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PENNSYLVANIA ELECTRIC LOCOMOTIVE

Experimental Design for Heavy Trunk Line Service to Operate Over 24 Miles of One Per Cent Grade

THE Pennsylvania has designed and built an experimental electric locomotive which is to be used ultimately to handle tonnage trains over the grade west of Altoona, Pa. This section includes the Horseshoe Curve and consists of a 2 per cent grade 12 miles long between Altoona and Gallitzin, the summit of the grade, on the eastern slope, and a one per cent grade 24 miles long from Gallitzin to Johnstown, Pa., on the western slope. This locomotive was built for the purpose of carefully developing a standard unit before going ahead with the production of the number of units required. In general the locomotive is somewhat similar to those used on the Elkhorn Grade electrification of the Norfolk & Western in that it uses three-phase motors, fed by a phase-converter connected to an 11,000-volt single-phase contact wire, it also uses the principle of transmitting the motor power to the drivers through regular standard side rods connected to a motor driven jack shaft.

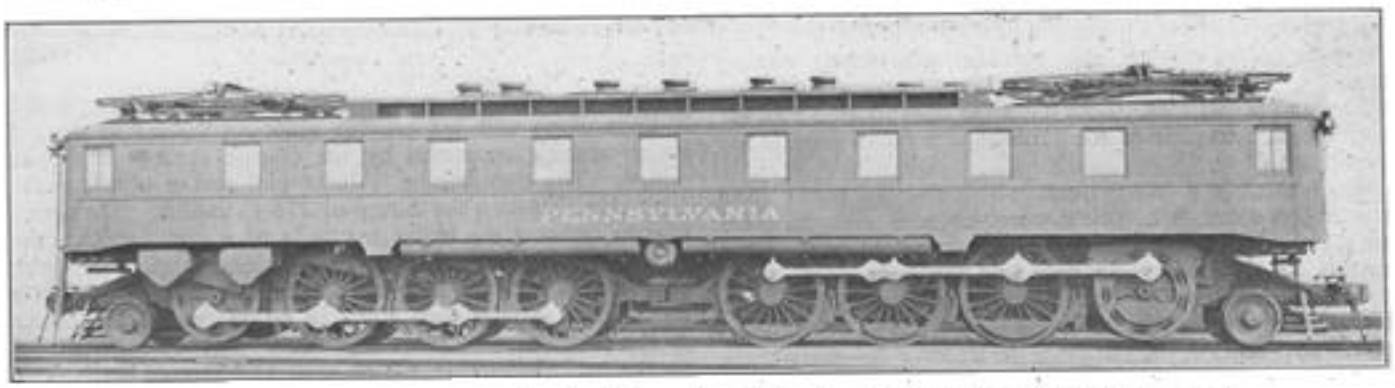

Fig. 1—Pennsylvania Electric Locomotive for Heavy Trunk Line Service on Two and One Percent Grades

Many of the important details, however, in the new locomotive are distinct departures from any previous design. The most unique feature of the locomotive is that instead of being made up of two cabs like those on the Norfolk & Western and the St. Paul, it consists of only one cab which rides on two articulated six-wheel driving trucks.

The locomotive is to be given a preliminary trial on the Philadelphia-Paoli 11,000-volt electrification of the Pennsylvania.

The locomotive is designed to operate on 11,000 volts, single-phase, 25-cycle current taken from an overhead contact wire. The current is supplied to the primary of a static transformer which returns it to the track circuit and in so doing excites the secondary of the transformer from which the phase converter is operated. This phase converter changes the single phase current supplied to it by the transformer to three-phase current for the use of the traction motors. These motors, of which there are four, have a rating of 1,200 hp. each, giving the locomotive a capacity of 4,800 hp.

The three-phase current taken from the phase converter is supplied, through the necessary control switches, to the primaries of these motors and the secondary current thus generated in the other windings of the motors is controlled by the motorman by means of water rheostats, thus permitting very close regulation of the tractive effort developed by the locomotive during acceleration.

The two motors which are mounted on each truck frame are geared to a jack shaft driving the driving wheels through connecting rods and the springs in the gears of these jack shafts are so adjusted as to give the effect of a solid gear up to a tractive effort equivalent to 25 per cent of the weight on drivers. Therefore, under all ordinary conditions the effect of a solid gear is obtained.

