THE MOTOR USED ON THE 300-TON LOCOMOTIVES OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

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This article gives a good description of the mechanical features of the traction motors used on the Chicago, Milwaukee & St. Paul Railway. It is well illustrated with views and diagrams, which themselves give much important data. Operating results have proved the design of these motors to be highly satisfactory.—Editor.

The motors used on the 300-ton electric locomotives in service on the Mountain Divisions of the Chicago, Milwaukee & St. Paul Railway are known as the GE-253 and are the largest geared motors, mounted on an axle, which have been used in the electrification of steam railways. This article briefly describes the design and construction of these motors.

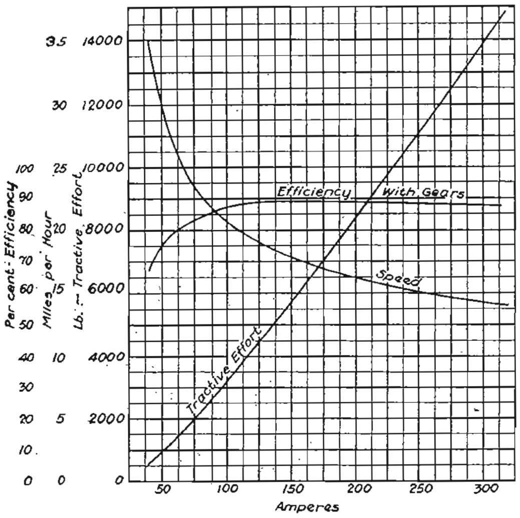

Fig. 1. Characteristic Curves. GE-253-1500/3000-volt Railway Motor. Volts per Motor, 1500; Gear, 82 teeth; Reduction, 4.56; Pinion, 18 teeth; Wheel Diameter, 52 in.

Based on the A.I.E.E. standard method of rating, the one hour rating of the GE-253 motor is 452 h.p.; the continuous rating, based on 100 deg. C. rise by resistance of the armature and 120 deg. C. rise by resistance of fields, is 396 h.p. These ratings are for a potential of 1500 volts, two motors being coupled in series for operation on 3000 volts. The motor is designed for operation with an external blower, and the volume of air used at the continuous rating is approximately 2500 cubic feet per minute. The air is blown into the motor through a large opening on the front of the magnet frame at the commutator end. It passes in parallel streams through the armature and over the field coils and is exhausted through openings in the magnet frame and bearing head at the opposite end of the motor from the commutator.

The motor complete, including spring gears, pinions, gear case and axle lining weighs 14,860 pounds. It has four main poles and four commutating poles. It is designed for shunted field control, the fields being shunted fifty per cent in motoring at full speed.

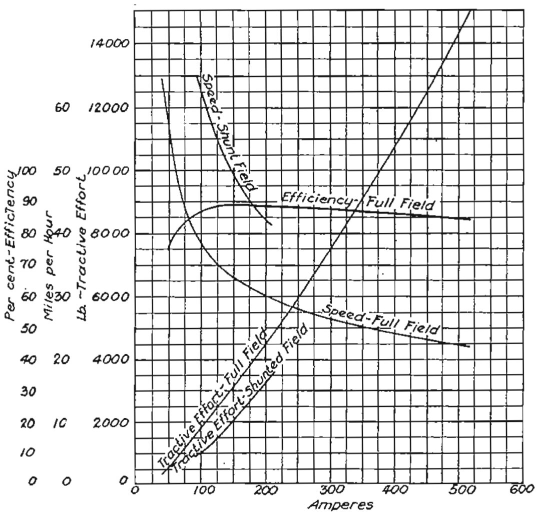

Fig. 2. Characteristic Curves. GE-253-1500/3000-volt Railway Motor. Volts per Motor, 1500; Gear, 71 teeth; Reduction, 2.45; Pinion, 29 teeth; Wheel Diameter, 52 in.

The armature has forty-nine slots, with seven coils per slot, and the commutator three hundred and forty-three segments. The armature coil has a single turn winding. The diameter of the armature core is 29½ in. The coils are insulated with mica and asbestos. At the one hour rating the speed of the armature is 446 revolutions.

There are four brush-holders per motor, each brush-holder having two brushes $\frac{11}{16}$ by 1¾ inches.

The main field coils are wound with strip copper in two sections with asbestos between turns. They are insulated with mica and asbestos, and have a final wrapping of strong cotton tape. They are, therefore, capable of withstanding high temperatures without injury. The commutating coils are made of edgewise wound strip copper and are insulated in a similar manner to the main field coils. All the field coils are thoroughly impregnated by the vacuum process. The main exciting field coils are not subjected to full voltage, since the armatures of two motors are connected in series with the fields of both motors on the ground side.

The commutating characteristics of the motor are most excellent, and it is possible to raise the voltage on a stand test fifty per cent above normal without injurious sparking. During operating periods of regeneration at voltages materially higher than 3000 the fields can be shunted to a surprising extent without appreciable sparking.

