Co., Saratoga, N. Y.	36,176	41,812
Augusta, Hallowell & Gardiner R. R. Co., Augusta, Me.	38,748	41,553
City Electric Ry. Co., Rome, Ga.	40,709	41,238
Rochester & Suburban Ry. Co., Rochester, N. Y.	28,142	40,705
Charleroi & West Side St. Ry. Co., Charleroi, Pa.	21,489	40,598
Athens Electric Ry. Co., Athens, Ga.	37,651	39,725
Colonial City Traction Co., Kingston, N. Y.	37,288	38,857
Middletown St. Ry. Co., Middletown, Conn.	40,421	37,590
Bennington & Hoosick Valley Ry. Co. Hoosick Falls, N. Y.	35,410	37,076
Citizens' St. Ry. Co., Fishkill, N. Y.	36,096	36,772
Framingham Union Street Ry. Co., Framingham, Mass.	35,793	36,596
Oswego Traction Co., Oswego, N. Y.	33,167	36,531
Monmouth County Electric Co., Red Bank, N. J.	37,990	36,334
Athol & Orange Street Ry. Co., Athol, Mass.	33,366	36,199
Harrisburg & Mechanicsburg Electric Street Ry. Co., Harrisburg, Pa.	30,456	35,525
Dunkirk & Fredonia R. R. Co., Fredonia, N. Y.	28,968	35,423
Springfield Electric Ry. Co., Springfield, Vt.	34,158	33,957
Phillipsburg Horse Car R. R. Co., Phillipsburg, N. J.	40,405	33,745
Lewiston & Reedsville Electric Ry. Co., Lewiston, Me.	7,765	33,725
Boone Electric St. Ry. & Light Co., Boone, Ia.	29,842	33,352
Utica & Mohawk R. R. Co., Utica, N. Y.	32,192	33,155
Farmington Street Ry. Co., Hartford, Conn.	20,156	33,099
Larchmont Horse Ry. Co., Larchmont, N. Y.	5,369	33,084
Raritan Traction Co., Perth Amboy, N. J.	16,692	32,945
Worcester & Blackstone Valley Street Ry. Co., Millbury, Mass.	18,717	32,229
Cortland & Homer Traction Co., Cortland, N.Y.	28,925	31,624
Punxsutawney Passenger Street Ry. Co., Punxsutawney, Pa.	11,536	31,561
Corning & Painted Post Street Ry. Co., Corning, N. Y.	27,758	30,803
Meadville Traction Co., Meadville, Pa.	32,353	29,576
Pottstown Passenger Ry. Co., Pottstown, Pa.	23,746	28,396
Southbridge & Sturbridge Street Ry. Co., Southbridge, Mass.	31,063	28,329
East Taunton Street Ry. Co., Taunton, Mass.	21,695	28,167
Troy & New England R. R. Co., Troy, N.Y.	26,768	27,782
Haverhill, Georgetown & Danvers Street Ry. Co., Georgetown, Mass.	26,310	27,002
Titusville Electric Traction Co., Titusville, Pa.	23,934	26,418
Cohoes City Ry. Co., Cohoes, N. Y.	28,201	26,102
Tarentum Traction Passenger Ry. Co., Tarentum, Pa.	22,591	26,058
Norfolk Western St. Ry. Co., Dedham, Mass.	23,802	25,421
Fitchburg & Suburban Street Ry. Co., Fitchburg, Mass.	22,596	25,401
Hartford & Springfield Street Ry. Co., Thompsonville, Conn.	25,226	25,206
People's Street Ry. Co., Nanticoke, Pa.	21,939	25,137
Total, 62 companies	$1,941,222	$2,313,054

Electric Traction and Standard Railways

BY E. HUBER

Up to the present two essentially different systems of electric traction have been successfully applied to standard railways of considerable length. Typical representatives of these systems are the Milano-Varese Railway (continuous current, third rail) and the Burgdorf-Thun Railway (two wires overhead, three-phase current).

One may ask, why has the success of such installations not advanced more quickly the problem of electric traction on standard railways generally, even in countries like Switzerland, where coal is expensive and water-power believed to be abundant?

It seems to me that electricians have generally solved the problem of electric traction in a way that does not appeal to the railway manager, and it may be that they have also modified this problem so as to make it look more feasible with the systems heretofore submitted to practical trial.

It has been argued in favor of electric traction that with it the heavy trains may be sub-divided into small trains or even into single car units. Now, while there are certainly sections in an extended standard railway system where a number of smaller trains would suit the public better than fewer but longer trains, the general and principal problem cannot be determined in this manner; provision must be made to handle freight trains and solid or mixed passenger trains from adjacent railways in a way that will not interfere with the latter's organization of traffic and traction even though they are operated electrically.

We are of the opinion that a system to meet the requirements and views prevailing in present railway practice must not ask the railway managements to restrict themselves or change their system of making up trains and arranging time tables. It seems to us even necessary to accept the present organization of the traffic as a basis for the development of a system of electric traction to supersede steam traction; and, what is almost as important, to supersede it gradually and to work simultaneously with steam, either on the same lines or on different lines, exchanging traffic.

The present method of handling the traffic on standard railways once accepted, the electrician is confronted with the problem of moving the trains now hauled by steam locomotives. This will cause him to abandon as the principal feature of his plan the small motor car unit and to provide for an electric locomotive which will take the trains as they actually are to-day, and handle them in the same way as the steam locomotive.

Will it now be possible to solve the problem by adopting locomotives for electric railways of the type of the Milano-Varese or the Burgdorf-Thun Railway? We think not, because it is an inherent feature of both these systems that the investment in line material and intermediate machinery and apparatus along the track is so heavy that it will be incompatible from the financial as well as the technical point of view, owing to the restriction in voltage, which seems to be a characteristic feature of both these systems. In this we do not except the trial line built by Ganz & Co. in the Valtellina, where three-phase currents are conducted to the vehicles by two insulated overhead wires at a pressure of 3000 volts. It is a matter of simple calculation to prove that economy in plant and operation will only be obtained when pressures are used far above those heretofore adopted. We do not take into consideration the trial line between Berlin and Zossen, which has been built with the view of solving the problem of high-speed railways, a type which is not likely to enter into the question which interests us at present.

The high tension forbids the application of three-phase currents because this system requires two contact wires insulated from one another. Only a single trolley promises to be reliable in operation. The voltage being high, continuous current seems to be excluded, and one is forced to come down to single-phase alternating current. This current, however, is not applicable to the working of the motors driving the axles of the vehicle. We have, however, already come to the conclusion that locomotives will have to be accepted because of the demands of the traffic organization. We shall, therefore, have to provide for sufficient adhesion weight of the locomotives. This requirement is most welcome, as it will permit us to put machinery on the locomotive to convert the high-pressure single-phase alternating current, which is most fit for the transmission and distribution of the energy, into continuous current of low pressure, which is best fitted for the working of the motors driving the axles. This conversion of current on the locomotive may be performed by a motor-generator, by a rotary converter, possibly with preliminary transformation of the voltage, or in other ways. We could now adapt the series-parallel system of control to the continuous-current motors on the axles. We find, however, the conditions to be favorable to the use of a system of adjusting the turning moment of the driving motors by adjusting the voltage of the continuous-current generator on the locomotive, using separate excitation. If this method is developed further a most satisfactory arrangement is obtained with regard to economy, graduation and safety in the control of speed, of starting, braking and returning energy to the contact line. This system in the form here outlined, with the exception of the high tension brought into the vehicle, has been described by Ward Leonard, in the article referred to where all the importance seems to be attributed to the economy of speed control.

William M. Mordey and B. M. Jenkin have also read a paper on electric traction on railways before the Institution of Civil Engineers in London on Feb. 18, 1902, to which reference may be made here.* In a foot note to the paper the authors have kindly mentioned that the Maschinenfabrik Oerlikon are engaged in practical work on these lines. In this paper the authors give a review of the different systems heretofore proposed and adopted and come to the conclusion in a way admirably logical that a system embodying a rotary converter to change a single-phase current into continuous current would have all the desirable features of a comprehensive system of electric railway traction.

Besides a great number of special arrangements which give the system its full value for the purpose aimed at, special design and construction of the several parts of the equipment of the locomotive, especially of the converter, has been necessary. The details of the current-collector and the contact line, together with safety devices, largely contribute toward facilitating the useful application of the general principle, and especially of its safe operation under high voltage, without which the rotary converter does not exert half its usefulness in electric traction on railways.

The Maschinenfabrik Oerlikon long ago appreciated the fact that the present traffic organization should be interfered with as little as possible. This firm has accordingly developed a system comprising the trolley line, the current-collector, the converter, the controllers and all co-operative parts, and has commenced to introduce it into practice. In this way it hopes to prove that an electric

* An abstract of this paper was presented in the STREET RAILWAY JOURNAL.

locomotive carrying converting plant need not have a prohibitive weight. The Maschinenfabrik Oerlikon is at present building a locomotive having four driving axles and developing 700 hp at the rails. The total weight of this electric locomotive in working order will be about 42 tons. The contact-line pressure is to be 15,000 volts.

We desire now to present details regarding the practical and extensive experiments made by the Oerlikon Company to show that the system briefly described possesses constructive advantages and that it will, without creating any traffic disturbances on existing railroads, enable the introduction of electrical operation, and that, finally, it possesses decided advantages over existing systems.

The employment of a rotary converter only becomes of value, in our opinion, when used in connection with high-tension circuits. This view is not shared by Ward Leonard, judging from the article mentioned in the introduction and from his 1891 patent, although at that time only street railways were considered. The principal motive of Leonard was the regulation of the turning moment by regulating the terminal pressure.

The fact that a transformer plant had to be installed on the moving car led people to abandon the idea, because too much stress was laid on the difficulties presented and too little on the advantages to be achieved, and because the use of the single-phase alternating current was lost sight of by engineers who had become accustomed to the direct and three-phase currents for traction purposes.

In conjunction with these currents, however, the rotary converter is equally applicable and the advantages of three-phase regulation can be retained. These, however, are not, in our opinion, the determining factors; of greater importance is the possibility to operate the converter by single-phase currents and the utilization of a very high pressure.

We have already stated that the Oerlikon locomotive was designed for a line voltage of 15,000. Assuming the train to weigh 250 tons, a speed of 24 miles and a grade of 10 per cent, then we are dealing with 575 hp measured at the track. Assuming the transformer locomotive to have a useful efficiency of 75 per cent, then we must take from the line

$$\frac{575 \times 736}{.75} = 565 \text{ kw},$$ or, assuming a shifting of the phases of 10 per cent and a pressure of 14,000 volts at the point of consumption, $\frac{565{,}000}{.9 \times 14{,}000} = 45$ amperes. The chosen output is not a maximum, but is above the average. We see that the currents even for heavy trains are not above those to which we are accustomed for street railways and small railroads and that the current may be easily collected if the construction be lighter and the speed greater.

This facilitates the construction of a suitable trolley line for ordinary roads. Before discussing this feature, however, let us consider a case in which there are two heavy trains in motion 24 miles apart on the same side of the feeding point. These two trains take from the line a total of 90 amperes. Assuming the two wires each to have a diameter of 8 mm, we have a loss of energy over the 24 miles of

$$\frac{400 \times .03328 \times 90 \times 90}{2} = 600 \text{ volts} \times 90 \text{ amperes} = 54{,}000$$

watts, or about 4.5 per cent of the energy supplied to the feeding point and about 4.1 per cent of the pressure at the feeding point.

Two such wires have a weight of about 680 lbs. per mile. We will assume the use of the rails for returning the current. We now have to deal with the one serious disadvantage of the alternating current, namely, the inductive effect in the rails, which shows itself in the increase of the apparent resistance and the actual loss of pressure. This effect increases with the number of periods of the alternating current. At 42 periods (Burgdorf-Thun road) the apparent resistance is eight times that of the ohmic resistance, according to W. M. Morley before the Institute of Civil Engineers, London. This results in losses in pressure on these long distances, even with small current densities such as are used with high pressures, and to eliminate these losses is very desirable in many respects. For this reason a small number of periods must be chosen, although this implies increase of weight and cost of the single-phase alternating-current generators, motors and transformers. According to the Oerlikon experiments with periods from 0 to 60, when the number of periods is 16 the rail resistance is increased three-fold, and if this is reduced to a copper wire having the same cross-section, we have 3 x 9, or twenty-seven fold. On a track weighing 70 kg per meter (140 lbs. per yard), this loss of voltage for a 25-mile rate is about $400 \times \left(\frac{.0166 \times 100}{\frac{700 \times 100}{7.6}} \right) \times 3 \times 9 \times 90 = 180$ volts, and, neglecting the shifting of the phase in the rails, 1.64 watt = 1.4 per cent.

In general, there are more than two trains on one side of the feeding point on a 24-mile section, but we believe that to assume three such trains at 12, 24 and 36 miles is a very unfavorable load, which would correspond in actual practice, considering trains of less weight, to perhaps double that number of simultaneously moving trains. The losses then, if we assume, for the sake of simplicity, two 8-mm wires for each 20-km section, become

Distance	Losses in Wires	Losses.			Rails, Single Gage ; Losses		Rails, Double Gage ; Losses	
	Wires of 8 mm.	Kw.	Volts	Amps.	Kw.	Volts	Kw.	Volts
0 — 12 miles	6	81	300	270	73	270	37	135
12 — 24 "	4	54	300	180	32	180	16	90
24 — 36 "	2	27	300	90	8	90	4	45
Total	..	162	900	..	113	540	57	270

That is a total of about 220 kw of 6 x 566 + 220, or 6.1 per cent of the total energy at the feeding point.

