wrought iron saddles with straps for holding horse blankets; a locomotive swinging alarm bell is hung under the toe board under control of the driver's foot. The foot piece of the brake extends across the footboard, so that the driver can operate the same from either side of the seat, or with both feet, at pleasure. The wheels are "Warner" patent of XXX quality, three feet two inches and four feet two inches in diameter, respectively, with 2½ × ¾ overlapping, round edge steel tires and brass open hub caps. The axles are two and a quarter inches, of imported refined iron, having bronze nuts secured by a linch pin. The springs are extra oil tempered, and so hung in connection with the Gleason & Bailey patent truss gearing, that the apparatus draws and rides like a light carriage. The body of the wagon is eleven feet six inches long, five feet four inches wide, and nineteen inches deep. There are brass railings around the driver's seat and surmounting the wagon body, supported by composition stanchions. The steps are all covered with corrugated rubber matting. Back of the rear wheels is placed a heavy metal mudsplash. Over all the wheels are sprung substantial metal mud fenders, supported by wrought iron brackets on the body of the wagon. Iron step pads and handles for mounting to the driver's seat and different openings in the wagon, are placed in accessible positions. A patent wind shield, bulls-eye and tubular lanterns are hung either side of the seat, so placed as to throw a powerful light forward; these lanterns are provided with non-heating handles, so that they can be taken off and used when occasion requires. Every feature and equipment of these wagons is novel, and the production of this company. The whip socket has a patent rein holder attached. Lockers for special tools, wire baskets, and iron framework for carrying hose bridges, etc., can be added to the wagon if required.

The Early Pioneers of the Electric Railway.

The names and achievements of the founders of electric railroading in this country, if not familiar to all electric railroad managers and engineers, are at least known to most of those engaged in the industry. But comparatively few, we imagine, among our readers are acquainted with the personality of the pioneers of the electric railway. All, with the exception of Mr. Van Depoele, whose death robbed the world of a most assiduous inventor and worker, are living and in the full vigor of their activity All are engaged in some branch of electrical research.

The public indebtedness to these early workers for their successful efforts to transform the street railway business, can hardly be over estimated.

THOMAS A. EDISON.

Thomas A. Edison, whose inventive genius has been fertile in so many branches of electrical science, early turned his attention to the electric railway. The development of the dynamo machine as an economical agent for the production of electricity, led the way to the adoption of electric power for transportation, and Edison was among the first to see the extensive use to which the new power could be put. In 1880 Mr. Edison built an electric locomotive and track, the latter being less than half a mile in length, at Menlo Park, N. J. The rails were insulated from each other, and each was connected with the poles of a dynamo, making one rail positive and the other negative. The voltage was 125, and the motor was an Edison dynamo of the Z or sixty light type. This locomotive was afterwards much improved.

In prosecuting his claim for patents, soon after the starting of this road, Mr. Edison found two other inventors, Messrs Siemens and Field, with claims covering largely the features for which his application was filed. The claims of the first named were denied by the courts to which recourse was had, and, as outlined below, consolidation was later made between the Edison and Field interests, resulting in the formation of the Electric Railway Company of the United States.

Soon after this the "Judge" was built by the newly formed company, and, as mentioned below, was exhibited at Chicago in 1883, carrying large numbers of passengers. Mr. Edison, though since devoting most of his energy and time to other fields of electrical development, has kept up his interest in electric railways, and has taken out a number of patents for important improvements in this line.

STEPHEN D. FIELD.

Stephen D. Field was born January 31, 1846, at Stockbridge, Mass., where most of his life up to his seventeenth year was passed. In 1863, he went to California and entered the service of the California State Telegraph Company. He remained in California until 1879, being most of the time engaged in the promotion of various electrical enterprises. He is the inventor, among other successful mechanism, of the multiple call answering back signal box, the dynamo system of furnishing currents for the operation of telegraph lines, the dynamo quadruplex, which has been adopted as standard by the Western Union Telegraph Company, and many features of the electric railroad of the present day.

The first public record of the modern dynamo electric railway is claimed by Mr. Field to be his United States patent of July 13, 1880, wherein is shown the complete organization of a practical electric railway. The specification clearly shows how such an organization should be constructed while the drawings show a working conductor, stationary generator, electrically propelled car, trolley pole and trolley running on the under side of the working conductor. Directions are given for bonding the rails for a return circuit, and the working conductor is described as insulated mechanically as well as electrically.

