New Passenger Locomotives for St. Paul's Rocky Mountain Division

Some Details Are Given of the Ten Engines Now Being Delivered to Replace the Original Ones on This Division Now Being Regeared for Freight Service

ABOUT four years ago public interest centered on the initial 440-mile electrification of the Chicago, Milwaukee & St. Paul Railroad over the Rocky Mountains. This epoch-making installation included as motive power ten passenger and thirty-two heavy freight locomotives. When later the extension over the Cascade Mountains was decided upon, five new passenger locomotives were ordered from the General Electric Company for this division and ten new passenger locomotives were ordered from the Westinghouse Electric & Manufacturing Company to replace the passenger locomotives on the division farther east, which were to be regeared for freight service.

The passenger locomotives for both divisions are now being delivered by the manufacturers. Up-to-date information regarding those for the Cascade Division was given in the ELECTRIC RAILWAY JOURNAL for Nov. 1, 1919, page 827. In a paper delivered before the New York Railroad Club, and abstracted in the issue of this paper for March 28, 1918, page 559, F. H. Shepard, director of heavy traction Westinghouse Electric & Manufacturing Company, gave a preliminary account of the passenger locomotive for the Rocky Mountain Division. It is now possible to reproduce an actual picture of the locomotive and to give a few of the design considerations. A later article will go into the more technical features of the locomotive.

The Rocky Mountain passenger locomotive has a capacity to develop 4200 hp. for one hour without exceeding normal temperature of the motors, and the normal starting drawbar pull is 100,000 lb. The drawbar pull can, however, be increased without injury to the electrical apparatus up to the point of wheel slippage.

The locomotive consists of two duplicate running gears of the Pacific type placed back to back, supporting a single cab. The wheel arrangement of the locomotive is 4-6-2-2-6-4, the drivers are 68 in. in diameter, the rigid wheelbase is 16 ft. 9 in. and the total wheelbase is 79 ft. 10 in. Rigid and floating center pins have been provided to relieve the cab structure of any pulling or bumping strains, all such forces being transmitted directly through the running gear.

This locomotive has been designed to include the features which have proved to be of distinct advantage in steam locomotive design. Other features kept in mind by the designers were to limit the amount of high voltage auxiliary apparatus, to provide facility for inspection of the main motors, to furnish a wide range of operating speed, and to provide the best possible disposition of the apparatus as to grouping and mounting.

Particular attention was directed to the articulation of the several trucks. In their design it was the endeavor to have each truck laid down to take care of itself and not have to be led along by any of its companion trucks. During the tests at East Pittsburgh this feature of the mechanical operation of the locomotive was said to be most pronounced, and to quote one authority, "the engine has the riding qualities of a Pullman car."

An effective study was also made of weight distribution and its equalization among trucks. With this latter end in view, comparatively long spring hangers were used so that any slight increase or decrease in their lengths, for the purpose of shifting the load, would not have any noticeable effect on the position of the locomotive springs.

Power is supplied for the locomotive from six motors of the twin-armature type, mounted on the locomotive running gear. The two armatures of each motor are permanently connected in series and the control is so arranged that at least two motors are always in series. The result is that with the locomotive voltage of 3000 on the overhead contact wire, that across any one armature never exceeds 750 volts during motor operation. The control is further arranged so that all main motor fields are connected on the ground side of the circuit, thus maintaining most of the voltage stresses on the motors practically in line with commercial usage for the past fifteen or twenty years.

The motors are mounted, one over each driving axle, on the frame of the locomotive, transmitting their power by means of an 89 to 24 gear-and-pinion reduction to the locomotive drivers. The gears and pinions are kept in mesh by a quill shaft supported on the locomotive frame and surrounding the locomotive axle with a liberal clearance. The connection between the driving wheels and this quill shaft is made by means of springs, one end of each of which is connected to the quill shaft, while the other engages a bracket on the spokes of the drivers. This arrangement permits the drive wheels to follow the unevenness of the roadbed without affecting the gear mesh, and it also provides a cushioning effect for the torque of the motors.

In the design of this type of quill shaft, the details have been governed by the experience of the manufacturers obtained from the successful application of a similar class of drive on the New York, New Haven & Hartford locomotive. Due allowance, however, has had to be made for the increase in tractive effort.

The cab structure of the locomotive, which also partially incloses and protects the main motors, contains the auxiliary apparatus necessary for the proper functioning of the motors. Enginemen's operating compartments are located at the ends, connected by aisles extending along the side of the cab. All high-voltage apparatus is inclosed in compartments, so as to protect the engine crew while the locomotive is in operation. When the locomotive is "dead," however, easy access is afforded for the inspection and adjustment of all apparatus by removing the compartment sides and by passage through center aisles opening through expanded metal doors onto the cross aisles.