Assuming the pressure at the 24-mile point to be 14,000 volts, then on the double-gage the initial pressure must be 14,000 + 600 + 225 = 14,825 volts. Then at the 36-mile point the pressure is 14,825 — 900 — 270 = 13,655 volts, and the total voltage variation on the 36-mile section at the supposed current density is 1170 volts of a total of 14,825 volts, or 7.85 per cent, and allowing for other losses of pressure a total of about 10 per cent. Yet this figure is far less than has been found on third-rail direct and three-phase systems of less than 1000 volts and for distances of less than one-third of those assumed in this calculation; and we know that the loses decrease as the square of the pressures.

The weight of copper corresponding to the foregoing is (20 + 40 + 60) x 2.45 kg = 108 tons for the line and for the 12-m rails $\frac{12}{60{,}000} \times 4 \times 1$ kg = 20 tons for rail connections. Adding 20 per cent for depot tracks, we require for a double-gage 36-mile section a total of 150 tons of copper, of 8750 lbs. per mile.

This shows that it is feasible to supply long distances with high voltages at small losses. The feeding points would be 2 x 36 = 72 miles apart. The equalization of the load on the power stations is perfect, and there are no transformer stations which are partly idle or without any load.

One might be tempted to choose a lower pressure, but we do not believe that a much lower pressure is sufficient, while the choice of a much higher pressure is not desirable or necessary. Small currents and track losses seem to be the determining factors, together with the safety of the line and insulation of the machinery. We believe that 15,000 volts is the highest pressure which can be generated directly by machines without much difficulty and conveniently transformed, and for which mechanically perfect insulators can be obtained. The problem is, therefore, to construct a trolley line and current-collector which will permit the use of 15,000 volts.

We may mention here that it is the use of a single-pole circuit that permits the adoption of lower pressures at large stations. We can picture to ourselves, for example, a third-rail installation using less than 700 volts while the line itself carries 15,000 volts. Using two current-collectors, that is, contact-shoes and contact-rollers, the high pressure and low pressure circuits can both be utilized if all circuits are connected to proper pressure transformers.

The high-tension wires are suspended from wires stretched between two sets of poles located at each side of the tracks, and these suspending wires are attached to high-tension insulators. If the contact-roller is used it can be easily insulated from the car. In general, the single-pole construction is a very simple one, and so far as safety is concerned is far superior to the customary overhead circuit.

Trolley wires have certain disadvantages which are more apparent in the case of high-pressure systems than when working on low pressure. It cannot be denied that the trolley wire is the most easily damaged portion of an electric railway system, and it would seem unwise to hang the fate of electric traction for trunk lines on a single wire. For this reason the Oerlikon Company has developed a new trolley conductor and collector in conjunction with an alternating-current traction system. The wire is located to one side of the road instead of over the tracks and is supported on ordinary trolley-wire supporters from beneath or at the side instead of from the top. These supporters are fastened to high-tension insulators. The current is collected by means of a conducting-rod which is movable about an axis in a plane perpendicular to the direction of motion of the car and can be moved around an entire semi-circle. By means of a spring the collector is continuously pressed against the trolley wire, but as it is permitted to revolve in a semi-circle the wire may also assume any position within this area. This does away with the necessity of span wires and permits a second auxiliary wire to be run next to the trolley wire, which may serve as a reserve in case of accident to the trolley wire proper.

The Oerlikon trolley is constructed in the form of a convex rod, which solves the problem of air switches and crossings. It permits passing over from a lateral high-tension line to a central low-tension line at large stations.

The Oerlikon Company has also developed a double high-tension insulation for trolley lines. It is so arranged that the insulation nearest the earth is short-circuited by a grounded fuse wire, to which an easily movable ball or white disc is mechanically connected. Should the upper insulation give out the fuse melts, the ball or disc is visible or changes its position and the employees are thus notified of the condition of the line. Insulation test wires might also be connected between the two insulations at each section of the road.

The current is returned through the rails, which are connected by efficient rail-bonds. Many methods are in use for obviating the disturbances in low-pressure lines within the neighborhood of the trolley line. The large differences of potential existing on long lines are eliminated very largely by boosters.

While the system under discussion conflicts with many street railway regulations regarding the overhead construction, none of the differences would furnish a reasonable objection to the construction of an economical and simple system.

The company has developed a plan for the effective protection of passenger cars against accidental contact with fallen trolley wires. It consists of metal rods which connect the longitudinal girders of the car frame with the roof of the car, and these rods are placed close together along the length of the car.

In regard to the converter locomotive, it may be briefly stated that its essential feature is the generation of direct current for the propulsion of the car motors and the utilization of single-phase alternating current. By a peculiar method of compounding the motors and generators and connecting all parts which affect the field, strength, etc., a method has been devised to regulate speed economically and automatically and to employ the starting and braking. The economical production of large tractive power at small speeds is a problem which is not solved by all systems having a constant e. m. f. at motor terminals. On such systems we find the objectionable peaks in the load diagram, which are responsible for the large power consumption and the installation of larger units.

The direct-current circuits are not connected to earth, thus insuring greater protection to the insulation than is usually the case on street car motors. All motors on the train, including those on the locomotive, can be simultaneously regulated. This makes it possible to increase the weight on the driving axles. This method will be welcomed on roads with heavy grades and defective rails. The method has other advantages, many of which have been pointed out in an article on this subject by W. M. Mordey.

It may be of interest to note that the converter locomotive built for small power, say 200 hp, may be used also for passengers, as not more than one-third of the floor area need be given up to the converter installation.

It is an error to believe that converter locomotives weigh considerably more than vehicles without transformers. The Oerlikon locomotive, which can exert a drawbar pull-up to 11,000 lbs. at a speed of from 21 to 24 miles, weighs approximately as follows:

Locomotive, dead weight	33,000 lbs.
Converter and exciter	35,200 lbs.
Regulators, circuits and collector	2,200 lbs.
Braking device	24,200 lbs.
Total	94,600 lbs.

Comparing this with a system on which the three-phase current is used, under similar conditions of speed, efficiency, grades, pressure etc., it will be found that the result is about the same for both systems.

The converter locomotive of 44 tons could be replaced by one or two three-phase cars weighing 30 tons.

If we assume the locomotive to have an efficiency of 75 per cent, a working factor of 0.9, a total train weight of 250 tons, a grade of 10 per cent, a speed of 24 miles and a pressure of 14,000 volts, then the locomotive requires 45 amps., while the three-phase motors and transformers having an efficiency of 80 per cent, a working factor of 0.9 and a weight of 236 tons require a current of 23 amps. each of which have to flow through two wires insulated from each other. Using the same amount of copper, therefore, the loss in the conductors is about the same for three-phase motor as for the converter locomotive, namely, 2 x 23 or 46 amps. There is, however, a saving of energy on the locomotive at starting which enables the raising of the working factor by using a synchronous motor for a converter. This necessitates shifting the phase only about 5 per cent.

While actual figures do not prove a decided difference, other considerations must prove the superiority of the single-phase, alternating-current converter locomotive.

In the opinion of the Oerlikon Company, a 10,000 volt or 15,000 volt three-phase installation is not practical, regardless of the Berlin-Zossen experiments. If three-phase currents of less than 15,000 volts could be led directly to the vehicle the small gain in total efficiency would be largely overbalanced by the single-phase installation in the case of the converter locomotive, the greater ease of speed regulation and the possibility of furnishing energy to the line within wide speed limits and not for high speeds alone.

In addition to these, the locomotive offers the following advantages over the three-phase motor cars:

The direct and indirect danger to passengers from the line is eliminated as much as possible.

The locomotive may be constructed entirely of non-burning material.

The motor equipment is under constant supervision, and by constant inspection its life is prolonged.

The division of the equipment between the locomotive and cars insures greater ease of inspection, making up of trains and minimizes labor and maintenance.

It is possible, furthermore, to run, in addition to the locomotive, a number of self-propelled cars for suburban or local traffic, or to attach a number of cars to the locomotives, or finally to operate branch lines having light traffic with direct current furnished by converter locomotives stationed at convenient points along the alternating-current main line.

The chief points of the Oerlikon system are high tensions and small currents, the laterally arranged and supported—not suspended—trolley line, the collector having a wide range of contact, and the low-tension branch circuits for large depots. Furthermore, the electric locomotive replaces the ordinary steam locomotive, and the necessary weight for this arrangement is obtained by the installation of the converter equipment.

Advertisements in Brooklyn Tunnel

The Rapid Transit Commission has displeased the Municipal Art Society, of New York, by not prohibiting the posting of advertising bills in the Brooklyn subway, the contract for which, it is expected, will shortly be let. In a communication to the Board the Art Society asks: "Is the subway for the convenience and pleasure of the public or to enable the operating company to make large profits? Is your desire to aid private interests more potent than public opinion? If a citizen were to appear before you and request the restoration of the provision stricken out, would you restore it as quickly as you removed it at the request of the private corporation?"

The society believes that advertisements should be prohibited entirely, but it asked only that the power to regulate, restrict and prohibit should be expressly reserved to the commission, so that the wishes of the public could be executed at any time, and the subway—the city's property—should be controlled by the city. As the commission has not given heed to the society's request, that body now insists that a provision be inserted in the contract prohibiting all advertisements in the subway, the entrances, the exits, the stations and the cars.

It is explained that until recently the commission thought well of the proposition that the city should restrict the advertising in the subway, and that a proper provision should be inserted in the proposed contract. The provision was stricken out, and full power to deal with advertising virtually given over to the private corporation. Under the contract, as at present drawn, the private company could make the subway even more hideous than the elevated stations, which are so rapidly becoming huge billboards. The Boston subway is free from posters, except on the newsstands, and the law prohibits their introduction. In fact, there is no instance of a subway, constructed under municipal management, where such powers have been given to a private corporation as the Rapid Transit Commission proposes to give to the operating company. The committee of the Municipal Art Society believes that the Rapid Transit Commission will reconsider its action when the matter is carefully considered.

Determining Value of Pennsylvania Tunnel Franchise

The sub-committee on contracts of the Rapid Transit Commission and officers of the Pennsylvania Railroad have held several conferences for the purposes of arranging the terms of payment and determining the amount of compensation the city should receive for the tunnel privileges, which the Pennsylvania Company is seeking. The negotiations were conducted by A. J. Cassatt, president of the Pennsylvania Railroad; Samuel Rea, vice-president, and James A. Logan, chief counsel. The sub-committee of the Rapid Transit Commission is composed of Alexander E. Orr, Charles Stewart Smith and Comptroller Grout.

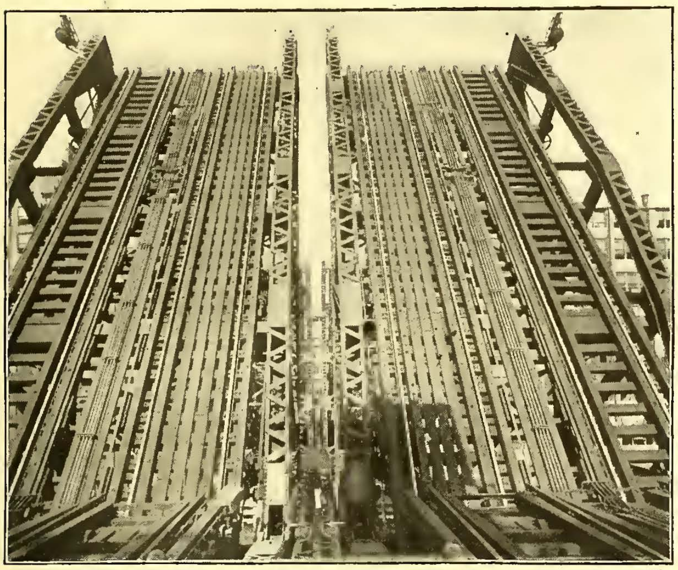
The railroad interests suggested that as the traveling facilities to be introduced into the city by the railroad would benefit the traveling public of the metropolis and would also increase the taxable values of the city, it would be an equitable arrangement if the company were allowed to operate the franchise it asked for at a nominal rental.

Messrs. Orr and Smith favored a liberal policy toward the railroad, but Comptroller Grout maintained that the franchise asked for by the Pennsylvania Company was one of the most valuable that had ever been sought from the city, and he proposed that the company should be made to pay a corresponding rental. Mr. Grout advocated charging the company for the first ten years of the twenty-five, 50 cents a year for every track foot; that is, for every foot of track laid and not for the length of the tunnel. For the subsequent fifteen years the company will pay $1 a year for every track foot. These prices must be paid not only for the trunk lines, but also for sidings and turn-outs. This was not favored by Messrs. Orr and Smith, who believed the percentage named by Mr. Grout would be prohibitive. It is believed that this demand will be modified somewhat, and that satisfactory terms will be adopted.

The compensation to be paid for some of the streets in Long Island City under which the company will tunnel could not be finally determined, for the reason that there are some nice points of law involved as to the right of the city to grant franchises for certain streets it is proposed to build under. The city does not own the streets in that borough, except such as have been acquired since January, 1898, through condemnation or dedication. The streets in Long Island City were laid out on property belonging to property owners, and the municipality owns only the easements. What now has to be determined is whether in addition to paying the city for the easement rights the Pennsylvania Company also will have to pay for the property rights. Another conference is to be held in about two weeks.

