delivery. Street delivery is expensive and should only be necessary in the smallest towns. Small agencies at general stores serve the purpose of delivery of freight in rural communities.

Through Tariffs

There is a movement to tie up all connecting lines into one freight system with through tariffs to all points. That would be the millennium of trolley freight. Many reasons, however, make this union difficult. In the first place some companies come under the Interstate Commerce Commission's jurisdiction, while others avoid it. The restrictions and regulations of the Commission seems to strike terror into their hearts. Next to the Commission bugaboo the most important obstacle is accounting. Accounting is like religion. Every road has a different system and each one thinks his is the best. There are blanket waybills, individual waybills, and old line express waybills and variations on all of them.

Franchise Rights

Every year add new towns to the list enjoying freight service. But it is not always without a struggle that franchise rights are obtained. Local politicians demand all sorts of concessions for the franchise privileges. It gives them campaign material and there are instances where street railways have been consistently denied the privileges and have had to resort to the state commission. Many restrictions are placed upon trolley freight by local governing bodies; some limit the length of cars to be used, others provide certain hours for the passage of freight cars, while in some cities certain streets are denied freight car operation necessitating long detours. This condition of affairs should be remedied by new legislation.

Tariffs

In most instances street railway freight tariffs were based on steam railroad rates. However present conditions warrant closer study before the issuance of new tariffs. It will be found that on long distance hauls that the electric railway may command higher rates that the steam railroad, but on shorter hauls truck competition, etc., in some instances make rates lower than the railroads. Speaking of class rates, calls attention to the experiment of the Connecticut Company in adopting a special classification of their own preparation which calls for only one class rate. This obviously simplifies billing and the checking of waybills and quotation of rates. Mr. V. S. Curtis, their General Traffic Agent, who is responsible for this classification believes that trolley lines cannot accept rules and regulations which are imposed upon steam railroads by the Interstate Commerce Commission through the official cassification. His idea merits careful consideration and it is believed by many that some day the Commission will issue a special classification intended for the use of trolley freight lines.

Convenience to Patrons

Relations with the general public have been cordial and perhaps no other method of transportation so enjoys the confidence of the shippers. This is due in part to the fact that the trolley freight service is in a position to grant many conveniences to its patrons. Special loading and unloading privileges, extra cars apart from schedule service, etc., make many friends. There is a minimum damage to freight enroute and prompt attention to whatever claims may arise. But the *main reason* for the success of trolley freight lies in *service*. In this one word lies the basis of everything. Quick service at reasonable rates will always bring patronage. In service also lies the future. May it bring its measure of success to the electric freight and its well wishers.

New Gearless Passenger Locomotives for The Chicago, Milwaukee & St. Paul Railway

Two Hundred and Sixty-Five Ton, 3000 Volt, D. C. Locomotive With Armatures Mounted Directly on the Driving Axles Tested at Speed of 65 Miles Per Hour.

The 3000-volt direct current locomotives here described are now being placed in operation for passenger service on the Othello-Seattle-Tacoma electric zone of the Chicago, Milwaukee & St. Paul Railway.

The original electrification from Harlowton to Avery, 440 miles, has now been operating for a number of years under the extremely bad weather conditions of the Rockies and Bitter Root Mountains and, as a result of its unqualified success, the same system will now be used to meet the several grades and snow conditions of the Cascade Range. The entire equipment for the original electrification was manufactured by the General Electric Company, including substations and locomotives. The motive power consisted of forty-two locomotives for freight and passenger service and four switchers. Of this original equipment, the freight and passenger locomotives were practically the same and differed from each other only in the gear ratio between motors and driving axles.