Regeneration of power on down grades and in braking on these locomotives is accomplished in the following

PASSENGER LOCOMOTIVE FOR USE ON THE ROCKY MOUNTAIN DIVISION OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILROAD

manner: Control of the excitation of the main motors for regeneration is initiated manually by the operator from the master controller, the exciting current coming from two small generators geared to idle axles. The excitation of the exciters is secured from an independent source, a motor-generator set operating in parallel with a small storage battery. It is obviously necessary to have a separate source of excitation for the motors during regeneration because these must furnish characteristics similar to those of a shunt or separately-excited generator for this purpose. All of the main motors are used during regeneration. The exciters are automatically connected to the low-voltage auxiliary circuits during motoring, thus reducing the necessary size of the motor-generator set which is used in regenerating operation to supply these circuits. During motoring the motor-generator is called upon to furnish current for lighting the train, charging the train batteries, excitation to the axle generator fields, the control circuits and for charging the storage battery. One of the axle generators is mounted on the inside axle of each bogie truck. They are built like ordinary interurban railway motors, but are separately excited and are wound for 90 volts.

The control of the locomotive provides three motor combinations, giving full series and two series-parallel connections. In the latter two connections there are two parallel circuits of three motors in series and three parallel circuits of two motors in series. In each of these motor combinations three running matches are provided, namely, full field, short shunt and long shunt. This gives a total of nine efficient speeds at the disposal of the engineman during motor running. While decending a grade, the excitation of the motor field is entirely under the control of the engineman, and may be increased or decreased as desired, causing corresponding increments and decrements in the regenerative effort of the locomotive. The speed of the train can thus be varied through any desired range. The full motor capacity of the locomotive is available for regeneration. The locomotive with a given current will develop 15 to 20 per cent more retarding effort during regeneration than tractive effort in motoring. On a 2 per cent grade it can hold about 60 per cent more load in descending than it can haul up the grade. On a 1 per cent grade it can hold more than double the load it can haul up.

Power for energizing the control circuit and the operation of the auxiliary apparatus, such as blower motors, the motor-driven air compressor, etc., when these are not being driven by the axle generators, is obtained from a small motor-generator set operated in parallel with a storage battery. The high-tension winding of this set is the only piece of revolving apparatus on the loco-

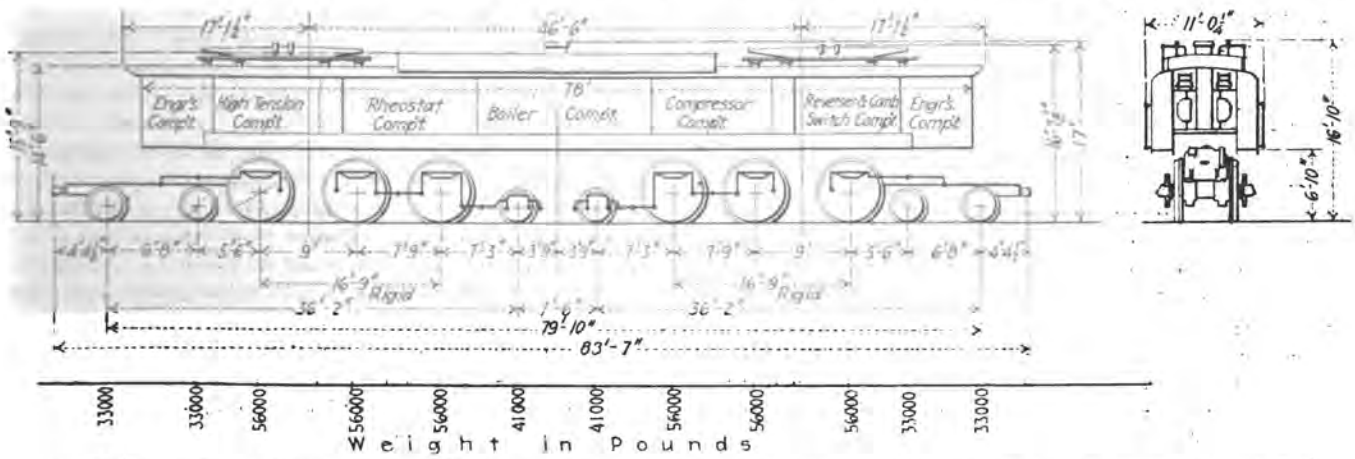

DIAGRAM SHOWING GENERAL ARRANGEMENT OF EQUIPMENT, DIMENSIONS, ETC., OF THE NEW PASSENGER LOCOMOTIVE FOR THE ST. PAUL ROCKY MOUNTAIN ELECTRIFICATION

motive, with the exception of the main motor, connected to the 3000-volt circuit. The low-tension side is also provided with slip rings for the collection of low-voltage alternating current for the headlights and certain of the interior cab lights.

All main motor and resistance circuits are opened by means of electropneumatic, 3000-volt switches, which are standard for the Westinghouse unit-switch control. These are provided with powerful blowout coils to extinguish the arc. Transfer of circuits where no high voltage current is to be broken is accomplished by means of cam-type contactor groups, adopted for the purpose of reducing space and weight by the elimination of the otherwise necessary unit switches. The control circuits of all unit switches and cam contactor groups are interlocked electrically to prevent false functioning of the apparatus. All unit switches, cam contactor groups, grid resistors, protective relays, etc., are mounted in the compartments as previously described.

