Electric Locomotive Performance on the Pennsylvania Railroad

Some very interesting figures have just been given out covering the performance of the electric locomotives used by the Pennsylvania Railroad on the Manhattan Division, operating passenger trains through tunnels entering New York City under Hudson River. This project has been noted at various times in the RAILWAY ELECTRICAL ENGINEER.

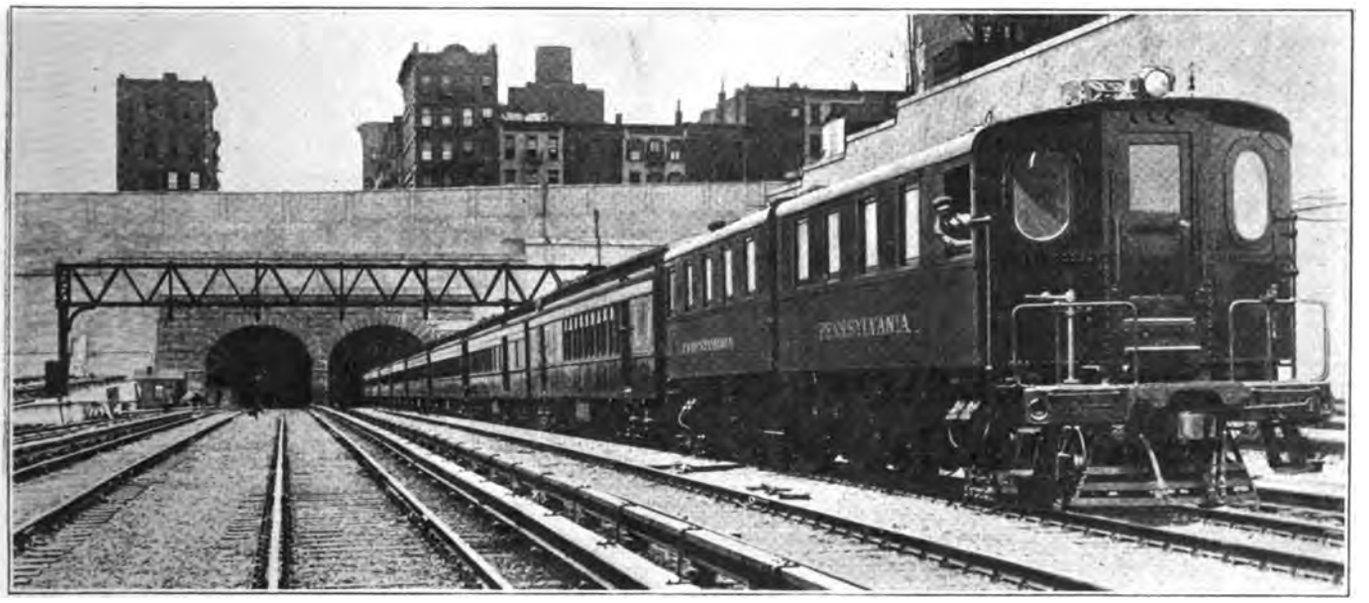
These locomotives have been in use for nearly four and one-half years and the data given below represents their performance during the period in a very striking manner.

motives is done in one of the regular steam locomotive repair shops.

On November 28, 1914, these 33 locomotives had completed four years' service, and during that period the mileage made and detention record is as follows:

Locomotive-miles	3,974,746
Total Engine Failures	45
Total minutes detention to trains	271
Locomotive-miles per detention	88,328
Locomotive-miles per minute detention	14,667

During this period, 463,588 train movements were



Typical Train with Electric Locomotive Running Into New York Under Hudson River.

They were designed to start and accelerate a 550-ton train, in addition to the locomotive, on a 1.93 per cent grade in tunnels, but in actual operation, 850-ton trains are frequently started on this grade and trains of 14 all-steel cars, weighing over 1,000 tons, are handled without difficulty.

Each locomotive in service passes over an inspection pit every 24 hours, when a running inspection of machinery is made, similar to that given steam locomotives over the pit, and slight repairs made where necessary. The average time required for this inspection is approximately ten minutes.

After 3,000 miles run, the locomotives are taken into the shop for a general or periodic inspection, when all electrical apparatus is thoroughly gone over, tested, cleaned and necessary adjustments and renewals made to all electrical and mechanical parts.

The shopping of these locomotives for general repairs is governed by tire wear, and a number of locomotives have run from 90,000 to 112,000 miles before it was necessary to turn the tires or do any general repair work.

The general overhauling and repairing of these loco-

made, or an average of 1,300 movements per detention, due to engine failures.

At Manhattan Transfer, where the change is made from steam to electric locomotive, on trains to and from the Pennsylvania station, the time allowed per schedule for making change, including necessary testing of air brakes, is four minutes; although the entire operation can be performed in three minutes, and has been done in two minutes.

