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(The asterisk indicates that the article is illustrated.)

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

In July, 1902, a policy of standardization of the entire locomotive equipment of the railroads known as the Harriman Lines was inaugurated. The roads concerned are the Union Pacific, Oregon Short Line, the Oregon Railroad & Navigation Company, Southern Pacific, the Chicago & Alton and the Kansas City Southern, comprising about 18,000 miles, and now operating more than 3,000 locomotives and 90,000 freight cars. The policy is a part of a plan which has been applied by Mr. Harriman in unifying practice, as far as practicable, throughout these lines. The director of maintenance and operation has had charge of the practice included under these heads, and the director of purchases, in conjunction with him and the general managers and the superintendents of motive power of these lines, has standardized all classes of locomotives, freight cars and passenger cars, including every detail. Complete specifications are made standard for locomotives and cars, reducing the purchasing to the simplest possible terms. To indicate the economical advantages of this standardization is the purpose of a series of articles on the complete locomotive standards, these being the most important development of the kind on any railroad. At the present time 366 of the standard locomotives are in service. That these standards are likely to influence the practice of other roads is indicated by the fact that 37 locomotives of the standard 2—8—0 type are now being built for the Erie Railroad.

As a result of the earlier work in this direction by the motive power officials of these roads, a number of standard details were agreed upon, and were illustrated in this journal in June, 1902, page 166.* Further development has included so many additional details that the entire subject is now taken up anew, the details having been decided upon after numerous meetings of all the motive power and executive officials.

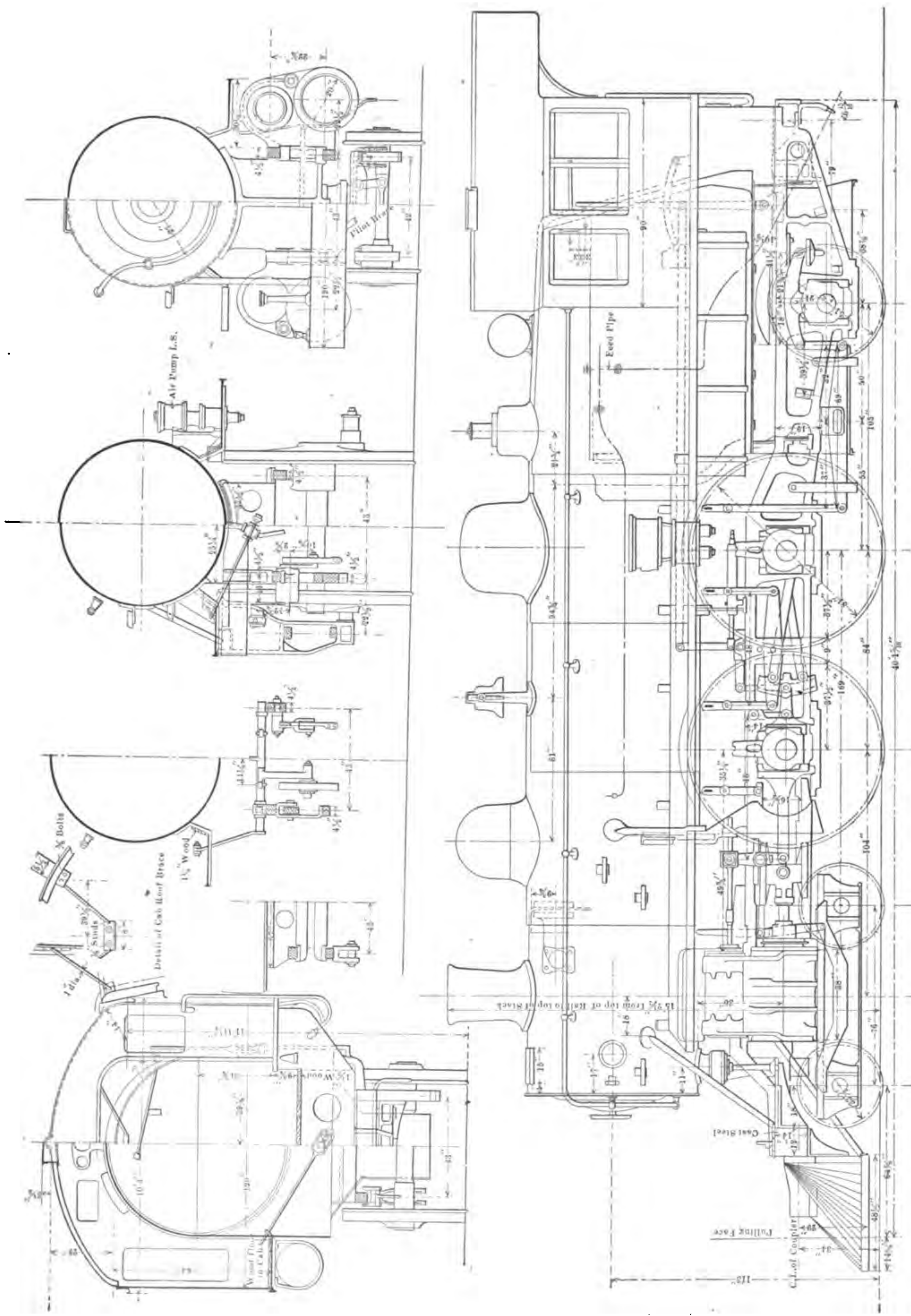
Four types are adopted for future construction, as follows: Atlantic type passenger, Pacific type passenger, consolidation freight and heavy switcher. It is intended to provide for all the demands of the immediate future from these four designs. The existing equipment provides a sufficient number of light locomotives for many years to come. From time to time experimental designs will be tried, with a view of adopting new standards whenever the advantages to be gained thereby are sufficient. For example, an experimental application of the 4-cylinder balanced compound principle is to be made with four locomotives of the 4—6—2 type now building at the Baldwin Works for the Oregon Railroad & Navigation Company.

Side elevations, and sections of the four standard types, together with a list of comparative dimensions and ratios are presented in this article, and discussions of the details will follow. An idea of the scope of the standardization is given in the following summary, which does not attempt to include all of the minor details:

The tenders for passenger engines will have 9,000-gal. tanks and provide for 12 tons of coal. They are of rectangular construction, whereas the freight engines will have Vanderbilt tenders, with cylindrical tanks of 7,000 gals. and 14 tons coal capacity. The switch engines have a special sloping tender of 4,000 gals. and 6 tons coal capacity. The cabs are the same for the various types, modified slightly to fit the different boilers. These will be shown in detail. In general terms,

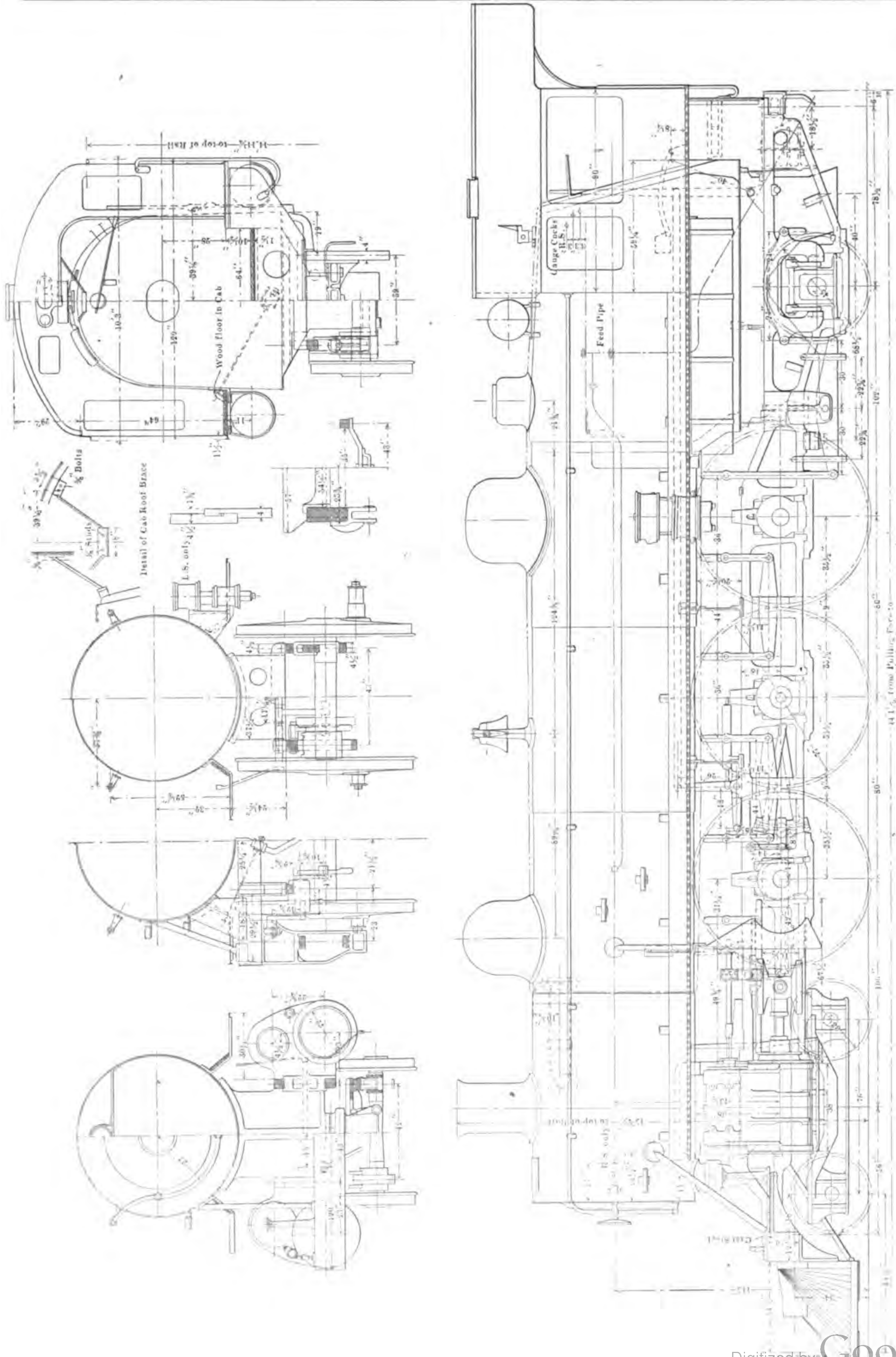
COMMON STANDARD COAL BURNING LOCOMOTIVES.
COMPARATIVE DIMENSIONS AND WEIGHTS.

Type	Atlantic.	Pacific.	Heavy Consol.	Switch.
Class	A-105	P-141	C-187	S-150
Common Standard Specification	101	102	103	106
RATIOS—				
Heating surface to volume of cylinder	260.7	248.	270.	179.5
Adhesive weight to heating surface	39.7	46.1	55.	82.
Adhesive weight to tractive effort	4.48	4.7	4.32	5.37
Tractive effort to adhesive weight, per cent	22.2	21.2	23.1	18.2
Tractive effort by diameter of drivers to heating surface	717.	754.	726.	873.
Heating surface to tractive effort, per cent	11.2	10.3	7.84	6.5
Total weight to heating surface	73.	72.	61.	82.
Heating surface to grate area	53.6	61.	69.	60.3
Weight taken with three gauges of hot water, coal fire, sand and two men—				
Weight on front drivers, about	53,000 lbs.	48,000 lbs.	47,600 lbs.	49,100 lbs.
Weight on intermediate drivers, about	......	......	45,300 "	53,400 "
Weight on main drivers, about	52,000 "	45,000 "	48,700 "	47,500 "
Weight on back drivers, about	......	48,000 "	45,400 "	......
Weight, total, on drivers, about	105,000 "	141,000 "	187,000 "	150,000 "
Weight on truck, about	45,000 "	37,000 "	21,000 "	......
Weight on trailer, about	46,000 "	44,000 "	......	......
Weight, total, of engine, about	196,000 "	222,000 "	208,000 "	150,000 "
Driving wheel base	7 ft.	13 ft. 4 ins.	15 ft. 8 ins.	11 ft. 4 ins.
Wheel base of engine	27 ft. 7 ins.	33 ft. 4 ins.	24 ft. 4 ins.	11 ft. 4 ins.
Wheel base of engine and tender	58 ft. 2 ins.	63 ft. 10⅛ ins.	55 ft. 11¾ ins.	42 ft. 9 ins.
Height top of rail to top of stack	15 ft. 2½ ins.	15 ft. 2½ ins.	15 ft. 2½ ins.	14 ft. 4½ ins.
Height of cab at eaves above top of rail to center of eave radius	11 ft. 11¼ ins.	11 ft. 11¼ ins.	11 ft. 11¼ ins.	11 ft. 4¾ ins.
Width of cab over shields	10 ft. 3 ins.	10 ft. 3 ins.	10 ft. 3 ins.	10 ft. 3 ins.
Width of cab over eaves	10 ft.	10 ft.	10 ft.	10 ft.
Width over cylinder casing	9 ft. 8¼ ins.	9 ft. 10¼ ins.	9 ft. 10¼ ins.	9 ft. 6¾ ins.
Center line of boiler from top of rail	9 ft. 5 ins.	9 ft. 5 ins.	9 ft. 6 ins.	8 ft. 7 ins.
Center to center of cylinders	88 ins.	89 ins.	89 ins.	88 ins.
Center to center of frames	43 ins.	43 ins.	43 ins.	43 ins.
Cylinders	20 x 28	22 x 28	22 x 30	20 x 26
Driving wheels, outside diameter	81 ins.	77 ins.	57 ins.	57 ins.
Driving wheel centers, outside diameter	74 ins.	70 ins.	50 ins.	50 ins.
Engine truck wheels, diameter	33½ ins.	33½ ins.	30½ ins.	......
Trailing truck wheels, diameter	51 ins.	45 ins.	......	......
Tractive power (M. E. P. 85 per cent. of boiler pressure)	23,506	29,920	43,299	27,915
Fire box	108 in. x 66 in.	108 in. x 66 in.	108 in. x 66 in.	108 in. x 40¼ in.
Grate area, square feet	49.5	49.5	49.5	30.2
Heating surface of tubes, square feet	2,475	2,874	3,266	1,650
Heating surface of firebox, square feet	180	180	171	172
Total heating surface	2,655	3,054	3,397	1,822
Boiler, smallest o. d. diameter, inches	70	70	80	70
Tubes, number and diameter, in inches	297-2	245-2¼	413-2	276-2
Tubes, length, in feet	16	20	15	11½
Boiler pressure, lbs.	200	200	200	180
Valve, type	Piston	Piston	Piston	Am. Bal.
Valve, travel	6 ins.	6 ins.	6 ins.	6 ins.
TENDER, Type	Rectangular	Rectangular	Cylindrical	Rectangular, Sloping
Coal capacity, level full, tons	10	10	14	6
Water capacity, gallons	9,000	9,000	7,000	4,000
Weight of tender, empty	54,400 lbs.	54,400 lbs.	48,720 lbs.	39,770 lbs.
Weight of tender, water carried	75,000 "	75,000 "	58,330 "	33,330 "
Weight of tender, coal carried	20,000 "	20,000 "	28,000 "	12,000 "
Weight of tender, loaded	149,400 "	149,400 "	135,050 "	85,100 "
Weight of tender truck	9,975 "	9,975 "	9,975 "	6,800 "



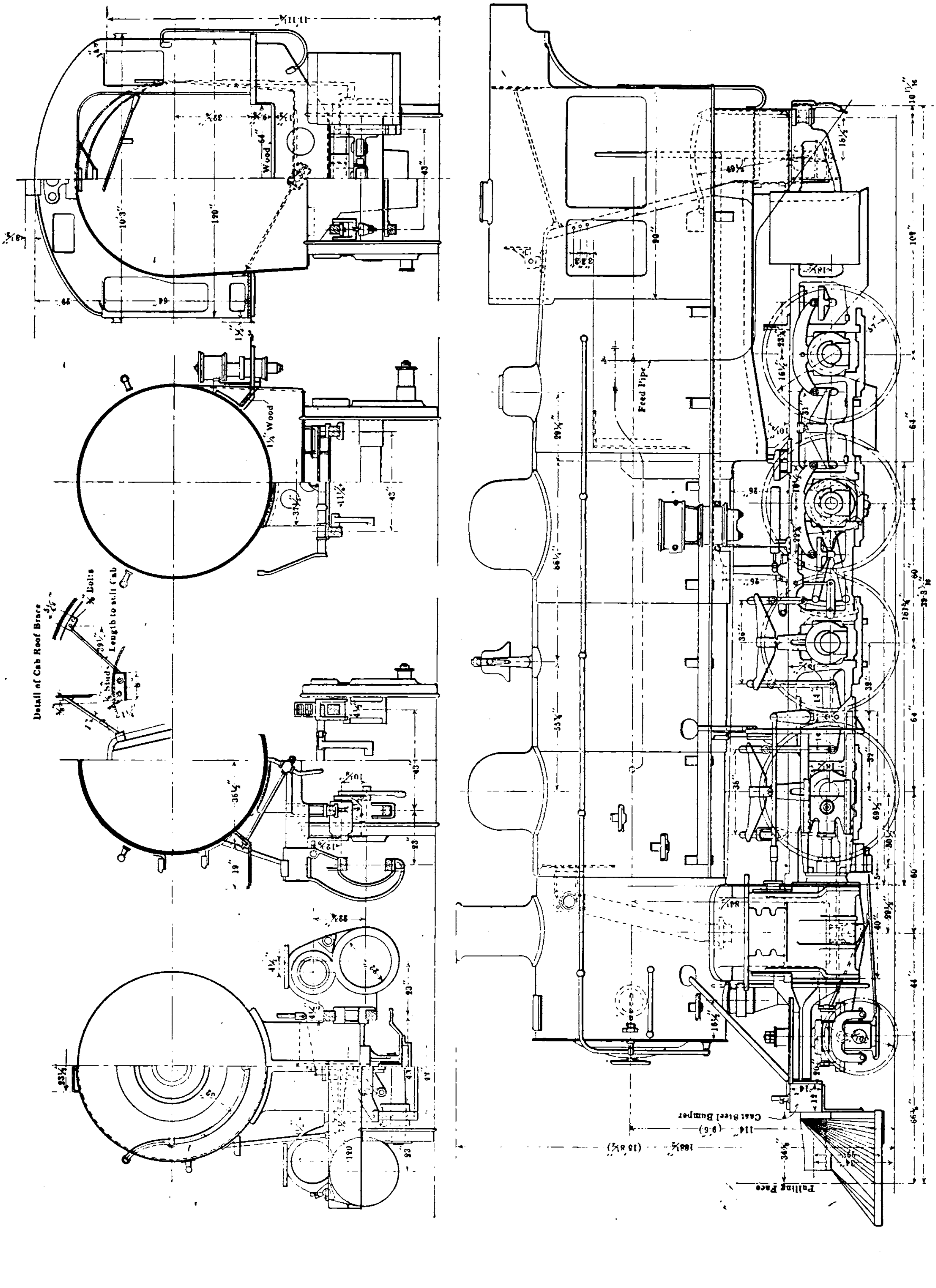
4—4—2 (ATLANTIC) TYPE PASSENGER LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.



4—6—2 (PACIFIC) TYPE PASSENGER LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.



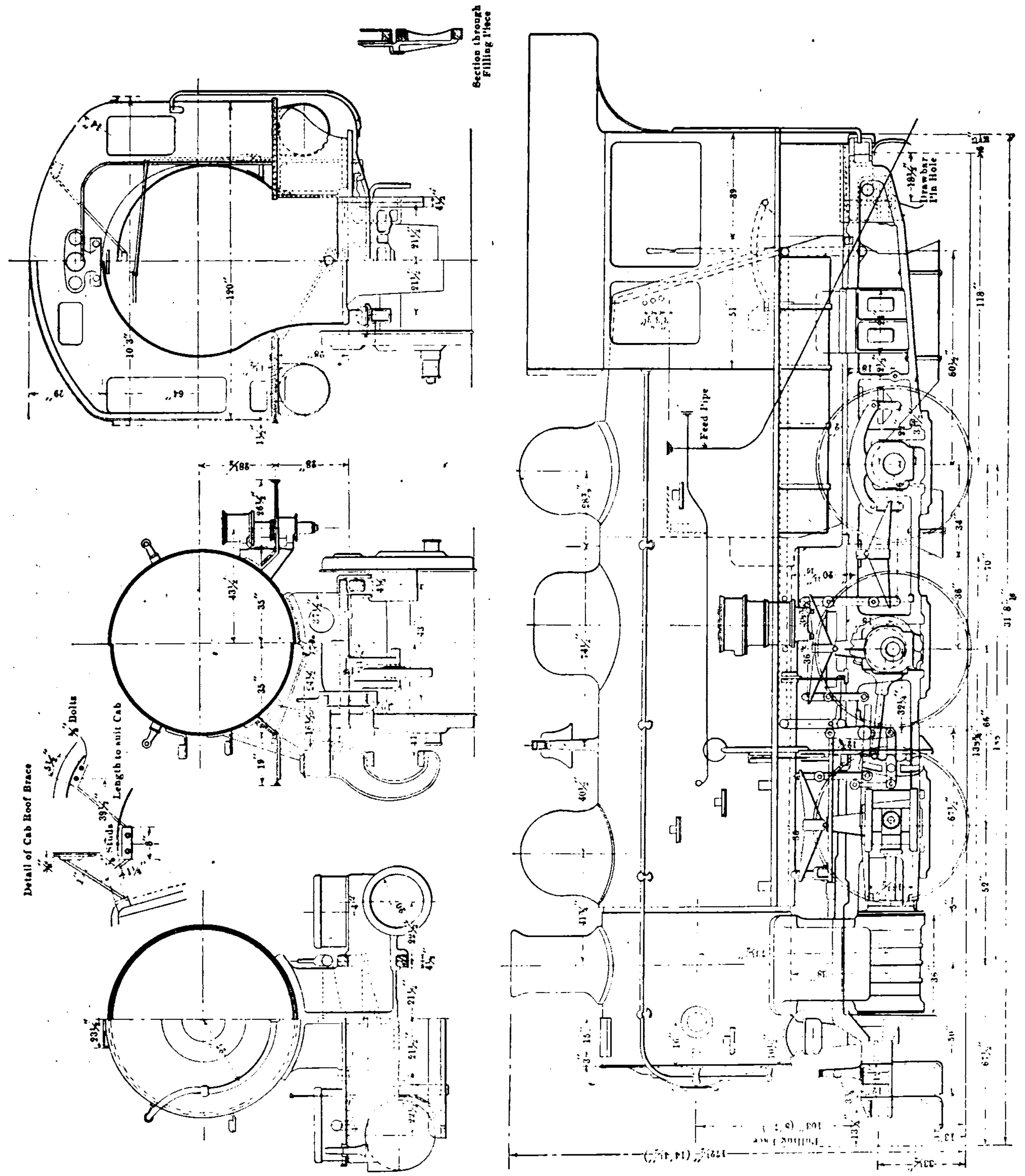
2—8—0 (CONSOLIDATION) FREIGHT LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.

the following parts are common to all the locomotives, special mention being made of those which are modified for the switch engines:

STANDARDS COMMON TO ALL NEW LOCOMOTIVES.