Newly Designed Locomotives Distinctively for Passenger Service

The new locomotives are an entirely different design built distinctively for passenger service and possess some very interesting mechanical and electrical features. They will be used on the new Cascade electrification strictly for passenger service and the present passenger engines will be adapted for freight service by changing the gear ratio. The locomotives are of the bipolar, gearless type, with motor armatures mounted directly on the driving axles. On this fundamental

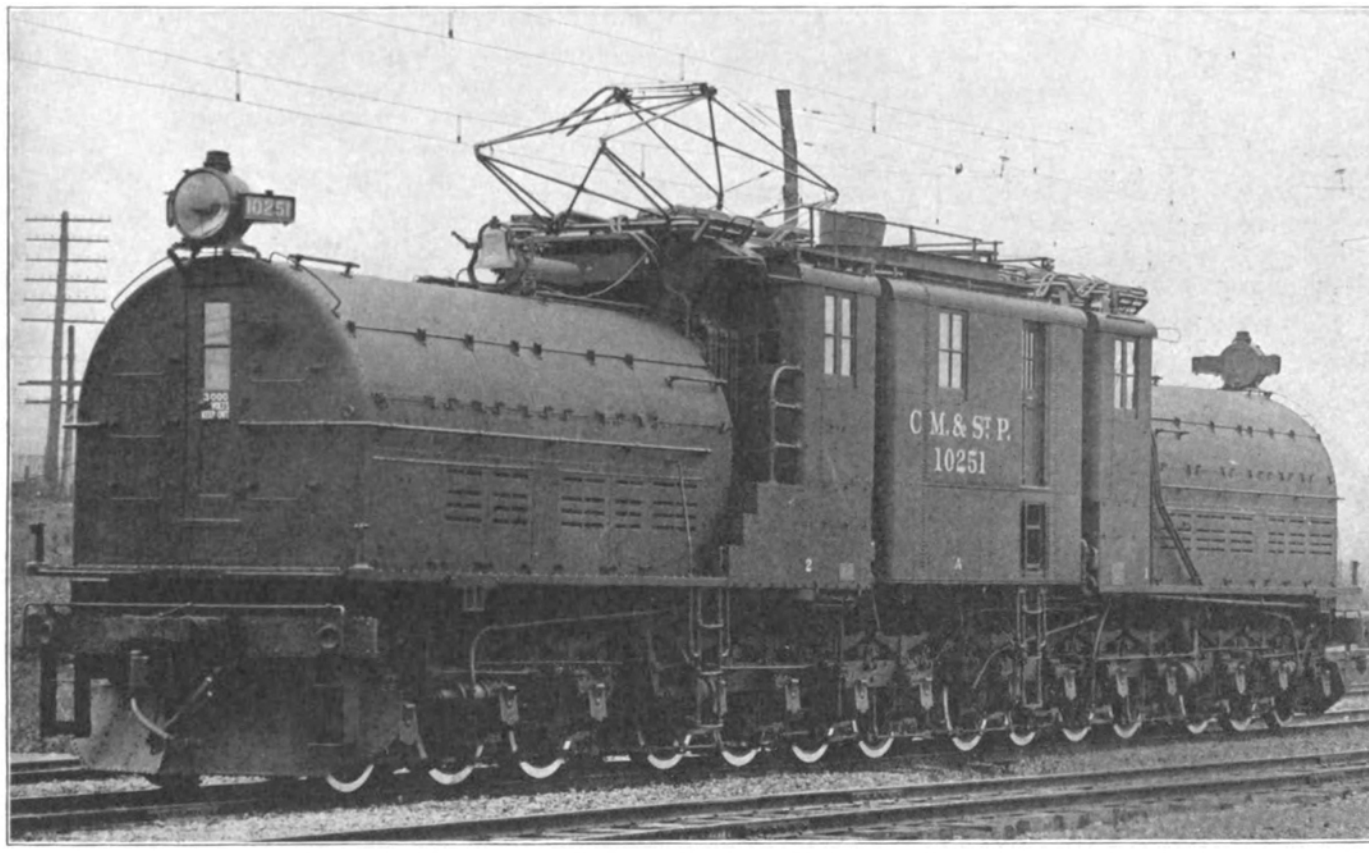
feature, they follow the design of the gearless locomotives in use on the New York Central Railroad, which have given remarkable operating results during the past ten years. The chief advantage of this method of construction is the great simplicity of mechanical design which eliminates all gears, armature and suspension bearings, jack-shafts, side rods or other transmitting devices. The remarkably low cost of maintenance of the New York Central locomotives over the entire period is attributed largely to the gearless type of construction.