This patent was thrown into "interference" with several rival inventors, the result being to so embarass and restrict Mr. Field in his operations that long before the issuance of his patent the business was so firmly established in the hands of powerful corporations as to place the unfortunate inventor so far in the back ground that nothing was left for him but recourse to the courts to establish his rights. A law suit, having this end in view is now in progress in the United States courts.

Mr. Field's first dates in the United States patent office are a caveat filed May 21, 1879, and patent application filed March 10, 1880, and issued after a prolonged interference in 1889. In May, 1880, Mr. Field commenced the construction at Stockbridge, Mass., of an experimental electric railway, but was delayed by various causes, so that the road was not put in operation until 1881, when it ran for some time very successfully. At the Chicago Railway Exposition, in 1883, the Electric Railway Company of the United States, which then represented both the Field and Edison interests, as mentioned above, exhibited an electric locomotive, the "Judge," weighing about three tons and operating by a third rail. This locomotive was put in operation June 9. 1883, drawing a trail car, and carried over 26,000 passengers during the two weeks in which it ran. The Field and Edison interests were afterwards separated, the patents of the former being retained by Mr. Field and those of the latter by the Edison Electric Light Company, now represented by the General Electric Company.

FRANK J. SPRAGUE.

Ensign Frank J. Sprague, a graduate of the Annapolis Naval Academy, class of '78, installed his first electric railway in the Durant sugar refinery on East 24th Street, New York, in May, 1886. Pivoted trucks underneath a platform car were used, and the method of gearing and motor support adopted was similar to that now in use, so that this equipment may be regarded as the prototype of the present direct geared type of motor car equipment. Previous to the date mentioned above, Mr. Sprague had become well known in the electric field through his investigations in electric railway and motor work, and in being the patentee of a large number of valuable inventions relating to the electric transmision of power, he being the first to bring out a constant speed motor for stationary work.

In the summer of 1886, Mr. Sprague commenced a long continued series of experiments on the 34th Street branch of the New York Elevated Railway, with a car equipped with a pair of pivoted trucks, and in the spring of the following year the Sprague Electric Railway & Motor Company took a contract for equipping the Passenger Railway, of St. Joseph, Mo., and the Union Passenger Railway, of Richmond, Va. The latter was for eighty motors, eleven miles of track, and 375 H. P. generating plant, and the road was to be completed in ninety days, at a cost of $110,000. These roads were started experimentally in the fall of 1887, but the Richmond road not regularly until the beginning of February, 1888. The electric railway at Richmond was by far the largest which had up to that time been equipped, and as the results attained were largely instrumental in giving electric railway construction the impetus which it has since had, and in convincing street railway managers of the successful commercial results obtainable with electric power, it seems fair to say that to Mr. Sprague, more than to any other one man, is due the credit of inaugurating the enor-

E. M. BENTLEY.
W. H. KNIGHT.
J. C. HENRY,

F. J. SPRAGUE.
T. A. EDISON.
C. J. VAN DEPOELE.

LEO DAFT.
S. D. FIELD.
S. H. SHORT.

mous development of the electric railway industry in this country which has excited the amazement and admiration of foreign engineers and workers in the "tramway" field.

The characteristics of the Sprague motor equipment, as used in elevated railway experiments in New York, and in the railway at Richmond, and which, it is claimed, were new in electric railway practice up to that time were: An independent truck with motors exteriorly centered upon the driven axles so as to maintain parallelism between the driving shaft and the driven axles; flexible support of part of the weight of the motors on the truck to allow perfect freedom in following the motions of the axles, suspension being below the car springs; the method of flexible suspension, avoiding all shock and jar and danger of stripping gearing, and the maintenance at all times of a spring touch to prevent back lash of the gears; direct single reduction of gearing; the use of fixed brushes for both forward and backward running. This equipment marked the abolition of ropes, belts, sprocket wheels and chains for the reduction between armature and axle. Besides the characteristics already mentioned, the Richmond road exhibited the following unique peculiarities: A feeder system with main and working conductor, the latter being of silicon bronze; main and working conductor system also applied to the rails; a universally movable trolley carried in the center of the car body; a series multiple and commutated field magnet method of control; single movement control for both speed and direction of movement.

Mr. Sprague's first proposal for a centrally located, upper pressure, contact trolley taking current from a conductor above the track, and following the line of all tracks and switches, was in connection with a suggested electrical equipment for the underground railroad in London in 1882 and 1883.

When the Sprague Electric Railway & Motor Company was absorbed by the Edison General Electric Company, Mr. Sprague was retained by the latter company as consulting electrical engineer, but wishing to be independent, he resigned the position at the end of a year, to devote himself to the solution of other problems, but remained in touch with consulting work as president of the corporation of Sprague, Duncan & Hutchinson, Limited.

