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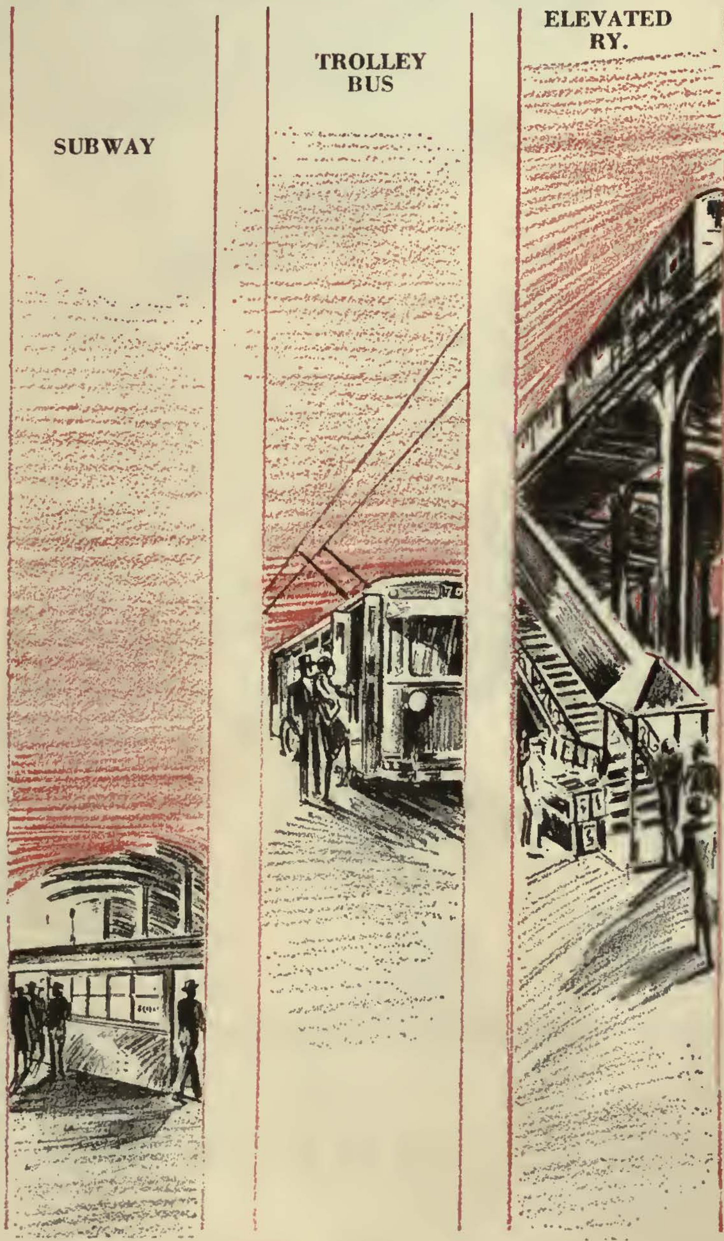

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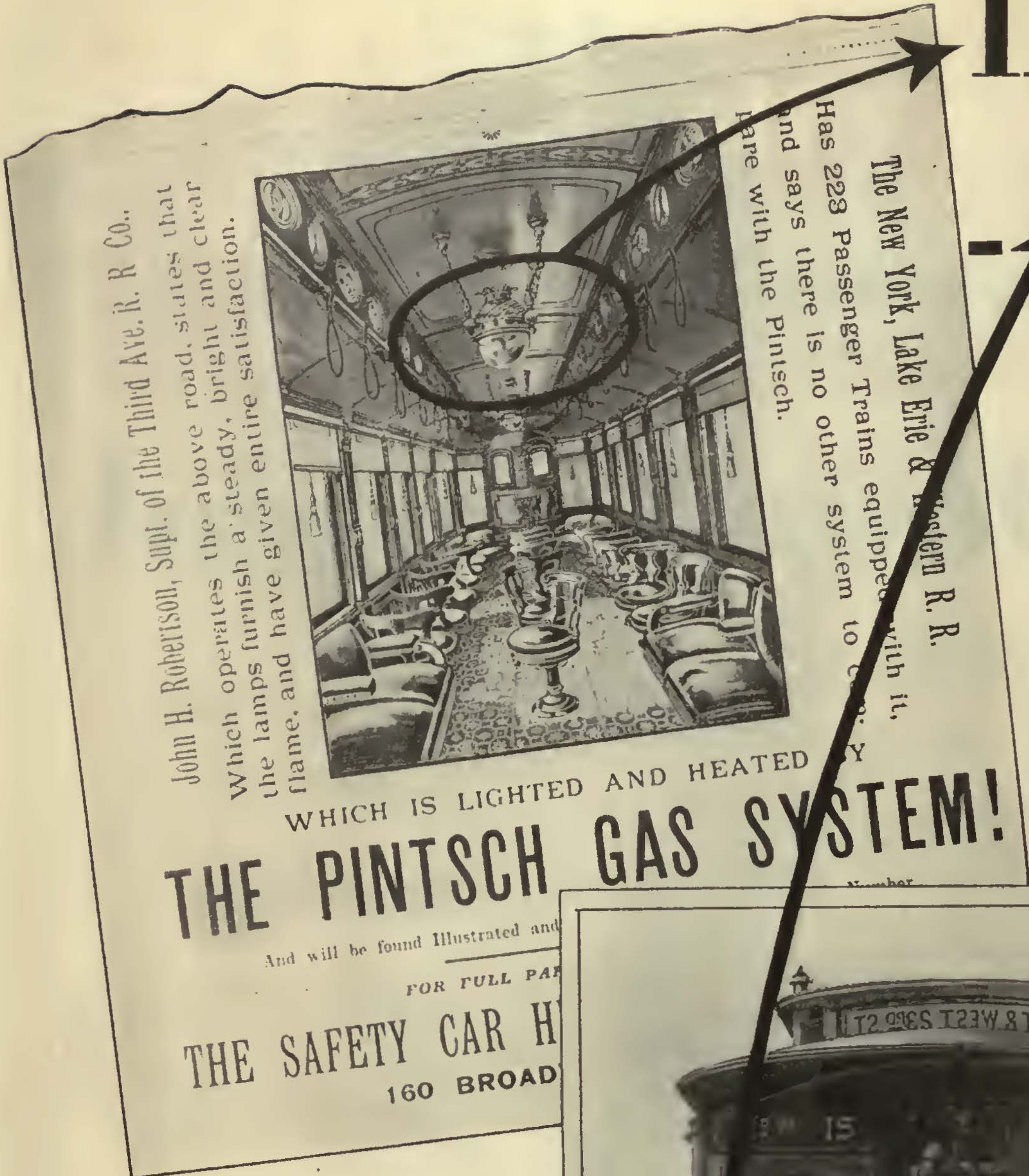

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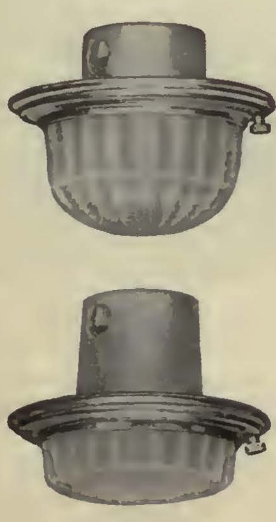

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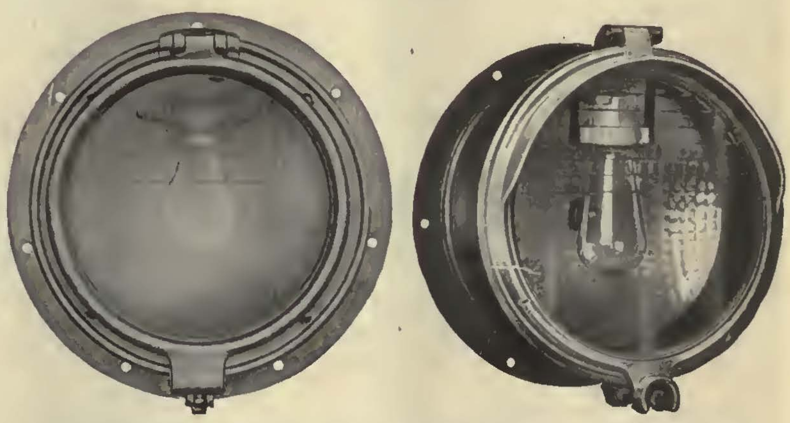

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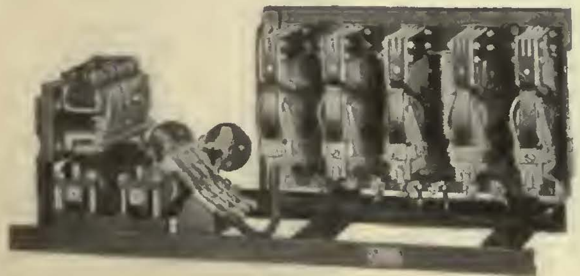
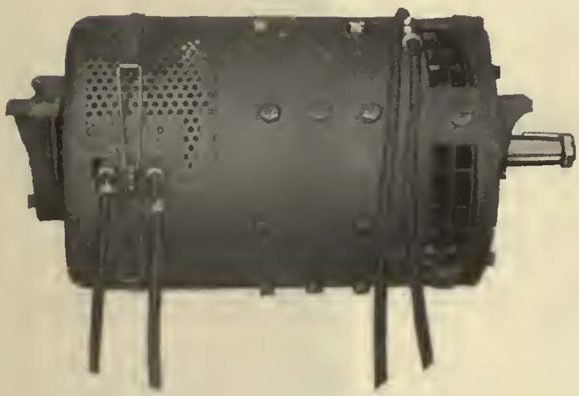


Type M group with master controller, reverser, and contactors



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ELECTRIC RAILWAY JOURNAL

Volume 75
Number 10

Consolidation of Street Railway Journal and Electric Railway Review

A McGraw-Hill Publication—Established 1884

JOHN A. MILLER, *Editor*

New York,

September 15, 1931

Building on the Experience of

A Half Century of Progress

Foreword by
JAMES H. McGRAW

COMMUNITY TRANSPORTATION in America is still a comparatively young industry. Less than 50 years have elapsed since the first practical application of electricity as a motive power for street cars. Some of the men prominent in the electric railway industry today have been actively associated with it since its birth. Over its problems they have worked and worried, argued and amplified, planned and perfected. Its progress and improvement have been their first concern, and they have good reason to be proud of their accomplishments.

From modest beginnings the business of community transportation has grown to be one of the great industries of the country. Not only has it increased in size but it has also broadened tremendously in scope. Fifty years ago community transportation and street railway service were synonymous. Today the street car is still a vital element in urban transportation, but it is not the only element. On the one hand it has been supplemented by rapid transit lines and electrified suburban railroad lines, and on the other by the motor bus and the trolley bus. For individual service it has been supplemented also by the taxicab. Slowly but surely the services of these different elements are being co-ordinated. The street railway operator of yesterday has become the transportation merchant of today.

New types of rapid and comfortable transportation service, undreamed of a half century ago, have been developed. These developments in turn have been responsible for a great change in the distribution of population. Even more significant, perhaps, is the change that has taken place in the travel habits of the people. Once they were accustomed to live and move within a comparatively small orbit. Now the situation is vastly different. We have become a fast-moving travel-loving nation. We like to go places, and not waste any time about it. We have become thoroughly transportation conscious, with a well-developed sense of travel discrimination.

Our cities are expanding and their populations are increasing at an accelerating rate. People are using more transportation today than at any previous time in the history of the world. Public transportation service must keep pace with these developments. We must meet the constant demand for new facilities. But we must do more than that. We must furnish the kind of transportation the public wants. People today have no more liking for old-fashioned styles in transportation than they have for old-fashioned styles in clothes. If the history of this industry shows any one thing more clearly than others, it is the inevitability of change.

Modern demands can be met only with modern standards of service. Whether the vehicle be an electric rail car, a gasoline motor bus, a trolley bus or a taxicab, its design and operation must be attuned to the times. Interest is now focused on this subject to a greater extent than ever before. The problems presented are complex and difficult, but not more so than those which the industry has solved successfully time after time. When the history of transportation during the next 50 years is written, it will record new names and new achievements worthy to stand beside the famous names and great achievements of the past half century.

WHERE once the horse or mule car wended its almost solitary way carrying occasional passengers, the modern electric car now carries vast multitudes intent upon speed despite congestion undreamed of in an earlier day

By
JOHN H. HANNA
President
American Electric Railway Association
President
Capital Traction Company
Washington, D. C.


The picturesque horse-drawn omnibus on Broadway, New York, a century ago—the forerunner of our modern transportation vehicles

Evolution of Community Transportation

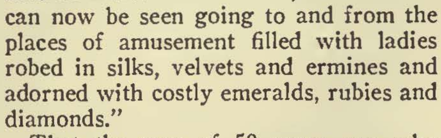
MASS TRANSPORTATION in the cities of this country was by no means an infant 50 years ago. It was already 50 years old, and was an industry of considerable importance. Nearly 400 years before some inventor had discovered that wheeled vehicles would move more readily and easily if a track of some sort was provided for them, but this discovery did not bring about the extensive use of rails until the development of the steam railroad.

Horse-drawn vehicles carrying both freight and passengers were used on Fourth Avenue in New York in 1832, and even before that freight had been moved by this means, but in a desultory fashion. While the growth of the horse street railway was rapid throughout the '50s and '60s, there was no attempt at a co-ordinated system which would care for the entire needs of the community. Every large city in this country and many of the smaller ones had one or more street railway systems meeting their transportation requirements. These roads were managed by men who, judging from their records of achievement and public utterances, were well up to the high standard of ability which we believe our industry enjoys today.

Fifty years ago there were 415 such companies, operating 18,000 cars over 3,000 miles of track, and utilizing the services of more than 100,000 horses. They carried nearly 1,250,000,000 passengers per year, and had a combined capitalization of $150,000,000.

The place which the street car occupied in the cities of that time is described in the following words of the Honorable Moody Merrill, of Boston, at the opening meeting of the first convention of street railway men, which was held in Boston on Dec. 12, 1882: "Cars can now be seen going to and from the places of amusement filled with ladies robed in silks, velvets and ermines and adorned with costly emeralds, rubies and diamonds."

That the men of 50 years ago who carried the responsibility of urban transportation were progressive and alive to their responsibilities is best shown by the encouragement and support given to the early developers of electric traction, and the rapidity with which that system was adopted after its feasibility had been established. Prior to that time, particularly in the '70s and early '80s, great improvements in horse car service had been accomplished. Frequency of service was increased, and the later cars, with their highly decorated exteriors, contained added conveniences for patrons, showing a realization of the need of public approval. This point of view was expressed in many spoken and written utterances of the day.


America's first street car, the "John Mason," placed in service on the New York & Harlem Railroad in 1832

The first decade of the past 50 years was the period of experimentation in electric propulsion. A Vermont blacksmith, Thomas Davenport, apparently was the first to conceive the possibility of using electricity for moving a vehicle. He built and exhibited a small electric motor car in 1835. Later experiments by Professor Farmer, of Newport; Professor Page, of the Smithsonian Institute, and others made further progress. Professor Page, in 1851, was able to propel a small car over 5 miles of track near Washington at the unheard of speed of 19 m.p.h. His des-

For many years the animal-drawn street car reigned supreme

One of the early experiments in electric operation utilizing an overhead "troller" carriage—progenitor of the trolley

On some of the early installations small electric locomotives were used to draw the passenger cars

tination was the famous dueling grounds at Bladensburg, which may have been significant, as his primary batteries, his only source of power, were entirely destroyed when he got there. All of these experiments were doomed to failure until the development of the power-driven dynamo, and the discovery that the dynamo would function as a motor when current was applied to it.

Edison's Menlo Park car in 1880 and Van Depoele's at the Toronto Industrial Exposition in 1884, with other early and valuable work by John C. Henry, Leo Daft, Professor Short and others, all culminated in the first large commercial electric railway, built by Frank J. Sprague in Richmond in 1888. Without in any way discounting the importance of earlier experiments, it was Mr. Sprague's success in Richmond that was the foundation stone of the electric railway.

In the meantime, while awaiting the development of a suitable electric system, many other means of substituting mechanical for horse power were tried. The most important of these was, of course, the cable road, such as had been used for years in mines, and which was first developed for passenger transportation in San Francisco in 1873. The cable system was extremely costly to install and operate, but furnished a reliable, convenient means of transportation. While slow, as measured by modern standards, cable car speeds of 10 to 12 m.p.h. were twice as fast as those attained with animal power, and cable lines furnished the backbone of city transportation for a number of years in many of the larger cities. The cable system was a wonderful engineering development; its acceptance and widespread adoption were further evidence of the courage and progressiveness of the early leaders.

Numerous other means of propelling public vehicles were tried during this period but were found wanting. Steam locomotives, while giving acceptable service on elevated lines, were found unsuitable for obvious reasons on city streets. Storage battery cars were strongly urged, but failed to give satisfaction because of added weight, the time necessary for recharging the batteries, and their short life. Compressed air cars were operated from storage tanks and attempts were made to use pipe lines along the track. Both methods were short lived. Various forms of chemical motors using caustic soda or ammonia gas appeared and rapidly disappeared in the frenzied search for a substitute for the horse and mule, but the many advantages of the electric motor, fed by current generated at central stations, soon drove all other competitors from the street car field, except in such unusual conditions as the steep hills of San Francisco where cable cars still run.

After Sprague's success in Richmond, the growth of overhead trolley lines was marvelously fast. The Richmond operation began in February, 1888, and before the end of that year about 25 other roads in all parts of the country were using electric propulsion, not as an experiment, but as a permanent basis of their transportation systems. As many more were under contract.

Successful use of electricity resulted not only in the rapid elimination of horse and cable lines, but also in a sharp growth in total street car mileage. In 1887, just before the opening of the Richmond system, there were only 29 miles of electric road in the country, 357 miles of cable lines, and approximately 5,000 miles of horse car lines. Ten years later the electric mileage was 13,765. Cable roads, which had reached their peak in 1893, had been reduced to 539 miles, and only 947 miles of horse car lines were left. Another decade increased the electric mileage to more than 34,000, and left only 62 miles of cable and 136 miles of horse-car lines. Much of this horse-car mileage was in New York, which operated the first horse car in 1832, and the last one, which clattered and jingled on its final trip in 1917.

The year 1890 found the electric system definitely established as a practical means of furnishing street car service, and growing with astonishing rapidity. The total investment in the industry had increased to nearly $500,000,000—more than three times that of ten years before. Similar increases, though not quite to the same extent, were shown in the length of line, number of cars and passengers.

The "Gay Nineties" represents perhaps the most important decade in the history of electric transportation. It was marked principally by engineering developments and improvements in the electric system, the utility of which had been established in the previous decade. In 1890, 500-volt standard pressure was adopted on practically all systems. It was found that equipping the old horse cars with motors did not meet the needs, and double-truck cars 30 to 40 ft. long were introduced in St. Louis and Boston. It marked the beginning of the vast number of improvements in rolling stock which have since continued uninterrupted.

The first street car motors had been placed inside the car or on the platform, belted to the car axle. These soon were replaced by motors supported on the axle. At first a single gear reduction was used, but with the light motors had to be replaced with double-reduction gears. Single-reduction motors returned in 1890, and were soon adopted generally. The first motors were open, but these were soon superseded by so-called waterproof motors with tight cast-iron casings. Today's tendency toward the use of ventilated motors and high-speed armatures with a multiplicity of gears or worm drive is an interesting throwback to the early design.

Track construction, too, was radically changed. Heavier rails were found necessary. The opposition of municipal governments to the use of T-rails brought about the girder rail design, and the many inventions of improved rail joints naturally followed.

This period was marked by many consolidations of both operating and manufacturing companies. The first holding company, McKee Syndicate, composed of New York, Pittsburgh and Philadelphia bankers, acquired numerous properties, and the general tendency was for the co-ordination of the many railway companies of each city into a single system. In the '80s numerous manufacturing companies were in active competition for the street railway business. But consolidations were soon in order. In 1890 the Edison General Electric Company, formed by a merger of the various companies carrying Mr. Edison's name, combined with the Sprague Electric Railway & Motor Company. In the meantime, the Thomson-Houston Company, of Boston, had acquired the patents and interests of Messrs. Daft, Van Depoele, Bentley and Knight. These two large companies were in keen competition, in which they were joined in the same year by the entrance of the Westinghouse Company into the traction field.

In 1892 the Thomson-Houston Company the the Edison Company consolidated, establishing the General Electric Company, which, with the Westinghouse Company, has dominated the business since. These two great companies, through their progressive policies and their scientific research, have made possible the tremendous growth of electric traction.

Invention of the three-phase system of power transmission, first made applicable to railway work in 1894, tremendously broadened the scope of electric railway development. Prior to that, the limitation of 600-volt d.c. transmission limited the use of electric cars to comparatively short lines. The possibility of transmitting large amounts of electric power economically over long distances completely changed this situation. It marked the beginning of the interurbans which played such an important part in the development of the country, and which made possible the spread of population from the congested districts of the cities to the suburban areas.

The same period saw an elevated electric railroad at the Chicago World's Fair and the beginning of electric operation on the elevated roads in Chicago,

Thomas A. Edison and a group of friends riding on his experimental electric railway line at Menlo Park in 1880

both of which were of far-reaching importance. The latter was the forerunner of rapid transit systems, without which the larger cities in this country or abroad could not exist. The year 1895 also saw the first permanently successful conduit electric system developed, by Albert N. Connett, on the Metropolitan Railroad's lines in Washington. Other forms of conduit systems had been tried in Washington and European cities but had not been satisfactory. Mr. Connett's work made it possible for the cities of Washington and New York, where the overhead trolley wire was banned, to take care of their transportation needs by a more satisfactory plan than by cable or horse power.

The first practical use of electricity for steam railroads was made in 1895, when the Baltimore & Ohio Railroad placed its electric locomotives in tunnel service at Baltimore, and the New Haven Railroad equipped its Nantasket Beach line for electric operation. The B. & O. locomotives were a remarkable engineering achievement, and continued to furnish satisfactory service for many years. The advantages to passengers of the elimination of smoke and cinders in terminal tunnels were clearly shown by this undertaking and resulted in the adoption of similar systems in New York and elsewhere.

Consolidations continued to take place; the Boston Elevated leased for a long term the West End Street Railway, one of the largest systems in existence; the elevated lines in New York were electrified; and in January, 1900, the first contract was let for a rapid transit subway system in New York.

The end of the century found the industry well stabilized financially, and, from an engineering point of view, with a total track mileage in excess of 20,000, of which 95 per cent was electric. The investment had grown to nearly $2,000,000,000, and the railways were carrying 4,500,000,000 passengers annually in 62,900 cars.

The early years of the century were marked even more than the previous period by consolidations of operating companies throughout the country, and by the electrification of the Pennsylvania Railroad and the New York Central lines entering New York City.

About the beginning of the twentieth century, a development took place which was to have a marked effect not only on street railways, but on all forms of transportation. Horseless vehicles had been talked about for years, but when the first crude automobiles began to appear on the streets, few people even dreamed of the important effect they would have on our future social life. Street car managers who had been worried temporarily by the bicycle craze of the early '90s thought, if they gave any serious consideration to the matter, that this was merely another passing fancy. The bicycle was responsible for the invention and development of the pneumatic

Steam dummies and passenger trail cars held an important place in the industry for some years

rubber tire, and it was this invention, coupled with the improvement of the internal combustion engine, which made possible the tremendous growth in the use of motor vehicles and which entirely changed the aspect of the transportation business both in and out of cities.

By 1910 automobiles had become a common sight on city streets and country roads. Their influence was beginning to be felt by public carriers of passengers. Before that time no surburban developments were thought of unless they were accompanied or preceded by the building of a trolley line. The new vehicles had not yet affected, however, the continued growth of electric railways both city and interurban. Electric railway mileage in 1912 was 40,808, nearly double that of ten years previous, the number of passengers was in excess of 9,500,000,000 and the capitalization more than $4,500,000,000, both more than doubled in ten years.

Managers were finding out, however, that there was a limit to the amount of money to be made. Except for the severe business depression of 1893, the street railway business had been uniformly growing, not only in size but in financial strength. It was the aristocrat of the utilities; its securities were in demand and selling at good prices. About this time, though, managers began to discover that this font of gold was not unlimited. The continued extension of service given at the same rate of fare; growing burdens in taxation imposed by municipalities and by demagogical politicians who delighted then, as they do now, in opening their guns at the first sign of prosperity, together with increasing cost of labor, began to affect net earnings so that capital was not as friendly as it had been.

The rapid growth of the automobile industry and particularly the development of cheap reliable cars selling for under $1,000 naturally had made some inroads on mass transportation, but it was only with the appearance of the so-called jitney between 1915 and 1920 that the industry first realized just how serious automobile competition could be. Jitneys, second-hand automobiles operated by private individuals at a 5-cent fare, blazed forth like wild fire, starting on the Pacific Coast and spreading over the whole country. Arguments that this form of transportation could not economically continue to exist and that permitting jitneys to run constituted a direct violation of franchise agreements under which street railways were operating did not prevent the serious inroads which they made for several years. Their life was relatively short and few operate today, but they left a scar on many previously prosperous companies. In 1920, thousands of them were still running, although fundamental economics and regulatory restrictions were beginning to put them out of business.

The jitneys were quickly followed by buses, which at first were nothing more than large automobiles operating under the same circumstances as the jitney but carrying more passengers. The introduction of the bus was fought at first by many railways as strenuously as had been the jitney, but before long it became evident that here was a real transportation tool, and that the trouble was not in the vehicle but the way it was used. The old warfare between rail vehicles and those running freely on highways which had been fought out about the middle of the last century was begun again but under different conditions. Rubber tires and good roads changed the situation and made the fight take on quite a different aspect. Electric railway managers, like their predecessors of 30 years before, were wise;

The early interurban lines following along the winding country roads contributed greatly to the development of countless small outlying villages

they did not long fight the use of the new transportation tool but adopted it for their own, realizing that, while it did not and would not supersede electric railway lines, it had its proper place in the transportation field, and that place would best be filled if all forms of urban passenger transportation were coordinated in one operating unit.

When this country entered the World War in 1917, the street railway industry included 44,800 miles of track—a growth of 30 per cent in ten years. Approximately 80,000 cars, with 295,000 employees were carrying 11,305,000,000 passengers per year, and a total capitalization of $5,136,000,000 was reached.

The War, of course, brought many changes, affecting no industry in this country more seriously than the electric railways. Practically doubled costs of both labor and material were not and could not be completely compensated for by increased fares. More track and more cars were needed to serve the many wartime industries which grew like mushrooms, particularly on the Eastern seaboard. Lessened earnings weakened the financial standing of the industry, and, in many instances these necessary improvements were made with funds borrowed from the Federal Government. There were many receiverships, but the majority of the established systems in larger cities were able to weather the storm successfully. The 5-cent fare, with or without reduced-rate tickets, had been in existence for generations, and there was a great disinclination on the part of the public and regulatory bodies to change it, in spite of the fact that there were few other things which a nickel would buy.

The gravity of the situation and the menace which it offered to municipalities influenced President Wilson, at the suggestion of the Secretaries of Commerce and Labor, to appoint a Federal Electric Railway Commission to investigate the whole matter carefully and report recommendations. Public hearings were held and thousands of pages of testimony were taken, after which the commission made a unanimous report. They found that the industry as a whole was in a serious financial situation and not properly functioning; that in order to remedy this condition economies in operation and improvements of service should be instituted; that financial structures, where necessary, should be adjusted to meet actual values; that unfair assessments, such as paving construction and maintenance of bridges, should be eliminated; that rigid regulatory control by municipal or State governments should be continued; but that this should be flexible in character and provide sufficient revenues to encourage the influx of capital. They particularly urged a prompt and reasonable settlement of franchise problems. This investigation and report had a beneficial effect on the industry as a whole. Generally speaking, its recommendations were followed by the companies and in many instances by regulatory bodies. The result was a reduction in the number of receiverships and a general improvement throughout the industry.

The story of the past ten years is well known. Fares were usually but not universally increased; one-man cars, first developed for smaller cities during wartime difficulties, were found entirely suitable, if properly designed, for large city systems; financial reorganizations, when called for, took place, and many operating economies were effected; and the bus was adopted for supplementing rail operation, or supplanting it in a few instances where traffic was light. These changes brought improvements in the earnings and financial condition of the companies, in spite of the exceedingly rapid increase in automobiles, and the sudden springing up of thousands of cheap, flat-rate taxicabs, operating at low, competitive rates frequently under inadequate regulation.

The present depression found the industry still feeling the effects of the difficulties oppressing it during and following the war and though improving its position gradually but surely, this business has been affected as have all others. Unemployment has severely reduced the number of passengers and the amount of freight handled, with their attending revenues, without much chance of compensating savings in expense. Although some reduction in material prices has taken place, wages of electric railway and bus operators have remained unchanged. The industry's losses have not been as severe as those of many others, and there is every reason to hope that a return to normal business conditions will be accompanied by the satisfactory recovery and stabilization of urban transportation systems.

Any history of city transportation would be incomplete without reference to two of the most important and vital factors affecting it, that is—franchises and fares. In the earliest horse-car days, municipalities welcomed the advent of a more convenient and rapid means of transportation and encouraged its promoters. As soon as the business was found to be profitable, restrictions began to be placed on franchises, maximum fares were established, and the practice was begun of using public carriers as tax collectors by assessing against them many burdens not related to their business. The greater number of franchises were for a limited period of years; fares were fixed at 5 cents, independent of the length of the ride, with tickets at reduced rates in many instances. This arrangement was satisfactory as long as the operating companies were small and their lines short, but it became obsolete when the introduction of electricity led to extension of service beyond the original city limits. When franchises began to expire or when extensions of them were needed, the subject became a much more important one, and many conflicts arose in its settlement. As cities grew, capital in great quantities was required for extending their transportation facilities. This capital was not available unless some assurance was given that it would be safeguarded and paid for. Municipalities demanded lower fares or a share in the profits.

One of the first serious attempts to stabilize the situation was the adoption of the so-called service-at-cost plan in Cleveland in 1910. This plan provided for close regulation by the municipality of all details of service and expense. It established machinery whereby fares would be automatically lowered or raised to meet the actual cost of furnishing the service, including allowances for maintenance, operation and renewals, and a return of 6 per cent on an agreed value of the property, a value materially less than the outstanding capital obligation. It permitted purchase of the property by the city at any time on six months' notice, and laid down the terms under which purchase might be made. This experiment was satisfactory; it resulted in a much improved service to the citizens of Cleveland, and a lower rate of fare until war costs changed conditions. The franchise was extended in 1919 for another 25-year period. After a few years, modifications of the Cleveland plan were established in many other cities of the country, and, while not always entirely satisfactory, the service-at-cost theory presents probably the most satisfactory solution of the franchise problem.

One of the early cars used at Richmond. The success of this installation in 1888 gave great impetus to the electrification of street railways

Among other means of obtaining relief from the difficulties arising from increased costs during and following the World War were studies and experiments in changing the fare structure. All street railways had been operating since their inception on the simplest form of fare structure—the same fare for all service and all lengths of line—although fares varying in proportion to the length of ride had been the rule in other countries. Zone-fare schemes were tried in numerous instances during and after the war, but were generally unsuccessful because of their unpopularity. Suburban communities had been built up on the basis of the flat rate and objected strenuously to having this arrangement disturbed. Weekly and Sunday passes have been tried with varying success, and now are becoming increasingly popular.

Schemes of the same nature intending to encourage the use of public transportation vehicles had been tried even in the '70's and '80's. In Reading, annual tickets were sold, first at $12 and later at $15 and $25. Monthly tickets from $1 to $1.50, limited to certain hours of work days, were tried, as were other forms of cheap commutation tickets. The most interesting experiment was the sale of life tickets at $300 each and $500 bonds with interest payable in tickets to obtain sufficient money to build an extension of the horse car line. This experiment was probably the first instance of the modern practice of customer ownership.

Reference has been made to the adoption of the gasoline bus as a transportation facility. While the fight between highway and rail transportation about the middle of the nineteenth century resulted in a decided victory for rails,

The Metropolitan Elevated in Chicago was the first rapid transit line to adopt electricity. Its advantages were quickly demonstrated and other lines were converted to electric operation

public transportation by horse-drawn vehicles over city streets continued in a number of instances.

Probably the most notable example of long continued use of buses is on Fifth Avenue in New York City. The laying of rails on this famous thoroughfare had been prohibited when early horse car lines were built on Manhattan Island, but the need for some form of public transportation resulted in the operation of horse-drawn stages by the Fifth Avenue Transportation Company in 1885. Experiments with gasoline and gas-electric vehicles were begun a few years later but the first successful operation of motorized buses on Fifth Avenue did not come until 1907 when a number of French chassis with American-made bodies were put in service. The early work of this company had much to do with the development of the motor bus now so extensively used.

The general use of buses by electric railways began about 1920. In that year there were 21 companies operating 110 buses over 35 miles of route. This practice grew rapidly, and five years later 250 companies were operating 4,441 buses over 12,000 miles of route. At the beginning of 1931 there were 390 electric railways operating 13,522 vehicles on 26,099 miles of route. Widely spread statements that buses are rapidly supplanting electric roads is controverted by the fact that only 67 companies, operating an average of 5½ buses each have abandoned all rail operations and substituted buses. Street railway companies now are generally such in name only. The companies and men responsible for furnishing passenger transportation in our cities have assumed the responsibility of giving that service in whatever form the public may desire.

Not only has the gasoline bus been adopted, but in recent years great strides have been made in the use of the trolley bus. This vehicle was tried experimentally many years ago, but only within the past three years have vehicles been perfected which are giving satisfactory service. The first company to make extensive use of the modern trolley bus was the Utah Light & Traction Company, Salt Lake City, which, beginning in 1928, has put a total of 26 in service. The largest trolley bus system in the country today is operated by the Chicago Surface Lines, using 114 vehicles. The trolley bus will undoubtedly take a very prominent place in the transportation systems of the future as it offers, for a certain character of service, many advantages over either trolley car or gasoline bus.

The industry has not confined itself to the use of mass transportation vehicles, but also has adopted the taxicab in numerous instances for supplementing other facilities. The operation of taxicabs by an organized company cannot be successful unless this service is subject to the same sort of regulation applied to the mass vehicle, but the ideal solution of the urban transportation problem undoubtedly lies in the unified control of all forms of public transportation in each community with responsible management and under strict regulatory control.

The problems confronting mass transportation as an industry today are many and at times seem almost insurmountable. The usefulness of reviewing failures and successes of past years may be questioned. Conditions change; methods and practices must change with them; but the fundamental policy of giving to the public upon whom we depend for our existence the best available form of service at the lowest reasonable price has remained unshaken throughout the industry's long and interesting history.

Urban life increasingly requires the movement of persons within and without the city's boundaries. This movement can never be accomplished solely by means of individual vehicles. Mass transportation facilities are required and always will be, and there is no reason to doubt that the successors of the long line of men who have notably carried on this important business in the past will be equally as successful in the future. To do so satisfactorily, they must be helped and not hindered. This is a public and not a private business, but it is contrary to the spirit of this country that the Government itself undertake the operation of any business which can be successfully carried on by private capital and under private management.

On the part of the public, franchise questions must be settled in a manner fair to all concerned but must be settled positively. Inequitable burdens in the form of special taxes must be removed and the co-operation of regulatory authorities given to managements in their efforts to improve their financial condition and the service which they render. On the part of the managements the realization that this is a changing age and that the public desires something different and better than what it has had in the past must be recognized. Important studies are now in progress for the development of a vehicle which will better meet the public needs, of the important fare question, and of many other operating problems. The industry has met serious situations throughout its history, and will unquestionably succeed in overcoming its present difficulties.

Washington, D. C., in the early nineties, showing the underground conduit system, which is still used there and also in New York City

Looking Ahead

in Urban Transportation

By

G. A. RICHARDSON
First Vice-President
American Electric Railway Association
Vice-President and General Manager
Chicago Surface Lines

Public transportation facilities are absolutely essential to the occupants of buildings such as this. If they had to depend upon private automobiles another structure of equal size would be required for garaging

The tremendous increase in the number of private automobiles has overtaxed the capacity of existing streets and hindered the movement of mass transportation vehicles

FOR twenty years — ever since the automobile began to assume importance in urban traffic—the electric railway industry has been struggling through various stages of readjustment. There have been times when the leaders of the industry have been inclined to waver in their faith in the future and when the conviction was strong in the public mind that electric railways were obsolete, or at least obsolescent. The industry has successfully survived the "wild cat" jitneys and the clamor which hailed the motor bus as the modern cure-all for local transportation ills. It has weathered the storm of increasing costs of operation and necessary fare adjustment, and it is finding new means of meeting competition which caters to the public's desire for comfort and speed. Now the time seems to have arrived when it is possible to evaluate the various elements which are involved in urban transportation, and to plan for the future with a considerable degree of confidence. We now know the limitations of automotive traffic, and we are at least beginning to understand the transportation needs of the modern city.

The automobile has encouraged people to move about as never before. Habits, customs, forms of entertainment, and the whole scheme of city life have been drastically altered. The new restlessness and roaming spirit have been developed by the freedom possible with widespread use of automobiles for the amusement period of the day. Of course, the family car, or one of them, is also put to work on slight excuse as a carrier to and from work. The sense of luxury or of personal prestige derived from the use of an automobile appeals to many, and certainly has caused a decrease in the street railway riding from what otherwise would have resulted from the growth of population. Yet, when compared with the tremendous increase in automobile passenger-miles and registration, the constancy of the street car ride curve is truly remarkable. The automobile has unquestionably affected travel on the established local transportation agencies, but not to the extent that is popularly believed. Passenger automobiles in the United States in 1929 were operated a total of approximately 300,000,000,000 passenger-miles — many times more than the total for all other land transportation facilities—but the greater part of this represented riding which would not have existed if there had been no private automobiles. It was stimulated by the new vehicle, in conjunction with the normal development of the country, advancing standards of living and better highways.

Since 1921 motor vehicle registration in the United States has increased from 10,464,000 to approximately 27,000,000. In this same ten-year period, the business of electric railways for the whole country has shown no increase, but neither has it shown a decrease. Total passengers of electric railways of the United States in 1921 numbered 14,593,234,000. In 1930 they were 14,600,000,000. It is evident, therefore, that the loss of patronage by electric railways due to increasing automobile ownership is not as great as some people would have us believe.

The streets are congested by parked vehicles, and vehicles cruising to find parking space or left standing out in the second lane in sheer desperation. Movement is becoming slower, driving is more annoying and the air isn't so pleasant to breathe. New streets have been built and old ones widened, but the costs are now beginning to hurt, and the cities' bonding limitations aren't so far away. The crest of the wave is passing because the surge has overwhelmed the facilities to the point where costs and difficulties must be reckoned. The terminal conditions are becoming strained, and yet only a small proportion of the people are being served.

In Detroit only 26.6 per cent of the people, except pedestrians, moving outbound from the central business district in the evening rush hour go by taxicab and private automobile. In Philadelphia it is 18.1 per cent, in St. Louis 21.0 per cent, and in Chicago 11.1 per cent.

As pointed out in the report of the Rapid Transit Commission of the City of Detroit for 1930, the density of traffic is increasing at a greater rate than the increase in automobile registrations, and it is clear that traffic in the central business district of some large cities is approaching the point of saturation. Under present conditions of city development it would be impossible to carry by private automobiles all of the rush-hour riders, even if all of them had automobiles.

Garages cannot be provided to house the cars that would be needed. It takes almost exactly the same floor space per person served to house the automobile as is needed for him in office space. That would mean one twenty-story garage building for each twenty-story office building. Imagine half the ground space used for garages and, therefore, double the rent cost of doing business! Already the streets in the apartment neighborhoods are becoming choked with cars that are stored on the streets all night. Some day these must be cleared not only to restore freedom of movement on the street, but because of the very tragic results that may come from a fire that the firemen cannot reach due to the parked cars. Terminal conditions at both ends of the route are about to control the extravagant use of the automobile. Consequently, the automobile as a factor in local transportation becomes less important as the size of the city increases.

Modern large-capacity car with doors at front, center and rear is an efficient vehicle for handling mass transportation

In spite of all the handicaps of operation and difficulties of financing additional equipment, the rapid transit lines of New York have shown steadily increasing patronage. From the year 1923 to 1930 the number of passengers on the Interborough Subway system increased by 42 per cent. On the Brooklyn-Manhattan system the number increased approximately 39 per cent. In Chicago the number of passengers carried by the combined public carriers increased constantly each year up to 1930, when the business depression began affecting traffic. Careful checks of the persons within the central business district of Chicago made in 1926, 1928, and 1929, show that, of those in the district at one time, not more than 7 per cent arrived by means of automobiles.

The automobile cannot assume the burden of local transportation, and it remains for the electric railway industry to continue to carry it. Fortunately, the experience of the past few years and the advancement made in process of development point the way toward success in this effort.

The electric railway operator knows that the public expects of him: (1) a vehicle which approaches as nearly as possible in mass transportation the comfort of the automobile; (2) increased speed; and (3) dependability. The public wants equipment that is attractive in appearance and quiet in operation. It is very critical of any lack of efficiency or courtesy on the part of operators. Given the right kind of service, the large majority of the urban residents would rather use a public conveyance for business errands and to and from their places of employment than to suffer the annoyances of traffic congestion and lack of parking facilities to which they are subjected when using private automobiles.

To have reached an understanding of the demands of the public and to meet these demands are quite different things. An industry which for more than a decade has had to struggle for bare existence cannot be expected to be in the best trim for rejuvenation overnight. Nevertheless, great progress has been made, and is being made, in modernizing service.

Proper development of franchise provisions, efficient management, adequate street and traffic control by municipalities and the encouragement of common carriers by public regulation which permits a fair rate of return are all essential to successful transportation planning. It is important that there be an understanding on the part of the community of the economics involved in local transportation. The people must realize that facility of communication is the very basis of existence of cities, and that improved methods of general transportation are at the root of city growth. They must recognize that the success of the city is more dependent upon good means of circulation than upon any other factor under its control.

They must also be brought to understand the relative value of various means of transportation. The automotive vehicle has been so prominently before the public and the demand for street space for it has been so great that the people ascribe to it a greater importance in city transportation than it possesses. For example, in the report on the economics of rapid transit, published by the American Electric Railway Association, it is shown that the northwestern division of the Chicago Rapid Transit Lines north of Chicago Avenue would cost to reproduce approximately $2,500,000 per mile. A parallel boulevard, 100 ft. wide, through this same zone if built now would, in the first 5 miles, cost approximately $4,250,000 per mile. The present use of the northwestern branch for the rush hour is about 30,500 persons in the northbound direction, and its ultimate capacity, if used like the rapid transit lines in New York City, would be substantially 100,000 passengers per hour.

A boulevard 100 ft. wide used to its capacity by automobiles could not serve more than 4,100 persons per hour in a northbound direction. In other words, it would take seven and one-half boulevards used by automobiles to give the same capacity in an outbound direction as the present use made of this one line, to say nothing of its ultimate capacity. To get this capacity in boulevards would cost approximately $32,000,000, and would destroy a strip of land for housing purposes 700 ft. wide throughout the entire length of the improvement. No one argues that cities should not provide facilities for automobile traffic, but it is high time that some consideration be given to the relative expenditure of money on the basis of the total number of persons to be served.

In many communities progress is being made toward the working out of a sane and sound plan for the development of local transportation. The fact that so much has been accomplished within the last two or three years indicates a growing understanding on the part of the public, and a keener desire on the part of managements to provide better service. A recent example of this is provided by the city of Chicago where, within the last 2½ years, enabling legislation has been obtained from the State General Assembly, a comprehensive plan for unification and development of all local transportation facilities has been worked out, and the necessary ordinances have been enacted by the City Council and approved by the people by a vote of nearly six to one. It is not contended that the ordinance for a comprehensive, unified local transportation system in Chicago is perfect, but it embodies many principles of the economics of transportation which are today recognized as essential.

Under the ordinance, which is now before the courts for judicial approval, Chicago will have a unified local transportation system, comprising, under one management, rapid transit, surface and bus lines, with transfer privileges between the three classes of service. The rapid transit lines will consist of elevated tracks and city-built subways. The new company, which will take over the existing properties, will expend $200,000,000 in the first ten-year period on extensions and improvements of rapid transit and surface service, and the city will expend approximately $100,000,000 on the subways, which will be equipped and operated by the company. This is more money for improvements than the present value of surface and elevated properties.

Special assessments, based on the principle of requiring the property immediately benefited to pay part of the cost of the improvement, will be utilized in financing the city-built subways. The company will pay 3 per cent of its gross revenue into a special city fund, which can be used only for transportation purposes. It will be relieved of many of the special taxes which the present companies are now required to pay.

Regulation will be by a local transit commission, which must allow a sufficient rate of fare to provide an adequate return on the investment. The property will be operated under an indeterminate permit. This set-up will enable the company to provide not only for immediate needs, but also to work out a sound financial policy suitable for the development and continued growth of transportation commensurate with the needs of the community.

The plan recognizes these four important principles:

1. That subways for local transportation are, in fact, but an additional street for the accommodation of the public, and, as such, should be paid for by the city in part by special assessment in the same way as streets are built for automobiles.

2. That co-ordination of all local transportation service under one management is essential to economy and efficiency in operation.

3. That equal opportunity for making use of the various transportation facilities should be afforded, so far as possible, to all residents of the community.

4. That rapid transit is essential for long-distance riding, and that surface and bus lines are most effective when used as feeders to the rapid transit lines, for short rides, local service, and to serve neighborhood business communities.

These principles are important in planning any large city service. Their incorporation in State law and franchise provisions is a long step forward.

In addition to the progress made recently in franchise planning, the electric railways of the country are beginning to achieve definite results in the improvement of equipment to fit modern conditions. An outstanding example of this is the trolley bus. Its many advantages over both the street car and the motor bus for certain kinds of service are now very generally recognized. In Chicago, where more than 100 trolley buses are now in operation, this vehicle has met with general public favor. Its quietness of operation, its comfortable riding qualities, its comparative freedom from equipment failures and the absence of exhaust gases are among its strong points. In Illinois the trolley bus has been classified legally as a street car, thus saving the cost of motor vehicle license fees, which, together with the saving on gasoline taxes, amounts to a considerable sum saved annually as compared with the use of gasoline buses. This permits more and better service to be given.

Material modernization in car equipment, under the leadership of the Electric Railway Presidents' Conference, also promises to contribute much to the forward movement in the improvement of the electric railway industry.

It must be apparent, even to the most

The trolley bus—a type of vehicle particularly well fitted to meet certain kinds of transportation demands—is becoming increasingly popular

gloomy pessimist, that the industry at last is emerging from the doldrums of the post-War period. It is setting its face confidently toward a future which holds promise of a sound financial and physical structure, designed to meet all of the needs of local transportation service.

What has been said here is applicable for the most part to electric railway properties in the larger cities. The circumstances and problems in smaller cities are somewhat different. There the automobile has proved a greater menace, and as earnings have decreased, ability to provide proper service has diminished. These smaller properties encountered difficulties to which the larger properties are not subject. But even in smaller cities there are ample indications of a better understanding of the problems and a more hopeful prospect of their solution. Some properties, even during the present depression period, are earning a good rate of return because of effective analysis and solution of the transportation possibilities.

In many of these cities street cars may not be the best units for service. The cost of paving construction, the maintenance of track and the payments of special taxes or charges for the privilege of operation create such an added burden in carrying charges that the properties cannot be made to pay, because these costs are balanced against too few fares per mile of track. Yet these cities must have some kind of public transportation.

Smaller cities hope to grow larger. Even to survive, they must have comforts, conveniences and necessities. Among these are numbered adequate water supply, schools, industries with good payrolls, competent merchants, park systems and public spirited citizens willing to plan for the community's welfare. All of these are useless, however, unless there are also provided adequate facilities to permit citizens to travel conveniently and economically between homes and work—to schools, to shops, stores, offices, to amusements and on the myriad errands of daily life. Can every man, woman and child, every office boy or clerk, operate his own automobile or beg a ride from a neighbor? Can the streets or vacant lots store these cars when they have arrived at high-school, at department store, or at the bank, A community small enough that its citizens may have the alternative of walking can perhaps get along with the automobile as the sole agency of local transportation. But such a small town cannot hope to realize the dream of most small towns—to grow into a city. What business could afford to move to such a community, or if there, could hope to do more than a mere country store trade?

Business men and citizens' representatives must be awakened by illustration and education as to the possible solutions appropriate to each city's problems. An answer can be worked out that will give the citizens the lowest costs of living and most desirable city growth, that will promote the best prosperity of the business men and of the citizens even while permitting a satisfactory return on the investment in the transportation system. There is no uniform prescription or standard answer as to the details of a plan, but there is absolute certainty that no city can afford to fail to work out for its own welfare a satisfactory way of maintaining some public form of communication.

Whether the city is large or small, however, there are certain factors which enter into any successful planning for the future of transportation. In the first place, the franchise must be such as to give assurance of permanency. It must be fair enough in its terms to encourage investors to supply the money that will permit improvements which will encourage riding. This, in turn, makes progressively better transportation service and then encourages more people to ride on public carriers. There must be incentive in the form of opportunity to earn adequately on the investment in order to encourage efficient management and to assure a high degree of responsibility on the part of the company in managing its own affairs and in assisting the city in problems common to both the city and the transportation system. Franchise provisions must be such as to remove unfair burdens and limitations which interfere with good operation. The management must have the power to readjust its lines and routes and to expand its service. Political control of operation or schedule requirements is inefficient and wasteful and should be eliminated. Traffic segregation should be encouraged by city and company and appropriate regulations for the use of the streets by all classes of traffic should be worked out on a co-operative basis. Unfair competition from independent bus systems or flat-rate taxicab systems, which cannot in themselves be profitable, is deadly to good local transportation service and it certainly should not be permitted.

On its part, the company must maintain a management of such quality as to justify public faith in its ability to provide adequate transportation and at a reasonable fare. Such a management will develop a thoroughly trained group of men and will keep its costs well under control by the most efficient use of its facilities and the highest degree of skill in planning and supervision. Vision, sales ability and a high quality of leadership on the part of the management are necessary to success in winning and holding public good will. The local transportation industry is in a state of transition, and it can look with confidence toward a time, not far distant, when it will be fully re-established financially and able, therefore, to give a superior service to the communities which depend upon it for their growth, prosperity, and, in fact, for their very existence.

Typical Concentrated Business Center of a Large Metropolitan Area

Although outlying business districts are developing rapidly in many cities the congested central areas offer an increasingly serious problems to transportation agencies in moving their vehicles freely

Emblem of the American Street Railway Association

Emblem of the American Electric Railway Association

How the

Association Has Aided

the Industry

By

J. N. SHANNAHAN

Chairman Advisory Council
American Electric Railway Association

President
Omaha & Council Bluffs Street Railway
Omaha, Neb.