Rolling Lift Bridges Prevent Drawbridge Accidents

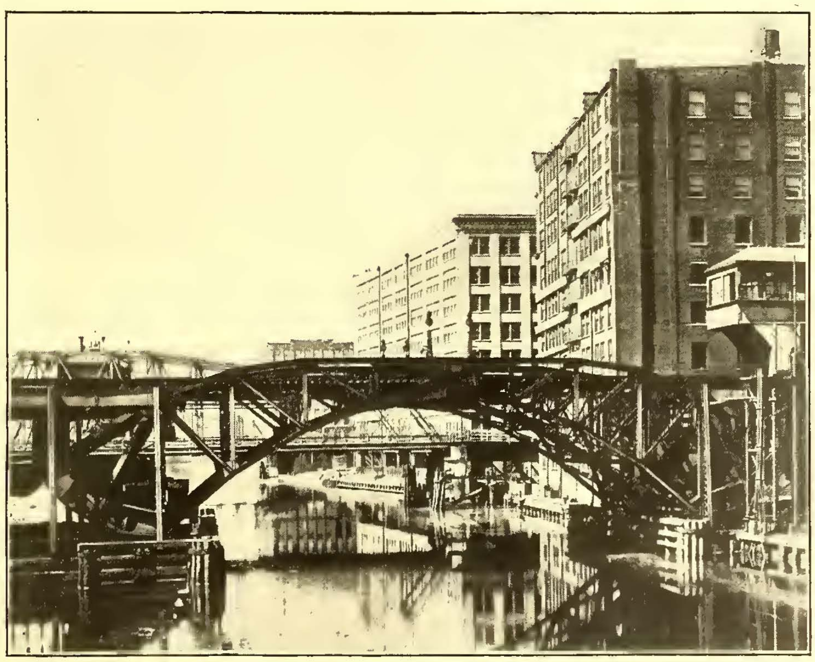
The slight accident on the bridge of the Metropolitan West Side Elevated Railroad, of Chicago, which was spoken of and illustrated in the STREEET RAILWAY JOURNAL, and which would have been very serious had the bridge been other than the bascule type, brings to mind forcibly the advantages and safety of this kind of bridge, and also calls up some interesting historical facts regarding the Metropolitan bridge at Chicago. This bridge was the first of the now well-known Scherzer type of rolling lift bridges. In fact,



OPEN SCHERZER BRIDGE. AN IMPASSABLE BARRIER TO TRAINS

it was the peculiar problem which had to be met by the Metropolitan Elevated in crossing the Chicago River that led to the design of the Scherzer rolling lift bridge, and this was the first one of the kind constructed. When the Metropolitan Elevated was being built a most difficult situation had to be faced in regard to crossing the river. The road had its right of way between Jackson and Van Buren Streets between two swing draw bridges turning on center pivots. There was not room for a swing bridge, because it would interfere with the swinging of the street bridges on either side, and furthermore the time required to swing a draw would cause much delay to train traffic. A bascule bridge hinged on pivots like the tower bridge in London was first designed. As this bridge had some objectionable features, William Scherzer, a civil engineer, was called in consultation by the company with the idea of eliminating them. A study of the question convinced him that the pivot type of bascule bridge was so objectionable that something better must be devised and the invention of the Scherzer rolling lift bridge was the result. The Metropolitan Elevated adopted and built this design of bridge, which was followed soon by one on the same principle on Van Buren Street next to it. William Scherzer, the designer of these bridges, died soon after the plans were completed, but the Scherzer Rolling Lift Bridge Company, of Chicago, continued the work of designing bridges under the patents, and to-day this type is rapidly being adopted for the most important locations. The Metropolitan bridge which prevented what might have been a terrible disaster on May 15 is a four-track structure 114 ft. from center to center of bearings, leaving a clear channel 108 ft. wide. It is in reality two double-track bridges, which can be operated either independently or together. After the accident traffic was resumed in 15 minutes on the two tracks not interfered with. It will be remembered that the motor car of the train ran onto the bascule just as it started to rise. It rose far enough so that the front truck of the first trail car was derailed and the platform hoods were smashed. Three views of this epoch-marking bridge are shown herewith. Since it was finished in 1895 many others of the same type have been built both in Chicago and elsewhere. It is quick to operate, and can be raised and lowered in much less time than it ordinarily takes to swing a draw. The Metropolitan bridge is raised or lowered in 30 seconds, and trains are run over it in less than one minute from the time of starting to lower. The government and vessel owners like these bridges, because they leave the stream clear of any center pier obstruction to navigation, and the bugbear of collisions of vessels with the bridge is done away with. As compared with other kinds of bascule bridges the Scherzer rolling lift has the immense advantage that the weight of the bascule and its counterweight is carried on a rolling rather than a pivot or trunnion, a rubbing bearing. The friction on a journal or pivot large enough to carry the weight of half a bridge and its counterweight as in the London tower bridge, is so great that much power is required to operate it, and the machinery must be correspondingly expensive. The Scherzer bridges, as the name implies, roll or rock on a smooth level surface practically without friction. The cost is also lower than for other bascule bridges, because of the peculiar design which permits the shortest and consequently cheapest span possible between bearing points for a given clear channel between piers. Nine of these bridges have already been built at Chicago, four of which replaced swing bridges across the Chicago River, and six more are under construction to replace swing bridges. The big six-track bridge at the approach of the South Terminal Station, Boston, is of this kind, as well as the most important railroad bridges in Cleveland. Manhattan Avenue between Brooklyn and Long Island City also has one of these bridges. Many others have been designed for use in the United States and foreign countries.

SCHERZER BRIDGE, OPEN



SCHERZER ROLLING LIFT BRIDGE, CLOSED

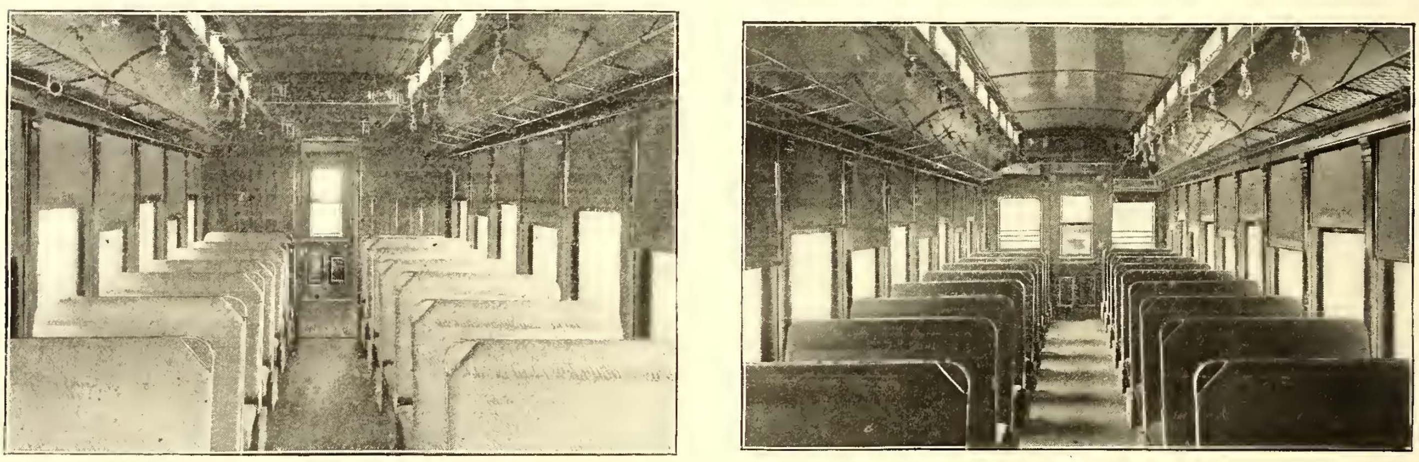
From Denver there comes a tale of a genuine elephantine stampede, caused by one of those wonderful specimens of the jungle getting his trunk tangled in a trolley wire. From all accounts it was rather a distasteful experience for Jumbo.

New Cars for Seattle and Tacoma

The cars now being shipped by the J. G. Brill Company, of Philadelphia, to the Seattle & Tacoma Railway Company deserve

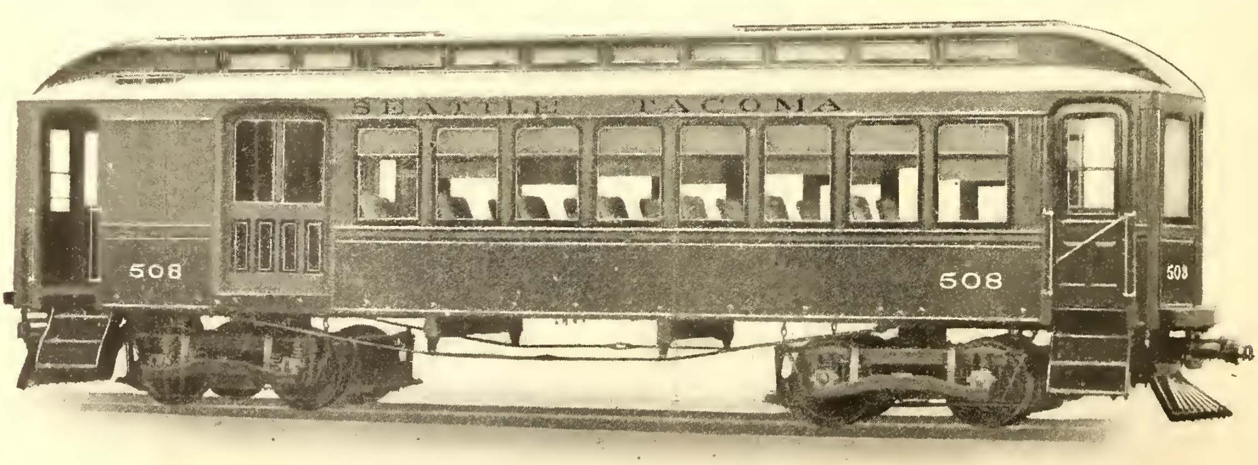
SEATTLE AND TACOMA PASSENGER CAR

a place in the first rank of the best productions of modern electric car building. The accompanying illustrations are worthy of careful examination, as they convincingly show the powerful and handsome construction, the roomy, pleasant and convenient interiors, and



INTERIORS OF SEATTLE AND TACOMA CARS

the attention which has been paid to every detail. Although fitted for third-rail contact the cars are wired for trolleys and have trolley platforms, so that a change may be made without withdrawing the cars from service. The cities of Seattle and Tacoma are about



SEATTLE AND TACOMA COMBINATION BAGGAGE AND PASSENGER CAR

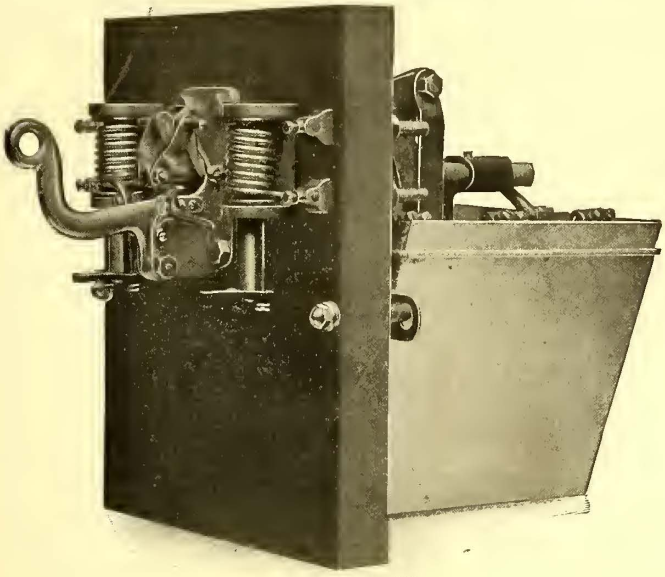
25 miles apart, and it is intended to cover the distance in steam railroad time. The Brill 27 trucks, upon which the cars are mounted, are capable of making 65 miles an hour.

There are eleven cars in this order: Two motor passenger cars, four motor combination passenger and baggage cars, four trailer passenger cars, and one trailer combination passenger and baggage car. The length over the crown pieces is 41 ft. 6 ins., and the width over the sills is 8 ft. 9½ ins. The straight passenger cars have a seating capacity of 44. The baggage compartments of the combinations have seats which fold against the walls.

The sills are reinforced with heavy iron plates, and the ends are strengthened and protected with Brill patented angle-iron bumpers. The steps are provided with traps to cover the openings at high station platforms. The motorman's cab occupies half the platform but does not prevent passengers passing through, as there are cabs at either end, and the motorman is therefore always on the off side. The window rails are very low and the windows large, adding to the coolness of the cars in warm weather. The sliding doors to platforms have drop sashes, as have also the front vestibule doors and outside cab doors. The interiors are finished in solid Mexican mahogany, handsomely carved and inlaid. The ceilings are light green, striped with gold. Each car is fitted with Dedenda gongs and Brill ratchet brake handles.

