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New Electric Locomotives for C. M. & St. P. Ry.

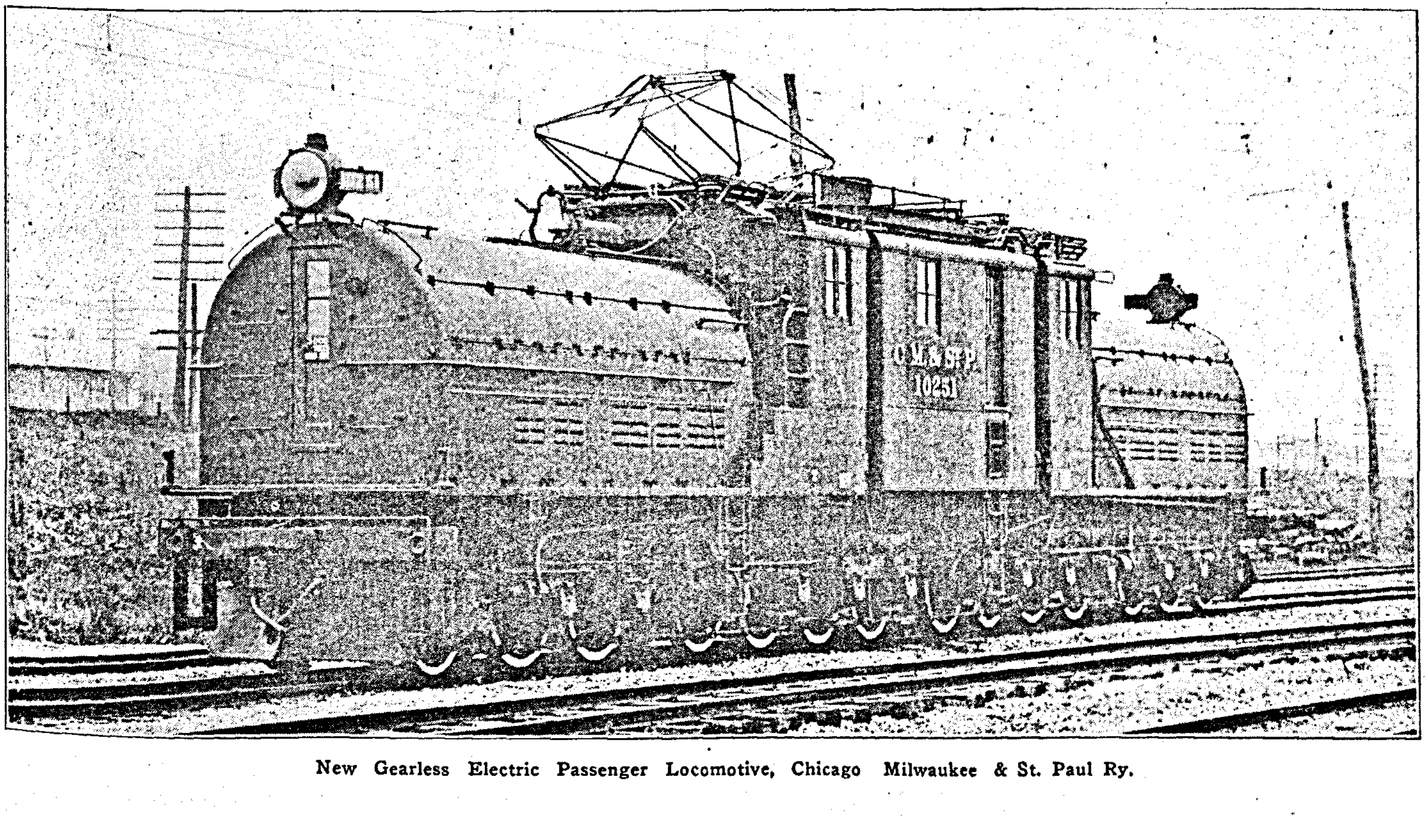
Latest Example of Electric Motive Power Reverts to N. Y. C. Type With Armatures on Axles

These latest electric locomotives for the Chicago Milwaukee & St. Paul Ry. weigh 265 tons each and operate on direct current at 3,000 volts. They will be used in passenger service in the Cascade electrified section serving the Seattle, Tacoma-Othello area, replacing geared locomotives which will be relegated to freight service. Of the fourteen axles, the front and rear are guiding axles, each of the twelve remaining carrying the armature of a bi-polar motor. Axle loads are but slightly more than 38,000 pounds. Speeds of 65 miles per hour have been attained with entirely satisfactory results.