Fig. 1 shows the speed, torque and efficiency curves of the motor with gearing for freight service; Fig. 2 shows similar curves for passenger service.

In mechanical design the motor, in general, follows well-known and thoroughly tried out lines of construction. Figs. 3 and 4 show

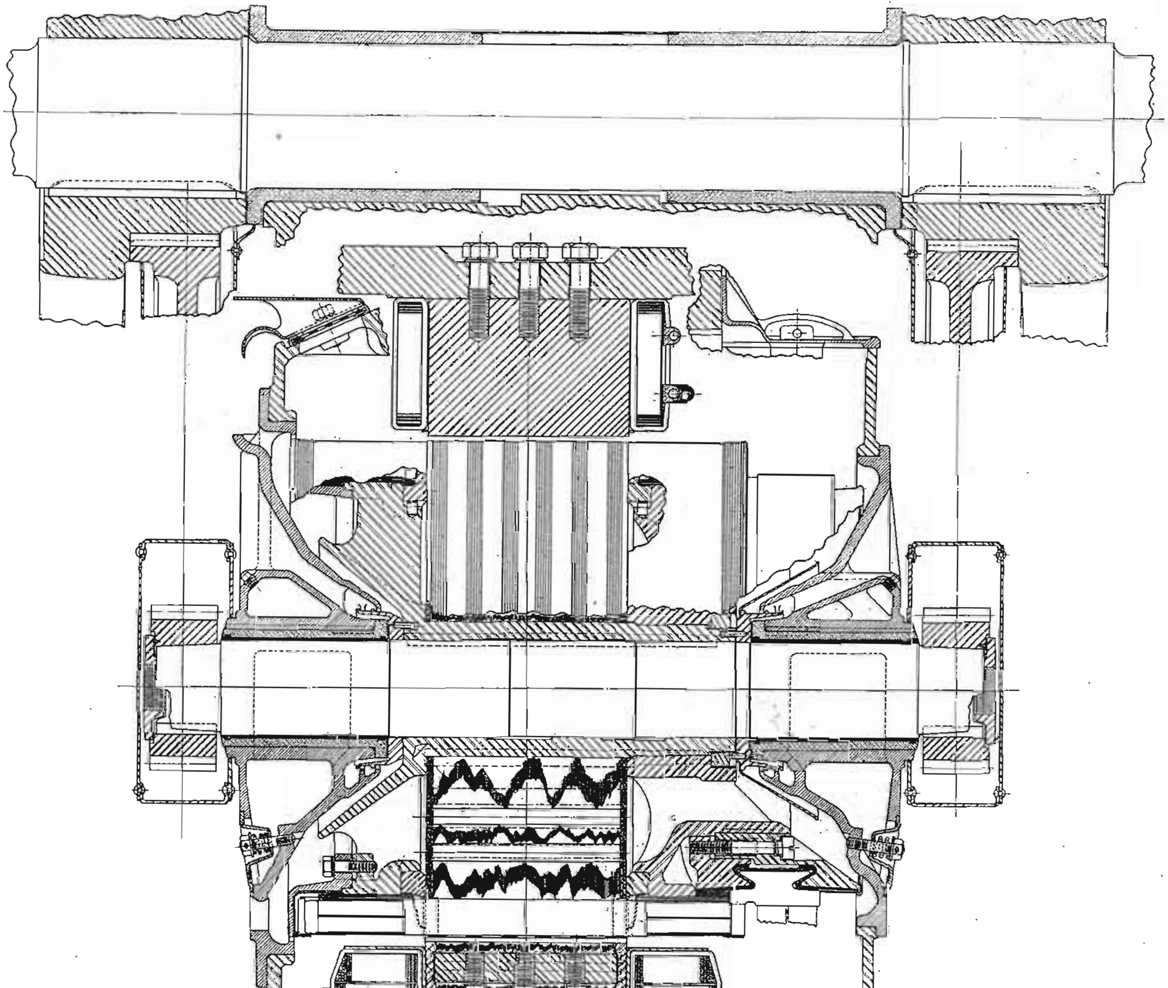

Fig. 3. Longitudinal Section of Motor

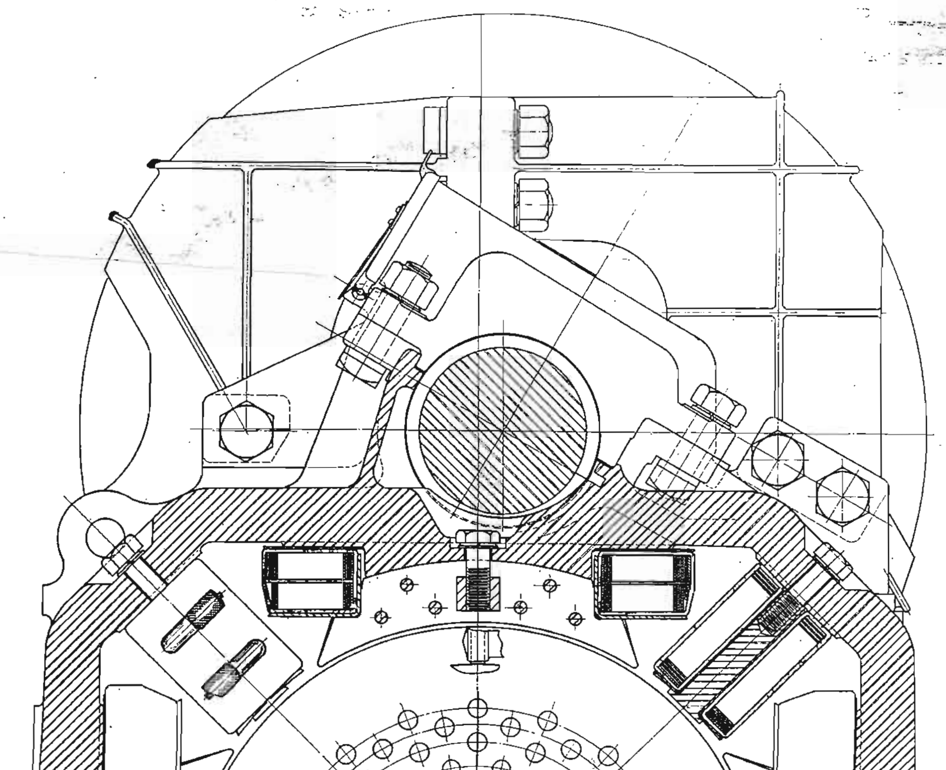

Fig. 4. Transverse Section of Motor

eighty-two teeth in the gear, and for the passenger locomotives there are twenty-nine teeth in the pinion and seventy-one teeth in the gear. Both gears and pinions are made of high-carbon oil-treated stock, having an elastic limit of 85,000 pounds per square inch.

The gear cases are made of sheet steel with rim and sides securely riveted together. The supporting brackets extend over the rim of the case and are securely riveted to the rim and sides. The magnet frame is made of cast steel and, except in size, differs but little in general appearance from standard box frame railway motors.

The front of the motor is carried on the truck through an improved spring suspension. The design is such that both the downward and upward thrust is taken through springs. This form of suspension largely reduces the shock on the motor in passing over switches, crossings or other rough places in the track. The spring gears, and to a less extent the motor suspension, relieves the teeth of the gears of "hammer blows," and equalizes the load on the pinion and gear teeth at each end of the motor.

The brush-holder design is of standard construction. The holders are supported and protected from the ground through mica insulated studs.

In service the motors have operated with most excellent results. The commutators take on a bright, smooth polish, with no indications of etching at the edges of the segments. The effect of the spring gears and spring suspension is to make the motors run with unusual quietness. There is no noticeable gear noise while the locomotives are in motion. The absence of vibration is also noticeable. This is quite a marked contrast to heavy twin geared motors when operating without spring gears and spring nose suspension. The motors run at a comparatively low temperature in service, the capacity of the motors being sufficient to handle heavier trains than originally contemplated.