Driving boxes and brasses.
Locomotive truck boxes and brasses.
Locomotive truck axles.
Smoke stacks.
Bells and sand boxes.
Air bell-ringer.
Pilots (except switchers).
Deck plates.
Front journals on main rods.
Front and back journals on side rods.
Crank pin brasses varied as follows:
Back end of main rod (Pacific and Consolidation).
Back end of main rod (Atlantic and Switcher).
Couplers (except front of switcher).
Dome bases, rings and caps.
Headlights.
Auxiliary domes (except switcher).
Cocks, valves and oil cups.
Tank hose (different length on switcher).
Brake shoes.
Eccentrics and eccentric straps.



SIX-WHEEL SWITCHING LOCOMOTIVE.

COMMON STANDARD LOCOMOTIVES, HARRIMAN LINES.

Cast steel front bumpers (except switchers).
Coupling bars (except switchers).
Spring buffers between engines and tenders.
Tender journal boxes (except switcher).
Cab brackets (except switchers).
Cab fittings.
Cinder hoppers.
Exhaust pipes and tips (tips of various sizes).
Cross heads.
Feed-pipe strainers and couplers.
Steam chest valves. (Piston on road engines. American balance on switcher.)
Grate casting (except switcher).
Piston rods (of 4 ins. in diameter, two lengths).
Piston rod packing (U. S. Metallic).
Valve steam packing (U. S. Metallic).
Links and saddles (radius varies).
Rocker shaft bearings.
Tender truck complete (except switcher).
Throttle valve and throttle dry-pipe ends.

Throttle levers and stuffing boxes.
Safety valves.
Water gauge, Klinger reflex.
Injectors (No. 10 Nathan Monitor road, No. 9 switcher).
Lubricators (Nathan Bull's Eye).
Whistles (chime on passenger, plain on freight).
Smoke box doors.
Steam gauges.
Spring saddles.
Wash-out plugs.

A great many of the minor details which are common to two or more designs and not common to all are not mentioned in this list. The parts listed include all of the most important features of the standardization. In the detailed description the most important parts will be discussed separately.

The courtesy of Mr. W. V. S. Thorne, director of purchases, in supplying this information is acknowledged, and that of the Baldwin Locomotive Works in supplying the drawings.

A SHOP SCHEDULE FOR LOCOMOTIVE REPAIRS.

Mr. Henry Gardner, assistant master mechanic of the Boston & Maine Railroad, has introduced into the Concord shops of that road a shop schedule, which is illustrated by means of the accompanying blank forms:

The object of scheduling or dating locomotive parts in a large railroad repair shop is at once seen when the proper delivery of all the parts needing general repair, for say, 20 or 30 locomotives, is considered. These many parts must, in general, go through the same process for all engines having the same class of repairs, and must follow the same route or course through the various departments. It is evidently out of the question for any one man, however retentive his memory, to follow all this material so that it will be delivered to the erecting shop when needed for the engine, and, therefore, some system must be employed to avoid unnecessary delays.

This system simply assigns to each part of the engine a proper date or day of the month when this part must be sent to, received at, and delivered in turn to the various departments comprising the route over which it is to travel. These parts all start from the erecting shop after the engine is stripped, and return to the erecting shop when wanted for final application.

Sheet No. X.

SCHEDULE SHEET.

Engine No. X. Date taken into Shop, X, '05.
Class, X. Date to leave Shop, X, '05.
Class of Repairs, C. Time allowed, 25 days.

This form contains constants for use in making out the repair record sheets.

Class of Work.	Wanted in Machine Shop.	Wanted in Smith Shop.	Wanted in Boiler Shop.	Wanted in Cab Shop.	Wanted in Paint Shop.	Wanted in Erecting Shop.	Received in Erecting Shop.	Remarks.
Boiler test (first)	..	..	2	..	..	2	..	..
Tender (first)	..	..	4	..	14	4	..	..
Cab	..	..	..	3	..	10	..	..
Valves and Yokes	2	3	..	..	..	10	..	..
Steam chests and covers	2	..	..	..	..	10	..	..
Tender springs	..	..	..	..	..	13	..	..
Spring rigging	..	2	..	..	..	16	..	..
Driver brake	..	2	..	..	..	16	..	..
Guides	2	..	..	..	..	16	..	..
Ash pan	..	..	3	..	..	18	..	..
Driving wheels	1	..	..	..	..	18	..	..
Eccentrics and straps	2	..	..	..	..	18	..	..
Cross-heads	2	..	..	..	..	19	..	..
Pistons and rods	2	..	..	..	..	19	..	..
Engine springs	..	..	..	..	..	19	..	..
Driving boxes, shoes, wedges	2	..	..	..	..	20	..	..
Link work	2	..	..	..	..	20	..	..
Main rods	0	..	..	..	..	20	..	..
Brass work	2	..	..	..	..	20	..	..
Flues set	..	..	20	..	..	20	..	..
Boiler work	..	..	20	..	..	20	..	..
Engine truck	..	..	..	..	..	20	..	..
Boiler test (last)	..	..	21	..	..	21	..	..
Smokebox work	..	..	22	..	..	22	..	..
Tender (last)	..	..	..	..	..	23	..	..
Parallel rods	0	..	..	..	..	23	..	..

The blank forms include a schedule sheet, date sheet, repair record sheet and shop repair cards. The date sheet or "Calendar" is used to quickly and accurately assign the dates as called for on the repair record sheet. This is done by means of the schedule sheet, which carries against the parts to be routed, numbers or constants, representing the increments of time between the receipt and delivery of these parts in the various departments concerned. The date sheet may be made for any number of months, and is merely a convenient aid in making out the repair record sheet. It may be made in the form of a slide rule, with the days of three months (Sundays and holidays omitted) on the fixed part, and numbers from 0 to 24, or the total number of days in the schedule on the sliding part. The 0 is placed under the day an engine comes into the shop and over the constants on the sliding part, the desired date when parts must be ready is read from the fixed part.

The schedule sheet is a counterpart of the repair record sheet but, instead of carrying actual dates, the corresponding spaces are used for the constants referred to. An engine may be allowed any number of days, the values of the constants varying in proportion to the total time.

The repair record sheet shows the names of the parts in the left-hand vertical column, and on the horizontal line at the top are headings for each department concerned. The shop repair card is a subdivision of the repair record sheet, and is used to extend the information on that sheet to the workmen who make the repairs to the different parts.

Sheet No. 201.

REPAIR RECORD SHEET.
Issued to
JOHN SMITH, Foreman.

Engine No. 2. Date taken into Shop, 2—27—'05.
Class T—84—c. Date to leave Shop, 3—27—'05.
Class of Repairs, C. Time allowed, 25 days.

Class of Work.	Wanted in Machine Shop.	Wanted in Smith Shop.	Wanted in Boiler Shop.	Wanted in Cab Shop.	Wanted in Paint Shop.	Wanted in Erecting Shop.	Received in Erecting Shop.	Remarks.
Boiler test (first)	....	....	3–1	....	....	3–1	....	....
Tender (first)	....	....	3–3	....	3–15	3–3	....	....
Cab	....	....	....	3–2	....	3–10	....	....
Valves and yokes	3–1	3–2	....	....	....	3–10	....	....
Steam chests and covers	3–1	....	....	....	....	3–10	....	....
Tender springs	....	....	....	....	....	3–14	....	....
Spring rigging	....	3–1	....	....	....	3–17	....	....
Driver brake	....	3–1	....	....	....	3–17	....	....
Guides	3–1	....	....	....	....	3–17	....	....
Ash pan	....	....	3–2	....	....	3–20	....	....
Driving wheels	2–28	....	....	....	....	3–20	....	....
Eccentrics and straps	3–1	....	....	....	....	3–20	....	....
Cross-heads	3–1	....	....	....	....	3–21	....	....
Pistons and rods	3–1	....	....	....	....	3–21	....	....
Engine springs	....	....	....	....	....	3–21	....	....
Driving boxes, shoes, wedges	3–1	....	....	....	....	3–22	....	....
Link work	3–1	....	....	....	....	3–22	....	....
Main rods	2–27	....	....	....	....	3–22	....	....
Brass work	3–1	....	....	....	....	3–22	....	....
Flues set	....	....	3–22	....	....	3–22	....	....
Boiler work	....	....	3–22	....	....	3–22	....	....
Engine truck	....	....	....	....	....	3–22	....	....
Boiler test (last)	....	....	3–23	....	....	3–23	....	....
Smokebox work	....	....	3–24	....	....	3–24	....	....
Tender (last)	....	....	....	....	....	3–25	....	....
Parallel rods	2–27	....	....	....	....	3–25	....	....

This Sheet to be returned to the Master Mechanic's Office when the Engine goes into service.

F. E. BROWN, M. M.

These sheets and cards are used in the following manner in these shops, although, of course, no two shops would employ the same methods, due to the differences in arrangement and classification of buildings and machines. The repair record sheet is first filled out by the master mechanic, and issued to the foremen of the different departments; each foreman receiving a duplicate sheet bearing all dates for the entire engine. From this each foreman issues the shop repair cards to the head men on the different jobs, or classes of work, which come under his jurisdiction. At Concord 12 of these cards apart, in order to provide for the dynamomenter springs and extend the full length of the car. Upon these channel sills rests a frame of cast steel plates, which supports the recording table, and forms a rigid connection between the draft sills and the table. To increase the stiffness of the car, end platforms are omitted.

The general arrangement of the dynamometer and the recording mechanism is quite similar to that of the Chicago & Northwestern dynamometer car, illustrated in this journal in June, 1900, page 172. The construction is modified because of a higher recording table, but the paper-driving mechanism, the dynamometer itself and the recording devices are similar. Springs, 16 in number, are arranged in two sets, with a follower between them. The casing gives these springs an initial compression. The free height of the springs is 10¾ ins. for one side, and 11¼ ins. for the other side; one set gives 50,000 lbs. capacity and the other set 100,000 lbs. The purpose of the initial compression in the springs is to cause the discrepancies between the deflections of increasing and decreasing loads to neutralize each other. The initial load is sufficient to guard against either side becoming entirely unloaded in the maximum draw bar pull. The recording movement is taken from the central follower, to which the coupler is attached, the pull and thrust of the draw bar being transmitted to the draft sills through the casting containing the springs. The vertical shaft connects the motion of the draw bar to the recording arm, which connects with a pencil arm by means of flexible steel bands. The pencil arm extended upon the opposite side of its pivot connects with a pair of dash pots, communicating motion to the arm by means of flexible steel bands.

The paper-driving mechanism is clearly shown in the engraving, which also illustrates the clutch for reversing the motion as the direction of the movement of the car is changed, thus always keeping the paper moving in the same direction. The pencil arm moves back to the datum position under the influence of the long steel spring, which also keeps the slack out of the motion. The vertical shaft leading to the pencil arm is supported upon ball bearings. The recording mechanism is equipped with an automatic integrator, and pens actuated by electricity are provided for the time, mile post, indicator card and other data.

The draw bar is carried on a special yoke, with roller bearings to carry its weight and take the side thrusts. This involves the use of horizontal and vertical rollers. The trucks have four wheels, each with equalizers; the wheel base being 8 ft.; the wheels being 35 ins. in diameter.

The speeds of the paper, as determined by the gearing and the driving mechanism, are such as to record 1-16, ⅛, ¼, ½ and 1 mile per ft. on paper.

COMMON STANDARD LOCOMOTIVES.

Harriman Lines.

Last month comparative dimensions and weights of the four standard locomotives for the Harriman Lines were presented with a brief statement of some of the parts which are made standard to all locomotives. Some of the details may now be recorded.

All classes of locomotives have the same eccentric strap. This was made in cast steel with a light webb section, as indicated in the sectional drawing. The section and side view illustrates the loose ring which is made in three parts and of brass. This ring is not secured either to the eccentric or to the strap and may revolve freely. It is provided with six ⅜-in. oil holes to carry lubricant from the outside to the inside. The oil cups are cast with the strap and two cups are provided at the lower side of the strap, having removable plugs in order to clean them. This standard permits of the use of one pattern of eccentric strap for passenger, freight and switching locomotives.

Eccentric.—One eccentric design fits all classes of engines. The eccentric throw is 5 ins., as shown in the drawing, the forward motion eccentric has a 6-in. bearing on the axle, whereas the backward motion has but 4¼ ins. This was done in order to avoid too great an offset in the eccentric rods and this arrangement makes it possible to use two eccentric patterns for all new locomotives on the system. The eccentrics are secured with key and set screws, the two halves of the backward motion eccentric being secured together by studs and those of the forward motion secured by studs and also by bolts on the projecting hubs.

Driving Boxes.—These are all cast steel and are of two sizes, one being 9 x 12 ins., common to all engines, and the other 10 x 12 ins., which is used for the main boxes of the consolidation and Pacific types. As the designs are in all respects similar, except as modified for the two journal diameters mentioned, the larger one only is shown. These boxes have substantial brasses 2¼ ins. thick at the crown and with four ½-in. oil holes from the oil pocket leading to the cavity at the center. Two strips of babbitt 2 ins. wide are let into the brass as indicated. The entire outer face of the outside of the box is babbitted in a dovetail groove. The cellar is of cast iron and is provided with a removable plate on the inside for convenience in packing.

Cross Head.—One cross head fits all engines. The body is of cast steel and the removable shoes are of bronze. The shoe area is 5½ ins. wide by 24 ins. long. The engraving also shows the cross head pin and piston rod end. This cross head is light and convenient to maintain. Oil cups are cast in the lower shoes and attached through the body of the cross head for the upper shoes. Each shoe is secured to the body by 4 bolts.

Wheels.—All the driving wheel centers are of cast steel with cavities for counterbalances of lead, which are figured by the Master Mechanics' Association rule. All of the driving wheels of the standard engines are shown, and weights, together with the counterbalance weights, are presented in the accompanying table. It will be noticed that in order to get approximately the same cylinder spread on all of these engines, viz., 89 ins. for the Pacific and Consolidation types; 88 ins. for the Atlantic type, and 87 ins. for the switcher, the length of the hubs of the driving wheels differ. It will be noted that in all cases the estimated weight of each crank pin hub is given in the table. The tires of the Pacific and Atlantic type are shrunk on and bear against a shoulder on the outside of the tire. The drawings show the distance of the center of gravity of the counter balance of each wheel from the center of the axle.

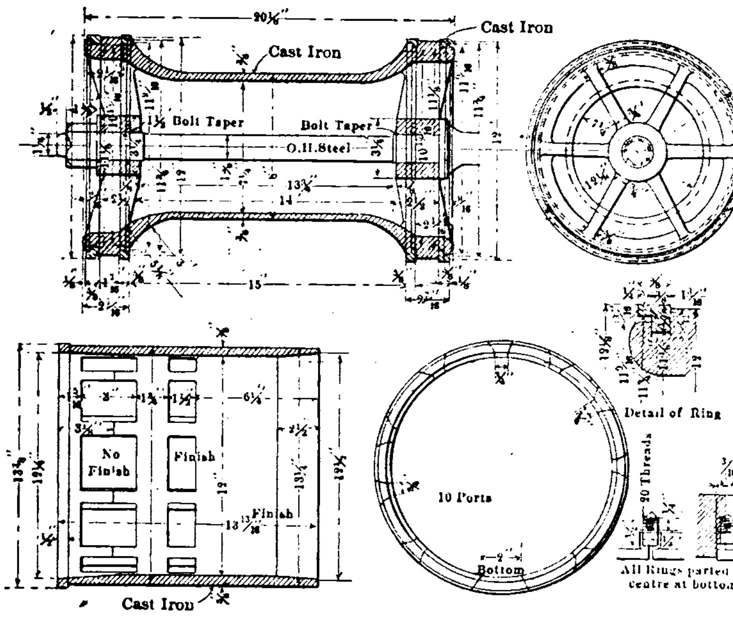
Truck Wheels.—All truck wheels have cast iron centers and steel tires made by the Standard Steel Works. For the Atlantic and Pacific types the truck wheels are 33½ ins. in diameter. The normal weights are as follows:

Tire when finished	480 lbs.
Tire when rough	540 lbs.
Center when finished	435 lbs.
Center when rough	475 lbs.
Two retaining rings	55 lbs.
Bolts and nuts	10 lbs.
Finished wheel	980 lbs.

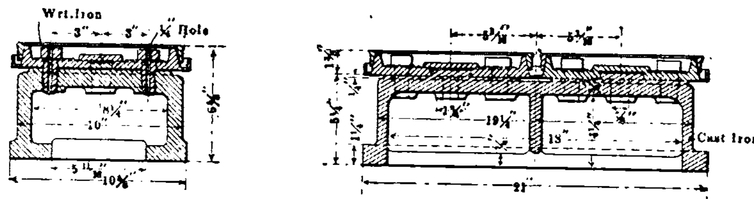
The truck wheels of the Consolidation types are 30½ ins. in diameter. The normal weights are as follows:

Tire when finished	434 lbs.
Tire when rough	490 lbs.
Center when finished	392 lbs.
Center when rough	445 lbs.
Two retaining rings	48 lbs.
Bolts and nuts	10 lbs.
Finished wheel	884 lbs.

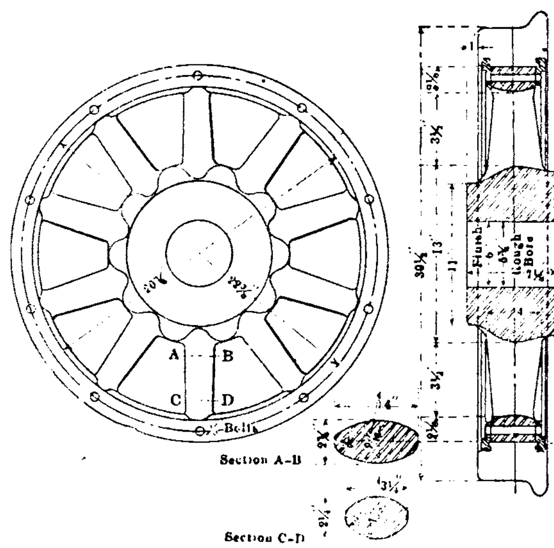
Valves.—The valves of the switcher are of the flat type with American balance, using two rings, all the rest are of the piston type, 12 ins. in diameter, one valve serving for all the road engines. This valve is of cast iron with 2 L-shaped rings at each end. The valve rods are all 2 ins. in diameter and vary in length only. The piston valves have internal admission, the motion being indirect and the eccentric rods are crossed. The engraving of the valve also illustrates the bushing and ports. The valve stems are not extended. Two pis-



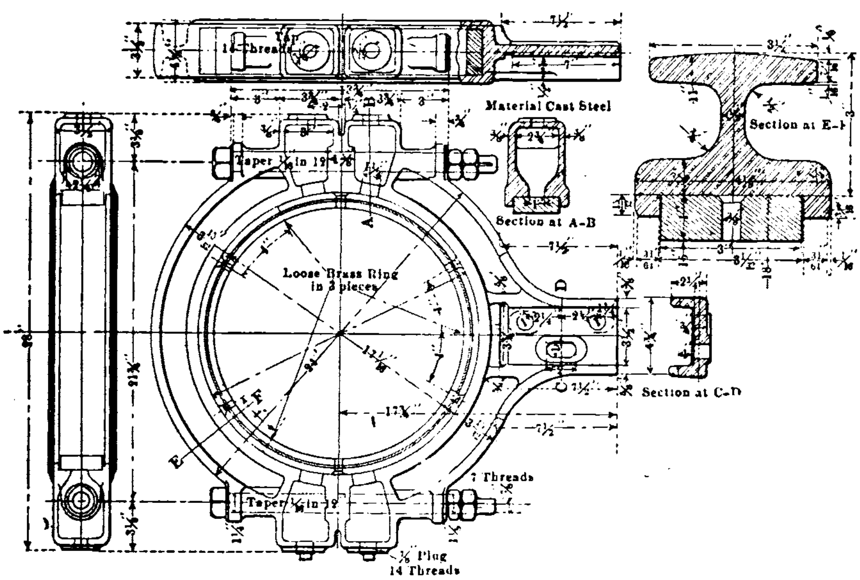
PISTON VALVE FOR ROAD ENGINES.



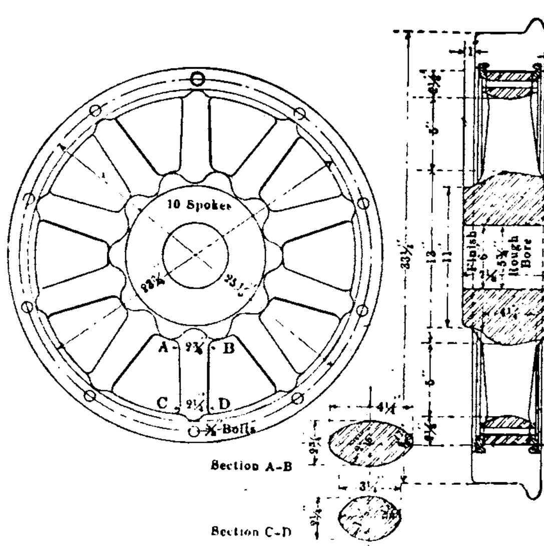
AMERICAN BALANCED VALVE FOR SWITCHERS.