Automatic Alternating-Current Circuit Breaker

The use of alternating currents in street railway work has become so general that railway engineers are becoming as familiar with alternating current as are lighting engineers. The merits of the improved automatic oil-circuit breaker, shown in the accompanying illustration, need therefore only to be pointed out in order to have them appreciated by railway engineers connected with long-distance transmissions, on either interurban or city roads. The circuit breaker has a capacity up to 300 amps., and is built for pressures up to 10,000 volts. It can be arranged either as a single-phase breaker, having a tripping coil on each side of the circuit, as a two-phase breaker, with a tripping coil in each phase, or as a three-phase breaker with a tripping coil in two phases, in every case the breaking of all lines being by the operation of any one tripping coil. It is thus seen that only one-circuit breaking mechanism is depended upon for opening the circuits of any type of transmission line, thus greatly reducing the liability of the breaker to fail in its operation.



IMPROVED OIL CIRCUIT BREAKER

The use of oil in a circuit breaker has been highly recommended by electrical engineering experts, and for simple and safe operation it is considered by the manufacturers to be far superior to the air-brake breakers. The manufacturers, however, have perfected a type of air-brake breakers which can be furnished to those installations where this type is preferable to the other. As it is the general practice to locate circuit breakers on top of switchboards and usually out of reach, the designers have endeavored to make this arrangement as convenient as possible for operation. The breaker illustrated is intended for such a position and is operated by a portable handle with a suitable hook at the end. Where, however, it is desirable to have the breaker within reach of the operator an insulated handle is substituted for the arm shown. The operator when closing the breaker loses control of the handle and an attachment is provided to open automatically the breaker if the short circuit or other difficulty on the line has not been removed. It is also possible to actuate the breaker mechanism by remote control if desired, so that it is not necessary to approach the switchboard.

The circuit breaker can be used as a switch when automatic action is not desired, the only change necessary being to remove the tripping coil and opening springs. It can be used either as a single-pole switch, two-pole switch, three-pole switch or four-pole switch. The tripping mechanism, although very sensitive and operated easily electrically is not affected by vibration, and it is claimed will not open by ordinary mechanical shocks. The oil receptacles in the rear of the board are removable and occupy a small space.

A large number of other styles of switches are made, including single and double throw, oil-break transfer switches, relieving the switchboard attendant of all liability to overload his line in manipulating his circuits and pneumatic-oil break switches operated by air. In the transfer switches a device is provided whereby the switch is locked when open so as to insure safety from being thrown in by jar or in any other manner that is not intended by the operator. This line of switches is made by S. B. Condit, Jr., & Co., of Boston, Mass., who not only design and manufacture high and low-tension circuit breakers and switches, but give special attention to designing and building high-tension switchboards.

An Improved Cooling Tower and Condenser

Since the introduction of cooling towers some ten years ago in this country they have been installed in a great variety of situations, and have become recognized as an important adjunct in all power stations where the water supply is limited. The accompanying illustration shows a type of cooling tower which has been developed by the Alberger Condenser Company, of New York, which has many points to recommend it for use in street railway work. It is constructed of sheet steel, carefully riveted and braced, and its substantial construction makes it suitable for all locations. There are two types manufactured by this company, in one of which the air is circulated by means of one or more fans and in the other by means of a stack placed above the cooling tower proper which produces a draft when the air becomes heated by the hot water from the condenser. The interior of the cooling tower contains a filling consisting of boards of swamp cypress, arranged in a regular manner so as to positively determine and compel the ultimate distribution of the water and air. The cooling tower thus prevents any haphazard or changeable directions for the currents of air and water, and retains a uniform effectiveness on the sheets of water exposed to the air. The extended surface of the water brings each particle in contact with the air, so that the cooling

COOLING TOWER AND BAROMETRIC CONDENSER

process is thoroughly effective. The same steam engine used to operate the fans in those towers which are not self-cooling, also drives a centrifugal circulating pump, which draws the water from the hot well and discharges it to the distributor of the cooling tower.

The Alberger natural draft cooling tower represents, however, the most advanced type, as no power is required to circulate the air. This tower is made in variable sizes, but the preferable height recommended by the manufacturers is about 80 ft. The accompanying illustration shows a view of one of these towers. The interior arrangement is the same as described above for the fan-cooling tower. The air, as shown, enters around the piers that support the structure of the tower. The condensing apparatus shown in this engraving is the Alberger Barometric Condenser, and is especially suited to large engines or to stations containing a number of engines which must exhaust into one condenser. The circulating pump used comprises hot and cold water pumps, operated by the same steam end. The cold water pump derives its supply of water from the cold well of the cooling tower and discharges into the barometric condenser, being assisted by the vacuum in the latter. The water there condenses the exhaust steam from the engines and falls down the barometric tube against the atmospheric pressure to the hot well from which it is removed by the hot water pump and discharged at the distributor of the cooling tower, and becoming cooled by the evaporation caused by the contact with the ascending air it finally reaches the cold well ready for a repetition of the process. The barometric condensers, as illustrated, are similar to those to be used in the power station which is soon to be erected for the Rapid Transit Subway Construction Company, of New York, the Alberger Company having received the contract for the condensers of this plant.

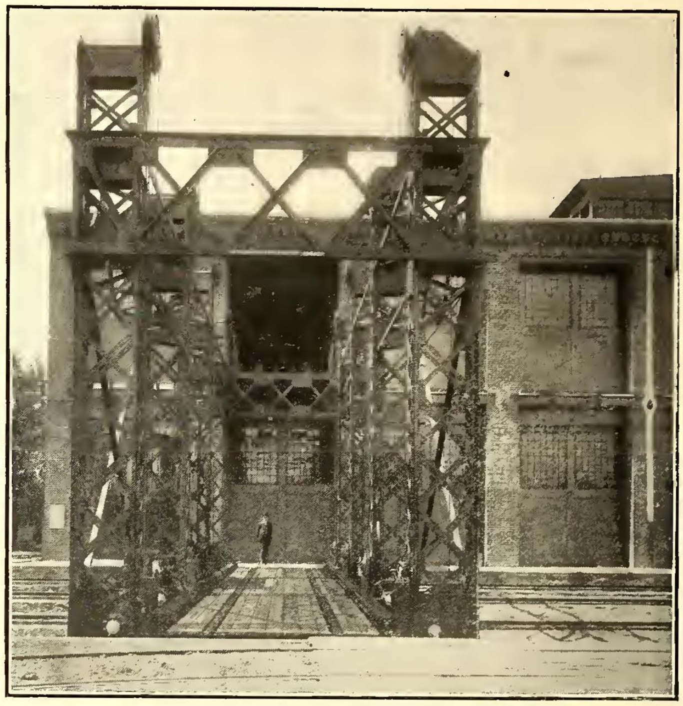
Novel Elevator and Transfer Table at the Brill Works

The accompanying illustrations show a combination electric transfer table and elevator recently completed for the new finishing shop at the works of the J. G. Brill Company, Philadelphia. The apparatus is of a new type and design, and contains a number of features especially devised to obtain every facility to expedite the movement of cars and thus save time and space.

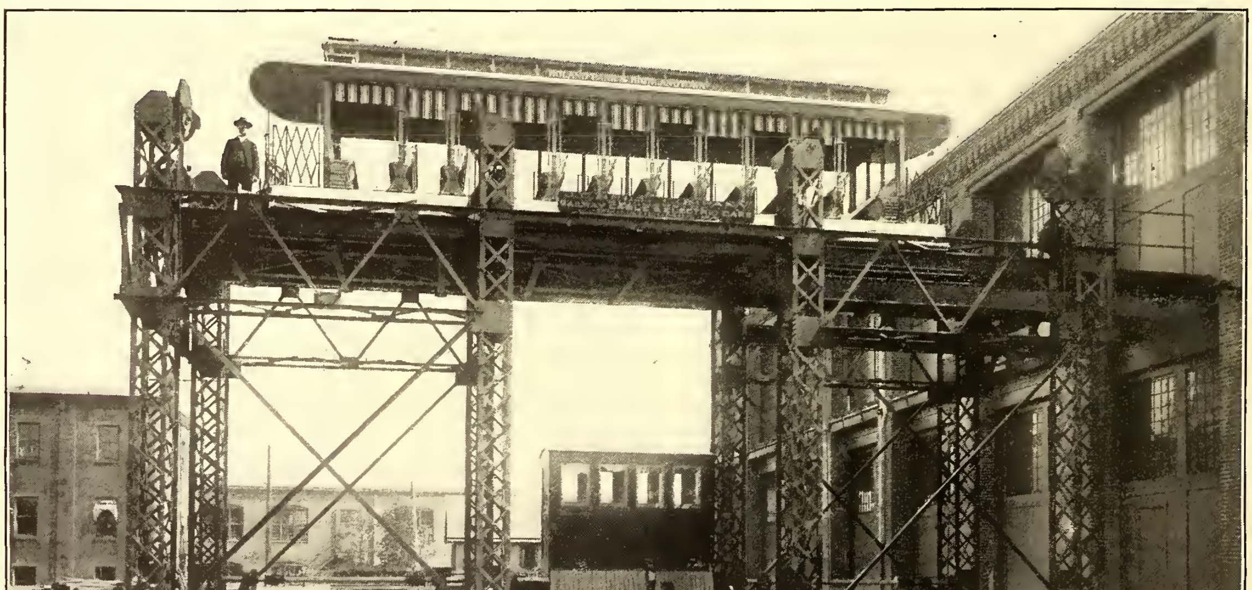
The finishing shops have recently been completed, and make one of the most imposing features of this extensive manufacturing plant. It contains two working floors, and this novel method of reaching the second story by means of the transfer table has been adopted with great success.

The motor not only moves the structure along the pit but also operates the elevator, and by means of a cable draws the cars on and off. The elevator is halted at top and bottom by automatic stops.

To see a large car drawn upon the table from the tracks leading from the other shops, moved 200 ft. along the front of the building and hoisted into a second-story door, and all within a few minutes, is not the least attractive of the many interesting up-to-date features characteristic of this large and busy plant. Cars ready for shipment are run from the elevator upon flat cars on tracks brought to the table from the trunk railroad lines, at the junction of which the works are situated. George P. Nichols & Brother, of Chicago, are the builders of the apparatus.



END VIEW OF TRANSFER TABLE



SIDE VIEW OF ELEVATING TRANSFER TABLE

The Willans Engine in America

The prospects for an extensive business for this well-known type of central-valve engine in the United States is very bright. The Bradley Maufacturing Company, of Pittsburgh, Pa., has purchased the American rights, together with all patterns and special tools formerly owned by the M. C. Bullock Manufacturing Company, of Chicago. The Willans engine will be built by the Bradley Company in sizes from 25 hp. to 3000 hp, the same standard of mechanical perfection that is found in those of English make. An entirely new plant is being erected, equipped with the most modern machinery and every facility for rapid manufacture, and prompt shipment will be provided.

Handsome Convertible Combination Cars

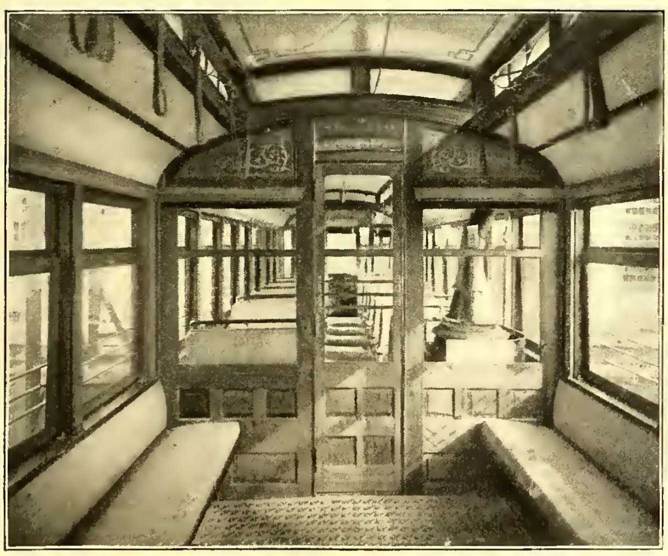
The engravings which accompany this article show a number of views of a style of convertible combination car built by the John Stephenson Company, of Elizabeth, for the Olean Street Railway Company, of Olean, N. Y. These cars have recently been shipped from the factory.

The cars combine the best and most desirable features of modern street and suburban railway practice. They have a number of useful and novel details peculiarly adapting them to the city and interurban service for which they are intended. The Stephenson convertible feature gives the road practically two complete equipments in one, enabling it to have both open and closed cars ready for service at any time, and only a few moments are needed for the change, which can be made if necessary while the car is in motion. Space is found in the wall of the car for the large lower sash, as well as for a steam road truss plank gained upon the posts. The pocket for the sash is closed by a cap, which forms the arm rest. The upper sash slides upward into a pocket which is so placed that there is no disfigurement of the interior, and the form of the roof is not changed in any way, the monitor being of the same width as usual.