IN 1882, a full half century had passed since the first street railway in the country was opened for service on the Bowery in New York, and, although the industry did not really begin to expand until the early '70's, developments came with a rush during the next decade, accompanied by tactics on the part of the promoters which were not always strictly ethical according to present-day standards. Each street railway, each executive, was a law unto himself, obliged to learn his own lessons, to work out his own salvation in his own independent way. Street railway managers were a hard bitten, highly individualistic crowd. They knew little of one another, and each guarded his financial and administrative methods as jealously as the guilds of the middle ages preserved their trade secrets. The average executive's association with others of his craft, generally confined to a competitor in the same city, was more apt to be unfriendly than otherwise. The mule, still supreme as the agency of motive power, often typified, as well, the unyielding, stubborn character of the chief executive.

And yet, at this time (it is still 1882 that we are talking about) the street railway business in the United States and Canada represented an investment of $150,000,000, a tremendous sum in those days. There were 3,000 miles of track and 35,000 employees. It is estimated that the companies that year carried an aggregate of nearly 1,250,000,000 passengers. Urban transportation was, in short, a major industry, even at that early period, but there was no central clearing house for the consideration of matters of common interest. And these matters were growing rapidly in number and importance.

Finally, after several abortive attempts, following an exchange of letters between a number of the leading operators, a call for a meeting was sent out, and a handful of executives met in a Boston hotel Dec. 12, 1882, and organized the American Street Railway Association. Once the ice was broken, distrust gave way to confidence under the stimulus of personal acquaintance and contact. Soon there were forged close bonds of common interest, and these bonds, growing out of that meeting of the pioneers, have continued without break to the present time.

At this period, the business of local transportation was just beginning a cycle of rapid expansion and transition. It was apparent to many far-sighted

IN SUMMONING the leaders of the street railway industry to meet at Boston for the organization of the American Street Railway Association, the following letter was sent to all companies in the United States and Canada:

**Louisville, Ky.,
November 8, 1882.**

Dear Sir:

Permit me to call your attention to a matter which has for some time been considered by a number of Street-Railroad men, viz.: The formation of an Association based upon well-established principles governing similar organizations, the object of which shall be the promotion and advancement of knowledge, scientific and practical, in all matters relating to the construction, equipment and management of street railways; the establishment and maintenance of a spirit of fraternity among the members of the Association by social intercourse and friendly interchange of information and ideas, to the end that the best service may be obtained at the least possible cost.

With this object in view, I have been requested by a number of street railway officials, both in the East and West, to issue this circular, and urge that your company send a representative to a convention to be held in the City of Boston, on the 12th day of December, 1882, for the purpose of organizing and adopting a Constitution for the government of such an Association.

It is expected that most of the prominent street railway companies in the United States will be represented. Will you be kind enough to notify Mr. J. E. Rugg, Superintendent, Highland Street Railway Company, Boston, Mass., at once whether your Company will send delegates, in order that adequate accommodations for the Convention may be made in advance? As soon as replies are received, arrangements will be made, and you will be notified of the location and the hour the Convention will meet.

**Very respectfully,
H. H. LITTELL,
Superintendent,
Louisville City Railway Company.**

operators that the horse must go, but there were serious differences of opinion respecting the agency of power that would take its place. During the first decade of the association's existence there was a constant search by individuals and groups for some better means of propulsion. Every suggested possibility which appeared to have any merit was subjected to serious study and experiment.

Hence, from its very inception, the association found itself the forum in which matters of great import to the industry were debated in all their aspects. Delegates came to the early conventions prepared to hear about the successful experiments with cable lines in San Francisco and elsewhere, and to discuss the relative merits of the variety of electrification projects then being advanced by that brilliant coterie of inventors which included Charles J. Van Depoele, E. M. Bentley, Walter Knight, Frank J. Sprague and Thomas A. Edison.

Increasing Importance and Scope of the Annual Conventions

Since that pioneer period, public transportation and the association which represents it have traveled far and fast. From humble beginnings in a Boston hotel room, the association has grown to be an institution of nation-wide extent and importance. Its early conventions—which were not always conventional—have developed into assemblies which draw thousands of delegates from all sections of the country. Its annual exhibit, which had its beginning in 1885, when twenty manufacturers displayed their wares in space provided by the Street Railway Journal, has developed into a veritable industry fair, occupying thousands of square feet of floor space, and representing an investment of hundreds of thousands of dollars. The papers and proceedings of its annual gathering attract the attention of operators, manufacturers and investors having a wide variety of interests.

From early discussions regarding the merits of blonde or brunette horses, their feeding habits and the ills that afflicted them, the subjects considered have broadened and ramified with the years. As the atmosphere became cleared of the suspicion and confusion that had surrounded the acquisition of some early franchises, there came a realization on the part of managements of the important mission their industry was destined to play in the development of the cities which they served. From matters closely political in character discussion turned more and more toward the engineering aspects and social importance of community transportation.

To the amazing—and amusing—history of that decade in our national annals which has been so aptly characterized as the "Gay Nineties," the street railways contributed a colorful and glamorous chapter. To the railways, more than to any other single influence, the development of our urban centers during that period can be ascribed. Without them, growth would have been checked and expansion would have been impossible. Quite naturally, the responsibilities of transportation managements grew rapidly and were sometimes obscured by the accompanying enthusiasm and optimism. If these often led to acceptance of committments which, at a later period and under changed conditions, were to arise to plague the transportation operator, let it be said to his credit rather than otherwise. With courage and vision he accepted the multiplicity of obligations imposed upon him, little knowing that in many cases destiny was awaiting around the corner armed with a club.

The annual dinner was an extremely entertaining climax to the convention of the early days

During most of this period, the Street Railway Association and its various committees carried on in a more or less perfunctory manner. There was no paid secretary and no permanent headquarters organization worthy of a name until 1904, but a considerable correspondence relating to various problems of interest had been carried on in the name of the association over a long period of years. Officers of the association made appearances from time to time before legislative bodies, and considerable effort in behalf of the industry was exerted in local and national affairs.

For nearly a quarter century the original name, American Street Railway Association, served its purpose well. Inclusion of many interurban railways in the organization made it seem desirable to adopt a name of broader scope. Accordingly at the 1905 convention the name was changed to American Street and Interurban Railway Association. Later it was decided to get rid of this rather cumbersome title, and at the 1910 convention the organization became the American Electric Railway Association, by which name it has been known for the past 21 years.

As the business expanded and became departmentalized, it led to the development of specialists who felt the need for the consideration of their own common problems. As the association did not provide an agency for this purpose, the various affiliated organizations came into being. The accountants organized at Cleveland in 1897, to be followed by the engineers in 1903, the claim agents in 1904 and the transportation and traffic men in 1908. At the Saratoga convention in 1903, the manufacturers, who had been closely associated with the parent body since its earliest organization, effected an organization of their own for the purpose of handling the annual exhibit, which had assumed important proportions.

During the midyear meeting held in Chicago in 1916 the constitution and bylaws of the association were amended so as to open up the membership to manufacturer companies. At the 1919 convention a final readjustment in the relationship between the railways and the manufacturers was effected by an arrangement providing for representation of the manufacturers on the Executive Committee. Since that date, they have worked with operators with a splendid singleness of purpose. Both on the Executive Committee and on the various committees of the affiliated associations, the manufacturer members have rendered faithful and valuable service. Their advice and co-operation has undoubtedly added much to the weight of the reports which have been rendered on various matters connected with engineering and operation.

The Association Has Guided the Industry's Development

From its inception, an important function of the association has been to acquire knowledge relating to the construction, equipment, management and operation of electric railways, and to disseminate that information among its members. Its purposes have been to improve practices in all departments of electric railway affairs, to establish and maintain a spirit of co-operation among its members, and to encourage friendly relations between electric railways and the public. The manner in which it has carried out these obligations is revealed by a review of the proceedings of the association covering the entire period of its existence. In the course of events, it has closely followed, and to no small extent influenced, many phases of the development of public transportation, including physical design, operating methods, economics and policies affecting its relations with the public and with its employees.

In 1911, under the direction of one of its committees, there was inaugurated the study of electric railway fares and the items entering into the expense of operation. This study culminated in the publication of "The Cost of Urban Transportation Service," the most complete and comprehensive study of the subject ever undertaken. Other studies carried on under the direction of the association have included such subjects as valuation, financing, franchises, workmen's compensation laws, and governmental and municipal regulation and control.

The Fare Research Bureau, which began its existence in May, 1914, performed a work of great value in defining and outlining fixed and variable cost factors, the trend of operating costs and the cost of rush-hour service. The bureau also investigated the experience of Cleveland and Toledo with limited-term franchises. In November, 1914, the association drafted and adopted a broad code of principles, defining in clear-cut terms the position of the industry upon many of the disputed problems of the day.

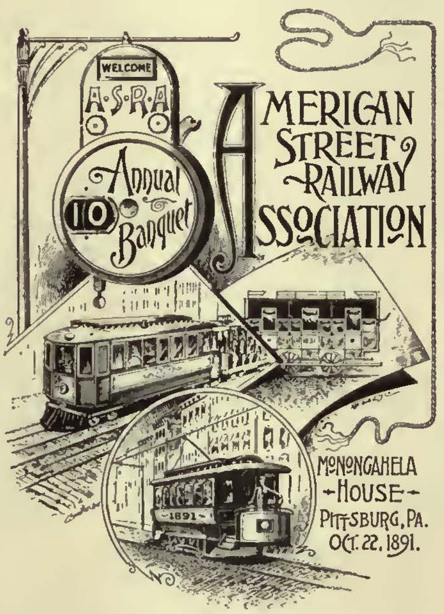
When the jitney made its appearance and began seriously to undermine the financial stability of many street railways, a special committee was appointed to consider and make recommendations to the various companies as to the manner in which this menace could be best combated. Within a surprisingly short time a report was prepared embodying an extensive and close study of the situation, accompanied by a statistical and technical study prepared by the Bureau of Fare Research.

In August, 1916, when the Adamson Bill, calling for an eight-hour day for interstate carriers, was jammed through Congress, the electric railways, which, under the first draft of the bill, were included within its scope, were specifically exempted through the prompt intercession of the then president of the association, assisted by the chairman of the Committee on Federal Relations.

Association Helps in War

Promptly at the outbreak of the World War the president of the association pledged to President Wilson the patriotic support of the electric railways in the furtherance of any measures which should be deemed necessary in the conduct of national defense. A committee was appointed to co-operate with the Council for National Defense, and a succession of bulletins was issued from association headquarters in support of such measures as fuel saving, increasing crop production, liberty loans, and the protection of national property at strategic points.

Later, in November, 1917, there was organized under the auspices of the association, a War Board for the purpose of co-ordinating the facilities of the electric railways of the country and to place them more effectively at the command of the government and of industry. Meetings of the board were held at frequent intervals during the period of the conflict, and questions having to do with taxation, labor difficulties, necessary financing of construction, etc., were settled with the minimum of delay. Space is lacking wherein to tell in detail of the accomplishments of the board. It should suffice to say that its efforts and accomplishments were such as to warrant the commendation of the War Department. The efforts put forth during this period served as nothing else could to nationalize the industry. Confusion of counsel was eliminated. Unity of purpose was accomplished.



Another interesting banquet program cover, showing the first street car in America and two "modern" vehicles

In the difficult days of reconstruction following the War, the association and its various committees took an active part in stabilizing the industry in the face of unsettled conditions. The War Board became the Committee on Readjustment. As the result of high price levels and disturbed labor conditions, and of the failure of the prevailing 5-cent fare in many cases to provide necessary revenues and maintain the properties, the electric railways found themselves in a critical situation. To a large extent credit was lacking, and in many localities the companies were not properly performing their functions. The 5-cent fare, it is true, had begun to give way rapidly by the time the War was over, but other spectres, had, in the meantime, arisen to plague the railways. When, in June, 1919, President Wilson appointed the Federal Electric Railway Commission to investigate the affairs of the transportation companies, the association's Executive Committee appointed a committee of 100 men, selected from the leading executives of the industry, to co-operate with the commission in presenting the position of the electric railways.

Hearings continued before the commission for months, and out of them were developed and disseminated many of the principles which constitute the fundamentals of sound community policy with respect to local transportation at the present day. Under this category may be included the inauguration of the movement for the elimination of special taxes for sprinkling and paving. To the work of this committee can also be traced the beginnings of adequate regulation of jitneys and other motor competition, and the earliest efforts toward the financing of extensions into new territory by the property thus benefited. From this period, too, and out of the post-War emergencies can be said to date the first comprehensive efforts toward the establishment of better public relations through publicity and advertising, in all of which the association took an active part.

Up to the filing of the commission's report, the electric railway industry, in theory at least, had been conducted upon the principle that the parties interested were the municipalities on the one hand and the companies upon the other, and that their interests were of necessity hostile. As the outgrowth of the commission's findings it became apparent, as never before, that the public at large had a real stake at issue, and that the interests of the public, the municipalities and the railways were closely interwoven and dependent one upon the other.

Committees Have Been Active in Studying Many Problems

The association early learned the value of doing much of its work through the agency of committees. They may be said to constitute the very basis of the association's usefulness. Upon the personnel of its committees and upon the diligence with which they pursue the problems assigned to them depends in large measure the success or failure of the organization. And in this respect they have not failed. In their membership, these committees have represented over the years the highest business and professional ability to be found in the special fields of inquiry undertaken. Carefully and painstakingly prepared with the assistance of the association staff, their reports rank among the best management and technical publications produced by any branch of technology or industry. Sound, practical advice and suggestions have in this manner been made available.

No single electric railway could hope to make such complete investigations

At the Pittsburgh convention in 1891 the manufacturers exhibited their products on steamboats and barges

into a variety of subjects as the committee reports afford. The cost would be prohibitive and the information would be most difficult to obtain. The problems of so important an industry will always require study and thought, and it is highly essential that those who are to solve them have at their disposal the very fullest and detailed information that can be made available. As an agency for supplying this information, the association has proved itself to be particularly well fitted.

The Engineering Association, organized in 1903, has as one of its objectives the promotion of uniformity of practice—that is to say, of standardization. This objective is kept constantly before its committees and usually constitutes an important part of their work each year. As an outgrowth of this phase of the association's work, there has been developed over a period of years the Engineering Manual, a handbook of standards, recommendations and miscellaneous practices, which has become a reference volume of great value.

The standard classification of accounts as laid down by the Interstate Commerce Commission for the guidance of electric railways is today the basis of all correct electric railway accounting. And the standard classification, in its present form, was made possible through the unselfish and untiring efforts of the American Electric Railway Accountants' Association.

In 1925 there was created what came to be known as the Advisory Council, composed, in the main, of the principal company executives and representatives of the large owners. This was done to interest these men directly in the administration and functioning of the association, and to secure their active co-operation in formulating its policies. The council, in common with the Executive Committee, functions through the managing director of the association. In this way, there is one man clothed with the necessary authority to speak for the association and its membership. Only in this way can this industry give authoritative voice to its views on the problems that confront it.

There is another important matter which is liable to have a most vital bearing on the future of the local transportation business. Believing, as one must in these days, that the industry or business which does not inaugurate and carry on active research work is destined to be relegated far to the rear, the officers of the association undertook to develop a program of intensive research and to devise ways and means of financing the cost. It seemed to these men that this program should not be directed nor carried on by the association, as such, but by a separate organization. There was, therefore, created for the purpose, what is known as the Electric Railway Presidents' Conference Committee. The cost of the work was underwritten by a group of operating and manufacturing companies.

This having been accomplished, the Conference Committee soon realized that the successful outcome of their project depended upon the man who was chosen to have responsible charge of the research work. The chairman of the Presidents' Conference Committee, Dr. Thomas Conway, Jr., who, with several others, had first voiced the need of this program of research, gave a great deal of time and thought to the selection of the chief engineer. The man chosen was Prof. C. F. Hirshfeld, of Detroit. He had, it seemed, pre-eminent qualifications for the post, and has the full confidence of all those who are associated in the movement.

Through all the years of its development, the policies of the association have been wisely planned and efficiently carried out. But however valuable its work may have been in the past, it cannot rest upon laurels already won. In order to endure it must continue to be alert to changing trends, new responsibilities and the needs of the future.

To function best it must have the active interest and co-operation of its member companies and their executives. It provides all the machinery needed for individual companies to help themselves on common problems. But unless this machinery is fully utilized, it operates at only partial efficiency. As time goes on, the association serves to knit the industry closer together. This group consciousness may be made almost irresistible if wisely guided and directed. It is through increased collective action that we may expect to master the many baffling problems which continue to beset us, but which in large measure differ only in details as they are encountered on individual properties.

Many conditions affecting our industry are national in scope. They must be met in a national way, with every company closely united in the work. The wisdom and experience of the best men in the industry, in the future as in the past, are needed to establish and promulgate the principles upon which the industry is to proceed. There is a constantly increasing need of spokesmen removed from local prejudices, free from local animosities and able to speak with authority. No single company can provide this; no sectional group can do this. The association alone can properly fulfill this very necessary function.

From the first showing of street railway products in 1885, the annual exhibit has developed into a tremendous and spectacular display of transportation equipment

Some Important Dates in the Industry's History

1832—First American street car line, on the Bowery, New York City.

1833—Henry invented his "electric engine."

1835—Davenport made several motor car models, using batteries. Fundamental idea of motor for propulsion patented in 1837.

1838—Davidson exhibited electric locomotive with batteries at Aberdeen.

1840—Pinkus granted first patent for an electric railway.

1847—Lilley and Colton developed model locomotive using rails for conducting current from stationary battery.

1847—Farmer developed first electric locomotive in America at Dover, N. H.

1850—Hall exhibited an electric motor car at the Mechanics' Fair, Boston.

1851, April 29—Page operated battery car train between Washington and Bladensburg, 5 miles, at 19 m.p.h.

1859, May 10—Beers patented a 1½-in. rail to be laid on wooden stringers.

1861—Siemens invented dynamo.

1863—London Underground opened first subway in world, using steam.

1867—Pacinotti discovered the reversibility of the dynamo.

1868, June—Harvey tried cable drive locomotive on ½-mile elevated line in New York City, the first elevated in America.

1871, April 20—Steam dummy and three cars used on Ninth Avenue Elevated in New York City, the first commercial rapid transit line in America.

1873—Van Depoele exhibited a motor for tractive purposes.

1873, August—First street cable line put in operation in San Francisco.

1875—Green, of Kalamazoo, made first use of an overhead trolley.

1877—First girder rail rolled by Cambria Iron Company, at Johnstown, Pa.

1879—Siemens and Halske, at the Berlin Industrial Exhibition, propelled a miniature locomotive and three cars with power from a dynamo.

1880—Edison ran small locomotive at Menlo Park, N. J., using power from a dynamo and a third rail.

1881—Field ran a large motor car at Stockbridge, Mass., using a dynamo, a wire in a conduit and a rail return.

1881—Daft conducted early experiments.

1881 — Hopkinson proposed series-parallel control.

1881—Siemens and Halske started first commercial electric railway in world at Lichterfelde with two cars.

1882—Van Depoele installed system at Chicago, current conveyed by wire.

1882, Dec. 12—American Street Railway Association, now the American Electric Railway Association, organized at Boston.

1883—Edison, Field, Mailloux and Rea operated a 3-ton locomotive, "The Judge," with third rail at the Chicago Railway Exposition.

1883—Van Depoele ran car at Industrial Exposition in Chicago, using an overhead and over-running trolley wheel.

1883, November—Daft operated 2-ton locomotive, "Ampere," on 12-mile line of Saratoga & Mt. McGregor R.R.

1884, July 27—Bentley and Knight opened first commercial electric railway in America at Cleveland, using underground conduit system.

1884—Van Depoele operated train at Exposition in Toronto, using underground conduit.

1884, November—First issue of Street Railway Journal appeared, the outgrowth of a street railway department in the *Journal of Railway Appliances.*

1885, August—Daft opened commercial line between Baltimore and Hampden, using a third rail with wheel for contact and later overhead.

1885—Henry built electric railway at Kansas City, with two overhead wires and over-running trolley wheels.

1885, Aug. 26—Daft locomotive, "Benjamin Franklin," on Ninth Avenue Elevated, New York City, marked first use of electricity on an elevated line.

1885, Oct. 21-23—First Convention Exhibit, at St. Louis, sponsored by Street Railway Journal, twenty exhibitors.

1886, November—Montgomery, Ala., with Van Depoele system, was first city in world where street railways were run entirely by electricity.

1888, February—Sprague system at Richmond with 40 cars was largest installation to date and embodied advanced designs.

1888—First commercial freight locomotive built for service in Ansonia and Derby, Conn.

1890—Minneapolis - St. Paul line of 9 miles first permanent interurban.

1890—Westinghouse Electric & Manufacturing Company entered the electric railway field.

1892, April—General Electric Company formed as consolidation of Thomson-Houston, Edison General Electric, the Sprague and other companies.

1893—General Electric exhibited a 30-ton freight locomotive at the Chicago World's Fair.

1893, April 20—Elevated Intramural Railway at World's Fair, Chicago, opened, using motor cars and trailers.

1895—First heavy interurban line, from Cleveland to Akron, 25 miles.

1895—Synchronous converter first used in railway work, Lowell & Suburban Railway.

1895, May 17—First permanent all-electric elevated in America opened, the Metropolitan West Side in Chicago.

1895, June 30—New Haven started commercial service on its electrified Nantasket Beach line.

1895, Aug. 4—Baltimore & Ohio started regular freight operation through electrified tunnel in Baltimore, after a month or more of trial.

1897, March 23—Street Railway Accountants' Association of America organized at Cleveland.

1897, September—First subway in America opened at Boston, for surface cars.

1898—Multiple-unit control first used, South Side Elevated, Chicago.

1899—Siemens and Halske introduced first trolley bus in world at Berlin.

1899—First underground rapid transit line in America opened at Boston, using multiple-unit trains.

1901—First American trolley bus demonstrated by Eastern Trackless Trolley Company, of Boston.

1903, Feb. 16—American Railway Mechanical and Electrical Association, organized at Cleveland.

1904, April—Imperial Transit Company operated gasoline motor bus line in St. Louis.

1904, Oct. 12—Street Railway Claim Agents' Association of America organized at St. Louis.

1905—First electrified suburban service inaugurated by Long Island Railroad.

1905—Interpole railway motor introduced.

1905, August — Interurban bus line opened from Springfield to Jamestown, Ohio, 22 miles, by electric railway builders, three Oldsmobile buses.

1905, Sept. 27—Name of association changed to the American Street and Interurban Railway Association.

1905, October—Fifth Avenue Coach Company, New York, ran first gasoline-electric bus.

1906, April 27—American Street and Interurban Manufacturers Association organized.

1907, August—Fifth Avenue Coach Company placed fifteen gasoline buses in service, the first large motor bus line.

1908—New Haven Railroad electrified with single-phase, 11,000 volts.

1908, Jan. 30—American Street and Interurban Transportation Association, organized at New York City.

1908, June—Street Railway Journal purchased *Electric Railway Review* and formed Electric Railway Journal.

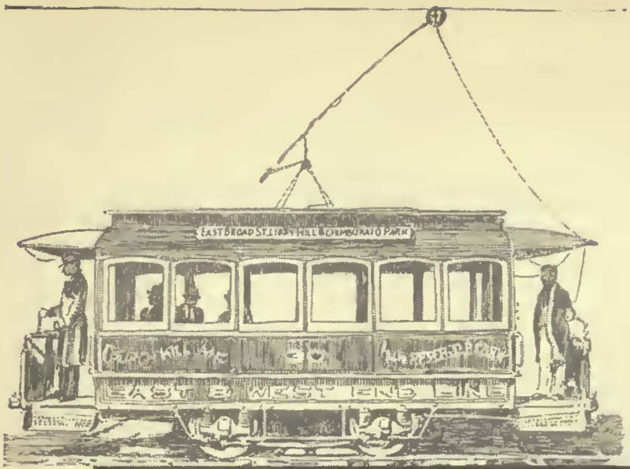
1910, Sept. 11—First commercial trolley bus system in America started in Laurel Canyon, near Los Angeles.

1910, Oct. 10—Name of association changed to the American Electric Railway Association.

1914—Mercury arc rectifier tried for railway service by Pennsylvania R.R.

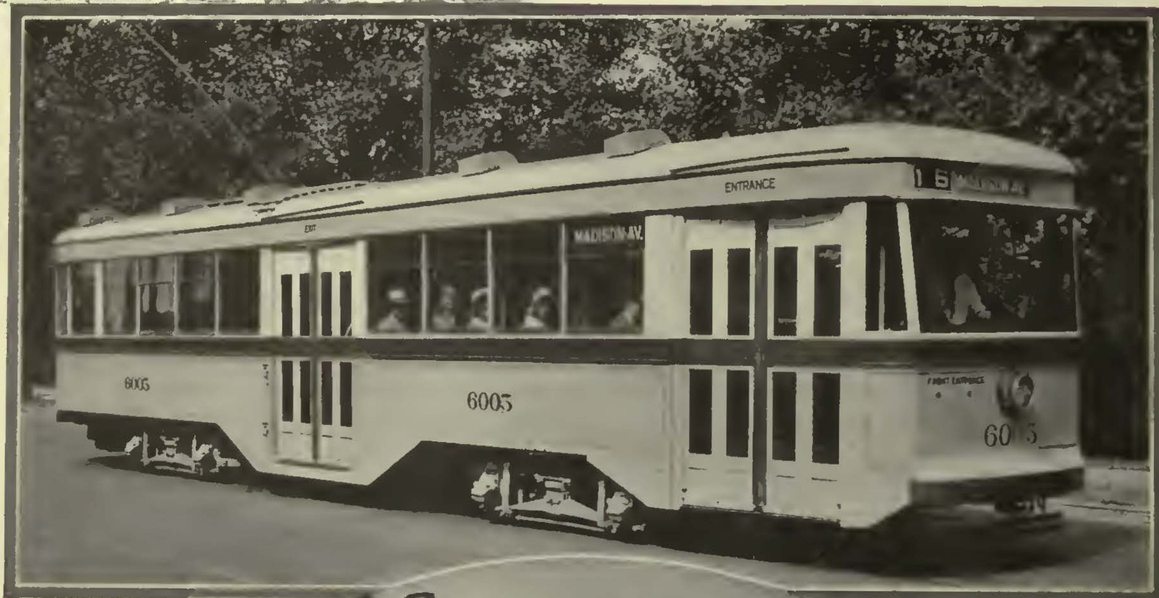
1914, July 1—First jitney appeared in Los Angeles.

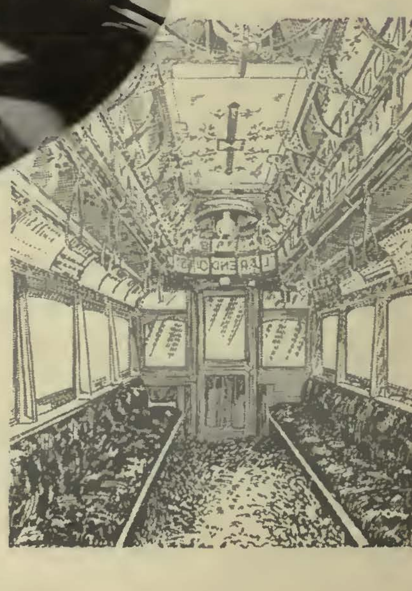
1916, Nov. 1—Birney safety cars for one-man operation in Fort Worth.



The Old and the New

ONE of the original four-wheel cars which were operated on the Sprague system at Richmond in 1888, and one of the roomy, attractive cars placed in service in Baltimore in 1930





THE comfortable interior of a modern car with individual leather-upholstered seats, dome lights and attractive flooring presents a striking contract to the old "luxurious interior" with carpet-covered benches, oil lamps and straw-littered floor

Car Design

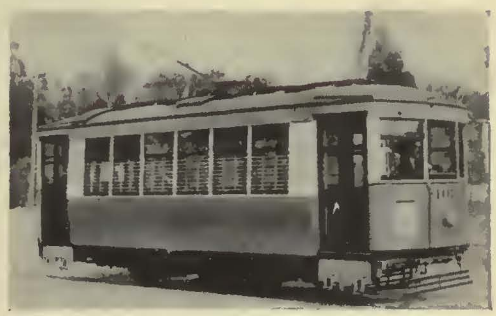
Reflects Steadily Rising Standards of Service

By
JOHN A. MILLER
Editor
Electric Railway Journal

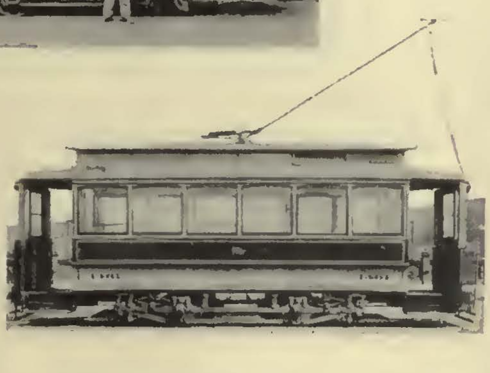
Omnibus-type horse car with entrance at center of rear end

Mule-drawn street car with end platforms

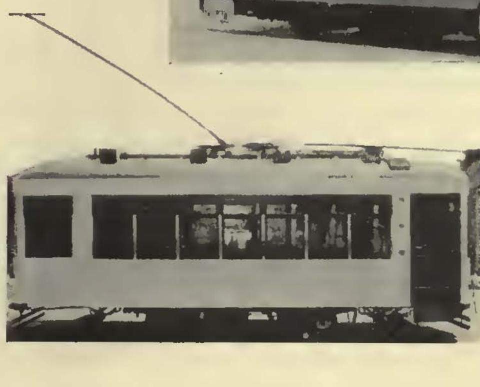
At left—early single-truck electric car



At right—A modern single-truck car with front entrance and automatic rear exit



Improved type of single-track car with partly inclosed platforms

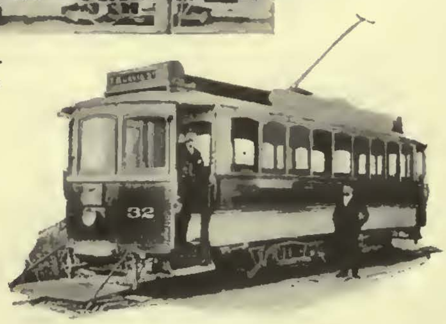


The Birney car, which came into widespread use about 1916

When public transportation vehicles were first introduced in England late in the seventeenth century, they were denounced as a pernicious evil. Before then a person who owned no private conveyance had been accustomed to walk or ride a horse from place to place. This condition was generally accepted as being entirely fitting and proper. When public coach service began, one critic expressed the opinion that "Those who travel in the coaches contract an idle habit of body; become weary and listless when they have rode a few miles, and are then unable to travel on horseback and not able to endure frost, snow or rain, or to lodge in the fields." Considering the crudeness of the early coaches, which had no springs and few cushions, this fear of the enervating effect of their luxury seems to have been somewhat exaggerated. But crude though these early coaches were, they represented the first step in the development of the commodious and comfortable public transportation vehicles being operated today over thousands of miles of railways and highways.

Coach service between towns began long before it was thought necessary to have local service within the limits of any single city. Thus the earliest ve-

Old-style double-truck car with open platforms

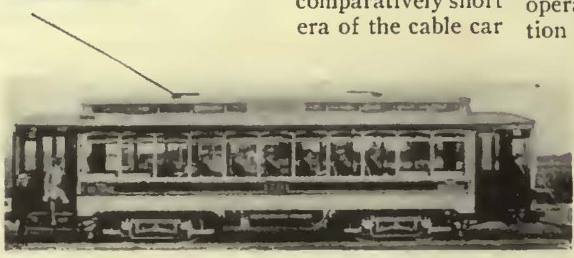


Double-truck car with partly inclosed platforms

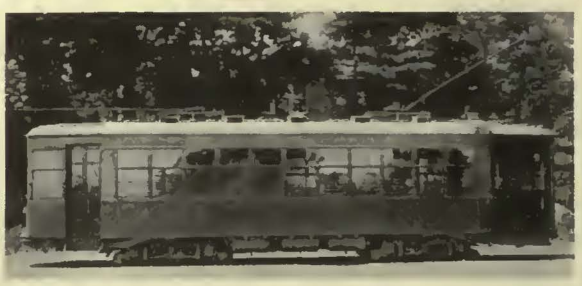
hicles were designed for comparatively long hauls. Accommodations were provided for only a small number of passengers, seldom more than ten. Seats were transverse, some facing forwards and some backwards. Entrance and exit were by means of a small door in the center of the side. The driver was seated on the roof at the front end. Sometimes there were seats for passengers, too, on the roof.

When coaches were introduced in local service it was found necessary to increase the seating capacity and to provide more convenient facilities for passenger ingress and egress. To meet these needs a vehicle was developed with seats placed longitudinally and the door located in the center of the rear end. The position of the driver remained the same. Passengers paid fare by passing their money through a small aperture alongside the driver's seat. Most of the horse-drawn omnibuses in city service before the beginning of the era of street railways were of this type.

The design of the first street railway car in the United States, the "John Mason," operated on the New York & Harlem Railroad, followed the older omnibus design with side doors, but this style was soon abandoned in favor of the rear door. In general, the earliest street cars were nothing more than omnibus bodies mounted on flanged cast-iron wheels. The greater ease of hauling vehicles on metal rails, however, encouraged the adoption of larger car bodies. An open platform was added at one or both ends of the car body. The driver's position was changed from the roof to the platform. On heavy routes, a conductor was added to the crew to aid in the handling of the passengers, he taking his position on the platform at the end opposite from the driver. During the comparatively short era of the cable car no important innovations in design were made. The double-end open-platform car already described was in use throughout the country on both horse and cable lines when the first electric operation began.



Semi-convertible car—very popular about twenty years ago



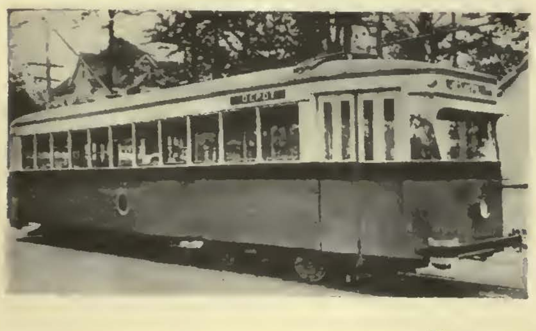
Recent type of light-weight double-truck car with arch roof

The bodies of the early electric cars followed the same design as the horse cars. With the rapid expansion of electric operation, however, a great variety of other body designs were soon developed. Some have since been abandoned while others have continued with more or less modification until the present day. To describe them all in detail, with the dates when they were developed, would require a volume. Moreover, similar designs were often brought out practically simultaneously in different places and it is scarcely possible to establish a definite order of priority. For that reason consideration in this article will be limited to general trends.

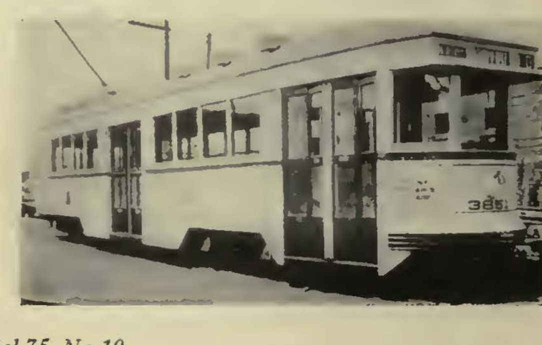
Classification of car designs is based upon a number of characteristics such as the service for which the vehicle is used, its size and construction, and the method of operation for which it is intended. Under the heading of service, passenger cars fall into three major groups: city, interurban, or rapid transit. Under the heading of size and construction the principal classifications are single truck or double truck; single deck or double deck; open, closed or some combination arrangement. Under the heading of operating characteristics the classification is according to the door arrangement, and whether it is designed for operation in both directions or only one.

The history of the industry shows some significant changes in the trend of design of cars for city service. As has already been mentioned, the bodies of the early electric cars followed the general design of their forerunners—the horse cars. They had short bodies mounted on four wheels. At first the axle boxes were attached individually direct to the framework of the car. Soon, however, it was found desirable to mount both axles in a separate framework, or truck, upon which the body rested. Thus was evolved the single-truck electric car.

As electric railway service increased in popularity, it became desirable to increase the size of the car. The limit of length of body which could be satisfactorily carried on a single four-wheel truck was soon reached. A new design was then developed whereby the car body was supported on two independent four-wheel carriages, or trucks, pivoted near the ends of the body. This design had been adopted many years before by the steam railroads. A number of proposals had been made from time to time for the use of double-truck horse cars, but at the time of the introduction



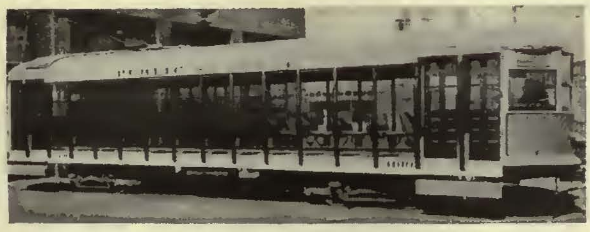
At left — The first "automotive" type street car brought out in 1927



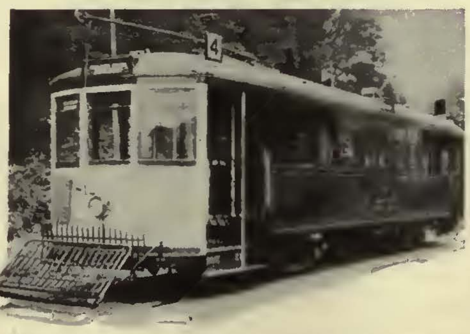
At right — Large capacity front-entrance center-exit car for heavy city service of electricity as a motive power for street cars, the single-truck vehicle was in almost universal use. Just when double-truck cars were introduced on the electric railways is uncertain, but it was at an early date.

As time went on, the double-truck car became increasingly popular, and the single-truck car began to fade from the picture. In 1916, however, a notable reversal occurred. Efforts were then being made to reduce the weight of cars, and to provide more frequent service. To meet these needs, the so-called Birney car was developed, a lightweight, single-truck car, arranged for one-man operation, and provided with special safety devices. During the period of the World War and the years immediately following, this type of car achieved a considerable measure of popularity. While its light weight and low operating cost were undoubted advantages, the riding qualities of the original type of Birney car did not fully meet the increasing public demand for comfort in transportation vehicles.

Open cars of this type were very popular some years ago



Sixteen-bench open car with sides screened and end doors installed for one-man operation



California type car with closed center section and open sections at both ends

Utilizing the experience gained with the Birney car, however, the designers in 1924 brought out a light-weight, double-truck, one-man car. This type of vehicle possessed many of the same advantages as the light-weight single-truck car and had better riding qualities. During the past ten years it has achieved marked popularity and has been widely used for many kinds of service.

Recently articulated units have been developed consisting of two car bodies mounted on three car trucks, one at the outer end of each body, and one at the center common to both. In this way, a large capacity is provided with comparatively light weight. Because of this and because the unit can be operated satisfactorily with only two men, it has certain advantages over two cars coupled together in a train. Its use, however, has been limited to a few of the larger cities and some interurban lines.

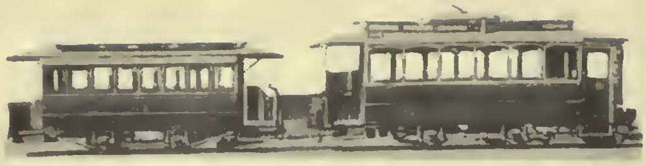
A second method of classifying car bodies from the standpoint of construction depends upon the number of decks. In England, and in some British colonial lands, double-deck cars have been used extensively for many years. A few double-deck horse cars and cable cars and one steam-motor car were built in this country in the early days of the street railways. Attempts have been made at various times to introduce double-deck vehicles on the electric lines, notably in New York City and Pittsburgh. The design has not met with marked favor here, however, due principally to the unwillingness of passengers to climb up and down the stairs to the upper deck. At the present time there are no double-deck electric railway cars in operation anywhere in the United States.

During the era of greatest development of the horse car, open cars were widely employed for summer service. While the first electric cars were of the closed type, the open car soon came into extensive use on the electric lines. Its popularity continued until some years after the turn of the century. But the introduction of the pay-as-you-enter method of fare collection in 1905 occasioned a swift decline in the popularity of the open car among street railway men, as these cars were not considered well adapted for such operation. Another factor partly responsible for their decline was the added cost of having duplicate sets of cars for summer and winter service. More recently, the open car has regained a measure of its former popularity. Some companies having cars of this type available, have operated them during the summer months, using two men and the old-fashioned method of hand collection of fares. Others have screened the sides of the cars, and arranged them for one-man operation. No new open cars have been built in recent years, however, and there appears to be little likelihood that they will play an important role in the future.

Compromise designs between open and closed cars have been developed at various times. One of these was the "convertible car" with removable side panels developed about 1895. Later came the "semi-convertible car" with permanent side panels below the seat level, and windows arranged to be raised up against the roof, leaving a large part of the side open. At one time a half-and-half car was tried in New York and some other Eastern cities, with one section open and one section closed. This compromise, however, seemed to please nobody. In fair weather, everyone wanted to be outside, and in bad weather everyone wanted to be inside. A somewhat similar, but more successful, design is the so-called "California-type" car. This has a closed section in the center and more or less open sections in the ends. Under the climatic conditions prevailing on the Pacific Coast where this type of car is used, it has

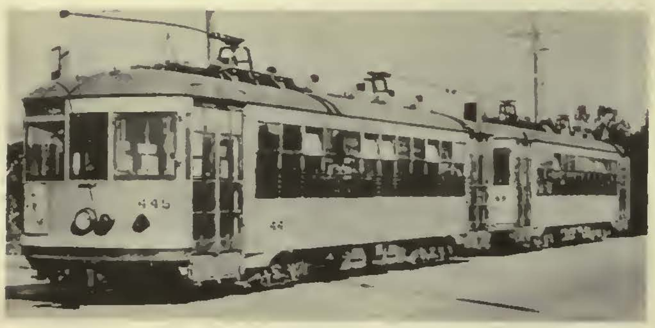
This double-deck open car was tried at one time, but did not prove successful in regular service

Experimental double-deck car operated for several years in New York City—since discontinued



Old type trailer train of single-truck cars

A more recent type of trailer train composed of double-truck cars



Light weight multiple-unit train

Multiple-unit train for heavy city service

Articulated unit with two car bodies mounted on three trucks

Latest type of M-U car for rapid transit service

proved very popular and is being operated extensively at the present time.

Operating conditions have had a marked influence on the design of cars used on many railways. Classification of car bodies under this heading depends on whether or not the car is capable of being operated in both directions and also upon the arrangement of entrance and exit facilities.

In the days of horse-drawn omnibuses, the vehicles were all designed for one-way operation. When rail vehicles were introduced, they could not be so easily turned around and a problem arose concerning means of reversing direction. The original street car, the "John Mason," was designed for operation in either direction. But this style of vehicle was soon abandoned in favor of the car already described with entrance in the middle of the rear, frequently called the "bob-tailed" car. This could be operated only in one direction, and turn-tables or similar devices had to be provided at the ends of the route. The bob-tailed car was superseded by the car with an open platform at each end, which could, of course, be run in either direction with equal facility.

Although some single-end electric cars were built in the early days, the double-end design remained the favorite until the introduction of pay-as-you-enter operation. With this type of fare collection it was found desirable to have an ample rear platform where a comparatively large group of passengers could stand while waiting to pay fare rather than to have them wait on the street and thus delay the starting of the car. During the decade 1905-1915 a great many single-end cars with large rear platforms were built. Track loops or wyes were constructed to enable them to reverse direction. This added expense was more or less offset by the saving in control and braking equipment, wiring and piping on the car. On some routes, however, no convenient means of turning could be arranged, and double-end pay-as-you-enter cars came into widespread use, with platforms smaller than those of the single-enders.

Although recent years have seen marked changes in operating practices, the basic factors in favor of and against the single-end car remain virtually unchanged. It is simpler and easier to build. Fewer doors are necessary and only one set of electrical controls is required, so that it costs less. Its appearance is ordinarily more attractive than that of a double-end car. On the other hand, it is less flexible in service because of its inability to reverse direction except at certain fixed points.

In the days of the bob-tailed horse car and for many years thereafter passengers entered and left the car at the rear end. Use of the rear end of the car for both entrance and exit of passengers, however, created some confusion and congestion as loads increased.

Typical old-fashioned heavy interurban car

Modern light-weight interurban car

Just when the practice began of having passengers enter at the rear and leave at the front is difficult to determine. This arrangement appears to have been used to a limited extent before the introduction of pay-as-you-enter operation. The latter, however, did much to popularize it. While many pay-as-you-enter cars provided for passengers to leave at either end, efforts were made to encourage the continuous movement of passengers through the car by having them board at the rear and leave at the front. This reduced the tendency to overcrowd the rear of the car.

Numerous modifications of the original pay-as-you-enter plan have been made in recent years, with consequent changes in door and platform arrangement. Three general plans of door arrangement have been widely used with both single-end and double-end cars. These are (1) doors at both ends; (2) doors at front and center but not at rear, and (3) doors at front end only. The methods of utilizing these doors for entrance and exit depend largely on whether the car is operated by one man or two, and also on the individual preference of the management, the prevailing idea being to avoid confusion and delay by separating the boarding and alighting passengers.

The idea of a door in the center of the side of the car is by no means a recent development. Only a few years after the beginning of electric operation of street cars several companies tried the experiment of joining two short car bodies together into one large unit with a center door. At various times in the history of the industry other center-door cars have been built. In general, however, it has not been found satisfactory to have center doors only, on account of the interference of boarding and alighting passengers already mentioned in connection with the rear-door-only arrangement. Combination of front and center doors, however, have worked out well in many instances. An interesting variation of this design is a car recently developed in Chicago with front, center and rear doors all on the same side.

Recent type of high-speed interurban car

Not long after the adoption of the rear-entrance front-exit design, a new type of vehicle was brought out in Philadelphia, called the "near-side" car. This was a single-end car with a large double door at the front end. The conductor had a railed-off space in which he was stationed just behind the motorman. Passengers boarded the car through one half of the double door and left through the other half. In recent years this same general plan has been widely used in one-man operation.

An important development following the "near-side" car was the Peter Witt car. In this design the front door continued to be used for entrance, but a center door was used for exit with the conductor placed alongside this center door. Cars with this door arrangement have also been used for center entrance, front exit.

The extension of one-man operation in late years, with both entrance and exit at the front end, re-created in some measure the old problem of conflict of boarding and alighting passengers. To meet this situation the automatic rear exit was evolved so that the weight of a passenger standing on a treadle plate causes the rear door to open after the car has been brought to a standstill. Many recent one-man cars have been equipped with this device.

Interurban cars have generally followed through the same stages of development as the city cars, except that of accommodating large crowds, and since stops are relatively infrequent the saving of fractions of seconds is a matter of less importance. Hence the end-door designs have continued to be favored over those with center doors. Where interurbans are operated with one man the system of having both entrance and exit at the front has generally been favored.

Design of rapid transit cars at first followed closely along the lines of steam railroad practice. As the crowds to be handled became greater, center doors were introduced in addition to those at the ends. More recently the end doors have been eliminated and three or four doors have been provided, spaced evenly along the side of the car.

From the structural point of view the changes in car design have been extensive. As the power of a team of horses determined the weight that could be

Modern heavy interurban multiple-unit train hauled, the horse cars were built as lightly as they could be made without falling apart. Framing was always of wood, which was the lightest and most easily fabricated material available. The body was built upon the platform constituting the floor framing, which also had to be made strong enough to hold the running gear. The car platforms were added as separate units and contributed practically nothing to the strength. Side panels and roof ordinarily were made of three-ply veneer on account of its lightness.

With the introduction of electric power came faster acceleration and braking rates, as well as higher speeds, but in return the weight limitation was removed. Heavier framing was adopted to withstand the added strains, but the same general design was followed as in the horse cars. However, the practice was introduced of cutting through the roof framing to insert a monitor deck. While this was considered advantageous for light and ventilation it weakened the structure materially.

Steel framing first came into use in the subway cars of the New York Interborough system. This construction was undertaken when it was decided that inflammable wooden construction was too dangerous for use underground. In those cars the principle was adopted of designing the car structure as a whole, making each member do its part in contributing to the strength. The top sills formed girders from which a considerable portion of the weight of the body was hung, and the underframe was lightened correspondingly. Platforms were made integral with the body, so that they were a source of strength rather than an added burden to be carried by the body framing. The success of these cars created a demand for steel construction in street car service, but design had not progressed sufficiently that steel cars could be built as light as wooden cars. Weights crept up steadily, increasing the power demand and causing added wear on tracks.

A reversal in the weight trend came with the design of the original Birney car, brought out in 1916, and in its successors. The arch roof came back to supersede the monitor roof, permitting continuous window posts and carlines, stiffening the body and reducing weight. Ventilation was taken care of by mechanical devices. Present trends in body design are toward the use of steel framing, with a certain amount of wood for fillers and trim. This reduces noise and makes the assembly of the body somewhat easier without any material effect on the weight.

Within the past few years considerable attention has been given to weight reduction, both in car bodies and in trucks. This has been done both on account of the expense of hauling dead weight around and in order to provide a simple means of getting faster acceleration and higher speeds even with small motors. One of the most promising methods is through the use of lighter materials, chiefly the strong alloys of aluminum that have been developed recently. By the use of these alloys the weight of a member of given cross-section can be reduced to one-half or less that of steel with no loss of strength.

One of the most notable improvements in car design has come within comparatively recent years. For a long time there was not much change in the exterior appearance of the ordinary rail vehicle. The introduction of completely closed platforms together with the substitution of an arch roof for the old-fashioned monitor deck gave the car a more compact appearance. Following this the car builders began to give greater attention to the alignment of windows, doors, etc., to secure a streamline effect. This development was further stimulated by the introduction of the so-called automotive type car first brought out at Springfield, Mass., in 1927. Since then, constant effort has been made to secure graceful proportions and pleasing appearance. While it cannot perhaps be said that the modern electric car is a thing of great beauty it is at least a neat, trim, business-like looking vehicle, far more attractive in appearance than its forerunners of a generation ago.

Originally the horse car was merely a shell with seats for passengers and a place for the driver. With electrification of street railways, motors and control were added to the car equipment. Then in turn various devices were introduced to assist the crew in their work. These included air brakes, sanders, mechanically-operated doors and steps, fare boxes and registers, energy-saving devices and the like. With the advent of one-man operation came safety control, automatic interlocking of doors, treadle release, and many other devices that have tended to make car operation more efficient and that add to the safety, comfort and convenience of the passenger.