In spite of extended work in other lines of electrical research, Mr. Sprague retains his fondness for the electric railway field, in which he has performed such valuable services, and it is rumored that he will re-enter the tramway field. He is an enthusiastic advocate of the use of electric power for heavier work, and in connection with Doctors Duncan and Hutchinson has nearly completed a 1,000 H. P. electric locomotive, for the North American Company for experimental work. On this subject, however, he avoids all visionary propositions, his belief being epitomized in a statement made in his inaugural address as president of the American Institute of Electrical Engineers, in Chicago, in 1892: "It narrows itself down to the one question of the number of train units operated between the terminal points." He has also devoted more thought than probably any other electrical engineer to the solution of the New York rapid transit problem, and his plans, if adopted by the Rapid Transit Commission, would undoubtedly result in the removal of this, at present, perplexing question from the minds of New Yorkers. He is the representative in this country of the Greathead system as exemplified in London.

Mr. Sprague's recent work, like that in the early electric railway field, displays great originality of thought, combined with a fertility of invention in the application of mechanical and electrical principles, and his ambition now is to make the hydraulic elevator an obsolete machine. Associating himself with Chas. R. Pratt, he attacked the hardest elevator duty, and the new Postal Telegraph building has challenged the hydraulic elevator on its own grounds in one of the largest plants in New York by machines illustrating one of the most interesting examples of the direct application of electric power to mechanical work, and of departure from established standards. The Sprague Electric Elevator Company is now building a substantial factory at Bloomfield, N J., where, it is rumored, some new inventions of Mr. Sprague's will be brought out, which will revolutionize the methods of this important industry.

Mr. Sprague's inventions have rewarded him from a financial standpoint, and he has amassed a considerable fortune which is unhesitatingly spent in developing new work. He is married, has one son, and lives in a very handsome residence, the former residence of a son of General Grant, on West End Avenue, in New York City.

LEO DAFT.

Leo Daft was born in Birmingham, Eng., in November, 1843. His father was Thomas B. Daft, a prominent civil engineer. Mr. Daft early showed a leaning toward mechanical and electrical pursuits, and in 1858 entered the University College, at London, where he had many opportunities for special instruction, and where he became acquainted with Sir William Siemens, who lent him considerable electrical apparatus for carrying on his experiments.

Mr. Daft came to America in 1866, and first engaged in railroad engineering, afterwards in various minor enterprises. He went to England in 1879, but upon his return to this country, about two months later, the developing activity in electrical matters attracted his attention, and recalled him to his old profession. His first connection was with the New York Electric Light Association, which was soon merged into the Daft Electric Light Company, with works first in New York, then in Greenville, N. J., and later in Marion, N. J. The company was almost immediately and exclusively devoted to the development of electric power, and established several electric power stations in Boston, New York, Worcester and elsewhere. In 1883, Mr. Daft built an electric locomotive called the "Ampere," for use on the Saratoga & McGregor Electric Railroad, and in the following year installed a short line at Coney Island. In the early part of the spring of 1885, Mr. Daft was requested to furnish an electric equipment for the Baltimore Union Passenger Railway Company, and on August 8, 1885, this road was put into operation. The first motor cars used were the "Morse" and the "Faraday," and a third rail was used to conduct the current to the car. The Daft system was adopted on a number of roads, and the Daft locomotive, "Ben. Franklin," was operated for some time on the Ninth Avenue elevated road, in New York City.

Mr. Daft is now engaged as a consulting electrical engineer on the Pacific Coast, with headquarters at Seattle, Wash., and has turned his attention chiefly to long distance power transmission and large railway and light installations. One of these latter has recently been completed at Everett, Wash., under his supervision, and is in very successful operation.

WALTER H. KNIGHT AND EDWARD M. BENTLEY.

The names of Walter H. Knight and Edward M. Bentley are closely associated in the early history of electric railroading, in which they took a prominent part. In 1883 Mr. Knight resigned from the electrical department of the Patent Office to take charge of some electrical engineering work, and, forming with Mr. Bentley the Bentley-Knight Railway Company, was soon engaged in electric railroad experimenting.

The first electric road of the company was built in the fall of 1883, in the yard of the Brush Electric Works at Cleveland, where Messrs. Bentley and Knight equipped a street car with a Brush motor, and built a short section of conduit. The first public line equipped by the Bentley-Knight Railway Company was the Quincy Street extension of the Garden Street line of the East Cleveland Company's system.

