



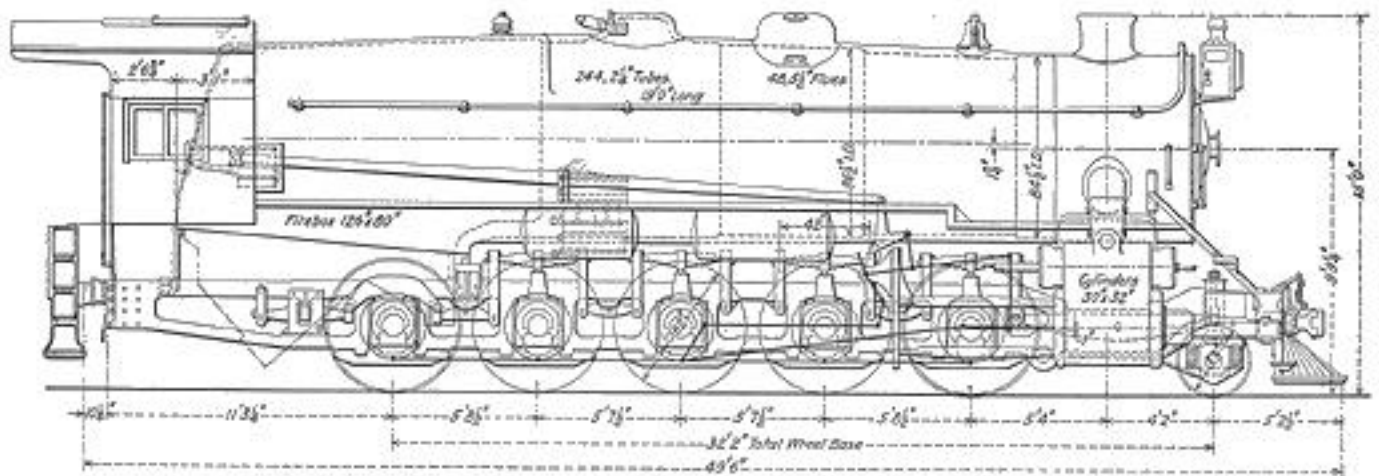
## P. R. R. DECAPOD TYPE LOCOMOTIVE

Maximum Cut-Off Is 50 Per Cent; Tractive Effort  
80,640 Lb. at 7 M. P. H.; Boiler Pressure 250 Lb.

IN December, 1916, a Decapod locomotive having a total weight of 366,500 lb., a weight on drivers of 334,500 lb. and a tractive effort of 80,640 lb. was built by the Pennsylvania Railroad at its Juniata shops. The locomotive is the first of its type to be placed in service on this road and is known as the I-1-s class.

There are several unique features in the design which represent wide departures from customary practice in locomotive engineering. Instead of operating at a maximum cut-off of approximately 90 per cent, the valves have been given a steam lap of two inches and the maximum cut-off with the reverse gear in the corner is 50 per cent. In order

of 82 in. and is made of  $1\frac{1}{4}$ -in. plate,  $1\frac{1}{2}$ -in. rivets in  $1\frac{9}{16}$ -in. holes being used in the longitudinal joints. Like the Mikado boiler, the main barrel course is made in two halves which are joined on the horizontal center line. The shoulders peculiar to the Belpaire type boiler are flanged integral with the upper half, and the rear end of the lower half is flanged to form the throat sheet. A one-piece pressed dome is mounted on this course. The boiler is fitted with a Schmidt superheater of 48 units placed in  $5\frac{3}{4}$ -in. flues. There are 244  $2\frac{1}{4}$ -in. tubes, the length between the tube sheets being 19 ft. The firebox includes a combustion chamber 3 ft. long and is equipped with a firebrick arch.



Elevation of the Pennsylvania 2-10-0 Type Locomotive

to secure a maximum tractive effort in proper relation to the weight on drivers, this necessitates the use of much larger cylinders than are required where 90 per cent cut-off can be obtained. The cylinders are 30 in. in diameter by 32-in. stroke and owing to clearance limitations which prohibit a further increase in the diameter of the cylinders, the boiler pressure was fixed at 250 lb. per sq. in.

With the notable exception of the high boiler pressure, the Decapod type boiler is of the same general design as that of the class L-1-s Mikados, a large number of which are now in service on the Pennsylvania Railroad.\* While there are differences in details, it will be noted by a comparison of the data for the two types given in the accompanying table of dimensions, that there is little difference in the capacity of the two boilers.