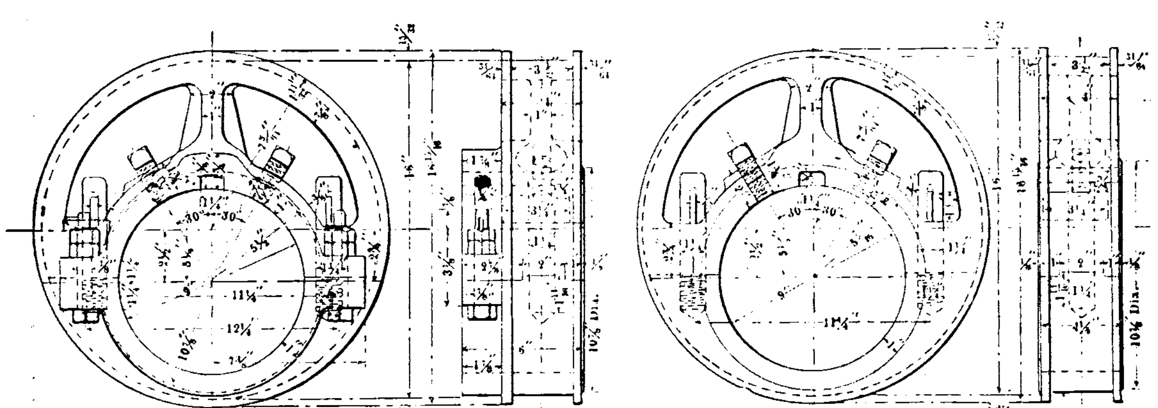
TRUCK WHEEL, CONSOLIDATION TYPE.



ECCENTRIC STRAP, ALL ENGINES.



TRUCK WHEEL, PASSENGER ENGINES.

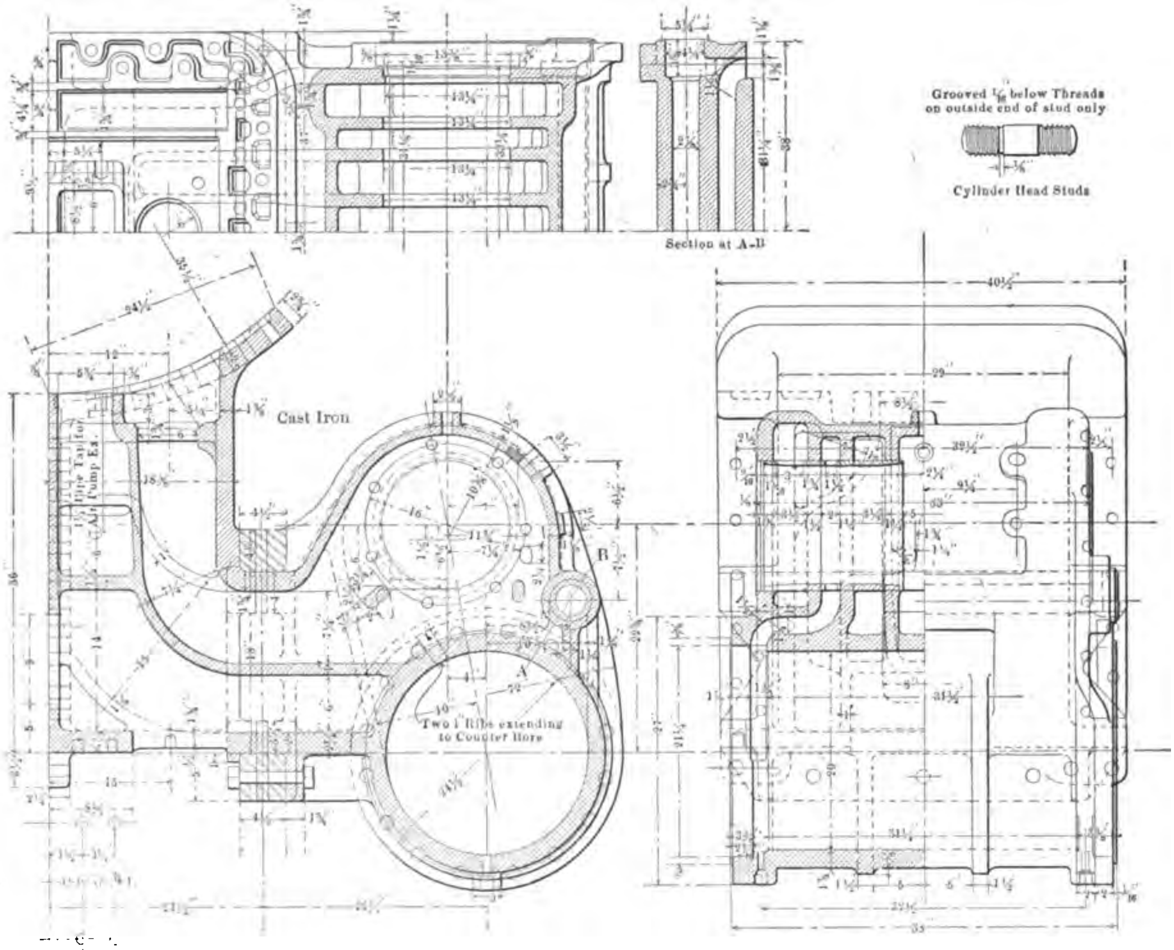


Forward Motion

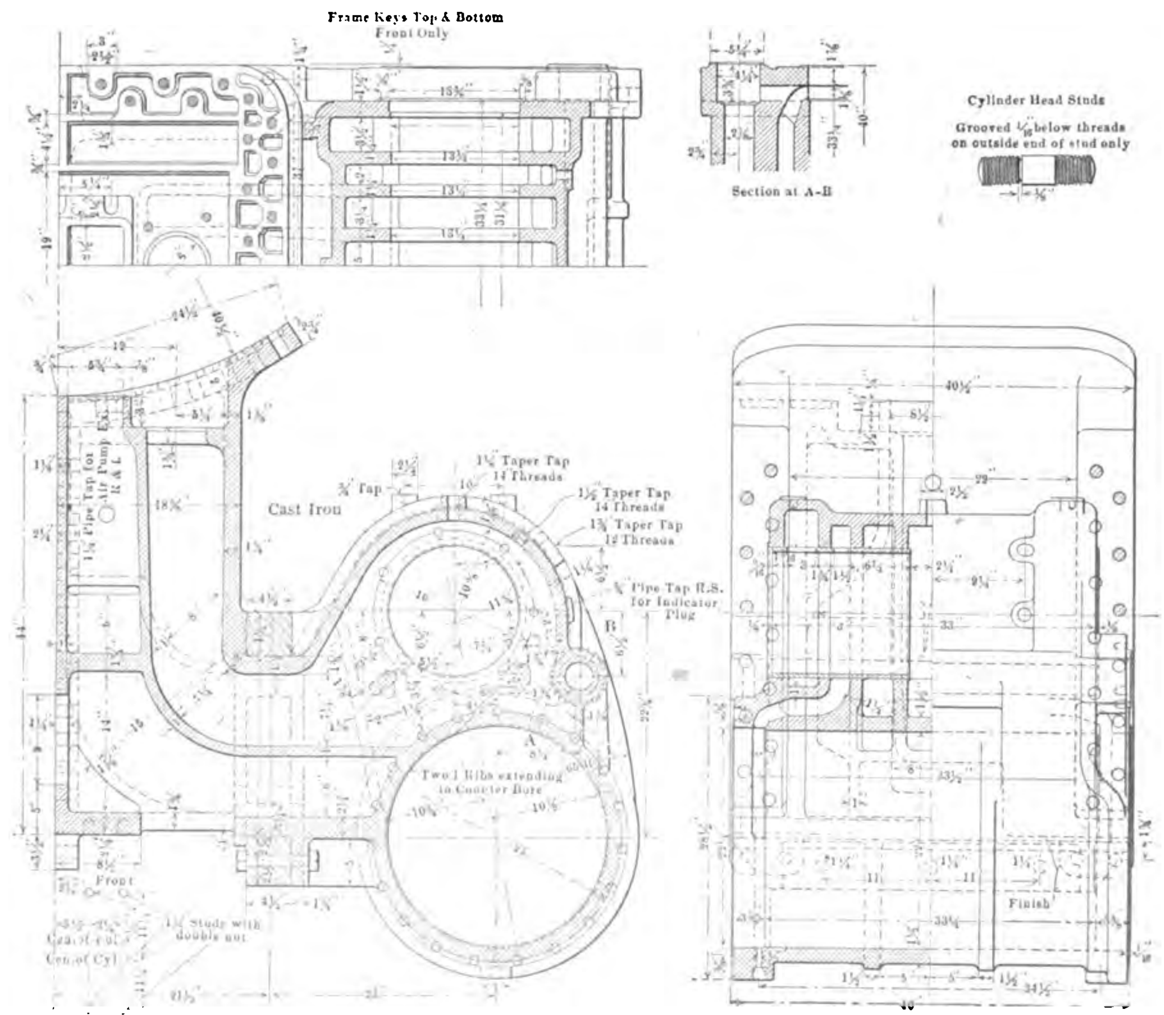
Backward Motion

ECCENTRICS FOR ALL ENGINES.

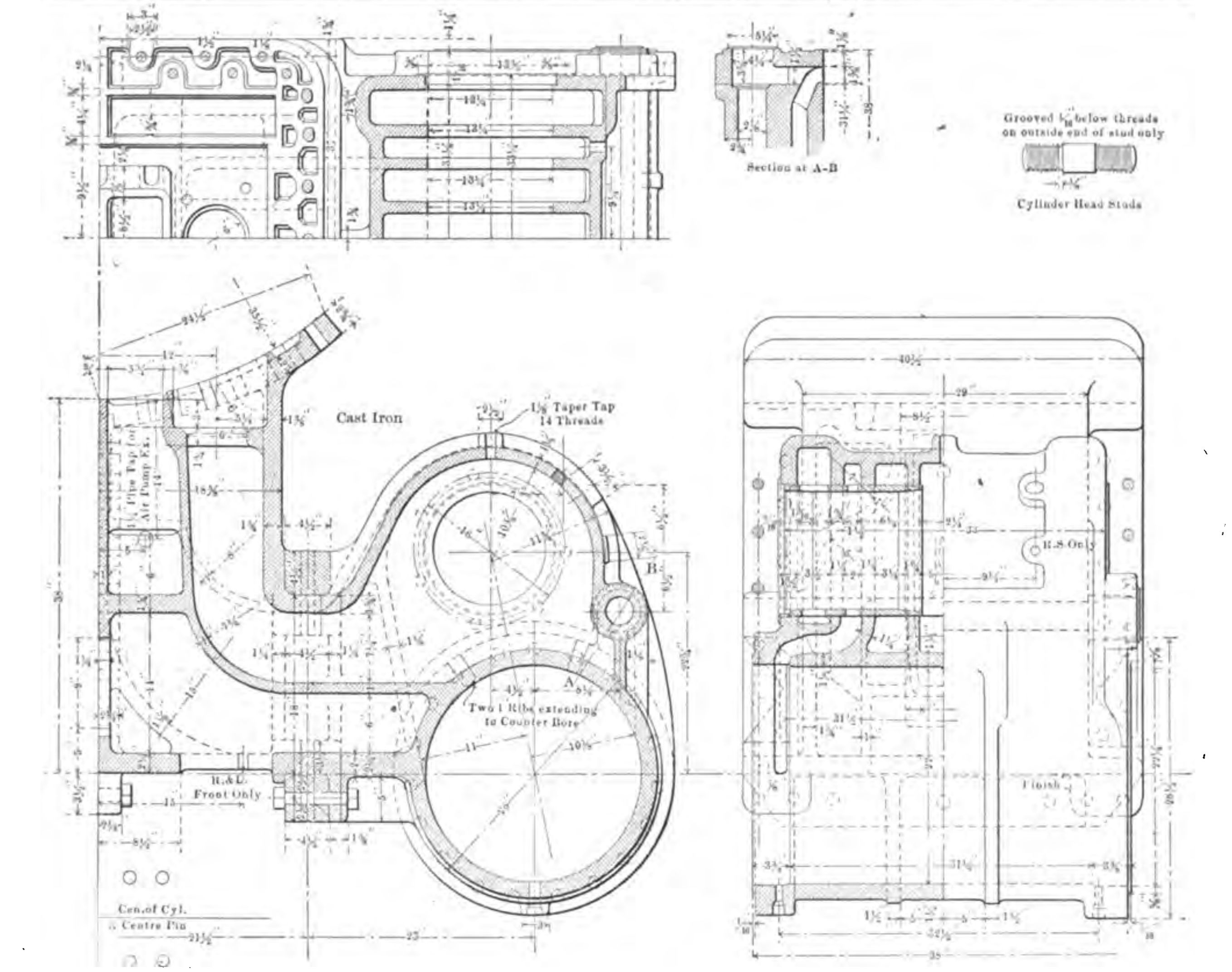
COMMON LOCOMOTIVE STANDARDS—HARRIMAN LINES.



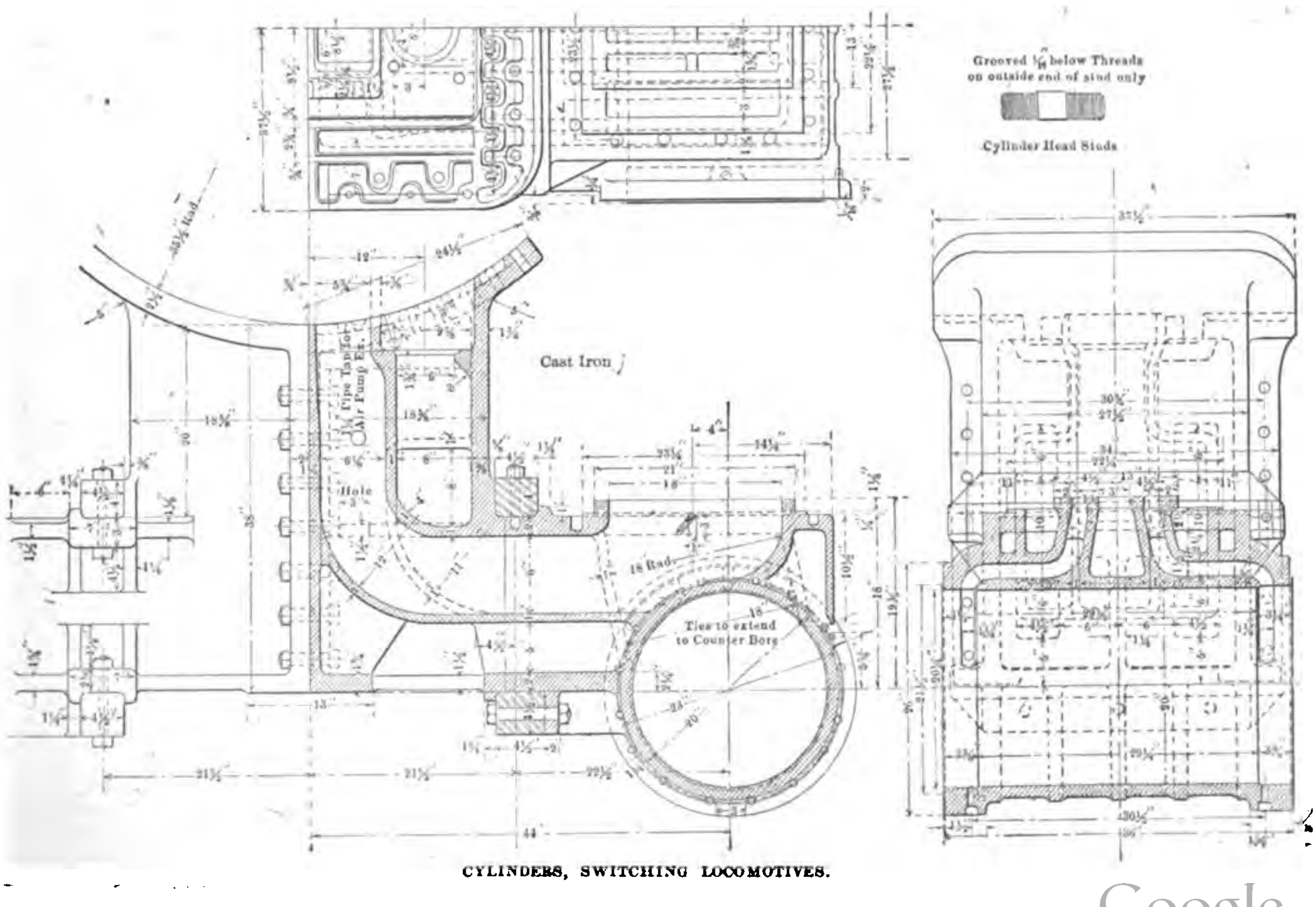
CYLINDERS, 4—4—2 (ATLANTIC) TYPE.



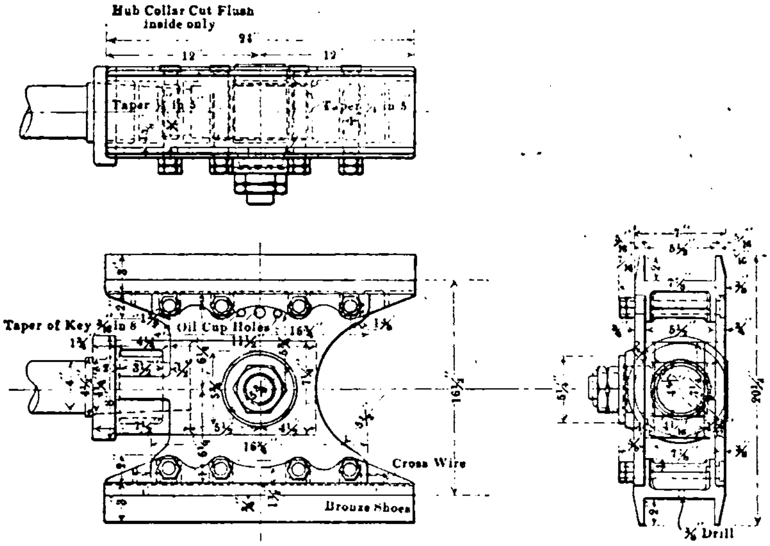
CYLINDERS, 2—8—0 (CONSOLIDATION) TYPE.



CYLINDERS 4—6—2 (PACIFIC) TYPE.



CYLINDERS, SWITCHING LOCOMOTIVES.

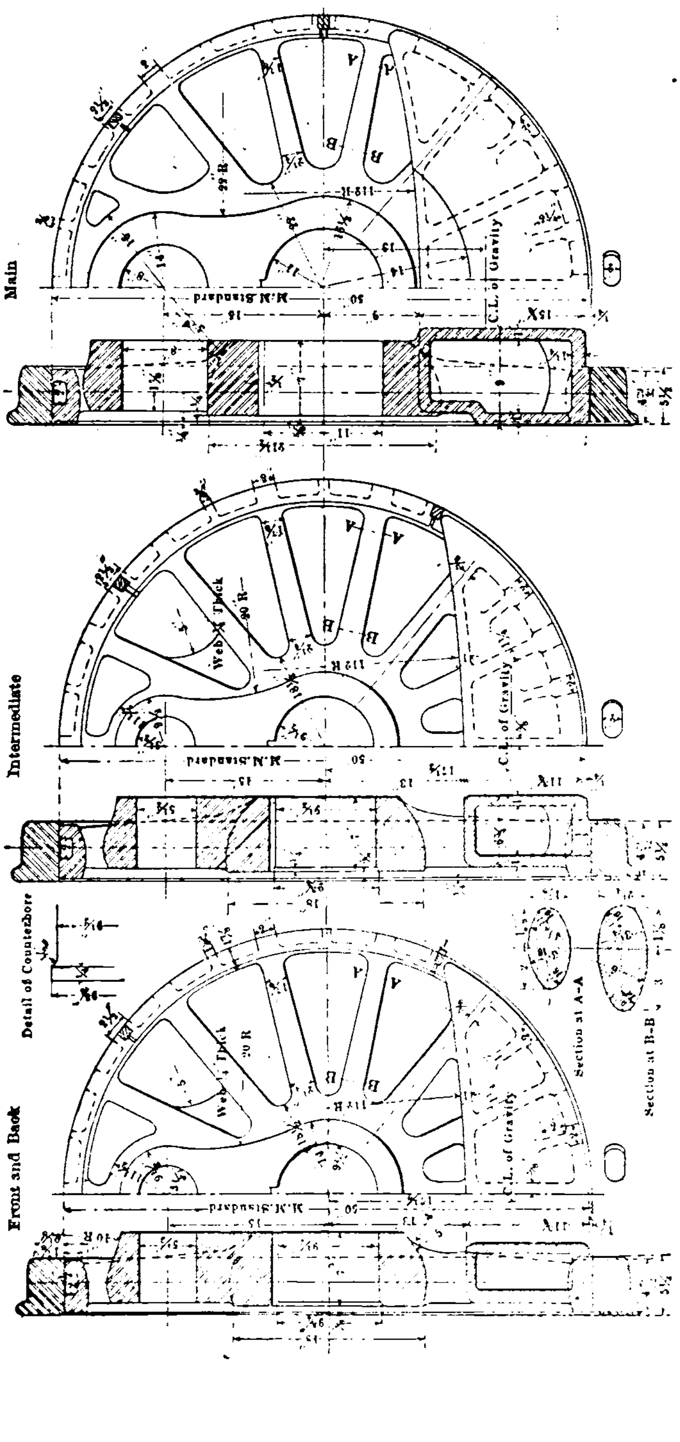


CROSS-HEADS, ALL ENGINES.

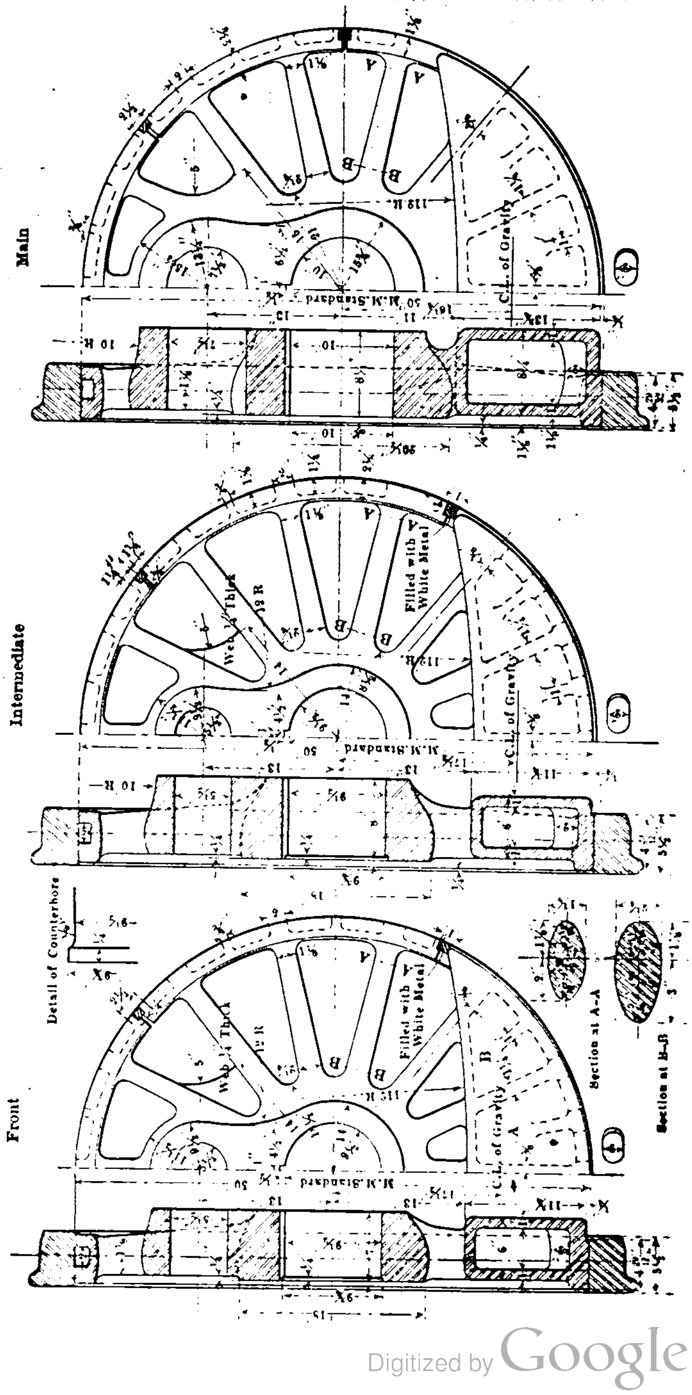
COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

NORMAL WEIGHTS OF DRIVING WHEELS.