The original electrification of the Chicago Milwaukee & St. Paul Ry. from Harlowton, Montana, to Avery, Idaho, 440 miles, has now been operating for a number of years under the extremely bad weather conditions of the Rocky and Bitter Root mountains and, as a result of its unqualified success, the same system will now be used to meet the severe grades and snow conditions of the Cascade range. The motive power consists of 42 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 ratios between motors and driving axles.

The new locomotives are entirely different in 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 their gear ratios. The locomotives are of the bi-polar gearless type, with motor armatures mounted directly on the driving axles. In this fundamental feature, they follow the design of the gearless locomotives in use on the New York terminal of the New York Central R. R., which have given remarkably satisfactory 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.

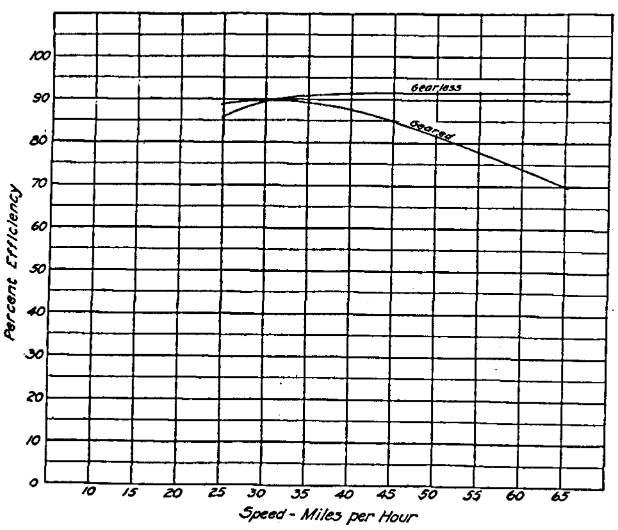
The new Chicago Milwaukee & St. Paul locomotives weigh 265 tons with 229 tons on drivers. They have fourteen axles, twelve of which are driving and two guiding axles. The weight of the armature and wheels is the only dead weight on the track and this is approximately 9,500 pounds per axle. The total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



New Gearless Electric Passenger Locomotive, Chicago Milwaukee & St. Paul Ry.

of the weight of the locomotive but, being distributed among twelve axles, results in a weight of only 38,166 pounds per axle.

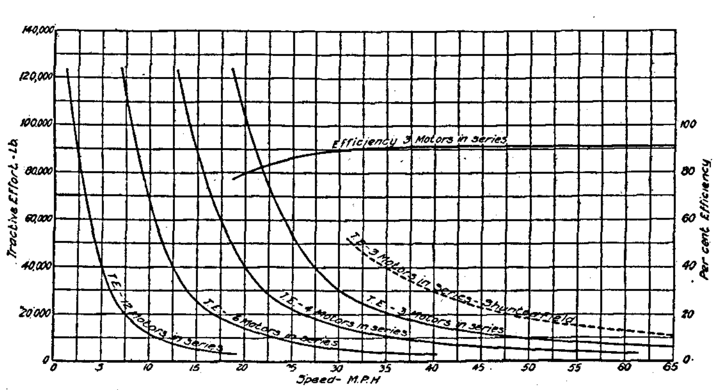
One of the most interesting and important features of the locomotive is the design of the leading and trailing trucks



Comparison of Efficiency Curves, Geared vs. Gearless Electric Locomotives.

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 65 miles per hour which is the limit of speed on the length of test track available. These tests also indicate that the locomotive will operate at much higher speeds with equal success.

