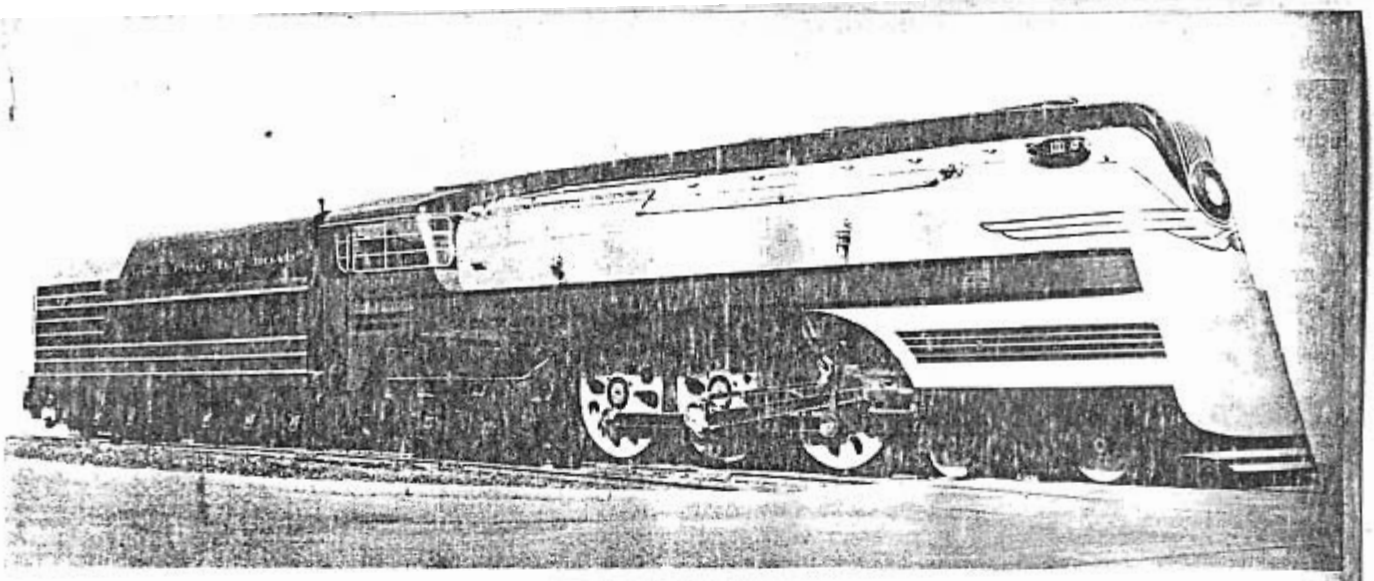


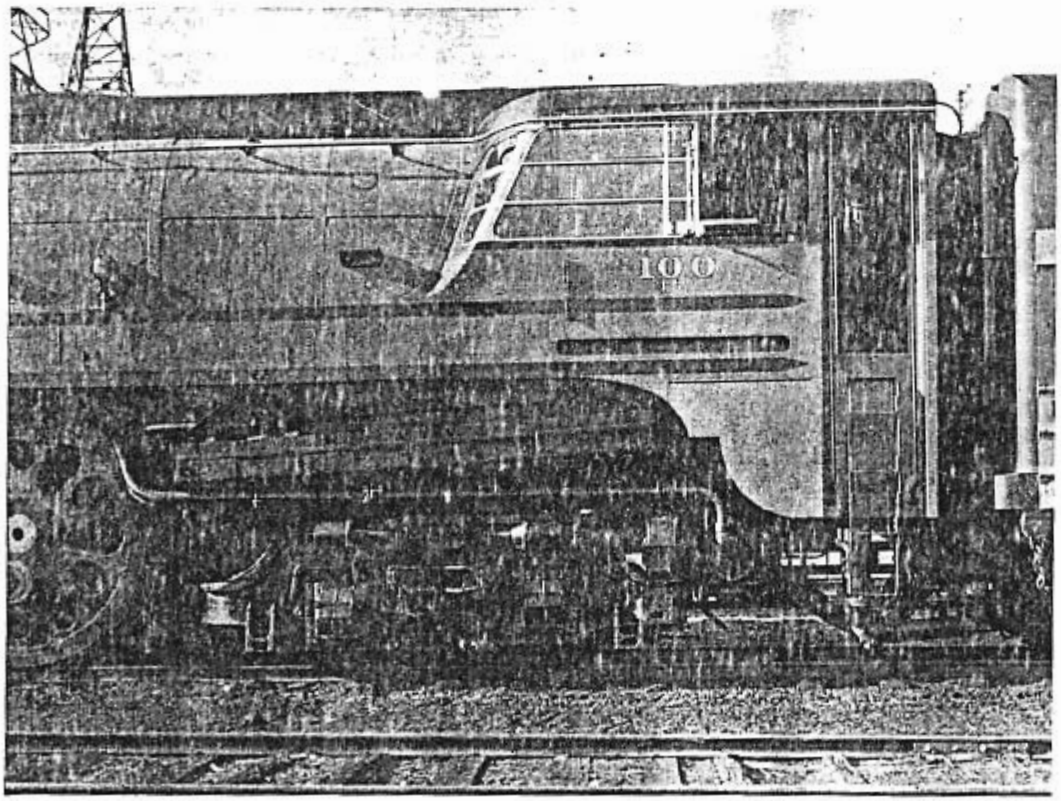
Distinctive Design Features 4-6-4 Type

Milwaukee Locomotives

Passenger motive power designed for heavy service develops tractive force of 50,300 lb. and weighs 415,000 lb. — Boilers have welded fireboxes

In August the American Locomotive Company delivered, from its Schenectady, N. Y., plant, six 4-6-4 type heavy passenger locomotives for service on the Chicago, Milwaukee, St. Paul & Pacific. While the new locomotives follow the general appearance of the original Hiawatha they are not solely for service on that train, but will be used on the Olympian and Pioneer Limited trains between Chicago and Minneapolis, a distance of 418 miles, and west of Minneapolis on the Olympian, to Harlowton, Montana, a distance of 914 miles. In the development of this "speedlined" design, Otto Kuhler, consulting engineer of design, collaborated with the railroad company and the builders.

These locomotives develop a tractive force of 50,300 lb. with a boiler pressure of 300 lb. and 84-in. driving wheels. The tenders carry 20,000 gallons of water and 25 tons of fuel.



The vestibule cab is of distinctive design and has a window arrangement which provides unusual visibility

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Machinery Details

The foundation of these locomotives is a General Steel Castings Corporation's engine bed in which the cylinders, back cylinder heads, center plates, air reservoirs, link support, guide-yoke brackets, expansion-shoe pads, air-pump brackets and driver-brake fulcrums are cast as an integral part of the bed. The boiler is supported at the front and back of the firebox on expansion shoes, at the cylinders and by a waist sheet between the first and second pair of drivers.