Weight of Locomotive

The new Chicago, Milwaukee & St. Paul locomotives weigh 265 tons with 229 tons on drivers. They have fourteen axles, twelve of which are driving and two guiding axles. The weight of the armature and wheels is the only dead weight on the track and this is approximately 9,500 pounds per axle. The total weight on drivers (458,000 pounds) is 86 per cent of the weight of the locomotive but, being distributed among twelve axles, results in a weight of only 38,166 pounds per axle.

Distinctive Features

One of the most interesting and important features of the locomotive is the design of the leading and trailing trucks and the method of suspension of the cab weight upon them. The successive trucks are coupled together in such a way as to deadbeat or break up any lateral oscillations which may be caused by inequalities of the track. The weight of the main cab is so supported on the front and rear trucks that any lateral thrust or kick of the leading or trailing wheel against the track is cushioned by the movement of the main cab, which increases the weight bearing down on the wheels at the point where the thrust occurs, and automatically reacts to prevent any distortion of the track. The result of this design is such as to give riding qualities at high speeds which have probably never been attained before in a double-ended locomotive. Exhaustive tests on the General Electric Company's test tracks at Erie, Pa., have demonstrated the remarkable riding qualities of the new locomotive at speeds as high as sixty-five miles per hour which is the limit of speed on the length of the test track available. These tests also indicate that the locomotive will operate at much higher speeds with equal success.



New Gearless 3000-Volt D. C. Electric Passenger Locomotive for C. M. & St. P. Ry. Exhibited Before Prominent Railway Officials at Erie, Pa., Works of the General Electric Company, November 7, 1919

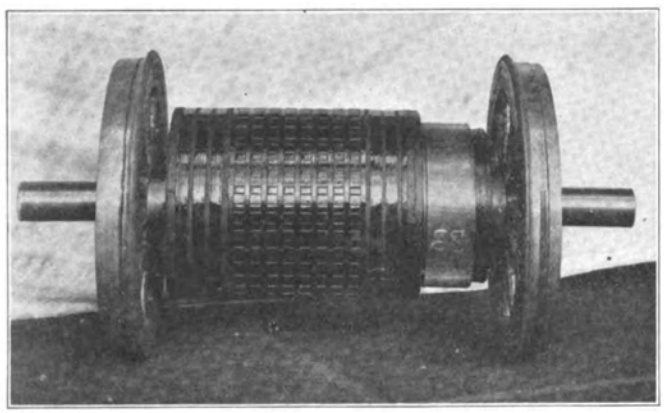
Hauling Capacity

The locomotive is designed for handling in normal service a twelve-car train weighing 960 tons trailing against a grade of 2 per cent at 25 m.p.h. This performance required 56,500 pounds tractive effort which is equivalent to a coefficient of adhesion of 12.3 percent of the weight upon the driving axles. The wide margin thus provided between the operating tractive coefficient and the slipping point of the motors, as well as the ample capacity of the motors, will allow this locomotive to haul trains with as many as fourteen cars in emergencies. For continuous operating, the locomotive is designed to operate at 42,000 pounds tractive effort at a speed of 25 m.p.h.

Dimensions and Weight

Length inside knuckles	76 ft. 0 in.
Length over cab	68 ft. 0 in.
Total wheel base	67 ft. 0 in.
Rigid wheel base	13 ft. 11 in.
Diameter driving wheels	44 in.
Diameter guiding wheels	36 in.
Weight electrical equipment	235,000 lb.
Weight mechanical equipment	295,000 lb.
Weight complete locomotive	530,000 lb.
Weight on drivers	458,000 lb.
Weight on guiding axle	36,000 lb.
Weight on each driving axle	38,166 lb.