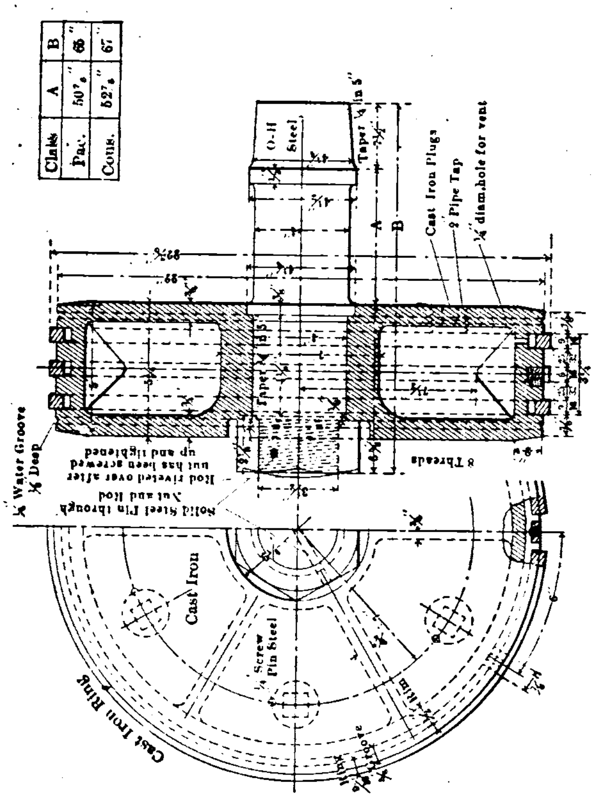
	Centre Only. Rough	Centre Only. Finished	Tire Only. Rough	Tire Only. Finished	Estimated Weight of Crank Pin Hub	Lead Filling	Total Weight of Completed Balance	Finished Wheel with Balance
ATLANTIC TYPE.								
Main	2840	2500	1480	1419	180	390	658	4366
Front	2800	2450	1480	1419	139	128	332	4059
PACIFIC TYPE.								
F. & B.	2430	2191	1400	1339	106	53	326	3620
Main	2710	2321	1400	1339	152	456	840	4210
CONSOLIDATION.								
F. & B.	1895	1487	1015	998	140	270	509	2765
Inter.	1960	1509	1015	998	140	348	635	2855
Main	2250	1825	1015	998	235	825	1392	3648
SWITCHER.								
Front	1868	1468	1015	998	102	174	425	2640
Inter.	1894	1484	1015	998	118	315	568	2807
Main	2217	1767	1015	998	190	625	1044	3390



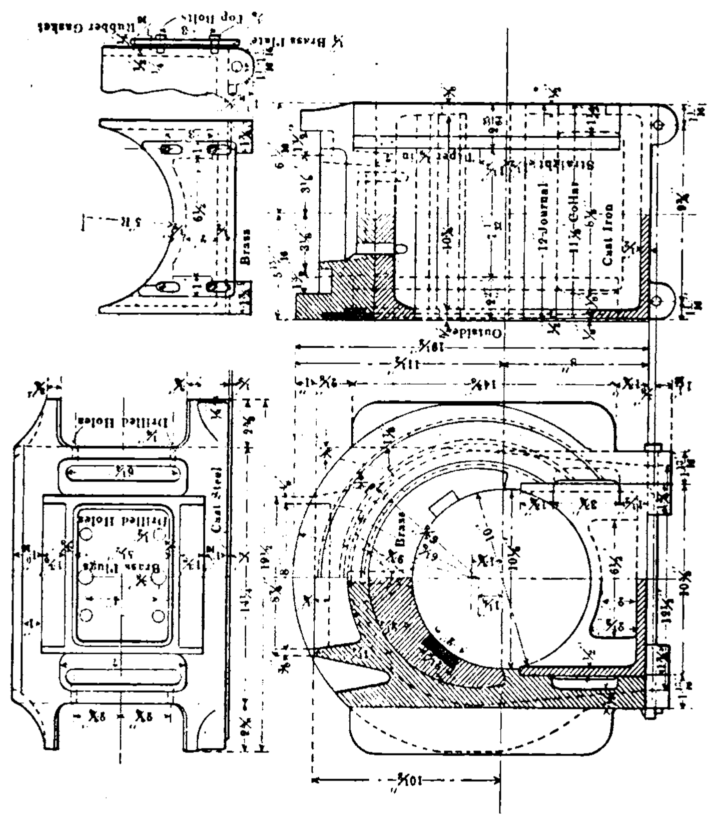
DRIVING WHEELS, 2—8—0 (CONSOLIDATION) TYPE.



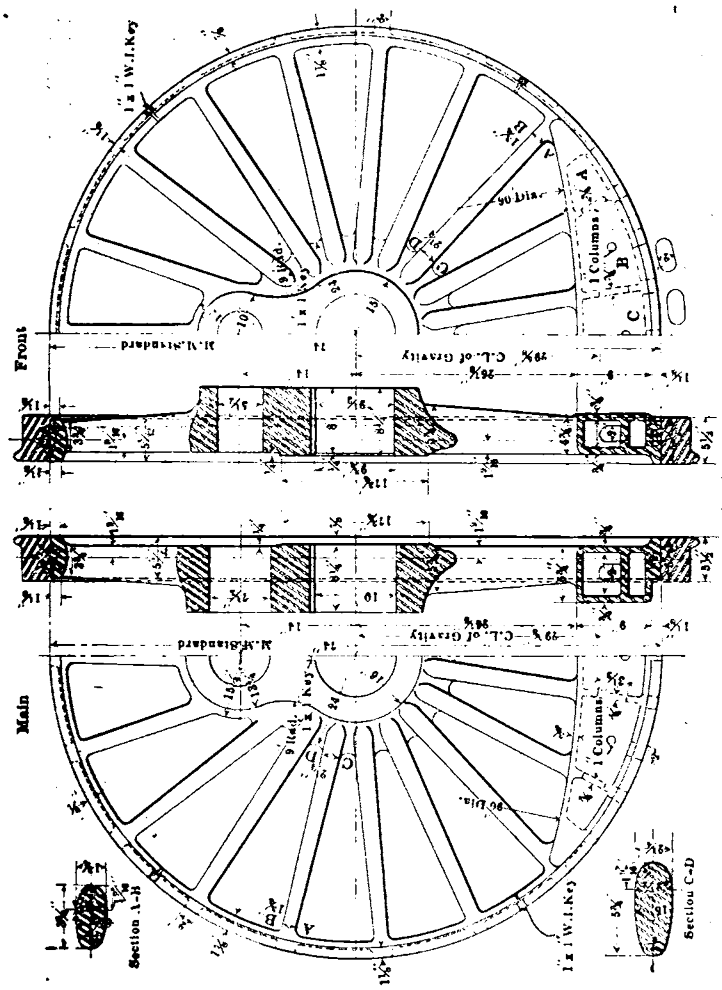
DRIVING WHEELS, SWITCHING LOCOMOTIVES.



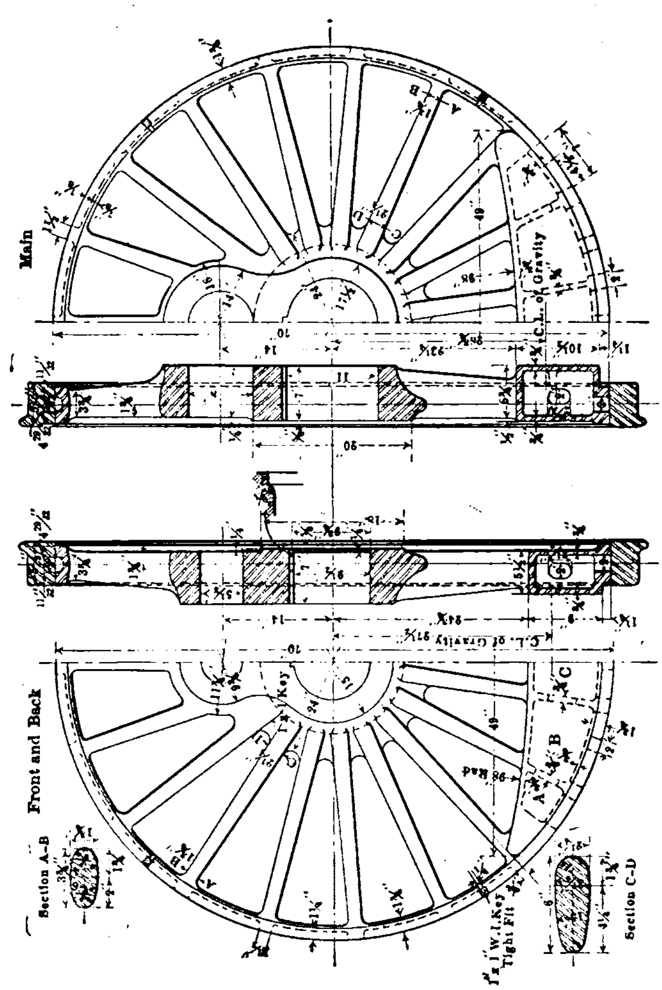
PISTON—PACIFIC AND CONSOLIDATION TYPES.



MAIN DRIVING BOX—CONSOLIDATION AND PACIFIC TYPES.



DRIVING WHEELS, 4—4—2 (ATLANTIC) TYPE.



DRIVING WHEELS 4—6—2 (PACIFIC) TYPE.

ton drawings suffice for all engines. The Atlantic type and switcher take 20-in. pistons and the Consolidation and Pacific types 22-in., the piston rods being all 4 ins. in diameter and vary in length only. The pistons are of cast iron 5¼ ins. thick, each with three cast iron packing rings. The pistons for the Consolidation and Pacific types are illustrated, the only difference between these and the one for the Atlantic type and switcher being in the diameter of the piston and the length of the piston rod.

Cylinders.—As already stated, all road engines have the same piston valve and valve stem packing and the same piston rod packing, and the cylinders are arranged to bring the centers of the valves at the same distance from the centers of the frames. All of these cylinders are provided with a modification of the Sheedy circulating pipe, provided for in the cylinder casting itself. All the cylinders have the same exhaust and steam pipe seats and the same length of saddle fit except the switchers which have a lighter saddle. The exhaust pipes are held by six studs and each steam pipe by four studs. All the road engines are double bolted all around. The cylinders are all arranged for 43-in. frame spacings and for the same cross section of frames.

These details give evidence of unusual care in designing, the chief purpose being to adhere to common standard construction without sacrifice of other factors to secure this result.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.

Other details will be presented later.

REPORT OF COMMITTEE ON FREIGHT EQUIPMENT.

ROCK ISLAND COMPANY.

II.

(*For previous article see page* 153.)

EDITOR'S NOTE.—This study of the car equipment of the Rock Island and 'Frisco systeme deals first with the composition of the equipment, its age, cost and present value. This is followed by a statement in detail concerning the condition of the equipment, the recommendations as to retirement or improvement. In this portion of the report various equipment parts and devices, which have given good service, are recommended. A large proportion of the report is occupied by a statement concerning all the various groups of cars now in service. The following section deals with numbering and classification, and the report closes with recommended designs for new equipment. The size of the report and the large variety of different classes of cars forming the equipment of a combination of roads, together with the very large investment in car equipment are impressive features of this unique document. No argument could possibly be stronger to show the necessity from a commercial standpoint of standardization. Abstracts from the report follow:

It is the opinion of the committee, based on the information given in these diagrams, and actual observation of the equipment, that the limit of safe, useful and economical operation of wooden cars is reached at the ages given below:

Box cars	18 years
Furniture cars	18 years
Refrigerator cars	12 years
Fruit cars	14 years
Stock cars	14 years
Coal cars	14 years
Flat cars	14 years
Ballast cars	12 years

and that an annual depreciation, based on the above terms of years and allowing for the value of the scrap material in the cars, should be charged off, so that when the limit is reached the car can be retired from revenue service and either be destroyed or used in yard or work train srvice only. Attention is called to the fact that the average of these limits is practically the same as established by the M. C. B. Association, viz., 16 years.

To find the value of a car at any age within the limits above given, subtract from the original cost the scrap value. Multiply this result by the percentage shown opposite the age, and add the scrap value.

In calculating the value of the caboose cars, the age limit has been take at 25 years.

Tables give the number of cars in service October 1st, 1904, arranged in series, showing in each case the car numbers and initials, length, capacity and age, also a list of the principal features of construction, together with the recommendation of the committee as to what should be done for its betterment, if 60,000 lbs. capacity or over, or the limit of expenditure, if less than 60,000 lbs., which, if the condition of the car indicates must be exceeded, will determine that it shall be retired from active service.

In determining the limits the committee was governed by not only the age and condition of the cars, but by the strength of the body bolsters, which are the foundations upon which the superstructure is carried, and which when weak are the cause of excessive wear of wheel flanges and also derailments, by excessive friction on the truck side bearings. (These limits vary from $10 to $80, depending upon the capacity and the general character of the equipment and construction. The tables are omitted.—EDITOR.)

The limit is made higher for cars equipped with the American continuous draft rigging, because of the fact that if it is thought advisable to apply an improved type of draft, it must of necessity be applied to both ends of the car at the same time, whereas in the case of a car equipped with a single spring draft, the new type may be applied to one end at a time.

VALUATION OF CAR EQUIPMENT.

	Box and Furniture.		Fruit, Stock, Coal and Flat.		Refrigerator and Ballast.	
Years.	Rate.	Percentage.	Rate.	Percentage.	Rate.	Percentage.
1	5.5	.945	7	.93	8	.92
2	5.5	.890	7	.86	8	.84
3	5.5	.835	7	.79	8	.76
4	5.5	.780	7	.72	8	.68
5	5.5	.725	7	.65	8	.60
6	5.5	.670	7	.58	8	.52
7	5.5	.615	7	.51	8	.44
8	5.5	.560	7	.44	8	.36
9	5.5	.505	7	.37	8	.28
10	5.5	.450	7	.30	8	.20
11	5.5	.395	7	.23	8	.12
12	5.5	.340	7	.16	8	.04
13	5.5	.285	7	.09		
14	5.5	.230	7	.02		
15	5.5	.175				
16	5.5	.120				
17	5.5	.065				
18	5.5	.010				

Example: A box car costing originally $660 has a scrap value of $110. What is it worth when 16 years old?

Original cost	$660	
Deduct scrap value......	110	
	$550	
Percentage	.12	
	66.00	
Add scrap value......	110.00	$176.00 value at 16 years.

These recommendations as to the limit of expenditure are only general, and intended to show the relative worth of the cars, and are subject to modification in the case of such cars as have been rebuilt within five years, upon inspection as outlined hereafter, and are intended to apply only to the bodies of the cars, and they do not include the cost of running repairs to the trucks, couplers or air-brakes. The intent in recommending limits is that these amounts may be expended on such cars when they come to the shops for repairs after a given date, for instance, January 1, 1905, and should they again come to the shop for repairs to an equal amount within six months after leaving the shop, they should be retired at once. To assist in determining the amount of expenditure required for repairs, the committee suggests the preparation of schedules for each class of car, showing the cost of the various parts, and an example showing its application.

When a car is received at the shops requiring repairs in excess of the limit, report should be made at once to the general superintendent of motive power and authority obtained the boiler is 10 ft. above the tops of the rails, this being the greatest height of boiler in our record.

DIMENSIONS OF THE LARGEST LOCOMOTIVE BOILER.

Working pressure	235 lbs. per sq. in.
Diameter outside the first course	84 ins.
Distance between tube plates	20 ft. 10¾ ins.
Thickness of barrel and saddle sheets	1 in.
Thickness of tube sheet	¾ in.
Thickness of outside firebox and back head	⅝ in.
Number of tubes	436
Diameter of tubes	2¼ ins.
Height of boiler centre above rail	10 ft.
Height of stack above rail	15 ft.
Firebox length (inside)	108⅛ ins.
Width (inside)	96¼ ins.
Thickness of tube sheet	½ in.
Thickness of crown sheet	7-16 in.
Thickness of side sheets	⅜ in.
Thickness of back sheet	⅜ in.
Grate area	72.2 sq. ft.
Heating surface, firebox	219 sq. ft.
Heating surface, tubes	5,366 sq. ft.
Heating surface, total	5,585 sq. ft.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

III.

(For previous articles see pages 154 and 200.)

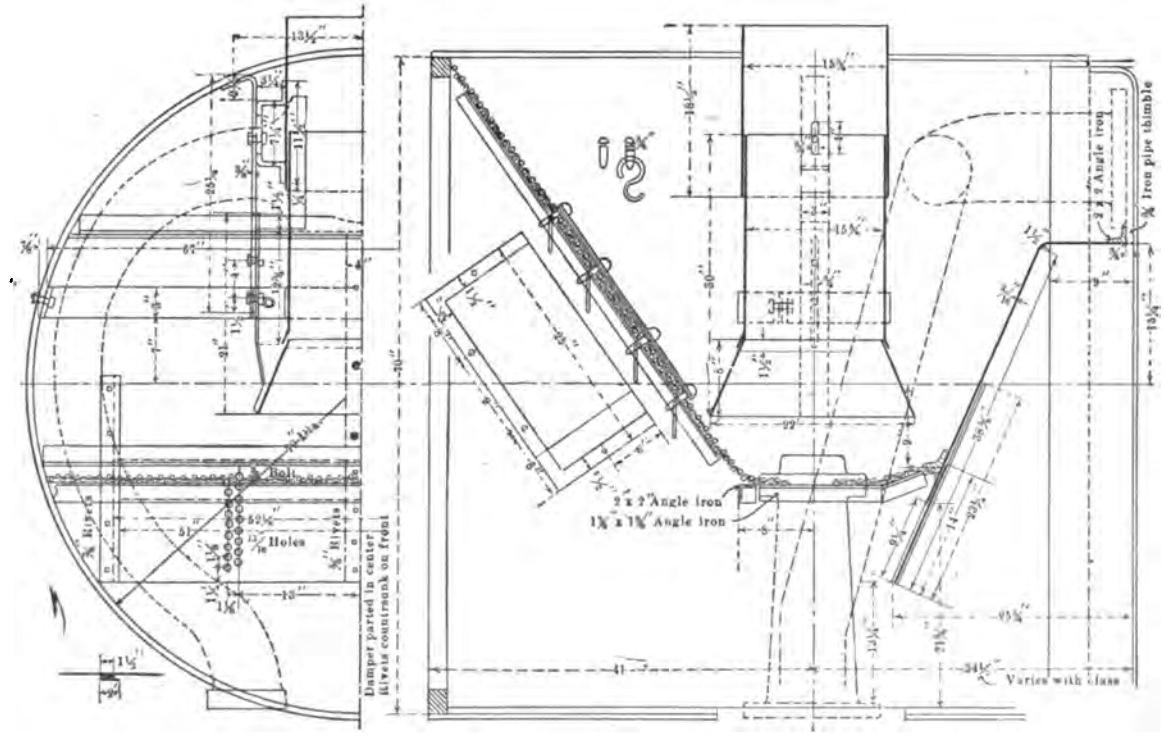
SMOKE BOX ARRANGEMENT.

As given on page 154 of the May number of this journal, the boiler diameters of the four types of standard locomotives are 70 ins. for the Atlantic, Pacific and switching locomotives and 80 ins. for the heavy consolidations. The smoke boxes are all sufficiently long to provide for cinder pockets in front of the cylinders and in fact all of the standard engines are fitted with them. The lengths of the smoke box rings are as follows: Atlantic, 71¼ ins.; Pacific, 91 9-16 ins.; consolidation, 69 9-16 ins.; switcher, 57½ ins. These will be illustrated later in connection with the boilers.

The arrangement of the smoke boxes is the same for all engines except as modified by the two diameters of boilers, the boiler of the consolidation type being larger than the others.

The same exhaust nozzle casting is used for all engines and the same size petticoat pipe with a 22-in. flare at the bottom. The diaphragm plate varies in size between the 70 and 80-in. boilers, but is arranged in the same way in both. This also applies to the netting. The distance between the center of the exhaust pipe and the front ring of the smoke box of the Atlantic and Pacific types is 41 ins., this distance on the consolidation is 46 ins. and on the switcher 38 ins. The distance from the center of the exhaust pipe and the front tube sheet varies necessarily in the different classes. It will be noticed that these petticoat pipes are all made in a single piece and are 15¾ ins. inside diameter.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.



STANDARD ARRANGEMENT OF LOCOMOTIVE FRONT END—HARRIMAN LINES.

AMERICAN LOCOMOTIVE COMPANY TO BUILD AUTOMOBILES.—This company will build a plant at Providence, R. I., adjacent to the Rhode Island Locomotive Works, where, under the supervision of Mr. Haughton, the Berliet automobile is to be built, the American Locomotive Company having secured the exclusive right to manufacture these machines in this country. The initial output will be about 200 cars; the first machines to be 40 and 20 h.p. It is likely that the construction of automobile trucks for heavy service will follow.