Work on this road was begun in the early summer of 1885, and on August 1, of the same year, a street car was put in operation. This car was immediately used in the business of the company, and, so far as was possible, was kept in continuous operation. The road was, of course, largely an experiment, and many changes were made to ascertain the best form of gearing, motor control and line construction, but it was operated regularly as part of the service of the railway company, and was the first commercial electric railway in this country. It was about two miles long, with a branch track, and the current was taken by a collecting device passing through a slot in the conduit, making contact with the conductors there.

Messrs. Bentley and Knight were next engaged in the construction of a trolley road at Woonsocket, R. I., and then in the construction of a combined trolley and conduit road at Allegheny, Pa. The latter was on the Federal Street line, and operated successfully for several years. A combined trolley and conduit road at Boston, and an overhead trolley road at Lowell were afterwards installed by the Bentley-Knight Company. Soon afterwards this company was absorbed by the Thomson-Houston Electric Company.

Mr. Knight was a resident in Boston at the time that the West End Railroad Company of that city was proposing the equipment of its line with the cable system, but President Whitney's attention having been directed to the advances being made in electric traction, a trip was made to the Bentley-Knight road at Allegheny, Pa., and the Sprague road at Richmond, Va. Before his return Mr. Whitney had concluded to change over to the electric system, and Mr. Knight was delegated to select a site for the power station and draw up general plans. Soon after the absorption of the Bentley-Knight Company by the Thomson-Houston Company, mentioned above, Mr. Knight became chief engineer of the railway department of that company, a position which he still holds in its successor, the General Electric Company.

Mr. Bentley, after the absorption of the Bentley-Knight Railway Company, engaged in the practice of law, and is now a member of the firm of Bentley & Blodgett, attorneys, Boston.

JOHN C. HENRY.

John C. Henry was born in Woodstock, Ont., in 1848. He learned telegraphy at an early age, and was connected with several railroads as train dispatcher. In 1869 he entered the service of the Union Pacific Railway Company, of the Eastern Division, as electrician. During his connection with this road, which lasted about ten years, he brought out a number of valuable inventions, including the Henry Velocimeter. This device has been slightly modified by Mr. Boyer, who was in Mr. Henry's employ, and is well known as the Boyer Speed Recorder. During his service as railway electrician, Mr. Henry devoted a great deal of study to the subject of the application of electric power to the operation of cars.

In 1884-5, Mr. Henry, who was then a resident of Kansas City, constructed there an electric railway, using overhead wires. This road is claimed to be the first of the kind ever constructed. In the fall of 1885, he made some experiments in heavy electric railroading on a branch of the Fort Scott Steam Railroad, where heavy freight cars were operated. Mr. Henry later, in 1886, equipped the Kansas City Fifth Street Railroad with his street railway system. Here he employed, it is claimed, for the first time the following features which are still in common use: The trolley wires were of No. 1 hard drawn copper and were supported centrally over the street from insulators and span wires to poles placed along the curb lines; the trolley engaged the sides and bottom of the wires and was so held by spring pressure; the current was supplied by compound wound, constant potential dynamos; the motors were series wound and were journaled on the car axles at one end, the other end being spring supported; the gearing was encased and ran in oil; the practice of using two pairs of tapering brushes was discarded and a single pair which abutted the commutator was substituted. An independent switch was added to reverse the motor instead of shifting the brushes.

In 1887, Mr. Henry removed to San Diego, Cal., and constructed a number of electric roads, one of which contained 9 per cent. grades which were surmounted by his motors and trail cars with success. The system of underground feeders was first introduced on one of those roads. In 1889, Mr. Henry removed to New York, where he has since been engaged, not only in electric railroad investigations and improvements, but as an expert to some of the largest electric corporations. Mr. Henry took out a number of fundamental patents during his early electric railway work and his claims as the inventor of the main features of the trolley system of to-day, are now before the United States Court, in a suit which is being defended by the Westinghouse Electric & Manufacturing Company. He is most assiduous in his profession, and has taken out many patents for improvements in electric railway work during the last few years. He is a resident of Westfield, N. J.

CHARLES J. VAN DEPOELE.

Charles J. Van Depoele, whose death occurred March 18, 1892, in the vigor of his activity as an electrical engineer, was born in Litchervelde, Belgium, in 1846. His father was a railway engineer. Mr. Van Depoele came to this country in 1871 and settled at Detroit.