Number of motors	12
One hour rating	3240 h. p.
Continuous rating	2760 h. p.



Driving Wheels and Motor Armature. The Armature is Mounted Directly on the Driving Axle

Tractive effort—1 hour rating	46,000 lb.
Tractive effort—continuous rating	42,000 lb.
Tractive effort—2 percent ruling grade with 960-ton train	56,500 lb.
Coefficient of adhersion ruling grade	12.3 percent
Starting tractive effort—25 percent coefficient of adhesion	115,000 lb.
Rate of accerleration starting 2 percent ruling grade	0.48 m. p. h. p. s.

Control Equipment

Advantage is taken of a new scheme of connections by means of which four of the main locomotive motors are utilized to furnish exciting current during regeneration, thus reducing the size of the motor generator set used for control, accessories and train lighting. An appreciable reduction in the weight of control equipment is obtained, at the same time providing for effective regenerative electric braking on the down grades. The motor-generator set furnishes control current for operating the contactors and for charging an 80-volt storage battery which supplies lights and power for the accessory apparatus. The master controller is constructed in three sections arranged for both motoring and regenerating, all of the cylinders being suitably interlocked to prevent incorrect manipulation.

Electrical Equipment

The motor is bipolar, two fields being supported from the truck springs with full freedom for vertical play of the armature between the pole faces. For full speed operation, the twelve motors are connected three in series with 1000 volts per commutator. Control connections are also provided for operating, four, six, or twelve motors in series. Additional speed variation is obtained by tapping the motor fields in all combinations. Cooling air for each pair of motors is supplied by a small motor-driven blower. This arrangement avoids the heavy duct losses encountered with a single large blower.

The gearless locomotive shows a much better efficiency at high speeds than the geared type owing to the elimination of the gear drive. In passenger service, where there are long stretches of level track and stopping points are comparatively few, a much higher efficiency is obtained in all-day service.

The 3000-volt contactors and grid resistors are mounted in the curved end cab at each end of the locomotive. In one of these cabs there is also located the 3000-volt d. c. air compressor and storage battery. In the other is located a small motor-generator set and the high speed circuit breaker. The operating cabs contain the master controller, indicating instruments and a small air compressor operated from the battery circuit with sufficient capacity for raising the pantograph when first putting the locomotive in operation. Near the controller are the usual air brake handles for standard braking equipment.

The center cab is occupied by the oil-fired steam boiler for heating passenger trains, with accessories, including tanks for oil and water, circulating pumps and a motor-driven blower for furnishing forced draft. A slider pantograph, similar in construction to those now in use, is mounted on each of the operating cabs. This pantograph has two sliding contacts, giving a total of four points per slider with the double trolley. The pantograph and flexible twin trolley construction enable the locomotives to collect currents as high as 2000 amperes at speeds up to sixty miles per hour without noticeable arcing at the contact points. The second pantograph is held in reserve as a spare. Sand boxes, with pipes leading to each pair of driving wheels, are located directly beneath the pantograph outside the operating cab.

The new locomotives will operate over the section between Othello, Seattle and Tacoma, including seventeen miles of 2.2 percent grade from the Columbia River west and nineteen miles of 1.7 percent grade between Cedar Falls and the summit of the Cascades. The traffic over this division consists of the heavy main line transcontinental passenger trains "Olympian" and "Columbian" carrying from eight to twelve steel passenger coaches which will be handled over the maximum grades without helpers. Freight pushers are already in operation on the 2.2 percent grade, using two of the locomotives from the original electrification. It is expected that electrical operation during the coming winter will assist in overcoming many of the delays which are commonly met with during winter operation in this district.