THE CONTROL EQUIPMENT, WITH REGENERATIVE ELECTRIC BRAKING FEATURE, ON THE LOCOMOTIVES OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

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The author describes the control features of the St. Paul locomotives in great detail. The article is profusely illustrated which greatly helps an understanding of the text. Special attention is paid to the regenerative control.—Editor.

The engineer of a single 282-ton St. Paul electric locomotive has an enormous concentration of power at his command. The ease, efficiency, reliability and safety with which this power is made to serve the purpose of the engineer, while he maintains his train schedule involving wide variations in locomotive speeds, up and down grade, over the rugged profile of the Rocky Mountains, depends in a large measure upon the motor control equipment.

Owing to the great power needed in this exacting transcontinental service, the control design, both mechanically and electrically, includes many interesting departures. Particularly owing to the economic and safety requirements of definite speed regulation by electrical means down grades, the novel feature of regenerative electric braking has been provided in addition to the air brakes.

COLLECTION OF CURRENT

The system of current collection, which must be capable of handling unusually heavy currents at high speeds, has the distinctive feature of using two parallel adjacent copper conductors supported alternately and independently, by loop hangers from the same messenger wire. A continuously flexible contact surface, for the most part of double area, is thus obtained. In addition, each pantograph is equipped with two sliding contacts. Ordinarily, therefore, there are four points of contact between the collector and the trolley wires. With this very flexible combination a single pantograph, (and there are two on all locomotives for emergencies) can easily collect the heavy currents obtaining in the St. Paul service. Sparking is entirely eliminated. The current required for a single locomotive at the continuous rating of the motors is 840 amperes. In the passenger service, speeds up to 60 m.p.h. and over are attained.

Figs. 8 and 9 are characteristic curves based on 3000 volts line showing the amperes per motor obtained, at different locomotive speeds, in the freight and passenger service