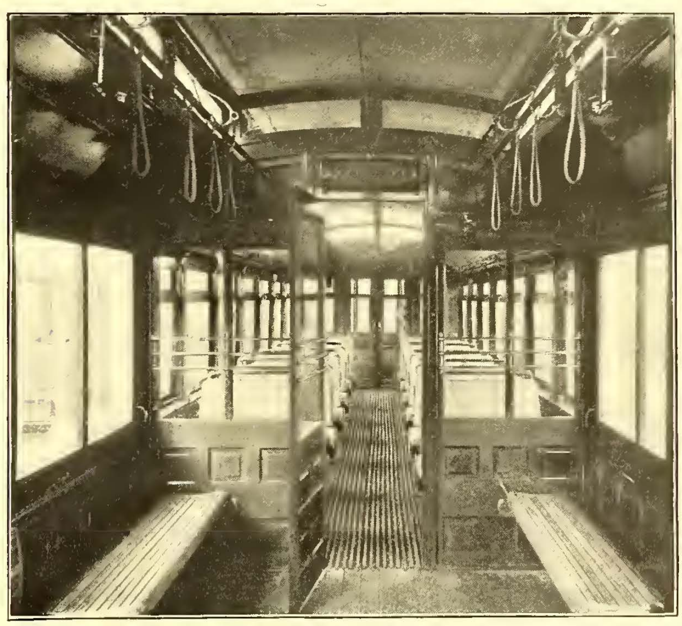
By lifting only the small upper sash into the roof, no weight worth mentioning is added to that part of the car, and there are no strains brought upon the posts. The window opening obtained by the Stephenson arrangement is as great as that of any open car, measured from the elbow of the passenger upward. This type of car possesses several important advantages over the ordinary open cars. It avoids crowding to a marked degree, which is one of the reasons for its great popularity with passengers. Another reason is that those seated next the side of the car are not annoyed nor disturbed by those entering or leaving, as is the case with cars having side entrances.

All the cars of the order are built with two compartments. One of these for passengers takes up about 20 ft. of the body, the remaining 8 ft. in part of them is used for a baggage room, and in the others is fitted up for a smoking compartment only. These cars have 28-ft. bodies and measure about 37 ft. over the dashers. The vestibules have street-car bonnets and are completely enclosed. The floors of the vestibules are dropped, and the platform timbers are plated with angle-iron. The buffers are of channel iron of the Stephenson spring pattern, which gives an elastic resistance to blows, thus saving the frame from strains. In the cars without side doors there is a flat truss in the wall of the car coming up to the window rail and ending in the sill. The bodies have curved sides, reducing the width at the sills, and adding to the stiffness. All the side sills are plated with steel, and in the baggage and passenger cars the plate is of more than the usual depth.

PASSENGER CAR FOR OLEAN STREET RAILWAY



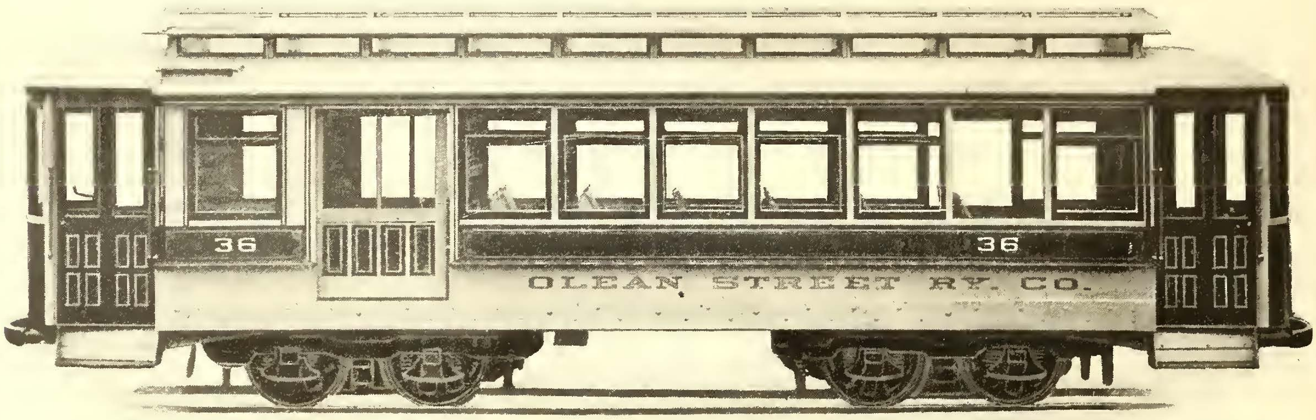
INTERIOR OF SMOKING COMPARTMENT



INTERIOR OF BAGGAGE COMPARTMENT

The interior finish is solid mahogany, with handsomely inlaid panels in the end of the car and on the partition. The same finish is used in the smoking room. The seats are of the walk-over pattern, with a hand rail on the back, making a secure grab handle for those standing or moving. Hand straps are provided, but they seem hardly necessary. There are twelve seats in the passenger end, and four in the smoker. In the outer corners of both compartments are stationary longitudinal seats. In the baggage room the seats are longitudinal and extend the whole length of the compartment. They are supported on folding brackets, and are hinged in the center so that the half in front of the door can be turned over endwise out of the way when the door has to be opened. The arrangement can be seen in the engraving of the interior. Both parts of the seats can be dropped against the side of the car when the space is needed. The use of the compartment for smokers has been found not to interfere with its usefulness for carrying freight, etc. The baggage room side of the partition carries three electric heaters. One of these is placed over the door and the others are over the windows. This arrangement, though peculiar, seems to work very well. It was necessitated in this case by the fact that there was no other available place in the compartment, doors and the folding seats taking up the whole of the wall space near the floor. The end doors and windows are fitted with motorman's curtains, which have spring rollers placed vertically.

The trucks are the Stephenson No. 20, with a 4-ft. wheel base.

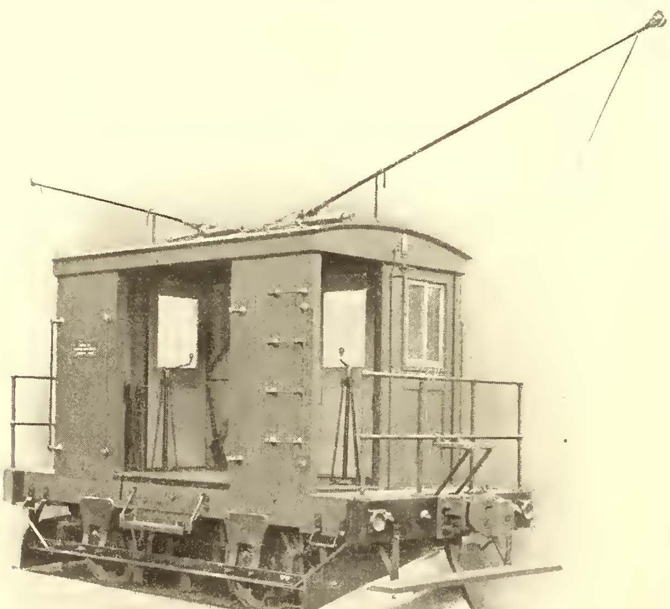


COMBINATION BAGGAGE AND PASSENGER CAR

They are capable of taking the shortest curves with ease, and at the same time can run safely at the highest speed which may be needed. The double journal springs and the long spring-suspended links make this truck very easy upon any track at any speed. One valuable feature is the small amount of power required. The "internal friction" is insignificant, consequently little power is wasted.

A Novel Electric Switching Locomotive

The illustration herewith is made from a photograph of a yard switching locomotive recently completed for the Lonsdale Company, whose principal offices are in Providence, R. I., and whose mills



A NEW SWITCHING LOCOMOTIVE

are at Lonsdale, R. I. The locomotive was made by the Taunton Locomotive Manufacturing Company, Taunton, Mass.

This electric locomotive will be used for handling cars from the tracks of the New York, New Haven & Hartford Railroad, which connect with the yard tracks of the Lonsdale Company. It was constructed and completely equipped electrically at the Taunton shops, and was shipped on its own wheels over the tracks of the New York, New Haven & Hartford Railroad directly to the mill yard in Lonsdale. It is equipped with automatic Tower couplers, with Westinghouse No. 49-B railway motors, and with a Christensen air brake outfit. The wheels are 30 ins. in diameter, running on 4-in. axles, with a wheel base of 6½ ft. The main framing timbers are of hard pine, 2 ins. x 3¾ ins. The bumpers at each end are of oak, 12 ins. x 7 ins. The extreme width is 7 ft. 4 ins., and height to top of roof 10 ft. 6 ins. A snow plow is fixed at each end, and in addition the wheels are protected by diggers and scrapers, which keep the track clear under all ordinary circumstances. The locomotive weighed complete when shipped 8½ tons, and is expected to haul on a level four loaded cars.

Provision is made by means of pockets to increase the weight of the locomotive by the addition of cast-iron cubes, if such increase in weight shall be found necessary. The specifications required that the side doors of the cab should be of extra width to take large packing cases. End doors are provided so that the trolley can be controlled from the platform, and coupling arrangements are such as to fit the locomotive for use with standard steam road freight cars.

The Edge Moor Water-Tube Boiler

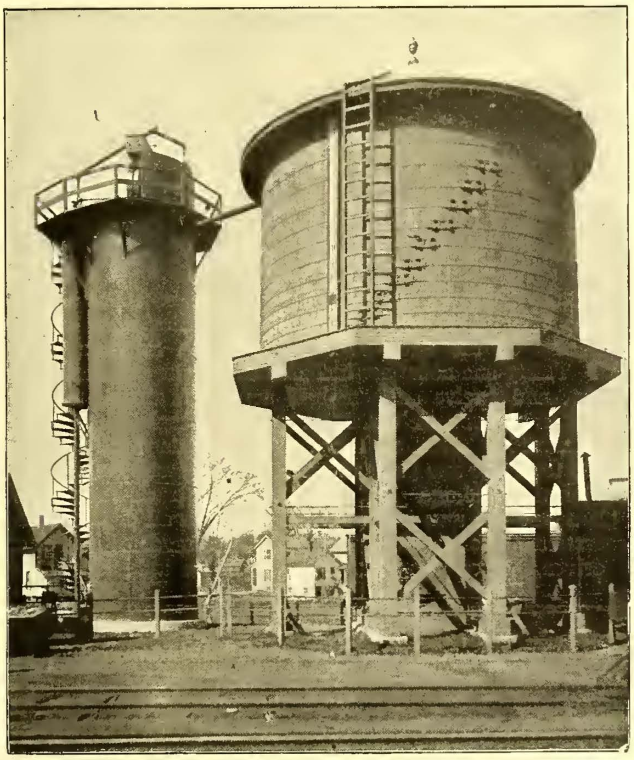
There are many points peculiar to water-tube boilers that have made this type the one in general use in street railway plants. While, as in all mechanical devices some faults can always be found, it has come to be generally conceded that the water-tube boiler meets the requirements of electric power stations in the most satisfactory manner, and to supply this demand the Edge Moor Iron Company, of Edge Moor, Del., began in 1895 to manufacture a class of high-grade water-tube boilers which have proved exceedingly efficient and durable. The boilers are made in sizes from 75 hp to 1000 hp, and for steam pressures up to 200 lbs. per square inch. Quick steaming properties and the ability to force the boiler to the utmost capacity of the furnaces are obtained by making the areas of the path of circulation of the water larger than is often found in the horizontal types of water-tube boilers, and the liberal water surface provided maintains an even water level without undue vigilance on the part of the men in charge.

Mechanically the water-tube boilers are as perfect as are the other products of the Edge Moor Iron Company. All flat surfaces are effectually stayed, and no stayed surfaces nor riveted seams are exposed to the intense heat of the direct fire from the grates. The boiler is supported upon columns in the front and upon expansion rollers in the rear, giving ample opportunity for expansion without touching the brick work, which constitutes the setting. The arrangement is such that the parts of the boiler are subdivided, providing the principal feature of safety embodied in sectional boilers.

The facilities of the company at the Edge Moor works are excellent. Extensive machine, forge and assembling shops, containing the highest grade of tools, enables the company to turn out the very best work in the most expeditious manner. Freight connections are made by the Three Front Railroad with the Pennsylvania Railroad, Philadelphia & Reading Railroad, and Baltimore & Ohio Railroad, insuring prompt delivery of boilers as soon as the order can be filled.

An Efficient Water Softener

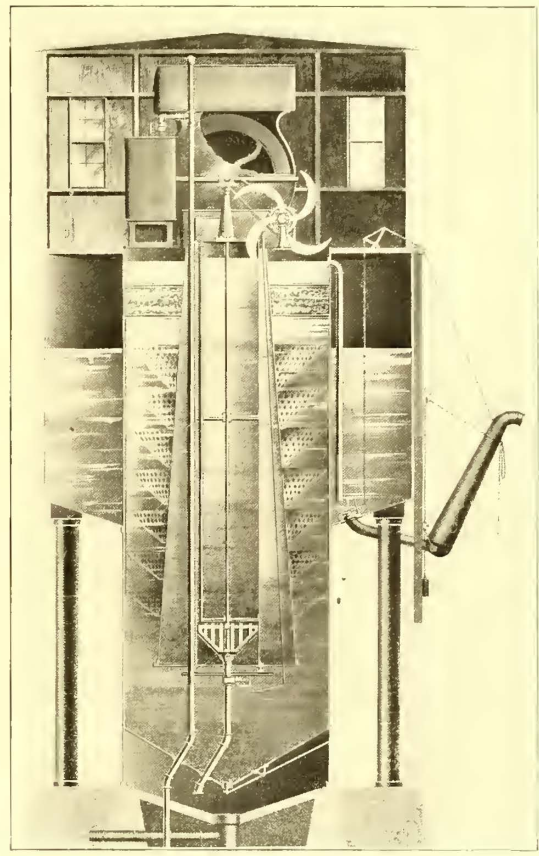
Steam plants in connection with street railway and lighting installations are only operated at the highest efficiency when the boilers are free from scale. Street railway plants in particular are subject to extra heavy strains at certain times during the day, refering particularly to the extra heavy pull during the early evening hours, at which time the boilers are usually worked to their full capacity. There is, perhaps, no branch of steam engineering to which more attention has been given than the prevention of the formation of scale and its removal after it is formed. It is needless to say that methods having in view the removal of scale already formed are efforts directed against an effect and not a cause. The cause of the formation of scale is too well known to require extended notice here; suffice it to say, therefore, that scale is usually formed by the deposition of the salts of lime and magnesia upon the tubes and sheets of the boiler, due to heat, pressure and evaporation of the water. The use of boiler compounds adds to the material already in the boiler, and at best can only affect the material in the water so that the scale formed is not hard, but will be deposited in a soft, easily removable form. One of the most approved methods of relief is to remove scale-forming material before the water enters the boiler.