Becoming interested in the electric light, he constructed a dynamo in 1880, and soon after moved to Chicago and aided in the organization of the Van Depoele Electric Light Company. The first railway operated under the Van Depoele system was an experimental road installed in Chicago in the winter of 1882-3. In the fall of 1884, Mr. Van Depoele installed a conduit railway at the Toronto Exposition, and in the following year converted the same to an overhead trolley road, the wires being supported from brackets. The current was collected by an under-running trolley. Three cars and a motor car were run, and the road carried over 10,000 passengers per day. A speed of about thirty miles per hour was attained. In the fall of 1885, Mr. Van Depoele experimented on the streets of South Bend, Ind., with a number of motor cars. Later roads were installed in Montgomery, Ala.; Windsor, Ont.; Detroit, Mich.; Appleton, Wis., and Scranton, Pa. Mr. Van Depoele's first road used the over-running trolley; later the under-running trolley was employed.

In 1888, the Thomson-Houston Electric Company purchased all of Mr. Van Depoele's electric railway patents, and from that time until his death Mr. Van Depoele was connected with that company as electrician and inventor. Mr. Van Depoele was a prolific inventor and a tireless worker. He probably did more to boom the business in its infancy than any other man.

SIDNEY H. SHORT.

Sidney H. Short was born in Columbus, O., October 8, 1857. He received his entire education in that city, being one of the early graduates from the Ohio State University. While still young, he displayed inventive genius by developing one of the first telephones. His patents are now the property of the American Bell Telephone Company, of Boston, Mass. For two years prior to his graduation he was employed at the Ohio State University as instructor in the Physical Laboratory. Immediately after being graduated, Mr. Short accepted the vice-presidency of the Denver University, filling the chairs of physics and chemistry until the work became too much for one man, when he resigned the chemical work and gave all his attention to the department of physics. He remained with the University for five years. In the spring of 1885, he constructed a short electric railway here. The track was made of T rails laid on cross ties, the two conductors being supported on insulators between the rails.

The car had four wheels and a rigid truck; the motor was geared with one pinion and one gear to the axle. The car body was eight feet long, and fitted with a rheostat lever and reversing lever. The success of the road was so great that a party of capitalists induced Mr. Short to give up his professorship and develop a street railway system. The conduit system was adopted and five miles of track were laid on 15th Street, in Denver, and operated with considerable success. The difficulties with insulation in the conduit in wet weather, and the imperfections of the early types of motors and generators led to electricity being finally abandoned and the cable substituted. This was in turn given up, and the road is again equipped with electricity, the overhead trolley system being used.

In 1889 Mr. Short returned to Columbus, where, under the firm name of S. H. Short & Company, a short line about two and a half miles in length, using the overhead system and series motors, was built. In 1888 Mr. Short constructed another line on the overhead series system in St. Louis. In June, 1889, he made Cleveland his home, and organized the Short Electric Railway Company, with a capital of $5,000,000. The manufacturing was done by the Brush Electric Company. Railways were built in Muskegon, Mich., Indianapolis, Jamestown, Rochester, N. Y., and many other cities, the Rochester railway calling for the installation of 200 motors, an order then unprecedented. The motors were of the double reduction type, and the cars were run on the multiple arc system. In 1891 Mr. Short put upon the market a single reduction motor, and at the Pittsburgh Convention in the same year, his first gearless machine was shown. As the original inventor of this, the gearless, type of machine, it will, doubtless, always bear his name.

In the summer of 1892 Mr. Short sold his entire interest in the Short Electric Railway Company to the Thomson-Houston Electric Company, of Boston, Mass., and thereby severed his connection with the company. He has since been engaged in developing, for the Brush Electric Company, the largest arc light dynamo ever built. This machine has a capacity of 125 lights of 2,000 C. P. each, but it has been operated successfully carrying a load of 150 lamps, all burning at their full candle power.

Since completing this machine, Mr. Short is turning his attention to new and very important developments in the electrical field, which he hopes to soon bring before the public.

A New Rapid Transit Plan for New York City.

The latest plan presented to the New York Rapid Transit Commissioners comes from a syndicate represented by R. T. Wilson. This syndicate proposes to deposit $1,000,000 to be forfeited if it fails to sign the contract for the construction of the road when the execution thereof shall be authorized by the vote of the people of the city.