The locomotive is designed for handling, in normal service, a 12-car train weighing 960 tons trailing against a grade of two per cent at 25 miles per hour. This performance



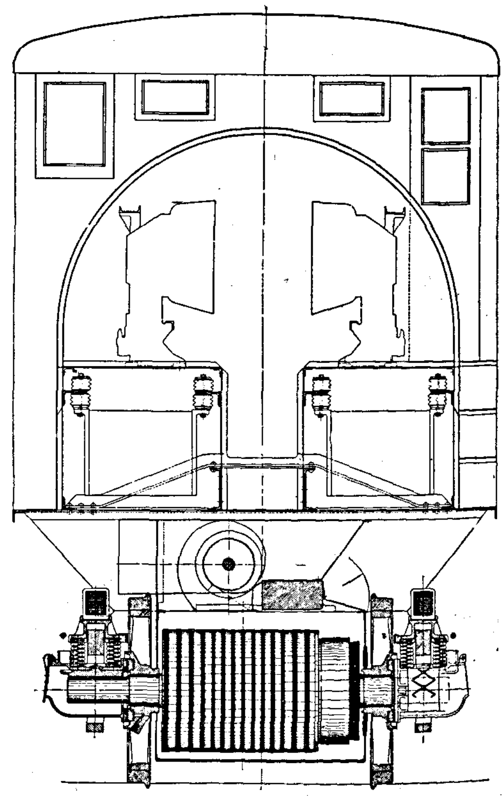
Characteristic Curves of Gearless Electric Locomotive.

requires 56,500 pounds tractive effort which is equivalent to a coefficient of adhesion of 12.3 per cent of the weight upon the driving axles. The wide margin thus provided between the operating tractive coefficient and the slipping point of the wheels, 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 operation, the locomotive is designed to operate at 42,000 pounds tractive effort at a speed of 25 miles per hour.

The total weight supported on driving axles is practically the same as that on the present geared passenger locomotives, weighing a total of 300 tons. The table below gives the principal dimensions, weights and capacity of the gearless locomotive:

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	485,000 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.
Tractive effort—1 hour rating	46,000 lb.
Tractive effort—continuous rating	42,000 lb.
Tractive effort—2 per cent ruling grade with 960-ton train	56,500 lb.
Coefficient of adhesion ruling grade	12.3 per cent
Starting tractive effort—25 per cent coefficient of adhesion	115,000 lb.
Rate of acceleration starting 2 per cent ruling grade	0.48 m.p.h.p.s.

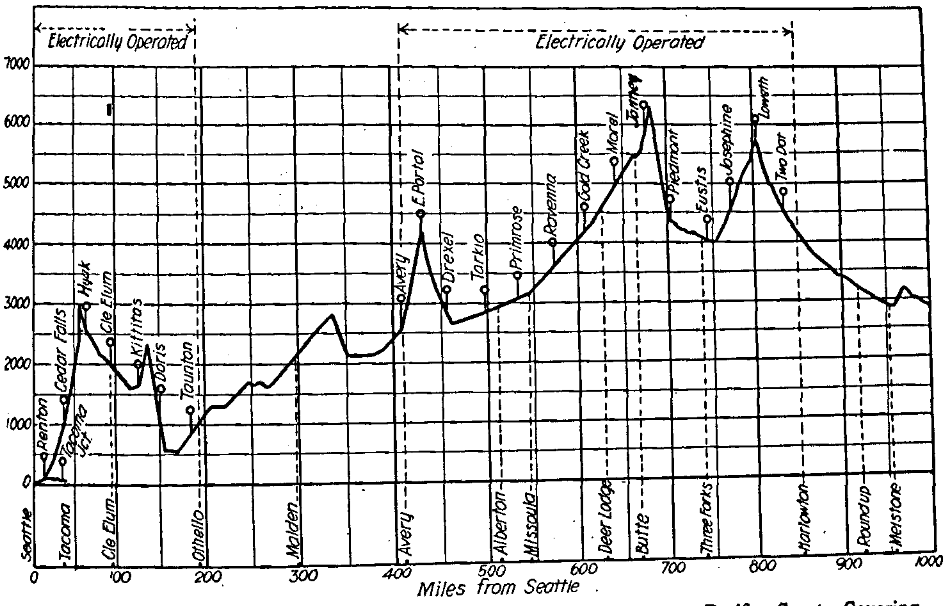
The control equipment for the new locomotive is similar in most respects to that used on the original locomotives which have now been operating nearly four years. Modifications were, of course, necessary to comply with the different arrangement of motors. Advantage is taken of a new scheme of connections by means of which four of the main locomotive motors are utilized to furnish exciting current during



End Elevation and Cross Section, New Gearless Electric Passenger Locomotive, C. M. & St. P. Ry.