The locomotive has two operating speeds with possibilities of operating at any intermediate speed from zero to the maximum, by means of the rheostatic connections. The lowest of these speeds is 10.3 m. p. h. and is obtained by connecting the motors on either truck in cascade with each other and in parallel with those on the other truck. It is contemplated to use this speed only in slow movements and around yards. The other speed of 20.6 m. p. h. is obtained by connecting the motors on both trucks in parallel and this is the speed at which the locomotive is designed to operate in

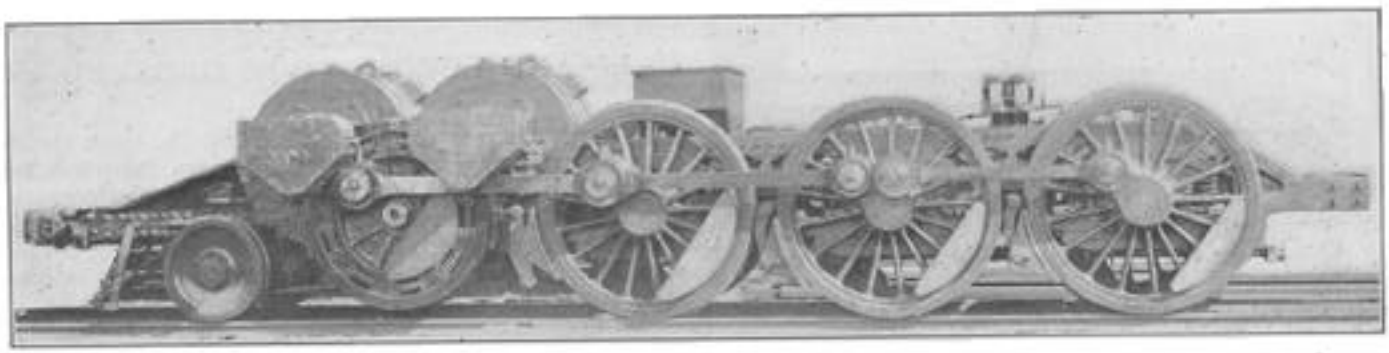

Fig. 2—One of the Driving Trucks for the Pennsylvania Electric Locomotive Showing Motor and Spring Gear Jack Shaft

road service and at which it gives a tractive effort of 87,200 lb.

The cab containing the electrical machinery is 72 ft. 6 in. long and 10 ft. wide over sheathing. It has two Z-shaped center girders 26 in. deep, made of plates and angles covered on top with a plate 6 ft. 1⅛ in. wide, which forms the platform floor to which the electrical machinery is attached. The side framing is of the same type as on Pennsylvania passenger cars, consisting of U-shaped posts bent at the top to support the lower roof deck and sheathed with ⅜-in. plates. The upper deck extends only over the central part of the cab for a length of 36 ft. 9 in., leaving a space at each end of cab for the pantagraphs.

To permit removal and replacing of electrical machinery the roof of the upper deck is removable and the turtle back decks at each end of cab are equipped with large hatches. No lining is provided for the body of the cab, but the motorman's ends, which are separated from the main cab by partitions, are lined and insulated and provided with a resilient floor covering. For the protection of the motorman the ends of the cab are also provided with strong vertical members, similar to those used in Pennsylvania steel passenger and postal cars. Both sides for the full length of the upper deck are made in the form of louvres to provide for ventilation.

Each truck is a motor truck, which receives power from two motors through a spring wheel on each side, mounted on a jack shaft. Each gear wheel is connected to the three drivers by the usual side rods and the remainder of the drive and running gear is similar to those used for steam locomotives. The spring gear for each truck is of the three point suspension type, one point being over the pony truck and the other two points over each frame, consisting of equalizers over each box, elliptical springs between journals and helical springs outside of the first and third journals.