The syndicate proposes to commence the construction immediately upon the execution of the contract, and to build that portion between the City Hall and 14th Street within two years, between 14th and 59th Streets, and south of the City Hall, within three years and the uptown section within four years from the time of signing the contract. As soon as the routes mentioned pay 4 per cent. on the cost an additional mile on either side of the city will be built, and as soon as that extra distance pays 4 per cent. on its cost an additional mile be built, and so on until the northern termini are reached. The city is requested to loan the syndicate two-thirds of the cost of each mile of track when approved, in 3 per cent., fifty year, gold bonds, with the provision that the loan from the city shall not be over $2,500,000 per mile on any part below 42d Street, and $2,000,000 per mile on any part above. It is also provided that the loan from the city shall not exceed $30,000,000, the syndicate agreeing to pay the interest on the bonds and redeem them at maturity.

The plan proposes an underground road having a double deck, two-track tunnel, sufficiently below the street to clear all pipes, etc., the method of propulsion to be electricity or some other power not requiring combustion, and the motors to be capable of a uniform speed of forty miles per hour, exclusive of stops, for long distances.

Care of Street Car Motors.

At a recent meeting of the Massachusetts Street Railway Association some very interesting discussion was had on the care of street railway motors on the different lines represented.

Robert C. Brown, of the West End Street Railway Company, stated that the equipment of that line consists entirely of W. P. 50 motors, and that the practice is to inspect to a certain degree—especially as regards brushes, leads and other parts which are likely to get out of adjustment easily—every day. Every third day the car is "over the pit" and is thoroughly inspected from trolley wheel to rail. Every other third day the brush holders are removed, at the same time this inspection goes on, and cleaned. Also the journal caps, and so far as possible, the motor, in general, receives a thorough wiping. Once every thirty days the motors are taken apart, the lower half of the shell being dropped into the pit. When this is done, all the parts of the motor are inspected and thoroughly cleaned. The brasses are removed, the oil wells cleaned out, the commutator and armature thoroughly cleaned, and the whole motor put in as cleanly a condition as possible. This is followed finally by a coat of asphaltum paint. This paint is used at all cleanings, a little each time, as it gives a good surface to the iron, and leaves it in a condition that allows of its being more easily cleaned. At the same time the axle gears and pinions, both of which are of steel, are closely examined for loose bolts, loose keys, wear and other depreciations. Two men can do this work in two and a half hours. The foreman gives the whole car a thorough inspection at the same time.

As a protection against water, the openings at each side of the motor are covered with snug fitting canvas shields. A canvas curtain is also hung from the car body at the commutator end. These guards work well in practice and keep the water out. In the snow plows the motors are on the floors of the body, and need very little attention in service.

E. C. Foster, general manager of the Lynn & Boston Street Railway, stated that that company had some fifty cars equipped with F 30 motors, and seventeen with No. 6 Sprague, all of which have been in service from three to five years, and the remainder, with W. P. 30, W. P. 50 and G. E. 800 motors.

The F 30's require a great deal of care and attention; as the capacity of the armatures is somewhat limited, they become heated, and as a result, will short circuit and burn out. The intermediate shaft and gear are also a source of expense, and the pans are a source of annoyance; in fact, they seem to be made up of delicate parts which seem to create trouble and annoyance to those having them in charge. Certainly, for the winter season, they are not adapted and cannot be operated with any profit in a northern climate. In the summer season it might be profitable to have a limited number of open cars equipped with them, to be run on special occasions, but for regular service they are not as satisfactory as those of modern types. The cost of keeping them in repair is about three times as great as it is with the W. P's.

The W. P. 30 motors have given very good service, yet, are not considered of sufficient capacity to do the work required of them, in operating over grades of 5 per cent. with trailers; the last season, during the summer months, the company operated ten seat cars with trailers, and with the type K controller, and they did the work very nicely, but they were not of sufficient capacity to do it continuously without impairing the usefulness of the motors.

The W. P. 50's are very profitable motors, and, the cost of maintenance is less than with the other types and they are given very hard service.

The G. E. 800 seems to be the ideal motor, as it is very efficient, having a greater capacity than the W. P. 50, is a more "speedy" motor, and has about 1,000 lbs. less weight, which is something to be considered. Great difficulty is experienced in maintaining perfect joints. When it is necessary to have the weight in order to obtain traction, that weight is created by the burden of passengers in the car. When the passengers are not there, the weight of the car is burden enough to give proper traction. An average schedule of eight miles per hour is maintained, although in remote localities a speed of twelve miles is sometimes attained.

P. F. Sullivan, general manager of the Lowell & Suburban Street Railway Company, stated that the repairs and maintenance of their road was cared for on the following system: In the car house skilled mechanics are in charge who are responsible for results. The object is that when a car leaves the shop newly equipped, such equipment shall be thoroughly done, through the best material and workmanship, and after that a thorough inspection. Motors, trucks and cars are numbered and an official record is then begun, and date and description of any repairs made are kept, comparisons formed, and causes sought.

