

or is suited to it. It also helps solve one of the hardest problems of the average college man—that of finance. It is an advantage to the company, for after seeing the kind of

work required, the man can plan his last year of school so as to take the subjects that will be of most value to him in railroad work.

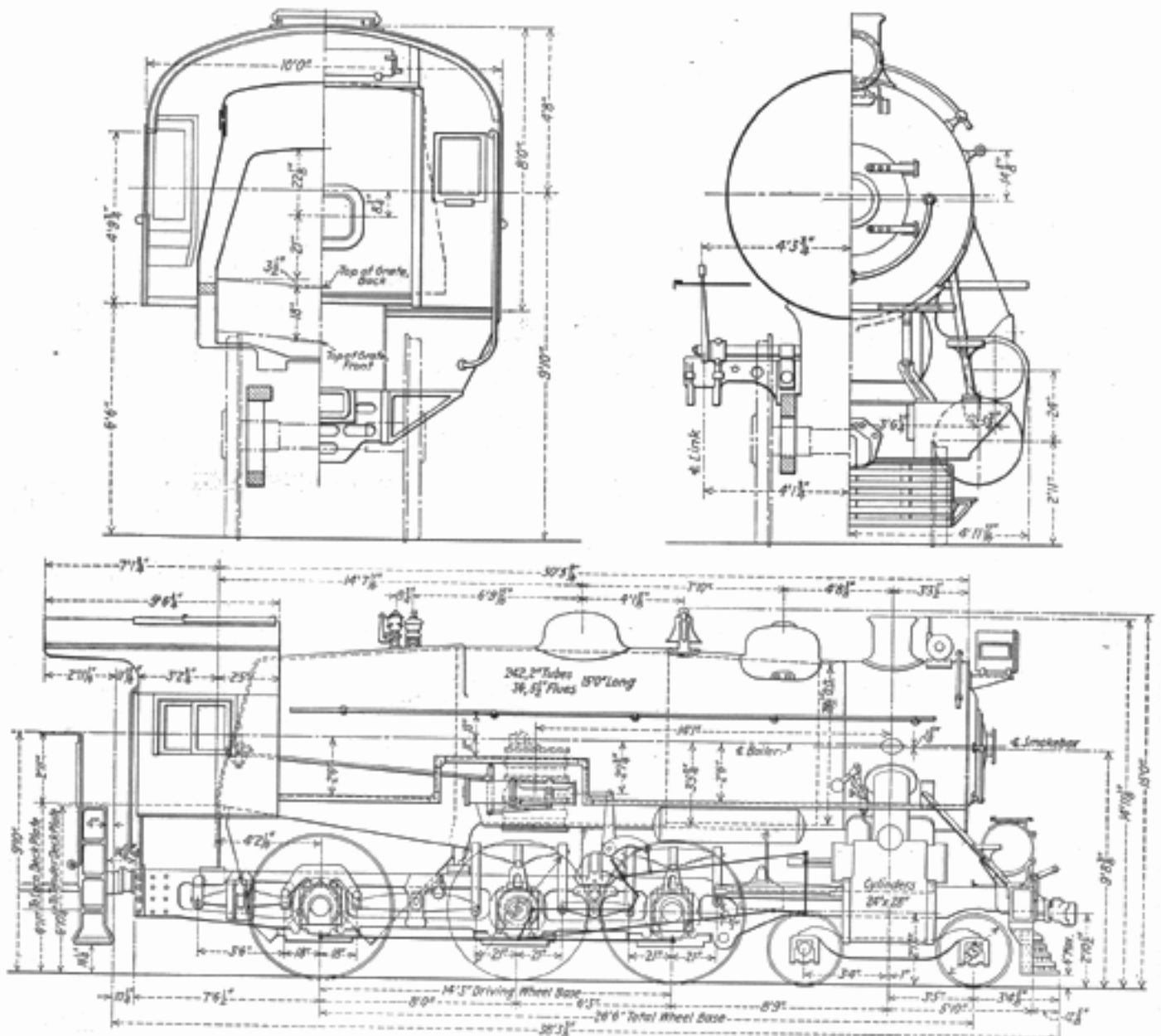
# Pennsylvania Ten-Wheel Passenger Locomotive