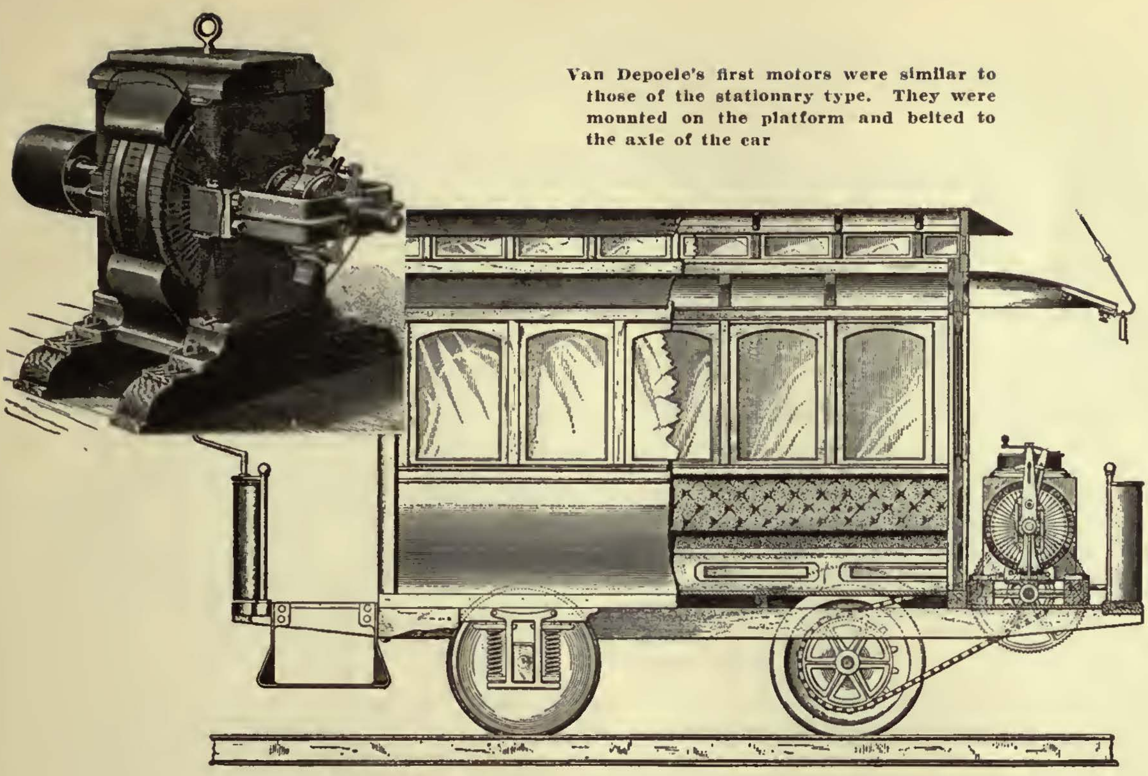
From the standpoint of the passenger, the seats, lights, heat, ventilation, etc., are of greater interest than the structural features of the car. To trace all of the many steps in the evolution of these details, however, is beyond the scope of this article. The old carpet-covered longitudinal bench has been transformed into the deep-cushioned leather-upholstered individual seat. The old dim oil-burning lamps have been superseded by electric lights, unshaded bulbs at first and now the attractive dome fixtures. Straw scattered over the floor was once the only means of keeping the passengers' feet warm in cold weather. Coal-burning stoves were a great improvement when they were first introduced on the cars, but even they have now to a large extent given way to electric heat. Where ventilation was once secured simply by opening the windows, it is now arranged through such effective ventilating apparatus that the condition of the air in the average car can be made as good as in one's own home.

Much attention has been directed toward reduction of noise in operation, particularly that part which can be traced to elements in the car. Padding and sound-deadening materials in sides and roof, as well as various types of flooring, have been effective in preventing sounding-board effects. Electrical equipment and brakes have been so constructed as to eliminate noise. Motor gears, which have been a frequent offender in the past, have been quieted by the addition of lead inserts of steel rings welded on. Wheels have been fitted with wooden, rubber or lead plugs that break up resonance. More care has been taken to eliminate from the design parts that are likely to come loose and rattle. Special attention has been paid to designing the car so that, in addition to being quiet when built, it will remain so throughout its life if given ordinary care in maintenance.

Notable Improvements in Exterior and Interior Appearance

Early cars were notable for rather ornate decoration both inside and outside. Present practice tends more toward simplicity, but the ultimate effect of the modern method of decorating is undoubtedly more attractive than was the old. Moreover, the elimination of ropes, straps and contraptions of various kinds has greatly increased the attractiveness of the car interior. The introduction of appropriate floor coverings has greatly improved the appearance. All these things have resulted in making the modern car more comfortable and attractive in the same manner that improvement in structural design has made it more efficient.

Looking back broadly over the history of car design during the past century it will be seen that there have been few sudden and radical changes. Progress has been made step by step as one detail after another has been redesigned and improved. The advances made during this period in structural design have been of far-reaching importance, but no more so than those which have added to the comfort and convenience of the passenger. Progress in car design has reflected accurately the steadily rising standard of electric railway service. The perfect car has not yet been evolved, nor is there any likelihood that it will be, but improvement has been rapid in recent years and attention is being focused on this subject to a greater extent today than ever before. As a result we may confidently expect to see a continued improvement in car design that will keep pace with the exacting demands of the riding public.



Van Depoele's first motors were similar to those of the stationary type. They were mounted on the platform and belted to the axle of the car

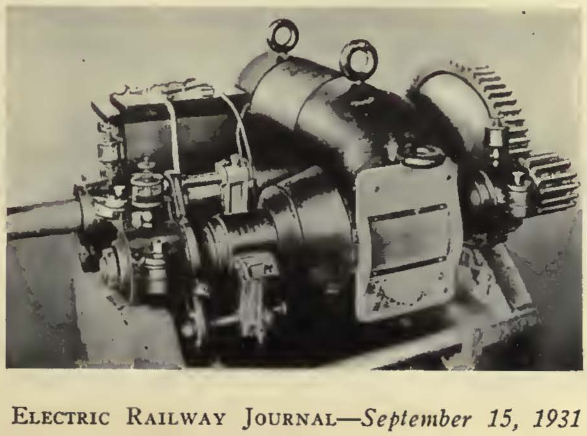
Continuous Progress

Has Characterized

Motors *and* Control

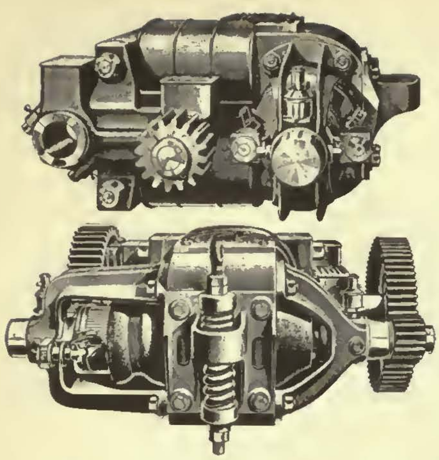
EVEN in its infancy, the electric motor stood out as a giant in the transportation industry. Sturdier and more adaptable than other motive powers, it soon displaced them and completely dominated the field. For half a century it has held its place as the most satisfactory means of drive. While steady progress in motor design has taken place throughout this 50-year span, the developments in the last five years have done more to improve the railway motor than those made in any comparable period since the experiments of the pioneers that led to stabilized types. Still further revisions that will make for better performance under the changing conditions ahead are likely. Similar progress has been made in methods of control and in control equipment. These have done much to assist the motor in doing its best under all conditions of service.

Most significant is the gain in output per unit of volume and per unit of weight that has taken place. For instance, a 35-hp. motor of 30 years ago weighed just short of 2,000 lb. A standard 35-hp. motor of today that weighs approximately 1,300 lb., or less than two-thirds as much, not only has better electrical performance, but actually has a greater continuous capacity. Even lower weights have been attained by some special high-speed motors of this same rating. Dimensions have shrunk along with the weight, so that the new motors are far more adaptable and permit the design of new types of drive previously unthought of. Better acceleration and higher speeds are natural results of these major improvements in the street railway motor.



One of the earliest Thomson-Houston motors. It was almost identical with the generators of the same make, but was turned on one side and fitted with double-reduction gearing

Greater appreciation of the progress that has been made in motor design will be had from a brief review of the steps that have taken place since it first was realized that electricity is



Sprague's motor used on the Richmond road was a distinct improvement over previous types. Originally designed for single reduction, a change to double-reduction gearing was later found necessary

an ideal source of power for the propulsion of vehicles.

History of the electric railway motor can be divided readily into four distinct periods:

1. Experimental—Prior to 1888
2. Development—1888-1895
2. Refinement—1895-1925
4. Revision—1925-

During the experimental period, the main purpose was to prove that electric propulsion was feasible. The history of the electric motor goes back nearly a century, for in 1835 Thomas Davenport, a blacksmith of Brandon, Vt., conceived the idea of using an electric motor for driving machinery. He obtained fundamental patents in 1837 on the use of the motor for propulsion. Had his work been followed up, these would have been extremely valuable, but it was ten years before any further development took place. Moses G. Farmer in 1847 built a model electric locomotive which was exhibited in Boston, and in 1851 Prof. C. G. Page built a car which actually made a successful trip on a railroad track.

Invention of Dynamo Was an Essential Step

All the early attempts were doomed to failure, since the only source of electric power was the chemical battery, high in cost and expensive to operate. It was not until the "reversibility" of the dynamo pointed the way to an adequate source of power that further experimental work was practicable. In fact, it was in 1878, ten years after the discovery of this principle, that Stephen D. Field experimented with electric motors for driving a car. To him the Patent Office awarded prior rights on his inventions. In 1881 he exhibited a locomotive which had a bipolar motor with a longitudinal shaft. This drove a countershaft though a bevel gear, the countershaft being spur-geared to the axle. The direction of motion was reversed by changing the brush position.

Early motors were mounted inside the car body or on the platform. Bentley and Knight in the equipment of their Cleveland road in 1884 were the first to place the motor under the car floor. It drove the axle by means of coiled wire ropes, which later were replaced by friction wheels and bevel gears. Their motor also was the first to use a series connection of field and armature. Other designers followed similar lines, using various methods of drive. In the Baltimore installation of 1885 Daft used compound-wound motors with a single-reduction drive by means of an internal gear. Some of the later Daft roads employed double-reduction gears, since the armature speeds were too high for a single reduction.

Frank J. Sprague in 1886 developed the method of supporting one end of the motor on the axle and the other on the truck, the method which is in general use today. This motor had single-reduction gearing.

Bentley and Knight a year later brough out a motor with double-reduction spur gears protected by inclosure in a gear case. Another innovation was the use of brackets made a part of the motor frame, on which were carried the bearings and brush holders. The motors were series wound, and were connected in parallel on the circuit.

Many Innovations on Richmond Road

Equipment of the Richmond road in 1888 by Sprague, which was the largest installation up to the time, saw a number of changes in practice. Two series motors per car were used. They were bipolar with axle suspension. Originally the motors had single-reduction gearing, but when it was found too light the motors were redesigned and double-reduction gears substituted. The motor fields were wound in sections, and the control was effective in part by varying the number of field turns. As in earlier motors, copper brushes were employed.

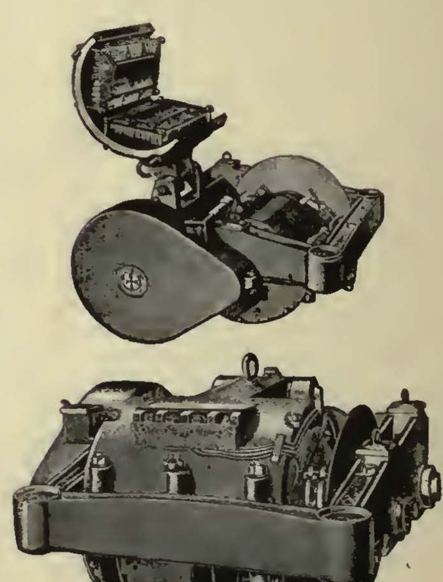
When the Thomson-Houston Company entered the field in 1888, it advertised the combination of practically all the improvements that had been made up to that time. Two motors were placed on a specially designed truck independent of the car body, the drive being with double-reduction spur gearing. The field was made of iron forgings. A series field winding was used with external resistance control. At the suggestion of Van Depoele, carbon brushes replaced the copper brushes, previously used almost universally.

By this time, all the essential elements for a practical railway motor had been developed. However, the design was still very crude and much development work was necessary before the street railway could be considered a commercial success. C. O. Mailloux in 1890 brought out a motor for use on a storage battery system that was a distinct step in adding ruggedness and reliability. It had a four-pole field, while slotted laminations with coils placed in the slots replaced the smooth core with the armature conductors on the surface as in earlier designs. The commutator was cross-connected so that one pair of brushes could be used. Later motors built by Mailloux used wave-wound armatures for the same purpose.

Beginnings of the Iron-Clad Motor

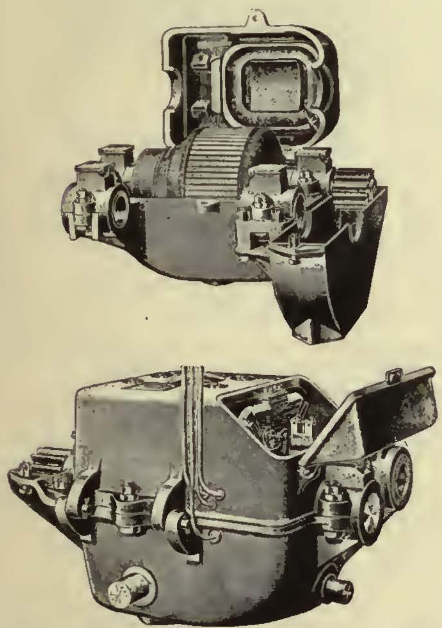
About the same time the Westinghouse Company brought out its first railway motor, which was followed the next year by its No. 3 motor. These motors were distinguished by the cradle in which the fields were carried, and which formed a shield for the motor, as well as a support for the armature bearings and bearings for carrying the motor itself on the axle and the truck frame. The motor had four salient poles placed at a 45-deg. angle, and the field frame was split in a horizontal plane to facilitate inspection and removal of the armature. The armature was slotted, and in the No. 3 motor formed coils were used instead of the hand-wound coils of earlier types. The motor was partially open, but the frame around it gave some protection to the armature and commutator.

Inclosure of the field frame was seen first in the WP-30 motor, placed on the market by the Thomson-Houston Company in 1891. This was a bipolar motor with only one field coil, placed at the top of the case. The magnetic circuit was formed of a partially closed case



The first motor to use a magnetic frame completely surrounding the armature was the Westinghouse No. 3. It had form-wound coils which surrounded the armature. This case was cast of mitis iron in halves, the lower part being arranged to drop.

Gearless motors were tried by several manufacturers, but were found unsatisfactory and were abandoned. The armature speed was necessarily so slow that a good design was practically impossible, and the support of the armature to provide a reasonable amount of springing was an almost insurmountable obstacle. In more recent years gear-



With the formation of the General Electric Company in 1892, the GE-800 was brought out. This was totally inclosed

less motors have been used on some high-speed locomotives where small-diameter driving wheels are permissible.

All Essentials Worked Out by 1893

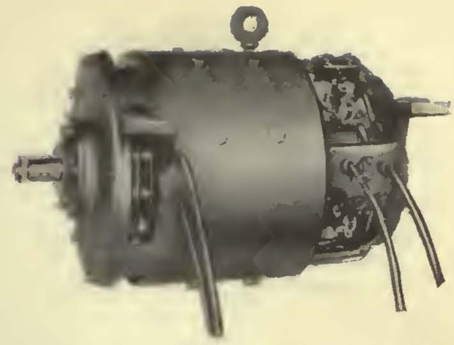
In 1892 the Thomson-Houston, Edison, Sprague, Brush, Sperry and Short interests were combined to form the General Electric Company, and the earlier lines of motors manufactured by these concerns were abandoned, being superseded by a line of which the GE-800 was typical. These motors embodied most of the good features of their predecessors, but had two salient and two consequent poles, so that their performance was not entirely satisfactory. In 1895 they were replaced by a new line, of which the GE-57 was the earliest. About the same time the Westinghouse Company brought out the 12-A motor. These two lines were typical of the revised design which embodied every essential for successful operation, and which continued practically standard for many years. The characteristics of these lines may be summed up as follows:

1. Series connection of field and armature, giving high starting torque and rapid increase of speed.
2. Frame made of steel castings of a shape to surround and protect the interior of the motor.
3. Armature core made of slotted punchings, and coils wound and insulated before inserting.
4. Wave-wound armature acting in a field with four salient poles, with a single pair of brushes.
5. Carbon brushes set midway between the poles, and not shifted in position when reversing direction.
6. Single-reduction spur gearing between armature and axle, with armature speeds of 500 to 1,000 r.p.m., and gear reductions between about 5:1 and 2:1.
7. Gears inclosed in a malleable iron case containing a supply of lubricant.

Several other American electrical manufacturers brought out competitive motors in the decade that followed, but none of them showed any marked superiority over the lines brought out by the two large companies, which made consistent improvements from time to time, although there were but few radical changes. The split frame which was a feature of the earlier motors gave way to a solid frame, since with increased reliability the need for changing armatures was reduced, and it was found more satisfactory to run the truck out from under the car and remove the motor as a whole when making repairs. The poles were made of laminated steel, bolted into the motor case in order to make the magnetic circuit more uniform. Both field and armature coils were improved by changes in shape, better types of insulation, and the use of strap or square wire coils where needed to give capacity. New methods of dipping and baking so as to impregnate the windings with insulating material increased the life of these parts greatly. Better commutator design, uniformity in the dimensions of bars and mica, and selection of better grades of mica, as well as correct dimensions and material of brushes improved commutation.

Introduction of Interpoles an Outstanding Step

Probably the outstanding development of the refinement period was the introduction of the interpole about 1905. This change was the addition of a set of poles placed between the main poles and carrying windings in series with the armature, the number of ampere

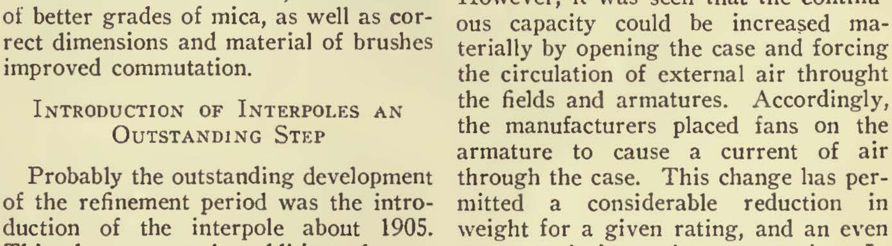


For the newer drives motor dimensions have been reduced to the limit. The GE-1126 automotive-type motor is an example of this development

turns being approximately equal to and opposing the armature ampere turns. This reduced the distortion of the main field flux to a negligible quantity and permitted sparkless commutation at any load or speed, or in either direction of motion, without any change in the brush position. Although the current density in the brushes is raised, there is less heating of the commutator and very small brush wear. Commutator wear is almost nothing. Introduction of the interpole also has made feasible the use of voltages higher than the conventional 600 which has been used for many years in street car work.

Ventilation Increases Motor Capacity

For years motors were built totally inclosed. On account of clearances they could not be made absolutely waterproof, but would withstand splashing, and some motors even would submit to operation through a flooded street without taking in an appreciable amount of water. However, it was seen that the continuous capacity could be increased materially by opening the case and forcing the circulation of external air throught the fields and armatures. Accordingly, the manufacturers placed fans on the armature to cause a current of air through the case. This change has permitted a considerable reduction in weight for a given rating, and an even greater gain in continuous capacity. In some motors, particularly for heavy traction work, reliance is not placed alone on armature fans, but air is sup-



The Westinghouse No. 12-A motor, shown at the left, was the first motor to incorporate the essential features that have since become standard. In comparison is seen the same company's No. 508 motor, which is a modern machine having the same rating

Early controllers were simple resistance switches. This type manufactured by the Thomson-Houston Company is a good example

plied to the motor by means of a flexible tube from an external blower system. This permits a further increase in rating, as the circulation of air is not dependent on the movement of the armature.

Grease lubrication, which, while not entirely reliable, was standard for many years on account of its simplicity, has been supplanted by oil, ordinarily supplied to the bearing surface through a wool waste wick. In some recent bearings the oil is contained in a sealed well, and inspection and replacement are necessary only at infrequent intervals. Many of the smaller motors now are built with ball or roller bearings.

When a campaign was made a number of years ago for a material reduction in car weights, along with lower step heights, it was found that this would not be possible with slow-speed motors of conventional design, which, in general, required wheels of 30 to 33-in. diameter for sufficient clearance. The manufacturers met the demand by bringing out entirely new lines of motors suitable for the modern cars. The principal change resulting in weight reduction was an increase in armature speed. Improvements in gearing have made practicable the employment of far greater speed reductions than had been the custom. Improvements in design and in the ventilation system have made it practicable to reduce the weight of the motor even more than in the inverse ratio of the speed. Methods of suspension in which the entire motor weight is spring borne have been of assistance on account of reducing road shocks and permitting smaller clearances in the motors.

Greater Weight Reductions Forecast in Future

Undoubtedly, the future will see still greater weight reductions. It is possible to make the motor magnetic circuit of rolled steel of high permeability instead of cast steel. Light-weight alloys can be used for non-magnetic parts. Higher armature speeds are by no means out of the question. There is a growing school of advocates of the shunt and compound-wound types of motor, which also have possibilities for weight reduction.

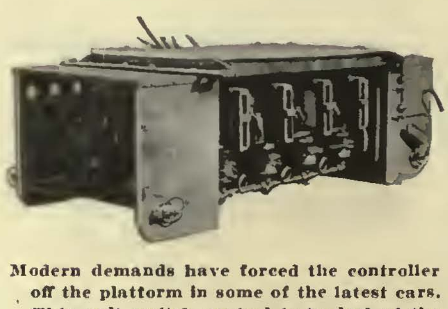
Contemporary with the development of the street car motor, there has been a like change in motors for heavy traction. It is not possible to follow the design through in a similar manner, since there has been such a diversity of systems of supply, of requirements and of individual characteristics of design that there has been no standard for comparison. There has, however, been a parallel improvement from the crude beginnings, and similar innovations have been made in the various types of heavy-traction motors.

Control Developments Are Equally Striking

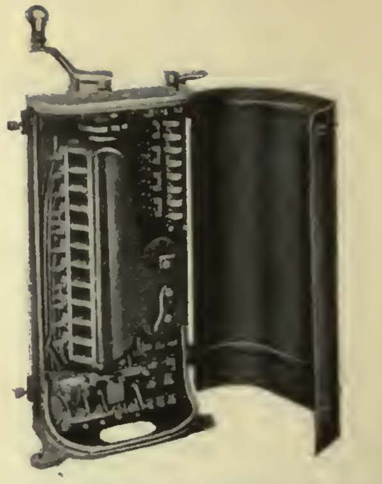
Control methods and controllers have undergone a development not less striking than that of the railway motor itself. The first controllers were merely hand-operated switches for throwing the power on and off. It soon was seen that better regulation was necessary, both for the safety of the car and for the protection of the generating equipment. With the acceptance of the series-wound motor, the insertion of series resistance, cut out in steps as the motor gained speed, became the custom for control. Various forms of resistance were used, of which sheet iron and cast iron were the most popular.

In some installations, notably those by Sprague, the field windings were divided into sections which were inserted or cut out to vary the resistance of the circuit and at the same time the number of ampere turns of the field. With the crude motor designs of that day, the performance with weakened field was found unsatisfactory and the method was abandoned.

Probably the outstanding development in the control of electric railway motors was the invention of the series-parallel system, which was brought out by the Thomson-Houston Company in 1892. With this the two motors are placed in series at starting or for slow speed, and then reconnected in parallel for high speed. Suitable resistances in series are used for further control of the speed. This method has become universal for use with direct-current series motors, the principal differences between the several types of control being in the method adopted for transition between the series and the parallel connections. The chief advantages of this control are that it is much more efficient, reducing the waste of energy



Modern demands have forced the controller off the platform in some of the latest cars. This unit switch control is typical of the designs adopted for use with a pedal



From its inception, the Type K controller was a success. With various modifications, it is still the standard where platform control is used

during acceleration, that it requires less expensive equipment for controlling the acceleration, and that it provides two economical operating speeds.

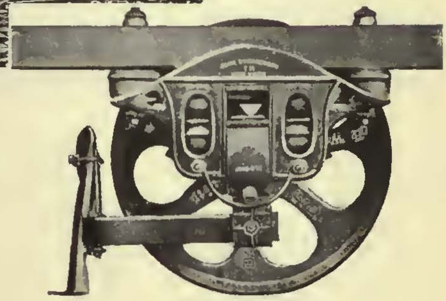
Drum Switch Adopted as Standard

Various types of controllers have been used, but many years ago the drum switch was adopted and has been the standard ever since. In this type the circuits terminate in fingers which press on conducting segments mounted on an insulating drum which makes the proper connections between the fingers to establish the desired circuits. The Type K controller, which was brought out as one of the first series-parallel controllers, has been modified to handle the circuits of street railway motors of various sizes, and with several modifications of the plain series-parallel connection. In these modified forms, its use has been almost universal where a platform controller is desired.

For some of the heavier equipments, as for rapid transit and interurban service, particularly where several cars are controlled from one position, remote control has been developed. The first control of the multiple-unit type, invented by Frank J. Sprague for use on the Chicago elevated lines, consisted essentially of a modified Type K controller mounted beneath the car and driven by a small pilot motor, which in turn was controlled by the motorman. Later types of remote control substituted individual switches instead of the drum, and they were opened and closed either directly by electro-magnets or by air pistons controlled by electro-magnets. All multiple-unit controllers embody these general features.

One of the recent developments is the adaptation of multiple-unit control for single cars, the master control being through a pedal. The operator thus is able to adjust the speed at his convenience through the pressure of his foot.

In the horse car days the journal boxes were mounted directly on the car sills, without trucks



Truck and Brake History

Shows Radical Developments

By

MORRIS BUCK

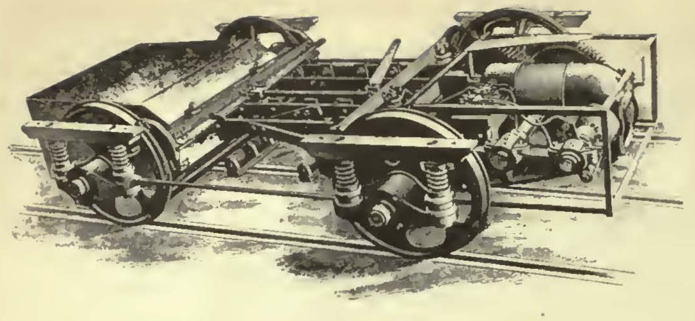
Engineering Editor
Electric Railway Journal

EARLY horse cars followed the design of the stage coach. Naturally the running gear consisted of loose wheels revolving on fixed axles attached to the car body. Before long it was found advantageous to reverse this practice, and the plan was adopted of having a pair of wheels pressed or keyed rigidly on a long axle which revolved in journal boxes. With track curves of moderate radius this plan was quite successful, and it has been continued ever since. It made possible a better form of bearing and permitted the journal box to be spring supported in a pedestal. At first it was customary to mount the pedestals rigidly on the car framing, so that the only movement permitted was vertical play against the springs. So far as can be ascertained all the early horse cars used axle bearings that were bolted to the wooden side sills. This made for a simple structure and, with the wheels acting as trailers only, no particular difficulty was encountered in keeping the axles in alignment.

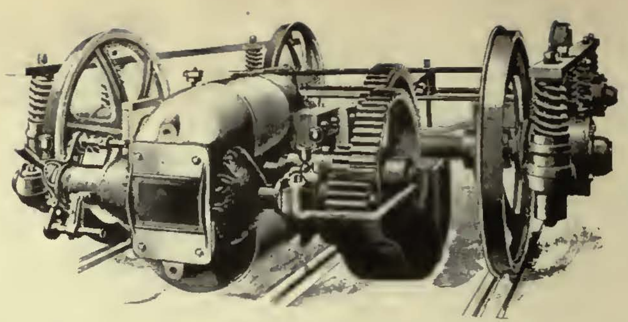
The early electric railway designers mounted the propulsion motors on the platforms. Since this method soon proved impracticable, they were mounted on the axles, usually on existing horse cars. Very soon it was found that with the removal of the limitations which the ability of the horse had imposed on car weight and speed, the running gear was entirely inadequate for the more powerful vehicle. Accordingly, about 1888, representative car builders brought out designs in which the running gear was assembled into an independent structure. The leaders in this movement were Bentley and Knight, who had also been pioneers in the installation of the earliest electric railways. One type of truck was designed with a rectangular frame which extended entirely around the top, and which was intended to keep the car body in alignment, strengthen it and prevent too much lateral motion.

Later, it was found necessary to spring-support the frame. The axle box support was at first suspended from the under side of the journal box, and cushioned with rubber at the point of connection with the box. Practice showed that it was necessary to have the wheels and axles removable without disturbing the axle box frame, springs and other parts of the running gear. The design was then modified so that the frame would be supported over the journal boxes and cushioned at the top.

Soon it was found desirable to devise some means of overcoming longitudinal pitching motion. This was accomplished by placing elliptic or semi-elliptic springs at the four corners of the truck. Many designs of single trucks have been developed, but they all have to meet the requirement of turning around sharp curves with the four wheels mounted on two parallel axles. Since the distance traveled by the inner and outer wheels is different, there must be slipping. Also, with the axles parallel, there always is a tendency for the wheel flanges to climb over the rail head and derail the car. These difficulties have restricted the general use of a single truck to cars of not more than about 30 ft. over-all length and a total weight of some 20,000 lb. The maximum wheelbase is usually between 8 ft. and 9 ft. In most designs, the side frames extend a considerable distance beyond the wheel line at each end to form a support for the springs.



One of the early separate trucks, brought out by Bentley and Knight in 1888. The journal boxes have short beams for attachment to the car sills



A modification of the Bentley-Knight truck, brought out soon after the previous one, had side bars tying the axles together to maintain spacing independently of the body

Numerous attempts have been made to overcome the inherent disavantages of the single truck. The most usual is to permit the axles to swing in such a manner that they will take a radial position when the car goes around curves. The Radiax truck is perhaps the best example of this. A swing link suspension, with two pins at the lower end of each hanger, carries the journal boxes and allows some longitudinal movement of the axles, but tends to return them to parallelism as soon as the car is on straight track.

Other plans involve the use of wheels mounted in a manner similar to the front wheels of an automobile, the axle being rigid and the wheel hub free to turn through a small angle. While none of the plans so far brought out has been entirely successful, the field existing for a small four-wheel car makes the problem interesting for the designer.

A more pretentious attempt to overcome the limitations of the single truck was the Robinson radial truck, brought out in 1890. This arrangement consisted of three single-axle carriages articulated together. The end carriages supported the car body through swivel bearings, while the middle one, which was free from any pivotal connection with the car body, would at all times keep its axle perpendicular to the track rails. The passage of the car around a curve, by swinging the middle axle out of line, turned the outside axles to a radial position. While the truck accomplished its purpose, its complications were so great that it never was widely accepted as a solution of the running gear problem.

Mounting of a car on two swiveling four-wheel trucks was adopted by steam railroads in early days to obviate the disadvantages of the single truck. At various times they were used on horse cars where conditions demanded the use of long cars. Within relatively few years after the advent of electric traction, about the beginning of the present century, employment of two swiveling trucks became fairly common on street cars. While the wheel loads and car dimensions are not great enough to demand the use of eight wheels for purely structural reasons, the superior riding qualities, ease of negotiating curves, and possibilities of higher speeds have caused the single truck to all but disappear from American street car lines.

Early double trucks were merely steam railroad trucks with provision for mounting of electric motors. It soon was found that they were not sufficiently flexible to make for easy riding on rough track, and designers attacked the problem of obtaining a more flexible support for the car body. As a result, a number of types were brought out.

Support of the bolster, or cross-member to which the car body is attached through a center bearing and a king bolt, can be arranged in a number of ways. The simplest is to fasten it directly to the side frames so that they form one integral unit. This practically duplicates the arrangement used on the single truck. Cushioning of the support is then entirely through the springs carrying the weight on the journal boxes. These springs may be elliptical or helical, or a combination of the two. In any event, the spring action is confined to absorbing vertical play of the axles, and there is no compensation for swaying of the superstructure. The rigid bolster truck was suitable for slow speeds, principally for freight motor cars and locomotives.

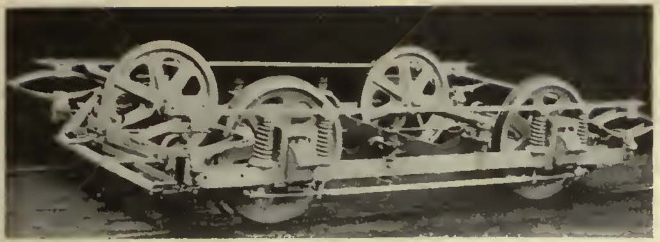
The floating bolster, which was adapted from steam railroad practice, is mounted on elliptic springs which rest on the side frames of the truck. It has an independent vertical movement and travels in ways in the side frames. This type of construction, which had long been standard for steam railroad freight cars, was adopted for electric cars fifteen years ago to obtain an extremely low over-all height in order to lower the car floor and eliminate a step. While it is not suited to high-speed work, the arch-bar truck has been quite successful in city service.

Best results in high-speed service with any of the conventional types of truck are obtained with the swinging bolster. Here the bolster travels in a guide or transom, and is mounted on elliptic springs. Unlike the floating bolster, the springs do not rest directly on the side frames, but are carried in a saddle hung from the transom, so that opportunity exists for a side swing of the superstructure. Various auxiliary spring systems have been devised to increase the flexibility still further. Trucks of this type have been used for all classes of high-speed passenger service. Since a certain amount of height is necessary to gain flexibility in a truck of this type, it is somewhat difficult to adapt it for use under extremely low-floor cars.

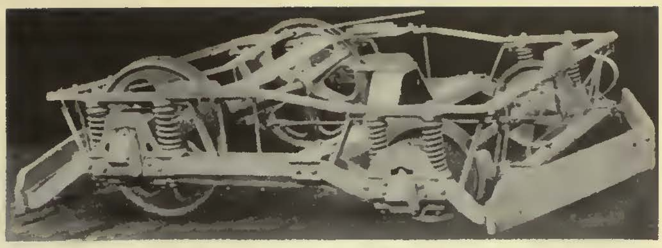
Since the two trucks of a car may be mounted any distance apart, there is no practical limit on length of body that can be supported. Overhang on curves is the greatest limitation, and this can be minimized by mounting the trucks a considerable distance from the ends of the body. The wheelbase of the truck itself must, however, be kept short enough so that the car can negotiate curves of the minimum radius encountered. This may cause difficulties in the mounting of motors and brake rigging. Ordinarily, the motors are placed between the axles, but by placing them outside the axles the wheelbase can be reduced materially. The maximum allowable wheelbase is seldom more than 7 ft.

Efforts have been made in recent years to design trucks which will eliminate the principal disadvantages of standard types. Requirements of today call for high speeds and high rates of ac-

This early Brill truck represents a further development. The framing is more rigid and the journal boxes are carried in guides



A somewhat more recent single truck with elliptic springs inserted to reduce oscillations of the car body



The maximum traction truck was a favorite when two-motor equipments were popular

celeration and braking. Smoother riding and quietness are demanded to meet the competition of the automobile. Ease of access is also essential, calling for low step height, with the ultimate desire to eliminate steps altogether. But above all there has been an insistent demand for weight reduction. This is an essential factor in attaining most of the other requirements. Light weight means reduced power demand, which in turn makes possible smaller motors. Again, it permits reduced dimensions, and makes possible changes in body construction that otherwise would be out of the question.

One of the earliest devices to overcome the objections to the standard double truck was the maximum traction truck, brought out by the J. G. Brill Company in 1891. The distinguishing feature of this truck was that one axle carried standard 30-in. wheels, while the other had wheels of a considerably smaller diameter, usually about 22 in. The center bearing was offset so that between 60 per cent and 75 per cent of the total car weight was carried by the large wheels. It was used with a two-motor equipment, one motor per truck, the weight of the motor adding to the portion of the body weight carried through the center bearing. Use of the maximum traction truck permitted a saving in height of as much as 10 in., and it was claimed that one step could be eliminated through it. The principal difficulty was that, due to the unequal distribution of weight, there was a tendency of the small wheels to derail. The maximum traction truck was entirely unsuited to high speeds, and, of course, the possible adhesive weight, even with the offset center bearing, was materially less than with the standard trucks with equal diameter wheels and four motors per car.

Since the early days of electric railways the propulsion motors have been hung from the axles on bearings which are made integral with the motor case. This arrangement serves to align the driving pinion of the motor with the driven gear on the car axle. Thus mounted, the motor is free to rotate around the car axle. It is restrained by means of a bar or other member connected to the side of the motor case opposite the axle, and held to the side frame or end frame of the truck through springs. Approximately half the motor weight is thus carried directly on the axle, and its weight is transferred to the track through the wheels without the medium of springs. With increased weights of motors the resultant pounding became increasingly destructive.

In recent years it has become standard practice to use two motors on each truck, one to an axle. By this means, the maximum unsprung weight on any axle is only slightly more than one-half of what it is with a single motor per truck. Progress in motor design has made it possible to obtain practically as good efficiency with four motors per car as with two. Naturally, it has resulted in lighter members of the truck and has permitted the use of smaller axles, bearings and other parts. Less power transmitted per axle has made it possible to use smaller gears and higher reductions, so that the motor speeds have been increased and weights reduced correspondingly.

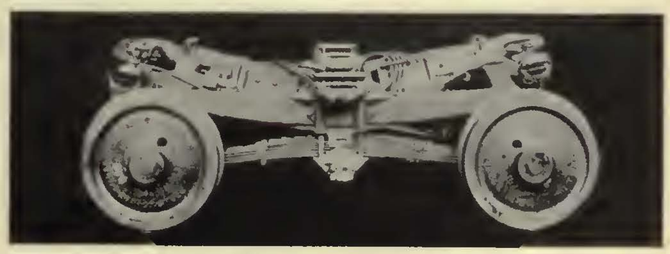
With all these changes there still has been a demand for trucks of even better performance. Manufacturers have met this in a number of different ways. Some have followed along conventional lines, but in general the changes have been radical. One of the most successful has been the abandonment of spur gearing and the subsitution of worm drive. With this the motor speed can be as high as is desirable from the electrical standpoint. Longitudinal mounting of the motor has removed the limitation to its length imposed by placing it between the wheels, and also has made it possible to extend the motor shaft to any desired length. Development of the worm drive principle has been carried out by the Timken-Detroit Axle Company, and a number of designs have been made by that company to incorporate improvements from time to time as experience has shown them desirable.

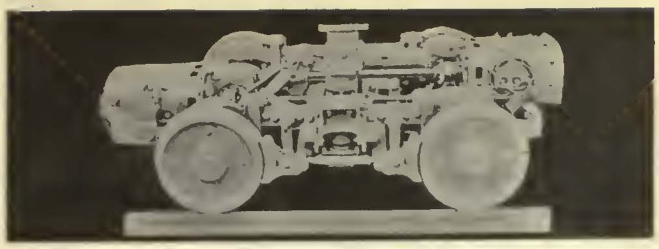
Less radical changes have been made by the J. G. Brill Company and the St. Louis Car Company in modifications of the swinging bolster type of truck to adapt it for high-speed motors under low-floor cars. This has necessitated a change in the arrangement of the swinging links to give them sufficient length for flexibility of the truck. Additional springs have also been included for easy riding. Motor drives with these trucks include a single-reduction spur-geared motor, mounted so that practically its entire weight is carried free from the axles. Another type is a worm gearing in which the motors are mounted outside the axles, with long drive shafts connecting them to the opposite axles. Still another arrangement is the W-N drive, which reverts to the double-reduction gearing, but with the difference that the motor is swung entirely free of the axle. A recent truck of the Cincinnati Car Corporation employs a modified form of arch-bar truck to accomplish the same purpose of providing flexibility of motor mounting.

Development of braking methods followed naturally along with the changes and improvements in motive power. Hand-brake rigging had been standardized for steam cars and horse cars for many years before the days of electric motors. With the higher speeds and greater loads of the electric cars, it soon was found that the existing brakes were inadequate. Originally, brakes were supported from movable points, subject to the action of the car

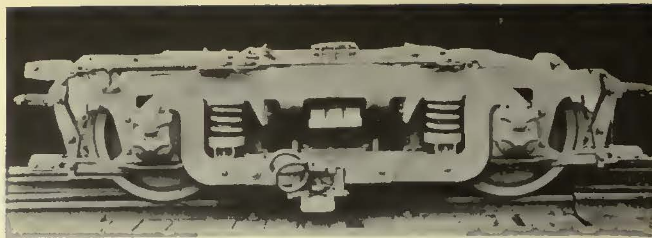
A standard short-wheelbase truck of the swinging bolster type of recent design

One of the recent Timken worm-drive trucks. Structurally it is a modification of the arch-bar type





An adaptation of the swinging bolster truck to worm drive. Individual brake cylinder and drive for each truck are used



One of the newer trucks of the arch-bar type, arranged for double-reduction drive

springs. They would not equalize the pressure of the brake shoes on the wheels. This forced a change of the system to a form in which the brakes were supported from the axle box frame and equalizing levers incorporated in the brake rigging. With the advent of the independent car truck the lever system was built on it, and the connections with the hand staffs for the operating levers made through chains or a combination of chains and levers, thus providing a maximum of flexibility.

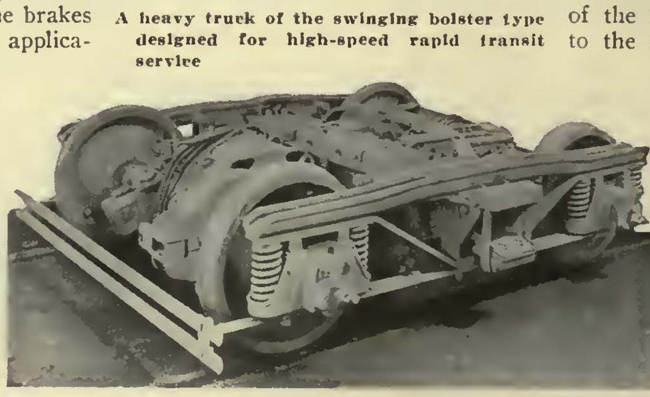
With the adoption of mechanical power, the hand brake had to be supplemented with a brake that did not depend on the brawn of the driver. Cable cars ordinarily employed track brakes, consisting of brake blocks pressed against the rails by a system of levers. These were also hand brakes, and required a heavy pull or an extremely long leverage. The air brake, which had been so successful in steam railroad service, was soon adapted to the needs of street cars. One of the earliest air brakes was installed by the Westinghouse Air Brake Company in Pittsburgh in 1890. It had an axle-driven compressor and a control not unlike that in use today for straight air. Other manufacturers entered the field, and many different types of air brake were brought out. Stationary air compressors with storage tanks on the cars have been tried. By 1895 motor-driven compressors had driven out the axle type. No essential change has been made in the straight air brake since that time. When rapid transit made it necessary to run cars in fairly long trains, the automatic air brake was adapted to the service. The use of automatic air has continued wherever trains of more than two cars are used to any extent. Electro-pneumatic control of the brakes in order to obtain simultaneous application on all cars of a train has been used in all recent rapid transit equipment.

From the earliest days of electric railways it was realized that the motors could be used for braking, either by short-circuiting them through a resistance or by using them as generators and feeding current back into the line. Many inventors have attacked the problem and working on these principles, have devised brakes which have been practical. Electric current, either generated by the car motors or taken from the line, also has been used for various solenoid brakes. The most effective of these have a shoe or shoes touching or approaching the rail head, the lever system being so arranged that the car is drawn against the rail with increased force, thus making the wheel brakes more effective and preventing skids. The best known of the early brakes of this type was the Newell brake, brought out by the Westinghouse Company in 1901.

Numerous other types of brakes have been used. The friction brake of W. L. Abbott, developed on the North Chicago Street Railway in 1889, was one of the earliest of the so-called momentum brakes. By pulling on a lever a chain was drawn tightly around the axle, the movement of the axle itself tightening the chain further and increasing the braking effort. Another brake tried out in the early days was the hydraulic brake. One type, developed by Lombard in 1895, used compressed oil for applying the braking force. A somewhat similar brake was brought out by J. H. Neal of Boston in 1900. Both types used axle-driven compressors to pump the oil into a reservoir against air pressure. After some 30 years, the hydraulic brake has again been brought forward in a car developed at Joliet. The new brake, however, is of the static type, and requires no pump.

Some recent cars are fitted with air brakes of the automotive type, similar to those used on buses and trucks. These brakes dispense with a large part of the lever system, and the travel of the mechanism is reduced so much that the ordinary cylinder with a piston moving a considerable distance can be replaced by a diaphragm with relatively small movement. By this means the quantity of air needed is greatly reduced and the air compressor can be correspondingly much smaller.

A heavy truck of the swinging bolster type designed for high-speed rapid transit service



From early days the actual friction producing the braking effect was developed by shoes pressing on the wheel treads and sometimes on the flanges. Wear of wheels and shoes makes frequent adjustment necessary. Furthermore, the shoes have a limited life. Cast iron, with or without inserts of various materials to increase the friction or reduce the wear, has been the accepted material for brakeshoes for years. Improvements in composition and methods of casting have resulted in a material increase in the life of brakeshoes, without a corresponding loss of service of the car wheels.

As a means of reducing the need for adjustment and in order to retain uniformity of braking over a wide range of conditions, a number of designers have gone to the adoption of brakes in which the wheels are not used as surfaces for producing friction. The earliest of these was the band brake in which a band of fabric, usually reinforced with a metal backing, is drawn against the outer surface of a metal drum attached to the axle. This type of brake gave fair service, but it was unreliable when wet and also was rather troublesome to maintain, since the bands wore out rapidly. Some designers have reversed the practice, a pair of brakeshoes of molded material being used to press against the inner surface of a drum attached to the axle or inside the wheel. This type of brake can be entirely inclosed, making it proof against the weather. Still another plan is to use shoes pressing against one or both of the radial faces of a disk attached to the axle or to the armature shaft. Each of these devices has merit and with all of them the travel of the parts is much less than with the ordinary type of wheel brake. Also the braking surfaces, not being used for other purposes, wear away less rapidly and fewer adjustments are needed. The parts are fewer in number and are lighter than those of the wheel brake.

Victory Over Political *and* Engineering Obstacles *Is*

Rapid Transit Achievement

By Ewing Galloway, N. Y.

Rapid transit trains on the Brooklyn Bridge have united the boroughs for many years

"PURSUIT of a suitable and adequate system of rapid transit has been constant. The sought-for ideal has been at times almost in sight; again it has disappeared, only to be revived as the struggle for it grew in strength. Romance and tragedy, few successes and many failures marked the quest. In its service men . . . have sunk their all in vain attempts to materialize their dreams only to retire bankrupt and see other men reap golden harvests from their crops. The history of rapid transit is replete with flashes of genius and the sordid spirit of greed. The struggle for public franchises alone . . . provides material for a thrilling drama." Thus James Blaine Walker, secretary of the New York Transit Commission, sums up the history of a service that has been vital in the upbuilding of great metropolitan cities.

NEW YORK

New York City, the largest metropolis on the continent ever since Colonial days, was easily the first to become seriously congested. Manhattan Island was settled at the southern extremity and, being long and narrow, grew toward the north. Three steam railroads entered the city and several others reached terminals in New Jersey and Long Island, connecting with Manhattan by ferries. Omnibuses were the principal local vehicles. By 1850 they made up nearly 40 per cent of all the traffic on Broadway. A count showed a thirteen-second headway. Street cars ran on some of the other thoroughfares, but the service was inadequate to meet the heavy demands.

It was to alleviate such conditions that in 1864 Hugh B. Willson, heading a number of prominent New Yorkers, incorporated the Metropolitan Railway Company, with a capital of $5,000,000, to construct an underground railroad. The plans called for an arch-roof tunnel lined with brick and carrying two tracks. Propulsion was to be with steam locomotives. The line was to run in Broadway from the Battery to 34th Street and then in Sixth Avenue to 59th Street. The London Underground had opened in 1863, and its success caused the project to be well received. In the Legislature, however, the opposition of the existing transportation lines blocked a franchise. A new bill passed by the Legislature in 1865 was vetoed by the Governor. Several bills were introduced by other persons, but nothing came of them.

However, in the confusion the railroad law of 1850 was amended in 1866 by authorizing the formation of a company to build a railroad with a cable driven by stationary power as a source of propelling force. Charles T. Harvey, in whose favor this amendment had been passed, planned to build an elevated railway with his patented cable drive. His main route was from the Battery up Greenwich Street and Ninth Avenue and finally to Kingsbridge. He also proposed lines up Broadway to Yonkers and up Third Avenue to Harlem. Harvey organized the New York Elevated Railroad Company, and in 1867 constructed an experimental single-track section of his railway ½ mile long in Greenwich Street northward from Battery Place. This was placed in trial operation in June, 1868. The plan was adjudged practical by the commissioners provided in the act. So well were the directors pleased that they authorized the inventor to extend the line to Cortlandt Street.

Financing proved difficult, and in 1869 the bankers forced a receivership. After a reorganization the single track was extended in 1870 as far as 30th Street. The cable method of propulsion proving a failure, the bondholders obtained permission to substitute steam locomotives, and on April 20, 1871, operation began again with a train of three cars hauled by a dummy engine. The road has been in service ever since.

Pursuant to a law passed by the Legislature of 1868, construction of a "pneumatic dispatch" tunnel was permitted under Broadway for mail and packages. The promoters built a section of passenger tunnel instead. It was a 9-ft. circular bore 312 ft. long between Warren and Murray Streets. Alfred E. Beach, the inventor and builder, used the shield method of tunneling for the first time in America. A circular car fitting closely inside the tunnel was propelled by air pressure obtained from a large blower at the end of the tube. A trial trip was made in February, 1870. The Beach company failed to raise capital and the atmospheric system did not prove a success.

The same session of the Legislature, 1868, authorized a subway up Pearl and Mulberry Streets, Fourth and Madison Avenues to the Harlem River. Some work was actually begun to hold the franchise, but the line never was built. Several other subway companies were organized in succeeding years, but none of them managed to do any construction.

Meanwhile considerable activity was manifest in elevated railroads. Dr. Rufus H. Gilbert and his associates obtained a charter in 1872 for a "patent" railroad of his invention. Tubular iron roadways were to be suspended above the street from Gothic arches and cars propelled through them by atmospheric or other power. The route was that of the Sixth Avenue line. The panic of 1873 prevented the company from getting capital and application for relief was made to the Legislature. As a result the act of 1875 was passed creating the first Rapid Transit Commission. The act confirmed the routes of Gilbert's company and also laid down many "connecting" lines for the New York Elevated Railroad. The commissioners authorized the latter company to build a connection with its Ninth Avenue line to reach the Grand Central station by an "extension" from South Ferry. This was the Third Avenue elevated.

By the Rapid Transit Act the commissioners were authorized to organize a company to build a road if none of the existing companies carried out the plans approved. Under this clause the Manhattan Railway Company was organized ready to step in if either the New York Elevated or the Gilbert Elevated failed to complete its contract. The former company completed the Ninth Avenue line as far as 59th Street and began operating it in 1876, and to South Ferry in 1877. The Third Avenue line from South Ferry to 42nd Street was opened in August, 1878, and extended to 125th Street in December of the same year. In 1880 the Second Avenue line was built to 67th Street and the Ninth Avenue line extended to Harlem.