The work is only half done when a car leaves the shop and is passed into the hands of relatively unskilled help. It is assumed that a man before taking charge of a car is absolutely ignorant, has no interest in the apparatus, and the aim is to teach him so that he will look out for his motors and create a rivalry so that a man will boast of his record.

A green man is placed on the car in charge of a competent motorman, taught the names and methods incidental to car control, and is recommended as being competent to take charge of the car. He is then placed in the repair shop under the direction of the foreman, and shown all the parts, their relation to each other, and in order that he may realize more fully what certain carelessness would amount to, he is given the list price of the various parts. When in the shops such men take the place of helpers in all branches, and are paid accordingly.

To help to create an interest there are prizes for the motormen whose cars have had the best records in point of expense, delays, etc. All loss of mileage or taking off of cars is reported directly to the manager's desk, who exacts an accounting for the cause from the superintendent.

By following the above methods it has been possible to adopt a standard of car mile expenses, and the different foremen are given to understand that if the expenses are kept below such a figure they may expect a present at the end of the fiscal year. The equipment consists chiefly of W. P. 30 motors, Bemis standard trucks, thirty-three inch wheels. Nearly all cars are equipped with type K controllers, and all have gear cases. The cars were previously equipped with the former style of Bemis truck, thirty-inch wheels, but it was found in the line of economy to change.

N. E. Weston, superintendent Lawrence division of the Lowell, Lawrence & Haverhill Street Railway, mentioned considerable trouble from water getting on the commutator and brush holder during sleet storms in winter and also from the salt put on the tracks destroying the insulation of the wires underneath the cars, and stated that a strip of No. 1 duck, painted with fireproof paint, hung between the motor and the wheels on either side, formed a sufficient protection. This road uses S. R. G. 15 and W. P. 25 motors, two to each car.

The S. R. G. requires a seventy ampere fuse, and the W. P. a 100 ampere fuse. Great care has to be exercised that the men do not use the larger fuse on the smaller motors, as they are liable to do if not watched closely. If this is done, and the small motors become overloaded, they are apt to burn out. There are at the barn three night men. One of them looks after the cleaning of the cars, sweeping the floors, washing the windows and taking care of the stoves; the other two go through all the cars, lift all traps, and make a thorough examination of every part—lead wire, brushes, brush holders, etc.—and find all troubles that they possibly can. If they find a car that cannot be easily repaired, they put a sign on it, "leave this car in," and the repairs are made during the day by the electricians. These men oil all bearings every night, using in all oil cups a motor compound from the Vacuum Oil Company, that costs eight cents per pound; for the other bearings a cheap dark machine oil is used. All trucks, brakes and brakeshoes are also examined every night.

The car barn is so arranged that there is pit room enough to hold twelve cars. These pits are all heated by steam, and the men can walk under the cars easily, using a drop light, and making careful inspection of everything.

When an armature is burned out, the car is placed over the pit, and the armature is lowered down with chain falls and taken from under the car, through the pit, then to the armature room, and a new one put in its place.

James F. Shaw, treasurer of the Wakefield & Stoneham Street Railway, made some interesting statements with regard to the use of electric heaters on the Haverhill & Amesbury road, which line has used these heaters for the past two winters on a run of eighteen miles, having no difficulty in keeping the cars warm on the coldest days. The heaters used are the Burton, Cochrane and New England. The Burton heater to heat moderately takes four amperes, and on extremely cold days ten, more or less. The New England heater takes three amperes for each side of the car, which may be run in series or multiple. Several other lines are using electric heaters and although they cost slightly more than stoves, they are more satisfactory.

Chicago's Street Railway Traffic in 1893.

In this issue are published the reports of the three principal Chicago street railway lines The following comparison of the traffic returns will be found of interest:

	Passengers carried.	Increase.
Chicago City Railway	120,596,270	32,577,409
West Chicago Street Railroad	107,053,461	12,534,987
North Chicago Street Railroad	60,311,673	9,892,216
Total	287,961,404	55.004,612
	Gross earnings.	**Increase.**
Chicago City Railway	$ 6,059,989	$1,659,046
West Chicago Street Railroad	5,235,633	615,408
North Chicago Street Railroad	3,014,889	493,277
Total	$14,310,511	$2,767,731
	Car miles.	**Increase.**
Chicago City Railway	26,304,090	5,483,380
West Chicago Street Railroad	16,813,134	1,230,993
North Chicago Street Railroad	9,224,173	676,382
Total	52,341,397	7,390,755
	Operating expenses.	**Increase.**
Chicago City Railway	$3,422,040	$612,609
West Chicago Street Railroad	2,829,982	205,671
North Chicago Street Railroad	1,412,755	78,703
Total	$7,664,777	$896,983

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We heartily invite correspondence upon all subjects of interest to street railway men. Information regarding changes of officers, new equipment, extensions, etc., will be greatly appreciated for our official directory and news columns. We especially invite the co-operation of all interested to furnish us particulars that the directory may be correct and of the greatest possible value.