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 battery is, in general, similar to those used on the passenger coaches. 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.

The motor is bi-polar, two fields being supported upon the truck springs with full freedom for vertical play of the armature between the pole faces. The outline of the locomotive with a sectional view typical of four of the motors, indicates the location of the armatures and the magnetic section. For



Profile of Chicago. Milwaukee & St. Paul Ry. from Harlowtown, Montana, to Pacific Coast, Covering Both Eastern and Western Electrification

full speed operation, the twelve motors are connected three in series of 1,000 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.

As may be seen from the accompanying curves, 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. These curves show an efficiency at 50 miles per hour approximately 10 per cent higher than the geared type of locomotive.

The 3,000-volt contactors and grid resistors are mounted in he curved end cab at each end of the locomotive. In one of these cabs there is also located the 3,000-volt direct current 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, in the No. 2 cab, a small air compressor operated from the battery circuit. This compressor is of sufficient capacity to raise 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 2,000 amperes at speeds up to 60 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.

One of the illustrations shows a continuous profile from Seattle to a point about 1,000 miles east, including the Cascade electrification, the Harlowton-Avery electrification and the intervening 220 miles. The new locomotives will operate over the section between Othello, Seattle and Tacoma, including 17 miles of 2.2 per cent grade from the Columbia river, west, and 19 miles of 1.7 per cent 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 per cent 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.

The locomotives herein described, as well as the entire equipment for the original electrification, including substations, were manufactured by the General Electric Co. They are a product of the company's extensive plant at Erie, Pa., at which point a large company of steam and electric railway officials assembled on Friday, November 7, to inspect the engines and witness the tests to which they were subjected.

Tank Car Maintenance

By Paul Bateman.

A discussion and criticism of some of the existing tendencies in tank car design and maintenance. The author is superintendent of the Peoples Tank Line Co. at Coffeyville, Kan. His comment on the above subject is adapted from a recent issue of the official journal of the American Society of Mechanical Engineers.

Since tank cars constitute a large item of initial expense to almost every producer and marketer of petroleum products, it is of some importance that they be maintained at a point of greatest efficiency with a minimum of upkeep expense. As an engineer and designer for several years in the employ of two of the largest car builders in the country, it was a matter of circumstance that one of the outstanding ideas of the car builders was forcibly brought to the writer's notice, that being in substance, the purpose to design something different.

The best engineering practice is sometimes made subservient to the principle of designing something on which a claim for a patent may be made. This practice has resulted in innumerable types of cars, each type with its own variations, and has greatly complicated the problem of maintenance of equipment. Repair shops have been called into existence by the impossibility of car owners carrying a sufficient variety of parts to repair their cars properly. Although there are some few concerns which employ experienced repair men, the owners of cars must in general trust to inefficient labor to perform work that requires specialized knowledge and experience. Behind the experience also there must be knowledge, not only of how to make the repairs, but as to why a part requires repairs and how to prevent a recurrence of the same trouble. To make this clear reference may be had to Fig. 1 showing the end of the underframe of a car. There are innumerable variations in the end structure, but the principle must remain the same in all.

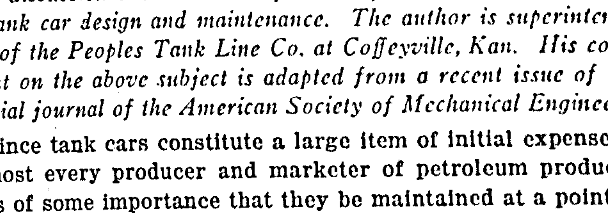


Fig. 1—Typical Arrangement of Center Sills and Draft Attachments.