The barrel of the boiler has a minimum internal diameter

The smokebox design is generally similar to that of the Mikado type locomotive. The exhaust pipe stands about 21 in. above the bottom of the smokebox and is fitted with a circular nozzle having four internal projections. The ring blower, however, has been removed from the nozzle tip and placed at the choke of the lift pipe, which is 17 in. in diameter. This arrangement is effected by the use of a combined blower ring and lift pipe bell casting, which is shown in detail in one of the drawings.

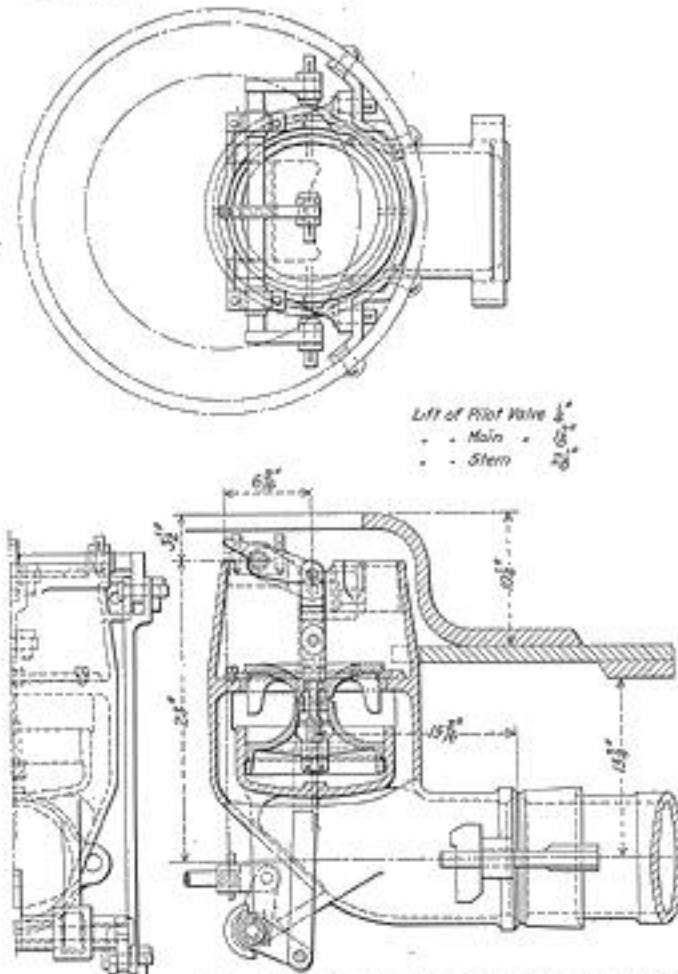
Each of the frames is a single steel casting 44 ft.  $8\frac{1}{4}$  in. long with a driver brake shaft bearing cast integral. The top rail is 7 in. wide by 8 in. deep, the section changing to a width of  $9\frac{1}{2}$  in. and a depth of  $7\frac{1}{2}$  in. over the jaws; the lower rail is 6 in. deep. The single rail section to which the cylinders are attached is  $5\frac{1}{2}$  in. wide by 20 in. deep.

Steam is supplied to the cylinders through an  $8\frac{1}{2}$ -in. dry pipe and 6-in. branch pipes, the admission being controlled by the balanced throttle valve. The steam distribution is con-

\* This class was fully illustrated and described in the *Railway Age Gazette, Mechanical Edition* of July, 1914, on page 343.

trolled by 12-in. piston valves and Walschaert valve gear. With the exception of the increased lap which limits the maximum cut-off to 50 per cent, the arrangement does not differ from the usual Pennsylvania practice.