Address all communications to
Street Railway Publishing Co.,
Havemeyer Building, 26 Cortlandt St., New York.

We Heartily Appreciate the almost unanimous endorsement by street railway managers of our forthcoming financial supplement, "American Street Railway Investments" It has been made evident to us, in the large number of letters which we have received in answer to our circular letters of inquiry, that our belief in the necessity of such a publication is well founded, and that our purposes and methods have been understood and approved. It is already certain that this supplement will be the most complete and valuable compilation of financial information concerning street railways ever produced.

Through the Death of William Richardson, recorded in our January issue, the street railway industry parts with a member which it could ill afford to lose, and one whose place can not be refilled. Mr. Richardson was one of the few remaining members of that older generation in the street railway field who, engaged in the business some thirty years or so ago, when its importance and future were not appreciated and by keen foresight, combined with careful management made it one of the leading factors of municipal advancement and prosperity. Mr. Richardson lived to see the opening of a new era in street railway development, by the adoption of a motive power not dreamed of when he began his work as a street railway manager, and a progress made during the last six years equal in magnitude to all those in the preceding twenty-five. Mr. Richardson did not try to confine the benefit of his thought and experience to his own road. He was a most enthusiastic member of the National and State Street Railway Associations, of whose meetings he was a regular attendant, and in whose proceedings and councils he took an active part. He was a firm believer in that far-seeing policy of giving others the results of one's experience, and was not above benefiting by the advice of others in return. An example of his foresight and discernment is shown in his early advocacy of electric power for car propulsion and its adoption on the road of which he was president as soon as municipal permission was obtained, though used for so many years to animal power. Mr. Richardson deserves the thanks of the members of the street railway fraternity for the many benefits which he has conferred on them, and his memory will be cherished as of one who was a friend of all.

The Electric Railway Field has now reached such gigantic proportions, and the science of electric railway construction and operation has advanced so rapidly, that it is hardly possible to realize the fact that the industry is still very young. Less than ten years ago the inventors, to whom we are indebted for our apparatus of to-day, were engaged in working out the fundamental principles of electric railway design and operation and there was not a single electric road in regular operation. The honor roll of workers in this field is a long one, and one of which every American and every street railway man may well be proud. To no one man and to no one set of men can be attributed the credit of creating the electric railway of to-day. Like all great undertakings, it is the product of many minds. To many of those engaged in the operation of extensive systems this early work remains obscure and half or entirely forgotten. To recall to the minds of such the early struggles and problems in the electric railway field, we publish in this issue the portraits and short biographical sketches of nine of the pioneers in this country, and to whom the greater portion of the early development of the electric railway is due. This, like other branches of electrical development, seems destined to be a battle ground for patent litigation, and while the questions of law involved in these suits remain unsettled, there is certain to remain a degree of indefiniteness as to the ownership of the legal rights in certain inventions. Credit for actual work performed and progress made in the art, however, should be given, independent of the fact as to whether an invention, if made, was of such a character as to secure a patent for its exclusive use to the inventor. We should, therefore, give the due meed of praise to all those by whose efforts the great industry represented by our electric railways was established.

The Attention of Street Railway Managers in Southern cities should be turned to the various methods of increasing the patronage of their lines, which have proved so efficacious in other sections of the country, particularly in the West. It is not unusual to find Western city systems earning from $5 to $10 per capita, owing to excellence of management, frequency of service, high schedule speed, and sometimes the establishment or development of public pleasure grounds, beer gardens or picnicking resorts by the street railway companies themselves. The negro population in the South is not infrequently an element of strength rather than weakness, because of the well known fact that a "darkey"—the most improvident of mortals—will spend his last "picayune" for the pleasure of coursing over the country on the delightfully mysterious electric car. The constantly increasing number of Northerners who pass their winters in the South will patronize the local railways as a daily diversion if they are provided with clean and easily riding cars. When all is said and done, much depends on the ingenuity of the street railway manager in educating his permanent public to ride more and more frequently. In too many cases the cars are running on too long headway, and