EXTERIOR OF WATER SOFTENER

The Kennicott water softener, illustrated herewith, is an apparatus particularly adapted to the needs of street railway and lighting plants. The apparatus is claimed to be unique among water-softening apparatus, in that it requires but a single foundation, the whole apparatus being contained in one steel tank; all small parts being enclosed in the main body of water so that danger from freezing is obviated. A peculiar feature of this machine is the surrounding soft-water storage tank. These machines are built either with or without this storage tank, which, however, is of particular value to street railroad plants, for it may be filled with soft water during the night or middle of the day, when the load is light, to be drawn on when the consumption of water is greater than the hourly capacity of the machine. The apparatus treats varying quantities of water with varying quantities of materials automatically, and without re-setting, the amount of water entering the machine being automatically governed by the amount of water drawn from it. It is equipped with an efficient mechanical agitator, which furnishes at all times lime water of uniform strength; this is claimed to be a great advantage over many forms of apparatus which attempt to furnish lime water simply by the introduction of water into the lime saturator through a pipe, depending upon the force of this stream of water to properly agitate the lime. The above-mentioned agitator is operated by a cast-iron water wheel, which is situated at the top of the apparatus, and is turned by the water as it flows into the machine, thus no external power is required. This water wheel also operates a lift wheel which lifts soft water, measuring it automatically into the lime saturator so that the lime is dissolved in some of the already softened water. This makes a great saving in the use of lime, because that material is most easily dissolved in soft water. This water wheel also operates a hoisting apparatus, by means of which the material used for the purification of the water is hoisted to the platform surrounding the top of the machine, thus doing away with much objectionable labor. The continuous water-softening apparatus has many advantages claimed for it over the old intermittent forms of water softener.

Water is drawn from this apparatus without repumping. The water to be purified after flowing over the water wheel falls into the top of a conical downtake, where it is intimately mixed with solutions of lime and soda or any other chemical necessary for the purification of the water. This mixing is of great importance, as it is not sufficient that the water and reagents should simply flow together, but should be thoroughly agitated together. Here the precipitation of the objectionable solids takes place, and as the water flows through the conical downtake its rate of flow steadily



SECTIONAL VIEW OF WATER SOFTENER

decreases so that the precipitate falls away from the water from which it was formed and collects in the bottom of the machine. Here the "sludge" produced is removed by means of a dump valve, shown in the sectional view of the machine, and the scale forming materials are blown into the sewer instead of allowing them to go into the boiler. The water after flowing through the conical downtake turns and rises through a series of baffle plates where particles too light for sedimentation are entangled, and after forming in large enough quantity slide off these plates and fall to the bottom of the apparatus. These baffle plates are entirely self-cleaning. The water finally passes through a filter of common packing excelsior, this filter requiring renewal about once in three months. This form of filter, it is claimed, is much to be preferred to sand filters, as it requires no water for washing, apparatus using sand filters being open to objection on account of the large amount of water required to wash them, which precludes their use in many stations.

These Kennicott purifying plants are constructed of a sufficient size to allow plenty of time for the reaction between the precipitating reagents and the water to take place.

The apparatus being entirely automatic requires attention only for the supplying of the chemicals and for cleaning out. The chemicals usually used are lime and soda, according to the Porter-Clark process, and these may be introduced and the machine operated by an unskilled workman who puts the lime and soda in their proper receptacles and blows off the "sludge." The time required is usually not more than half an hour per day. This apparatus is in use on a number of prominent railroads, among which are the Union Pacific, the Chicago, Burlington & Quincy, the Chicago & Eastern Illinois, etc., as well as many power plants in different parts of the United States. The device is the invention of Cass L. Kennicott, who is vice-president of the Kennicott Water Softener Company of Chicago, the sole manufacturer of this apparatus.

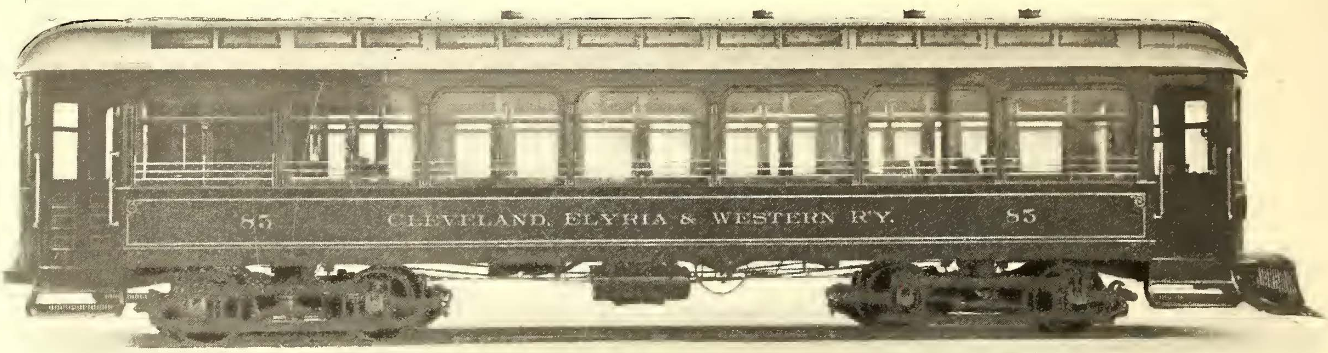
Modern Automatic Couplers

The W. T. Van Dorn Company, Chicago, which, as was announced some months ago, received the contract for supplying couplers for all the elevated lines of the Manhattan Railway Company, New York, will also furnish the couplers for the new rapid transit subway of that city. During the last few years this company has had a most phenomenal success with its product, the various points of simplicity, effectiveness, durability and strength seeming to have been almost immediately recognized by the managements of the most important railway systems in the country. The Van Dorn couplers are now the standard on all elevated roads, and it is safe to say that wherever trailers are used on either city or interurban lines they are acknowledged to be in the front rank of coupling devices. It has been the intention of the manufacturers to make a coupler that would have as long a life as the car to which it is attached, and the results obtained show that this condition has been almost invariably satisfied. One effect of this reputation is that the Van Dorn Company has its factory kept continually working at its full capacity, and is constantly behind in filling contracts.

Rossiter, MacGovern & Company, New York, have recently bought the greater part of the machinery, including engines and generators, of the One Hundred and Forty-Sixth Street power station of the Metropolitan Street Railway Company of New York. This well-known concern has sold to the Boston & Northern Railroad Company, and are installing in its station, two 850-kw General Electric generators, direct-connected to Pennsylvania Iron Works engines.

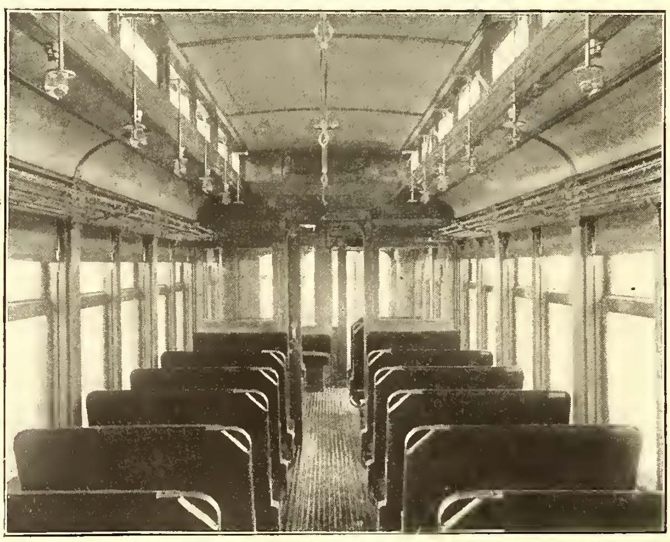
First Cars from the New Kuhlman Factory

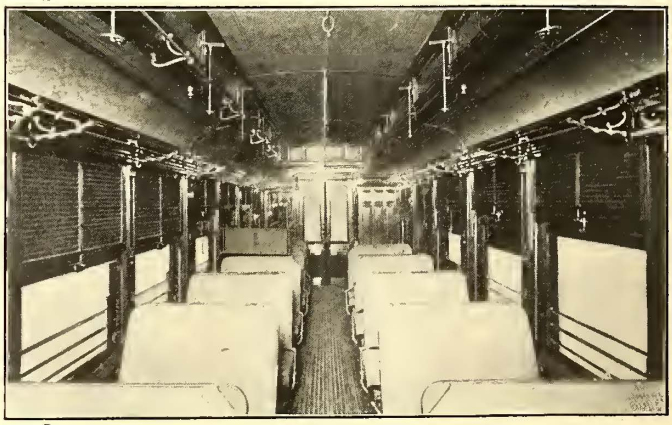
Next week will mark an important epoch in the history of the well-known G. C. Kuhlman Car Company, of Cleveland. At that time the first lot of cars built in the company's magnificent new factory will be completed, and the event will be celebrated by an interesting ceremony. It is hoped that the first car will be run from the shop by a most distinguished motorman in the person of Senator Mark A. Hanna, president of the Cleveland City Railway Company, for which company the new cars are being built. A number of handsome cars are nearing completion in the new shops and deliveries will shortly be made to some of the most prominent city and interurban roads in the country.



STANDARD DOUBLE-TRUCK PASSENGER CAR

There is nothing finer or more complete in or near the big manufacturing city of Cleveland than the plant which this company has established at Collinwood, eight miles from the center of the city, on the Lake Shore & Michigan Southern Railway tracks. Thirty-one acres are included in the site purchased by the company, and twelve and one-half acres are already under the cover of seven immense buildings recently completed. Even with these extensive facilities the company finds itself somewhat cramped for space and plans are already being made to extend one of the largest buildings. There are 3 miles of tracks in and around the plant, and 500 men will be employed when all departments are in operation. The machinery is all new, and much of it is electrically driven, power being furnished from an independent power plant. The buildings are for the most part of saw-tooth roof construction, giving the maximum floor space and the best of light.

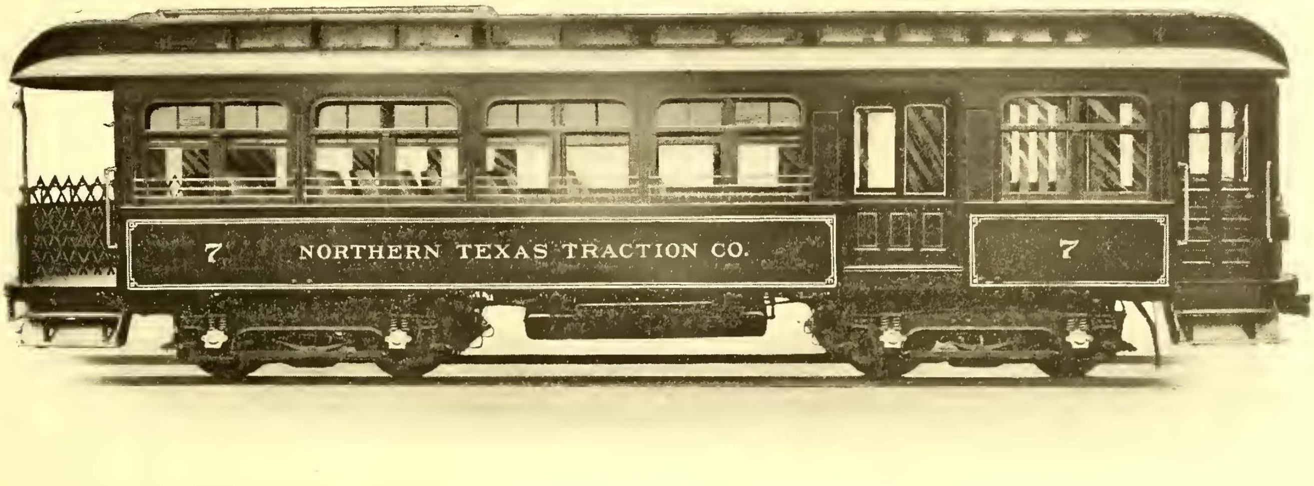




INTERIORS OF NEW KUHLMAN CARS

It is interesting while describing the new shops to examine some of the recent work of the company. At its former shops there have just been completed several of the finest and largest interurban cars ever built, and others of similar design are nearing completion in the new plant. Two of the latest productions are illustrated herewith. Of the Cleveland, Elyria & Western pattern shown, six have just been delivered to this company, and others are under construction for the Columbus, Delaware & Marion Railway, of Columbus, and for the Kansas City & Leavenworth Railway Company of Kansas City. These cars have 39-ft. bodies and are 49 ft. 6 ins. over buffers, 8 ft. 6 ins. from top of floor to upper roof, and 8 ft. 5 ins. wide over steel sill plates. The seating capacity is forty-nine passengers. They have Hale & Kilburn frieze plush walk-over seats, with spring-edge cushions and extra high corrugated backs fitted with bronze grab handles. They are finished in solid mahogany with maple ceilings, while the curtains are of figured silk, and the trimmings of bronze. The windows are double and of French plate-glass. The cars are provided with toilet accommodations and hot water heaters.