Class G5s, a New Design for Local Passenger Service with 68-in. Drivers, Develops 41,328-lb. Tractive Force

**G**RADES often require double heading when using some of the smaller Atlantic and eight-wheel type locomotives in local passenger traffic on the Pennsylvania Railroad System; during the last few years the need for a medium-size locomotive for this service has become urgent. This service requires large tractive effort for quick starting and rapid acceleration to avoid delay in getting trains under way. Tractive effort for this kind of service is of greater importance than high speed.

A ten-wheel locomotive has been designed, of which 40

have been built at the Juniata (Altoona, Pa.) shops of the railroad to meet this requirement. Some of these locomotives are now hauling heavy trains over steep grades on most exacting schedules and the service results amply justify the design. The locomotive has 24-in. by 28-in. cylinders and, with 205 lb. boiler pressure, develops a tractive effort of 41,328 lb. on 68-in. driving wheels. Although not intended primarily for high speed service, the counterbalancing is such that it may safely maintain a speed of 70 miles an hour. This is made possible by the lightness of the reciprocating



Elevation and Cross Sections of Pennsylvania Ten-Wheel Passenger Locomotive, Class G 5s

parts, which weigh 1,008 lb. on one side, or only .425 per cent of the weight of the locomotive. A piston pressure of 92 lb. per pound of reciprocating parts is thus developed.

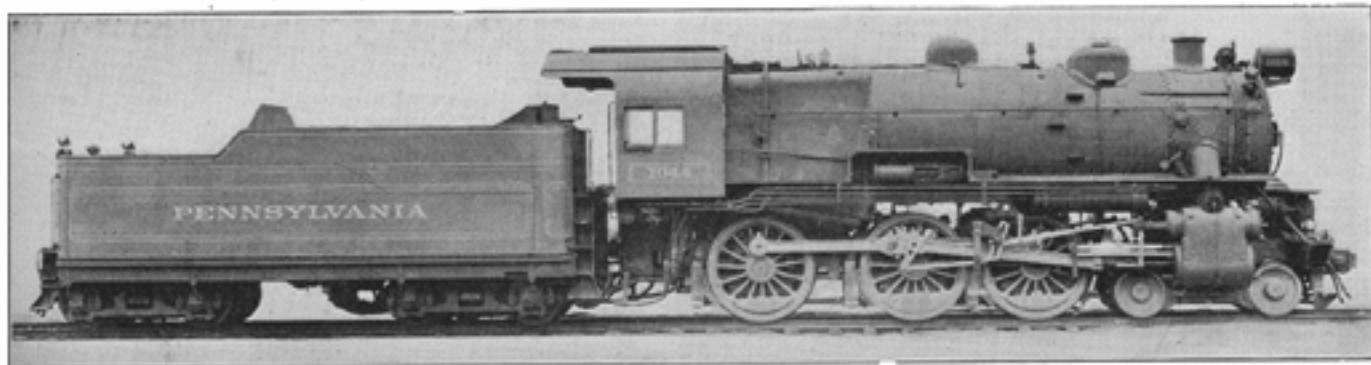
**Boiler**

While the locomotive approaches the Pennsylvania K4s Pacific passenger locomotives in starting force, the boiler capacity compares closely with that of the E6s Atlantic type. Although the shell is somewhat shorter, the tubes have been made the same length by building the firebox without a

A Type A superheater, consisting of 36 units, with a heating surface of 798 sq. ft. is used. The front end is of the self-cleaning type with an inside extension to the smoke stack reaching slightly below the center line of the boiler insuring proper draft through all flues.