Gilbert's lines were held up by legal proceedings, but the Sixth Avenue line to 59th Street finally was opened in 1878. Financial difficulties ensued, and the Manhattan Railway came into the picture in 1879, leased both systems, and completed construction. With the extensions to the Harlem River in operation traffic grew by leaps and bounds and the enterprise became profitable. More than 60,000,000 passengers were carried in 1880. Fares of 10 cents were established, but the Rapid Transit Commission specified a 5-cent fare during hours when workers were going to or from business.

Testing New York's first elevated in Greenwich Street—1867

Following the success of the first elevated railroads in Manhattan the demand was made for similar facilities in Brooklyn. The Brooklyn Steam Transit Company was chartered in 1870 to build an elevated road from Fulton Ferry to Flatbush, but capital could not be raised. However, the Brooklyn Elevated Railroad was chartered in 1874 to build a road from the end of the new Brooklyn Bridge to Woodhaven through Fulton Avenue and East New York. After numerous vicissitudes ground was broken in 1876, but it was not until 1885 that the first section was put in service. Meanwhile the Kings County Elevated Railroad was organized in 1878. It also had difficulties, but finally built the Nostrand Avenue line, which was placed in operation in 1888. The Union Elevated Railroad, organized in 1886, built several lines which were leased to the Brooklyn Elevated Railroad. Within a few years all the properties in the city were acquired by the Brooklyn Rapid Transit Company.

All of these lines, both in Manhattan and in Brooklyn, were operated for years with steam locomotives. Success of electric service in Chicago and elsewhere caused agitation in favor of electrification in New York. Finally arrangements were made to equip the Brooklyn lines, which began service with multiple-unit electric trains in 1898. Electrification of the New York elevated lines was then a foregone conclusion, and they were all converted with the multiple-unit system by 1902.

Agitation in favor of city-owned lines in New York began as early as 1873, when the plan was suggested by Abram S. Hewitt, later Mayor. For many years public opposition was apparent, but in 1891 an amendment to the Rapid Transit Law authorized the Mayor to appoint a Rapid Transit Commission with power to lay out routes for construction with either public or private capital. Such a board was appointed, but failed to accomplish anything, and the Legislature of 1894 created a new commission. Alexander E. Orr was chairman and William Barclay Parsons chief engineer. This was the board that built the first New York subway. One of the early decisions of this new board was that underground railways were necessary. Difference of opinion developed as to route, a board of experts recommending a line on the East Side through Fourth Avenue, while the commission itself favored Broadway. Finally, after a great deal of argument, including an appeal to the Supreme Court, a compromise route was selected in 1897 going from City Hall via Elm Street and Fourth Avenue, across 42nd Street and up Broadway to Kingsbridge. Extensions under Lenox Avenue and to Bronx Park also were included. Four tracks were specified from a loop at City Hall to 103rd Street, all on one level. This zigzag route proved costly years later when extensions were made. A modification of the original plan extended a two-track line from City Hall to a loop at the Battery.

Formation of Greater New York in 1899 by inclusion of Brooklyn, Queens, Richmond and the Bronx caused more or less embarrassment, for the proposed line was entirely in New York County. The Manhattan Railway about the same time caused trouble when it arranged to apply for extensions to its system. The large bond required of the contractor, $15,000,000, also made it difficult to get anyone to undertake the construction. The new city administration, too, seemed ready to block the project. About this same time the Metropolitan Street Railway, controlling all the surface cars in Manhattan, came forward with a proposition to build the subway in return for a perpetual franchise. But finally, by the end of 1899, the legal difficulties had been smoothed out. John B. McDonald, who was backed by August Belmont, was the successful bidder for Contract No. 1, which provided for construction and operation of the line for 50 years. The city furnished such land as necessary and the contractor supplied the equipment for operation. In 1901 it was decided to extend the subway to Brooklyn, and Contract No. 2 was executed to cover that portion of the line. Operation of the first portion of the subway began Oct. 27, 1904, with multiple-unit electric trains. The extension to Atlantic Avenue, Brooklyn, was opened in 1908.

During the progress of the work the Interborough Rapid Transit Company was formed to operate the subway on its completion. In 1903 the new company leased the Manhattan Elevated Railway for 999 years, placing the Interborough in control of all rapid transit lines in Manhattan and the Bronx. Before the completion of the subway the Metropolitan Street Railway formulated plans for a competing subway which were given great attention. Finally the Interborough was forced to purchase the Metropolitan company in 1906.

Meanwhile new routes were being laid out by the Rapid Transit Commission. Before the first subway had been in service a year it began to be inadequate. Criticism of the commission, despite its success, became so insistent that in 1907 a law was passed abolishing it and creating two State Public Service Commissions, the first district comprising New York City and the second district the remainder of New York State. One of the first acts of the new commission was investigation of the acquisition of all the Manhattan surface car lines by the Interborough. In the progress of the investigation the creditors of the surface car company forced a receivership. As a result of this receivership the surface lines in Manhattan were split into two new companies, the New York Railways and the Third Avenue Railroad, the latter entirely independent of Interborough influence.

Rapid transit projects were pushed as fast as possible. The mistake of the zigzag subway was rectified by making two routes, east side and west side. The lines were continued through to Brooklyn. Station platforms in the old subway were lengthened and third tracks were added to the Second, Third and Ninth Avenue elevated roads. New routes were laid out in the Bronx and in Queens. After considerable difficulty it finally was decided in 1911 to award the subway contracts jointly to the Interborough and the Brooklyn Rapid Transit Company. Construction work was begun the same summer.

The changes made by the dual system contracts were far-reaching. The Interborough previously had 191 miles of subway and elevated track. This was increased to 360 miles. The Brooklyn system, formerly all elevated, went from 105 miles up to 260. In other words, the single-track mileage of rapid transit lines in the city was more than doubled. Minor additions have been made since that time.

Even with this great expansion the needs of the city have not been met. Politics crept in and prevented a continuous program of expansion to meet the growth of population. After several changes in legislation the present Board of Transportation was organized in 1924 and empowered to build new subways. Following many delays construction was started in earnest in 1928, and it is hoped to have the first of the new lines, the Eighth Avenue subway, in service before the end of this year.

By Underwood & Underwood

The famous 110th Street curve on the Manhattan Elevated when rapid transit in New York was young

HUDSON TUBES

From early days ferries plied across the Hudson River between New York and New Jersey. The irregularities of the service prompted various schemes for tunnels under the river, dating from the middle of the nineteenth century. However, the first to be incorporated was the Hudson River Tunnel Company, formed in 1873 to construct an underground line connecting New York with the railroad terminals in New Jersey. Work was begun late in 1874 by sinking a shaft in Jersey City at Fifteenth Street. Litigation held up the work until 1879, when the shaft was sunk deeper and a heading started for the tunnel 60 ft. below the surface. The plans adopted called for two elliptical tunnels, each holding one track. The north tunnel was driven 280 ft. when a blowout of air occurred in 1880, drowning the workmen and flooding the tunnel. In 1881 work was resumed, but it was stopped for lack of funds the next year after the north tunnel had been driven 1,542 ft. from New Jersey and 74 ft. from New York, and the south tunnel 570 ft. from New Jersey. Work was resumed at various times and a small amount of progress made. In 1889 S. Pearson & Sons of London took over the work with English capital and by 1891 carried the north tunnel to a point 3,900 ft. from New Jersey by the use of the shield tunneling method. Again funds gave out. It was not until 1902 that the scheme became active again when William G. McAdoo organized the New York & New Jersey Railroad. This company resumed the work, and the same interests formed the Hudson & Manhattan Railroad to build two similar tunnels to lower New York. The north one of the old tubes was carried through in 1904 and its mate in 1905. A franchise was obtained to continue the line in New York under Sixth Avenue as far as 33rd Street. Meanwhile work was started on the lower pair of tubes, and twin 22-story office buildings were erected over the terminal at the New York end. These lines began operating in 1908. In 1912 a connection was made with the Pennsylvania Railroad and through service established to Newark. From the beginning the system was operated with all-steel multiple-unit trains.

CHICAGO

Observing the success of the elevated railroads in New York, it was not long until demands were made for similar facilities in Chicago. There was some talk of building a line like Harvey's elevated in New York. Again, as early as 1886 Chicago was planning subways. In 1888 a proposal was made for an underground transit system to have a main line under Monroe Street, with a loop about the business district. This plan never progressed much farther than the ordinance stage.

Following this project a real step was made in 1888 when a company was formed to build an elevated railroad to the South Side. Consent was soon obtained and construction was begun. In anticipation of the World's Fair of 1893 work was pushed and the road was opened on June 6, 1892, as far as 39th Street. It was extended to the fair grounds in Jackson Park in time for the exposition. Steam locomotives were used to haul trains of trail cars. Unlike the elevated railroads in New York, which were erected over city streets, this and other Chicago lines built later were constructed on private right-of-way through the middle of the blocks. Thus the South Side line became known as the "Alley L."

private right-of-way for the greater portion of the distance.

Meanwhile the Lake Street Elevated Railway had been built parallel to the Metropolitan for a distance of 6½ miles from the center of the city. So successful was the latter that the Lake Street line was changed over to electric operation during June, 1896.

Last of the rapid transit systems to be built in Chicago was the Northwestern Elevated. The first contract was let in February, 1895, but it was not opened until 1900. It was the first one of the elevated lines for which electric service was planned from the inception of the road.

As originally built the Chicago elevated railways were operated independently. Each of the four systems had its own terminal at the outskirts of the central business district, which at that time was about ½ mile square. In 1894 a loop delivery line was proposed, and after somewhat extended negotiations it was constructed by a new company, financed largely by the four elevated railways. The new line made a double-track loop on Wabash Avenue, Fifth Avenue, Lake Street and Van Buren Street, with connections to the four systems.

Chicago Aerial Survey Co.

Chicago's famous Loop District—made possible by rapid transit

One of the great attractions at the World's Fair was the Intramural Railway. It was an elevated loop line, with its several stations near the principal exhibit centers. The road, opened for traffic on April 20, 1893, was the first demonstration of heavy electric train service. Passenger cars equipped with motors hauled one or two trailers. On the occasion of "Railroad Day" a demonstration was given of a train of seven trailers hauled by a single motor car. The road was in service the entire time of the exposition. It carried thousands of passengers and gave a great impetus to heavy electric traction.

In 1892 A. F. Walcot of New York formed the Metropolitan West Side Elevated Railway to be run with 40-ton steam locomotives. Success of the Intramural Railway made the builders change their plans and adopt electricity. When the line was opened on May 17, 1895, from Franklin Street for a distance of 5 miles westward it was the first permanent all-electric elevated railroad in the United States. Like the South Side Elevated it was built on

Contracts for the electrification of the South Side Elevated, the last of the Chicago systems to be converted, were let in 1897. Unlike the older electrifications, in which one motor car hauled several trailers, this one called for the use of several motor cars, controlled jointly by one motorman through the use of the multiple-unit control system devised by Frank J. Sprague. This installation, put in service in May, 1898, proved epochal in rapid transit. All the other elevated railroads soon were equipped with multiple-unit control, either the Sprague system or the electro-pneumatic type.

Certain tunnels had been built toward the end of the last century to carry the street car lines under the rivers to prevent drawbridge delays. In 1900 John M. Roach, then president of the Union Traction Company, proposed a system of subways under the principal downtown streets connected with the under-river tunnels to provide a terminus for the principal street car lines. Nothing came of the project, nor of others which were brought forward at various times.

When the consolidation ordinances of 1907 were drawn up subways were incorporated as an element in the plan. Annual payments of the surface lines to the city were impounded to form the nucleus of a fund for construction of rapid transit lines. From time to time plans have been made to begin such a system, but up to the present no definite action has been taken. Legislation adopted last year for the consolidation of all local transportation lines in the city, however, paves the way for the construction of rapid transit subways in Chicago's business district, with subsequent extensions of subway and elevated lines to cover the entire city.

BOSTON

Rapid transit in Boston dates from 1891. During that year Henry M. Whitney discussed the possibilities of an underground passenger railway as a means of reducing street congestion in the business district, principally on Tremont Street. Early in 1892 the Rapid Transit Commission, formed the year previous to investigate the matter, agreed on a provisional loop route, partly elevated and partly underground. The plan was not approved and in 1894 the Legislature appointed a new board. The arrangement adopted called for a double-track subway from an entrance at Park Square via Boylston and Tremont Streets to an underground loop at Park Street. Surface cars were diverted into it from the Back Bay and Roxbury districts. This section, opened in September, 1897, was the first subway in America. Another pair of tracks enter the subway at Pleasant Street, paralleling the first pair of tracks from Boylston Street to Park Street, with a second loop at that point. A similar subway with four tracks went from the vicinity of North Station via Haymarket Square to Adams Square and Scollay Square, where loops were constructed. A connection under Tremont Street between Park Street and Scollay Square gave a through route under the city. As a result all street car tracks were removed from Tremont Street.

Subway construction in Boston was undertaken by the city and the structure leased to the operating company. This was an innovation in the history of city railways in America. Need for real rapid transit service becoming more and

Entrance to the Boylston Street Subway at Park Square—the first subway in America

more apparent, in 1897 a bill was passed in the Massachusetts Legislature for the charter of a comprehensive elevated railway system. The main route was to be from Sullivan Square in Charlestown to Dudley Street in Roxbury, via Atlantic Avenue, a distance of 5 miles. It also was proposed to construct an alternate route under Tremont Street, utilizing the street car subway between North Station and Pleasant Street, joining the elevated track as near those points as possible. This plan was adopted with minor modifications and the line was placed in service in 1899 with multiple-unit trains. Thus Boston not only has the first subway, but also the first underground rapid transit system in America. The Atlantic Avenue elevated was not opened until August, 1901.

Inauguration of rapid transit service deprived the surface lines of one pair of tracks under Tremont Street, but it made possible a new type of transportation. The rapid transit trains in Boston are run by the same company as the surface cars, and at prepayment stations in the subway it became possible to change cars without the use of paper transfers. This system was later extended by the establishment of prepayment areas for surface cars under elevated stations and at a few subway stations.

Soon it was realized that Boston's rapid transit system was inadequate. Construction of a new tunnel beneath Washington Street, opened in 1908, gave a more direct route for the trains, and the Tremont Street subway was restored to its original purpose of carrying surface cars.

East Boston was connected with the center of the city by a tunnel under the harbor between Maverick Square and Scollay Square, begun in 1900 and opened at the end of 1904. Later it was extended to Bowdoin Square to provide a direct route to East Cambridge and Somerville. The Washington Street elevated was extended from the terminal at Dudley Street to Forest Hills in 1909, and from Sullivan Square to Everett in 1919.

The most important of the later developments in Boston's rapid transit program was the inception of the Cambridge-Dorchester subway. The original portion of the system was built by the company but later was purchased by the State of Massachusetts and leased to the railway. The first section, opened in 1912, connected Harvard Square, Cambridge, with Park Street, the Charles River being spanned by a bridge. Subsequent extensions carried the line to South Station, Andrew Square and Ashmont. The latest extension has been made through the electrification in 1929 of a branch line leased from the New Haven Railroad. This line, between Ashmont and Mattapan, is being operated with high-speed surface cars, but has stations of the rapid-transit type.

Market Street—under this is Philadelphia's first subway

PHILADELPHIA

In 1901 the Pennsylvania State Legislature passed an act sanctioning the incorporation of elevated and subway companies, and the Philadelphia Council granted franchises for several projects, including numerous elevated lines as well as a subway under Broad Street. In 1902 the Council authorized the building of a subway under Market Street east of the Schuylkill River to take the place of the elevated road contemplated in the original franchises. Several other franchises were passed. All of them subsequently were acquired by the Philadelphia Rapid Transit Company, and a broad plan for giving genuine rapid transit facilities in conjunction with the existing surface lines was formulated. As in Boston, all lines are run by one company and transfers are given between rapid transit and surface cars.

First of the routes to be constructed was that portion of the Market Street subway between the west side of City Hall and the Schuylkill River, where it crossed on a bridge and continued on an elevated structure to a terminal at 63rd Street. Soon the line was extended to 69th Street and a joint terminal established with several interurban railroads. This first section of the subway, begun in 1903 and completed in 1905, contained four tracks, the two inner ones being for rapid transit trains and the two outer ones for the diversion of surface cars from Market Street. The latter tracks were later extended in a loop around City Hall, and the rapid transit subway continued east to the Delaware River. In 1920 the Frankford line was placed in service.

Construction of the Market Street elevated differs from that in New York, Chicago and Boston in that the structure has a closed concreted floor system, preventing drippings to the street and reducing noise materially. The track is laid with wood ties on 5 in. or more of broken stone ballast.

Plans for a subway under Broad Street were made many years ago. They were modified several times, and it was only in 1928 that the first section, from City Hall to Erie Avenue, was opened. Extensions underway and contemplated will, in conjunction with the surface cars and buses, give Philadelphia a modern co-ordinated transportation system.

Typical track construction of the early '90's. "Bolted Up" special trackwork on chairs laid in Atlanta, Georgia, 1891

Improvements in Track

FIFTY years ago is far enough back so that only an occasional track man has any personal recollection of the track construction of that time other than as a passenger on some horse car line, or perhaps in riding a high bicycle across a cobble-paved track at imminent risk of disaster. One of the best-known members in the industry admits that his ambition was to drive the extra horse pulling the car up the hill for the sake of riding down on the horse's back. In several very hilly cities the "hay-motor" himself rode down the hill on the back platform.

The same ambitious youth referred to above says:

> One of the reasons why I left the street railway business in 1891 was the result of an engineering report to the effect that their present construction of 6-in., 70-lb. rail on a 4-in. stringer on cross ties would last indefinitely, if not forever. This followed a survey in which no measurable wear was found on the rails after a year's use. My reaction at the time was that maintenance of such a proposition was not likely to call for much engineering service.

In 1881 there were about 6,000 miles of street railway track in the United States, but these were horse car tracks, for at that time it was only the dreamer who thought of electrically driven cars. Then the cable car was considered the coming means of city transportation. Even the flat rail had a predecessor in the bar or flat strip of wrought iron, which, nailed to a wooden stringer, formed the support and guide for the car wheels. An interesting intermediate type was that of a bent plate laid in St. Paul and Minneapolis in the early '70s. This track consisted of wooden stringers, 5 in. square and 16 ft. long, laid on wooden ties. The stringers were drift bolted or spiked to the cross ties. On top of the longitudinal stringers, bent iron plates, weighing 23 lb. per yard, were laid to act as rails. The track was narrow gage, 3 ft. 6 in. wide. The cost of such construction was $6,000 per mile.

This type was succeeded by the "side-bearing" flat rail, and that, in turn, by an early form of girder rail. Paving in those days, if any, was usually of cobble stone. In the Twin Cities, 50 years ago, they tried for a few years a type of round cedar block, only to learn, as we well know now, that perfection in a pavement has not yet been attained.

The cars that rolled over these old rails were 10 ft. long, mounted on four light wheels, and weighed about 1,000 lb. Each car was drawn by one horse or one mule. The fare box was placed in the front of the car, and the passengers were expected to deposit their fare on entering the car. If the passenger was forgetful, the driver rang a bell until he paid his fare.

The cars on each line were painted a different color to distinguish the line. In winter, the cars were heated by a small sheet-iron stove on one side in the middle of the car. The driver stood on the front platform protected by a sheet-iron dash extending a little above his knees. The driver attended to the horse, kept a lookout for passengers, saw that all passengers paid their fare, and was on the car sixteen hours per day with twenty minutes off for lunch. The wages were $35 per month.

Just as the horned toad and certain shellback types of animals have, we are told, survived their contemporaries by millions of years, so the flat rail and the horse car persisted for many years, side by side with the improved track and electric operation. Probably the most notable instance was in New York City. Horse cars were operated there until 1917, and horse car tracks have persisted unused to the present time, being gradually removed as streets are repaved. Most of the tracks, it is true, were changed to girder rail construction, but it was of a very simple type.

An intermediate step was the use of storage battery cars on the old horse car lines, which necessitated some track reconstruction and the installation of improved special work, giving a construction similar to standard trolley track, except that it was somewhat lighter. Some of these storage battery lines are still in operation in New York City.

It is perhaps not generally understood in other parts of the country why this curious condition existed, but there was a good reason for it. In the first place, overhead trolley construction has never been permitted on Manhattan Island except for very short distances over some of the bridges from the Borough of the Bronx. The underground conduit or slot type of track construction required in Manhattan is extremely expensive, costing from five to ten times as much as ordinary surface track, depending on the amount of underground obstructions to be moved and the extent of complicated special trackwork required. In the second place, the building of rapid transit lines in New York, beginning about 30 years ago, has completely altered not only the lines of traffic but the distribution of residence, business and industrial districts. The ferries, which formerly carried an enormous amount of traffic, have virtually disappeared, except those to Staten Island supported by the Municipality and those to New Jersey supported by steam railroads. Entire street railway systems that once served these ferries and were profitable have ceased to exist or are no longer able to pay dividends, so that the failure to change horse car lines to electric lines was not due to lack of foresight or initiative but rather to the use of good judgment and to hard facts.

By the end of the first decade of the past 50-year period the design of rails had passed through the experimental stage and reached the types with which we are still familiar. Among the outmoded rails were the side and center bearing flat rails, the Wharton "Butterfly," the Louis & Fowler box girder rails, the Gibbon Duplex, and the Gribble box girder rails. The first girder rail actually rolled was the Section 72 of the Cambria Iron Company, Johnstown, Pa., in 1877 for the Clay Street Line in San Francisco.

The track in horse car days is best described by a track man, now retired, whose delightful personality and entertaining reminiscences are known to all

Have Kept Pace with the **Industry's Needs**

By
E. M. T. RYDER
Way Engineer
Third Avenue Railway
New York, N. Y.

track engineers in this country and Canada.

The rail was 1½ in. thick in the head and was laid on a wooden stringer the width of the rail and 6 in. deep, resting on similar sized crossbeams set about 10 ft. apart. The rail was spiked through the tram portion of the stringer. If insufficient space was allowed at the joints, in very warm weather the middle portion of a 30-ft. rail would rise from the stringer several inches and remain until it could be cooled with water. If it turned over sidewise onto the pavement, the services of the track gang were required to restore it to place. In the meantime, the cars would roll along on the wooden stringer. This was not an unusual event, for many old timers had seen cars in New York City pulled entirely from the track to clear an unloading truck which temporarily blocked the way.

In New Orleans where suburban track was laid without paving, and cars were drawn by one mule, a plank about 1 ft. wide was laid in the middle of the track, and the mule, generally wise to conditions, kept religiously on the plank lest, in wet seasons especially, he become mired in the soft ground.

A search of the old volumes of ELECTRIC RAILWAY JOURNAL brought to light so many instructive and amusing facts that a few of them are given below. In the 1880's we have this description of the different track gages for horse car lines that were used in England and France.

The gage adopted in England is the same as that in this country—namely, 4 ft. 8½ in. In France the gage is 1.54 meters, or very nearly 5 ft. The gage is so wide that when two horses are pulling the car, they can trot with ease without stepping on the rail. In this country the horses are continually stepping on the rails because the gage is narrow. The French say that when the rails are placed nearer together than their standard it is necessary to harness the horses in tandem. Although tandem driving is perhaps best for freight hauling, it is not desirable for the transportation of passengers.

In the same period, the West End Company, in Brookline, Mass., is reported as laying track with English grooved rail known as the "Liverpool Rail." In section it was of the I-girder form, similar to that in use on steam roads, but was 7 in. high with a ½-in. web with a 6-in. flange and face.

A description of the foundation will make some track engineers decide that they were born too late.

The bed for the rail consists of concrete filled trenches, 8 in. wide by 8 in. deep, made of the best Portland cement, one barrel of cement to two barrels of sand, mixed with small, hard broken stones, and well rammed. The base of the rail has a continuous bearing on the surface of the concrete.

Before the day of mass transportation
"Five Points," Atlanta, Ga., 1892

Not to neglect the pavement, a description is given that will be vivid to the older men in the industry.

While for many reasons the cobblestone is an excellent pavement for the space between the rails, yet, as ordinarily laid, the cobble footway soon looks like a relief map of the moon. The stones being of unequal size, the small ones sink deeper into the bed than the larger ones. Hence, those which offer most resistance to foothold and traction give the roughest riding to ordinary vehicles. It is necessary to bed the larger stones next to the stringers to give the stringer and rail lateral stiffness. The rest of the cobbles are generally put into the ground without reference to their size and shape.

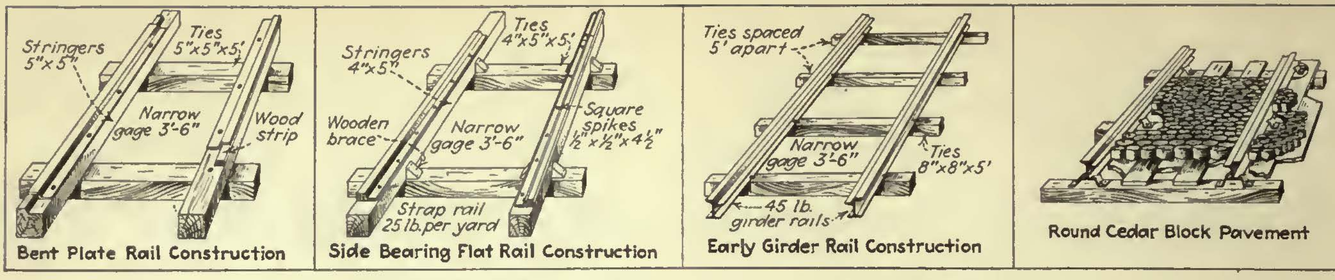
There are some who may imagine that the steel tie is a recent invention, but several early attempts were made to construct a metallic roadbed. In this construction no wood was used. The rail was of a peculiar shape with a 2-in. web on the underside, and was keyed to hollow cast-iron stringers connected at intervals with flat iron tie rods. The stringers were cast in sections of 4 ft., and weighed 82 lb. The system cost $1,000 per mile more than wood construction, but "once built there is no cost for repairing the substructure, and when a rail wears out it can be replaced without disturbance of stringers."

The word "girder" appears first during the '80s.

One would naturally think that the first cost of laying track by the girder system would be larger than by the old, but the manufacturer is prepared to prove that it is much less, and that they will last five times as long.

It is interesting to note that many of the earliest rails were built without any bottom flange. The rails were then placed on chairs, and many efforts were made to find a design in which the head would be renewable without taking up

The same location as it appears today



Some interesting types of early track construction in Minneapolis

the support. A common method for obtaining height without paying for all the steel required by the solid 9-in. rail was to support a shallow rail on chairs. Such an installation was made in Atlanta in 1891.

The rail joint problem may or may not be solved at the present time. In the '80's they were still able to write:

This rail joint is designed to furnish a joint for rails that will prevent the lamination of the rails at either end, and also the jarring and noise created by the passage of the car wheels over the joints.

Now we go to the '90s, but find there are still problems unsolved and noises that force the building of new tracks. On the Fourth Avenue Railway, owing to the rigid construction of the roadbed, cars made a great deal of noise which could be heard two or three blocks from the Bowery. This construction soon proved unsuitable owing to its rigidity. The blocks were taken up and stringers of Georgia pine substituted, the granite stringers being sold to the city for gutter stone.

Girder Rail Aroused Early Discussion

Fast and furious raged the battle over track design during the '90's. A proponent of the Gibbon duplex lap-joint rail, which was laid in New York City, took this crack at the coming girder rail:

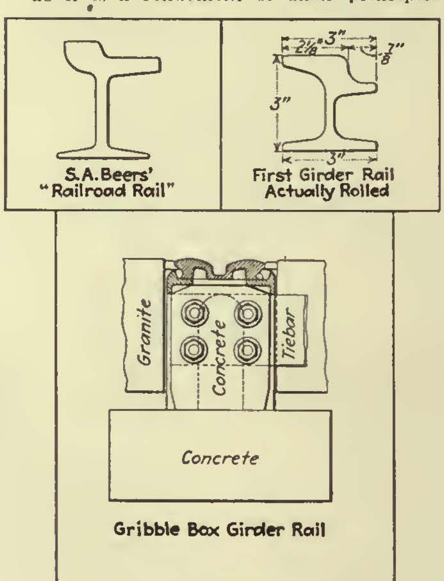
An English fad, fortunately as difficult to introduce in America as the single eyeglass, is a street rail weighing 100 lb. per yard, of which 7 per cent represents its head-wearing capacity and 93 per cent its scrap residue. But apart from the discomfort of riding on so inelastic a track, the short service rendered by the rail for so great an expenditure of material, and the serious annoyance of a complete interruption of travel at its frequent renewals, the track lacks homogeneity, and at every 30 ft. of its length, vibratory waves, set in motion by travel, break with a shock that speedily renders abortive this effort to perpetuate the device of hitching together rails to form street railway track.

Some one is sure to ask about the special track work of the last century. Below is a vivid description by an old-timer of how it was manufactured in horse car days:

Less than twenty years ago, when a turnout was to be built, a pattern maker from an iron foundry would visit the ground with a load of wooden strips, which he would proceed to lay out on the ground, bending them to form the necessary curves. Having secured the model together, he would cut it into pieces so that he could load it onto a wagon and return to his shop. Patterns for cast-iron switches, mates, frogs and crossings would then be made and the rails bent to conform with the model. That work built this way would not always fit is not strange, for the wooden strips would often insist on warping out of shape before they were used. A piece of work was built after this manner as late as 1895.

Although the problem of rail expansion has been subjected to constant study it seemed to have been solved long before the middle of the 50-year period.

The modern girder rail is not so much a radical improvement over its predecessors as it is a refinement of basic principles



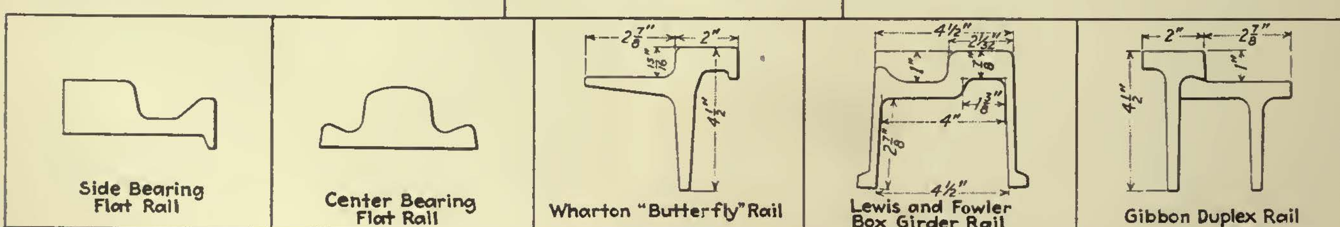
Here is a description of the vagaries of the old flat rail in hot weather:

Following steam railroad usage, rails were kept open at the joints ⅛ in. or more to allow for expansion. To test the correctness of this practice for girder rails laid in paved streets, Mr. Moxham began a series of experiments on a 1,500-ft. stretch of track of 6-in. rail spiked to wooden ties and covered none too well with macadam. For nine months, hourly records of the air temperatures, and daily trials of the movements of the rail, if any, were made. To insure no expansion or contraction would take place at the joints, it being old track, all splice bars were removed, shims inserted wherever practical, and new special joint bars with sixteen turned and driven bolts inserted. As no expansion or contraction could be measured, this fact was published and the art of track laying from that date on has been for tight joints.

To A. J. Moxham and Tom L. Johnson is due the credit for the development of the girder rail and the rolling of many different sections. They organized in 1883 the Johnson Steel Street Rail Company, with the financial assistance of A. V. Du Pont, and the manufacture of the girder rail was begun in Johnstown, Pa. The Johnson Company then built their own rolling mill in Lorain, Ohio, where they rolled their first section in 1889. At this mill was produced the first 9-in. girder rail, weighing 90 lb. per yard. In the course of time the number of girder rail sections increased to over 300, varying in weight from 30 lb. to 174 lb. per yard. The name, The Lorain Steel Company, was adopted in 1898.

Track Construction Served As Model for Highways

The second decade of our 50-year period was one of enormous expansion, with electric lines reaching out from the cities into interurban territory, and with tracks varying from those on lines with poor alignment, grades and construction to those on lines approaching the best practice. The writer vividly recollects



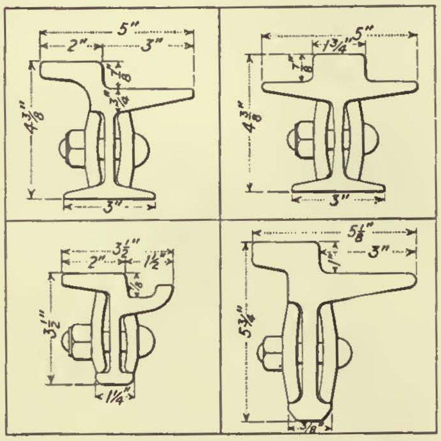
acting as assistant engineer in the construction of interurban lines in Connecticut where the improvement in alignment put to shame the highways alongside which the electric lines were built. Since that time, of course, the highways have taken on the engineering characteristics of railroads, and are being built with great attention to alignment, grades, super-elevation, drainage, and similar features.

During the development period of street railways there was but little attention paid to maintenance. Later, when the extension of electric lines decreased and stiffer competition was encountered as a result of the advent of the automobile, increasing attention was paid to track maintenance. One of the results was the attempt to establish standards in the industry. The way engineers' first efforts were directed toward standardizing the manufacture and design of rails. A.E.R.E.A. specifications for the manufacture of open-hearth steel girder rail were approved as recommended specifications in 1911. The present designs for 7-in. and 9-in. girder rails were adopted in 1910, and, after various revisions, became American standards in 1923. Efforts to agree on complete designs for track construction failed, due to the old bogey of local conditions, which frequently meant local prejudices. In 1915 a recommended design was approved for tee-rail construction on wooden ties and ballast, but nothing more definite has yet been accepted. One reason for this has been the fear that however satisfactory definite designs might be for the majority, they might prove embarrassing to some companies because of local problems of finance and control.

The present manual shows upward of 50 standards in the way division, covering both specifications and designs. In the development of these standards the helpful co-operation of the manufacturers was enjoyed. Much of the work, especially in the study of track layouts, would have been practically impossible without this aid. Standards have been adopted for track spirals, car clearance easements, and branch-off frogs. A factor which has also helped to simplify special trackwork has been the adoption of standard wheel flanges.

During the past few years designs have been worked out for manganese-steel track switches of all standard radii. All tongues are of similar design and are manufactured to definite limits so as to be interchangeable for each radius. Records of trial switches installed in the last two or three years are now being studied. It seems likely that the use of standard switches will increase. However, we have far to go to reach the position already attained by Canadian operators, who use standard switches in perhaps 90 per cent of their track layouts.

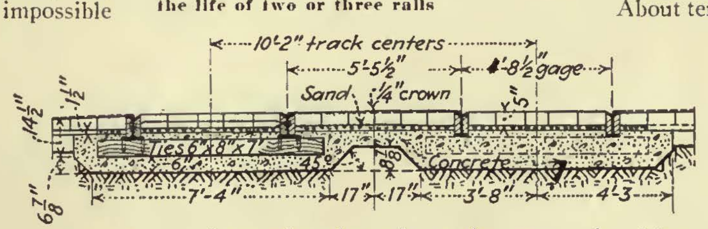
As the electric railways grew older it was found that 25-year franchises had a way of expiring sooner than was expected. Added to the fiercer competition, this resulted in financial turmoil for the systems in many cities. Reorganizations became prevalent, and were sometimes followed by rehabilitation on a large scale which gave engineers the opportunity to use carefully timed reconstruction methods involving track standards, on a hitherto unprecedented scale. In Chicago, during the five years from 1907 to 1911,



No one had more to do with the development of the girder rail than Tom L. Johnson—above are some of his early specimens

inclusive, more than 500 miles of track were rebuilt. Standards were adopted for track alignment and for individual special work pieces. All switches were of either 80-ft. or 160-ft. radius, and all manufacturers furnished switches of the same design. Unfortunately, the Chicago alignment differed from that in use anywhere else. The present A.E.R.E.A. standards conform to the general practice throughout the country, and are not interchangeable with those of Chicago. However, in standardizing as thoroughly as they did, the Chicago engineers pointed the way for the larger standardization program which followed.

Chicago's standard of construction for heavy traffic streets is typical of the type of track with a foundation that will last the life of two or three rails



The standard that eventually became widely used on heavy traffic streets in Chicago is typical of similar work in other cities, and follows the policy of building a foundation that will permit the successive use of two or three rails. It is practically the antithesis of some recent types of track construction where rail life is the keynote of the design, and the whole structure is scrapped when the rail becomes worn.

Another notable installation on a large scale was that in Toronto, where standardization was carried perhaps to a greater extreme than was done anywhere else.

The third installation that might be mentioned covers a slightly different field. The Eastern Massachusetts Street Railway was a consolidation of many small companies operating in and between some 50 towns in Massachusetts. During the rehabilitation about 400 miles of track was overhauled or rebuilt. The figures become imposing when we get down to such items as rail joints. About 150,000 joints were welded and ground. Of the total mileage only about 20 per cent was rebuilt with new rail, even though much of the track had light tee-rail. Some of the existing girder rail was in such condition that the ends had to be bent up vertically before welding. Most of the welding was done by the metallic arc process, and novel designs were tried and tested. The open track was put in good operating condition at a cost of from $1 to $2 per lineal foot, and about $5 a foot covered the paved track, exclusive of pavement.

As we take up modern methods we find that some of them at least have come into use more slowly than is creditable to the industry. For instance, there is a very general use today of treated ties, especially creosoted ties, but even now their use is by no means universal. It was in 1887 that Street Railway Journal informed its readers that in London, England, ties were being made of creosoted fir. At the present time one of the chief duties of our Committee on Wood Preservation is felt to be the necessity of educating our way engineers and executives to the large money savings that can be made by the use of treated wood in the street railway industry.

About ten years ago, the Committee on Welded Rail Joints of the A.E.R.E.A. was created to co-operate with the American Bureau of Welding and the United States Bureau of Standards. Seven progress reports have been issued, the latest in May of this year. This committee was financed by cash grants from the association, from a number of street railways and manufacturers, and by contributions of material, labor, testing facilities, and expert advice from a large number of manufacturers, universities and individuals. The reports give figures of tests on all the types of welded joints in general use, as well as a number of experimental types. They also show photographs and diagrams covering preparations of joints, testing machines used, condition of joints, after testing to destruction, results of tests, photo-micrographs, etc. The reports are evidence of the value of this type of industrial research.

Through similar co-operation, a committee of the Ways Division of the A.E.R.E.A. has been studying the subject of welding both in connection with welding rail joints and building up of special trackwork. Much progress has been made, and the building up of manganese, as well as carbon-steel surfaces, is now the general practice throughout the country.

Going still further in this line of research, studies of the use of special steels both for rail and special track work are being made. The use of intermediate manganese rail as rolled for steam railroads is being experimented with by electric railways. This rail contains about ½ to 1¼ per cent manganese, or from ½ to twice as much manganese as is specified for the standard carbon steel rail. Mention might be made at this point that steel with manganese content of about 12 to 13 per cent was invented by R. A. Hadfield, the great iron master of Sheffield, England, and was used with hard center special track work in about 1895. Many attempts have been made to find substitutes having equally valuable wearing properties, with the additional advantage of easy welding qualities. As yet there has been no general substitution of other alloys for manganese.

Study of Rail Corrugation

We are all familiar with David Harum's famous statement that a few fleas are good for a dog. Most of us have also heard the dictum that every enterprising business organization needs at least one thorough-going pessimist. In the track maintenance game the place of these two nuisances is taken by the problem of corrugated rail. Theories for cause of it have been announced a number of times, but any given theory is sooner or later disproved. In fact, corrugation is so utterly mean and cantankerous an occurrence that it will even disappear out of pure spite as witnessed in the following account from the City of Brotherly Love.

Many theories have been evolved to explain the cause of corrugation, and I guess everyone interested has at least one of his own. One incident clings to my memory, which I believe cured my theorizing. It was suggested that the cause was the piling up of metal in the rail head in front of the wheel, due to the overstressing of the upper fibers in the head. If such were the case, it could be determined by measuring carefully the height of the rail at several points before and after corrugation. We selected a particularly troublesome location on a curve of long radius, which carried traffic at high speed. This curve would invariably develop heavy corrugations shortly after installation. We took a new 30-ft. rail curved to the proper radius, and in the middle of the base, and copper plugs were inserted at intervals of about 2½ in. to provide non-corrosive measuring points. The height of the rail was then carefully measured at each of these points with a micrometer caliper. The old corrugated rail was then removed and the new rail installed, care being taken not to disturb the ties or paving any more than was necessary. We waited considerably longer than the normal time for corrugations to appear at that location, but nothing happened, nothing ever did happen, and if my memory serves me correctly, the rail wore out without appreciable corrugation. Thereupon I stopped theorizing and devoted my energy to the more practical work of removing the trouble as it developed.

Although in some cities the cost of paving is nearly equal to the expense of all other way items combined, yet a small portion of our literature is taken up with its discussion and very little time and thought is given to it, if we can judge from the relative number of pages in the A.E.R.E.A. Proceedings. Paving seems to be like a disease that is not proper to discuss, and must be kept wholly within the family due to "local conditions." This is a pity, as more knowledge and more publicity would doubtless aid in helping each engineer to profit by the experiments and mistakes of others. Of course, we throw the blame for it upon the fact that usually the local authorities have control in the matter, and our arguments and prayers are of little avail. For example, granite, asphalt and concrete pavements are familiar in every city, but many times one of the three types will occupy 90 or at least 75 per cent of the track area, while in a neighboring city these conditions are entirely different. This is a subject that could profit from analysis of the results of experience more than any other in the way department.

In the Washington, D. C., standard, adopted in 1929, the concrete pavement is practically the sole support of the rails

The obligation of street railways to pave the track area came down from horse car days and varied in different cities and States. That it is an unjustifiable burden has been manifest by the relief granted in many cities. How extreme a load it was in some cities can be indicated by the burden carried by the Philadelphia Rapid Transit, many of whose franchises required paving the full width of the street. At one time it was responsible for maintaining 6,500,000 sq.yd. of pavement, equivalent to 300 miles of city streets from curb to curb, assuming an average width of 36 ft., or four traffic lanes.

The subject of modern track enters such a controversial field that it is impossible to cover adequately here all its phases. It is enough to note that there are two major types—the so-called one-life track, and the type that can be relaid without disturbing the foundation. The Chicago standard is a good illustration of the renewable type, while the track laid in Washington, D. C., in the fall of 1929, will serve to show the type in which concrete pavement is itself practically the sole support of the rails, as light steel ties act only as tie rods to maintain the gage, and to some extent reinforce the steel under the concrete.

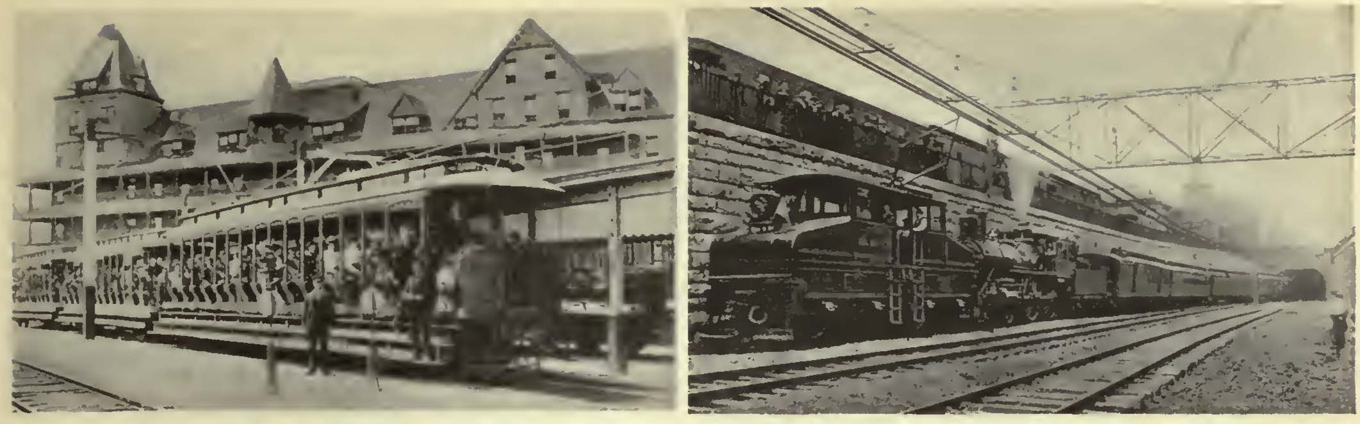
No history of the work of way engineers for the past 50 years would be complete without at least one anecdote indicating the difficulties sometimes encountered in laying track. The following sketch, written by an engineer who has practiced on both the Atlantic and Pacific Coasts, gives a story that will bring a chuckle to the older members of the profession, many of whom can duplicate it with stories from their own experience:

In building a track along a minor street on which there were several residential houses, some of the people objected to the line being on their street. One lady in particular refused to let us erect a pole in front of her property. We dug the hole about 5 ft. deep, and when we got ready to put the pole in she jumped into the hole. Of course, she could not get out, so we left her in there and built another hole beside the first one, installed the pole and then pulled her out.

Progress Will Continue

And now, as the preacher would say, as his audience gets uneasy at the end of his harangue, please remember as you go out that the history of the past 50 years shows how gradual is our progress despite the fact that we have really advanced a great deal. To the younger men this should mean that no end can be set to the progress of the future, and that the opportunity for improvement is just as good for them today as it was for the old-timers of 50 years ago.

Valuable information in this article was furnished by the following, to whom acknowledgment is gratefully made by the author: C. A. Alden, E. B. Entwisle, C. M. Griffith, B. P. Legare, C. A. Smith, G. B. Taylor, F. B. Walker, and C. L. Wilson.



America's two pioneer installations of railroad electrification—the Nantasket Beach line of the New Haven and the Baltimore tunnel line of the Baltimore & Ohio—began service a day apart in 1895

Railroad Electrification of 4,500 Miles

A Notable Record of Progress

By
SIDNEY WITHINGTON
Electrical Engineer
New York, New Haven & Hartford Railroad

FROM the pioneer electrically operated locomotive cars to the highly developed, powerful electric locomotives of today is a far cry indeed. The earliest electric freight locomotive in this country, a 75-hp. unit built in 1888 for handling freight in Ansonia and Derby, Conn., and now preserved on the New Haven Railroad as a relic, presents an impressive contrast beside a modern electric locomotive. Yet from such crude beginnings the art of railroad electrification has grown. The progress which has taken place in but little more than two score years is one of which electrical engineers may well be proud.

The earliest "heavy" electric locomotive, exhibited at the Chicago World's Fair in 1893, weighed 30 tons and contained several features, such as gearless bipolar motors, quill-mounted on the axles, which have been retained in many modern designs. In fact, that locomotive, later purchased for the Manufacturers Railroad in New Haven, is still, with some modifications, in service in industrial switching after nearly 40 years.

Early development of the electric street railway industry provided an effective school for the pioneer projects in what may be termed "railroad electrification." In the year 1888-1895 street railways grew rapidly. As the service demands increased it was, of course, necessary to develop suitable power production and distribution facilities. When electricity was considered for steam traction problems, a not inconsiderable amount of development, not only in motive power, but also in power generation and utilization had taken place, and was available.

The two earliest steam railroad electrification projects were devloped nearly simultaneously in 1895. Each represented the solution of a typical railroad problem, although quite differently. The Nantasket Beach line of the New York, New Haven & Hartford Railroad between Nantasket Junction and Pemberton, Mass., near Boston, carried dense summer passenger traffic. The New Haven management was much intrigued by electric traction, partly on account of the obvious advantages of the then new form of energy, as contrasted with steam, and partly because of the growing possibility of local competition from interurban trolley service. It was felt that electrification of the Nantasket Beach branch, with 8 miles of double track, would provide experience of value in any subsequent development.

Power was supplied from a steam plant located at Nantasket, direct from the bus-bars at nominally 600 volts, in accordance with the then standard practice. The trolley wire, designed for heavy service, was a figure 8 section of approximately No. 000,000 size (330,030 circ.mil), and weighed about 1 lb. per foot; it was hung by direct suspension from brackets. Today it is amusing to note that the trolley wires and feeders were at first supported upon sawed pine poles without insulators, the wood being relied upon for insulation. Needless to say this was subsequently modified, though much of the original trolley wire is still in service. The motive power consisted of ten motor cars, each normally hauling four trailers. Since the service was a summer one only, many of the cars were of the open type, with steps running the entire length.

The Baltimore & Ohio Railroad originally ran around the center of Baltimore. Train movements had long been inconvenient because of the necessity of ferrying. When the development of electric facilities appeared to justify, the management took the oppor-

Typical installation of overhead catenary on the Pennsylvania Railroad between Philadelphia and Wilmington. The type now being installed on other sections is quite similar

At right—Double catenary construction was a feature of the original New Haven electrification out of New York

When the Great Northern rebuilt its line through the Cascade Mountains, the electrification was revamped also and extended to cover a greater portion of the route

At right—Electrification has proved extremely successful in switching and yard service, as in the Bay Ridge extension on Long Island

One of the late Pennsylvania locomotives for high-speed passenger service. New designs are being constructed for both freight and passenger trains between New York and Washington

Trains are now hauled to a terminal under the heart of Cleveland's business district with electric locomotives

tunity to construct and equip a tunnel for electric operation under the city. The route electrified was about 3 miles, and the three 96-ton locomotives first acquired were by far the largest electric equipment constructed up to that time. Each had four 360-hp. gearless motors, mounted on the axles. The original contact device comprised a shuttle-like brass shoe sliding in an overhead inverted channel which consisted of two 3x⅜-in. Z bars riveted to an 11½x¼-in. cover plate. This contact arrangement has since been replaced by third rail at the track level. The power distribution was nominally at 600 volts.


Most recent of the New Haven's passenger locomotives are these motor-generator units, which run either on single phase or direct current

There has been some discussion as to whether the Baltimore & Ohio tunnel or the Nantasket Beach line of the New Haven could claim to be the first "steam railroad electrification" in this country. The first electric train order on the B. & O. is dated July 1, 1895, and commercial freight operation started on Aug. 4 of that year. The Nantasket Beach electrification, after an extended period of test, started "commercial service" on June 30, 1895, and so it may be said to have slightly but definitely antedated the B. & O. electrification.

The New Haven management was much pleased by the success of the Nantasket electrification, and embarked upon a program of electrification which included various parts of the system and somewhat diverse classes of service All of this was at 600 volts d.c. Some lines had overhead trolley (either in direct suspension or supported by catenary messenger), and some third rail. The handling of various classes of service electrically under differing conditions permitted the accumulation of much information of value in subsequent installations. The original third rail was in the form of a flattened A, installed midway between the running rails. The shape was chosen with the idea of shedding water and protecting from weather the wooden blocks which supported it. The contact surface was 1 in. above the track rail heads, which allowed the shoes to clear the rails at turnouts, crossovers, etc., but was not high enough to foul the equipment. This location without protection was found hazardous, and was later abandoned.