ELECTRIC VS. STEAM TRACTION.—Mr. L. B. Stillwell, at a recent Institute traction dinner, said in regard to the Manhattan Elevated system: "Electrification of the elevated lines in New York has increased their capacity by one-third, and has decreased by one-fifth the time spent on trains by the average passenger. It has been demonstrated that the cost of maintenance of electrical equipment of rolling stock is materially less than steam equipment. It has proved that electricity can render more reliable service than steam, the aggregate delays due to all causes on the Manhattan lines now being less than one-half per car mile what they were when steam was used as a motive power.

RAILROAD MILEAGE OF THE WORLD.—According to figures printed in the *Archiv fur Eisenbahnwesen*, the total railroad mileage of the world at the end of the year 1903 was 531,659 miles. Europe has 186,566; Asia, 46,293; Africa, 15,549; Australia, 16,595, and America (North and South) has 268,655 miles.

COAL MINED IN 1904.—The production of coal in the United States in the year 1904 amounted to 351,196,953 tons of 2,000 lbs., of which 73,156,709 tons were Pennsylvania anthracite. During the past four years the amount of coal reclaimed annually from the culm banks by washing has amounted to about 2,500,000 tons.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

IV.

(*For previous articles see pages* 154, 200 *and* 250.)

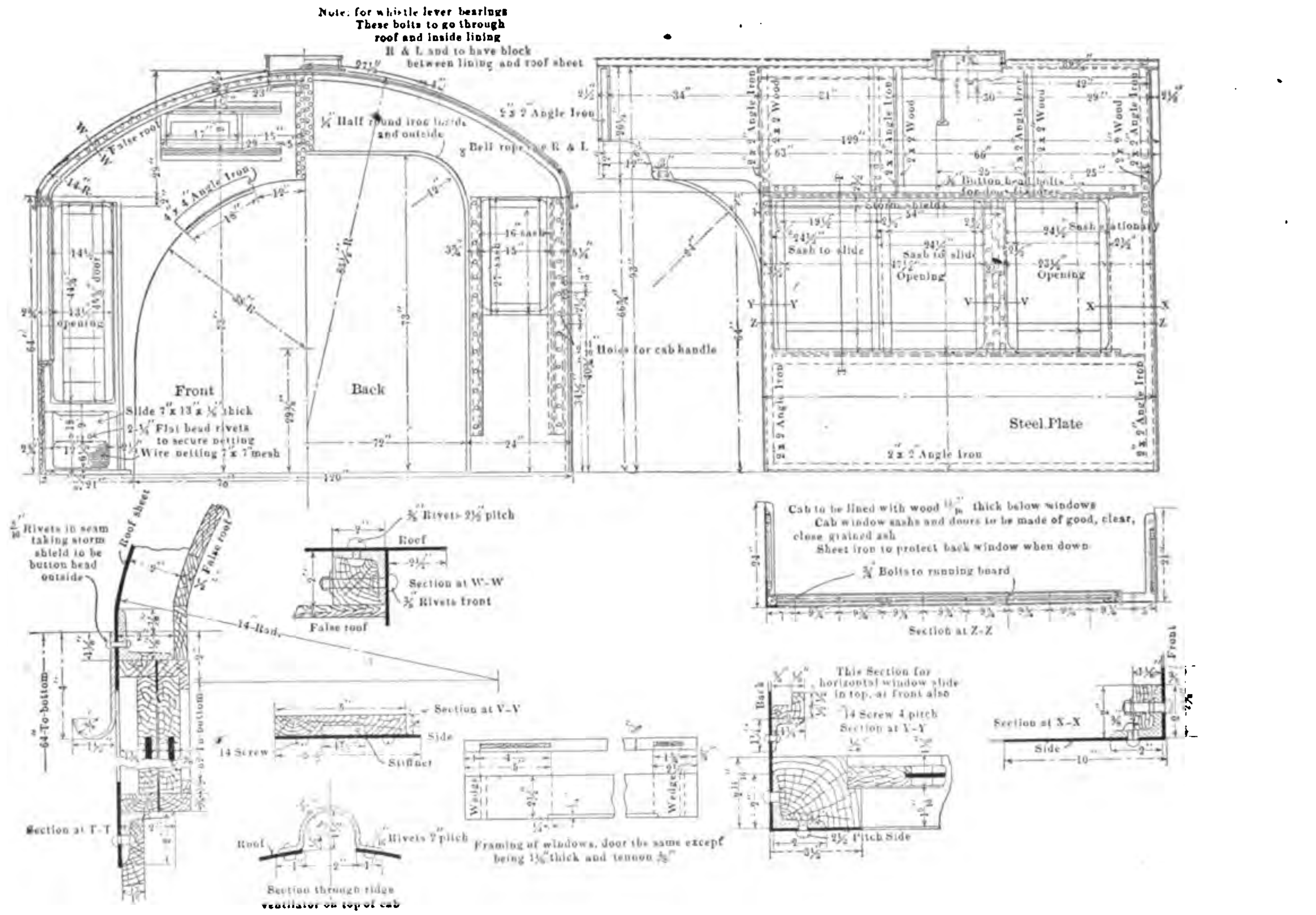
CABS.—The cabs of all four of the standard types are of the same general design, all being of metal with wooden roofs, the frames being of 2-in. angles, the sheets being of 7-lb. steel. The only essential variations are confined to the fitting of the cabs to the different boilers. All of the cabs are 120 ins. wide, and all are 90 ins. long under the windows.

BILL OF STEEL.

4 pieces 60½ x 93 No. 8 steel for front and back.
2 pieces 64½ x 90½ 7-lb. steel for sides.
2 pieces 63½ x 70 7-lb. steel for front of roof.
2 pieces 66½ x 70 7-lb. steel for back of roof.
The angles for the frame throughout are 2 x 2 in.

All of the cabs are braced to the back heads of the boilers by means of two diagonal rods 1 in. in diameter. They are secured to the boilers by means of 4 x 4-in. angles, 18 ins. long.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.



STANDARD CAB FOR PASSENGER LOCOMOTIVES—HARRIMAN LINES.

The designs are sufficiently alike to permit of illustrating the construction with one drawing, which is that adapted to the passenger locomotives which are of the Atlantic and Pacific types. These cabs have ridge ventilation in addition to the trap ventilator through the roof. The windows are large, the side windows having three sashes, of which the forward one is stationary while the others slide. The cabs all have 9 x 17-in. slide windows in front over the boiler. The glazed doors opening on to the running board are 13½ x 44¾ ins., each having a 6½ x 12-in. wire netting opening, covered with a slide of steel plate. The rear windows of the cabs are 16 x 26 ins. over the sash. The details shown in the drawing, together with the section through the roof, show the construction of the frame and the attachment of the wooden portion. It will be noticed that a space of 2 ins. is provided between the ½-in. false roof of wood and the outer steel roof. The cabs have 3-16-in. wooden lining below the windows. The bill of steel for the cabs of the Atlantic and Pacific types shown in the engraving is as follows:

TROUBLES OF LONG AGO.—In the old days during zero weather we would frequently have a number of rails broken in a single night. I recollect we had 255 rails broken in one night between Cincinnati and Cleveland, when the thermometer made a drop from 40 deg. above to 10 deg. below zero in fifteen or eighteen hours. We have seen the wonderful advance made since the introduction of steel rails and steel-tired car wheels. In the old days it was not anything unusual to find a broken car wheel in a train when the thermometer dropped suddenly; and the old pumps on the side of the boiler would sometimes freeze up and the whole road would be tied up over night. All that has been overcome, and we never hear of anything of the kind. It seems marvelous what was accomplished in those days of train despatching and the movement of trains by telegraph with so many difficulties to overcome. Some of the younger generation of railroad men can scarcely realize the trials and tribulations of railroading thirty years ago.—*Mr. C. S. Rhoads, before New York Railroad Club.*

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

V.

(*For previous articles see pages* 154, 200, 250 *and* 288.)

FRAMES.—While the frames of these four types of standard locomotives differ necessarily for the different types of wheel arrangement, they were designed with a view of using the same principles throughout. They are all of cast steel, and the pedestals are arranged for the standard driving boxes, which were referred to in the June number, page 200, the driving boxes being in two sizes for 9 x 12 and 10 x 12-in. driving journals. The Atlantic and Pacific types of passenger locomotives have 10 x 12-in. main journals, all of the other boxes being for 9 x 12-in. journals, thus rendering it possible to use but two driving boxes for all engines. The rear ends of all the frames are alike, to receive the same deck plate. All the frames are 4½ ins. wide, and all are spaced at 43-in. centers. As far as possible the same cross sections of frames are used throughout, but the consolidation frames are ½-in. deeper throughout, in order to secure additional strength and weight. All the frames have rails 5½ ins. deep above the driving boxes, with the exception of the consolidation, which is 6 ins. deep at this point. The pedestal binders are all of rectangular section, secured by double bolts, no pedestal tie bolts being used in any of these frames. The joints in the lower rails, between the main frames and front sections, are provided with double keys throughout and the upper joints with single keys, this construction being the same as that illustrated in connection with the Pennsylvania Class H—6—A locomotives, illustrated in this journal in June, 1899, page 181. There is a marked similarity in the common standard frames, and the pedestal binders are practically the same, varying only in length. All the frames have double front rails.

Because of the use of the Rushton radial trailer truck on the Pacific type and the rigid trailer truck on the Atlantic type, due to its shorter wheel base, the rear portion of the frames of the passenger engines differ in detail construction, specially as effected by the pedestals for the trailer trucks. All the frames are protected by chafing plates of ¼-in. steel for protection against moving links from wearing into them. All joints are double nutted.

By referring to the general plans of the standard engines on pages 155 to 158, it will be seen that the boilers are supported from the mud rings by flexible plates in the case of the passenger engines, by flexible plates and sliding bearings in the case of the consolidation engines and by sliding expansion supports in the case of the switchers. In the design of these frames specially careful attention was given to the frame splices.

The courtesy of Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, in supplying this information is acknowledged, and that of the Baldwin Locomotive Company in furnishing the drawings.

AUTOMATIC RECORDING INSTRUMENTS FOR POWER PLANTS.—One of the best devices for the control of a power plant is the automatic recording instrument recording steam pressure, voltage, current wattage, temperature on heating systems, pump speeds, etc. The most important in an ordinary power house are the steam pressure chart and voltage chart; the former records conditions in the boiler room, the latter, conditions in the engine room. The pressure line cannot be good unless the water level and fires are attended to, nor can the voltage line be correct if the switchboard is neglected. It is excellent practice to require that a written explanation of any irregularity in these charts be pinned to the chart, and an engineer or fireman with a too frequent repetition of bad charts should be discharged.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

DR. W. F. M. GOSS ON VALVE GEARS.

From the beginning of locomotive valve gears, countless devices have been proposed affecting either the valve or the gear which gives it motion, whereby the card may be made larger than that which results from the normal link-driven plain valve. A typical card is shown at A. Concerning such devices, I would note that it is usually assumed, though the assumption is erroneous, that anything which increases the area of an indicator card is desirable. For example, in the engraving, for 20 per cent. cut-off and a speed of 40 miles an hour (card A) the plain outline is the normal card around which has been drawn a so-called improved card. The difference is the shaded area, and is presumably the result of the adoption of some new form of gear. Obviously, the shaded area represents increase of power. The first mistake that is made concerning the change is that the increase in power results in no expense. Again, while the truth of the preceding statement may be admitted, it is often urged that one may measure pressure and volume represented by two indicator cards such as are shown by these cards and derive therefrom an estimate of the relative amount of steam used per horse power per hour under conditions which each represent. Such estimates are, in fact, fairly reliable when made between cards agreeing closely in form, and when all conditions of running are the same, but, as a general proposition, nothing is more misleading. If there are differences in speed, or in initial or final pressure, or in the number of expansions, the percentage of the total amount of steam used which is shown by the indicator will change. Anything which may produce a change in the temperature of the metal of the cylinder at any one point in its cycle is likely to produce changes in the whole cycle. As is well known, a considerable percentage of the steam drawn from the boiler for each stroke of the engine condenses on entering the cylinder. While the interchange of heat causes some change in the amount of water in the cylinder as the piston proceeds on its course, by far the larger part of the initial condensation continues in the cylinder until the exhaust port is open, when it flashes into steam and disappears with the exhaust. While the process is a complicated one, and cannot within the limits of the present paper be accurately defined, the fact is that any change in the form of any line bounding an indicator card has its effect upon the amount of steam which must be admitted to make up the loss due to initial condensation. A change in the cycle remote from the period of admission may have as pronounced an effect on the quantity of steam required as a change in the period of admission itself. There is, in fact, no way to measure performance of a steam engine but by weighing of the feed or the exhaust. Again, a further illustration of the fact that the mere increase in the area of an indicator card is not significant, is to be found in the ease with which such increase of area may be secured. In locomotive practice it is quite unnecessary to adopt a new gear. If, under the conditions prescribed, the normal card (see engraving) is not large enough for the work, the reverse lever may be advanced on its quadrant until the cut-off is 35 per cent. of the stroke instead of 20, whereupon, in this particular case the normal card becomes equal in size with the card representing an assumed improved gear. The real question, therefore, may generally be stated as follows: Is the improved card at 20 per cent. a better card than the normal card of equal area at 35 per cent. cut-off? Will the former yield a horse-power upon the expenditure of less steam than the latter? It is upon this latter statement that the argument rests. No device which seeks to improve the steam distribution in a locomotive can succeed which does not save steam when compared with devices now in use. In proportion as it saves steam, it both increases the efficiency of the engines and increases their maximum power, for since the boiler capacity is limited, a pound of steam saved is a pound of steam available for additional services.

Turning now to a consideration of the margin upon which

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL

OCTOBER, 1905.

CONTENTS.

COMMON STANDARD LOCOMOTIVES.

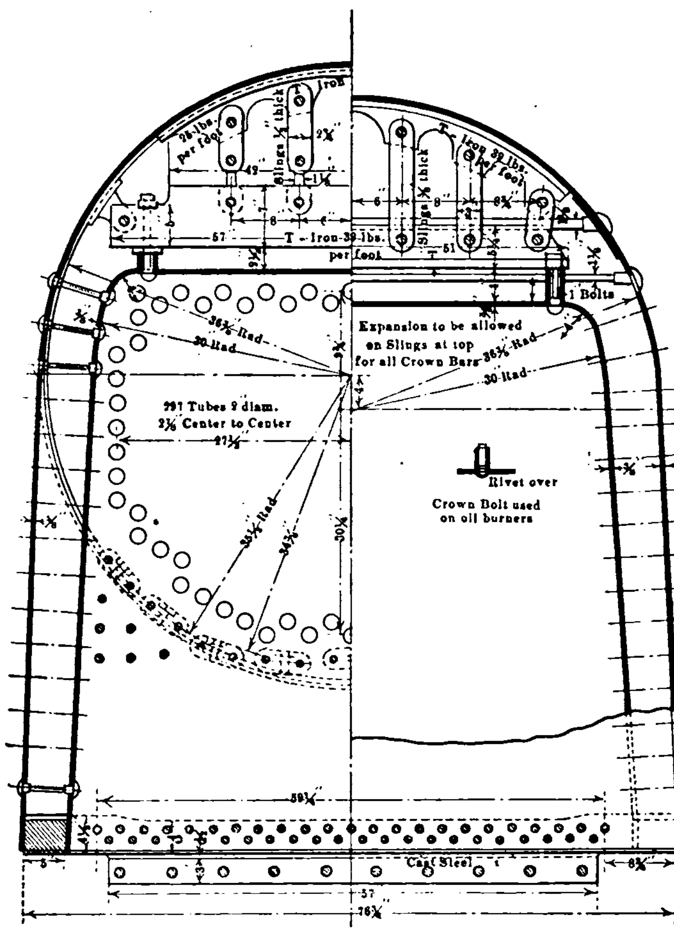
HARRIMAN LINES.

VI.

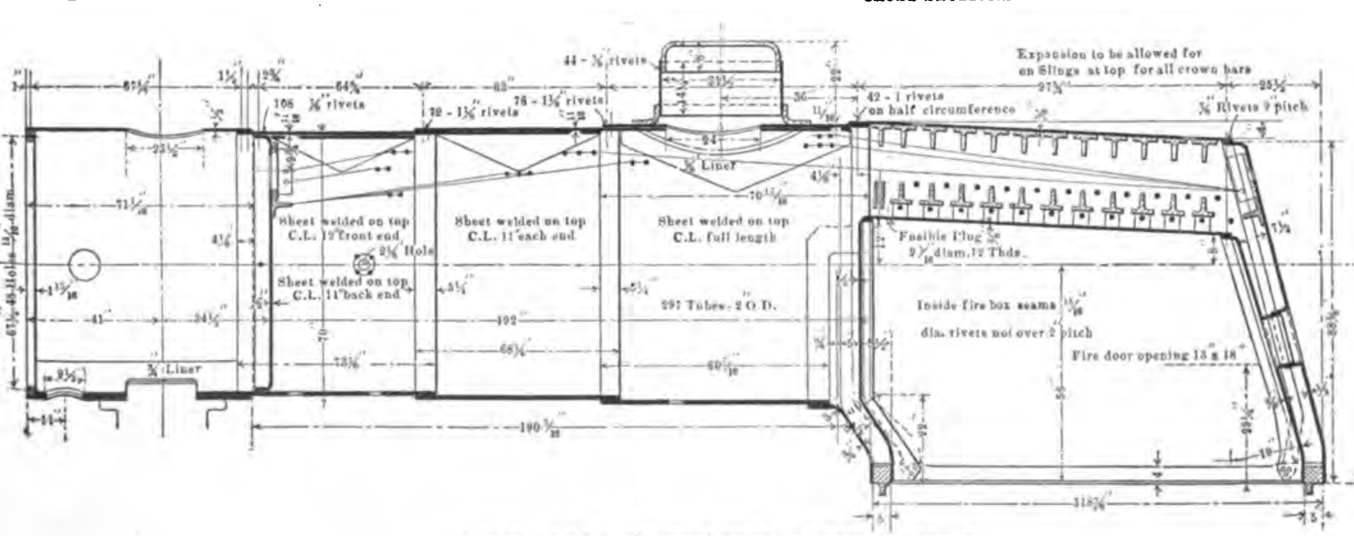
(For previous articles see pages 154, 200, 250, 288 and 322.)

The general dimensions of the boilers were given in the table in the May number of this journal, page 154, which indicates that there are but two sizes of boiler barrels, all of which are 70 ins. in diameter outside of the first ring, except the boilers of the consolidation locomotives, which are 80 ins. in diameter. The three designs of the road engines have the same size firebox, viz., 108 ins. long by 66 ins. wide. All have the same grates and the same grate casting was applied in all with somewhat different shaking rigging for the different types. An important item in this boiler construction is a water space of 5 ins. all around the fireboxes of the road engines. The water spaces for the switcher firebox are 4 ins. in front and 3½ ins. at the sides and back.

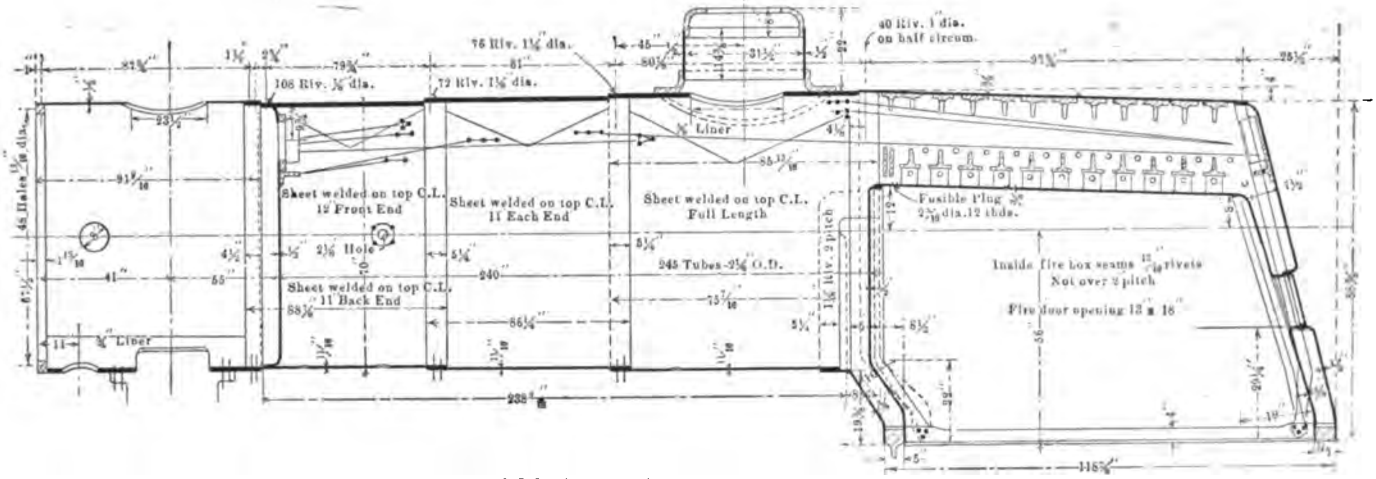
The fireboxes of the Atlantic and Pacific types are exactly alike, the chief differences between these boilers being in the length. All of the mud rings are of cast steel, 5 by 4 ins. in section and reinforced at the corners. They are all double



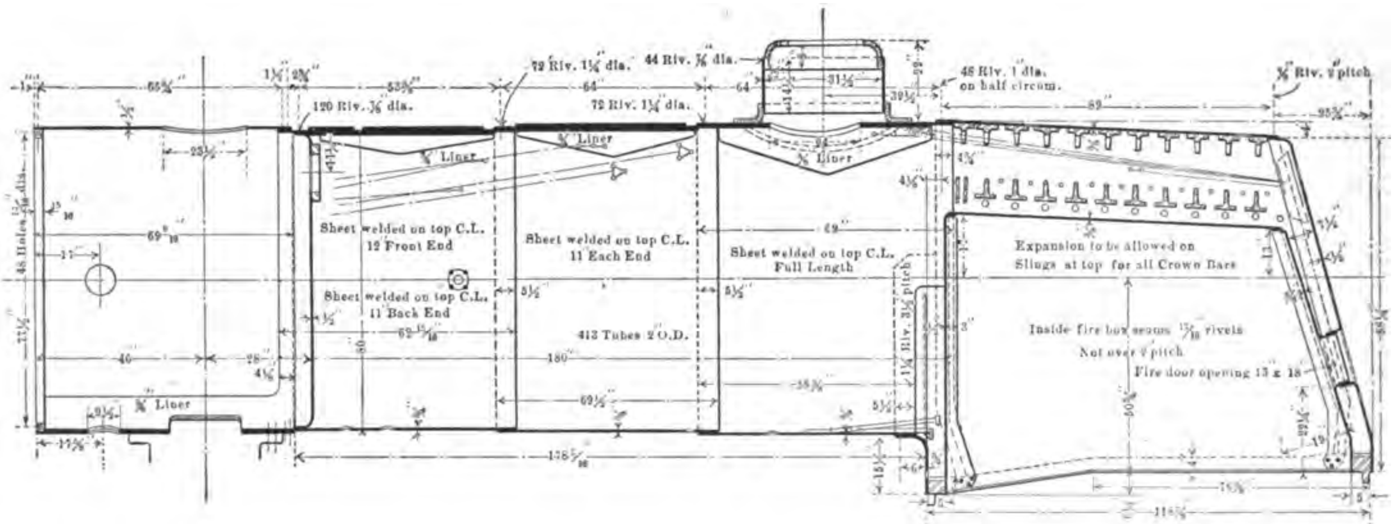
CROSS-SECTIONS THROUGH FIREBOX.