The use of a 2-in. steam lap necessitates some auxiliary

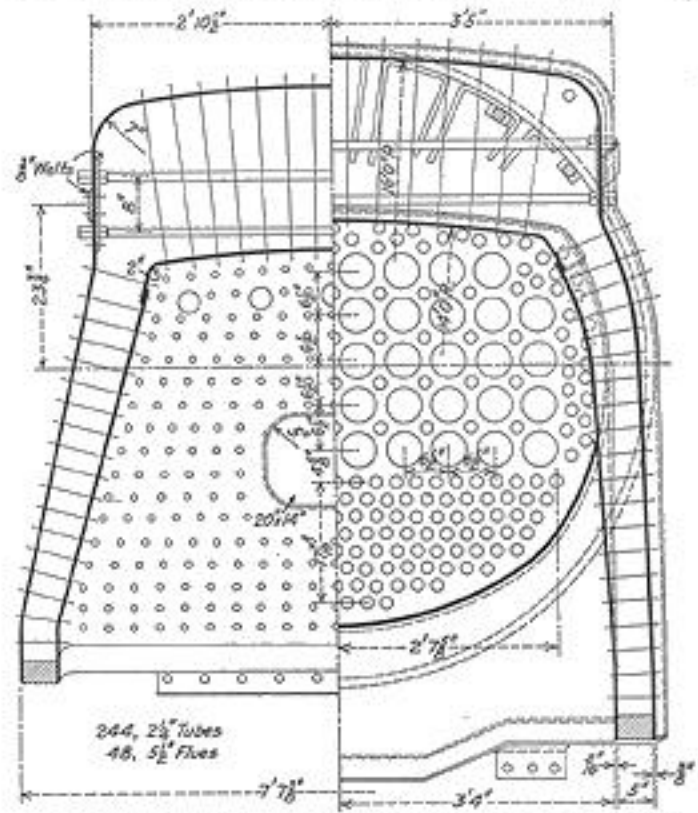


Throttle Valve of the Pennsylvania Decapod Type Locomotive

means of admitting steam to the cylinders when the locomotive is standing in order that it may be started from any position of the crank pins. The means of meeting this requirement is extremely simple. Pockets about  $1\frac{3}{4}$  in. deep are cored out of the inside edge of each steam port in the valve chamber, two in each port located 180 deg. apart.

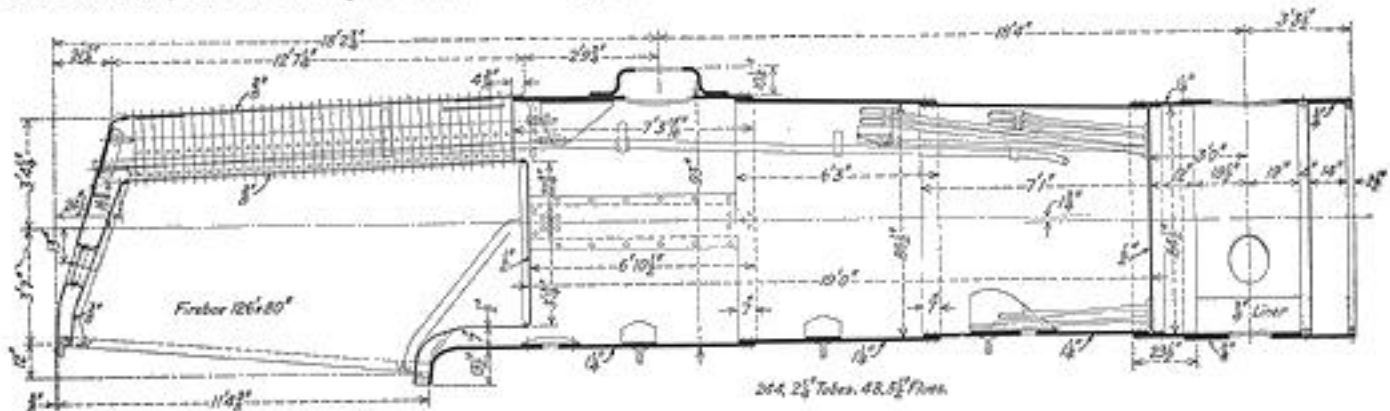
the auxiliary ports are so placed that their steam lap is  $\frac{1}{4}$  in. These ports serve to move the engine only until the main ports are opened.

The purpose of the use of the 50 per cent cut-off is to eliminate the range of cut-offs within which the water rate of the cylinders is excessive, thereby making possible an increase in the ratio of cylinder power to boiler capacity. By



Half Sections Through the Firebox, Showing the Tube Layout

referring to the data for the two classes it will be seen that with but slightly increased boiler capacity an actual tractive effort at 7.2 miles per hour of 80,640 lb. is obtained from the class I-1-s locomotive as compared with a calculated maximum tractive effort of 57,850 lb. for the Mikado type. This is further reflected in the ratio of tractive effort times diameter of drivers to equivalent heating surface. As an indication of the extent to which this increased ratio is justified, it has been found that the tractive effort at 25 miles an hour is 44,400 lb.