In the meanwhile, use of electric traction was rapidly growing in the urban, rapid transit and interurban fields. The invention of multiple-unit control had provided great stimulus. A number of steam railroads were confronted with problems for which the solution was obviously electrification, and when the development in the art justified, a very considerable degree of activity was manifest. This activity, for natural reasons, was at first concentrated in the vicinity of New York, with its problems of congestion and of terminal operation.

Steam railroad electrification in the vicinity of New York was inaugurated by the Long Island Railroad in 1905, from Flatbush Avenue, Brooklyn, to Rockaway Park, about 16 miles. Electrification on that railroad has been gradually but steadily extended, and now includes about 450 miles of track. This electrification, comprising as it does suburban service, utilizes largely multiple-unit cars, of which there are now 1,077 in operation. Through trains in the electric zone are hauled by electric locomotives. Distribution is by third rail at nominally 600 volts.

Close upon the heels of the Long Island Railroad in the vicinity of New York, the New York Central-New Haven Railroad electrifications into the Grand Central Terminal were inaugurated. These installations were primarily the result of legislation on account of operation in the Park Avenue tunnel. Electrification of the Grand Central Terminal presented the opportunity to enlarge its capacity greatly by creating two levels for the terminal tracks. This involved, of course, complete reconstruction of all the facilities, and included an enormous amount of excavation. all in solid rock, and all necessarily carried on without interruption of service.

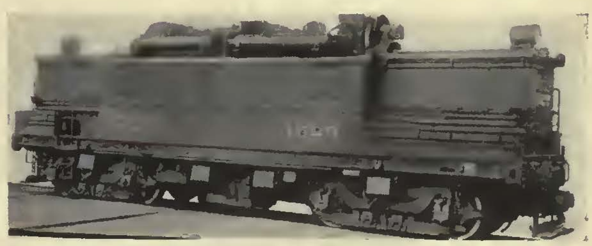
The New York Central management chose power distribution at 600 volts d.c. A novel type of third rail was developed with the contact surface on the lower side to reduce snow and sleet difficulties and to allow as much protection from accidental contact as possible. The initial New York Central electrification extended from the Grand Central Terminal to Kingsbridge and to White Plains, N. Y. Subsequent extensions reach Peekskill on the main line, Yonkers on the Putnam branch, the Port Morris branch and the West Side tracks in New York. Nearly 400 miles of track are now included. The initial electrification was for passenger service only, including suburban trains and through trains in the suburban zone; both multiple-unit cars and locomotives thus were employed. Recently freight service has been added. The road now operates about 170 electric locomotives, of which quite a number are of the three-power type, and 355 multiple-unit cars.

The New Haven management, although obliged to run trains over the New York Central's third-rail tracks for about 12 miles, adopted single-phase alternating current, with overhead trolley wire. It was the intention that the New York suburban passenger electrification was but the beginning of an extensive program to include all types of service. The initial installation extended to Stamford, Conn., the end of the suburban zone. Extensions, however, were subsequently made to New Canaan, New Haven, and Danbury, and to White Plains, N. Y., and freight service was included. Now 150 electric locomotives and 301 multiple-unit cars are operated over more than 800 miles of track, including trackage rights over the New York Central and Long Island Railroads.

Terminal Electrification Develops Valuable Air Rights

An interesting feature of the Grand Central Terminal electrification has been the development of the air rights. The entire terminal area of many acres is now occupied by high buildings (one of 34 stories) erected over the tracks, and forms the center of one of the busiest sections of New York.

Meanwhile, the Pennsylvania Railroad had constructed and, in 1910, opened for service its passenger terminal on Manhattan Island, designed to serve also the Long Island Railroad, and had connected it with Long Island and New Jersey by tunnels. The tracks of necessity were electrified. All trains from the South and West change to


For the electrification of its West Side freight tracks in New York, the New York Central uses three-power locomotives that can run independently with Diesel oil engines

electric power at Manhattan Transfer. Construction of the coach storage yard on Long Island reduced to a minimum the expensive terminal yard space in Manhattan. This early electrification utilized third rail of the same design as that developed for the Long Island Railroad. In accordance with the Pennsylvania's comprehensive plan, this section is now being equipped with overhead trolley wire to carry power at 11,000 volts, connecting with the New Haven electrification and utimately with that to Washington.

The West Jersey & Seashore Railroad, owned by the Pennsylvania, electrified its high-speed line between Camden and Atlantic City in 1906, utilizing mainly third-rail at 600 volts. Of other somewhat similar installations made in various parts of the country during this period, one of the most interesting is that of the Southern Pacific Railroad at Berkeley, Cal., at 1,200 volts direct current.

Many Tunnels Electrified to Eliminate Smoke

For some time New York held the center of the stage, in this country at least, in railroad electrification. Nevertheless, a number of railroads in all parts of the country were watching the results obtained in New York. Long tunnels had for years been a problem where they created points of congestion for freight or where the smoke caused inconvenience to passengers. On this basis, the St. Clair tunnel of the Grand Trunk between Sarnia and Port Huron was electrified in 1908; the Cascade tunnel of the Great Northern, in 1909; the Detroit River tunnel of the Michigan Central, in 1910; and the Hoosac tunnel of the Boston & Maine in 1911. It is characteristic of the desire for experimentation that no two of these electrifications utilized the same system of power distribution.

Other than these tunnels and extensions of existing electric zones, there was not much activity in the field between 1908 and 1913, although some extensions were of considerable magnitude and the mileage of electrified track in this country was more than doubled.

A somewhat new problem was met in 1913, when the Butte, Anaconda & Pacific Railroad, an ore-carrying line in Montana, was equipped for electric traction. This problem was not one of a terminal, a tunnel or of dense traffic, but largely one of general economy. There were, to be sure, some heavy grades, but the locomotives were not equipped for power regeneration. While general economy may be said to have been the direct justification for this installation, the local conditions are not typical. Water power is unusually abundant and readily available in the Northwest. It is of interest as an indication of the continuing efforts at explorations in the field of heavy electric traction that the power distribution system adopted was one never before installed, 2,400 volts d.c. with an overhead catenary-supported trolley wire. The B., A. & P. now operates 123 miles of track electrically with 28 electric locomotives.

The years 1914 and 1915 witnessed two exceedingly important electrification projects. Both are over heavy mountain grades and both utilize regeneration, but except for this they have little in common. One is in the West and the other in the East; one utilizes power distribution at 3,000 volts d.c. and the other at 11,000 volts, single-phase. It is of interest that of these two important electrification installations utilizing regeneration on heavy grades, one should utilize hydro-electric power where the energy cost is, relatively speaking, a secondary consideration, and the other obtains power from a steam plant close to the coal mines

These three-cab locomotives haul 9,000 tons of coal on the Virginian Railway

where fuel cost, and therefore energy charges, are also relatively very low. The advantages of regeneration are in both instances, therefore, primarily not saving of power but are largely those of holding trains on long down grades.

The first of these roads, the Chicago, Milwaukee, St. Paul & Pacific Railroad, started its electrification in 1915. This road crosses three mountain ranges, the Rockies, Bitter Root and Cascade Mountains. The controlling reasons for this electrification were the same as those for its neighbor, the B., A. & P.—namely, cheap water power and heavy grades—although other advantages also accrued, notably that of electrically holding heavy trains on long descending grades. The Milwaukee, being a transcontinental road, has been able to capitalize its electrification to some extent in capturing tourist travel, for the absence of smoke through the scenic mountain routes, electrified for more than 650 miles, with 880 miles of track, makes good advertising. Fifty-six electric locomotives take power at 3,000 volts d.c., from an overhead catenary trolley.

The second of the pair of roads mentioned, the Norfolk & Western Railway, commenced nearly contemporaneously with the Chicago, Milwaukee, St. Paul & Pacific Railroad, electrifying its coal-carrying route through the mountains of West Virginia. The initial project made unnecessary a very heavy expense for double-tracking and tunnel work. Extensions have been made from time to time, and that road now operates electrically about 210 miles of track. The sixteen locomotives are of interest on account of their size and also because the traction motors are of three-phase induction type, taking power from an 11,000-volt single-phase trolley through a phase-converter. By changing the number of motor poles, two operating speeds are obtained which are practically constant, regardless of the grade or load, whether on level track, up-hill taking power, or down-hill regenerating.

Pennsylvania Railroad Inaugurates Extensive Program

The period about 1915 also saw the inauguration of the electrification of the Philadelphia surburban service of the Pennsylvania Railroad. The Broad Street Station had become very seriously outgrown, and that road was faced with the alternatives of electrifying a large part of its suburban traffic or of spending a great deal of money to enlarge and modify the terminal. Operation of suburban trains to Paoli and Chestnut Hill by means of multiple-unit cars very satisfactorily solved the immediate problem and postponed for about fifteen years any necessity for terminal changes. This installation and its extensions, utilizing an 11,000-volt trolley, also provided an effective laboratory for developing subsequent comprehensive plans. Electrification of the suburban service about Philadelphia now includes lines to Trenton, Wilmington, West Chester and Norristown, 437 miles of track and 345 multiple-unit cars. The new underground Broad Street suburban terminal, made possible by elimination of steam from suburban service, has been completed in connection with the comprehensive changes at West Philadelphia, releasing much valuable land in the heart of the city. Air rights over this terminal are of great value.

Following the installations of 1915 and 1916, there was little activity in new projects for nearly a decade; although some extensions of existing electrifications were made both geographically and in service. The New York Connecting Railroad was electrified from the New Haven system at the Harlem River to the Pennsylvania system at Sunnyside, L. I., to permit through passenger train interchange between the roads. In 1925 two notable electrification installations were made, one by the Virginian Railway and the other the Illinois Central.

The Virginian electrification, like that of the Norfolk & Western, carries very heavy coal traffic over mountain grades. The concentration of power demand in a single electric train on the Virginian is probably the greatest up to this time in railroad service. Trains of 6,000 and 9,000 tons are normally handled. The three-cab Virginian locomotives weigh more than 1,000,000 lb. apiece! As on the Norfolk & Western, regeneration is employed on descending grades. The Virginian power distribution is at 11,000 volts, single-phase, and 230 miles of track are electrified; the electric motive power of the road consists of fourteen locomotives.

The Illinois Central electrification at Chicago was inaugurated in 1926, primarily for suburban passenger service, although some freight and all yard switching on the Chicago terminal tracks north of Roosevelt Road are included. The distribution of power is by means of catenary-supported trolley wire, carrying 1,500 volts d.c. The road now operates 280 multiple-unit cars over 154 miles of track. Of ten locomotives operated, six are equipped with oil engines. This electrification was carried out in accordance with the terms of an agreement with the city of Chicago.

At about this time, also, the Baltimore & Ohio Railroad electrified its Staten Island rapid transit lines, in compliance with legislation of the State of New York. Some 50 miles of track are electrified, and 90 miltiple-unit cars are operated.

Many Extensions Made

From 1926 to 1930 activity was largely confined to extensions of existing electrifications. The most important project in that period was perhaps that of the Great Northern, which in connection with its new tunnel in the Cascade Mountains and the extension of its electrification in 1927, changed its power system to 11,000 volts, single-phase for a total of 93 miles of track. Nine locomotives are employed, all of the motor-generator type, supplying direct current for the traction motors from the alternating current supply. These locomotives are equipped for regeneration of power, although like the C., M., St. P. & P. electrification, the water power is in itself relatively very cheap. Electric braking on long down grades is the important consideration.

In 1927 the electrification of the Long Island-Bay Ridge section and the New York Connecting Railroad freight tracks, from the New Haven at the Harlem River to the float bridges at Bay Ridge, was inaugurated. This allows through runs of electric freight trains between Bay Ridge and Cedar Hill. Physically, this electrification is an extension of the New Haven, from which it takes single-phase power at 11,000 volts. The Long Island acquired seven single-phase freight locomotives to handle its service in this section. About 100 miles of track are involved in the project.

Last Two Years Notable in Heavy Traction

The years 1930-1931 have been perhaps the two most notable in railroad electrification since the pioneer efforts. Four important installations constributed to the progress of these years: the Cleveland Terminal, the Delaware, Lackawanna & Western suburban electrification in New Jersey, the Reading suburban electrification at Philadelphia, and, above all, the Pennsylvania's program between New York and Washington.

The Cleveland electrification, completed about a year ago in connection with the new union terminal facilities there, comprises about 60 track-miles over a 17-mile route through the center of the city. Three railroads utilize the facilities: the New York Central, the Big Four, and the Nickel Plate. Trains are handled through this terminal by 22 electric locomotives. The distribution system is 3,000 volts d.c. by overhead trolley. The controlling reason for this electrification was the development of air rights over the terminal tracks, which ultimately will be of grerat value to the owners.

The D., L. & W. electrification, which handles most of the suburban service out of Hoboken, was inaugurated last year, and is on the basis of 3,000 volts d.c. About 158 miles of track are equipped, and 282 multiple-unit cars have been provided. The reason for this, as with most suburban electrifications, was primarily congestion.

The Reading Railroad suburban electrification at Philadelphia, inaugurated in the summer of 1931, is at 11,000 volts, single-phase. This comprises about 161 miles of track, with 70 multiple-unit cars.

The Pennsylvania's program, already referred to, is by far the most comprehensive in the United States. Trains will be operated electrically between New York and Washington. This is of especial interest as it is one of the few electrification projects based entirely on broad economies to be derived as compared with steam, under very dense traffic conditions.

Electrification Should Have a Notable Stimulus

About 4,500 miles of track have been electrified in this country, an average of nearly 200 miles a year for the past 25 years. The adoption of electricity in industry being now prominently before the country, it may be expected that, as soon as there is indication of economic stability in the railroad industry, further advantage will be taken to increase efficiency by this means, and that it will have a notable stimulus. Universal railway electrification is not immediately on the way, however, for under present conditions the necessary facilities add very considerably to capital costs, and only under certain circumstances are the direct operating economies sufficient to offset the added capital charges and incidental expense. There is some danger of irresponsible legislative action in compelling railroads to electrify. Enough data are available to determine just when there is justification for electrification in any individual instance, and legislative coercion cannot in any way be justified, because forcing by such means of electrifications which may not be economically sound would inevitably tend to defer decisions in favor of projects which may be entirely desirable, and would thus injure not only the railroads themselves, but the communities which they serve.

The Transition Period in Street Car Motive Power—1890 to 1902

Figures of car and track mileage for the various types compiled by the Journal shows the phenomenal rise in the use of electricity and the steady diminution of other motive powers in the period.

Year	Electric		Horse		Cable		Steam and Miscellaneous		Total	
	Cars	Miles	Cars	Miles	Cars	Miles	Cars	Miles	Cars	Miles
1890	5,592	2,523	21,970	5,400	3,795	510	751	604	32,108	9,037
1891	8,892	4,061	21,798	5,302	4,372	594	815	642	35,877	10,599
1892	13,415	5,939	19,315	4,460	3,971	646	698	620	37,399	11,665
1893	17,233	7,476	16,845	3,497	4,805	658	616	566	39,499	12,197
1894	22,849	9,008	11,507	2,243	4,673	662	2,639	614	41,668	12,527
1895	27,720	10,363	9,522	1,914	4,798	632	2,705	609	44,745	13,518
1896	34,971	12,133	5,383	1,219	4,871	599	2,957	519	48,182	14,470
1897	38,536	13,765	5,144	947	5,199	539	2,653	467	51,532	15,718
1898	44,343	15,672	3,103	654	4,701	460	2,402	505	54,549	17,291
1899	50,658	17,969	1,489	416	4,250	403	2,339	425	58,736	19,213
1900	55,084	19,314	1,456	370	3,517	330	2,761	428	62,818	20,442
1901	62,591	22,063	1,411	332	2,543	241	2,332	400	68,877	23,036
1902	65,583	25,789	1,303	273	2,396	229	826	138	70,108	26,429

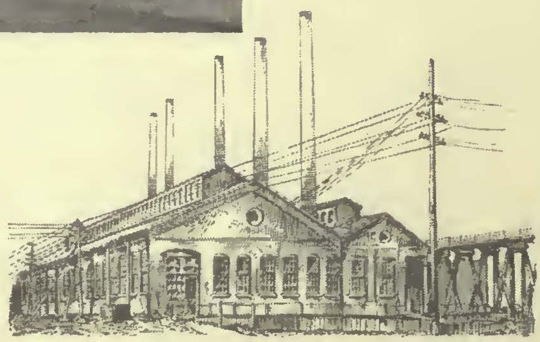
Power Generation

By

CHARLES RUFUS HARTE

Construction Engineer
The Connecticut Company
New Haven, Conn.

Early power stations sprawled out over a large area and belched smoke from many tall stacks. Contract the attractive modern substation in its setting suitable for a residential district



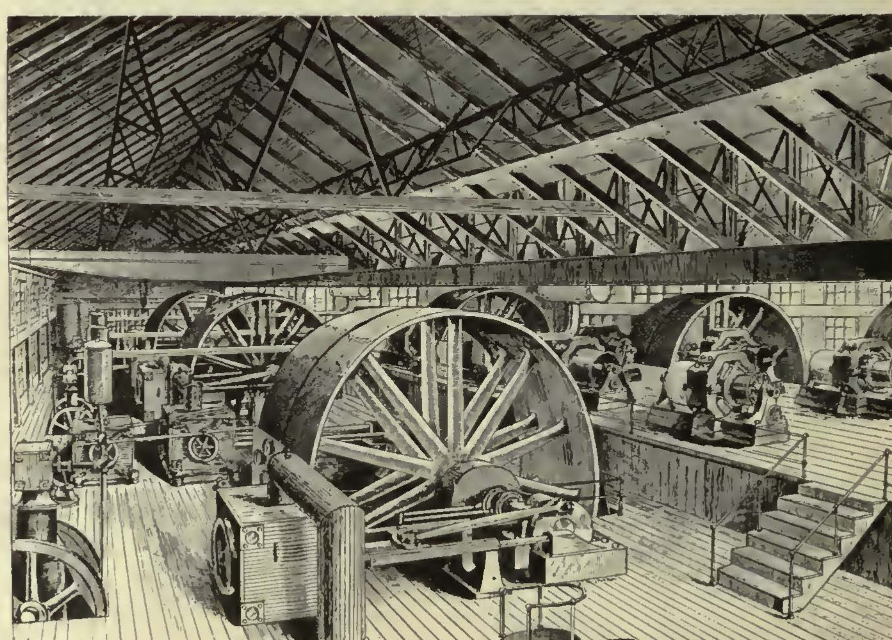
DEVELOPMENT of the power supply for the electric railway, and of the methods by which that supply is distributed to the cars, makes a story which to tell properly would take far more space than is here available. Only the high spots can be touched in outlining the steps which have brought us to the present state of the art; on the generating side, from the messy batteries of the experimental period, of but a few cat power, through the development of the direct-current generator from a mere toy to the great engine-type machines, the shift to turbine-driven alternators and conversion through rotary converters, to the present practice of leaving power generation to the central station companies, the railway owning only the conversion devices, either rotaries or mercury arc rectifiers, with a considerable proportion of the capacity in automatic substations. And if, on the side of distribution, there have been less radical changes, the many variations which have been tried out, in not a few instances with some temporary measure of success, make a story but little less interesting than that of the power supply.

The first experiments with electric traction, in the United States, those of Thomas Davenport, were made at just about the time—1832—that the first American street railway was put in operation in New York City, and when, in 1835, Davenport demonstrated his car, first in Springfield, Mass., and then a little later in Boston, the only street railway had been abandoned, not to be revived again until 1852.

It was, therefore, with reference to its application in railroad rather than in railway practice that Davenport and his immediate successors worked on the idea of electric traction, and they naturally followed railroad practice and used a locomotive which at the first carried its own power plant in the form of a primary battery. Fragile, slopping acid at every jolt—of which there were many—and otherwise misbehaving generally, these batteries were an unmitigated nuisance until Colton and Lilly in 1847 shifted them to a fixed position beside the track, and utilized the rails of the latter as the two sides of the distribution system by which current reached the motor. While this obviated many of the mechanical difficulties it did not, however, touch a very fundamental one, the exceedingly high cost of electric current so generated, and this remained an unanswerable argument against electric traction until the direct-current generator had become a commercial success.

The early generators were bipolar, requiring very high armature speed and close regulation. For driving them there were available two types of engine, the very compact short-stroke high-speed simple machines, of which the Armington & Sims, Ball, Buckeye, Ide, Porter & Allen, and Westinghouse were typical, and the sprawling long-stroke slower ones, both simple and compound, chiefly of modified Corliss type, the majority in any event being operated non-condensing.

At first, the speed required made



Great advances in compactness were made about 1890, as in the power station of the West End Street Railway of Boston, illustrated here

and Distribution

Have Undergone Many Changes

desirable, and in many instances necessitated, the use of countershafting, often fitted with clutches and quills to permit selective driving. The disadvantage of the friction losses was offset, in part at least, by the cushioning effect of the two belts, for the character of the load and the small size of the generators subjected them to frequent and heavy jolts. This arrangement necessitated a long engine room, even when, as was frequently done, the engines were placed on one side, the countershafting on the other, and the generators, belted back from the counter shaft, in mid-floor. It was necessarily wide if the plant was of any size, for the generators were very small, rarely of 100-kw. capacity. But since the big pulley wheels of the slower-speed engines had nearly one-half of the diameter below the floor, not a great deal of headroom was needed. This was also true in the boiler room, at least as to headroom. The old stand-by, the horizontal return tubular boiler, still was supreme, and the shape and small size of the units made it entirely practicable to put the entire plant under one roof. With the tall steel or brick stack, for natural draft was practically universal, the general effect was of a toadstool upside down.

With the rapid growth in size of the larger systems the great area necessary became a matter of concern. Improvements in design soon permitted direct belting of the engine to the generator behind it, a gain increased by the use of a vertical engine, and by the use of devices which, by increasing the arc of contact, permitted much shorter belts. A notable instance of the last type was the West End's station at Boston with its (for that time, around 1890) enormous Reynolds Corliss triple-expansion 1,000-hp. engines belted through two sets of arc increasers below the floor up again to the generators, which thus could be close to the engine.

That there was not entire agreement as to treatment, however, is apparent from the description in *Electrical World* early in 1892, of a proposed model station for which there were recommended 400-hp. engines operating at 70 r.p.m., and driving through countershafting.

By 1890 developments in several directions, which had originated chiefly on the electric lighting side, were beginning to reach the stage where they became important in electric traction. Of these the direct-connected unit was nearest to practical application, and by 1892 it was in use in some plants. The multipolar generator with its slow rotative speed made possible, as a first step, the so-called engine-connected unit with crank shaft extended on one or both sides of the engine frame to take one or two generators. With one generator there usually was a sub-base to which were bolted both the engine frame and the outboard bearing for the extended shaft; with two, they customarily were overhung, one on each side. This was very shortly followed by the true engine type, with the generator carried between the main bearings of the engine, and between the cranks if there were more than one.

Of the overhung units, the vertical marine-type engines with paired 200-kw. generators used in Milwaukee in 1892 were typical. Of the true engine type, the vertical marine-type engines with 525-kw. generator serving also as fly wheel for the Fair Haven & Westville line of New Haven, in 1896, and the horizontal twin tandem-compound engines for the People's Tramway of Philadelphia in 1895 were characteristic.

At this time (1895), there was still some question as to the advisability of using direct-connected units for the smaller installations because of their very heavy and abrupt swings, but the older practice of starting all car runs from a common point and on the same instant was dying out. Schedules were being adjusted to keep all the cars from climbing the steepest grades at the same time, and power installations were being given a little surplus over the absolute minimum. By 1900 the engine unit was practically universal. Incidentally, it was very close to its peak. Large units still were built—notably, such machines as the 5,000-kw. Reynolds-Allis unit with two vertical and two horizontal cylinders for the Metropolitan Street Railway of New York City in 1901—but the reign of direct-current generation was practically at an end.

Mercury arc rectifiers are a feature of many modern substations

To understand clearly the next change it is necessary to go back somewhat. Early developments in lighting had been with direct current, and there was a tremendous investment in the heavy copper conductors and costly conduit construction necessarry in view of the low voltage used.

Soon improvements in transformers made possible a high-potential primary distribution with transformation to the working potential practically at its point of use. This innovation had the result of cutting the copper required to but a fraction of that under the other scheme, and apparently threatening over-night to render the latter obsolete. There not unnaturally began what later was to be known as the "battle of the systems," of which one of the first elements was a matter whose outcome was very different from that which was anticipated.

The State of New York, in 1888, passed a law changing its method of capital punishment from hanging to electric shock at high potential. Fear that this would greatly prejudice the cause of alternating current led to unwise attacks on the law and resulted in bitter feeling on both sides. The objections proved unwarranted, however, and the alternating-current system was vindicated, although for a short time several States threatened to pass laws restricting the use of alternating currents to those of low voltage. With these threats out of the way,. development was rapid; at the Chicago World's Fair of 1893 there was exhibited a complete polyphase system, the elements of particular interest to the railway man being the generator, step-up and step-down transformers connected by a shunt transmission line, and a rotary converter feeding a railway motor.

The first application to electric traction was early in 1894, when three-phase current, turbine-generated at Baltic, Conn., on the Shetucket River was transmitted at 2,300 volts a distance of 4½ miles to Taftville, just outside Norwich, to synchronous self-starting motors, one of which was belted to a railway generator feeding the Norwich Street Railway. There followed three very important developments. First, one minute after midnight of Nov. 16, 1896, Buffalo received Niagara power for its railway system, one instance, if not the first, of the dominant tendency of today, the purchase of railway power from a central station company.

Second, it was now practicable to concentrate power generation at the most desirable point for that purpose, and to transmit to substations most economically located for feeding, greatly improving operating conditions, and often permitting the shut-down of small outlying stations with high generating costs; while by tying together the better plants the loads could be most efficiently handled.

Finally, although this did not at once appear, it led to the abandonment of direct-current generation.

The steam turbine, promising much in some directions, gave little hope for traction purposes, so long as direct-current generation was the main dependence, although some little success was had in comparatively small sizes using reducing gear. Success of polyphase operation with rotary converters changed the situation completely. It proved entirely practicable, although at first by no means a simple matter, to build alternators, particularly well adapted to turbine drive, and for the second time the existing stations became obsolete.

With the transition to direct-connected units and their growth to large size, the old large-area low-roofed engine room had to be replaced by one of far greater clearance. The tops of the cylinders of a 6,000-kw. vertical engine-type generator are fully 50 ft. above the floor, the armature frame projects some 20 ft. below it, there must be sufficient clearance between cylinder tops and crane to permit handling the parts of the engine and then room for the crane above that. But the floor area, at least for equal capacity, was very much smaller. Also, the trend toward mechanical coal and ash handling equipment and to the use of water-tube boilers with automatic stokers and overhead bunkers called for an equally high boiler room. On the other hand, mechanical draft tended to the use of comparatively short, large-diameter stacks, completely changing the appearance from that of the station of the belted age. Incidentally it will be noted that this gave the building of the latter only the efficient service life of the equipment it contained, for having been built for special service it was not at all well adapted to most other purposes, and while it was used in some cases as a substation this usually proved unsatisfactory unless a great deal of reconstruction was done.

The shift to the turbo station involved comparatively little change on the boiler side except to necessitate greater capacity in many instances, but it called for radical changes in the engine room. The turbo alternator itself is very much smaller than the corresponding capacity in an engine type unit, it is true, but, on the other hand, it requires much more room for its auxiliaries, which are preferably directly below it. While the shell of the second-period station could sometimes be utilized, so much was needed in the way of internal change that it usually amounted substantially to rebuilding it if it was not decided to rebuild completely, thus securing all the advantages of a new station rather than spend but little less and probably have to forego the benefit of some of the latest ideas. Again the life period of the building was that of the contained apparatus, but this time with less salvage; for the tendency to outdoor substations took away a use to which the belted station building frequently though generally unwisely was turned after it ceased to serve as a primary station.

While in the main the generating systems have kept as near the front in power generation as their load and financial conditions would permit, for at least the last decade the chief advances have been made by the central station companies. Theoretically, the advantage of purchasing the power from such a company, with its diversified load in which the peaks which so seriously trouble the railway plant are of comparatively little importance, is so great that there can be no question as to the wisdom of so doing. Practically, this is not entirely so.

There is a sense of security with an owned plant which it is hard to realize when the other fellow has control, and there have been whispers of instances where what seemed a highly advantageous contract was found to be not quite so satisfactory later, a discovery oddly enough made by the power company, soon after the railway plant was dismantled.

Whether or no such things have happened in the past, there is no question but that the chances for such sharp dealing are steadily diminishing if they have not vanished as a result of present-day public regulations, and it is but a question of time and not a very long time at that before railway generation will be very much the exception. For that reason, the advances of the last ten years in this field hardly belong in an outline such as this, particularly when it is necessarily so sketchy.

The story of the substation is one of about as radical change as that of the main stations. Difficulties experienced with the first rotary converters, and an unwarranted belief that they were at their worst (and a very bad worst at that) on 60-cycle current, led to the use of motor-generator sets, particularly if a lighting load in the same transmission line made 25 cycles undesirable, but as the various "bugs" were eliminated, the advantages of the rotary soon put it well ahead of its bulkier and as a rule less efficient rival, a supremacy it has held until the recent development of the mercury arc rectifier.

At the outset the entire equipment was looked upon as of frail health, and it was sheltered and housed in with the greatest care. Gradually it became evident that part after part could be put out-of-doors, even when subject to our Northern winters, until today only the more delicate control apparatus is housed.

With these discoveries came first the thought and then the demonstration that all but emergency operation could be done automatically, so that now the power systems of more and more of the railway properties consist only of one or more main substations, receiving current from a power company, each with a very small operating staff supervising rather than controlling a series of substations in which operation, including first-aid treatment in case of trouble, is entirely automatic.

The first distribution system consisted of the two track rails, and this plan, later modified by adding a third rail for the feeding side of the circuit, and the track rails for the return, was followed in experiments made until 1875, although in 1855 one Bessolo had suggested the possibility of using an overhead wire, and as the possibility of electric street railway operation approached probability it became increasingly evident that the open third rail would be impossible for such service. In the latter years, George F. Green, of Kalamazoo, Mich., used an overhead wire with track return on a model he built. In 1882 Finney operated a car at Allegheny, Pa., using a trolley which traveled on top of an overhead wire, and was connected with the motor by a flexible cable. Credit for the first really successful overhead system, however, apparently belongs to Charles J. Van Depoele, who had constructed and operated a small experimetnal line at Chicago in the winter of 1882-1883, and who, in 1885, successfully operated a train at the Toronto exhibition, using an under-running trolley. In the next two years he first tried over-running devices consisting of one or more wheels on top of the wire with one or two pairs of wheels gripping it from the side, but by 1888 he apparently had settled on an under-running trolley wheel at one end of an arm carried on top of a post so it could both turn in a horizontal plane and tilt vertically, with springs at the lower end to keep the wheel against the wire.

Sprague, in his Richmond installation, used a wheel at one end of an arm which had the other end set in a stiff spiral spring, giving it motion in all directions, while Daft, who had both sides of his circuit overhead, used a four-wheeled car riding the two wires, on which it was held by the deep grooves of the wheels and the weight of the towing rope and the cable down to the car. This plan was followed by several other experimenters of the time who had both sides of the circuit overhead. Bentley and Knight on their overhead section at Allegheny put the two wires in a vertical instead of a horizontal plane and used two separate little cars, the cable from the upper car being attached to the lower car as well, and both cables twisted together from this point to the car. It was the use of these little over-running cars or "trolleys," which gave the electric car its nickname. An unfortunate tendency on their part to jump the wires and come down, coupled with the serious complications at crossings of two lines resulted in their early abandonment in favor of the under-running device, usually with a wheel, although Prof. Sidney H. Short used a shoe on at least one of his lines, in 1889.

With but one exception, operation was as at present on a parallel circuit. Professor Short, beginning in 1885, for several years most vigorously urged series operation, and actually installed and operated several lines. This plan necessitated sectionalized double wire and complications and the fundamental error of the scheme resulted in its ultimate abandonment.

Using over-running devices, some form of goose neck support was necessary to allow passage of the collector, but above this support the overhead in many respects was quite like that of today. A report on perfect overhead, read before the American Street Railway Convention of 1892, at Cleveland, points out two differences, in its recommendations—that the No. 4 silicon-bronze to be used for trolley wire should have twisted splices, with approaches formed of cone-shaped tubes soldered over each end after twisting; and that there should be two guard wires at least 3 ft. apart, and 4 ft. over the trolley. It added a principle which is basic today, although too often disregarded: "Trolley wire hangers and pull-off brackets should be of the lightest make possible and still have the required strength and the very best insulation."

It is interesting that, as regards simple suspension, the devices of today differ from those of the very early period almost entirely in refinements rather than in anything really basic.

One of the earliest instances of catenary was apparently the Short installation on the Columbus (Ohio) Consolidated Street Railway, a picture showing ornamental gas-pipe bridges spanning from curb to curb "at intervals of about a block," while a messenger attached to the bridges carried droppers, each holding a cross bar with the support for the two trolley wires. The peculiar requirements and conditions of heavy traction service have necessitated some changes, but for the lighter wheel operation the simple hanger of the early period, after going through may elaborations of attachment to trolley wire and to messenger, has come back to the simple screw clamp ear used by Charles L. Henry on the Cincinnati single-phase line, with, however, a loop instead of the rigid clamp for the messenger. And with all the variations in the heavier service, the real advance was the plan first suggested by E. H. McHenry, of a duplexed trolley, the clamp connecting the two coming midway between the dropper attachments to the upper one.

Much more might well be said of the closed and slotted conduit and the stud systems at one time in use, and of the compressed air, superheated water, spring, gas, naphtha, carbon dioxide, and ammonia motors which were tried, but a mere outline would extend this article too greatly. After all, the great question of today is less about past history than future possibilities.

Complicated track layouts require careful treatment of the suspension fittings to produce good appearance of the overhead

A 1909 White bus—a far cry from the comfortable and commodious vehicle of today

Some Steps in the Development of the

Motor Bus

Back in 1917 this was the last word in bus design. At left—Bare floors and uncomfortable seats were characteristic of the early buses

Imperial Omnibus—the original low-level bus—built in 1921

25-passenger Mack, a type brought out early in the last decade

Recent 33-passenger gas-electric A.C.F. bus

By **CARL W. STOCKS**
Editor
Bus Transportation

The Modern Motor Bus

Reveals the Ceaseless Effort to

Improve Design

Ten years of progress—the 40-passenger Yellow Coach brought out in 1931 alongside a G.M.C. bus of the vintage of 1921

INTERESTED observers marvel at the rapidity with which changes in bus design have taken place during the past decade. Obsolescence, while rapid, has reacted favorably to the public, and forced many operators to keep their vehicles up to date in order to hold a place in local transport. It is perfectly plain that there has been a tremendous increase in the use of buses, but with each new use have come new features in design and new problems to be solved.

The automotive engineer has been quick to sense the necessity for revisions in design to meet these problems and at the same time to satisfy the operator's demand for greater capacity, for more power and higher acceleration, for better braking ability and for longer life of parts. In each instance the manufacturers, co-operating with the bus companies, have increased the reliability of bus service and enabled them to meet higher operating costs without an upward change in the fare structure.

Bus operators therefore are in a fortunate position. They now have far better vehicles than at any previous time in the history of the industry, and by prudent selection can fit these vehicles to routes for efficient operating performance according to known service characteristics.

Motor bus development was accelerated by the "jitney," where the passenger automobile was applied to commercial passenger traffic. As a medium for handling mass transportation in cities, however, the jitney was a failure. But it was not without its lessons to those who were willing and able to analyze the problem and the kind of service that was given. The wide use and popularity of the jitney indicated the need and demand for a flexible highway service. The wholesale failure of jitney operators gave sufficient evidence that the character of the vehicle used by them was not designed for the volume of traffic handled and the service charactertistics encountered. And further, the operators were not experienced in transportation problems. The jitney therefore can be looked upon only as a transitory vehicle, but its operators must be acknowledged as the forerunners of a more responsible organization which was necessary to put bus operation on a profitable basis.

The next step in the growth of highway transport was the use of standard motor truck chassis with bodies designed for passenger service. Operators of this type of vehicle met with fair financial success in many cities and suburban localities. In design these vehicles were more or less of a makeshift in the light of present-day development, but they did fulfill remarkably well the immediate need in the trackless transportation business. It was not, however, until vehicles were designed from the ground up that the permanent success of motor bus operation became apparent. In these designs safety, comfort and efficiency of the vehicle itself were considered as vital points in operation. A study of the fundamental factors from an operating standpoint indicated that a specially designed chassis was a necessity to insure economical and profitable motor bus use. The converted motor truck never made the ideal motor bus. It failed in power requirements and in riding comfort.

Safety, early recognized as a vital factor in bus design demanded a low center of gravity. This in turn brought about a lower floor level, the use of a wider tread rear axle, the use of underslung springs on the rear axle, and ultimately a kick-up in the frame, the use of the inverted worm and the drop type of front axle.

Lowering the floor level also made possible a reduction in the step height at the door, an important factor in speeding up loading and in reducing boarding and alighting accidents. The low step construction and floor level, which is now a feature of all bus designs, is an essential of comfort as well as safety and loading efficiency, because buses at the curb can make a quicker pick-up and discharge.

The originator of the low level, low center of gravity, wide tread, underslung type of chassis was the Trackless Transportation Company, which, about 1921, designed the so-called Imperial type of omnibus. Since that time many of the ideas first incorporated in this type vehicle have become universal.

Developments in bus design have been faster by many times than have occurred in any other transportation unit. Reasons for this are attributed to the fact that the automotive industry, notably the truck builders, had the basic experience to facilitate this ultra-rapid progress.

The development of the steam locomotive has taken more than a century, and the development of the electric car is only now celebrating its 50th anniversary. Even the airplane has seen more than a quarter century of development, whereas the motor bus has made its greatest advance in design in the last decade. In the last five years, or since the widespread acceptance of the bus as a vehicle for urban transport by the electric railway carriers, developments in design for the city type bus have had their greatest acceleration.

The small bus is proving popular for certain kinds of service. The type shown is a Dodge parlor car

In the past seven years nearly 200 bus chassis models have come and gone. In the same period, 49 manufacturers have retired from the field. Some retired permanently, while others, for the present at least, are merely inactive in production. Of those companies that are no longer in production, much that is good can be said. All of them contributed in one way or another toward the advancement of engineering knowledge. Some made mistakes, and in so doing pointed the right path for others to follow. In many cases their mistakes were but one step removed from actual positive accomplishments.

Many Manufacturers in Bus Field Have Come and Gone

Of the companies that are still in production at this writing, seventeen have entered the field in recent years, while 22 date back to what may be called the infant days of the industry. However, the more potent among them —with a few exceptions—have sprung up since 1922, or have expanded and flourished through consolidations or the introduction of new management.

In the early days of bus use 16-passenger vehicles were considered quite the maximum that could be mounted on a chassis. Since 1922, with the advent of specially designed chassis and the more extensive use of truck chassis to meet the operators' demand for greater passenger carrying ability, the average capacity of the conventional type of single deckers has climbed steadily from 25 to 37. In 1925 came the development of the so-called chassisless automotive street car type of vehicle, which further increased carrying capacity to 40 and 42. Within the past year has come the Duplex city type coach with 61 passengers on a single floor, and this year the pusher type drive with engine mounted at the extreme rear and driving forward to the rear axle was developed.

Mention may well be made also of the double-decker, which has undergone change with but a single thought in mind, namely, increased carrying capacity. Where 37 passengers was once the rule, this has been increased to 67.

With the transition from 16-passenger bodies to units of larger size, which meant a longer wheelbase and a greater body overhang at the rear axle, weaknesses in fundamental chassis units began to develop. It was not enough to lengthen out the wheelbase; in fact, this only served to aggravate other troubles. Engines that had been of sufficient power to handle small buses soon proved inadequate to carry the larger passenger loads, especially since the number of standees frequently increased in direct proportion with the number of seated passengers. Springs and drive-line units were unsatisfactory for the same reason. On the other hand, safety decreased because of lack of adequate braking power and inability to secure proper steering qualities for these heavily loaded vehicles.

Buses Designed Piecemeal

Overcoming one set of difficulties often meant the outcropping of a new set. Reduction of floor level height in the interest of lowering the center of gravity for safety and for greater ease in boarding and alighting, brought about an epidemic of tire and brake troubles. Another deluge of troubles came from the urge on the part of the local carriers for improved interior lighting facilities. Everyone recalls the battery and generator troubles and discussions current six and seven years ago.

Increasing the capacity of the body likewise meant heavier and more rugged body construction, a fact that brought forth frame troubles. Attempting to build bodies sufficiently rugged to withstand weaving caused difficulties due to the outrigger method of mounting. The body and the chassis were in a constant battle. As one was strengthened it immediately set about destroying the weaker member.

To top it all, numerous mechanical difficulties were encountered due to legal restrictions imposed by states and cities. In many cases these restrictions still are a thorn in the side of both carriers and manufacturers. Variations in restrictions as to dimensions and weights have proved burdensome to the industry because they have prevented the full enjoyment of economies resulting from the use of a standard design.

In some few instances, however, it has been possible to capitalize the legal requirements. For example, the ordinarily useless rear safety exit has been made to serve a dual purpose. By putting it on the right side, instead of the left, it can be automatically controlled to serve as a rear exit at all unloading points. Use of a rear door permits the passenger load to circulate from front to rear and materially lessens the time of stops, thus speeding up schedules.

Steel bodies with automatic rear exit door were a new feature in 1928

More Powerful Engines Developed

Ten years ago the four-cylinder engine reigned supreme in the city type of bus. In fact, it was not until 1926 that the six-cylinder engine attained a lead over the four, a lead which has been increased from year to year until the present time. Some few models are now even fitted with an eight, such as Studebaker No. 111, Yellow W and Flxible. Use of two six's in a single vehicle was originally announced in 1927 for use in a 40-passenger unit by Twin Coach. Later years have proved the popularity of vehicles of this size, which are now built by Yellow, Mack and A.C.F., although none of these employ more than one engine.

Power requirements of present-day engines cover a wide range. Small sixes rated at less than 50 hp. are available for service where loads are light, while the latest engines for recently developed large capacity vehicles are capable of delivering 175 hp. under actual service conditions. It is significant, perhaps, that the more recent models are designed to deliver a higher torque within the lower speed ranges. Furthermore, maximum engine speeds are held within reasonable operating limits, and because more thought has been given to the matter of proper rear axle reduction ratios it is possible to operate the engine more efficiently and with greater economy in so far as maintenance and increased life of wearing parts are concerned.

From time to time numerous experiments have been made to use fuels other than gasoline for engine power, although the present low price of gasoline has tended to subdue the interest in these developments, at least temporarily, and for the time being there is no indication that motor bus manufacturers are contemplating abandonment of the time-tried gasoline power plant. The Diesel holds attractive possibilities and undoubtedly merits consideration for use under conditions where it can be operated almost continuously at full load. On the other hand, a number of engineers contend that the high compression required for the Diesel is not essential in operation where wide open throttle is needed only at rare intervals.

Present tendencies in engine design are toward refinements that promote smoother operation and better all-around performance without adversely affecting fuel economy and operating costs. Apparently it is the aim of manufacturers to make every drop of fuel count. This is borne out by the nature and extent of changes in carburetion and manifolding in current designs. On the more recent engines downdraft carburetion and in some cases duplex intake manifolds, are growing in favor. Marked attention likewise is centered on the exhaust manifold, the object being to secure quicker and more complete scavenging of the combustion chamber, of reducing back pressure and of promoting more uniform velocity of exhaust gases.

The single-engined 26-27 passenger Twin Coach—a recent development in bus design

Interesting from the standpoint of efficiency and economy is the increasing use of materials designed to withstand better the severe demands required of the modern power plant. Nine engines out of ten now use silchrome exhaust valves to eliminate former common troubles due to burning, warping and pitting. Salt-cooled valves to promote more rapid heat dissipation also are increasing in popularity, particularly on overhead valve engines. Practically all cylinder blocks are nickel iron, and aluminum alloy pistons are gaining in favor as improved methods of heat treatment permit more accurate fitting.

Longer engine life, however, is not entirely due to use of improved materials; better manufacturing methods also are responsible. Machining of parts generally is being held within closer limits so that parts can be fitted with almost gage-block accuracy, a fact that accounts for the comparatively smooth and quiet operation of the present-day motor bus engine.

Improvement of the engine also has brought about similar betterment in the design of accessories and fundamental units. The fuel feed system, for example, has gone through a most interesting series of developments from the gravity feed to vacuum tank, and within recent years to numerous designs of mechanical and electrical fuel pumps. Gravity feed along with the thermo-syphon method of engine cooling went out of vogue on buses several years ago.

Battery ignition systems, used only on light-duty vehicles half a dozen years ago, now find almost universal application in the motor bus field. Voltage regulation likewise has been generally adopted, especially in the medium and heavy-duty fields using 12-volt systems for starting and lighting. Every increasing demand for electrical energy brought about by the use of more electrically operated devices on buses, and also by the demand for better interior lighting, has led to almost annual increases in battery capacity. Obviously this means more weight.

Increasing the engine power has brought about the need for greater strength in the transmission units. Clutches of multiple-disk design are now the rule except for light-duty vehicles. Improvements in the gearset have been made largely with the object of reducing noise without sacrificing strength. And although substantially increased engine power is now available but little attempt has been made to reduce the number of forward speeds in the heavier designs. The four-speed gearset, because of the flexibility of operation it affords, is used on all but seven of the 89 models carried in *Bus Transportation's* most recent table of bus specifications.

As to the type of final drive, honors are divided between worm drive and the bevel and spiral drives, 32 of the current models being equipped with the former type of drive and 30 models having one of the latter types. More than twenty current models are using double-reduction final drive. In latest developments of bevel drives the gear teeth are made larger and stronger, and one of the more recent rear axle designs has only one tooth in contact at a time.

Aside from the engine the bus braking system has probably received the greatest attention. The braking system furnishes a splendid example of how changes in one fundamental unit often affect an entirely different unit. For example, the almost universal trend toward the drive-shaft brake some years back was brought about by the manufacturers' efforts to secure a lower center of gravity through the use of smaller wheels.

A decade ago brake location was limited to the rear wheels, with a few makes using a combination drive-shaft and rear-wheel hook-up. During 1922 and 1923 the use of two sets of brakes on the rear wheels continued to increase, with the drive-shaft type dropping off slightly. It was also in the latter part of 1923 that four-wheel brakes were first used on buses. The following year nearly 5 per cent of the models were equipped with this innovation. It was also in this same year, 1924, that bus manufacturers began casting about for means to reduce over-all body height and hit upon the idea of using wheels of smaller diameter. Incidentally, it was these early steps that are primarily responsible for the low-hung, well-balanced bus of today. General adoption of drop frame construction, underslung frames and lower body sills were developments that came later.

The latest and earliest type of bus operated on Fifth Avenue, New York

Reduction in the size of the wheels brought about a new problem, namely, inadequate brake cooling. This form of trouble was most pronounced where two sets of brakes were mounted on the rear wheels. In seeking a way out of this difficulty the manufacturers began to look again with favor on the rear-wheel drive-shaft hook-up, with the result that 20 per cent of the models of 1925 were employing the drive-shaft combination and 70 per cent employed two sets of brakes on the rear wheels. Four wheel brakes had more than doubled in usage.

The year 1926 showed but little change from 1925. This was a year of extensive experiments on the part of makers of brake equipment and tire companies. The main objective was to eliminate brake heating conditions which had proved so destructive to tires, and at the same time to improve decelerative ability and generally to simplify brake design. What happened in the interim is a story familiar to all. Four-wheel brakes are now the accepted means of deceleration on all but a few models.

Brake actuation, as demanded by higher speeds, larger vehicles and heavy traffic also has kept pace with progress. Power brake appliances are now operated by air, by hydraulic pressure, by vacuum in the intake manifold, and to a lesser extent by servo multiplication of manually applied power. About 35 per cent of all current models are equipped with air brakes and about 25 per cent with hydraulic brakes.

The vicissitudes of the various wheel types is best indicated by the fact that wood wheels, with which nearly 60 per cent of early models were fitted, are now no longer used. And the cushion wheel, once proclaimed as the rival of all shock absorbers, is now but a memory. The disk wheel and the cast spoke wheel are now the only types found on buses.

Dual tires on the rear wheels, at one time a theory only, have long since become a firmly established fact. So, too, with balloon tires. Since their first use on buses in about 1926 they have become universal, and high-pressure tires are now used almost as infrequently as solid tires.

So much for the developments that lead up to the present. What, then, does the future hold? Suggestions have been advanced which involve such radical changes as the use of radial or opposed engines, possibly the Diesel, installed under the floor of the bus; of a synchro-mesh transmission perhaps with free wheeling or even the elimination of any form of gearset; of power steering; and of means for steam heating and for better disposal of exhaust gases. There is also a necessity for close study of ways and means to reduce the gross weight of vehicles, both body and chassis. Otherwise power plants will have to be further increased in size if equivalent acceleration rates are to be maintained. These and many other improvements, according to some authorities, are either in course of development or are receiving serious consideration.

By

CLIFFORD A. FAUST

Assistant Editor

Electric Railway Journal

The first trolley bus in the world, built by Siemens and Halske, of Berlin, in 1899

Vehicle placed in experimental service in 1903, at Scranton, Pa. —a pioneer of its type in America

A New Vehicle with an

Interesting Past—

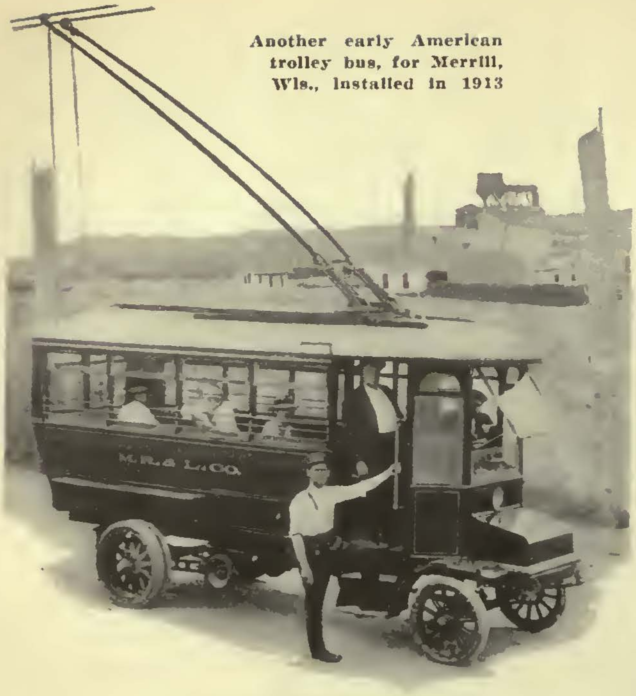
The Trolley Bus

IF YOU were waiting somewhere along the route of a modern trolley bus line and saw approaching you a vehicle with a bow collector, three-window street car body, a monitor deck roof extending forward several feet to cover the driver's high platform, four large wagon wheels and two small flanged wheels at the front, you would be greatly surprised, and rightly so, for you would be taking yourself back 32 years, to the year in which a vehicle of this description actually made its appearance in Berlin, Germany. Being the first trolley bus every developed, this vehicle, though possessing many of the essential characteristics of our present type, was a curious and very unusual contrivance.