The engine trucks are the General Steel Castings four-wheel type with 36-in. Davis cast-steel wheels, A. S. F. clasp brakes and Timken roller bearings. The driving wheels have Boxpok centers, 84-in. tires and Timken roller bearings. The journal diameter is 13½ in. at the main wheel and 12½ in. at the front and back. The Alco lateral-motion device is installed on the front pair of drivers.

The trailing truck is the Delta four-wheel type with centering device, furnished by the General Steel Castings Corporation with 38-in. Davis wheels at the front and 44-in. steel-tired wheels at the rear of the truck. The trailer wheels are equipped with A. S. F. roller-bearing units and clasp brakes.

The cylinders are 23½ in. bore by 30 in. stroke. Walschaert valve gear controlled by an Alco type H reverse gear actuates the 12-in. piston valves. The cylinder and valve chamber bushings are of Hunt-Spiller gun iron. The Z-type pistons are of rolled steel and both pistons and valves are fitted with Hunt-Spiller Duplex packing rings. Those on the pistons are the locked-lip type which require no bull ring and the valve rings are sectional bronze and iron.

The piston rod is of medium carbon steel, normalized and tempered, and is 5 in. in diameter. The crosshead and guides are of the multiple-bearing type. The main and side rods are of low-carbon nickel steel normalized, quenched and tempered. Floating bronze bushings are used at all pins with Hunt-Spiller fixed bushings in the rods. The crank pins are medium carbon steel and the main pin is hollow-bored.

The revolving weights at all wheels are cross-counterbalanced. The total weight of the reciprocating parts on each side is 1,681 lb.; the overbalance is 196 lb. on each wheel. The dynamic augment at 84 m. p. h. is 9,400 lb. in each wheel.