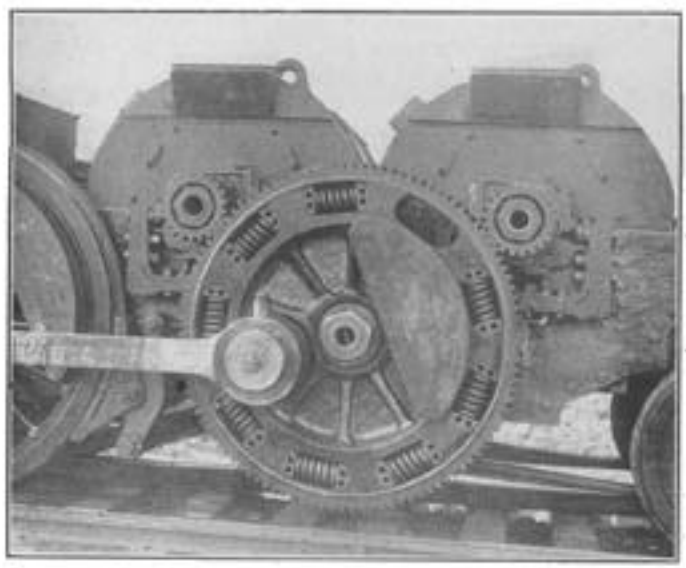

Fig. 3—A View of the Jack Shaft With Its Spring Gear

Brake shoes are provided for one side of each driver, the brake arrangement being of the usual steam locomotive type with two cylinders, each 16 in. in diameter and located between the frames between the second and third axles. The train brake and locomotive brake can each be operated independent of the other. Above the frames and between the first pair of drivers is located a sand box with sand pipes leading to the front of the first pair of drivers and to the rear of the third pair of drivers, and equipped with Leach double "E" sanders. The gear wheels have inward projections forming the jack shaft journals. The bearings therefore are solid bronze forced into a circular opening in the frame casting.

The center plate is located halfway between the first and second axles at an elevation of about the height of the top of the frames. Between the second and third axles an auxiliary spring support has been applied for the purpose of equalizing the loads on the various drivers, which will counterbalance the excess weight due to the location of motors between the pony truck and the first pair of drivers. The contact between the caps over these springs and the bottom surface of the cab must necessarily be a sliding contact.

Each motor truck includes a pony truck of the Pennsylvania Railroad type, with an elliptic spring located each side of the axle and supported on T-links. As the usual T-links alone will not provide sufficient lateral motion, a rocker casting supported by the elliptic springs has been added. The combination T-links and rocker permit sufficient lateral motion for curves of 275 ft. radius. The articulation between the motor trucks is of a construction similar to a pedestal attached to the cab center sills. The lower ends of the pedestal legs are connected together with a tie bar. This permits each truck to rotate around the center of the center plate without restriction. All bearing surfaces in the articulation are plated with manganese steel. The pulling and pushing strains between drawbars carry through the trucks and articulation in a direct plane 34½ in. above the rails so that the cab is entirely relieved of these strains.

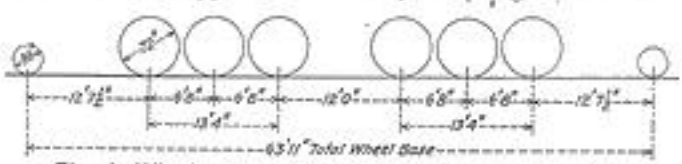

Fig. 4—Wheel Arrangement of the Pennsylvania Electric Locomotive

The principal characteristics of the locomotive follows:

Railroad classification	FFI
Overall length	76 ft. 6¼ in.
Total wheelbase	63 ft. 11 in.
Driving wheelbase	38 ft. 8 in.
Rigid wheelbase	13 ft. 4 in.
Height from rail to locked position of pantograph	15 ft. 6 in.
Height from rail to top of cab	14 ft. 8 in.
Width over cab body	10 ft. 0 in.
Overall width	10 ft. 1 in.
Diameter of driving wheels	72 in.
Diameter of pony wheels	36 in.
Weight on drivers	198 tons
Number of driving axles	6
Weight of each pony truck	21 tons
Total weight of locomotive	240 tons
Voltage of locomotive	11,000
Tractive effort at hourly rating of motors	87,200 lb.
Speed	20.6 m.p.h.
Capacity of locomotive—one-hour rating	4,800 h.p.

CARS AND LOCOMOTIVES ORDERED IN JUNE

Although June is usually a comparatively quiet month from the standpoint of equipment purchases, the purchases in June this year held up exceedingly well. The domestic purchases of locomotives were not large, but there were important purchases by foreign roads. The purchases of freight cars, however, were considerably larger than in the months immediately preceding. The purchases were as follows:

	Locomotives	Freight cars	Passenger cars
Domestic	64	31,945	2
Foreign	443	100	..

Among the important locomotive orders were the following:

Chicago & Alton	10	Mikado	Baldwin
Southern	25	Santa Fe	American
Russian Government	400	Narrow Gage	Americna

The important freight car purchases included the following:

Atchison, Topeka & Santa Fe	500	Gondola	Am. C. & F.
Canadian Government Railways	5,000		Can. C. & F.
Illinois Central	25	Caboose	Co. shops
	250	Box	Co. shops
	250	Stock	Co. shops
Marianna Coal Co.	1,000	Coal	Cambria
Missouri Pacific	500	Box	Co. shops
Norfolk & Western	2,000	Box	Co. shops
Pennsylvania	1,000	Box	Co. shops