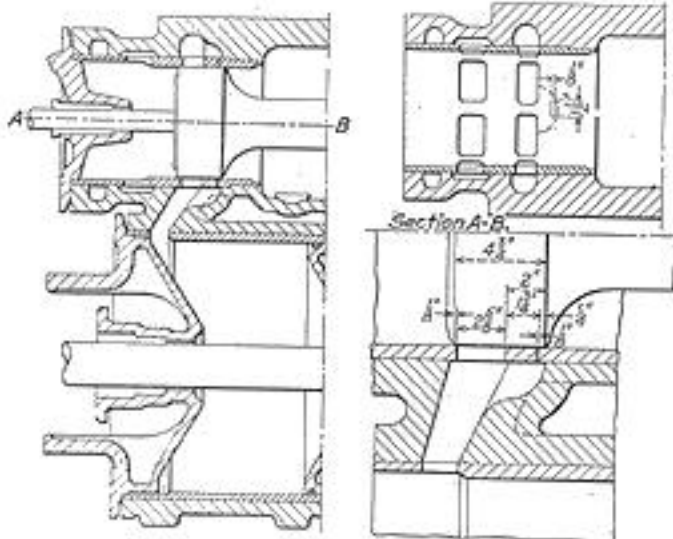
Boiler for the Decapod Locomotive, Which Carries 250 Lb. Working Pressure

Two ports  $\frac{1}{8}$  in. wide and  $1\frac{1}{2}$  in. long are cut through the valve chamber bushing, opening into the pockets in the valve chamber casting. This arrangement is shown clearly in one of the illustrations, from which it will be seen that

The design of the running gear and reciprocating parts follows very closely that of the Mikado type locomotives. The piston is of rolled steel and is carried on an extension piston rod. The piston rod, driving axles, crank pins,

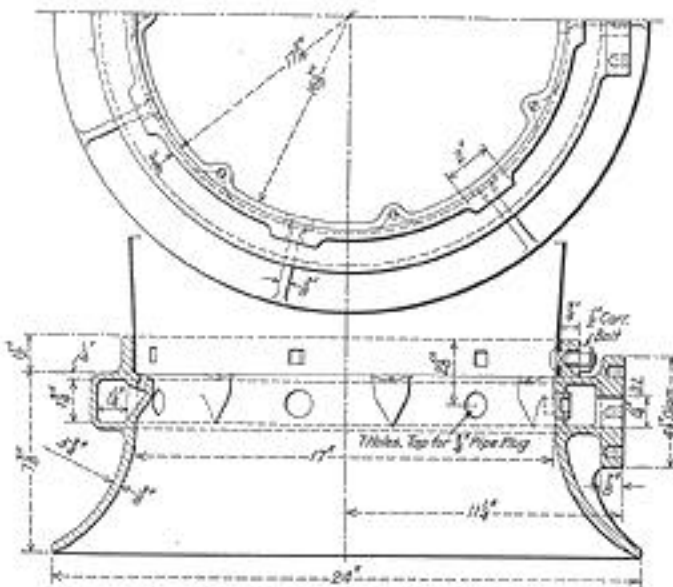


wrist pins and knuckle pins are all of hollow sections and are heat treated. In order to obtain a proper amount of clearance between the top of the rail and the bottom of the main rod at the rear end, the key bolt was put in from the bottom and this arrangement has been found to be very satisfactory. To obtain clearance between the rear end of the main rod and the side rod knuckle pins the special recessed knuckle pin and depressed nut were used.



Valve Chamber with Auxiliary Starting Ports

The driving wheels are 62 in. in diameter. The front and rear tires are flanged and are 5 1/2 in. wide. The intermediate tires are all flangeless, those of the main wheels being 8 1/2 in. wide, while those of the second and fourth wheels are 7 1/2 in. wide. The locomotive is designed to operate on tracks having a minimum radius of curvature of 350 ft. In the connection between the engine and tender, the old style double safety bars with slotted holes have been replaced with a single safety bar which is of the same



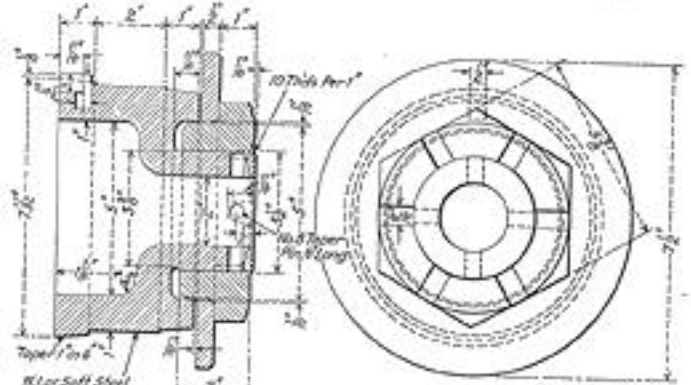
Ring Blower in Base of the Lift Pipe

cross section as the drawbar and 1/2 in. longer. It is placed immediately under the drawbar, being connected to the engine and tender by the drawbar pins.