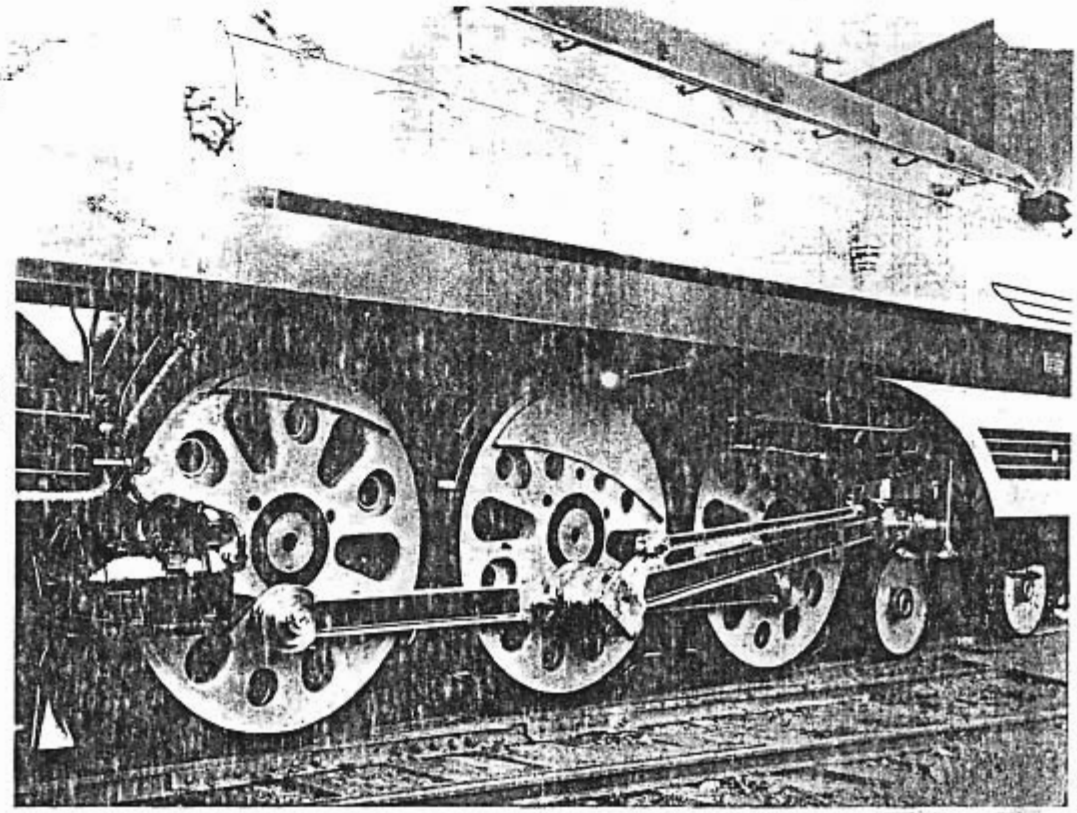
The Boilers

The boilers on these locomotives are built in three courses, the middle or dome course being conical in form. The inside diameter of the first course is 82½ in. and the outside diameter of the third course is 94 in. The thickness of the plate in the first course is ⅞ in. and $^{31}/_{32}$-in. plates are used in the second and third courses. The three barrel courses, welt strips and dome liner are silico-manganese steel having a maximum tensile strength of 82,000 lb. The front tube sheet is ¾ in. thick and the back tube sheet is ⅝ in. thick. The firebox is $96^{3}/_{16}$ in. wide by $144^{15}/_{32}$ in. long. The height from the bottom of the mud ring to the top of the crown sheet is 73½ in. at the rear and $88^{13}/_{16}$ in. at the front. The water space is 5 in. at the sides and back and 6 in. at the front of the firebox. The length of the combustion chamber is 44½ in. The roof and sides of the firebox are of silico-manganese steel similar to that used in the barrel course.