**Steam Distribution**

The valve gear is of the Walschaert type with all parts made as light as possible consistent with the strength desired. A standard 12-in. piston valve is used. An air operated



New Ten-Wheel Locomotive for Heavy Local Passenger Service

combustion chamber. In certain details, furthermore, interchangeability has been maintained, both for the sake of maintenance and to simplify fabrication. The E6s front end is an example of the former and the use of E6s dies in flanging the heavy barrel sheet connection for the top of the Belpaire firebox is an example of the latter. The outside throat sheet and the lower half of the rear barrel course are flanged in one piece, but owing to the location of the firebox over the rear drivers, the throat is shallower than the E6s boiler.

The internal diameter of the boiler is 76 3/4 in. at the forward end and 81 3/4 in. at the dome. This has made possible the insertion of 242 two-in. tubes and 36 five-and-one-half-in. superheater flues, the same as in the E6s boilers. The firebox is 110 1/4 in. long by 72 in. wide and has a grate area of 55.13 sq. ft. It is equipped with a Security brick arch supported on three 3-in. water tubes. The grate is arranged with a slope of 17.8 per cent towards the front.

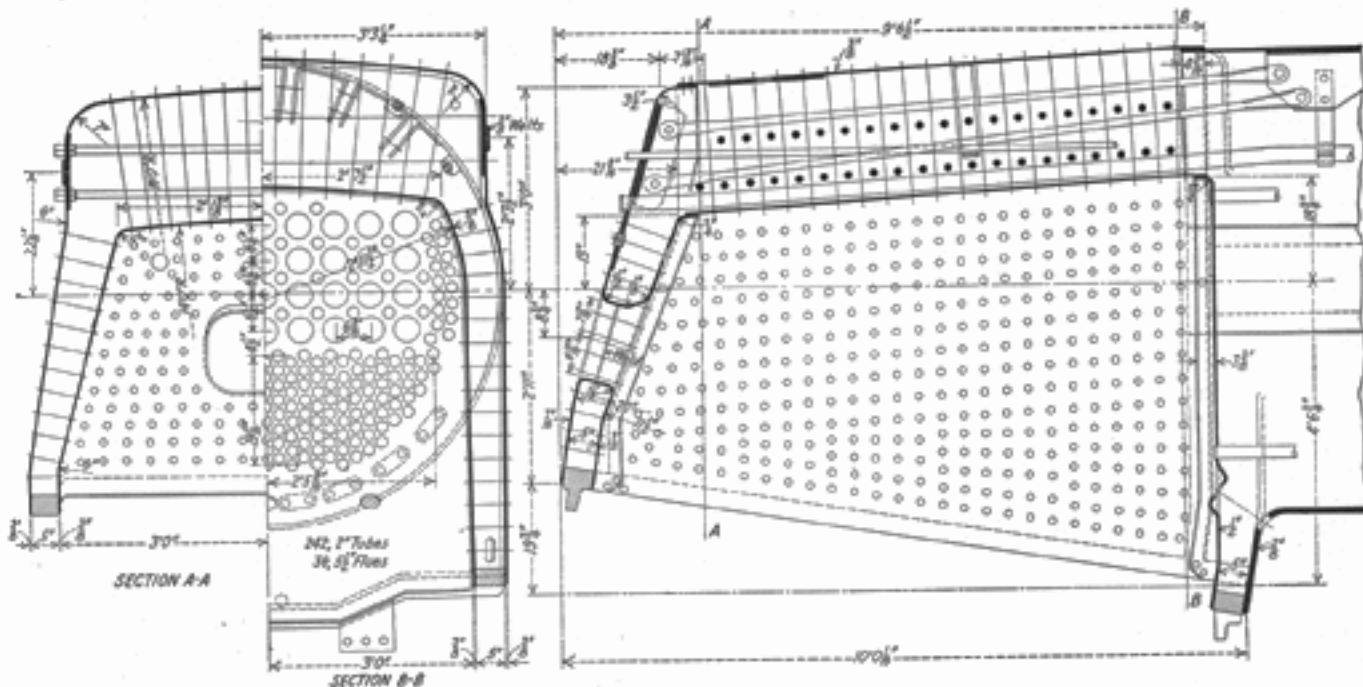
power reverse gear has been made standard for this type of locomotive. These designs are equipped with the Alco gear, which is provided with an auxiliary air reservoir and check valve to retain sufficient air for reversing the gear several times, or holding it in place in case the main supply of air fails for any reason.