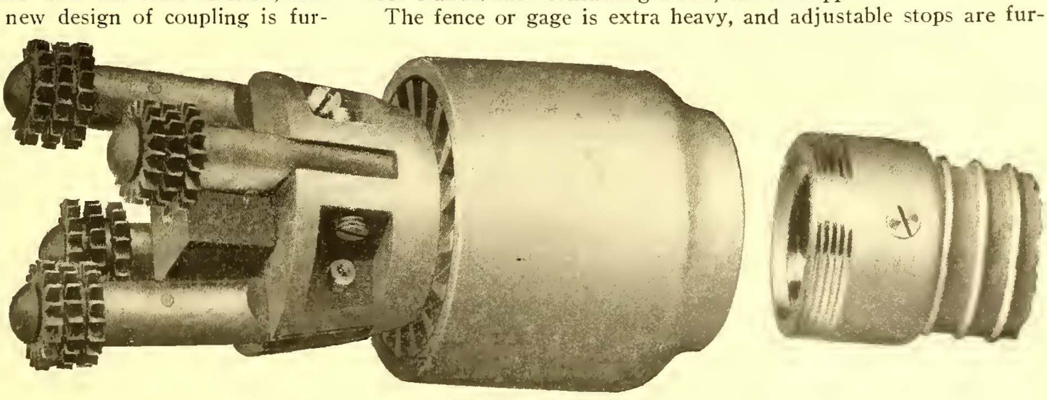
The cars for the Northern Texas Traction Company are 47 ft. over buffers, and 8 ft. 6 ins. from top of floor to upper roof. The width over steel sill plates is 8 ft. 4 ins., and length over body 36 ft. 3 ins. The combination cars have a seating capacity of thirty, and there are folding wall seats in the baggage compartment, which is 10 ft. 6 ins. in length. The seats are Hale & Kilburn rattan, walk-over spring-edge pattern, with bronze handles on seat back. The interior finish is cherry. There are toilet accommodations, and a unique feature is an adjustable partition which can be placed between any of the seats in accordance with the laws in certain Southern States requiring separate compartments for whites and blacks. A number of open trailer cars are being built for this road, as well as a magnificent private car of the same dimensions as the standard coaches.



COMBINATION BAGGAGE AND PASSENGER CAR

An Improved Boiler Tube Cleaner

The accompanying illustration represents the Weinland improved No. 8 water-power boiler tube cleaner, which is claimed to be a marked advance over those heretofore produced. The machine embodies the same general principles as other water power, ball-bearing cleaners made by the same manufacturers. The improved type, however, has been remodeled and has been made very much stronger than the other styles. The spider to which the arms are attached is now almost solid, so that it will withstand the severe strain put upon the arms and the bearings, including the balls, are larger so that it runs with the least friction, and consequently is more durable. A new design of coupling is furnished with each machine; this coupling being a great improvement over former designs in this line. It holds the hose securely so that it will withstand any pressure which the hose will stand without any danger whatever of pulling loose, as so frequently happens with the ordinary bands used in attaching hose. This little device in itself is of sufficient importance to highly recommend the apparatus, and will be appreciated by those who have suffered the annoyance avoided by its use. The Lagonda Manufacturing Company, of Springfield, Ohio, manufactures this machine. The company states that it will also continue to make the former No. 1 Weinland water-power, ball-bearing machine which is so well known to the users of tube cleaners. These cleaners have been sold in nearly every country on the face of the globe, and the manufacturers make a specialty of foreign trade.



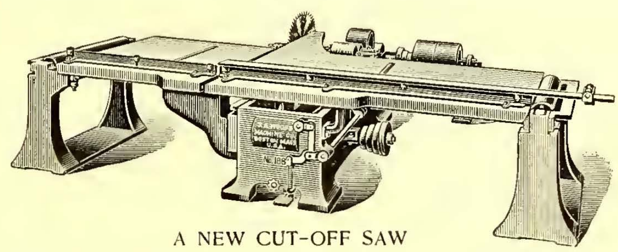
IMPROVED BOILER TUBE CLEANER

The new open smoking cars being run on the New York elevated lines are highly appreciated by the public.

An Improved Railway Cut-Off Saw

The heavy power-fed railway cut-off saw illustrated herewith has been recently placed upon the market by the S. A. Woods Machine Company, of South Boston, Mass., and is designed for cutting up lumber into accurate lengths. It will cut off timbers 14 ins. x 16 ins., or boards 30 ins. wide, and carries saws up to 40 ins. in diameter. It is claimed to be heavier, stronger and more rigid in construction than other machines upon the market, being adequate for the heaviest work.

The saw carriage is operated by power feed, with three speeds. It is under control of the operator by the action of a treadle, and is provided with quick automatic return. A tension device for the driving belt keeps the latter tight, and the pneumatic pulley on the saw arbor affects a saving of some 25 per cent to 35 per cent in power, being so arranged as to prevent air-cushioning of the belt. The arbor may be made long, so as to enable the operator to use a gaining head, when so desired. The rolls in the table support the stock and permit its easy movement. The table can be lengthened by an attachment of wood or iron as desired, for which additional floor stands, each containing a roll, can be supplied.



A NEW CUT-OFF SAW

The fence or gage is extra heavy, and adjustable stops are furnished, which can be quickly set for duplication of work. The stop bar as made is interchangeable, with fences on both sides of saw. With the countershaft, which is self-contained, is included the company's patent self-oiling loose pulley. Where much heavy cutting is to be done, this machine is very useful, and will pay for itself within a short time. It will do the work of several old-style saws at less expense, and is therefore a machine that will help the user keep down the pay roll, and at the same time, get out the work. One of these machines was recently shipped to the Rochester Street Railway, Rochester, N. Y., where it is highly appreciated.

The manufacturers are doing a large business in the street railway field with this and other high-grade car-shop woodworking machines, and their tools are rapidly becoming the standard equipment for this line of work.

Cord for Street Railway Service

The importance of details in the equipment of rolling stock is highly appreciated by master mechanics of those roads which are taken as examples of good management. One of the most frequent causes of trouble to the conductors is the breaking of the trolley rope, bell cord or register cord, and the only preventive for this annoyance is to purchase only such cord for these various uses as is made especially for street railway conditions. The Sampson Cordage Works, of Boston, Mass., are manufacturing a line of solid braided cords, wire center cords, waterproof cords, etc., which have been in general use for a number of years, and which have proven far superior to the roughly braided soft cords on the market which wear out quickly by abrasion. The hard, smooth, waterproof surface of the Sampson cord gives it a very long life, and the manufacturers claim for its use, therefore, considerable economy.

Trolley Cars for Weddings

A train of a dozen open trolley cars on the Union Railway was used at New Rochelle, N. Y., on May 28, to carry 200 guests from the railway station to the wedding of a society leader of that aristocratic resort. The guests arrived from New York by special train, and at the station were transferred to the trolley cars.

After the ceremony at the church the guests again boarded the cars and were taken to the bride's home in Pelham Road, where a reception was held. The trolley cars were used because it was impossible to get enough carriages in New Rochelle and the surrounding towns. The motormen and conductors wore bright new uniforms and were well rewarded by the visitors.

Projected Electric Railways in Spain

Consul-General Julius G. Lay reports, under date of May 1, as follows: "A royal decree of March 7 grants a concession to Don Teodoro de Mas y Nadel to construct, within the next six years, an electric railway between the towns of Vich and Amer, in the province of Gerona.

"The capital of 9,000,000 pesetas (about $1,200,000), which is estimated as necessary to build this railway, has not yet been subscribed; but if Señor Mas is as successful in securing capital from foreign countries as other promoters of electric railways have been, it will only be a short time before the road is in operation.

"I have obtained a memorandum of this project, showing in detail the estimated cost of construction, material required, water power available, cost of maintenance, receipts, etc., and plans and longitudinal profile, which I send for the benefit of those interested.

"Contracts for this road will, of course, not be thought of until the capital for its construction is subscribed. I will then report the names of chief contractors, but in the meantime I would advise our manufacturers of electric railway equipment to keep in touch with Señor Teodoro de Mas, of Vich, Spain, and correspond with him in Spanish."

Death of Colonel C. C. Howell

Colonel C. C. Howell, formerly vice-president, general manager and purchasing agent of the Knoxville Traction Company, of Knoxville, Tenn., died at Phœnix, Ariz., a few days ago. Colonel Howell retired from the Knoxville company last January, when the company was purchased by the Railways & Light Company of America, and at once went to Arizona to recuperate. Colonel Howell was born in Watertown, N. Y., and was the son of Cornelius Howell, a millwright. He had few educational opportunities and worked with his father as a mechanic and later in a large machine shop. He attended Ann Arbor University, where he worked to pay his expenses two years. When eighteen years old he went West, where he was connected with many important enterprises. Colonel Howell was for a number of years a resident of Denver, Col., and while there was brigadier-general of State troops of Colorado. It was in 1895 that Colonel Howell went to Knoxville, and from that time until he resigned from the Knoxville Traction Company he was closely identified with the growth of the company. He was a moving factor in nearly every public enterprise and his energy and clear insight were felt in many quarters. No sooner had he come to Knoxville than he went to work to rebuild the Knoxville Traction Company's system. He brought about the consolidation of the Knoxville Traction Company and an important independent company a few years after becoming connected with the Knoxville company. But Colonel Howell did not confine his busy life to street railroading. He was also manager of the Knoxville Electric Light & Power Company. He was a member of the board of directors of the Chamber of Commerce, and one of its most earnest workers. He was organizer and president of the Tennessee Gas & Coke Company. Colonel Howell was State Senator, too, and would have accepted a renomination had not his health failed. He is survived by a wife and two daughters.

New England Street Railway Club

The last monthly meeting of the New England Street Railway Club to be held before fall took place in the Walker Building of the Massachusetts Institute of Technology, Boston, on Thursday evening, May 29, with President Farrington in the chair. The feature of the evening was an address upon polyphase-alternating-current methods, given by Professor Clifford, of the Institute. Professor Puffer was expected to deliver a lecture upon this subject, as announced, but was unavoidedly absent. The lecture was devoted mainly to an exposition of the principles of three-phase transmission, illustrated by two small generators driven by a motor, and wired to step up and step down transformers operating in the lecture room in front of the audience. Phasing lamps and switches were wired up with the generators in such a manner that the effect of throwing the two machines in multiple, under various conditions of phase displacement, could be seen readily. A small transmission line was also run across the room.

Professor Clifford stated that in his opinion no great difficulty would be found in operating the direct-current sides of double-current generators in multiple with ordinary direct-current machinery if the loads were not severely fluctuating. In the latter case he considered the use of storage batteries advisable, in order to smooth out the instantaneous peaks of the load diagram.

A baseball challenge of the Boston & Northern Street Railway Company was read and accepted, the game to be played in the near future.

New Publications

Konstruktionstafeln fur den Dynamobau. By Prof. E. Arnold. Two board portfolios of sixty sheets each. Price per portfolio, 20 marks. Ferd. Enke, Publisher, Stuttgart. Third edition.

This is a new edition of the work originally issued by Prof. Arnold several years ago, which became well known from its merits to dynamo designers both in Europe and this country. As in the case of the previous edition, the work consists of two portfolios of sheets, one portfolio containing sixty sheets relating to direct-current machine design, and the other the same number of sheets relating to alternating-current design. The large number of machines represented are the designs of the leading European manufacturers, such as the Allgemeine Electricitäts Gesellschaft, Brown, Boveri & Company, Ganz & Company, Oerlikon Works, Lahmeyer & Company, etc. Wherever the author has been enabled to obtain full data of the machines, these are given on data sheets accompanying the designs. In the case of the majority of the designs, the electrical and magnetical data are extremely complete. Most of the sheets of designs are fully dimensioned, and it is to be surmised that where dimensions are lacking, it is not the fault of the author.

Taken together these portfolios give almost a complete view of the present state of European design with respect to direct-current and alternating-current machines, and should, therefore, be of the highest value to those interested in dynamo design. That Prof. Arnold has been enabled to thus present in greater or less detail the designs of the leading European manufacturers is notable, as showing the difference of policy between European and American manufacturers with respect to divulging details of their designing department.

NEWS OF THE WEEK

Canton, New Philadelphia & Coshocton Railway Company

The Canton, New Philadephia & Coshocton Railway Company has been incorporated recently for the purpose of connecting the Ohio cities named in the title by interurban electric railway. This will include the line already built between Canton and Massillon, and will further connect Navarre, Justice, Beach City, Strasburg, Canal Dover, New Philadelphia and Coshocton. The line from Navarre to New Philadelphia, 24 miles, will be built this year. The construction from New Philadelphia to Coshocton this year will depend upon the state of the supply market. L. E. Meyers, of Chicago, will do the construction work. The officers of the company are: P. L. Saltonstall, of Boston, president; L. E. Meyers, of Chicago, vice-president and general manager; Chauncy Eldridge, secretary and treasurer; John C. Weltz, general counsel.