The driver brakes are operated by two 18-in. air cylinders with 13-in. stroke which exert a braking power of 230,000 lb. The arrangement is similar to that described in connection with the class L-1-s Mikados.

In the following table the principal dimensions and data for the Decapod type locomotive are shown in comparison with those for the class L-1-s Mikado type locomotive:

General Data		
	Decapod Class L-1-s	Mikado Class L-1-s
Gage	4 ft. 8 1/2 in.	4 ft. 8 1/2 in.
Service	Freight	Freight
Fuel	Bit. coal	Bit. coal
Tractive effort	80,640 lb.*	57,850 lb.
Weight in working order	366,500 lb.	315,000 lb.
Weight on drivers	334,500 lb.	236,000 lb.
Weight on leading truck	32,000 lb.	27,000 lb.
Weight of engine and tender in working order	547,000 lb.	473,000 lb.
Wheel base, driving	22 ft. 8 in.	17 ft. 0 1/2 in.
Wheel base, total	32 ft. 2 in.	36 ft. 5 1/2 in.
Wheel base, engine and tender	73 ft. 5 1/2 in.	72 ft. 3 in.
Ratios		
Weight on drivers ÷ tractive effort	4.1	4.1
Total weight ÷ tractive effort	4.5	5.4
Tractive effort × diam. drivers ÷ equivalent heating surface †	786.7	622.0
Equivalent heating surface † ÷ grate area	90.8	82.4
Firebox heating surface ÷ equivalent heating surface † per cent	4.3	5.1



Details of the Knuckle Pin with Recess for Depressed Nut

Weight on drivers ÷ equivalent heating surface	52.6	40.9
Total weight ÷ equivalent heating surface	57.7	54.6
Volume equivalent cylinders with 90 per cent max. cutoff	21.4 cu. ft.	19.9 cu. ft.
Equivalent heating surface † ÷ vol. equivalent cylinders	297.0	290.0
Grate area ÷ vol. equivalent cylinders	3.3	3.5
Cylinders		
Kind	Simple	Simple
Diameter and stroke	30 in. by 32 in.	27 in. by 30 in.
Pistons		
Kind	Piston	Piston
Diameter	12 in.	12 in.
Greatest travel	6 in.	6 in.
Steam lap	2 in.	2 1/2 in.
Wheels		
Driving, diameter over tires	62 in.	62 in.
Driving, thickness of tires	1 1/2 in.	1 1/2 in.
Driving journals, main, diameter and length	12 in. by 16 in.	11 in. by 15 in.
Driving journals, others, diameter and length	11 in. by 16 in.	11 in. by 15 in.
Engine truck wheels, diameter	13 in.	13 in.
Engine truck journals	6 1/2 in. by 12 in.	6 1/2 in. by 12 in.
Trailing truck wheels, diameter	30 in.	30 in.
Boiler		
Style	Belpaire	Belpaire
Working pressure	250 lb. per sq. in.	205 lb. per sq. in.
Outside diameter of first ring	84 3/8 in.	78 7/8 in.
Firebox, length and width	126 in. by 80 in.	126 in. by 80 in.
Firebox plates, thickness	5 in.	5 in.
Firebox, water space	5 in.	5 in.
Tubes, number and outside diameter	244—2 1/2 in.	237—2 1/2 in.
Flues, number and outside diameter	48—5 1/2 in.	40—5 1/2 in.
Tubes and flues, length	19 ft.	19 ft.
Heating surface, tubes and flues	4,043 sq. ft.	3,747 sq. ft.
Heating surface, firebox	272 sq. ft.	288 sq. ft.
Heating surface, total	4,315 sq. ft.	4,035 sq. ft.
Superheater heating surface	1,360 sq. ft.	1,159 sq. ft.
Equivalent heating surface †	6,385 sq. ft.	5,766 sq. ft.
Grate area	70 sq. ft.	70 sq. ft.
Tender		
Tank	Water bottom	Water bottom
Weight	182,000 lb.	158,000 lb.
Wheels, diameter	33 in.	36 in.
Journals, diameter and length	6 in. by 11 in.	5 1/2 in. by 10 in.
Water capacity	9,000 gal.	7,000 gal.
Coal capacity	17 1/2 tons	12 1/2 tons

\* Actual at 7.2 miles per hour.  
† Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.