The throttle is of the floating stem type with drifting attachment, a design which is exceptionally easy to operate and responds instantly to any movement of the throttle lever.

**Frames and Running Gear**

The frames are of cast steel four inches wide and reinforced to 7 3/8 in. over the driving boxes. The driving axles have a 3-in. hole drilled through the center to facilitate their heat treatment. The journals are 9 3/4 in. by 13 in.

The piston rods on these engines are not of the extended type but are hollow drilled. They are 4 in. in diameter and



Belpaire Firebox of Pennsylvania Ten-Wheel Passenger Locomotive

have a 2¼-in. hole drilled through the center from end to end. This hole is reduced to 1½ in. at the piston fit and to ¾ in. at the crosshead fit where the ends of the rods are forged down. An important feature in the design of the piston rod is that its length is such as will enable the piston to be pulled out of the front end of the cylinder without cutting the piston rod loose from the crosshead. The piston is made with a rolled steel center and a cast iron bull ring fitted with cast iron piston packing rings.

The main rods are of I-section, 7½ in. deep at the rear end and 7 in. at the front end, with a 5½-in. milled section of the rod maintained throughout the length. The flanges are 4¼ in. wide and taper from ¾ in. in thickness at the forward end to one inch at the rear end.

The crosshead runs on three bar guides and is of exceptionally light construction.

A comparatively large tender is used with these locomotives because of the fact that many of them will be used where track tanks are not available. The water capacity is 7,800 gal. and coal capacity approximately 15 tons. The tanks are carried on four-wheel trucks, the front with 5½-in. by 10-in. journals and the rear will have 6-in. by 11-in. journals.

TABLE OF THE DIMENSIONS, WEIGHTS AND PROPORTIONS

Type of locomotive	4-6-0
Service	Passenger
Cylinders, diameter and stroke	24 in. by 28 in.
Valve gear, type	Walschaert
Valves, piston type, size	12 in.
Maximum travel	7 in.
Outside lap	1½ in.
Weights in working order:	
On drivers	175,000 lb.

On front truck	59,000 lb.
Total engine	237,000 lb.
Tender	175,500 lb.
Wheel bases:	
Driving	14 ft. 3 in.
Total engine	26 ft. 6 in.
Total engine and tender	62 ft. 7½ in.
Driving wheels, diameter outside tires	68 in.
Boiler:	
Type	Belpaire, wide firebox
Steam pressure	205 lb.
Fuel	Bit. coal
Diameter, first ring inside	76¼ in.
Firebox, length and width	110¼ in. by 72 in.
Height to crown sheet, back	48 in.
Height to crown sheet, front	73¼ in.
Tubes, number and diameter	242—2 in.
Flues, number and diameter	36—5½ in.
Length between tube sheets	15 ft.
Gas area through tubes and flues	6.92 sq. ft.
Grate area	55.13 sq. ft.
Heating surfaces:	
Firebox, comb. chamber and arch tubes	185 sq. ft.
Tubes and flues	2,677 sq. ft.
Total evaporative	2,862 sq. ft.
Superheating	798 sq. ft.
Comb. evaporative and superheating	3,660 sq. ft.
Tender:	
Water capacity	7,800 gal.
Fuel capacity	29,300 lb.
General data estimated:	
Rated tractive force, 85 per cent	41,328 lb.
Cylinder horsepower (Cole)	2,128 hp.
Speed at 1,000 ft. piston speed	43.3 m. p. h.
Steam required per hour	44,262 lb.
Coal required per hour	6,916 lb.
Coal rate per sq. ft. grate per hour	125.4 lb.
Boiler proportions:	
Comb. heat. surface + cylinder hp.	1.72
Tractive force + comb. heat. surface	11.29
Tractive force × dia. drivers + comb. heat. surface	7.68
Cylinder hp. + grate area	38.6
Firebox heat. surface, per cent of evap. heat. surface	6.5
Superheat. surface, per cent of evap. heat. surface	27.9
Weight proportions:	
Weight on drivers + total weight engine, per cent	75.1
Weight on drivers + tractive force	4.3
Total weight engine + cylinder hp.	111.3