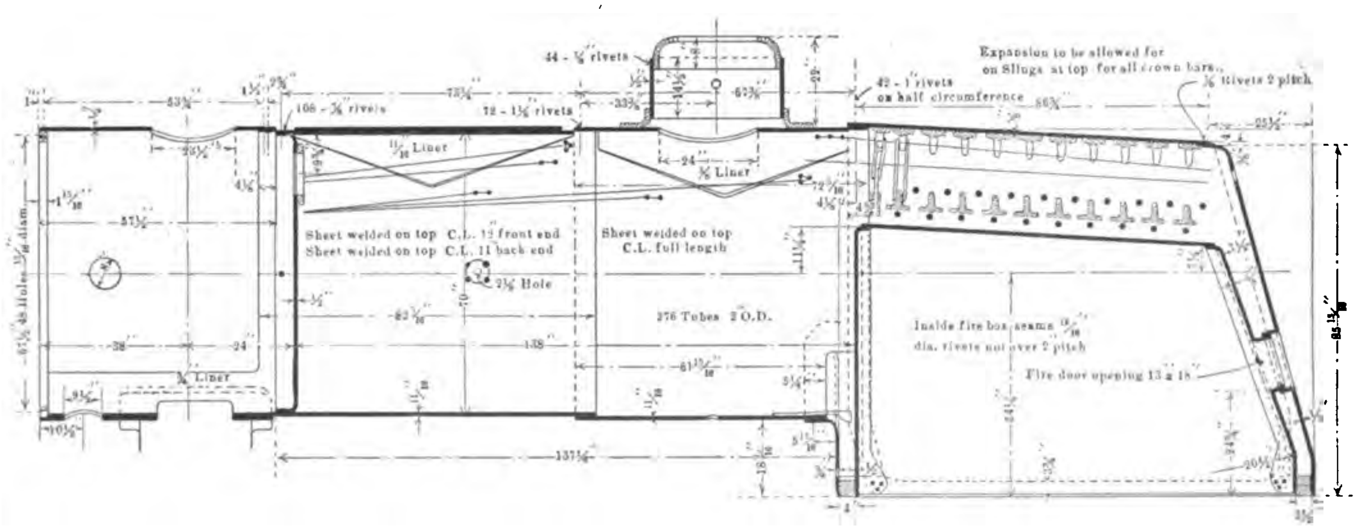
BOILER—4-4-2 (ATLANTIC) TYPE—HARRIMAN LINES.



BOILER—4-6-2 (PACIFIC) TYPE—HARRIMAN LINES.

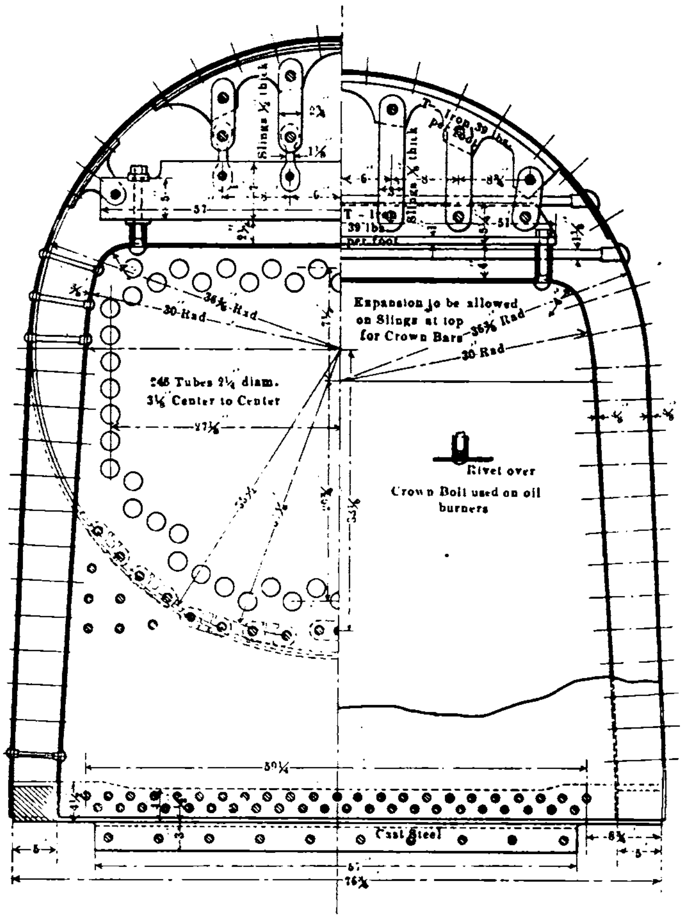


BOILER—2-8-0 (CONSOLIDATION) TYPE—HARRIMAN LINES.

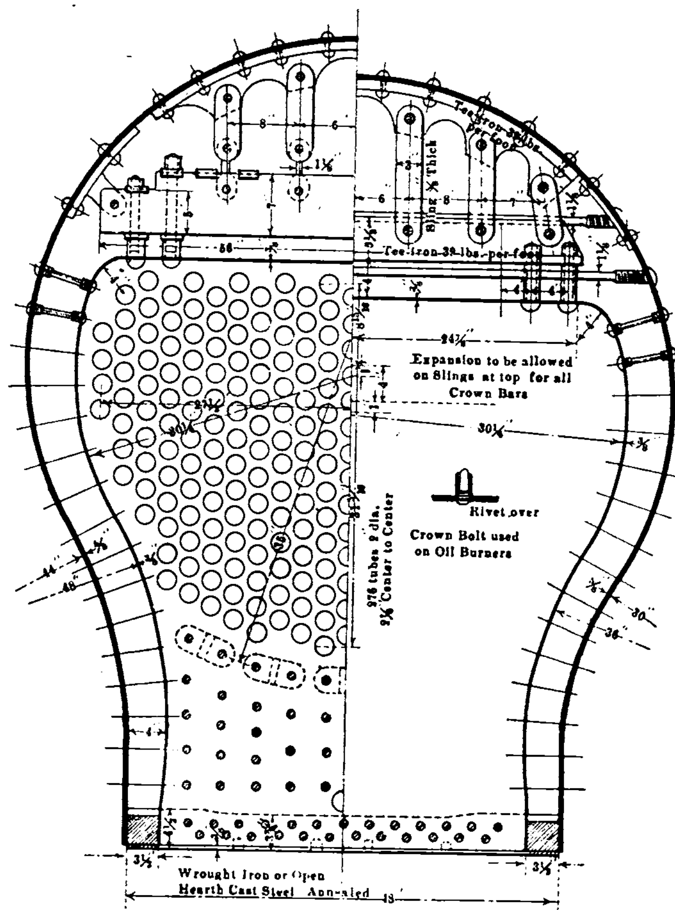


BOILER—SWITCHING LOCOMOTIVES—HARRIMAN LINES.

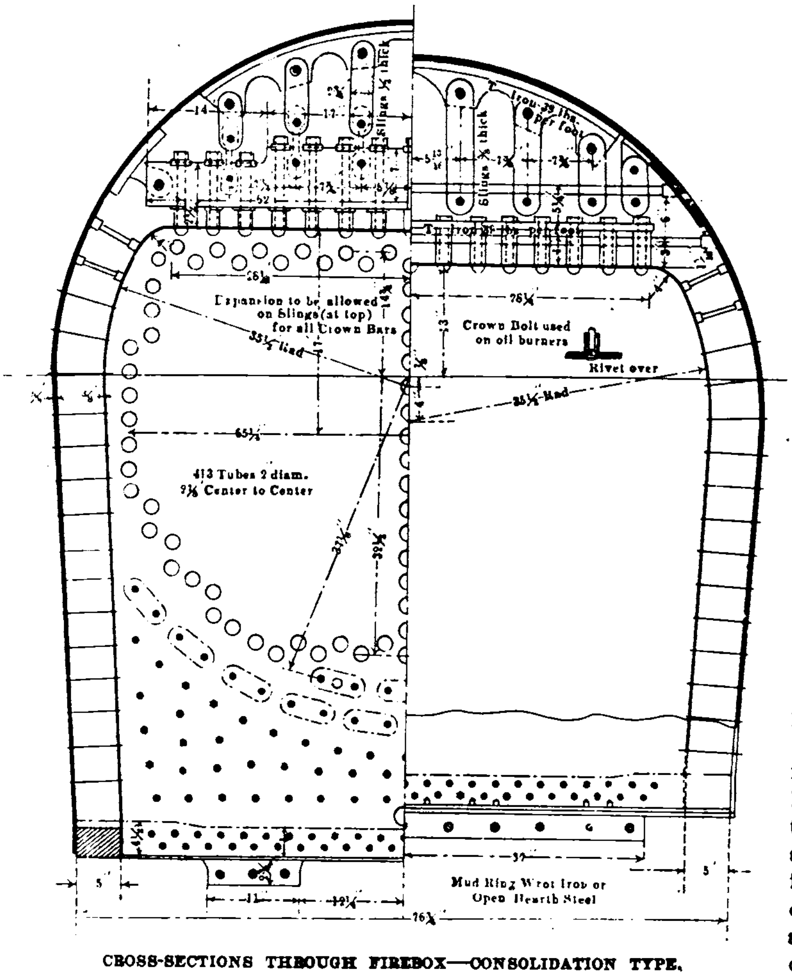
riveted. In all of the boilers the crown sheets are supported by T iron crown bars attached by slings to T iron roof bars which are continuous through the crown; that is to say, there is no break in the center. All the crown sheets are flat and all the boilers are straight top, except as the fireboxes slope towards the rear. The sheets are telescopic in all the designs. The circumferential seams are double riveted. The diamond welt horizontal seams are known as the Vauclain diamond boiler seam, which has an efficiency of 96 per cent. The dome ring is welded at the top and has no outside welt. The very long seams are welded for a length of 11 ins. at each end. The tube spacing provides ⅞-in. bridges, the tubes being arranged in vertical rows. The Pacific type has 2¼-in. flues because of their length, 20 ft., while the others are of 2 ins. in diameter. All of the boilers are fitted with 8-in. dry pipes with the Rushton open top throttle. The side stays are ⅞ in. in



CROSS-SECTIONS THROUGH FIREBOX—PACIFIC TYPE.



CROSS-SECTIONS THROUGH FIREBOX—SWITCH ENGINES.



CROSS-SECTIONS THROUGH FIREBOX—CONSOLIDATION TYPE.

diameter with 3-16-in. holes drilled 1¼ ins. deep in the outside ends only.

All the 70-in. boilers have 13-16-in. shell plates, and all the fireboxes have the same sheets. These boilers are all fitted with the Bates fire door, which is standard on the Southern Pacific Railway. All of the back heads are flanged to an angle of 15 degs. from the vertical, including the switcher.

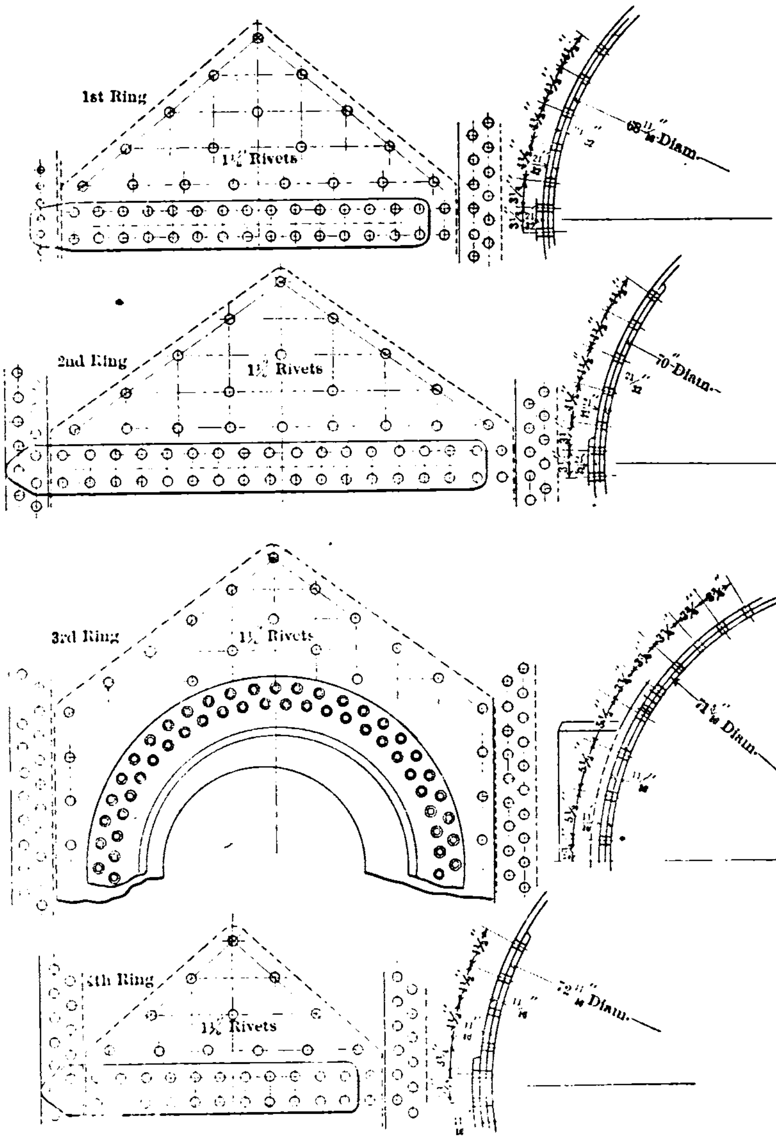
The switcher boiler is the only one with a narrow firebox. Its length is 108 ins. and its width 40¼ ins. This boiler has the same method of crown support, the same fire door and bridging of tubes as the other boilers. Except the switcher, which carries 180 lbs. steam pressure, all the boilers are built for 200 lbs. with a seam factor of five.

This set of standard boilers has been designed with unusual care in order to reduce to a minimum the amount of work in the boiler shop.

For information, drawings and permission to publish this description we are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines and to the Baldwin Locomotive Works. To the Baldwin Locomotive Works we are also indebted for the following description of the Vauclain diamond boiler seam which has been used by them for several years:

DIAMOND BOILER SEAM.—The accompanying engraving illustrates this seam as applied to the first, second, third and fourth rings, these joints having been designed for a working pressure of 220 lbs.

A well designed multiple riveted boiler joint would usually fail by tearing the plate along the outside row of rivets. It is, therefore, evident that the most efficient joint is the one that has a minimum amount of metal removed from this section, and at the same time has a sufficient number of rivets in the welt to prevent their shearing. This is the principle of the diamond seam, and because of its high efficiency it allows a considerable decrease in weight without greatly increasing the cost.



DIAMOND BOILER SEAM.

The calculations for the efficiency of this joint are the same as for any other multiple joint; like them it can fail by shearing the rivets, tearing the plates, crushing the rivets or plate or riveted joints; the bearing pressure per square inch is so small that the last method need not be considered.

To determine the efficiency it is necessary to calculate the strength of each line of riveting separately and compare it with the strength of the solid plate.

Considering the joint for the first ring we have:

46 ins. wide (rivet to rivet).
21-32 in. thickness of plate and welts.
1⅛ ins. diameter of rivets.
55,000 lbs., tensile strength of steel.
36,093 lbs., tensile strength of strip of plate 1 in. wide.

Through the first line of riveting the plate is weakened by the cross section of one rivet hole.

Therefore the net strength of this section is:

(46 ins. — 1⅛ ins.) x 36,093 = 1,623,272 lbs.

Strength of solid plate:

(46 ins. x 36,093) = 1,660,278 lbs.

Efficiency, = 1,623,272 / 1,660,278 lbs. = 97.7%

The second line of riveting is weakened by the removal of metal for two rivets, but in order to fail here the rivet in the first line must shear.

Therefore net strength of this section is:

Strength of plate = (46 ins. — 2¼ ins.) x 36,093 = 1,579,068
Single sheet 1 rivet .994 x 40,000 = 39,760

Total, 1,618,828

Efficiency, 1,618,828 / 1,660,278 = 97.4%

Third line of rivets:
3 holes 1⅛ ins. dia. = 3⅜ ins. net area of metal removed. Reinforced by 3 rivets in 1st and 2d row in single shear. Strength of plate = (46 ins. — 3⅜ ins.) x 36,093 = 1,538,463
3 rivets 1⅛ ins. dia. single shear = 3 x 994 x 40,000 = 119,280

Total 1,657,743

Efficiency, 1,657,743 / 1,660,278 = 99.8%

Fourth line of rivets:
4 holes, 1⅛ ins. dia. = 4½ ins. net area of metal removed. Strength of net area of plate = (46 — 4½) x 36,093 = 1,497,860
6 rivets 1⅛ ins. dia. in single shear 6 x .994 x 40,000 = 238,560

Total 1,726,420

Efficiency slight excess over solid plate.

Fifth line of rivets:
8 holes 1⅛ ins. dia. = 9 ins. net area of metal removed. Strength of net area of plate = (46 — 9) x 36,093 = 1,263,255
10 rivets 1⅛ ins. dia. in single shear = 10 x .994 x 40,000 = 397,600

Total 1,660,855

Efficiency—slight excess over solid plate.

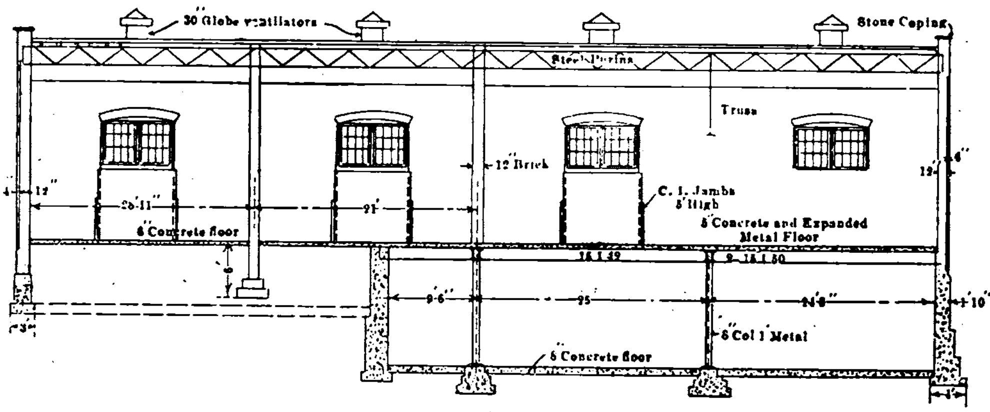
Sixth line of rivets:
The seam fails at this point by shearing the rivets between the outside welt and plate and by tearing the inside welt between the rivet holes.
15 holes 1⅛ ins. dia. = 16⅞ ins. net area of metal removed. Strength of net area of plate = (46 — 16⅞) x 36,093 = 1,051,208
14½ rivets, 1⅛ ins. dia. in single shear = 576,600

Total 1,627,808

Efficiency, 1,627,808 / 1,660,278 = 98%

Therefore, this particular design of seam has a minimum efficiency of 97.4%.

ENORMOUS TRAFFIC IN CITIES.—In New York, with its population of 3,750,000, there are being carried now on the surface, elevated and subway systems paying passengers, exclusive of so-called transfers, 1,200,000,000 per annum, a number very much greater than the number of passengers on all the steam railroads of both the American continents from the Atlantic to the Pacific, and from that most northern of all railroads, the Wild Goose Railway, near Nome, Alaska, within the Arctic Circle, to the most southern one in South America, the State Trunk Line, of Chili. London, with its population of over 6,000,000, but with inferior intra-urban railway facilities, carries about the same number as New York; while Paris, Berlin, Hamburg, Boston, Chicago and St. Louis are fast following in the leaders' tracks. Such figures need no further comment or explanation to indicate the dimensions of the problems of transit in great cities, and the difficulty of properly meeting the continual demand for increase in facilities as cities grow.—*W. B. Parsons, before Purdue students.*



Longitudinal Section

LONGITUDINAL SECTION OF THE REFINED OIL HOUSE.

inches of broken stone. They are each twenty-four feet square, each designed to be in service one-quarter of the time, and they are automatically cut in and out by a mechanism contained in a chamber four feet square at the intersection of each set of four filters.

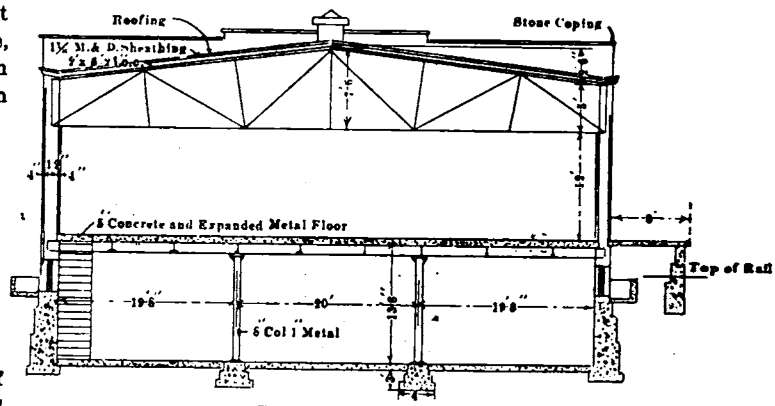
COMMON STANDARD LOCOMOTIVES.

Harriman Lines.

VII.