The "combined trolley car and automobile omnibus," designed by Siemens and Halske, was fitted with a bow collector for operation on railway tracks and storage batteries for running on streets where there were no tracks. By using the trolley circuit in places it was possible to lower the storage battery capacity, thereby saving weight, to charge the batteries economically and also to reduce the tractive resistance. To keep the vehicle on the track when operating as a trolley car, use was made of two flanged guide wheels which ran in front of the front driving wheels. When the vehicle was turned off the track these guide wheels were raised and the bow collector tied down. The body resembled that of a horse omnibus of that period and had four main wheels, similar to those used on ordinary farm wagons. Brakeshoes of the type found on wagons were used, but these were supplemented with an electric brake on all four wheels for emergency use. Four motors of 4 hp. each were employed, one for each driving wheel.

Ingenious as was this vehicle in conception, it presents a striking contrast to the modern trolley bus. Its 12-passenger capacity has been increased to 43 for single-deck vehicles and to 61 in the case of the largest English double-deckers; the high floor and awkward-appearing body have been superseded by a low well-proportioned body with arched roof and graceful lines; the large steel-tired wagon wheels have been replaced by small-diameter wheels with big pneumatic tires; the bow collector has given way to twin trolley poles; the high semi-inclosed platform for the operator has been replaced by an operator's section inside the body; the motor capacity has been increased from 16 hp. to 100 hp., the hand controls have been superseded by pedal control, and the simple wooden brakeshoes on the two rear wheels have been replaced by combinations of internal expanding mechanical brakes, rheostatic brakes and vacuum amplification, all operated by one pedal. Besides these changes many improvements have been made in seats, flooring, body construction, electrical insulation and doors.

The smooth ride now afforded by the modern trolley bus, the pleasing appearance it presents and the high speed it can attain with safety are noteworthy evidence of the progress made. Only a



Another early American trolley bus, for Merrill, Wis., installed in 1913

vivid imagination could have conceived the enormous growth that was to follow the introduction of this type of vehicle back in 1899. Although the vehicle experienced several setbacks in the way of complete abandonment of some systems and designs, the present operations throughout the world are so extensive that it has become an extremely important factor in transportation service.

In America alone there are now eleven systems, operating a total of 199 trolley buses. These are, in the order of the number of units in service: Chicago, 114; Salt Lake City, 26; New Orleans, 13; Rochester, 12; Philadelphia, 11; Detroit, 6; Cohoes, 4; Knoxville, 4; Rockford, 4; Baltimore, 3, and Brooklyn, 2. Before the present year ends, six more cities are expected to install trolley bus systems. These cities and the number of vehicles to be used are: Kenosha, 22; Memphis, 9; Peoria, 5; Shreveport, 5; Pawtucket, 4, and Duluth, 2. Seven other cities in the United States have decided to use trolley buses and may announce definite plans at any time, while 26 other cities are known to be seriously contemplating installations.

England is by far the largest user of trolley buses. A recent survey by the Journal showed that at the beginning of 1931, 24 systems in England and Wales were operating approximately 545 vehicles. Since this survey was made several of the municipalities have expanded their fleets, and three others have made first installations. The most notable is London, which expects to have 60 double-deck vehicles in operation before the close of the year.

On the Continent of Europe there are installations in Poland, Belgium, Italy, Denmark and Germany. In Africa there are two systems, in South America two, and in New Zealand one. In the Orient installations have been made in the Philippine Islands, Japan, the Dutch East Indies, the Straits Settlement and in China. The properties at Singapore and Shanghai, with 105 and 99 vehicles respectively, have what are believed to be the second and third largest systems in the world, being exceeded only by Chicago.

In the history of the trolley bus developments were gradual and steady from the very beginning. However, in the United States there have been two periods of special significance in its history, the one starting in 1921 and the most recent one beginning in 1928.

So far as can be determined the Siemens-Halske storage battery trolley bus, placed in operation in Berlin during 1899, was the first installation in the world. Early in 1900 the second installation of which details are known, was made in France by M. Lombard-Gerin. An experimental line, about 3,000 ft. in length, extended on a road along the Seine just outside the limits of Paris. In the design of this system a four-wheel over-running carriage was used on the overhead to collect the current. This carriage was driven by a little non-synchronous induction motor of the squirrel-cage type, supplied with 3-phase current from the motor of the main vehicle, and traveled at a speed slightly greater at each instant than the trolley bus itself. The trolley, with its motor, stopped when the principal motor stopped, and followed all the variations of the speed of the vehicle which it tended. The trolley, constructed entirely of aluminum alloy except the magnetic parts and weighing 40 lb., was connected to the vehicle with a cable of six conductors. Being flexible this cable permitted a wide touring range. To take care of operation on steep inclines, where the trolley would have a tendency to slip on the wires and drop back, an electromagnetic brake with shoes was attached to the trolley carriage and was controlled by a pedal in the vehicle.

Later in the same year, 1900, the Lombard-Gerin interests installed an experimental line at Vincennes Park during the Paris Exposition. Early in 1901, a similar system was installed at Eberswalde, Germany, near Berlin. After operating for five months it was abandoned because of excessive costs and insufficient patronage.

One of the notable installations in the early years was made in the Biela Valley, Germany, between Königstein and Königsbrunn, on July 10, 1901. This system, developed by Siemens and Halske and known as the Max Schiemann system, had an overhead structure very similar to that used today and had two separate trolley poles with shoes for current collection. Being an interurban line, trailers were added behind the passenger vehicles for the haulage of freight. This line remained in operation for three years, after which it was transferred to Wurzen, in Saxony.

In the period of activity beginning in 1921, Staten Island started a system with eight vehicles and later added fifteen more

What was probably the first operation of a trolley bus in America was the installation of a temporary line by A. B. Uphan of Boston, president of the Eastern Trackless Trolley Company, to demonstrate its practicability. The vehicle used resembled the lightweight street car of early days, had rubber tires, an outside platform for the driver, two motors and two trolley poles. The seating capacity was twenty. An interesting feature of the design was the use of trolley wheels in a horizontal plane, pressed apart and against the sides of the wire by a spring at the trolley base. Plans later were made by this company for installing a line in Franklin, N. H., between two railroad stations at distant points of the town, and in April, 1902, a franchise for operating the system was granted by the City Council. A little later announcement was made by two Lowell, Mass., capitalists that they were backing Mr. Uphan for a line between Franklin and Franklin Falls, N. H., and that permission had been secured to put systems in Lowell and other New England cities. Apparently, none of the contemplated installations were made. However, in 1903, the same company, with its name changed to the American Trackless Trolley Company, demonstrated its vehicle in New Haven, Conn., before a group of capitalists, who desired to try the vehicle in that city. Finally, on Nov. 2, 1903, the American Trackless Trolley Company formally opened an experimental line in Scranton, Pa. This line, 800 ft. in length, was run over private property and the ground covered was neither smooth nor hard, but exhibited conditions such as would be encountered on many country roads. The vehicle, as illustrated, used the horizontal trolley wheel idea, and apparently was the same one demonstrated on the two previously mentioned occasions. It was tested for a few months in Scranton and then abandoned.

In the meantime, during 1902, the Lombard-Gerin Company installed a 2.5-mile line with one vehicle at Fontainebleau, France. This system operated for 110 days, and provided valuable data for altering the design. It was similar to the original French systems, in that it used a motor-driven trolley carriage and flexible cable. Early in 1903 the A.E.G. of Berlin developed an interesting vehicle with six wheels, the two rear ones being replaceable by sled runners for operation in snow.

In 1904 a 2½-mile system with two short branches was installed between Monnhein and Langenfeld, Prussia. This was interesting because trolley bus locomotives were used for hauling two or three passenger or freight cars. In addition, the locomotives collected loaded farm wagons along the route to deliver agricultural products to the city.

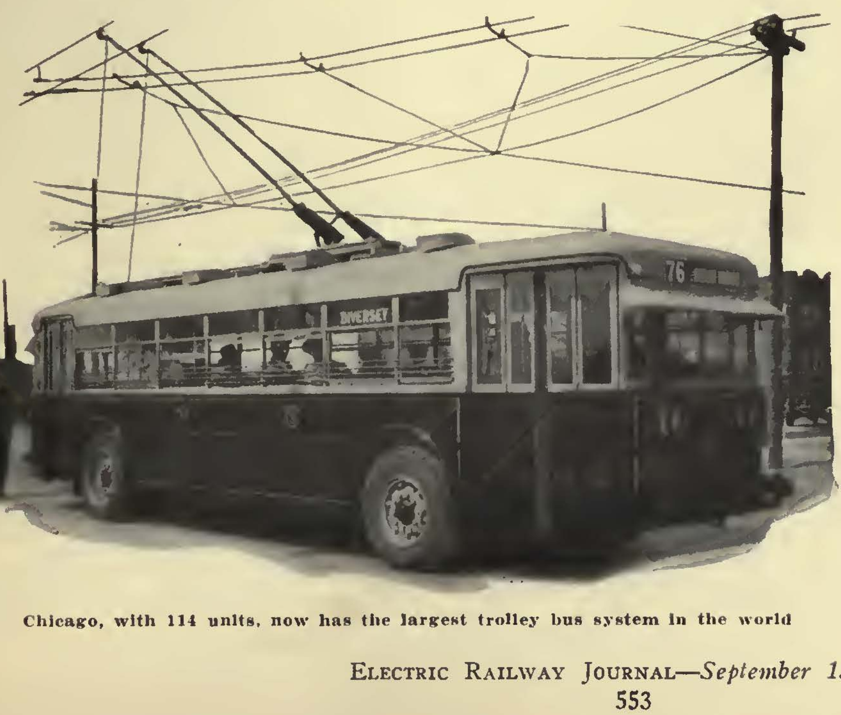
In the summer of the same year a charter was sought by the Sayre Trackless Trolley Company which proposed to furnish transportation in the boroughs of South Waverly, Sayre and Athens, in Bradford County, Pa. Granting of the charter was opposed by the attorney general of Pennsylvania, however, on the ground that existing statutes did not cover the operation of such vehicles.

The modern trolley bus introduced in Salt Lake City in 1928, revived interest in the vehicle in America

Commenting on one proposed system and the previous experiments that had been made, the Journal in November, 1904, stated that trolley buses held forth real possibilities and regarded the "unseemly merriment which the proposition provokes from the average street railway man," as unjustified. The editorial went on to state that the excessive cost of tires, averaging around 3 cents per mile for light automobiles, and the rough streets and roads, causing uncomfortable rides, excessive maintenance and high consumption of energy, were the two chief obstacles to be overcome. Commenting again in June, 1905, on proposed systems in Nahant and Brookline, Mass., the Journal stated: "The trackless trolley, whatever may be one's judgement as to its commercial merits, is not a thing to be turned down offhand in these days of automobiles. It is an automobile system with a continuous source of energy, being thereby limited in its sphere of action, but relieved of the necessity of carrying a prime mover with it." It further stated that the present rolling stock is at a serious disadvantage, being much more expensive than street cars of similar carrying capacity, and that the tire problem is a specially grave one.

During the period from 1905 to 1909, a number of systems were installed on the Continent of Europe, principally in Italy, Germany and Austria. Although there were several types in operation, there were only three fundamental designs. The Mercedes-Stoll system, used in various parts of Austria, operated a 12-passenger, 5,000-lb. vehicle, with a four-wheel over-running trolley carriage, joined to the vehicle with a flexible cable, similar to that used in the early Lombard-Gerin systems. Where only two wires were erected and two vehicles had to pass, the cable connections at the vehicles were switched. The most interesting feature of this vehicle was the building of the motors as a part of either the front or rear wheels. The armatures were wound on the axles, and the fields built right into the wheels. The Filovia system, found in several cities of northern Italy, also used a four-wheel trolley carriage, but instead of being over-running it was pressed against the under side of the wires with a single pole. The vehicles had a seating capacity of 20 passengers, weighed 6,000 lb. and had solid rubber tires on 33½-in. front wheels and 37½-in. back wheels. They were equipped with three water-cooled mechanical brakes, and two 15-hp. motors, mounted on the chassis. Spur gearing and chain drive for the rear wheels were used. The Schiemann system, used mainly in Germany, employed a 15-passenger, 6,280-lb. rubber-tired vehicle, equipped with a single trolley pole which pressed two trolley shoes against the wires. A single motor propelled the vehicle and was geared to the front axle.

On Sept. 11, 1910, the first commercial trolley bus system in the United



Chicago, with 114 units, now has the largest trolley bus system in the world

States was installed. This was a 1½-mile line of the Laurel Canyon Utilities Company, which extended from the Los Angeles-Pacific railway tracks near Hollywood, up Laurel Canyon to a settlement known as Bungalow Town. Service originally was given with motor buses, but they did not perform satisfactorily over this route, which had a minimum grade of 4.5 per cent, an average grade of 8 per cent and a maximum of 12 per cent. Accordingly, the company removed the engine and transmission from two Oldsmobile buses and substituted two 15-hp. motors, and a chain and sprocket drive. Two wooden trolley poles were used, with aluminum shoes for collection. No turnouts were needed in the overhead, since the vehicle could coast almost the full distance on the downhill trip. The buses used had a seating capacity of 16 and weighed 3,000 lb. This system was operated for several months before it was abandoned.

About this same time England became interested in the trolley bus and made extensive studies of existing systems. As a result both Bradford and Leeds started operation on June 20, 1911. These were the forerunners of several other systems to be opened up in the next and subsequent years. England contributed immeasurably in refining the trolley bus and in a few years assumed the lead in number of vehicles, a position still held.

An interesting variation of the trolley bus, known as the "trolley truck," was developed in New Haven, Conn., in the summer of 1912 by the Trolley Electric Vehicle Company of America. It used a single trolley pole, but had storage batteries for use away from the overhead.

The second commercial trolley bus system in the United States was installed in Merrill, Wis., by the Merrill Railway & Lighting Company, early in 1913. The high cost of building track over three railroad crossings and reconstructing a bridge over a river to support street cars was the principal reason for installing a railless vehicle. The general manager in Merrill had seen an electric bus for a department store in Chicago and requested the Field Electric Bus Company, the manufacturer, to construct a similar vehicle, equipped with a suitable motor and two trolley poles. The vehicle, weighing 6,000 lb., had a seating capacity of 18 passengers, and the single 15-hp. motor drove the rear wheels through a universal shaft, bevel gear, jack shaft, differential gear, sprockets and chains. This vehicle was used for approximately a year, when it was sold to the West End Street Railway of Boston. Since no reports of its use there are available it probably was never placed in commercial service in the East.

In 1921 a wave of keen interest in the trolley bus spread over this country. The history of the period from that date to the first of 1930 was reviewed in detail and supplemented with tables of all existing and abandoned systems in the January, 1930, issue of the JOURNAL, and only a summary will be given here. In 1921, the General Electric Company demonstrated a vehicle of Atlas Truck Company manufacture at Schenectady; this same vehicle was shipped to Virginia where it was tested in both Richmond and Norfolk; Detroit tried two types of vehicles, one with a Brill body and Packard chassis and the other manufactured by the Trackless Transportation Company of New York; Brill developed a vehicle and experimented with it at Philadelphia; the Toronto Transportation Commission placed four vehicles in service and the Staten Island Midland Railway inaugurated two lines, totaling 7 miles, with eight trolley buses manufactured by the Atlas Truck Company.

Comfortable, attractive and speedy trolley buses, like this one in Rockford, now operate in eleven American cities

The following year saw an experimental system with two vehicles installed at Minneapolis; a four-vehicle system over two routes started in Windsor, Ontario; the inauguration of a three-vehicle system in Baltimore, the oldest system now in operation; and the addition of 9 miles of route and fifteen trolley buses in Staten Island. Much activity also took place during 1923. Minneapolis and Toronto abandoned their systems; Windsor suspended service on one of its lines; Petersburg, Va., placed two vehicles in service; and Philadelphia and Rochester started their systems, both of which are still in operation. In 1924 Petersburg added three more trolley buses, and Cohoes started a system with four vehicles. The second line in Windsor and the entire Petersburg system were abandoned in 1926, and in the following year the largest installation made to date, in Staten Island, was abandoned.

This waning of popularity, however, was checked, and a renewed interest shown in this vehicle in 1928, when Salt Lake City inaugurated its extensive system with the modern type of trolley bus. The success of this installation led to an expansion of this fleet in 1929 and the starting of service in New Orleans. Manila had ordered eight vehicles in 1928 and placed them in service in February of the following year. The banner year in the history of the trolley bus was 1930, when Chicago placed 70 vehicles in service and ordered fifteen more, and Knoxville, Detroit, Brooklyn and Rockford all adopted the trolley bus. New Orleans also expanded its system during that year.

Early in the present year Chicago accepted four vehicles which had been on trial and purchased 25 more. The six cities which plan to inaugurate service before Dec. 31 have ordered a total of 47 units. Of these new installations the Kenosha one will be particularly interesting since it will replace completely the street car and motor bus services, and thereby become the first 100 per cent trolley bus system in America. At Shreveport the railway demonstrated a unit previous to a special election at which the vehicle was overwhelmingly approved.

From this outline of the history of the trolley bus it will be seen that it is an old vehicle, but the modifications of design in 1928 and the years following have been so revolutionary that it can now properly be termed a modern unit of transportation. Its success in the many cities where it is being used and the confidence which operators are gaining through observation of its performance in various kinds of service, indicate that in the years to come its operation may be expected to expand at a rapid rate and play a vital part in co-ordinated community transportation.

NEWS *of the Industry*

Improvement Projects

Santa Ana, Cal.—Pacific Electric Railway officials have agreed to build the necessary rail connections at a cost of $40,000 for proposed Pittsburgh Plate Glass factory here.

Washington, D. C.—Work has been started by the Mount Vernon, Alexandria & Washington Railway on relocation and rebuilding of its trackage in District property south of the Highway Bridge.

Minneapolis, Minn.—The Minneapolis Street Railway budget for 1932 to meet the proposed paving plan of the city is $559,275. Of this, $300,000 is for the track department, $125,000 for the power department, and $135,000 for the mechanical department.

Fare Changes

Toledo, Ohio—The Community Traction Company has adopted a 1-cent fare for children of less than eight years of age and under 50 in. high. A marker at the door is used to gage the height. Children of more than eight, regardless of size, can ride for 5 cents, or half fare, if tickets are used.

Bus Operations

Hartford, Conn.—The Connecticut Company, in furtherance of its plan to expand bus service here, has begun the operation of buses on the Broad Street route.

Jamestown, N. Y.—The Jamestown Motor Bus Transportation Company, bus operating subsidiary of the Jamestown Street Railway, has withdrawn its application to the Public Service Commission for permission to operate a bus line between Jamestown and Frewsburg, N. Y.

Jacksonville, Fla.—Colonial Stages has withdrawn its request for a franchise to furnish the city bus transportation to replace street cars of the Jacksonville Traction Company. N. B. Estes, vice-president of the bus company, attributed the withdrawal to the Council committee's slowness in considering the proposition, and inability of his company to get ready to operate the buses by the time the railway franchise expires if his proposition should be accepted.

Brooklyn, N. Y.—The Brooklyn Bus Corporation announced on Sept. 16 that three more bus routes of the twenty routes included in its franchise from the city would be placed in operation before the end of September. The bus company now has ten routes in service.

(Late News Continued on Page 556)

Ingenuity and Salesmanship Can Win Car and Bus Riders

"Ours is now a merchandising business as well as a standby ready to serve utility," declared Walter A. Draper, president of the Cincinnati Street Railway, in his message of welcome to the Central Electric Railway Master Mechanics' Association, in convention at Cincinnati on Sept. 9. The message was read in his absence by J. B. Stewart, Jr., general manager. "We must readjust ourselves to a new normal and as part of the readjustment many people must come to realize that the street car and bus must be their regular means of going and coming. To reach and keep this group our ingenuity and salesmanship will be put to the test."

Emphasizing the importance of studies now being made by the Master Mechanics Association, Mr. Draper said:

There has never been more need for a careful survey of what can and must be done by the local transportation industry than the present. We have been affected by the same things that have caused a slowing up in all industry, and we too should begin to feel the upturn when it comes. It is my opinion that very few lines will see a revival in extent anything like that experienced in 1929, and that a new normal will be established. It therefore becomes necessary for us to adjust ourselves to this new normal, a normal appreciably lower than any to which we have been accustomed.

If this be true, then the need will be great for us to give just the kind of consideration to readjustment that these master mechanics give to their work when they get together. I think we will have to consider not only how we can reduce costs, but also how we can provide a more comfortable, faster, cleaner and quicker ride.

There is a great deal to be said in favor of the convenience and cheapness of our public transportation, but the fellow who has bought himself an automobile and is willing to pay what it costs to ride back and forth prefers to go that way or he wouldn't do it. If he is compelled to give up using his automobile by economic reasons rather than because he finds the street car or bus more convenient, then he is going to miss his own automobile and is going to be inclined to criticise the public service. His own car may have been dirty and noisy and subject to breakdowns and delays, but he is going to excuse none of these things in the street car or the bus. We must, therefore, set up a standard that will not merely satisfy a passenger or will give him no warrant to complain, but a standard that will serve to attract customers and make a regular rider out of a casual one.

As Mr. Draper put it, a large part of the work to be done to make service attractive and serviceable lies in the domain of the master mechanic.

The Business Outlook

BUSINESS passes the middle of September with no signs of seasonal stimulation in any important line. Steel demand and electric power production remain stagnant, with steady slackening in freight movement and money turnover as measured by check payments. Building contracts and coal output alone give faint signs of response to seasonal influences. The continued climb of currency outstanding points to an increasingly acute crisis of confidence intensified by the steady weakening of security markets. The comparative steadiness of commodity averages is encouraging but conceals a still unstable price situation. The European picture likewise is superficially reassuring but the essential issues are still submerged.

—*The Business Week.*

Philadelphia Schedules Liberalized

To stimulate a general increase in business and social activity coincident with the approaching fall season, directors of the Philadelphia Rapid Transit Company authorized the operation of more frequent service on practically all of the company's street car routes, effective on Sept. 14. The new schedules provide an average of 8 per cent additional service for the entire surface system, with increases reaching 20 per cent on a number of lines.

Routes carrying the greatest number of passengers are, as a general rule, receiving the largest increases, although on many other routes where riding is comparatively light and where it is felt more riding can be encouraged, substantial additions to service are being effected.

Under the new schedules, daily car-miles will total 172,148 as against the former figure of 159,636. The increase in daily round trips operated will be 1,101.

Service on Broad Street Subway and Market-Frankford Subway-Elevated is also being adjusted upward.

Revenue Passenger Statistics Constant

The tabulation of railway and bus traffic for August, 1931, compared with August, 1930, as reported to the American Electric Railway Association by 111 companies is as follows:

August, 1931	363,805,552
August, 1930	404,745,536
Decrease	10.12 per cent

Adding the revenue passengers carried by the companies from which reports were received too late to be included in the totals given as of Aug. 12 218 companies reported for July as follows:

July, 1931	731,987,200
July, 1930	800,425,603
Decrease	8.55 per cent

Bus Operations

(Continued from Page 555)

St. Louis, Mo.—The Public Service Commission on Sept. 9 took the testimony of four companies that seek permission to operate bus service on Federal Highway No. 40 (the St. Charles Rock Road) between Edmonson Avenue, St. Louis County, and St. Charles, Mo. On this stretch of 7 miles, the St. Louis Public Service Company has asked to be allowed to discontinue railway service, but at the hearing some weeks ago on this application, none of the bus companies offered bus service as an alternative.

✦

Boston, Mass.—The City Council has denied the Eastern Massachusetts Street Railway permits to operate bus lines between Dedham-Boston line and Forest Hills terminal and between Pierce Square, Dorchester, and Ashmont terminal of Boston Elevated.

✦

St. Louis, Mo.—On Sept. 1 jitneys operating on the Delmar, Page-Wellston and South Grand Boulevard routes here commenced operating on a ten-minute schedule until 1 a.m. The lines compete with cars of the St. Louis Public Service Company and buses of the People's Motor Bus Company. For the late service a 25-cent fare is charged compared with 10 cents on street cars and buses. The service car organization is also operating seven cars on its South Broadway line at 1 a.m. at the same fare but at irregular intervals. Most of the cars seat seven persons in addition to the driver.

Service Changes

Los Angeles, Cal.—As a trial plan for improving Pacific Electric Railway service to Hollywood, the Board of Public Utilities and Transportation has approved the request of the company for a rerouting of its lines, application for which is pending before the California Railroad Commission. The board's engineers report that there is no basis for the contention that the Hollywood surface lines as a whole are inadequate.

✦

Chicago, Ill.—Opposition to the proposal of the Chicago Surface lines to institute one-man service in some sections of the city has caused the Illinois Commerce Commission to delay a decision in the case until the opposition has more time to air its views. E. J. McIlraith, Surface Lines engineer, said the one-man cars would be placed in operation only on night and Sunday shifts on lines where the service did not exceed the seating capacity of the cars, and in the daytime on lines where the passenger traffic is light.

Financial News

Butler, Pa.—The tangible property of the Pittsburgh, Harmony, Butler & New Castle Railway and the Pittsburgh, Mars & Butler Railway, which includes 120 miles of trackage, poles, overhead trolley wires, 34 passenger cars, 60 freight cars, 26 bridges, power stations and other equipment, will be sold on Oct. 7 in Pittsburgh by Maurice R. Scharff, the receiver.

✦

New York, N. Y.—The Transit Commission has denied the application of the Third Avenue Railway for a rehearing on its petition for permission to issue $240,000 in notes for the purchase of buses for subsidiary companies operating outside the metropolitan district.

✦

Olean, N. Y.—Alvin R. Bush, president and general manager of the Allegany Motor Coach Company, operating buses in southern and western New York and northwestern Pennsylvania, has been named receiver of the Erie County Traction Company, serving Hamburg, Orchard Park and Gardenville by trolley. The receiver plans to substitute bus for rail service.

✦

New York, N. Y.—Chairman Fullen, of the State Transit Commission, and others interested in promoting unification have compared the percentage drop in subway travel with the percentages of average recession in general industry and find the railroad losses are minor in comparison to those suffered by other business.

✦

St. Louis, Mo.—Chairman Waddill of the State Tax Commission has submitted the final recommendations of the commission to the State Board of Equalization, which fixes the final assessments. The commission's report covered the property of 53 railroads, fourteen street and electric interurban lines, 21 bridge companies, five telegraph companies, 190 telephone companies, 49 electric light and power companies and four oil pipe line companies. Street and electric railways values were fixed at $57,624,507, a decrease of $2,740,485. The Tax Commission fixed the assessment of the St. Louis Public Service Company at $40,001,026 compared with $44,452,395 last year, recognizing the ruling of the Circuit Court to adjust some of the phases of last year's assessment.

Commission Commends Milwaukee Merchandising

During the past two years, but more particularly within the past six months, the Milwaukee Electric Railway & Light Company has been making a determined, and apparently a successful, effort by managerial ingenuity and resourcefulness to promote street and electric railway riding, and thus win back a part of the market lost to the motor vehicle. On the Milwaukee system riding has been maintained on a comparatively constant level, and in spite of an unprecedented industrial depression there has been a tendency toward increased riding until the last two or three months, when unemployment has apparently increased markedly. In a business with a constantly expanding market it does not require exceptional managerial ability to furnish good service and earn a return. To produce such results in the face of a constantly declining market is a genuine accomplishment.—*Public Service Commission of Wisconsin.*

Regulation and Legal

Annapolis, Md.—The Anne Arundel County Taxpayers League at a meeting here discussed having the court act on a ruling handed down by the Attorney-General, which held that there could be no referendum on the law passed by the last session of the Maryland General Assembly exempting the Washington, Baltimore & Annapolis Electric Railroad from the payment of taxes for the next two years. The Attorney-General held that the petition filed with the State asking for the referendum lacked the necessary number of signers, 10,000.

✦

New York, N. Y.—*The American City* for September quotes from the article on the violation of parking restrictions contributed to Electric Railway Journal for August, by John A. Miller, Jr. Paragraphs from the original presentation are quoted which *The American City* thought particularly pertinent for presentation to its readers.

✦

Chicago, Ill.—Corporation Counsel William H. Sexton reopened the city's fight with the elevated lines for restoration of three-for-a-quarter fares on Sept. 14, when he mailed to the United States Supreme Court the city's brief appealing from the adverse decision of the United States District Court here. Oral arguments are expected to be made before the Supreme Court in October. The case has been kept alive since the District Court in September, 1930, issued a permanent injunction restraining the Illinois Commerce Commission from interfering with the increased rate, 10 cents straight fare.

General

Seattle, Wash.—Appointment of the Municipal Railway Commission of five citizens by Mayor Harlin has been confirmed by Council. After an organization meeting to choose its own chairman, and determine the initial terms of its members, to range from one year to five years, the commission will start upon the task of choosing an expert manager for the Municipal railway system, and laying out a program for operation.

✦

Richmond, Cal.—According to Richmond United, published by the local chamber of commerce, students of public affairs are wondering whether the next step may be a proposal for the East Bay Municipal Utility District to take over the transportation system now run by the East Bay Street Railways for the same cities now served with water, plus the city of Hayward. This could be done under the existing State law, provided it was favored by the people.

(Continued on Page 558)

Service Changes in Spokane

Buses were placed in service on Sept. 9 on the Cable Addition line of the Spokane United Railways upon the arrival of four new 28-passenger Fageol buses. The Cable Addition buses make a downtown loop. The city is now engaged in preparing to pave South Bernard Street, which is on the bus route. Consequent upon the adoption of buses for the Manito and Cable Addition lines, the Hillyard and Broadway lines have been linked, cars proceeding through the downtown district on Riverside Avenue. The Ligderwood line will make a loop in the downtown district. The East Sprague and Weest Cleveland lines have been linked. The routes of the Manito and Cable Addition lines have been so rearranged that cars make only one left turn in the business district.

A Plea for Settlement in St. Louis

The city of St. Louis, Mo., must act at once to solve its intricate transportation problems. So Stanley Clarke, president of the St. Louis Public Service Company, declared in an open letter sent to business men of the city in part as follows:

At the conclusion of our wage arbitration hearing, I stated that this company has been forced to cut its executive personnel to the point of bare operating necessity.

It is true that the present condition of abnormally low earnings is due to the depression, but unless we observe the most rigid economies, it will be impossible for us to continue to provide public transportation service.

These economies mean an abandonment of all our engineering and traffic studies and other research work. During the past several years we have spent many thousands of dollars in analyzing the transportation needs of St. Louis, and in seeking to arouse business men and the public generally to an appreciation of the necessity for immediate action in securing a transportation settlement. That money and that effort will have been wasted and St. Louis will have slipped back years in its civic development, unless there is decisive action in securing a transportation settlement.

Conditions surrounding public transportation service are not static. Operating methods change. Financial conditions change. The attitude of the public changes. The painstaking studies and well-considered recommendations by the city's transportation survey commission are in some respects inapplicable today.

So, if any benefits are to be garnered from the money and the labor that have gone into the research and planning carried on by this company and by other bodies and individuals in recent years, we must act at once. A year from now will be too late.

Nothing collects dust on the top shelf in the closet so effectively as a transportation analysis or report or recommendation. Let's keep transportation off the shelf.

Buffalo Men Praised

One thousand employees of the International Railway, Buffalo, and members of their families thronged the Statler ballroom on Sept. 11 in a victory convention celebrating the success of their fifth annual picnic and the achievement of a new record in safety performance. B. J. Yungbluth, president of the railway, presented to the men of Broadway station a set of engrossed resolutions recognizing their achievement in excelling all other departments in the value of tickets sold for the picnic. President Yungbluth also awarded a magnificent silver safety trophy to the men at Hertel station, champions in safety performance for August. The trophy will be held by Hertel station until its current safety performance is bettered by another station. The district making the best showing for the year will receive the trophy for permanent possession. Mr. Yungbluth paid special tribute to 27 men of that division who have operated their cars for one year or more without a single chargeable accident.

Remission of Baltimore's Park Tax Sought

Lucius S. Storrs, president of the United Railways & Electric Company, Baltimore, Md., has sent a letter to Mayor Jackson in which he points out the injustice of requiring the public or the company to pay the park tax while the thousands of motorists who make use of the parks pay nothing. Mr. Storrs says that justice to the car rider and railway requires the elimination of the tax, and the assumption of the burden of maintaining the parks by the taxpayers.

Mr. Storrs also suggests to the Mayor that, should it be found inexpedient to eliminate the tax completely, it may be possible to work out a plan under which there will be a gradual reduction in the park tax over a period of years. He indicates that if the city cannot now grant substantial relief, the advisability be considered of making the park tax collectible after the payment of the United's fixed obligations, but before any dividends are authorized on the company's common stock. During the time the tax has been in force, the United and its predecessor have paid the city more than $28,000,000.

The move for the elimination of the park tax by the United was made possible through action of the Maryland General Assembly at its session in 1929. At that time, authority to reduce or eliminate the tax was given to the city by a bill which was passed and signed.

Some of the members of the City Council have expressed their views one way or the other, but Mayor Jackson has made no public announcement. The tax amounts to about 9 per cent of the company's gross revenue, and the payments under it since 1919 have bulked to more than $1,000,000 a year.

New York Seeks Bids on Cars

Inquiry has been made by the Board of Transportation of the City of New York, calling for bids on 300, 500, 1,000 and 1,500 subway cars. Each car probably will cost between $30,000 and $40,000 fully equipped, depending upon the amount of special work required. On this basis, the award will involve from $9,000,000 to $60,000,000. Bids will be submitted on Oct. 25 and the award probably will be made soon afterward, calling for either of the four amounts involved, depending upon the advantage in price offered.

New Interurban Entrance Plan Under Negotiation

Negotiations have been opened between the Louisville Railway and the Interstate Public Service Company, which will probably result in the Louisville Railway operating the interstate interurban line between Louisville and New Albany, Ind. A contract between the Interstate and the Kentucky & Indiana Terminal Railroad, regarding trackage rights on the New Albany bridge; and also with the Louisville Railway, for use of its trackage from the bridge, 4 miles downtown, to the heart of the city, expires on Oct. 4. The local company also supplies power used by Interstate within Louisville. There is a differential between the two companies on local fares, but in the event the Louisville Railway took over the service, New Albany cars instead of coming uptown would probably carry passengers to a transfer point near the bridge, where they would take the local cars, thus reducing traffic congestion by doing away with interurban cars making the 5-mile haul, mostly within Louisville's congested district. The Interstate company took over the operation of the line from the Louisville & Northern Railway & Light Company on Oct. 5, 1906, for a period of 25 years.

Richmond Men About to Brush Up on History

Street car and bus operators of the Virginia Electric & Power Company going out on a sightseeing trip to become better acquainted with historic and other places of interest in Richmond in preparation for the large tourist trade that Richmond and Yorktown are looking forward to materialize during the sesqui-centennial celebration of the surrender of Lord Cornwallis on Oct. 19, 20 and 21.

Special Train Service From New York City

The Pennsylvania Railroad and the Central Railroad of New Jersey are providing special accommodations between New York and Atlantic City for the convenience of those attending the convention. These arrangements are for two different days.

The Central Railroad of New Jersey will provide special cars on the "Blue Comet" on Saturday afternoon, Sept. 26. The schedule follows:

	Daylight-Saving Time
Leave West 23rd Street, N.Y.C.	3:17 p.m.
Leave Liberty Street, N.Y.C.	3:30 p.m.
Leave Jersey City	3:42 p.m.
Leave Broad Street, Newark	3:40 p.m.
Arrive—Atlantic City	6:30 p.m.

Reservations for this and other Jersey Central trains can be made through the office of G. D. Ginder, general Eastern passenger agent, 143 Liberty Street, New York City. Phone Barclay 7-9700. Reservations can also be made through any of the city ticket offices.

The Pennsylvania Railroad will have special cars for the convention delegates on its train No. 1077 on Sunday afternoon, Sept. 27. The schedule is as follows:

	Eastern Standard Time
Leave Pennsylvania Station—33rd Street, N.Y.C.	3:25 p.m.
Leave Hudson Terminal, N.Y.C.	*3:15 p.m.
Leave Manhattan Transfer	*3:37 p.m.
Leave Market Street, Newark	*3:40 p.m.
Arrives—Atlantic City	6:25 p.m.

*(Approximate time).

V. E. Woodward, passenger representative, Pennsylvania Railroad, 390 Seventh Avenue, New York (phone Pennsylvania 6-6000, extension 613) will be very glad to make reservations on this or other trains on the Pennsylvania. Reservations can also be made through any of the city ticket offices.

The one-way railroad fare from New York to Atlantic City is $4.93, and the special round-trip fare to holders of convention certificates is $7.40.

All delegates from New York and vicinity are urged to avail themselves of one or the other of these specials.

Operator Sought for New York's New Subway

New York City's Board of Transportation expects to submit for approval at the first fall meeting of the Board of Estimate on Sept. 25 a form of contract for independent operation of the new Eighth Avenue subway and subsequently completed links of the city's new rapid transit system. With the contract draft, the board will submit a recommendation that proposals be invited from all operating concerns or management corporations that care to tender bids.

The operating contract will provide for its own termination, in the event of consummation of the negotiations with the B.-M. T. and Interborough for unification of their rapid transit lines with the city's network.

The proposed operating contract will have no provision for preferential payments, because no party except the city will have any investment in the new lines. It will provide for either a fixed operating fee or one based upon a lump sum and a percentage of gross revenues. Under it the Board of Transportation, as agent for the city, will have broad powers of supervision and audit.

Members of the Board of Transportation declare that they have not abandoned hope for eventual unification of all rapid transit lines, but conceded that no such plan could be put into effect by Jan. 1, 1932, when it is hoped to have the Eighth Avenue line in operation.

Coming Meetings

Sept. 26-Oct. 2—Annual Convention, American Electric Railway Association, Atlantic City, N. J.

Sept. 28-29—Annual Convention, National Association of Motor Bus Operators, Atlantic City, N. J.

Oct. 12-19—Annual Safety Congress Including Special Electric Railway Section, Chicago, Ill.

Oct. 29-30—Annual Transportation Meeting of Society of Automotive Engineers, Washington, D. C.

Nov. 19-20—Middle Atlantic States Equipment Men's Association, York, Pa.

Jan. 27-29, 1932—Electric Railway Association of Equipment Men, Southern Properties, Richmond, Va.

Reverberations of the Baltimore Case

In a review of orders made by it during the year ended June 30, 1930, the California Railroad Commission says that in only a single instance, namely that of the rate reduction of $300,000 for the Southern Sierras Power Company, was the commission forced to rescind its action. In that case the commission fixed the operating expense of depreciation on the basis of the cost of the depreciable physical property. Subsequently, the United States Supreme Court, in the United Railways & Electric Company, Baltimore, case, held that the operating expense of depreciation, allowed to a utility in the fixing of rates, should be computed on the basis of the present fair value of the depreciable property, and not on the basis of the cost of said property. In the light of this decision, the first of its kind, the commission says it had no alternative but to vacate its decision and to reopen the proceeding for reconsideration in conformity with the Supreme Court ruling.

Replacing Chicago "El" Pillars

Commissioner of Public Works, A. A. Sprague, of Chicago, recently asked Corporation Counsel William H. Sexton whether the Chicago Rapid Transit Company pillars, left standing in the streets when the curbs were moved back, could be declared menaces to safety; whether the "El" can be made to move the pillars back to the new curbs; and whether the "El" can be made to pay the cost of removal. The questions were brought up by an agreement for the removal of posts on Ashland Avenue, just south of Irving Park Boulevard.

To the first question the corporation counsel replied that the pillars, left standing when curbs are moved back, are menaces to safety; to the second question, he replied that the Illinois Commerce Commission now claims jurisdiction; to the third question, his answer was that a mandamus suit might be brought to induce the commission to act and determine who shall pay.

General

(Continued from Page 556)

Warren, Pa.—Traces of trolley operation here and in surrounding communities have vanished with the removal of the rails of the Warren Street Railway from the streets. The railway ceased operation on its city lines a year ago. Overhead equipment was removed immediately, but the last of the rails were taken up only recently. The Warren & Jamestown Street Railway, which discontinued operation of its 21-mile line between Warren, Pa., and Jamestown, N. Y., nearly two years ago, has completed the work of removing its trackage and overhead equipment. The Warren Street Railway has also scrapped its 14-mile line between Warren and Sheffield, Pa.

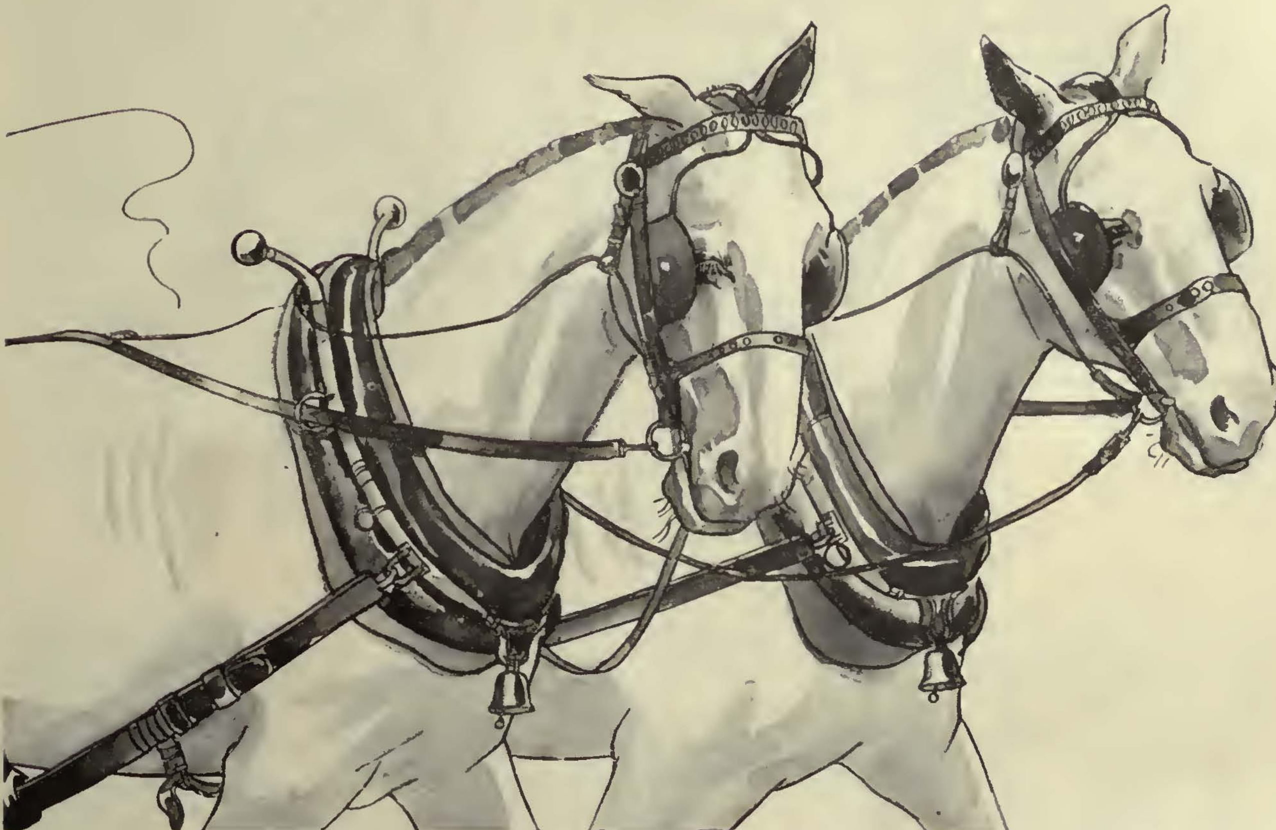
Havana, Cuba — Service over the Havana Electric Railway was scheduled to be resumed on Sept. 15 after an interruption of 45 days caused by a dispute over wages. Strikers agreed to accept a wage of 26 cents an hour, a compromise on the 24 cents offered by the company, and the 28 cents demanded by the strikers.

Washington, D. C. — J. H. Hanna, president of the Capital Traction Company and of the American Electric Railway Association, contributed recently to *Bus and Coach*, published in London, England, a 2,000-word discussion headed "Mass vs. Individual Transportation." Among topics upon which he touches are the growth of the use of the private car, traffic congestion, the pirate taxi and the studies being made under A.E.R.A. auspices of the problems of fares and of the design of a modern electric railway car purchasable at a comparatively reasonable cost. The points he made should redound greatly to the benefit of the English and Continental readers of that publication interested in keeping abreast of the mass transportation scene in the United States.

Wichita, Kan.—Motormen, bus drivers, and others employed by the Wichita Transportation Company, have been notified that a wage cut is imminent. Unofficially the cut is said to be 10 per cent.

Michigan City, Ind.—As a further step in the railroad's campaign to eliminate crossing accidents, the traffic lights at Tenth Street and Willard Avenue here have been co-ordinated with the movement of trains of the Chicago, South Shore & South Bend Railroad by a device of the familiar three-color type, which operates at regular intervals for the guidance of automobile and street car traffic. A somewhat similar installation was two years ago by the South Shore Line at Chicago Avenue here.


G



FROM two-horse power to 200 horse-power perhaps expresses aptly the immense 50-year strides of electric railway transportation.

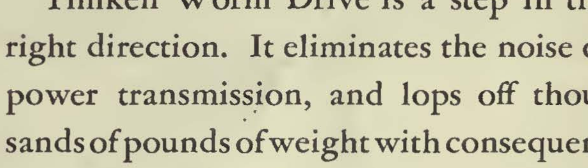
Yet the ancient horse-car, for all its delicate soporific odors and its stimulating variety of temperatures, had something that today's public *wants* in its transportation—

QUIET . . . SMOOTHNESS . . . LIGHT WEIGHT.

These were and *are* first principles; and traction engineering is sensibly getting back to them.

Timken Worm Drive is a step in the right direction. It eliminates the noise of power transmission, and lops off thousands of pounds of weight with consequent improvement in performance characteristics.

Timken Worm Drive needs no test, no argument. For any vehicle—trolley car, trolley bus, gasoline coach—it's right.



THE TIMKEN-DETROIT AXLE CO., DETROIT, MICHIGAN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ANNUAL CONVENTION
ATLANTIC CITY
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SEPT 26
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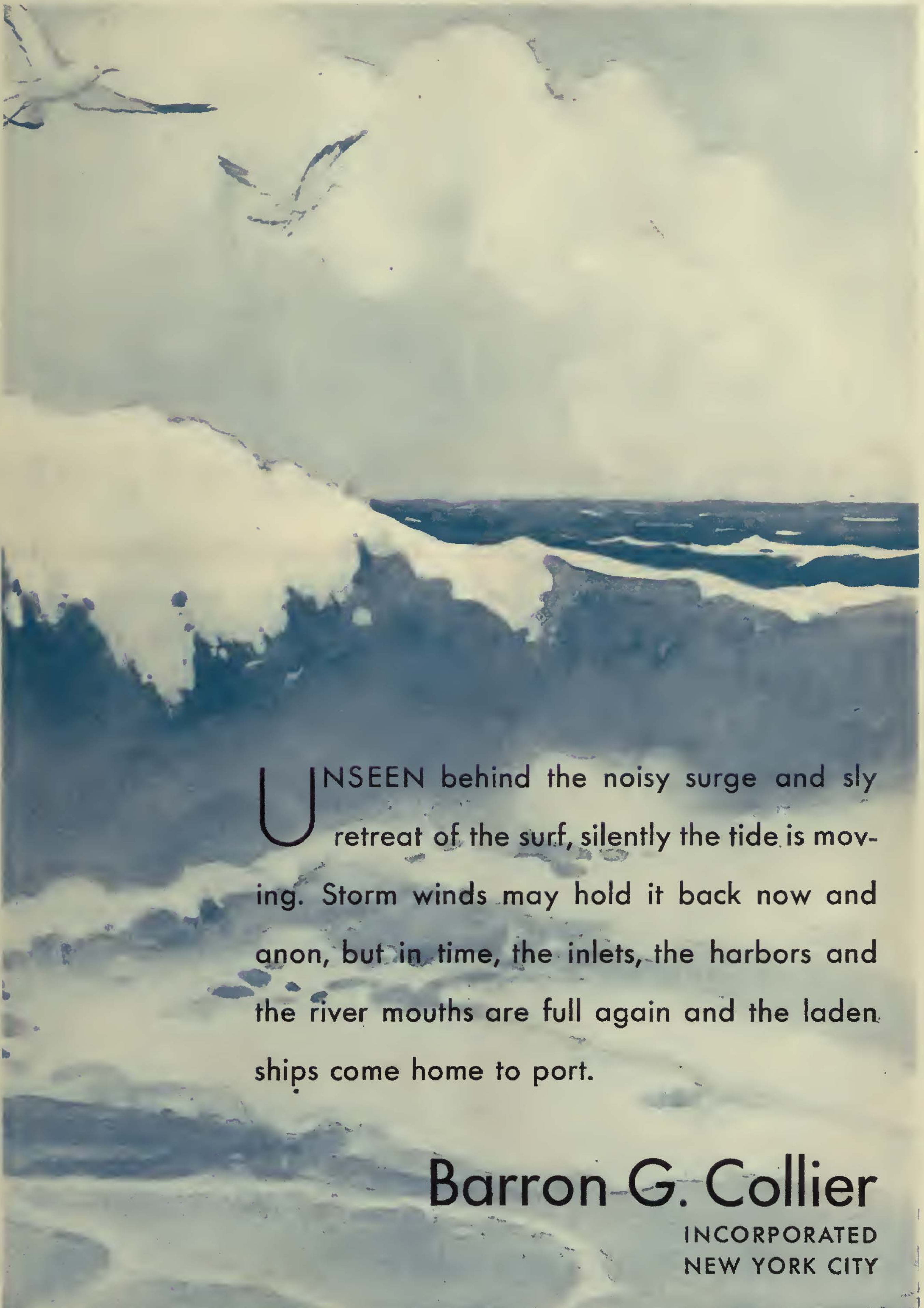
1931


UNSEEN behind the noisy surge and sly retreat of the surf, silently the tide is moving. Storm winds may hold it back now and anon, but in time, the inlets, the harbors and the river mouths are full again and the laden ships come home to port.
Barron G. Collier
INCORPORATED
NEW YORK CITY

Fire COMPLETE

Cuts Bus Operating

FIRESTONE BUS BALLOONS—provide extra values found in no other tire: 1. Gum-Dipped Cords which minimize internal friction heat and add 58% to the flexing of Firestone Cords. 2. Two extra protective plies under the Tread—26% greater protection against punctures and blowouts. 3. Tougher, wider, deeper-grooved tread—25% to 40% longer tire life and quicker trips through increased speed with safety which assures on-time schedules without delay.