## Bureau of Locomotive Inspection Report

### Increase in Defects and Accidents as Compared with Excellent Showing of Preceding Year

THE twelfth annual report to the Interstate Commerce Commission by A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, for the fiscal year ending June 30, 1923, shows a marked increase in the number of defects and accidents due to the abnormal prevailing conditions. An abstract of the report follows:

The percentage of locomotives found defective increased from 48 per cent during the preceding year to 65 per cent, and the total number of defects increased approximately 70 per cent. The deteriorated condition of motive power is sharply reflected in the increased number of accidents and casualties. A comparison of accidents and casualties during the year as compared with the preceding year shows an increase of 117 per cent in the number of accidents, 118 per cent in the number killed, and 120 per cent in the number injured.

Records covering locomotive failures indicate that the number of locomotive miles per locomotive failure decreased as much as from 50 to 70 per cent during the year as compared with the preceding year. Every locomotive failure caused by physical defects carries with it potential injury to persons, serious delay to traffic, and heavy property damage.

During the year there were 57 boiler explosions which resulted in the death of 41 persons and the serious injury of 88 others, an increase of 75 per cent in the number of such explosions, 86 per cent in the number of persons killed, and 93 per cent in the number injured, as compared with the preceding year. While most of these explosions were caused by the crown sheet having become overheated due to low water, the number of such cases where contributory defects or causes

were found increased approximately 135 per cent as compared with the preceding year. The contributory causes found clearly establish the necessity for proper inspection and repair of all parts and appliances of the locomotive and tender.

During the year numerous accidents were investigated where welds made by the fusion or autogenous process were involved. The investigations fully support the position pre-

LOCOMOTIVES INSPECTED AND DEFECTS FOUND

	1923	1922	1921	1920
Locomotives reported	70,242	70,070	70,475	69,910
Locomotives inspected	63,657	64,354	60,812	49,471
Locomotives defective	41,150	39,978	30,207	25,529
Percentage inspected found defective	65	48	50	52
Locomotives ordered out of service	7,075	3,889	3,914	3,774

ACCIDENTS CAUSED BY THE FAILURE OF SOME PART OR APPURTENANCE OF THE BOILER

	1923	1922	1921	1920
Number of accidents	509	273	342	419
Number killed	47	25	51	48
Number injured	594	318	379	563

ACCIDENTS CAUSED BY THE FAILURE OF SOME PART OR APPURTENANCE OF THE LOCOMOTIVE AND TENDER, INCLUDING THE BOILER

	1923	1922	1921	1920
Number of accidents	1,348	622	735	843
Number killed	72	33	64	66
Number injured	1,560	709	800	916

DERAILMENTS AND ACCIDENTS DUE TO DEFECTS IN OR FAILURE OF SOME PART OF THE LOCOMOTIVE OR TENDER

	1923	1922	1921	1920
Number of derailments*	38	22	8	7
Number killed	4	5	—	7
Number injured	157	61	20	18

\* Only derailments reported by carriers as being caused by defect in or failure of parts of the locomotive or tender were investigated or counted.