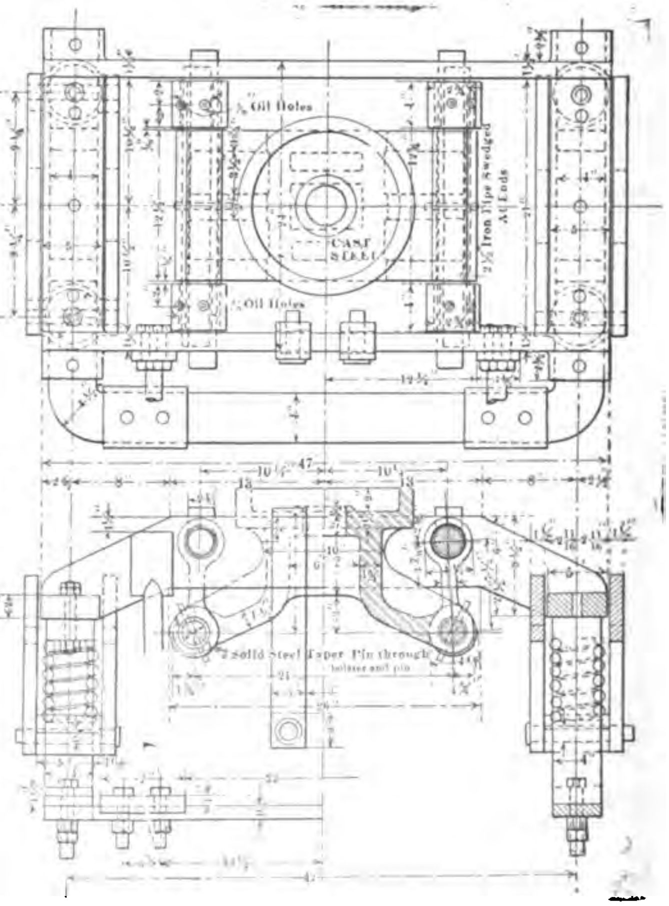
(*For previous articles see pages* 154, 200, 250, 288, 322 and 353.)

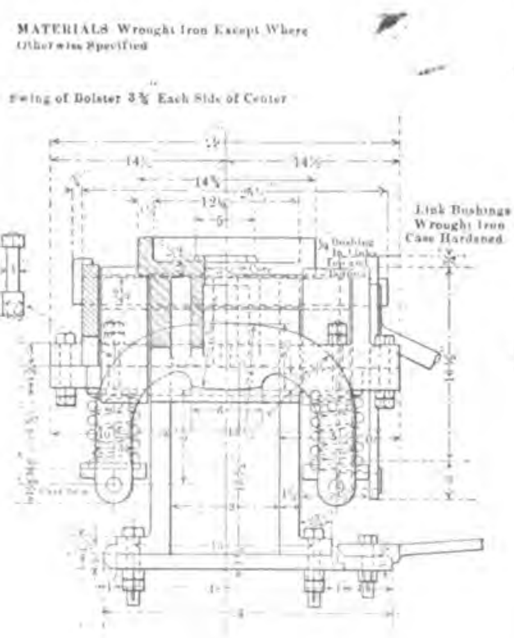
The accompanying illustrations show the construction of the leading and trailing trucks of the Atlantic, Pacific and consolidation classes. The trailing truck of the Atlantic type has inside journals without swing links and is not illustrated. The consolidation type has a cast steel swing bolster pony truck with wrought iron frame, without novelty in its construction. It is illustrated because it represents the standard construction for a very large number of freight locomotives. The journals of the truck wheels of all of the locomotives are 6 by 10 in.; the truck axles are standard throughout. The four-wheel leading truck for the Atlantic and Pacific type



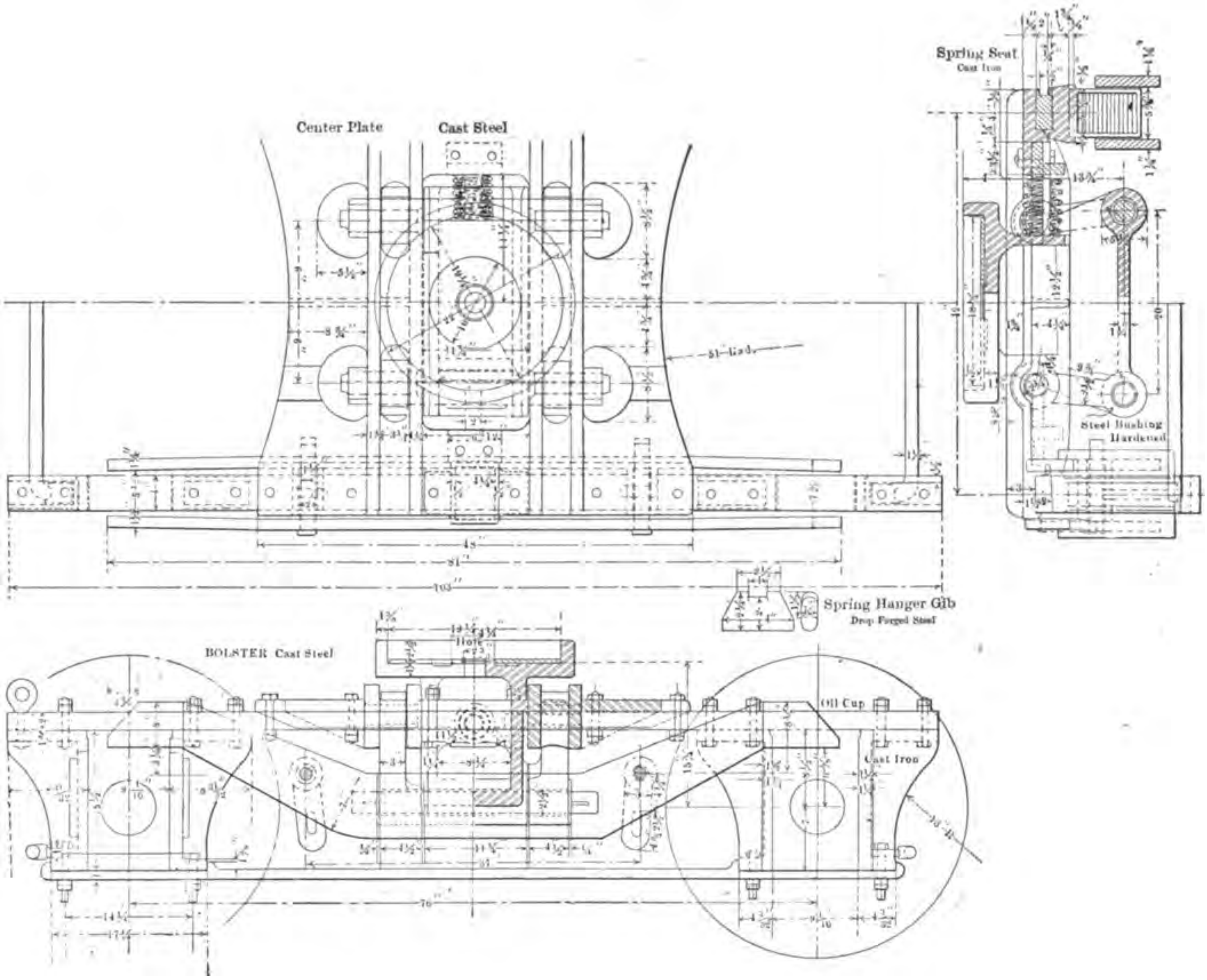
Tranverse Section

TRANSVERSE SECTION OF THE REFINED OIL HOUSE.

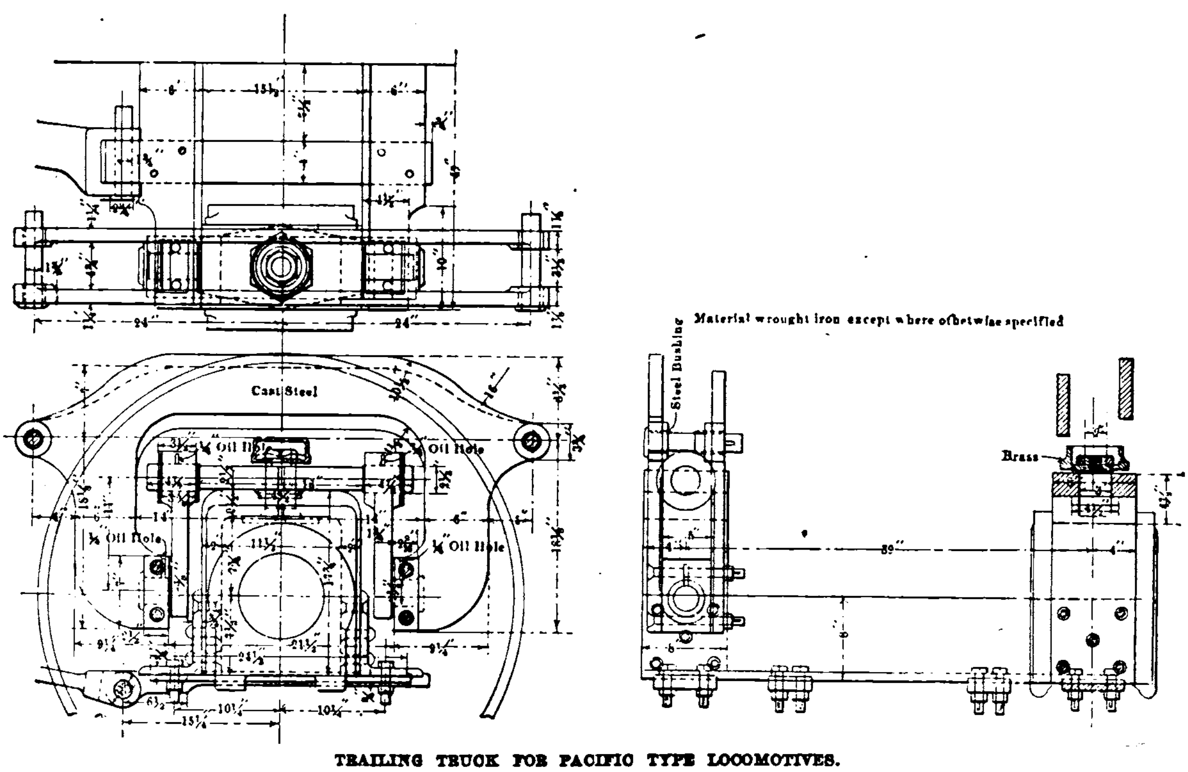




TRUCK FOR CONSOLIDATION LOCOMOTIVES—HARRIMAN LINES.



ENGINE TRUCK FOR ATLANTIC AND PACIFIC TYPE LOCOMOTIVES.



TRAILING TRUCK FOR PACIFIC TYPE LOCOMOTIVES.

COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

locomotives employ swing links combined with a spring centering device, the construction of which is illustrated in the engraving. The saddle and swing bolster are of cast steel, otherwise this four-wheel truck does not employ construction which is at all unusual. The Rushton trailing truck for the Pacific type passenger locomotive is illustrated. This construction has been referred to before in these pages. The swing links are 11 ins. long between centers, and are loaded by the cast steel equalizers.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.

50-TON STEEL TWIN HOPPER GONDOLA CAR.

The Lake Shore & Michigan Southern Railway has just received from the American Car & Foundry Company 1,000 50-ton steel twin-hopper gondola cars, which are constructed almost entirely of structural steel, and are notable because of several radical departures from ordinary designs. The cars are designed to carry a load 20 per cent. in excess of their nominal capacity, and will carry fifty tons of ore loaded directly over the hopper doors. They are intended as a general utility car for carrying such materials as coal, coke, ore, pipe, pig iron, rails, structural material, etc. The door openings are large and unobstructed, so that coke may easily be unloaded through them. The sides and top of the car are made especially strong and stiff, so as to adapt it for use on unloading machines and for carrying heavy structural material loaded on the top of the sides. The rivets in the floor of the car are driven with a special flat head to avoid countersinking, and the floor plates are so arranged as to facilitate the handling of coal or ore with shovels. Special care was taken to arrange the inside of the car so that the entire load would be emptied when on the unloader, as it has been found that, with the ordinary construction, considerable coal or ore does not slide out. The general dimensions are as follows:

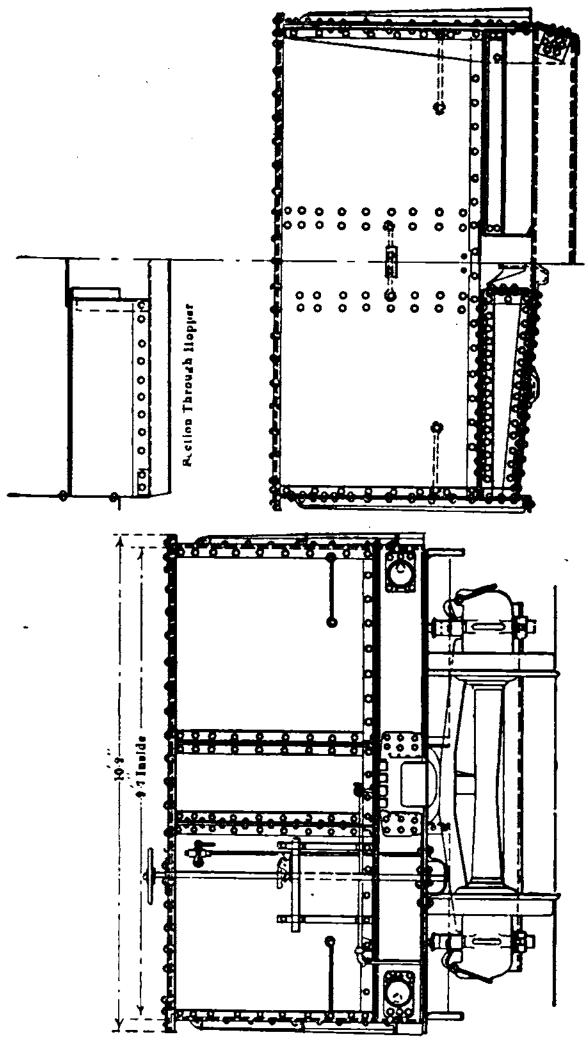
Length over end sills	38 ft.
Length inside	36 ft. 6 ins.
Width over sides	10 ft. 2 ins.
Width inside	9 ft. 7 ins.
Height inside	4 ft. 2 ins.
Height from top of rail to top of side	7 ft. 10¼ ins.
Height to lower face of center sills	2 ft. 8 ins.
Size of door openings	2 ft. 8½ ins. by 3 ft. 11⅞ ins.
Wheel base of trucks	5 ft. 5 ins.
Center to center of trucks	27 ft. 5 ins.
Weight of car	38,600 to 39,000 lbs.

The center sills are of 12-in. channels, 20.5 lbs. per ft., and extend through the body bolster and have 12-in. channel draft sills spliced to them. This splice is especially strong, as may be seen by referring to the detail drawing showing the application of the Westinghouse friction draft gear. Splice plates are placed on either side of each sill, the outer, or longer, plate taking the nine rivets, which hold the draft lug, while the draft lug itself butts up against the shorter inside splice plate, and thus prevents any tendency to buckle at this point.

The car is so designed that the center sills carry only a small proportion of the load. The load at the center of the car is transmitted to the side girders by means of the cross girder, consisting of two channels placed back to back. The details of the connection of this girder to the side sheets are unique. The gusset plate on the inside of the car passes down through the floor and between the members of the cross girder and is securely riveted to it. An inside plate, which is riveted to the lower part of the side sheet, passes down over the ends of the girder, is riveted to the bottom flanges of the girder channels and is also attached to the web of the channels by means of angles as shown.

Each side of the car is composed of four sheets, two of them extending from the bolsters to the ends of the car, so that they may be readily renewed in case of accident, and two extending from the bolster to the center of the car. The joint of the side sheets at the center of the car was very carefully designed, as the sides at this point are subjected to the most severe stresses, especially at their upper and lower edges. It will be noted that there is a splice plate on the inside and that the side stiffener fulfills this function on the outside.

Attention is directed to the channel at the top of the side and end sheets, which adds greatly to their stiffness sidewise and to the strength of the side girders. In addition to the gusset plates at the middle there are four other gussets on each side of the car. The sides are stiffened opposite each hopper door by pressed steel siffeners placed horizontally on the inside of the car, the angle of the projection on these stiffeners being such that coal or ore will readily slide off of it. It will be seen from the drawing showing the arrangement of the drop doors that the hopper sheet is riveted to the top of the center sill and passes down over it in such a way that it is impossible for any of the lading to lodge in the channels. Each end sheet is stiffened by the two gussets on the outside.



END VIEW. CROSS-SECTIONS.
50-TON STEEL TWIN HOPPER GONDOLA CAR.

Referring to the plan view it will be seen that the end sill is not straight, but slopes back from the center so that there will be no opportunity for the corners of the cars crushing each other on sharp curves. The floor plates are turned upwards at the sides and are riveted to the side sheets. Floor stiffeners, consisting of light channels, extend across the car at proper intervals and also diagonally across at each corner.

At the body bolster a filler casting is used between the center sills, and the bolster from the center to the side sill consists of a plate with angles riveted at both the top and bottom, and this is reinforced by heavy top and bottom cover plates which extend the full width of the car, the bottom cover plate passing down underneath the side and being riveted to the angle which forms the bottom member of the side girder.

The hopper doors are operated by the Dunham type drop-door mechanism, made by the United States Metal & Manufacturing

B-19, and 10-wheel engines, road class D-19, having 19,000 lbs. tractive power. The average weight of these engines is 100 tons. Deducting 100 tons from 595 tons gives 495 tons as the haulage capacity for all engines in road class 19, of whatever type, on a 1.3 per cent. grade.

It is evident that this method of grouping all engines of the same tractive power together, regardless of type, is an advantage to engines which are relatively light for their tractive power, while it is a disadvantage to those which are relatively heavy, since the same reduction for weight of engine and tender is made for both, unless the variation of weight is considerable, however, the percentage of error will not be great. Moreover, in getting the average weight of a group, switch engines, which are not ordinarily used to haul trains on the road, and Atlantic and Pacific type engines, which are usually used in passenger service, may be left out of consideration. If Atlantic or Pacific type engines, or other types, with high wheels and small tractive power in proportion to their weight, ordinarily used in passenger service, are to be used in freight service, they may be given a lower road class than their tractive power would indicate. Thus, a Pacific type engine with its tender weighing 334,000 lbs. may have a tractive power of. say, 27,800 lbs., and would ordinarily be classified as road class N-28. It may be, however, that there are 10-wheel engines on the road weighing 250,000 lbs. and having a tractive power of 28,400, and these would be classified as D-28. It is evident that the Pacific type engine would stall with a load which the 10-wheeler would easily haul, and the Pacific type engine may properly be classed as N-27.

In making up the tonnage rating books, the ruling grade for each section is first determined and the rating for the different classes taken direct from the second table mentioned above. If there are sharp curves on ruling grades the resistance due to the curve may be reduced to its equivalent in percentage of grade.

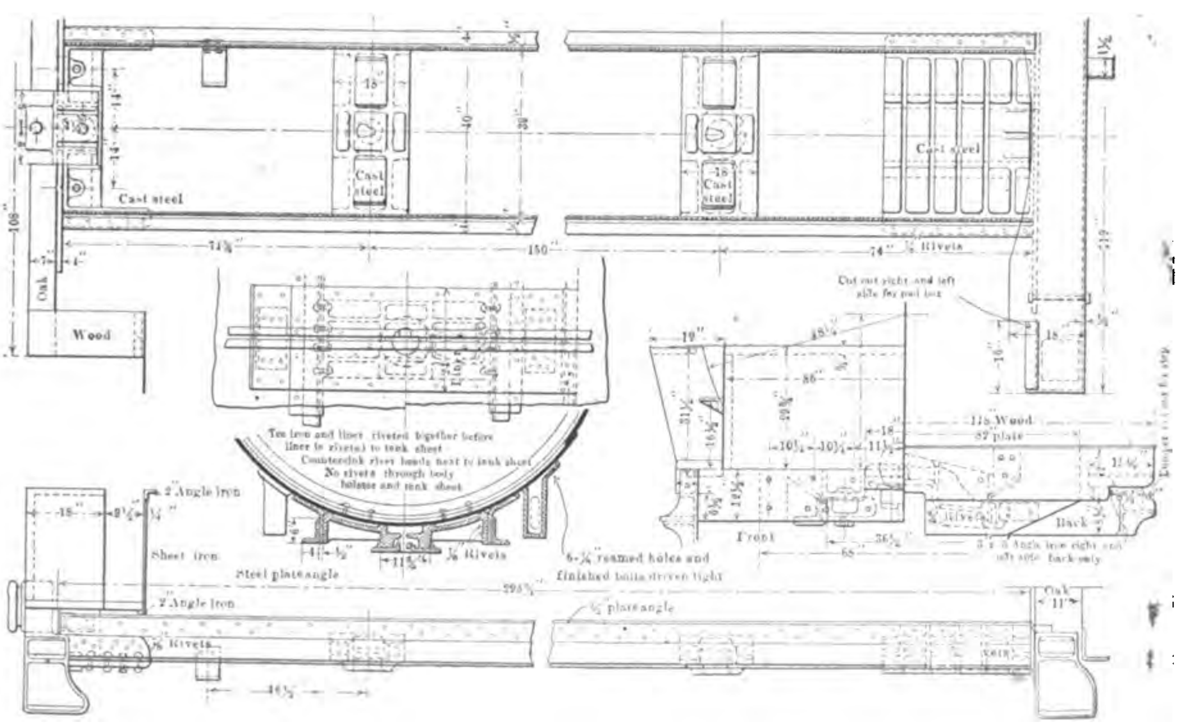
This method of classifying and rating engines is of particular advantage on a system made up of several smaller lines or systems and having a mixed equipment.