Firestone Tubes

are circular molded to perfectly fit the shape of the tire—no pinching or buckling. Firestone Tubes are built to give extra service under hardest usage.

TIRES · TUBES · BRAKE LINING

stone

SERVICE

Costs to the Minimum

Firestone New Type Bus Battery

with patented removable terminals and handles, and genuine one-piece hard rubber case, gives you extra power at lowest cost per mile.

Firestone Spark Plugs

eliminate compression and power losses, produce maximum spark. Firestone Spark Plugs are built to S. A. E. precision specifications.

Firestone Bus Blocks

meet every requirement for heavy duty braking with a minimum of wear on equipment.

It will pay you well to investigate this *complete* Firestone service—developed through years of close contact and daily experience with the bus industry. Your local Firestone dealer will gladly show you how it starts saving money for you *at once*. See him today and get the benefit of tested equipment and skilled service in cutting operating costs to bed rock! When purchasing new equipment insist on Firestone Balloons, Firestone Tubes, Firestone Rims, Firestone Batteries, Firestone Spark Plugs and Firestone Brake Lining.

Listen to the Voice of Firestone Every Monday Night over N. B. C. Nationwide Network

BATTERIES · RIMS · ACCESSORIES

OSGOOD-BRADLEY

A 42-seat vehicle built to electric railway standards

We should like to send you a complete specification describing the new features in detail. We think you will like this big trolley bus with its familiar standard railway equipment and with its rugged construction based on railway car principles of design.

You will be surprised by its roomy interior, with 42 comfortable passenger seats, wide aisle and plenty of room for entrance and exit.

You will be impressed with several Osgood-Bradley features—entirely new. For instance, the unusual and absolutely effective insulation from electric shocks to passengers boarding or leaving and the complete installation of control wiring on the interior above the level of the floor. Noiseproof rubber-mounted trolley board to prevent "rumble." Back-to-back seats over wheel-housings.

Let us demonstrate these, and other features, which make this new Osgood-Bradley Trolley bus a practical operating proposition for any electric railway company.

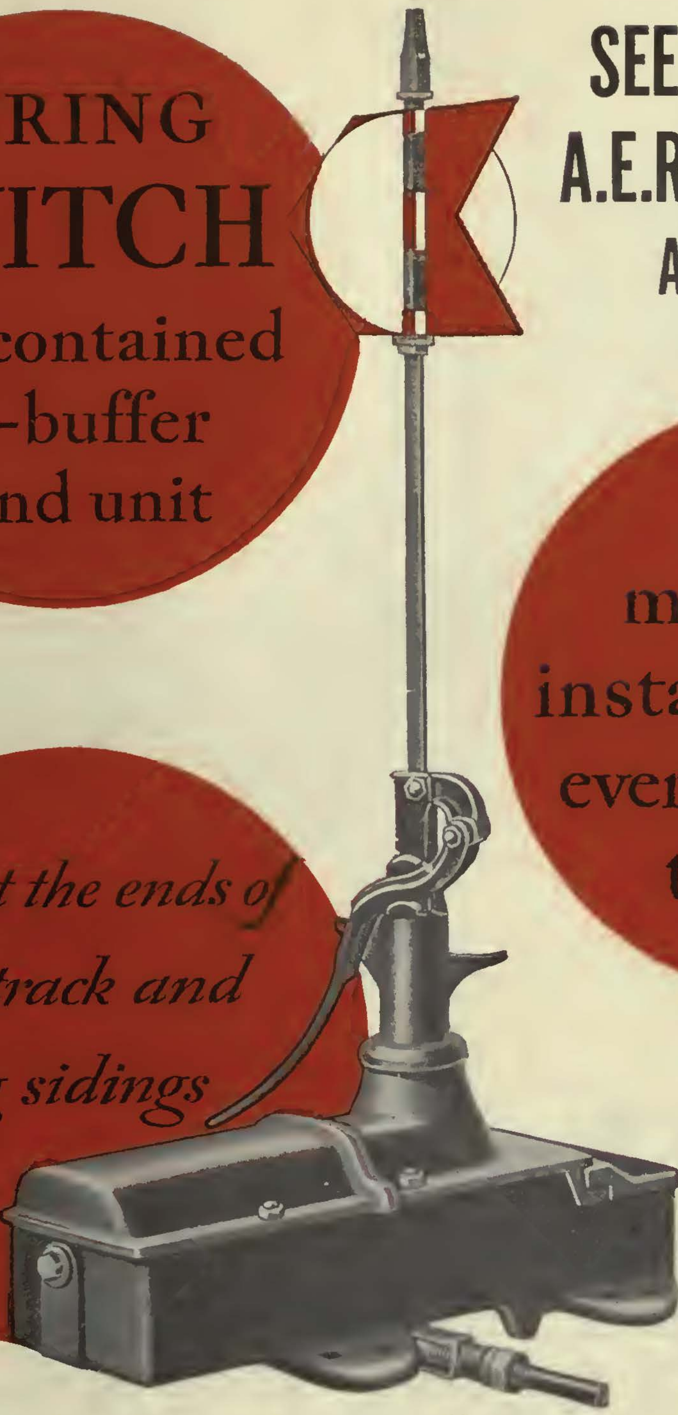
SPRING SWITCH

self-contained oil-buffer stand unit

SEE OUR EXHIBIT A.E.R.A. SPACE E-515 ATLANTIC CITY

Saves more than installation cost every month of the year

used at the ends of double track and passing sidings



3-IN-1 SWITCH STAND STYLE NO. 100-A

After severe tests at such locations, many of the leading roads have now adopted the 3-in-1 switch stand as standard. None of the claims we have made for this stand were disproved during these tests. The 3-in-1 was especially designed for use at the ends of double track and passing siding. Its three features, all combined in one compact housing, are:

1. The switch stand spindle is connected rigidly with the switch points, assuring positive target indication for position of switch points and rigid throw for hand operation.
2. Two automatic double-coil springs returning points after trailing train has passed.
3. A retarding oil-buffer preventing return of switch points between successive pairs of wheels.

This is the first switch stand to combine all these features in one compact housing; in hand throwing it *cannot* be closed and locked when an object intervenes between the points and the stock rail.

Many locations on your road need this switch stand. Write today for complete printed information about the 3-in-1.

RAMAPO AJAX CORPORATION

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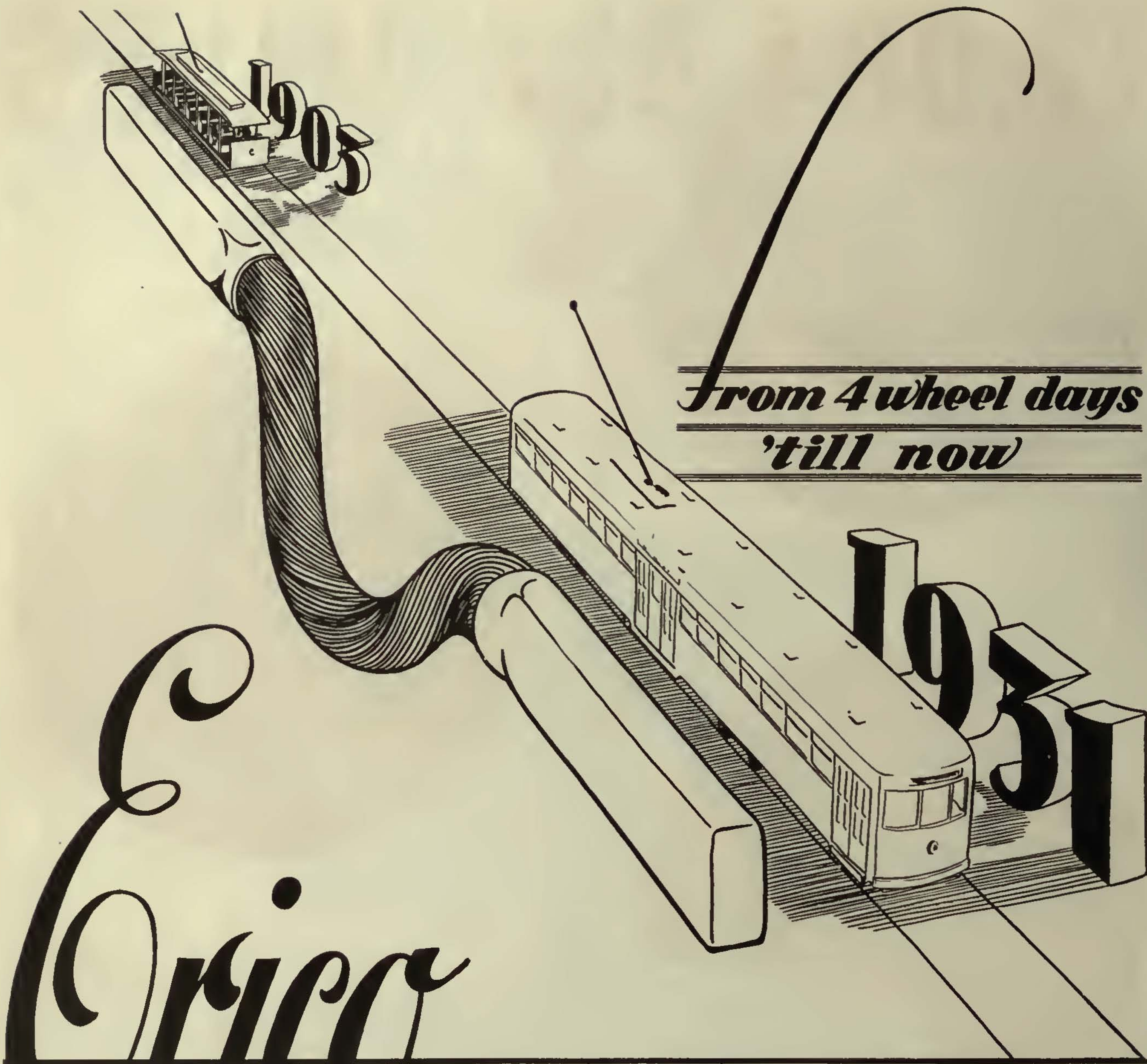
Sales Offices at Works and McCormick Bldg., Chicago Midland Bank Bldg., Cleveland, Ohio Builders Exchange Bldg., St. Paul Metropolitan Bank Building, Washington Union National Bank Building, Houston, Texas

Nine Racor Works: Hillburn, N. Y. Niagara Falls, N. Y. Chicago, Ill. East St. Louis, Ill. Superior, Wis. Pueblo, Col. Los Angeles, Cal. Seattle, Wash. Niagara Falls, Ont.



Erico RAIL BONDS HAVE HELPED TO MAKE THE CHANGE

Back in the days of the four wheel open cars, there appeared in Street Railway Journal for November 24, 1906, "The Electric Railway Improvement Co. is successfully introducing its method of welding rail bonds by current."—At that time development and early use of brazed bonds had preceded this announcement by three years.

As each succeeding year saw greater speeds, heavier cars and larger rails, the increasing important subject of rail bonding was met by improvements in Erico brazed bonds.

Today's problems in bonding recognize the sound engineering principles of welded bond efficiency pioneered by Erico 25 years ago. Erico now offers a complete line of welded bonds backed by the knowledge gained in our long experience with welded bonds. Call on us at any time or let us get together at Atlantic City—booth No. E-610.

THE ELECTRIC RAILWAY IMPROVEMENT CO.

2070 East 61st Place, Cleveland, Ohio.

Yellow

INTRODUCES

an entirely new conception of lightweight, low-cost, mass transportation » » »

A 40 PASSENGER Gas Mechanical Coach

Type **"40"**

A 44 PASSENGER Trolley Coach

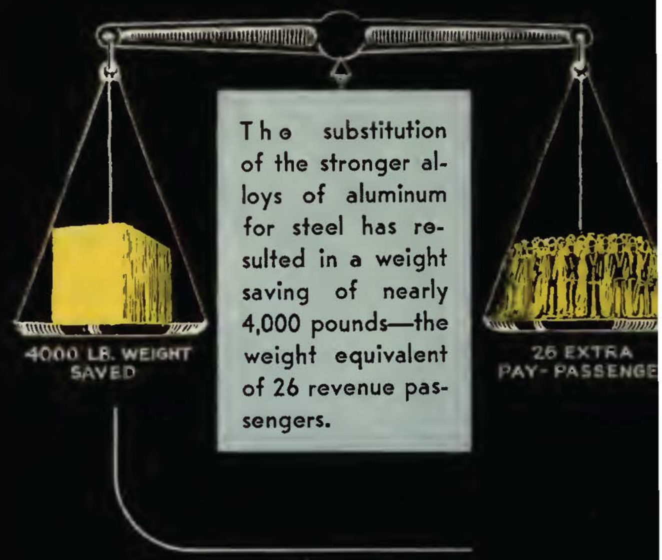
Type **"44"**

IN PRESENTING Type 40—a highly revolutionary advance in light weight, low cost mass transportation—Yellow has successfully assembled time tested mechanical units and proven engineering practices in a new and advanced way.

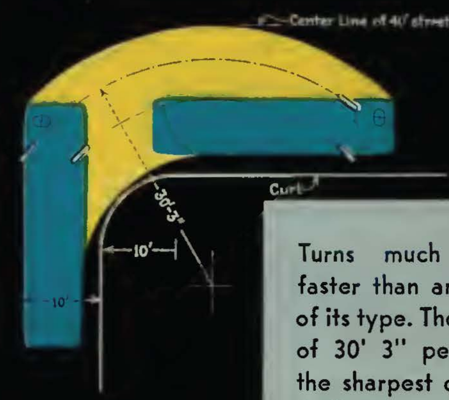
By substituting the stronger but lighter aluminum alloys for steel, nearly 4,000 lbs. of weight has been eliminated—the weight equivalent of 26 pay passengers. This means less weight per pay passenger and a 40 passenger vehicle that is lighter than a conventional 29 passenger coach, with gasoline, tire and oil mileage costs on a comparable level. Low operating costs are thus combined with greater revenue-producing possibilities.

In the rear—close coupled to the rear axle assembly—is the famous 150 h.p. "616" Yellow engine, with conventional clutch and transmission. This arrangement insures higher tractive efficiency . . . equalized tire loads . . . more space for passengers . . . more comfortable seating arrangement . . . better seat spacing . . . a full level floor . . . better headroom . . . insulation from engine heat and freedom from engine odors.

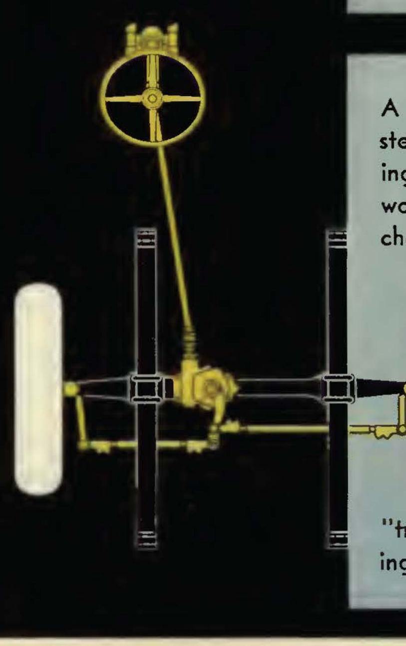
Provision is made for the quick (15 minutes) removal of power plant and the entire drive mechanism as a unit.



The substitution of the stronger alloys of aluminum for steel has resulted in a weight saving of nearly 4,000 pounds—the weight equivalent of 26 revenue passengers.



Turns much shorter and faster than any other coach of its type. The turning radius of 30' 3" permits rounding the sharpest corners without fouling opposing traffic lanes.



A new development in easy steering and simplified steering gear layout. Steering worm and sector are anchored to front axle with very short links direct to steering arms. The unsupported drag link is eliminated, steering play greatly reduced, shimmy and "tramp" eliminated, steering made extremely easy.

Exactly one-third the weight of the loaded vehicle comes on the front tires—two-thirds on the dual rears. Equalized tire loads insure longer tire mileage. Balanced distribution of weight insures exceptionally smooth, comfortable riding.

Note the level floor without ramps or kick-up and the use of large balloon tires all around.

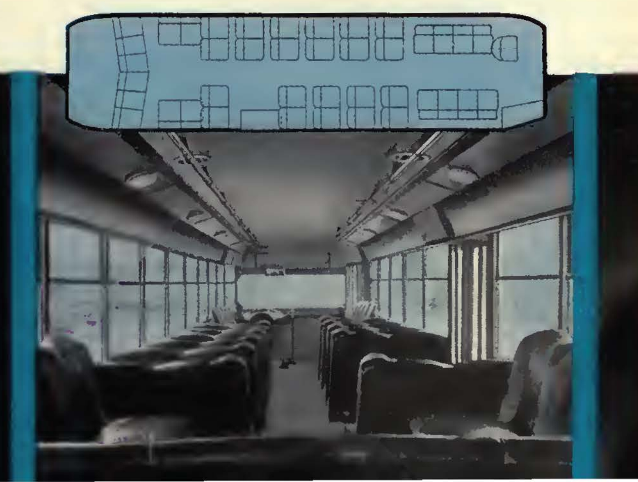
Type 40 can be brought to a smooth stop in its own length from a speed of 26 m.p.h.

There is exceptional provision for driver visibility. Shatter-proof glass is used front and rear.

MEASURE *the* MERITS

Fifteen outstanding features that build revenue and reduce operating costs.

1. Weight complete with gas, oil and water, only 15,500 pounds. Strong alloys of aluminum have replaced over 6,600 pounds of steel.
2. All metal construction. Fireproof. Lasting.
3. Perfect balance and equal distribution of weight on all tires.
4. A tremendous improvement in steering . . . a truly great engineering advance.
5. A perfectly level floor, without ramps or kick-ups.
6. Ample power—The famous "616" Yellow engine . . . 150 h.p.
7. Power plant and entire drive mechanism installed in rear of coach.
8. Complete insulation and freedom from engine odors, engine noise and engine heat.
9. Power plant and complete drive mechanism removable as a unit in less than 15 minutes.
10. Close coupled drive to axle reduces power losses and maintenance.
11. Short exhaust line . . . to rear of roof . . . reduces back pressure . . . eliminates offensive gases.
12. Real brakes—stops in its own length at 26 m.p.h.
13. Extremely short turning radius . . . 30′ 3″.
14. Wide comfortable seats and seat spacing—plus perfect vehicle balance—insures unusual riding comfort.
15. Exceptional visibility for driver and passengers.



WHERE aluminum alloys are substituted for steel, greater strength and far more liberal factors of safety are provided. It is in the elimination of unnecessary weight that Yellow has exercised the most rigid control. All body and frame sections are of aluminum. Seat weights are less than 20 pounds per passenger. Even the stanchions are of drawn aluminum tubing. These are finished in color and made tarnish-proof and grime-proof by the new Alumilite plating process. In addition to the direct savings in tire, gas and oil costs resulting from exceptionally light weight construction, there are many other advanced features of design that insure lower operating costs.

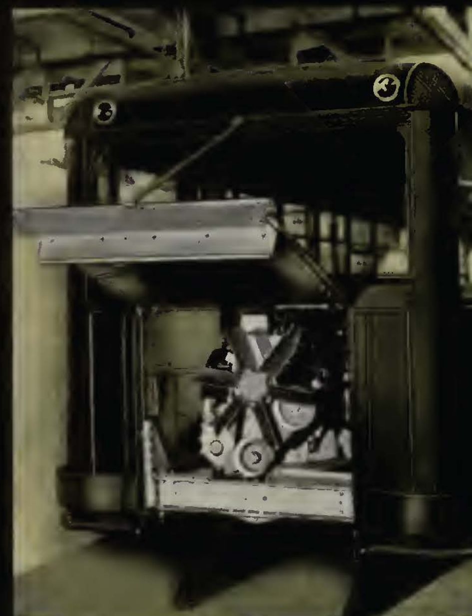
Perfect balance and distribution of load on front and rear axles not only reduces structural stresses but insures equal tire load and more uniform wear. The design also permits the use of the same size balloon tires all around, thus reducing tire inventory charges.

The power plant complete—that is, the engine, the transmission, the clutch and the differential—can be removed as a single unit in fifteen minutes. This is an important feature that greatly reduces layup time and maintenance labor costs because of the better accessibility.

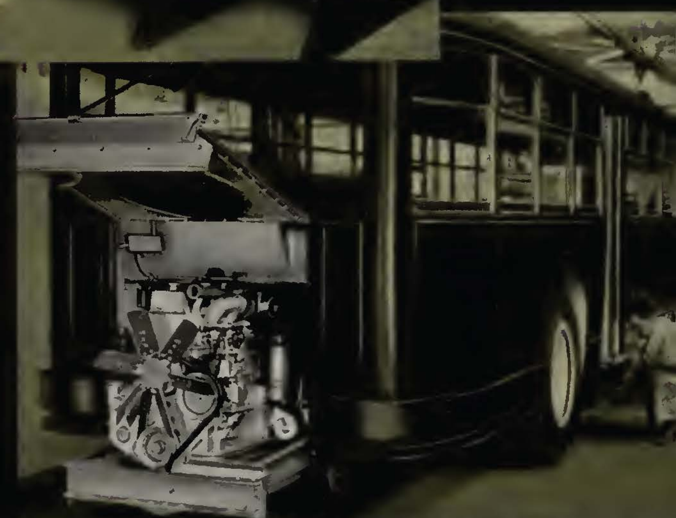
Mounting the power plant and the complete driving mechanism as a compact unit in the rear reduces tractive losses, length of drive, number of parts, weight and maintenance.

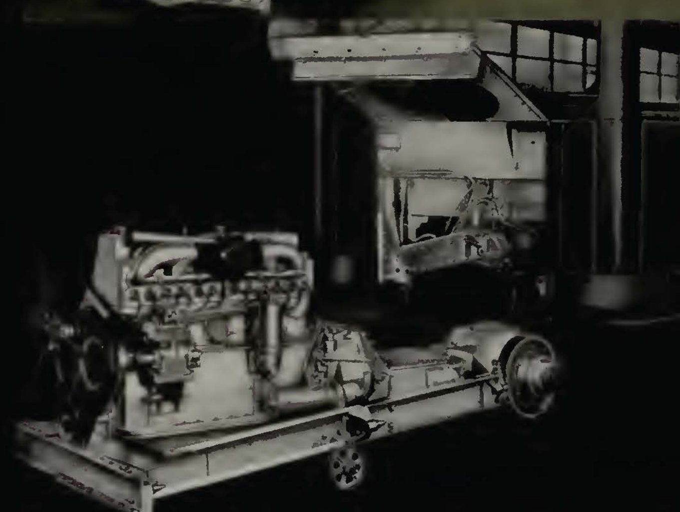
The all metal body construction provides longer life, simplified body maintenance and increases the interchangeability of units, with body parts and sections which are standardized and precision built over jigs and fixtures.

Supplementing these important operating ad-



The engine, tr mission, clutch differential can removed as a uni two men in fift minutes.

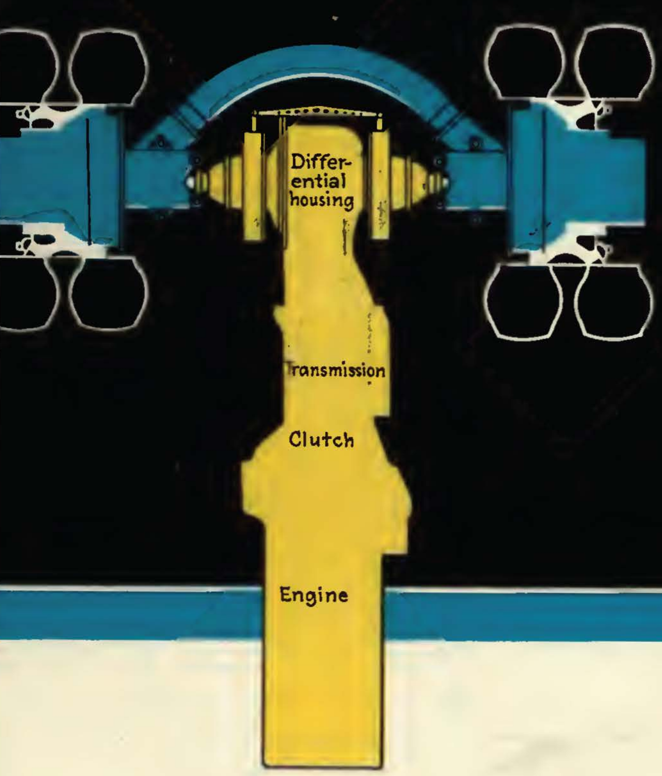




The entire driving mechanism is mounted on a portabl quick detachable sub-frame fitted with self-centering dowe which insure perfect automatic alignment.

Better heat dissipation from larger (20 in.) brake drums is secured by fastening them to aluminum alloy wheel centers having ventilating ribs.

The illustrations above show the dead rear axle with its wheel hubs and brake mechanism. Pulling out the full floating rear axle shafts leaves the differential, transmission, clutch and engine free for easy removal as a single unit.



vantages are many revenue building features which contribute to the safety, the comfort and the good will of passengers.

Of particular importance to passenger comfort is the complete freedom from noxious gas and engine odors and insulation from engine heat and vibration. Passenger comfort is further insured by wide, unobstructed aisles, more comfortable seating arrangement, wider seat spacing, exceptional visibility, unusual headroom, a full level floor, large, easy riding balloon tires, deep entrance and exit wells and ample width entrance and exit doors for easy loading and unloading.

Contributing to safer operation are exceptional visibility for the driver, the new General Motors development in simplified steering which eliminates all possibility of shimmy or tramp and prevents transmission of road shocks or vibration to the steering wheel at any speed. The combination of easy, accurate steering and short turning radius in so large a vehicle is causing universal enthusiasm among drivers. The larger capacity brakes give cooler, better acting, noiseless braking and a sure, quick deceleration with lower brake pressure.

The use of cast aluminum alloy wheel centers with ventilating ribs which enclose the brake drums insures cooler braking surface and at the same time permits the use of large diameter (20") brake drums. The braking system naturally includes Yellow's duplex type brake mechanism with four groove-ventilated 4-inch brake blocks on aluminum shoes.

Thus, by combining in a single design, extraordinary light weight, increased carrying capacity, exceptionally low operating costs, higher revenue possibilities and greater passenger appeal, Yellow has once again made an important contribution to the progress of the industry.

BRIEF SPECIFICATIONS

Wheel base	213 in.
Length over all, including bumpers	33 ft.
Width over all, including tires	96 in.
Head room	78 in.
Engine	150 h.p.
Generator	12 V. 750 Watt
Transmission	4 speed
Brakes	4 wheel air—20 in. gun iron drums—4 in. wide shoes
Brakes, emergency	2 drums on drive shafts
Tires, balloon, front and rear	9.75
Turning radius	30 ft. 3 in.
Total weight, including gas, oil, water	15,500 lbs.

Yellow Type "44" Trolley Coach

Seating 44 passengers

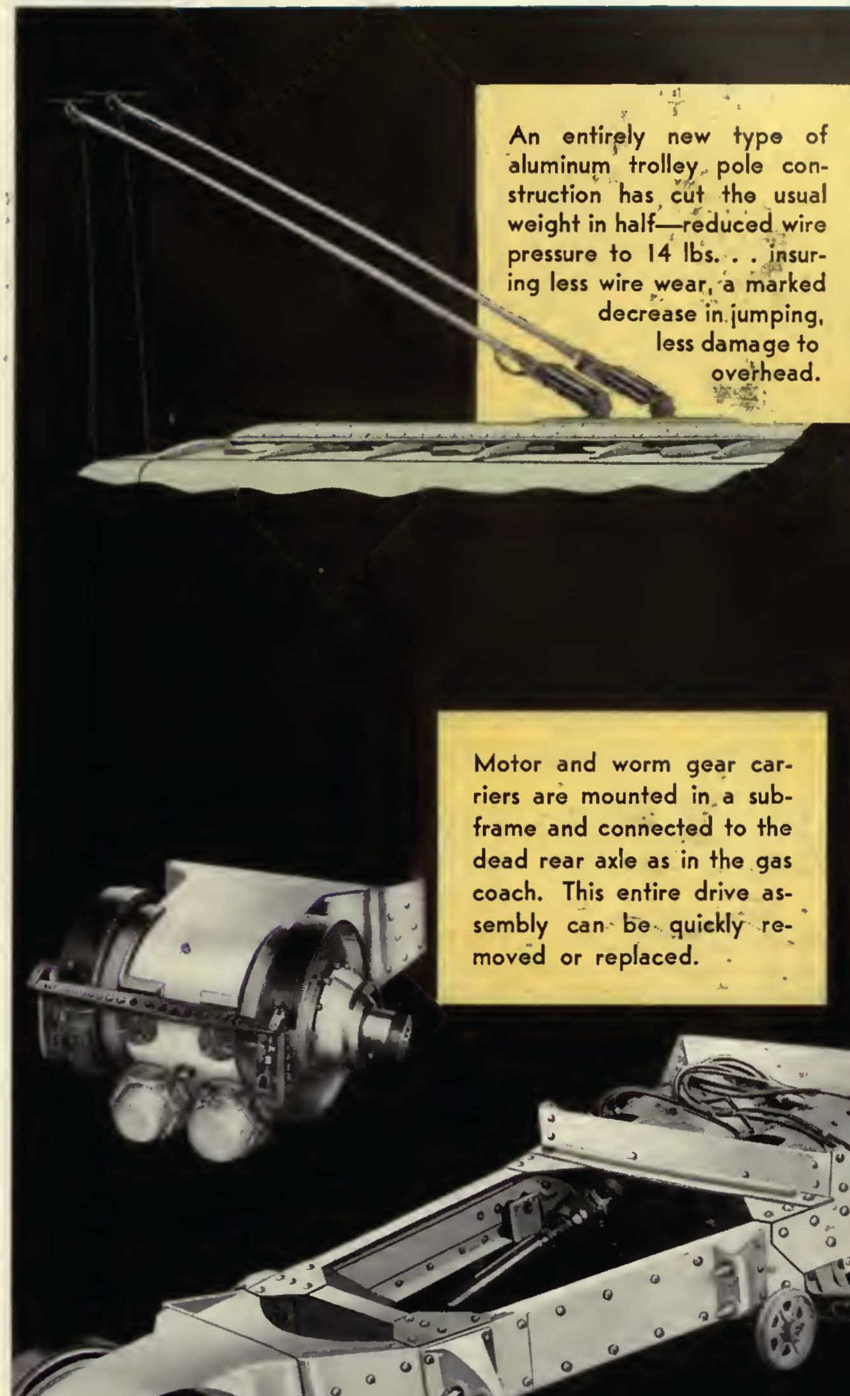
THE Trolley Coach has the same basic design and construction as the Gas Mechanical Coach. Only the power plants and related equipment are different. Otherwise dimensions and weights are identical and virtually all mechanical units and body sections are interchangeable. . . . Conventional engineering practices have been combined with advanced methods of either assembly or design to provide exceptionally low operating and maintenance costs and a new conception of performance and earning power.

THE Yellow Type 44 Trolley Coach has the same distinctive features of construction as the Type 40 Gas Mechani-l Coach—there is the same extensive use of uminum alloys, the same light weight and erfect balance of load, the rear mounting of ual motors and drive mechanism, quickly re-ovable as a single unit, the same full level oor, the new type of easy steering, the venti-ted aluminum alloy wheel centers, the greater rake area and braking power with 20-inch rums.

hese features have been combined with a dically new centralized underbody control stem of extreme simplicity, and a new type f light weight trolley pole construction that ngineers have been striving for years to per-ct. This new type of drawn aluminum trolley ole construction cuts the usual pole weight half, reduces wire pressure to 14 pounds, sures less wire wear, less damage to over-ead, less sparking, permits taking crossovers higher speeds, with less risk of jumping.

he lighter, more balanced weight of the oles and easier action on the wire eliminates oof noise, allows the use of a lighter trolley ase and permits the retriever to operate far ore quickly, thus preventing damage to over-ead and reducing rope wear.

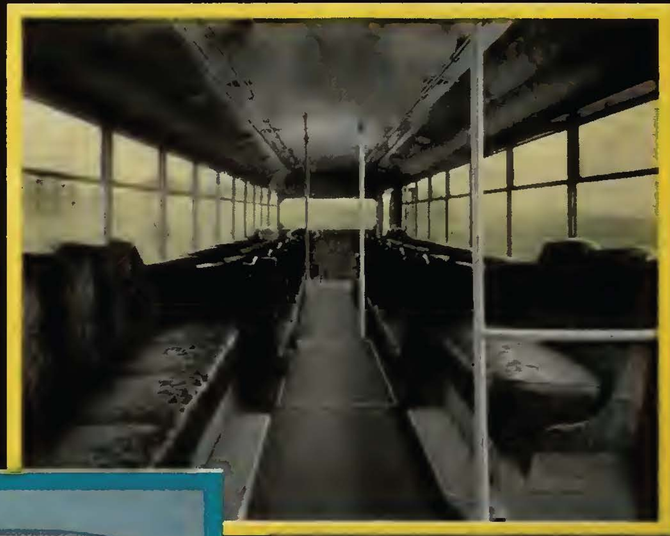
ll the electrical control equipment is com-actly assembled, in an insulated container, nder the center of the body where it is easily ccessible and fully protected. It is operated cable or rod controls from the driver's at. The lead-ins from the roof are carried rough one of the stanchions direct to the ntroller and three-fourths the usual trolley oach wiring has been eliminated.



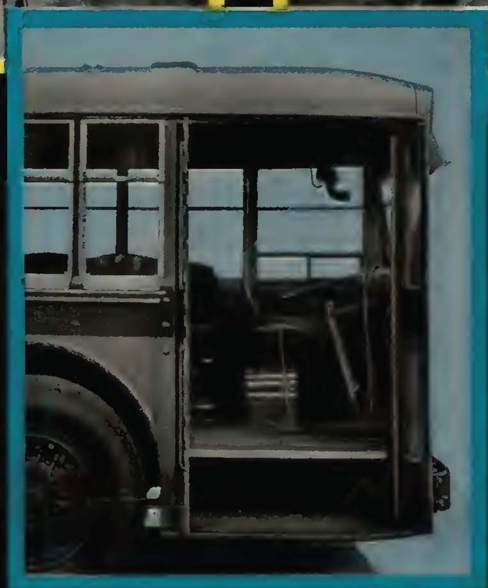
An entirely new type of aluminum trolley pole construction has cut the usual weight in half—reduced wire pressure to 14 lbs. . . insuring less wire wear, a marked decrease in jumping, less damage to overhead.

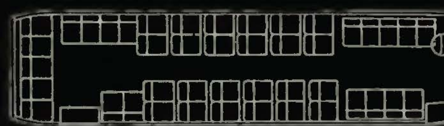
Motor and worm gear carriers are mounted in a subframe and connected to the dead rear axle as in the gas coach. This entire drive assembly can be quickly removed or replaced.

Motors and electrical equipment as specified. General dimensions, construction, weight, tire sizes, brakes and steering, same as in gas mechanical coach Type 40. Detail specifications on request.



The rear mounting of the two motors insures ideal weight distribution—equalized loads, easier steering. Two-thirds the weight of the loaded vehicle comes on the dual rear tires.





This wide entrance door is also available on the Gas Mechanical Coach Type 40.

A 3 h.p. auxiliary motor drives the air compressor, an automotive type generator and the ventilating blower which circulates clean cool air through the control boxes.

Motors are independently ventilated by sirocco fans on each motor shaft with air drawn from roof intakes past motor poles and armatures. This thorough ventilation reduces the chemical decomposition of air or "ozonation," thus protecting the electrical contact surfaces and insuring dependable operation.

And supplementing these major design improvements has been the rigid scientific elimination of all surplus weight, so that new low levels of operating costs could be realized and new and higher standards of performance achieved. The marked reduction in power and tire mileage costs, the great improvement in acceleration and deceleration and ease of handling, the practical provision for low cost maintenance, are all advancements which the industry has been anxiously demanding.

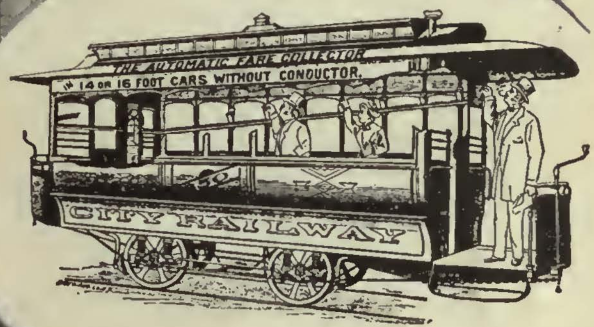
Yellow Type 44 is another great tribute to modern engineering—and an entirely new conception of the performance and earning possibilities of the trolley coach.

YELLOW COACH

GENERAL MOTORS TRUCK CO., *Pontiac, Michigan*

Subsidiary of Yellow Truck & Coach Mfg. Co.

Modern fare collection is *automatic*!



An 1885 fare collecting device —considered quite satisfactory some forty years ago—for cars *sixteen feet in length.*

PEREY Coinpassors are modernizing fare collection on street cars and buses in all parts of the world. They make fare collection automatic.

Congestion on platforms is avoided. Passengers enter the car quickly, without confusion.

Coinpassors occupy little space, leaving ample room on platform for passengers. Delays in closing doors and getting moving, even with crowds, are eliminated.

With Perey Coinpassors, one-man operation is practical on any size and type car. Platform men remain at their posts without the responsibilities of fare collection. Their only duty as far as fares are concerned is to make change and issue transfers.

And this modern fare collector is safe. Four smooth arms, without angles or corners, move easily as passengers walk through.

And every rider pays his fare—no one can evade the Coinpassor. Every fare is registered by the passenger himself, on a built-in, tamper-proof recording meter, as he passes through the turnstile. Here indeed is protection to revenue.

Let us tell you more about this modern—automatic—method of fare collection.

View showing Perey Coinpassor installed in one of the 150 new coaches purchased by the Brooklyn Bus Corporation.

Perey Turnstiles also include the Perey Coinpassor—the coin controlled turnstile for collecting fares at Subway, Elevated Railway and Pre-payment stations, Perey Passimeters for use in connection with Cashiers' Booths, Perey Electric Coin Boxes and the new Perey Bus Coinpassor. See them at our Booth No. C-319 at A.E.R.A. Exhibit, Atlantic City, or write for full details.

PEREY MANUFACTURING CO., Inc.

101 Park Avenue, New York

ROEBLING

Right from the Trolley or Contact Wire overhead, clear through to the Power Cables underground—every type of wire and cable used by electric railways is included in the Roebling Line. On the one hand there is Roebling Cable for pantographs—and at the other extreme there are Parkway Cables. A glance at the list to the right will give you a fair idea of the diversity of Roebling Wires and Cables for electric railway use.

We would welcome an opportunity to send you further information and to quote on your requirements. The nearest office below is at your service.

JOHN A. ROEBLING'S SONS COMPANY · TRENTON, N. J.
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ELECTRICAL WIRES AND CABLES

Nerve-racking noise

Floors, sides, rear end and roof deck of Car No. 4149 of the Cleveland Railway Company being insulated and acoustically treated with J-M Sound Absorbing Materials.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville**


15 MANHATTAN BRIDGE
BROOKLYN BUS CORP.
200
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MODEL "40"
Twin Coach
38-40 PASSENGER

As New York Goes— So Goes The Nation

IN 1927 WE stated in our Sales efforts that we believed that motor coaches with motors out in front of the driver would become obsolete.

WE ALSO declared motor coaches must be standardized in design—eliminating *successive* new models the causes of *excessive* depreciation.

NEW YORK—through great B. M. T. Corp.—has purchased 150 Twin Coaches—and New York always buys, in wearing apparel, motor cars, architecture or what not, only that which is most modern and the last word!

WE ASK YOU for a fair answer! Has not Frank R. Fageol's foresight and ability again been indisputably proven?

TRANSPORTATION economics are the corner stones of his bustling factory at Kent, conceded everywhere to be about the busiest plant folks run across these days.

As Frank Fageol Leads—
So Follows An Industry

1927 TWINS—Approved As A Real Advance

1928 " —Recognized As A New Standard

1929 " —Shattering Old Depreciation Beliefs

1930 " —Unchanged In Basic Design

1931 " —The Most Imitated Coaches In America

★ **Present Life Will At Least Be Doubled**
★ **Older Units Are Hard To Tell From The New**
★ **All Improvements Designed For Application To Units In Service**

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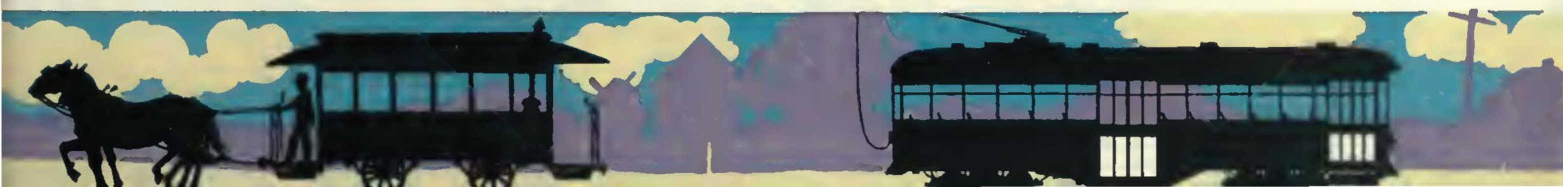


MODELS 20 & 30 — Twin Coach BY F. R. FAGEOL KENT, OHIO — 20-27 PASSENGER

Again ART RATTAN *Seats are selected*

This Time for
Brooklyn Bus Corporation's
Severe Service in
Greater NEW YORK

When it came to the selection of seats for the extremely severe service of the Brooklyn Bus Corporation in Greater New York—Art Rattan seats were picked for the 150 Twin Coaches ordered by B.M.T.

Again Art Rattan seats are the first choice for Buses which will be subjected to heavy traffic and hard wear. And Again Art Rattan low maintenance costs are responsible for their selection on a tough assignment.

Whether you order 10 or 100 Buses you can rely on lower maintenance costs and continued rider patronage with Art Rattan Seats. Art Rattan not only builds durable, comfortable seats but originates designs which later have a habit of becoming extremely popular.

Why not give your Buses the added advantages that Art Rattan Seats offer—in comfort, in durability, in low upkeep.

ART RATTAN WORKS, Inc

CLEVELAND, OHIO OAKLAND, CALIFORNIA

BUILDERS OF DE LUXE BUS AND STREET CAR SEATS

THEN

· NOW ·

Times have changed. The brake shoe needed to stop this car would *not* do in today's service.

TODAY'S service is composed of fast starts and quick stops. A greater demand is made on the braking equipment and a better brake shoe is needed. Diamond-S brake shoes answer the need of modern conditions. They embody the results of years of experiments and experience. For the best and most economical results, use Diamond-S brake shoes.

THE AMERICAN BRAKE SHOE AND FOUNDRY COMPANY

230 PARK AVE., NEW YORK

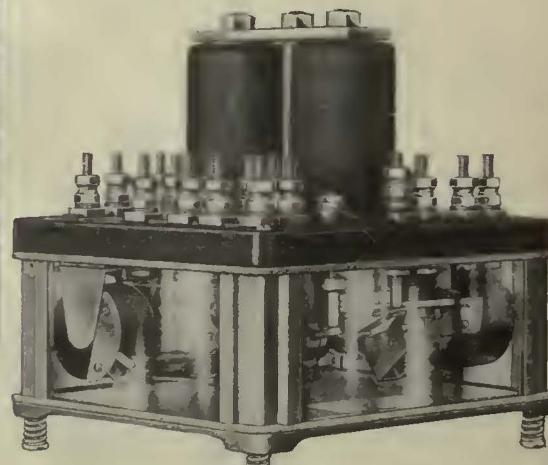
332 SO. MICHIGAN AVE., CHICAGO

TRACK AND SIGNAL MATERIALS

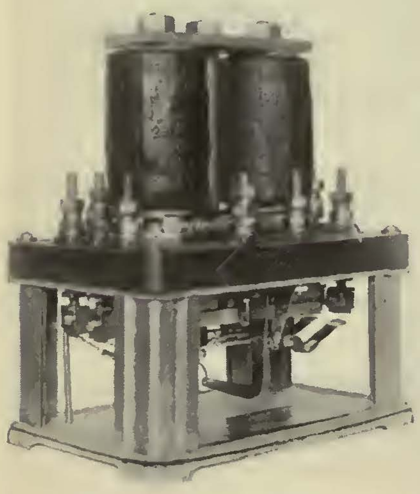
Crossings; Frogs; Switches; Gauge Rods; Reflex Signs; Flashing Light Signals; Track Instruments; Relays; Castings; and other Accessories

Two Directional Fusticlo Rail Contactors Used as Combination Cut-Outs and Starters. Also Shows Parkway Outlets.

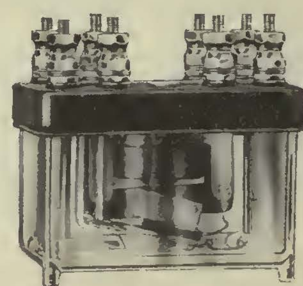
We offer you materials of the highest quality for your signal installations. Long years of service have proven the efficiency, durability and quality of our products. Now used on many of the largest railroads in this and foreign countries.



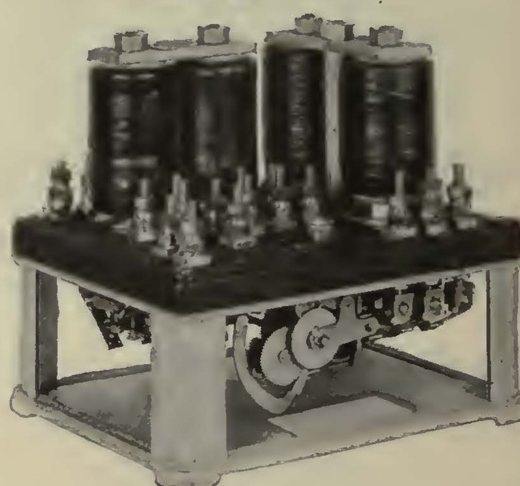
C-7 Automatic Time Release



C-1 Flashing Relay



D-1 Power Transfer Relay



C-3 Flashing Time Relay

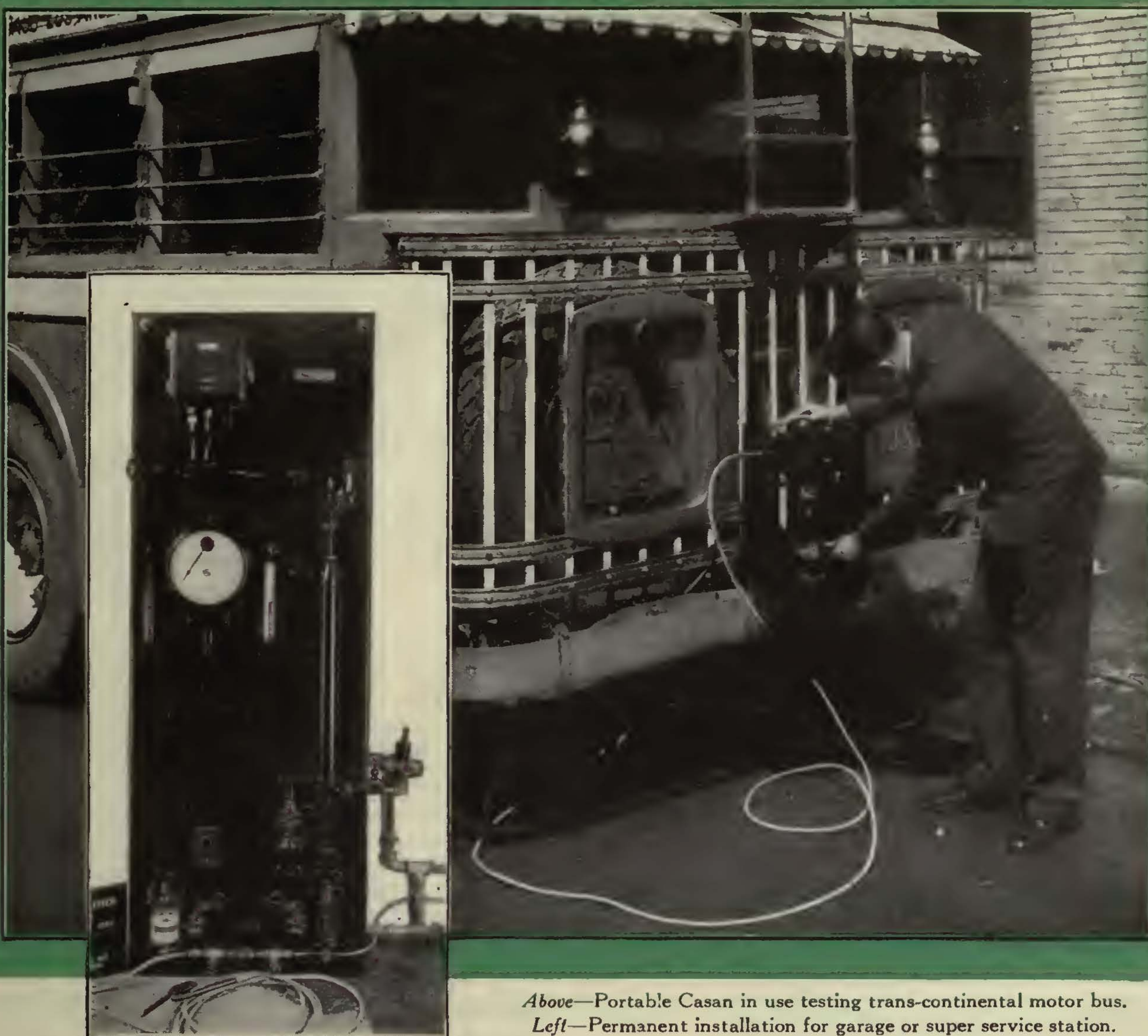
Reflector Sign

Flashing Lights With Battery Case

Reflector Switch Lamp

Further information will be furnished on request.

LOUISVILLE FROG, SWITCH & SIGNAL CO., Louisville, Ky.



Above—Portable Casan in use testing trans-continental motor bus.
Left—Permanent installation for garage or super service station.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INSEPARABLY linked with the development of Steel is the name "Carnegie." For nearly three-quarters of a century, Carnegie Steel Company has engaged in the manufacture of Steel—experimenting, learning, serving. The knowledge accumulated during this time, and the mechanical, metallurgical and engineering resources of this company are yours to summon. A dependable source of supply plays no small part in the success of a product or of an enterprise.
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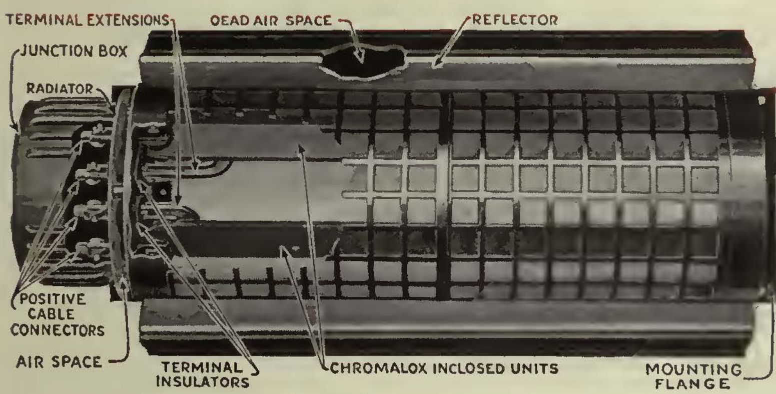
Two Great Advances in Car Heating Equipment



"UTILITY" Reflector TYPE Car Heater WITH Chromalox Enclosed Units

Gives Full Use of Electrical Energy Input.