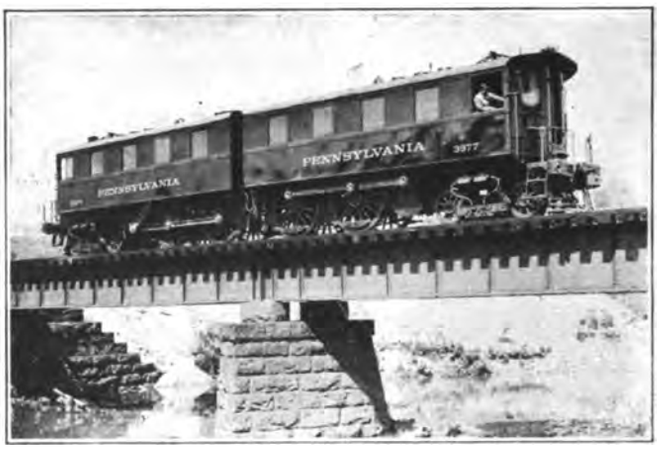
These locomotives are articulated machines, each consisting of two semi-units permanently coupled together, each semi-unit having a four-wheel bogie-truck and two pairs of driving wheels connected by side-rods, the semi-units being permanently coupled together at the driving wheel end. The locomotive frame, driving wheels, trucks and running gear are similar in general character to the standard American type steam locomotive and the relation of the various working parts on the two semi-units is similar in location to two steam locomotives coupled back to back.

Each semi-unit is equipped with a 2,000-horsepower motor connected to the driving wheels through a sys-

tem of parallel rods and cranks with an intermediate shaft, and is fitted with unit switches, master controller, Westinghouse automatic and straight air brake apparatus, electric headlight, pneumatically operated whistle, sand apparatus and other items of lesser importance. The locomotive equipment is so arranged that in the event of one motor being cut out of service, the entire locomotive can be operated from the other cab with the remaining motor. The unit switch control permits two or more locomotives to be coupled and all to be operated from either end of any one cab. The semi-units are interchangeable, and if any two semi-units are separated, they can be combined with any two other semi-units, as may be required in making repairs, or for other reasons. The controllers are fitted with four running notches, giving great flexibility of speed regulation, and permitting the most economical use of power during acceleration.

Each motor has a continuous rating of 1,000 and a maximum rating of 2,000 horsepower, or a total of 4,000 horsepower per locomotive. The motors are of the direct-current, field-controlled commutating-pole series type. The weight of each motor complete, including cranks, is 43,000 pounds. The motors are supplied with direct current at 650 volts from the third rail, through contact shoes, located on either side of each truck. The motors, control and the complete electric equipment was furnished by the Westinghouse Electric and Manufacturing Company, while the locomotives were built by the Pennsylvania Railroad in its own shops at Altoona.

The rated tractive power of each locomotive is 66,000 pounds, but in actual service 79,200 pounds has been registered.



Pennsylvania Locomotive, Showing Running Gear.

Weight and Dimensions.

Weight of locomotive complete	156.5		tons
Weight per driving axle	49,750		lbs.
Total weight on drivers	199,000		lbs.
Weight on each truck	57,000		lbs.
Total length overall	64 ft.	11	in
Rigid wheel base of each semi-unit	7 ft.	2	in.
Total wheel base of each semi-unit	23 ft.	1	in.
Total wheel base of each locomotive	55 ft.	11	in.
Total height of locomotive	14 ft.	8⅛	in.
Total height of cab	13 ft.	1⅛	in.
Total width of cab	10 ft.	8¼	in.
Diameter of drivers	72		in.
Diameter of truck wheels	36		in.

Electrification of Terminal Line at Great Falls, Mont., Chicago, Milwaukee & St. Paul Ry.

As an undertaking related to the forthcoming electrification of its main line between Three Forks and Deer Lodge, Mont., the Chicago, Milwaukee & St. Paul Ry. has recently installed electric motive power on its terminal line in the city of Great Falls, Mont. This city is at present the terminal of the new 138-mile branch line from Lewistown, Mont., connecting with the main line transcontinental division at Harlowton. The latter city is the eastern terminus of the 3,000-volt electrification now under construction. The Great Falls and the terminal yards are connected by a crosstown line, about 4 miles in length, known as the Valeria Way line. There are about 3 miles of additional electrified trackage, making a total of 7 miles. The terminal buildings include a large freight house, roundhouse, power plant and passenger station.

The tracks connecting the Falls yards and the terminal yard pass through the business part of the city; and it is expected that considerable benefit will be derived from the elimination of steam locomotive smoke from the center of the city, as well as a reduction in the cost of train haulage. The traffic includes the transfer of both freight and passenger trains from the Falls yards to the terminal station, as well as swtiching service in the terminals.

The electrical equipment is of sufficient capacity to take care of 580-ton freight trains operating at about 9½ miles per hour on the maximum grades of 0.65 per cent. Electric power is supplied by the Great Falls Power Co. from the hydroelectric plant at Rainbow Falls, about 6 miles from the substation. Energy is transmitted at 6,600 volts, 3-phase, 60 cycles, as generated at the power station.

Substation.

The substation equipment is located in the power station operated by the railway for heating the terminal buildings. It includes a 2-unit, sychronous motor-generator set with a two-panel switchboard for controlling the alternating and direct current units. The motor is rated 435 kva. (0.8 power factor), 6,600 volts, and operates at 900 revolutions per minute. Provision is made for starting as an induction motor through a compensator, which is operated from the alternating current panel. The generator is the commutating pole type, rated 300 kw. at 1,500 volts. The set is capable of carrying 200 per cent overload, or 900 kw. momentarily. Excitation for the alternating current motor fields and for the shunt fields of the direct current generator is furnished by a 10-kw., 125-volt, direct-connected exciter.

The switchboard consists of two natural black slate panels, one controlling the sychronous motor and the other the direct current generator and feeder. The