The center compartment of the locomotive is given up entirely to an oil-fired steam boiler, its supply tanks and auxiliaries. This boiler, which is for the purpose of heating the passenger trains, is capable of evaporating 4000 lb. of water per hour. Two storage tanks for water are provided, having a combined capacity of 25,500 lb. There is also a tank for fuel oil with a capacity of 750 gal. This steam boiler also feeds radiators in the operating cab.

The data for the locomotive are summarized in the accompanying table.

DATA FOR ST. PAUL PASSENGER LOCOMOTIVE FOR ROCKY MOUNTAIN DIVISION

Normal trolley voltage	3,000
Total weight	275 tons
Weight on drivers	336,000 lb.
Weight on leading trucks	66,000 lb.
Weight on trailing trucks	41,000 lb.
Total wheelbase	79 ft. 10 in.
Driving wheelbase	16 ft. 9 in.
Maximum rigid wheelbase	16 ft. 9 in.
Diameter of drivers	63 in.
Diameter of leading truck wheels	36 in.
Diameter of trailing truck wheels	36 in.
Locomotive capacity at 23.8 m.h.p. (one hour rating)	4,200 hp.
Locomotive capacity (continuous) at 80 per cent of above	3,360 hp.
Normal starting tractive effort	100,000 lb.
Normal speed on level track	55 m.p.h.
Capacity of steam boiler, per hour	4,000 lb.
Capacity of water tanks	25,500 lb.
Capacity of oil storage tank	750 gal.
Cab length	73 ft. 0 in.
Total over-all length	88 ft. 7 in.

Fare Situation in Toronto

THE *National Municipal Review*, which is publishing a series of articles on the fare situtation in different cities, covers in its issue for November, 1919, the situation at Toronto and San Francisco. The article on San Francisco is written by M. M. O'Shaughnessy, city engineer, and relates particularly to the history and present condition of the municipal railway. The article on the Toronto system is written by the municipal editor of the Toronto *Star*.

In Toronto the fares are still those provided in the agreement of 1891, namely: cash fare, 5 cents; tickets good at any time, six for 25 cents or twenty-five for $1; tickets good between 5:30 and 8:30 a. m. or 5 and 6:30 p. m., eight for 25 cents. Since 1891, when these rates were agreed upon, all costs of operation have greatly increased. Wages alone have doubled since June, 1916.

The company stock, which sold at 148 in 1913, has fallen to 42. The city has agreed to buy the property when the franchise expires in 1921, the price to be the valuation of its physical assets.

New York Electrical Society Has Historical Meeting

AT THE 377th meeting of the New York Electrical Society held on Nov. 25, last, Frank J. Sprague spoke on the development of electricity for railway transportation purposes. He spoke also of his own work at Richmond and on the Chicago South Side "L" and the New York Central electrification projects.

In speaking of the future of railway electrification he called attention to the attitude of the French commission recently in this country to study heavy electric traction. The commission after inspecting the Chicago, Milwaukee & St. Paul and other electrifications was enthusiastic over the use of high-voltage direct current and believed that this system was the only one for future electrification. Mr. Sprague himself believes that the economic performances developed by these locomotives will be even better than anticipated and predicts the use in the near future of a third-rail carrying 1500 to 1800 volts direct current, the use of regenerative control for braking purposes and the supply of power to the line when going down grade, the use of gearless motors and the interchange of passenger and freight locomotives.

In speaking of the urban electric railways, he pointed out that the government had, by price-fixing methods, doubled the railways' coal bills, raised the wages of their trainmen through a special war labor board, and their equipment cost more than in pre-war days; and yet this is the only industry, said Mr. Sprague, that does not have direct control over the selling price of its one product—service.

Referring to the New York situation, he said that while the subway system there is the most extensive in the world, it is now impossible to maintain the equipment in the safe operating condition demanded for the carriage of the ever-increasing hordes of people, and at the same time to carry them increasingly greater distances for the single fare adopted at the time the subway was opened.

The Public Service Commission, he stated, was playing a lone hand, but nevertheless was using commendable independent judgment against the city officials' dictum that, irrespective of existing conditions, no increase in fares shall be allowed because such would not be acceptable to the people. The average man, said Mr. Sprague, is disposed to deal fairly, and where differences concerning public welfare arise between a transportation company and a city, it is incumbent upon each to approach the situation in an open-minded manner and with absolute frankness, so that the public can see fairly and understand the merits of the case. It was useless, so far as the attitude of the public is concerned, for the railway or the Mayor to issue independent reports on conditions. What was needed was for the Mayor, the Public Service Commission and the company to agree upon some body, composed of technical and financial men, who will lay the facts of the case before the public. If the contentions of the railway are true, the public will accept this impartial body's solution.

Mr. Sprague said that personally he had no patience with the threat of receivership or municipal operation, for it is impossible for any political party to get the quality of men necessary at the price a municipality would pay. The men who run a railroad, he declared, must have an incentive for which to work and must take pride in their accomplishments.