Merit System of Discipline at Kansas City

On June 1 there went into effect on the lines of the Metropolitan Street Railway Company, of Kansas City, Mo., a new system of discipline fashioned after the Brown system, described in the Street Railway Journal recently. A list of merits and demerits has been posted at each car house of the company, together with a general order which thoroughly explains the workings of the system. The company has for some time been at work on a system that would adequately meet the requirements of its service, and the general feeling, both among officers and men, is that there has been worked out a system which will work greatly to the benefit of the men, and one that will result in making even more cordial than before the close relations between the company and its employees. The company will make such changes in the present system as may seem necessary after it has been given a thorough test.

Improvements at New Orleans

As far as magnitude is concerned, the consolidations at Atlanta, Birmingham, Savannah, Richmond, Norfolk and other Southern cities in which the railway and light interests have been brought under one management pale into insignificance when compared with the consolidation of the railway and lighting interests of New Orleans. With capital liabilities of $80,000,000 and systems that are most orderly, the question arises as to what changes and betterments are to be made by the New Orleans Railway Company in the various systems that it will hereafter operate as one. According to the financial plans already made, $7,154,000 will be set aside for future extensions and improvements. First of all, according to the plans of the company, there will be unification of the power distribution system, and to aid in carrying out this plan a large new power house to cost between $2,000,000 and $3,000,000 will be erected, it is said. This will mean that some of the present plants will be dismantled, while others no doubt will be kept as auxiliaries. Next to the building of the new power house probably the most important work will be the erection of large new car and repair shops. The company now has orders outstanding for about fifty new cars, and it is said that when the new car shop is built the company will build its own cars. At the present time there are a number of small houses, each of which is particularly well adapted to the needs of its particular system, but the consolidated company plans to build one, perhaps two, large houses, which will meet the demands more effectively than the present houses. Of course there will be physical connections between the various lines, and it is possible that there will be a general readjustment of lines. A universal transfer system such as has never before been enjoyed by the residents of any Southern city, will be inaugurated shortly, it is said.

Vestibuled Cars in Boston

The Massachusetts Railroad Commission decided on May 27 that the ends of all winter cars operated by the Boston Elevated Railway Company must be provided with vestibules before Jan. 1, 1905. The law under which this work is required (Chap. 414, Acts of 1900, Massachusetts Legislature), allowed the Railroad Commissioners to use their discretion in having the vestibuled cars introduced, and also to reverse or revise their decision regarding the cars of the particular company if they saw fit; consequently, though the Boston Elevated petitioned last year to be exempt from the law, the commission, finding that vestibuled cars were being operated in other cities, and that nothing had occurred in the history of the companies using vestibules to warrant changing back to the open ends, decided that the Boston Elevated ought, at least, to try some of the vestibuled cars and determine if the conditions would be as dangerous as the company's officials feared. Thirty-six cars, chiefly on the Neponset line, were accordingly placed in operation early last winter, and on May 19 the commissioners had before them the officials of the company, for an inquiry as to the results of the test, advising the company that it would require actual proof of any claim that there had been any accident that would not have occurred except for the vestibuled or enclosed platform. The inquiry was made privately, but it is understood that the company's facts, instead of showing danger from the use of vestibules, were rather to the contrary. At the time appointed the representatives of the company presented the record of experience in the use of vestibuled cars, contending that a further period should be given it for testing safety in operating these cars. After an examination of the evidence presented the commissioners sent a letter to the company stating that the figures examined were taken on a route where the company claimed the severest test would be made and on a sufficient number of cars to render the result accurate. The record showed that there have been fewer accidents from collisions with other cars, vehicles or persons than in the case of cars without vestibules, and no such accident has apparently taken place the cause for which can be said to have been the use of vestibules. While the number of accidents reported to persons getting on or off the cars indicates a lack of familiarity on the part of the traveling public in their early use, the figures presented by the company do not prove that there is necessarily any greater liability to accident of this kind in the use of these cars. The commissioners have therefore decided that all winter cars must be equipped with vestibules according to the order of Dec. 31, 1900.

Consolidation in Rhode Island

The details of the plan by which the United Gas Improvement Company proposes to take over the United Traction & Electric Company, of Providence, R. I., have been made public, and while it is said that negotiations are under way with this company only, the general impression prevails that the United Gas Improvement Company plans to absorb the gas and electric companies of Providence and vicinity. The United Gas Improvement Company will organize a new company, the Rhode Island Company, subscribing for its $2,000,000 stock at par. The Rhode Island Company will lease the United Traction & Electric Company, guaranteeing expenses, interest charges and 5 per cent on the stock. The United Gas Improvement Company, in turn, will guarantee fulfillment of the obligations of the latter until such time as $4,000,000 of the new property shall have been added to the United Traction & Electric Company's property. There will be organized under the laws of New Jersey another company, known as the Rhode Island Securities Company. The capital of this company will be $20,000,000, and there will be authorized an issue of $20,000,000 thirty-year bonds. The United Gas Improvement Company will deposit the $2,000,000 stock of the Rhode Island company with the Securities Company and will receive $3,500,000 of its 4 per cent bonds and $12,000,000 to be subsequently given as a bonus to the traction stockholders in the proportion of one to four, upon acceptance of terms shortly to be offered them.

Seven Years' Litigation Result in Victory for Trolley Interests

After seven years' litigation the Philadelphia, Bristol & Trenton Street Railway Company has gained a decisive victory over Henry L. Gaw, Jr., and established the right to lay tracks and build overhead construction in front of his property at Croydon Station, two miles from Bristol. Judge Yerkes, of the Bucks County Court, in Pennsylvania, handed down the decision on Monday, May 19, which terminates this eventful controversy. The case has frequently been referred to in these columns during the progress of the controversy, and a brief summary of the principal features will suffice here. Incidentally it may be mentioned that during the progress of this controversy, the railway interests were compelled to take out nine distinct charters, the last of which was that of the Bristol & Neshaminy Elevated.

After fighting through the courts for several years the predecessors of the Philadelphia, Bristol & Trenton Company practically secured the right to cross the lands in dispute by means of the Bristol & Bridgewater Railway charter, which was taken out under the steam railroad act, when the Focht-Emery law was passed by the Pennsylvania Legislature on June 7, 1901, prohibiting the running of trolley cars over steam railway tracks. The same law, however, provided for the building of elevated railways, and the Neshominy company was chartered two days previous to the passage of an amendment, which allowed "elevated railways hereinafter incorporated to operate only in cities or other congested communities," which could hardly apply to the rural districts around Croydon. The Neshaminy company fought the battle all over with Mr. Gaw, but it had the right of eminent domain and eventually secured the right to pass over the 1200 ft. of land in dispute by giving a bond to the Bucks County courts in the sum of $20,000, which was done. Scarcely was work begun on the elevated road when the Pennsylvania Company, which has backed Mr. Gaw in his legal fight, sent a force of men to the scene, and a hand-to-hand fight was only averted with much trouble.

A temporary injunction was secured from the Bucks County courts by the Pennsylvania Company and Mr. Gaw, upon the ground that the bond given was totally inadequate to the damages that might accrue, and on the additional claim that the Focht-Emery act was unconstitutional. It was this temporary injunction that was dissolved on Monday by Judge Yerkes.

The opinion handed down by the judge reads much like a romance in some ways, but he upholds the Neshaminy company in every point of law raised again: the injunction's permanency. Judge Yerkes holds that the former attempts to get the Philadelphia, Bristol & Trenton Railway (then operating as the Philadelphia, Frankford & Bristol) have no bearing upon the present case, except in so far as they review the history of the road and show the tenacity exhibited by the trolley company. The fact that the Neshaminy Elevated will be but a link in a chain of roads also has no bearing upon the case, he says, because such consolidation or continuation of lines is recognized by the State laws.

Judge Yerkes says that it is not his duty to criticise the acts of the Legislature, especially wherein it allows elevated railways to be built in country districts, because it is a law-making body, and the duty of the court is to enforce, not to make laws. The Pennsylvania Company raised the point that the Bristol & Bridgewater Company already covered this route, and would be injured by the building of an elevated road, but the judge sets this point aside on the ground that a third party cannot take up the alleged wrongs of another unless asked to do so and having a direct interest in the same.

Regarding the Pennsylvania's claim that the amendment to the Focht-Emery law prohibits the building of elevated railways in the country, Judge Yerkes says that this amendment especially provides that "companies hereinafter incorporated" shall be affected by the amendment, but says nothing about companies already incorporated, previous to June 20, 1901. The bond of $20,000 and the method of securing the property owner or owners, he holds to be according to law, and a just protection to all concerned.

The decision of Judge Yerkes was watched very closely by the trolley interests throughout the State of Pennsylvania, and particularly by the new companies incorporated under the Focht-Emery act for the purpose of building elevated and subway lines in Philadelphia, Pittsburg and other cities. The knocking out of the law by Judge Yerkes, if followed by a concurrence in the Supreme Court, would mean a complete upheaval and render valueless great franchise rights. It is understood that the transfer of the Union Traction lines, in Philadelphia, to the new rapid transit interests, were delayed until this case was decided. It may be merely a coincidence, but it is said that the papers in the transfer were not signed until an hour or two after Judge Yerkes' decision.

W. F. Sadler, Jr., general manager of the Philadelphia, Bristol & Trenton, the Bristol & Neshaminy Elevated, and contingent lines, told a Street Railway Journal representative when the decision was announced that his company would begin work at once, and would erect a steel elevated structure sixteen feet above the ground, over the 1200 feet of land in front of the Gaw place, with the approaches on the 4000 feet of land which he has recently acquired. An appeal to the Supreme Court will not interfere with the work now, and he added that it would not be long before the road was extended from Bristol to Trenton, as he has all the franchises and charters for that route. This will complete the trolley line between New York and Philadelphia, counting in the Trenton & New Brunswick Railroad, now building.

ENGINEERING SOCIETIES

THE CANADIAN ELECTRICAL ASSOCIATION will hold its twelfth annual convention, as already announced, on June 11-14, at Quebec. The Chateau Frontenac will be the headquarters of the association, and arrangements have been made with the railway companies for reduced rates. The general business of the association will be transacted in the Council Chamber of the City Hall. Visits will be made to many of the interesting electrical installations in the vicinity, and a number of papers relating to street railway matters will be presented. Among the subjects selected are the following: "The Electrical Equipment of an Ordinary Street Car," by A. B. Lambe, Toronto, Ont.; "The Use of Storage Batteries and the Electrical Distribution System," by A. A. Dion, Ottawa, Ont., and "Electrical Suburban Railways," by E. A. Evans, Quebec.

PERSONAL MENTION

MR. C. S. COLTON, formerly assistant manager of the Cleveland works of the Westinghouse Electric & Manufacturing Company, has accepted a responsible position with the Union Electricitäts Gesellschaft, of Berlin, as assistant to Mr. F. S. Drake, general manager. Mr. Colton will be located at the works at Charlottenburg.

MR. RODNEY CURTIS, for ten years president of the Denver Tramway Company, of Denver, Col., has resigned, and Mr. W. G. Evans, secretary of the company, has been advanced to the position. Mr. William N. Byers, for many years a member of the board of directors, has resigned from the company, and his place on the board has been filled by Mr. John A. Beller, manager of the company, who also has been made vice-president of the company.

MR. T. A. ESTEP, president of the R. D. Nuttall Company, Pittsburgh, Pa., expects to attend the International Street Railway Association's convention in London next month. His firm will have an extensive exhibit at the Agricultural Hall of its well known gears and pinions, which have already found a ready sale in European countries. Mr. Estep will probably meet a large number of friends from this side of the water while making new ones in England.

MR. GEORGE H. ANGER, of Wilmington, Del., expects to sail for England on June 7, in the interest of his father's inventions, and also with a view to establishing a company to manufacture the articles of railway equipment under his control. Among these is the new automatic brake adjuster, described a short time ago in these pages, a number of which are now in satisfactory operation on many roads in this country, notably in Wilmington and Baltimore.

MR. W. E. HAYCOX has resigned his position as general manager of the Ohio Central Traction Company and also of the Mansfield, Crestline & Galion Railway Pool. Mr. Haycox expects to take a much needed rest this summer at Magnetic Springs but has not decided upon his future connections. He has had a large experience in the street railway business and leaves the company with the most friendly feelings, the president, Mr. F. T. Pomeroy, expressing himself as highly pleased with the administration of affairs under his direction as general manager.

MR. EUGENE CHAMBERLIN, superintendent of equipment of the Brooklyn Heights Railroad Company, has resigned, his resignation taking effect June 1. Mr. Chamberlin has held the above position for nearly three years, during which time he has had charge of the entire repair departments of both the elevated and surface systems, and has introduced many reforms both in the reorganization of the Fifty-Second Street shops and in the outlying repair shops distributed throughout the borough. Before coming to Brooklyn Mr. Chamberlin had devoted his energies to steam railroad work, leaving the service of the New York Central & Hudson River Railroad, where he had held the position of master car builder of the Western Division, Syracuse and Niagara Falls and leased lines for eight years, to enter the street railway field. Since then he has developed many ingenious methods and machines for the repair shop, and done much toward standardizing the electrical and mechanical equipment of the railway's rolling stock. Members of the American Street Railway Association will remember the novel type of combination car with individual revolving seats, which formed the subject of his interesting paper before the New York convention last year. A large number of these cars are now in operation, with most gratifying results, from both the passengers' and railway's view point. Although having had no experience in street railway work before coming to the Brooklyn Heights Railroad Company, Mr. Chamberlin has become a most enthusiastic electric railway man, and will probably continue in that work. As yet, however, he has made no definite arrangements for the future.