Directs Maximum Amount of Heat to Lower Part of Car.

Heats the Feet and Not the Seat.

The Greatest Improvement Ever Made in Electrical Car Heaters.

"UTILITY-ARCOSTAT" Temperature Control

Regulates Within One Degree Fahrenheit of Any Predetermined Temperature.

Permanent Operating Point.

Highly Sensitive.

In Actual Service, Through Two Heating Seasons, of 1197 Arcostats Tested and Examined, Only One Out of the Entire Lot Failed to Function 100 Per Cent.

Write at once for full information

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Railway Utility Co.

Makers of Heating and Ventilating Equipment for Electric and Steam Railway Cars, Trackless Trolleys and Buses

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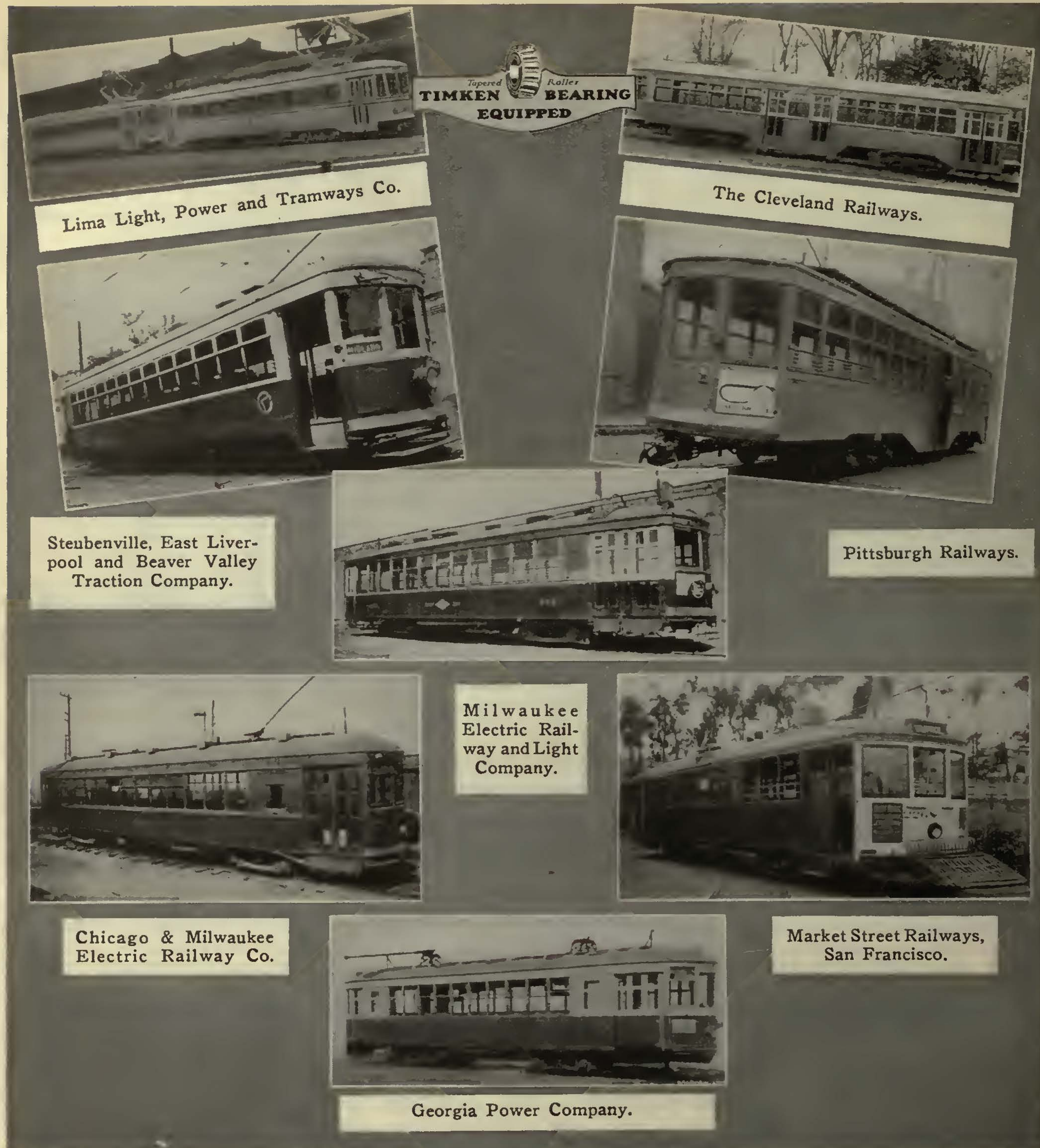
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Milwaukee Electric Railway and Light Company.
Chicago & Milwaukee Electric Railway Co.
Market Street Railways, San Francisco.
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Now . . .

the Fargo Coach line is exceptionally complete!

with the introduction of . . .

The new 29-passenger Parlor Coach with reclining seats and all-metal body—weighing complete less than 13,000 pounds . . . And the 33-passenger circulating-load type Street Car of like construction . . . Both many thousands of pounds lighter than vehicles of comparable capacity, and setting startling standards of performance. Replace dead-weight with paying passengers and benefit doubly—through lowered operating expense and added revenue from the additional passengers carried.

Parlor Coach, with reclining seats, has a capacity of 29 passengers—35 with auxiliary aisle seats; with non-reclining seats, a capacity of 33—with auxiliary seats 40. Overall length of coach is 30 feet.

Street Car seats 33 passengers and has aisle and loading well space for an unusually large number of standees. Circulating-load features assure rapid handling of passengers.

▲ ▲ ▲ *and*

Fargo 21-passenger Street Car

Seats for 21 passengers . . . Two large loading wells and 22-inch aisle (measured at seat cushions) accommodate upwards of 40 standees in comfort . . . Front entrance and rear exit doors—each 24 inches in clear—for rapid passenger circulation.

▲ ▲ ▲ *and*

Fargo 21-passenger Parlor Coach

Seats for 21-25 passengers. All, except auxiliary and rear section, are reclining type with 3-position adjustment . . . Interior baggage lofts are commodious and sturdy. Interior appointments finished in a distinctive modern motif.

and Fargo Sixes ▲ ▲ ▲

21-passenger Street Car

Seats for 21 passengers; conventional design throughout, with 6-cylinder 96-horsepower engine, full-floating rear axle, 10-inch double-drop frame, 4-speed transmission, weatherproof internal hydraulic brakes and many other modern features.

16-passenger Parlor Car

Seats for 16 passengers. Entrance door of one-piece type. Comfortable seats of the chair type. Attractive interior. 6-cylinder 96-horsepower engine and other features found in the Street Car shown above.

FOR COMPLETE INFORMATION WRITE TO

FARGO MOTOR CORPORATION

DETROIT, MICHIGAN

DIVISION OF CHRYSLER CORPORATION

E-1151 PRINTED IN U.S.A.

The first Thermit advertisement appeared July 2, 1904

STREET RAILWAY JOURNAL 181

THE GOLDSCHMIDT

PATENT

Thermit Rail Welding Process

CHEAPEST QUICKEST SIMPLEST BEST

No Distortion of Line **No Mutilation of Rail**

Joints on Curves as Perfect as on Tangents

One or Thousands of joints made with same ratio of economy
Old and worn joints quickly and permanently repaired
Rail ends actually amalgamated together.
Mechanical strength equal to rail itself. Electrical conductivity higher.
JOINT WEARS AS LONG as rail. System thoroughly proven.

See Exhibit, Metal Pavilion, St. Louis Exposition

Daily Demonstration, St. Louis Exposition, 4 P. M.

THERMIT RAIL WELDING IN HOLYOKE, MASS.

Goldshmidt Thermit Co.

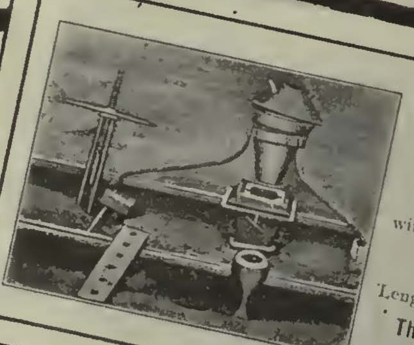
43 EXCHANGE PLACE, NEW YORK CITY

PARENT WORKS, FOUNDED 1847
GERMANY TH. GOLDSCHMIDT, Essen-Ruhr

GREAT BRITAIN Thermit, Limited, 27 Martin's Lane, Cannon Street, London, E. C.
FRANCE C. Delachaux, 67 Rue de Province, Paris
CANADA Wm. Abbott, 334 St. James Street, Montreal

IN THE beginning it was only the modest quarter-page shown below. But shortly afterward the more impressive display shown at the left was published. This was at the time when the American Electric Railway Association held its convention at the St. Louis World's Fair, in the Fall of 1904.

Read the points which they stressed in those first advertisements twenty-seven years ago. Thermit and its advantages are substantially the same today as they were then.



Thermit Registered Trade-Mark Rail Joint

(DR. HANS GOLDSCHMIDT'S PATENT)

A continuous rail with perfect and permanent electric conductivity, without bulky equipment or power supplied from outside.
Entire outfit consists of Magnesite Crucible and Sand Mould.
Equally applicable to Old Rails or New Rails, Single Joints or Lengths of Track.
Thermit Welding Portions made up to suit each section by

GOLDSCHMIDT THERMIT CO., 43 Exchange Pl., New York

THERMIT WELDING under traffic

Removable heating cover in place during preheating

First tried-out in 1928 on the Third Avenue Railway Lines, this method has been perfected by our engineers through almost continuous experimental installations on the tracks of several other companies where different conditions had to be met and overcome. Thousands of joints were welded during the course of these developments.

The process was offered for general use through our public announcement several months ago. Already a large number of roads have taken it up.

Thermit-Welding-under-traffic, as accomplished by this process, requires no bridges, no side-tracks, no other special equipment for taking the cars off the rail. The cars continue in operation all during the process of welding. "Three-minutes" has been established as the average time required to keep the cars off the joint, just when the weld is being "poured." The top section of the mold is then removed, and the cars proceed in the regular way. By a new mold design and a patented method of holding the rail ends, the cars are enabled to run directly on the rail during the entire process except for that three minutes of actual welding time. The process itself is just as easy and just as simple as the standard method of Thermit Rail Welding.

While this process of rail-welding-under-traffic is covered by patents and patent applications, it is available to users of Thermit without additional charge.

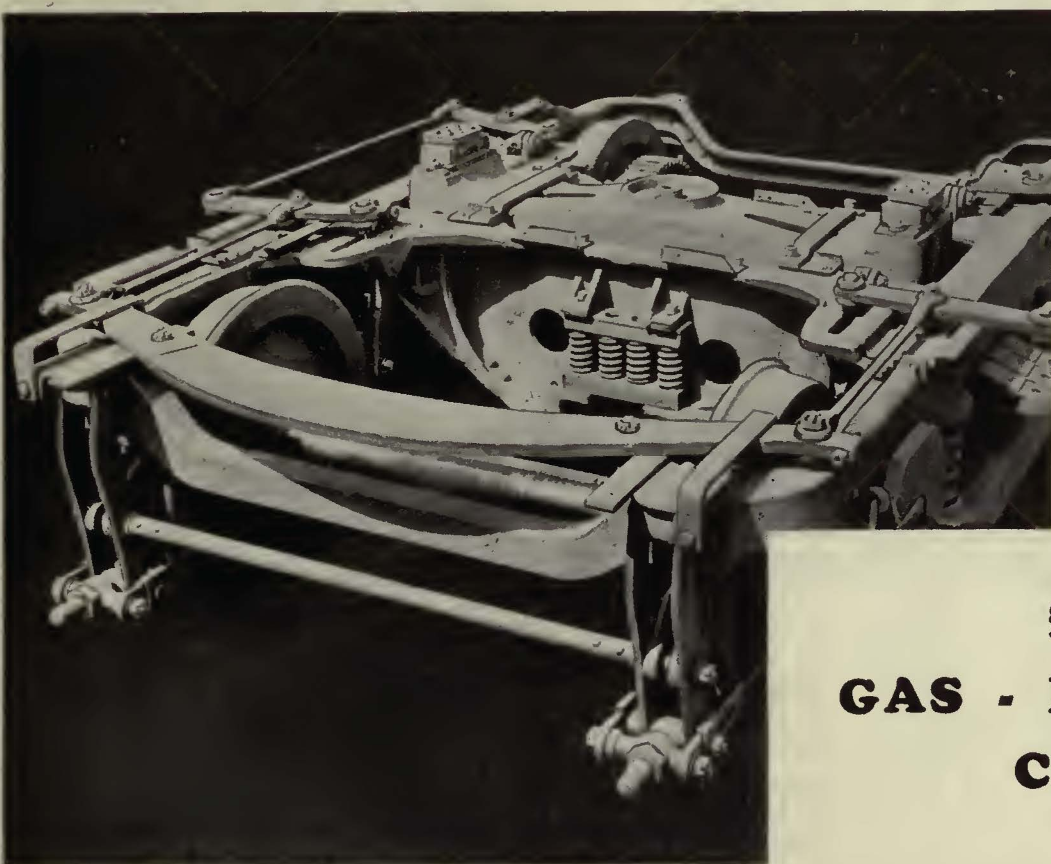
Ask any Metal & Thermit representative, or see us at the Convention, for full details, illustrations and estimates on this or any other phase of Thermit Welding.

Car operating over joint during preheating

The METAL & THERMIT CORPORATION

120 Broadway, New York, N. Y.

Pittsburgh Chicago Albany So. San Francisco Toronto



SIMPLEX CLASP BRAKES

for GAS - ELECTRIC CARS

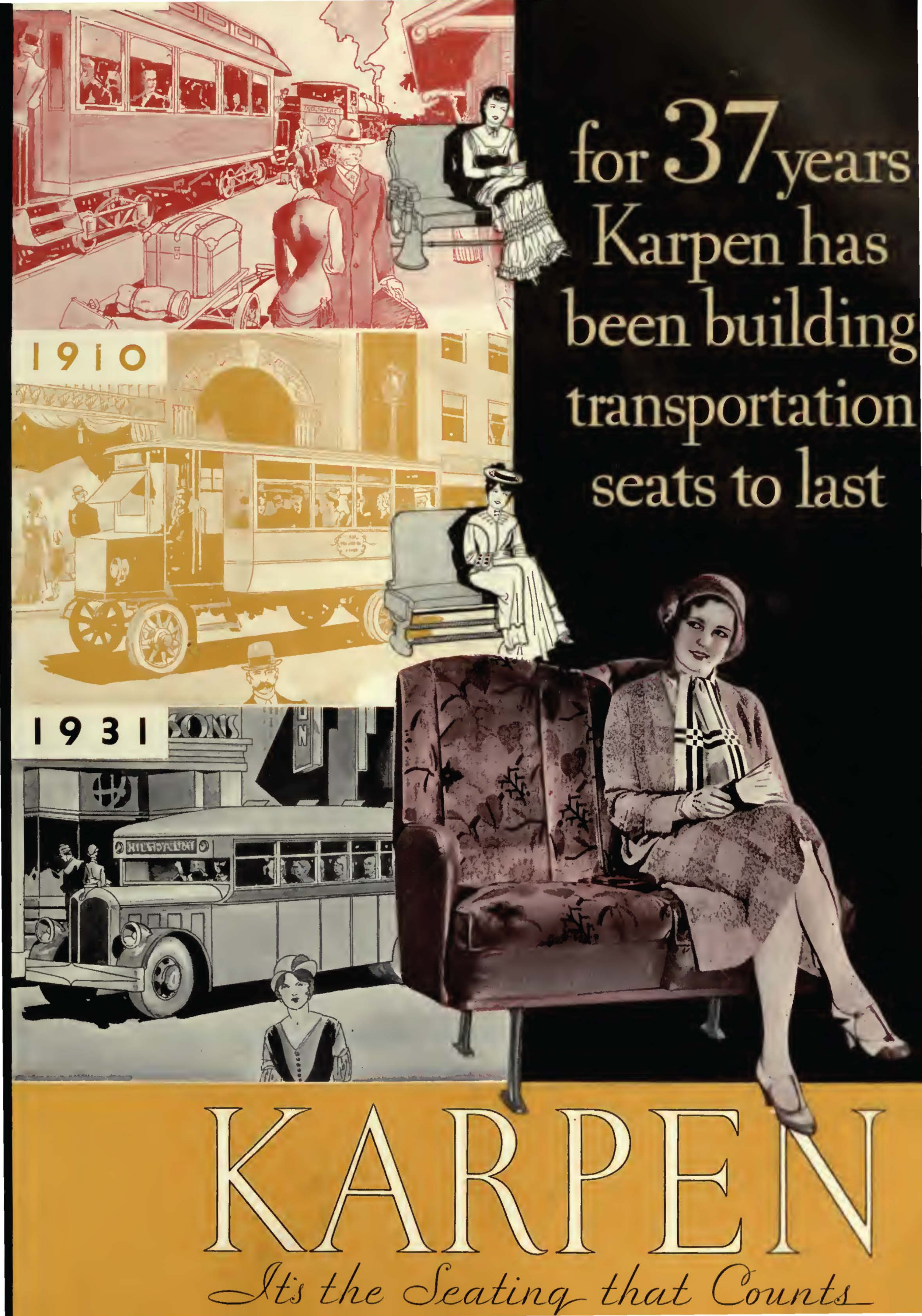
RAILROADS of the country are using American Steel Foundries Clasp Brakes for passenger equipment.

Greater retardation; reduction in brake shoe wear; desirable balancing of braking forces—all have proved the value of Clasp Brakes.

Gas-electric cars have increased in weight and size until they now are frequently larger than standard passenger cars. For these reasons, they, too, need Simplex Clasp Brakes. Clasp Brakes are applicable to Gas-Electric Car Trucks and should be included in your specifications.

AMERICAN STEEL FOUNDRIES

NEW YORK CHICAGO ST. LOUIS



1910
1931
for 37 years Karpen has been building transportation seats to last
KARPEN
It's the Seating that Counts

The SAFETY CAR . . . CONTROL EQUIPMENT

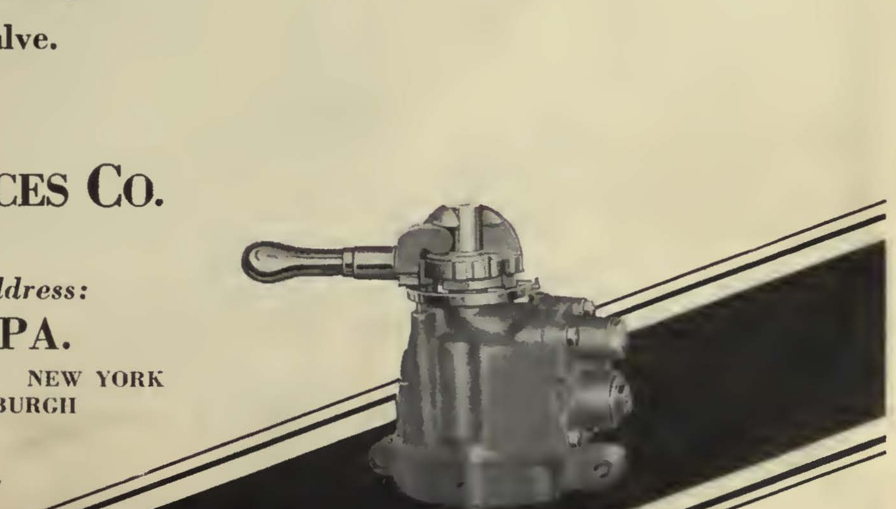
—on Display at the A.E.R.A. Convention

WE invite you to visit our exhibit at Atlantic City (space E-570) and let one of our representatives demonstrate to you the lastest improvements that help to speed transportation SAFELY — including the NEW Self-Lapping Brake Valve.

SAFETY CAR DEVICES CO.
OF ST. LOUIS, MO.

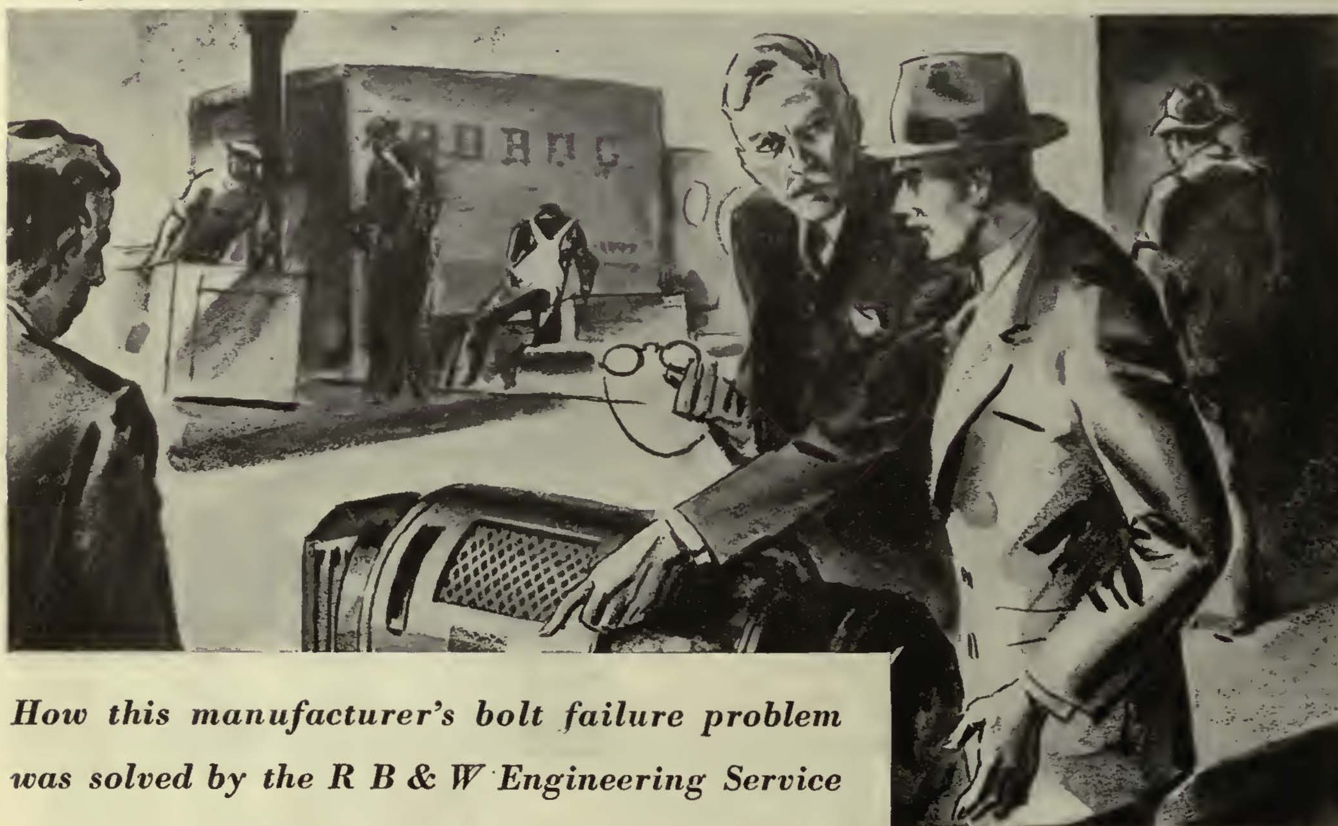
Postal and Telegraphic Address:
WILMERDING, PA.

CHICAGO SAN FRANCISCO NEW YORK
WASHINGTON PITTSBURGH



3144

HE FORGOT...
TO FIGURE INITIAL STRESS



How this manufacturer's bolt failure problem was solved by the R B & W Engineering Service

"Bolts still failing. Rush new shipment. Must have higher tensile strength." Thus wired a customer. And then the R B & W Engineering Service got busy.

The customer was a builder of a portable electric machine used in construction work. He was using bolts to attach the heavy machine assembly to the frame of a trailer truck. We had tested specimens of his bolts before shipment and they had shown 86,000 pounds, so the next thing to do was to make an on-the-spot investigation.

We discovered that the customer, when estimating the strength of the bolts he needed, had forgotten to allow for the initial stress placed on the bolts when his machine was assembled. The bolting together of the parts exerted a stress, which, when increased by service loads, exceeded the capacity of his bolts. A slight increase in diameter of the bolts eliminated his trouble.

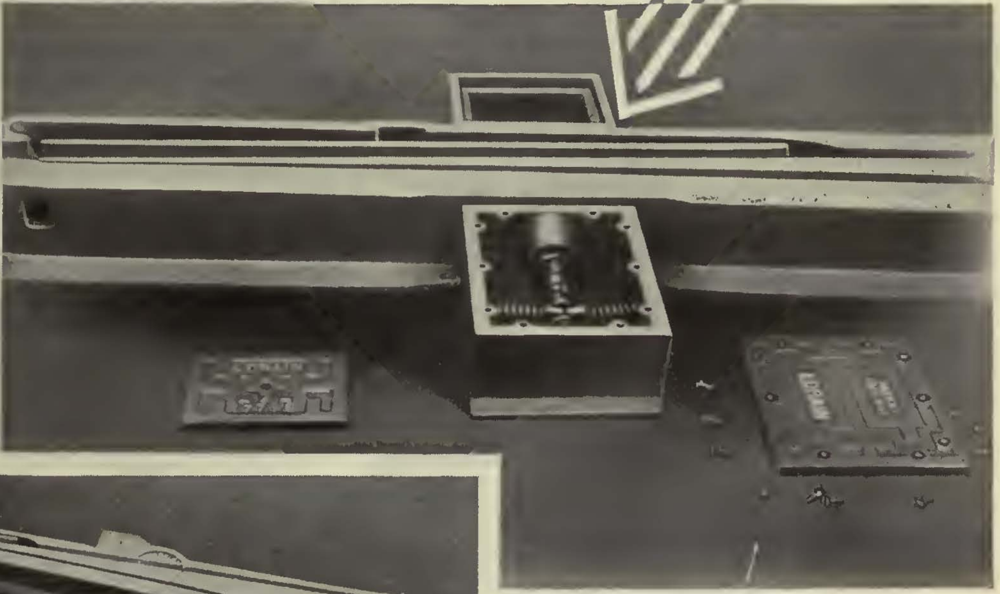
The skilled engineer, and the layman as well, can utilize the specialized knowledge of bolting material available without obligation through the R B & W Engineering Service. Send us your problems.

EMPIRE

RUSSELL, BURDSALL & WARD BOLT & NUT CO.

ROCK FALLS, ILL. PORT CHESTER, N. Y. CORAOPOLIS, PA.

Sales Offices at Philadelphia, Detroit, Chicago, San Francisco, Los Angeles, Seattle, Portland, Ore.



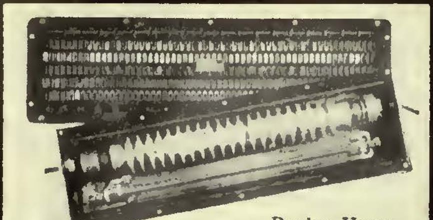
In 1889 they said:

" . . . . electricity now does practically everything except heat the car and it is not too much to expect that problem may be solved in the future"

from Street Railway Journal - 1889

CONSOLIDATED CAR HEATING COMPANY

JUST three years later—in 1892—the Consolidated Car Heating Company solved the problem by inventing and building its first electric car heater. We have all come a long way since 1889, when the above question appeared in the Journal, and "Consolidated" has led the way. The modern Consolidated Equipment shown on the following pages offers tangible evidence of outstanding progress.



Duplex Heater

Consolidated Heaters.

Styles and types to meet every requirement of modern electric railway and bus operation.

Pneumatic Door Operator
(Differential Type)

Consolidated Pneumatic Door Operators and Treadles.

Used on the finest electric railway cars and buses.

Electric Buzzer

Consolidated Buzzers, Push Buttons and other Car Signaling Devices.

For those who want perfection in equipment details.

Thermostat

Consolidated Thermostatic Control of Car Heaters.

The accepted standard of the industry.

NEW YORK
ALBANY
CHICAGO

CONSOLIDATED CAR-HEATING CO., INC.

MODERN METHODS

of Fare Collection speed operations and ensure Full Revenue thru Instantaneous Registration

An Indicator of Transportation Progress

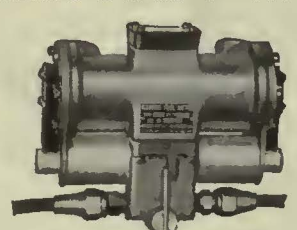
The Coin automatically and visibly records the fare on both the fare box and register.

Modern transportation *demands* instantaneous fare registration. Every improvement that tends to greater speed in passenger handling has a logical place in today's operations.

Johnson Electric Fare Boxes not only eliminate delays in fare collection but ensure full and accurate returns in revenue, the importance of which cannot be questioned.

With the modern trend toward one-man operation, some system of automatic fare collection must be adopted if such operation will be successful. Why not install the most efficient? Johnson Fare Boxes provide the fast, accurate, automatic, and instantaneous fare collection system that makes one-man operation possible and efficient.

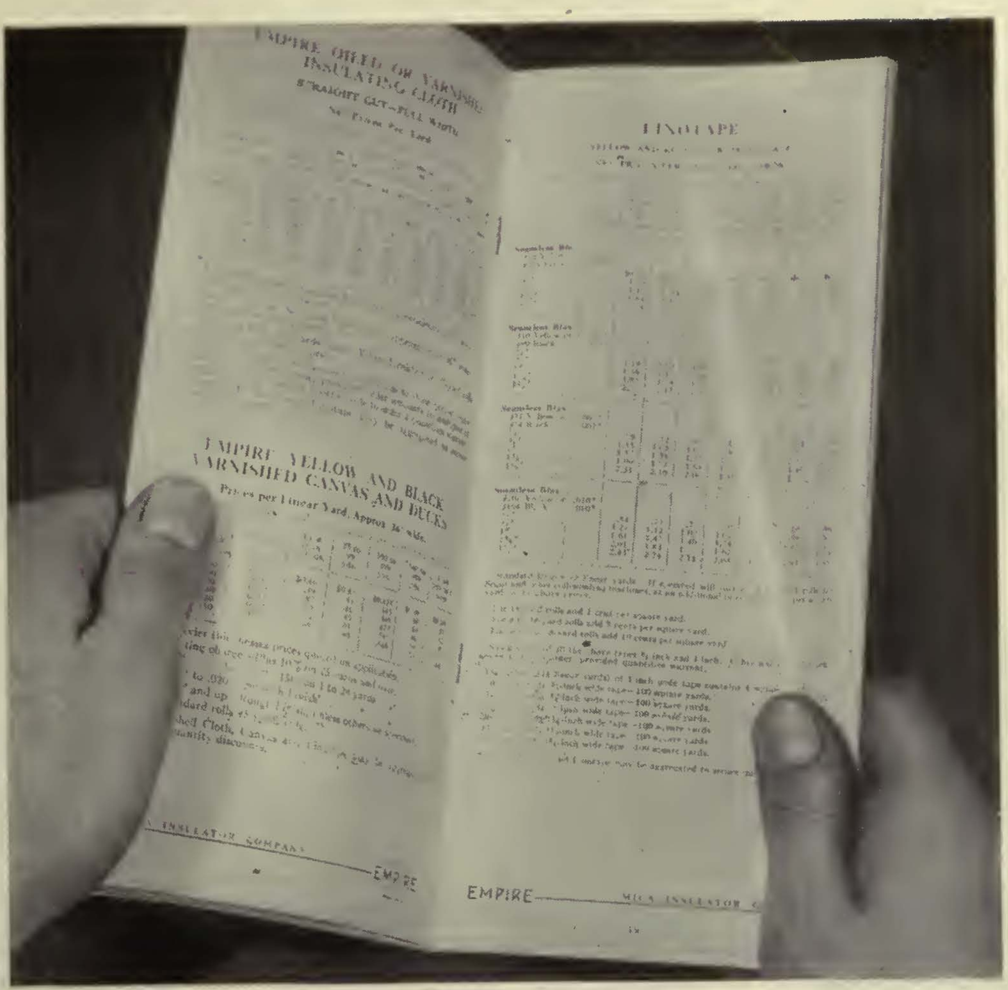
and to ensure Fuel Economy—
The Illinois Fuel Meter



Illinois Fuel Meters installed on your buses will measure actual fuel consumption in tenths of a gallon. With such accurate fuel measurements fuel wastes are readily detected.

JOHNSON FARE BOX COMPANY

4625 Ravenswood Ave., Chicago



Yours for the asking

this valuable electrical insulation data

More than 120 electrical insulations are listed in this new booklet. All the information is up-to-the-minute, including list prices and quantity discounts revised to conform with present conditions.

More comprehensive data on Lamicoid laminated Bakelite has been included in this issue. The characteristics and descriptions of many of the insulations have been amplified. In this booklet you have available at your finger tips, one source of supply for every electrical insulating material.

Thousands of electrical manufacturers and repairmen who received the first edition are receiving copies of this second issue. A copy is yours for the asking. Merely mention price list No. 91.

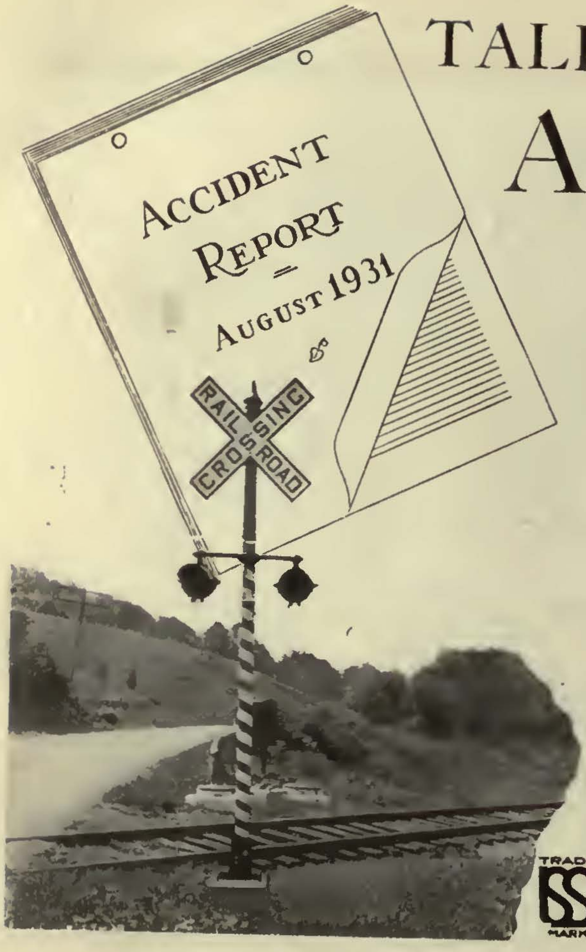
MICA INSULATOR COMPANY
200 VARICK ST., NEW YORK 542 SO. DEARBORN ST., CHICAGO
Sales Offices and Stocks at Cleveland, Pittsburgh, Cincinnati, San Francisco, Seattle, Birmingham, and Los Angeles, U. S. A., Montreal and Toronto, Canada. *Factories at* Schenectady, N. Y. and London, England.

MICO PERFECT INSULATIONS — MICANITE PERFECT INSULATOR REG. U.S. PAT. OFF.

MICA INSULATOR COMPANY
Electrical Insulations
A Type For Every Purpose

LAMICOID — EMPIRE PERFECT INSULATOR


Yes! Leather
has been the leading seat covering for over 50 years - - - - -
The 50th Anniversary of the A.E.R.A. marks another milepost in the progress of transportation. But through the years leather has held its pre-eminent place as the leading material for car and bus seats. No other material has been found to give quite as complete *all around* transportation service. General Leathers made by America's largest producer, attract patronage, they provide a clean, comfortable surface, and even though soft and flexible to the touch they wear like iron. No wonder they are always found on jobs where every appointment must be just *right*. No wonder operators have repeatedly specified them on new equipment. General Leathers are furnished in all colors to blend with any interior. They are easy to wash, and stand up under all climatic conditions. Specify General Leathers on all new rolling stock or order direct for remodeling.
America's Largest Producers
GENERAL LEATHER COMPANY
Newark, New Jersey

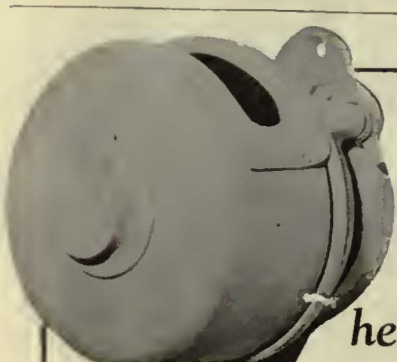


TALKING OF ACCIDENT STATISTICS

—users of "Union" Highway Crossing Signals find that accidents per 100,000 car miles have been greatly reduced, due to practically eliminating highway crossing accidents. And many of these installations have paid for themselves in a remarkably short time.

Our nearest district office will gladly give you more details. There is no obligation.

Union Switch & Signal Co.
SWISSVALE, PA.



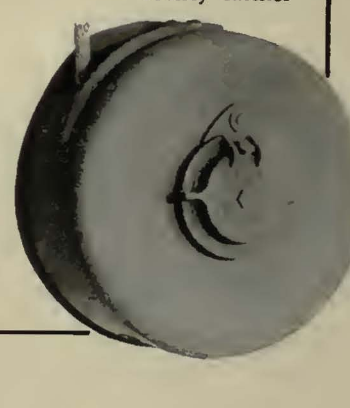
Interurban retriever—high speed

Trolley bus retriever

As suppliers to the electric railway industry since 1904—our heartiest congratulations to the A.E.R.A. association on its golden jubilee and to the men who, over the past 50 years have so successfully carried on its work.

City and suburban retriever

Trolley catcher



EARLL CATCHERS AND RETRIEVERS

Easy to Maintain and Operate, Simple, Light and Strong

Made by

C. I. EARLL, YORK, PA.

CANADIAN AGENTS:
Railway & Power Engineering Corp., Toronto, Ont.
IN ALL OTHER FOREIGN COUNTRIES:
International General Electric Co., Schenectady, N. Y.

ENGINEERS *and* CONSULTANTS

ALPHABETICAL INDEX

This index is published as a convenience to the reader. Every care is taken to make it accurate, but *Electric Railway Journal* assumes no responsibility for errors or omissions.

Searchlight Section — *Classified Advertising*

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or SPECIAL

UNDISPLAYED—RATE PER WORD:

Positions Wanted, 5 cents a word, minimum $1.00 an insertion, payable in advance.

Positions Vacant and all other classifications, excepting Equipment, 10 cents a word, minimum charge $2.00.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 inch $6.00
2 to 3 inches .... 5.75 an inch
4 to 7 inches .... 5.50 an inch

Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page. R.J.

COPY FOR NEW ADVERTISEMENTS ACCEPTED UNTIL 3 P. M. ON THE 20TH FOR THE ISSUE OUT THE FIRST OF THE FOLLOWING MONTH

POSITION WANTED

ARMATURE winder, electrician, 15 years' experience; references furnished; go anywhere on short notice. PW-248, Electric Railway Journal, 883 Mission St., San Francisco, Cal.

ENGINEER with broad experience of twenty years on design, construction, operating and consulting work on transportation and power systems, available for temporary or permanent engagement upon completion of present work about December 1. Last seven years with nationally known organization as transportation specialist covering investigations and reports on bus, urban, interurban and rapid transit properties. Resourceful, with initiative, tact and record of highly satisfactory and dependable service. Interview at convention arranged through Electric Railway Journal booth. PW-257, Electric Railway Journal, Tenth Avenue at 36th Street, New York.

If you are in charge of employment and need good men—

Or you are an individual seeking a better position—

ADVERTISE

in the Employment Columns of the

SEARCHLIGHT SECTION

FOR SALE—IMMEDIATE DELIVERY

STREET CARS

Four Cincinnati, light weight, closed type, double end, one-man, cross seat, semi-steel, Westgh. motors. Very economical in current consumption.

SHENANDOAH TRACTION COMPANY
Staunton, Va.

ROTARY CONVERTERS

1—500-kw., G.E. Synchronous Rotary Converter, full automatic, Type HC-10-500-720, Form P, 60 cy., 770 amps., 650 volts, 720 r.p.m., 6 ph. non-interpole, compound wound with 2-bearing thermostats, overspeed device, oscillator and flash-over relay.

3—185-kva., G.E. Transformers, Type HR, Form RP, 60 cyc., 1 ph., PV, 23000/20700, SV, 460/307/153, 5% reactance, outdoor, oil cooled. Equipped with A.C. and D.C. automatic switching equipment.

1—1000-kw., G.E. Synchronous Rotary Converter, full automatic, 650 volts D.C., 6 ph., 60 cy., 900 r.p.m., 1,540 amps. nominal, 2,310 amps. for 2 hrs. at 55° cont. rise, compound wound, interpole.

3—350-kva., G.E. Outdoor Transformers, 350 kva. nominal, 528 kva. 2 hrs. 60° cont. rise, reactance 1%, approx. voltage 24000/485, primary taps 24000/23400/22800/22200/21600. Equipped with A.C. and D.C. automatic switching equipment.

MOTOR GENERATORS

1—500-kw., G.E. synchronous, continuous current Generator, Type MPC, Class 4-500-720, Form H, 833 amps., 720 r.p.m., 600 volts.

1—G.E. Synchronous Motor, .8 power factor, Type ATI, Class 10-700-720, Form C, 720 hp., 720 r.p.m., 4,400 volts, 92 amps., 60 cy.

1—Exciter, continuous current, Type MP, Class 6-8-720, Form A, 64 amps, 720 r.p.m. 125 volts. Fully equipped with A.C. and D.C. panels.

WATTHOUR METERS 600 VOLTS

Switchboard Type

16—G.E. Type CS, 1200 amp., 2 wire, D.C.
13—G.E. Type G3, 4000 amp., 2 wire, D.C.
15—G.E. Type G3, 2000 amp., 2 wire, D.C.

MOTOR GENERATORS

1—1000-kw., G.E. Motor Generator:

1—G.E. Generator, D.C. cont. current, No. 349375, Type MPC, Class 10-1000-514, Form L, 3640 amp., 514 r.p.m., 275 volts full load.

1—30-kw. Exciter, D.C., No. 1357710, Type ECS-6-30-514, Form A, 240 amps, 514 r.p.m., 125 volts full load, cont. 50° C. rise.

1—1,440-hp. G.E. Synchronous Motor, Type ATI, Class 14-1120-514, Form C, 514 r.p.m., 4,000 volts, 142 amps., 60 cy., No. 413969.

Fully equipped with A.C. and D.C. Switchboard.

TRANSFORMERS

12—350-kva., General Electric, Outdoor Transformers, 350 kva. nominal, 528 kva. 2 hrs. 60° cont. rise, reactance 1%, approx. voltage 24000/485, primary taps 24000/23400/22800/22200/21600.

OIL CIRCUIT BREAKERS

4—FHK-130-24B, G.E. Oil Circuit Breakers, Indoor, 600 amps., 25,000 volts, TPST, equipped with motor operating mech. 70 to 125 volts D.C., interrupting capacity 19300 amps. at 2 o.c.o.

2—FHKO-230-24B, G.E. Oil Circuit Breakers Indoor, 600 amp., 25,000 volts, TPST, equipped with motor operating mech. 70 to 125 volts D.C., interrupting capacity 19,300 amps. at 2 o.c.o.

5—FHKO-136, G.E. Oil Circuit Breakers, outdoor, 400 amp., 37,000 volts, TPST, equipped with A.C. solenoid, interrupting capacity, 25,000 volts, 3,300 amps., 30,000 volts, 2,600 amps.; 37,000 volts, 2,000 amps.

THE DETROIT EDISON COMPANY

EDWARD T. GUSHEE, *Purchasing Agent*

2000 2nd Avenue, Detroit, Mich.

WE BUY RAILWAYS IN THEIR ENTIRETY!

Anything from a single car or motor to a complete operating system. Dismantling track and trolley is a job that should be done by experienced men. Let us relieve you of your dismantling problems—We pay highest market prices.

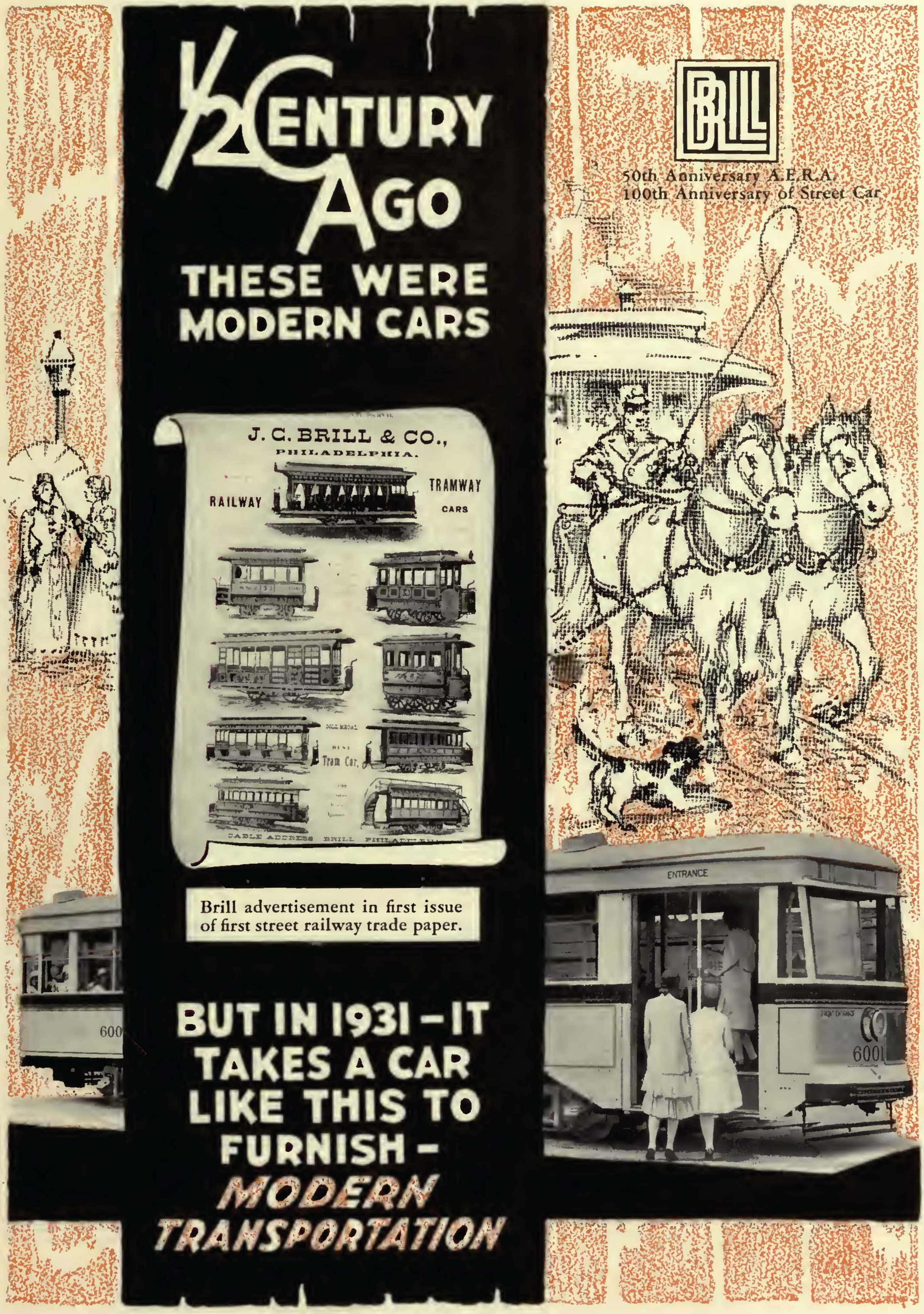
From our past purchases we are in a position to furnish some very desirable equipment. Economy is a big factor today. Listed here are only some of our equipment—Write, telling us your needs.

For Sale

Modern light-weight double truck cars
Birney single truck cars
Freight cars
Line cars
300 kw. Interpole 25 cycle rotary converter
300 kw. 60 cycle rotary converter
Cleveland Fare Boxes
K-36-J Controllers

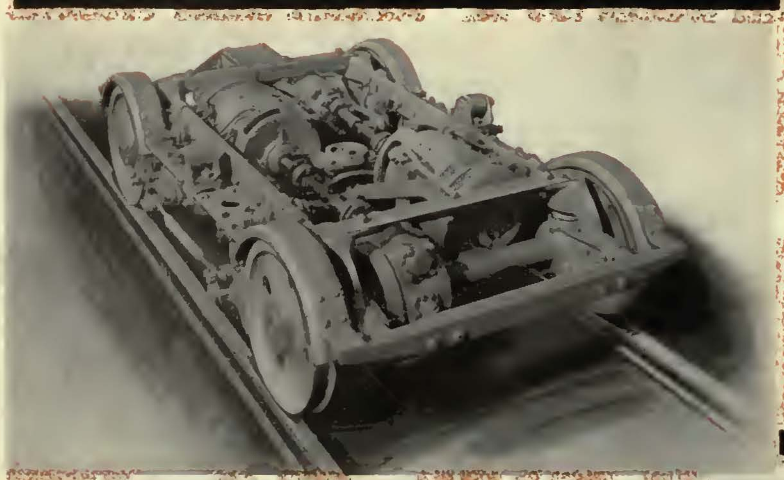
H. E. SALZBERG CO., Inc.

225 Broadway Established 1898 New York, N. Y.


½ CENTURY AGO
THESE WERE MODERN CARS
J. C. BRILL & CO.,
PHILADELPHIA.
RAILWAY
TRAMWAY
CARS
Tram Car.
BRILL
Brill advertisement in first issue of first street railway trade paper.
BUT IN 1931 – IT TAKES A CAR LIKE THIS TO FURNISH –
MODERN TRANSPORTATION
BRILL
50th Anniversary A.E.R.A.
100th Anniversary of Street Car
ENTRANCE
6001

TODAY NEW

BRILL ELECTRIC CARS - TRUCKS



90-E TRUCK

WORM-DRIVE

RESEARCH — THEN *SPEED* AND POWER SAVING

Extensive preliminary tests resulted in the stream line design of the Philadelphia & Western High-Speed Car exhibited on the plaza. Elimination of wind resistance means increased speed as well as lower power costs.

A LIGHT-WEIGHT TRUCK

Quiet operation, smooth and comfortable riding, low unsprung weight, light-weight high-speed motors, inside hung, with worm-drive axles and inside type frames are the outstanding features of this new truck.

Exhibited in spaces C-315 & C-316