NEBRASKA DIVISION

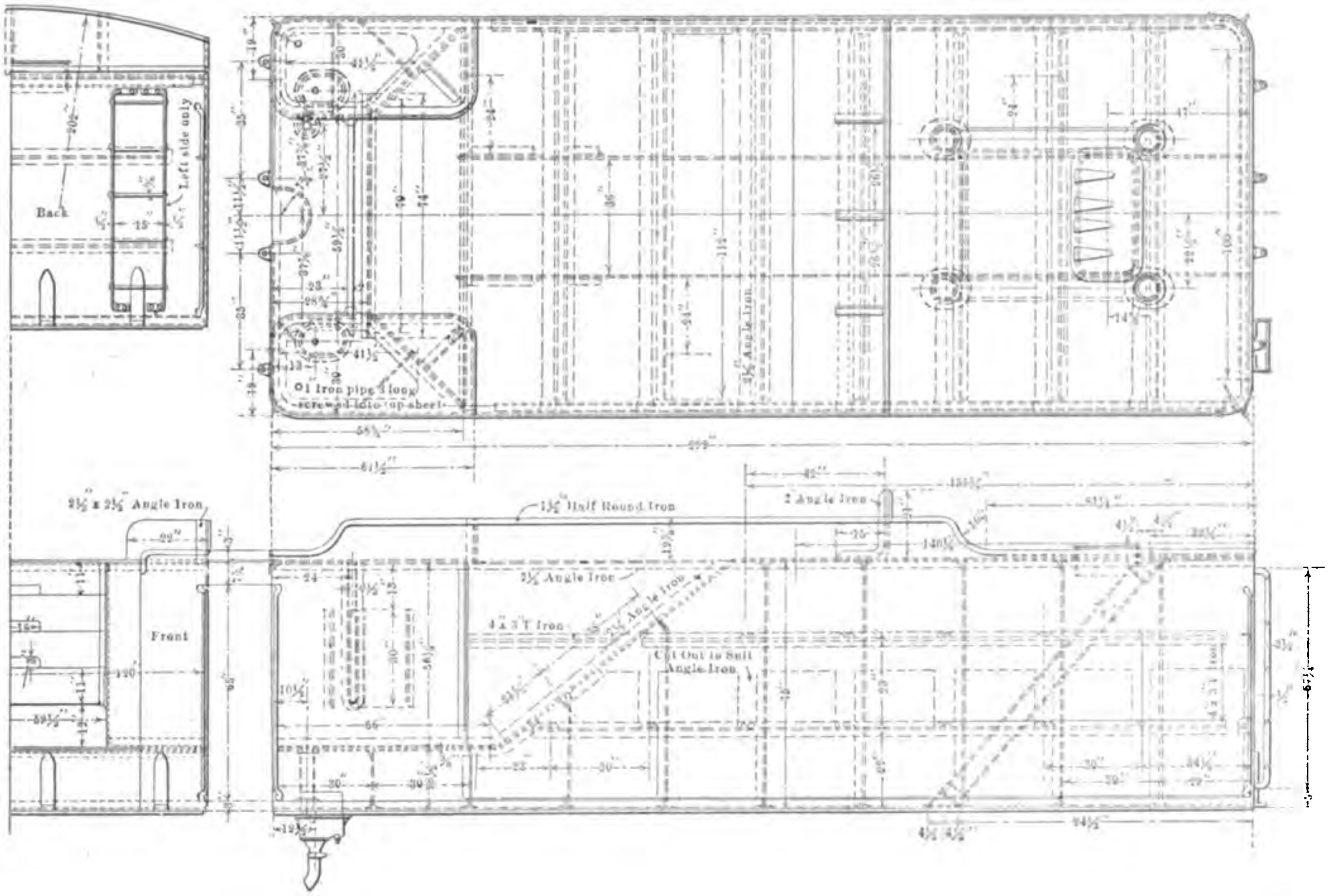
ST. JOE-FAIRBURY LINE

WESTWARD	ROAD CLASS OF ENGINE																				
	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12
ST. JOE TO HORTON	1560	1230	1185	1140	1110	1065	1040	995	925	915	870	625	775	740	705	675	615	550	545	505	465
HORTON " VIRGINIA	1335	1050	1010	975	945	910	890	850	785	780	745	705	660	630	600	575	525	495	465	430	395
VIRGINIA " BEATRICE	2630	2070	2000	1930	1870	1800	1740	1675	1575	1535	1470	1395	1320	1250	1195	1135	1055	990	925	860	785
BEATRICE " ELLIS	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
ELLIS " FAIRBURY	2275	1795	1735	1670	1690	1580	1515	1450	1360	1330	1270	1210	1140	1085	1030	965	910	855	800	740	665
HORTON–FAIRBURY (through)	1335	1050	1010	975	945	910	890	850	785	780	745	705	660	630	600	575	525	495	465	430	395
EASTWARD																					
FAIRBURY TO DU BOIS	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
DU BOIS " HORTON	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
FAIRBURY–HORTON (through)	1395	1100	1060	1020	990	950	930	890	820	815	775	735	690	660	625	605	550	520	475	450	415
HORTON " ST. JOE	1610	1265	1220	1175	1140	1100	1070	1025	950	940	895	850	800	765	725	695	640	600	565	520	460

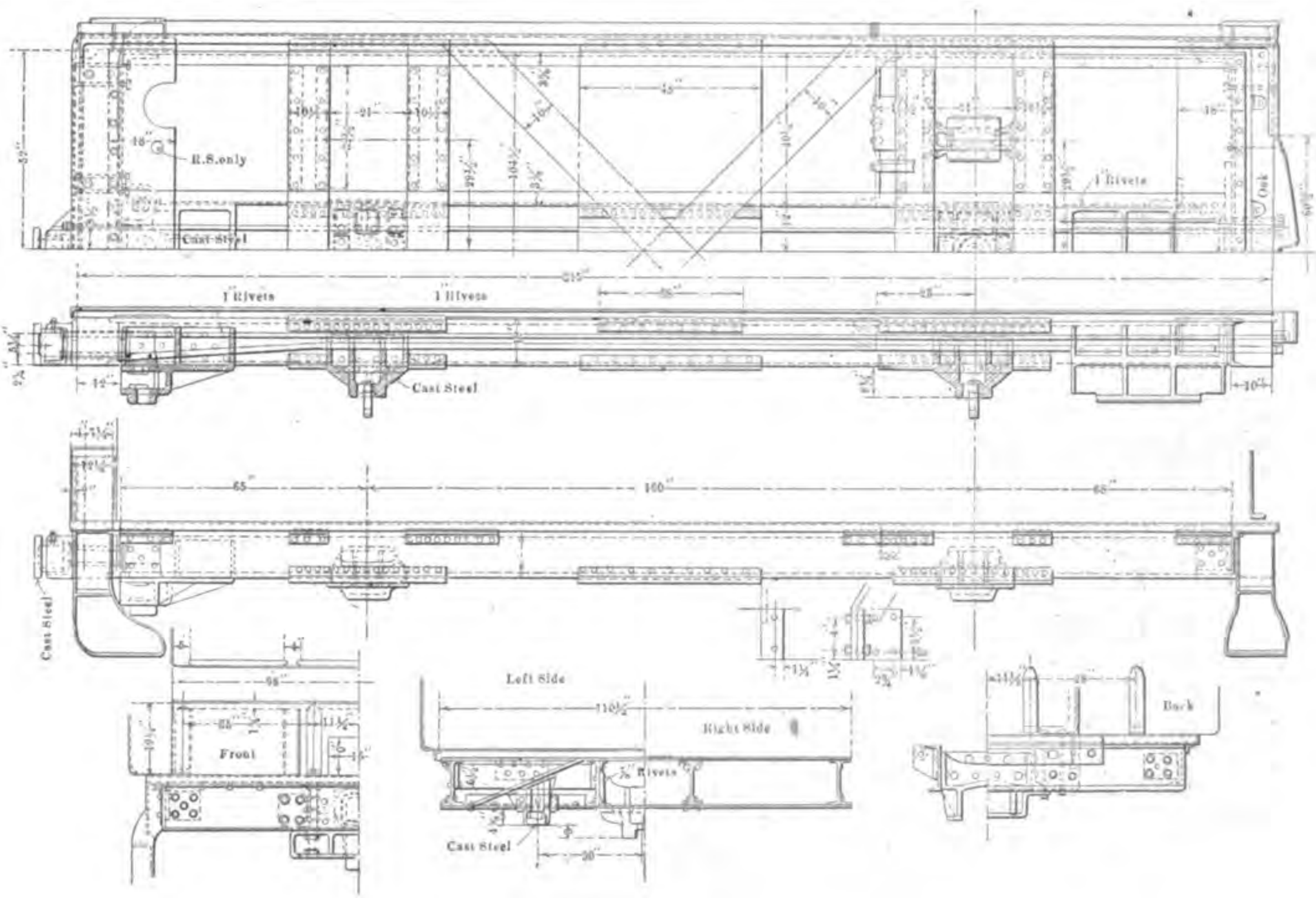
SHEET FROM TONNAGE RATING BOOK—ROCK ISLAND SYSTEM.



FRAME FOR CYLINDRICAL TENDER TANK—HARRIMAN LINES.



TENDER TANK FOR PASSENGER ENGINES.



TENDER FRAME FOR PASSENGER ENGINES.

COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

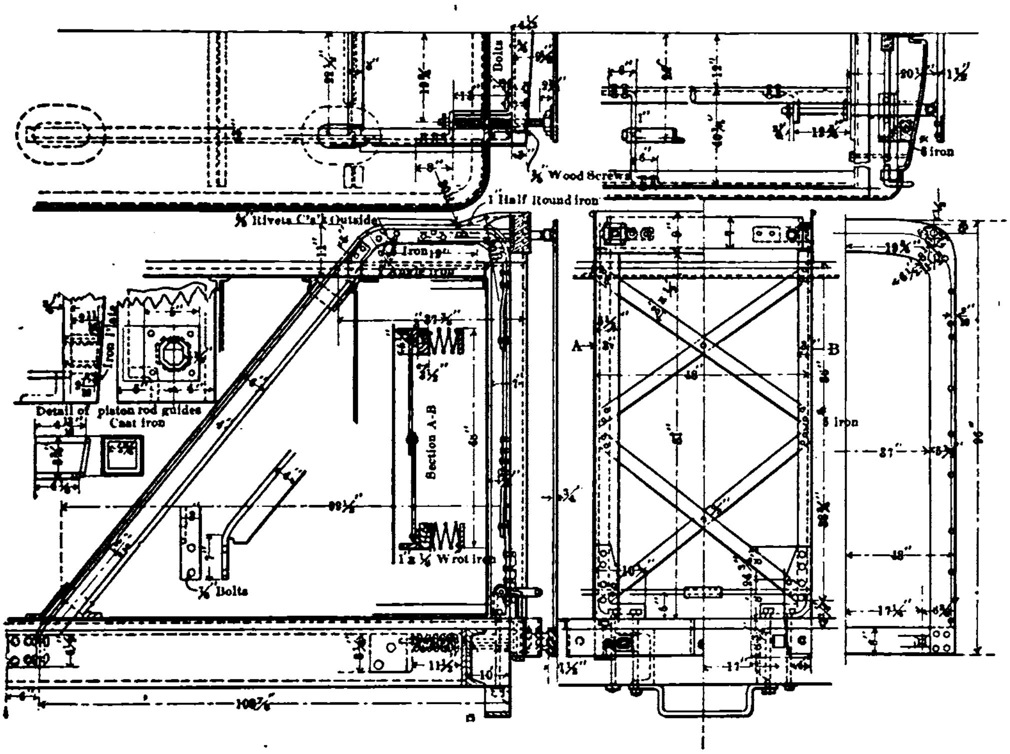
COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

VIII.

(*For previous articles see pages* 154, 200, 250, 288, 322, 353 *and* 400.)

TENDERS.—The freight locomotives have Vanderbilt tenders with a capacity for 7,000 gals. of water and 14 tons of coal. These tenders are frameless as the illustrations indicate. It was originally intended to employ this type of tender for all common standard locomotives except the switching class. In accordance with a latter decision the rectangular form was adopted for the passenger locomotives. The Vanderbilt tenders are built with a ⅜-in. plate, extending the full length of the tank at the bottom, and this is made specially wide to keep riveted joints entirely out of the way of shock of the draft and buffing stresses. Cast steel bolsters and draft castings are secured between ½-in. steel plate sills, which are bent into the form of angles and riveted to the body of the tank and to heavy longitudinal angles, as indicated in the drawing.

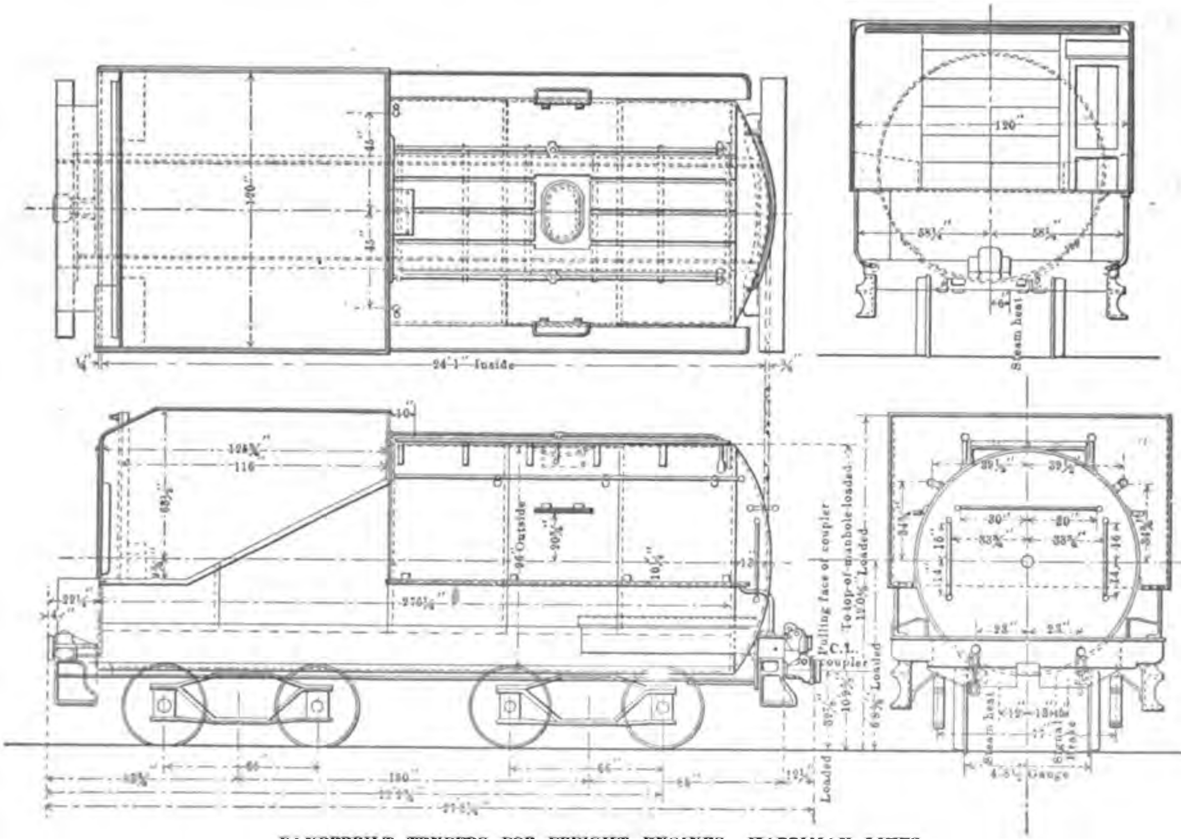


VESTIBULE ARRANGEMENT FOR PASSENGER ENGINE TENDER—HARRIMAN LINES.

TENDERS OF PASSENGERS LOCOMOTIVES.—For passenger service very large tenders with a capacity of 9,000 gals. of water and 10 tons of coal were adopted. These are believed to be the largest tenders used in regular passenger equipment. The frames are of 12-in. channels for side, center and end sills. To the end sills, oak timbers are secured. The framing drawing illustrates the cast steel center plates and the transverse and diagonal bracing plates, which are riveted on top of and beneath the sills. The draft castings are of cast steel.

These tenders are fitted with vestibule diaphragms, the frames of which are rigidly connected to the tender frames and braced by angles in 6-in. pipe passing down through the water in the tank.

The total height of the



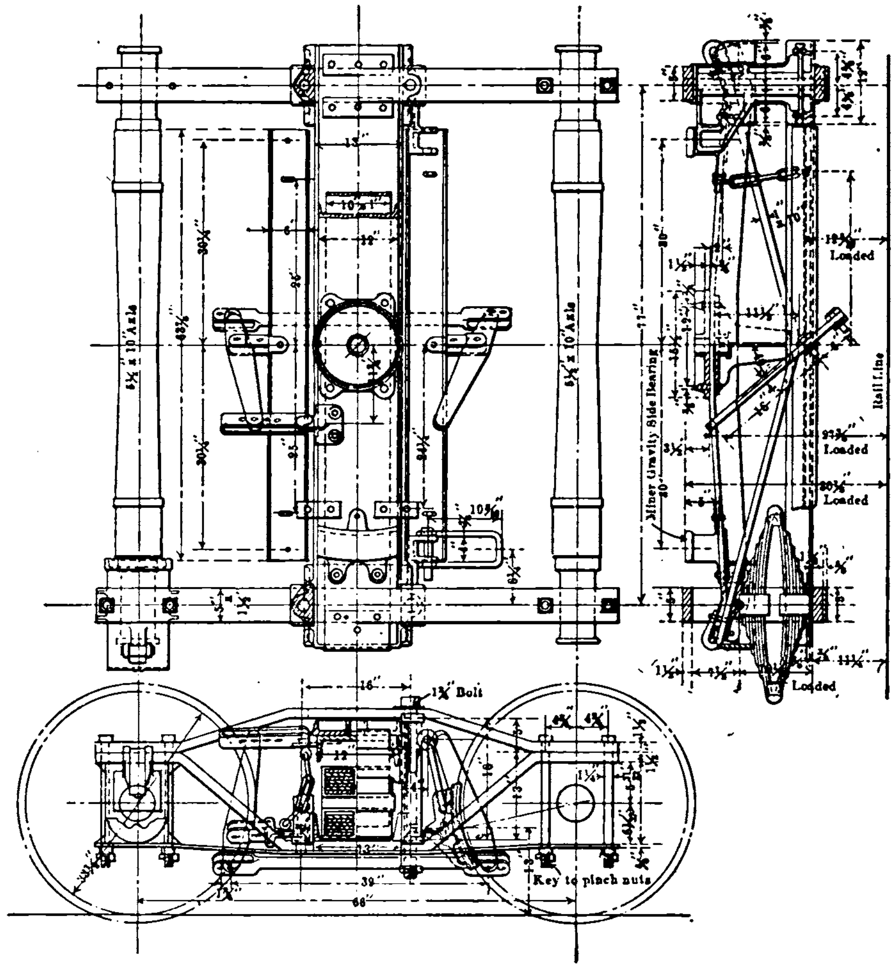
VANDERBILT TENDERS FOR FREIGHT ENGINES—HARRIMAN LINES.

tender over the coal board is 147¾ in. The total height from the rail to the top of the manhole ring is 130 ins. The total wheel base of the tender is 160 ins. The length of the tank is 229 ins. The tank has a water bottom with a depth of 18½ ins. under the coal space in front. At each side liberal tool boxes are provided. The tank bracing is in the form of angles and plates.

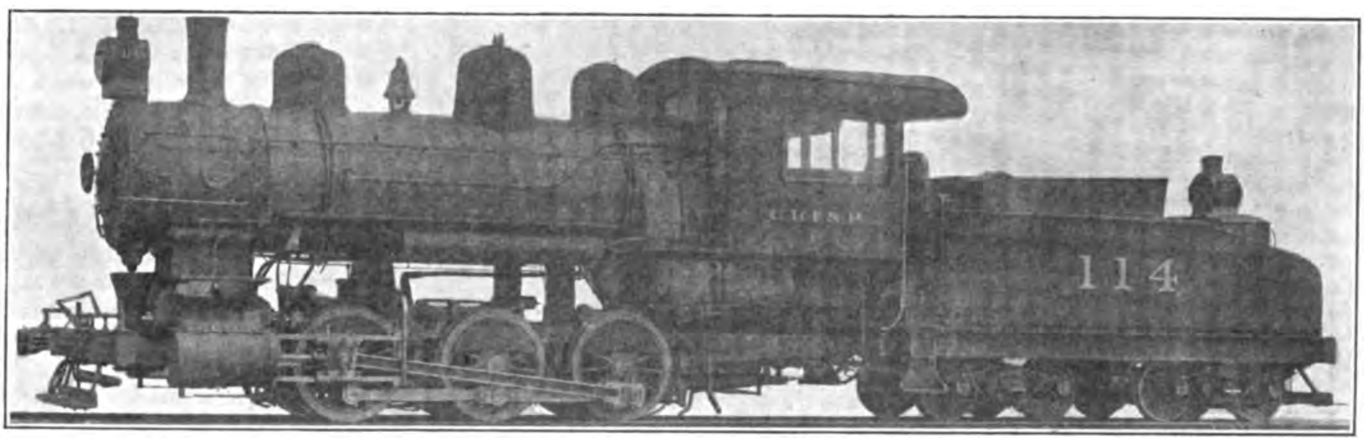
The tenders for the switchers are of ordinary construction with 10-in channel sills, weighing 30 lbs. per ft. The tank slopes towards the rear and the construction is in no way unusual.

TENDER TRUCKS.—These trucks are of the diamond arch bar type with Simplex bolsters. The drawings show the size of the various parts and the channel frames. The trucks for both road and switch engines have inside hung brakes. All road engines 5½ by 10 in. standard M. C. B. tender axles, and the switchers have 4¼ by 8 in. The center plates are of cast steel and M. C. B. contour. The tenders of the switchers have a water capacity of 4,000 gals. and a coal capacity of 5 tons. All of the tenders have Miner gravity side bearings.

The courtesy of Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, in supplying this information is acknowledged, and that of the Baldwin Locomotive Works in supplying the drawings.



TENDER TRUCK FOR FREIGHT ENGINES—HARRIMAN LINES.



SIX-WHEEL SWITCHING LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

SIX-WHEEL SWITCHING LOCOMOTIVE.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

The accompanying photograph illustrates one of a number of switching locomotives recently constructed for the Chicago, Rock Island & Pacific Railway at the Richmond works of the American Locomotive Company. Since the presentation of the report of the Power Committee of the Rock Island System a large number of locomotives have been ordered, which, while varying slightly from the detailed dimensions recommended by that committee, follow in general the plan which was presented in outline in this journal in March, page 84. The Baldwin Locomotive Works have built ten switching locomotives, thirty-eight 4—6—0 locomotives with Walschaert valve gear and two 4—4—2 balanced compounds. The American Locomotive Company have built twenty six-wheel switching locomotives, ten 4—4—0 passenger locomotives of which two are supplied with superheaters, twenty 4—6—2 passenger locomotives of which four have superheaters, and fifteen 4—6—0 locomotives for fast freight and passenger service. The Atlantic, Pacific and ten-wheel designs have already been illustrated in this journal, the present description completing the first series built in accordance with the suggestions of the Power Committee. This locomotive has 10¼-in. piston valves with direct valve motion and inside admission. The cylinders are 19 by 26 ins. Driving wheels, 51 ins. in diameter, which, with 200 lbs. boiler pressure, gives a tractive effort of 31,300 lbs. Additional features are presented in the accompanying table.