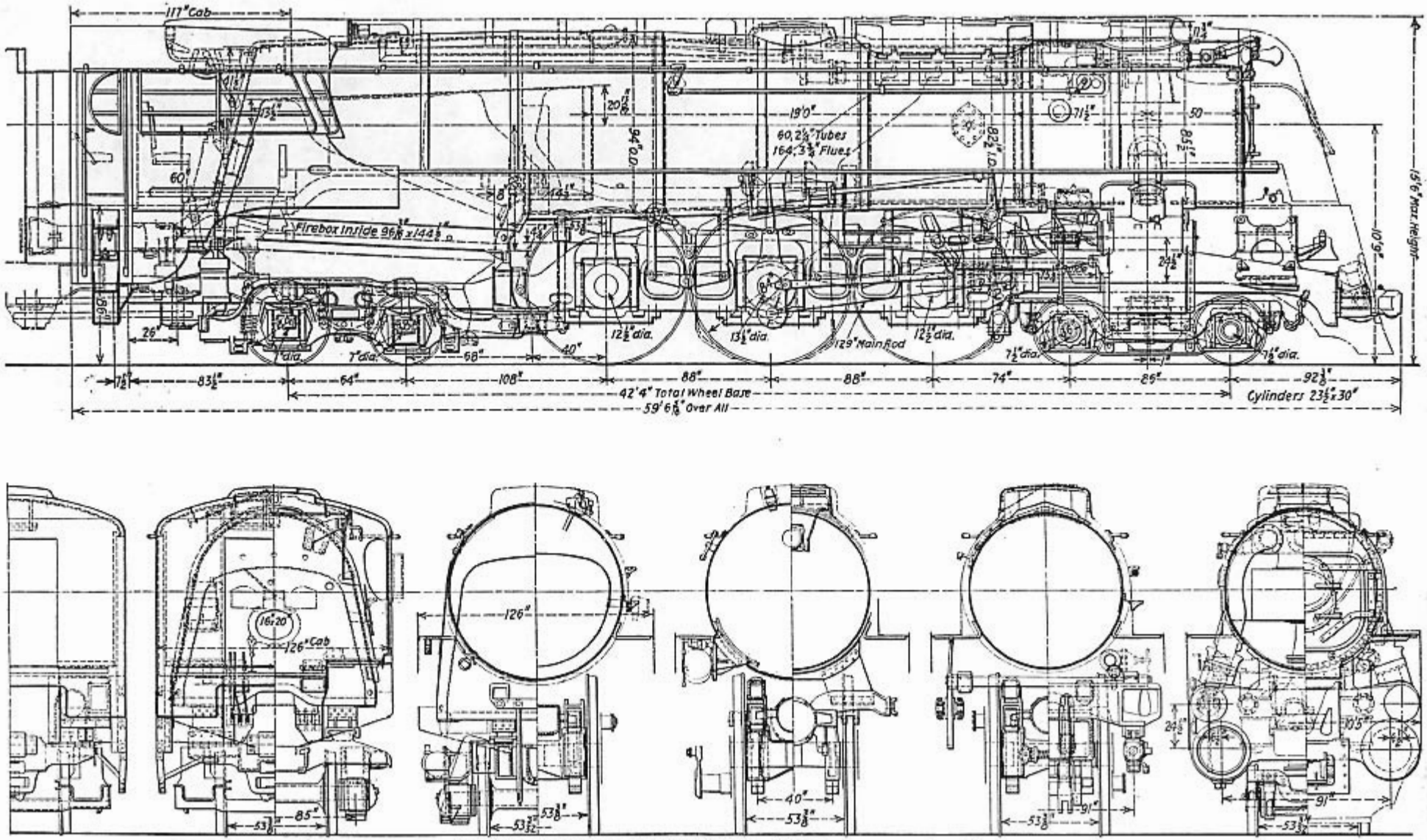
The roof sheet is $^{13}/_{16}$ in. thick while the outside side sheets are $^{9}/_{16}$ in. thick. The inside firebox sides and crown consist of three $^{13}/_{32}$ in. sheets welded together. Two Thermic syphons are located in the firebox, and a third one on the center line of the boiler is in the combustion chamber. In addition to the two syphons in the firebox, there are two 3½-in. arch tubes which, together with the syphons, support the American brick arch.

The boilers are fitted with sixty 2¼-in. tubes and one-hundred-sixty-four 3¼-in. flues. The length over the tube sheets is 19 ft.

The firebox is arranged for bituminous coal using Firebar grates. The grate area is 96.5 sq. ft. Coal is



The design of the streamline shrouding is such that the running gear is completely exposed



Elevation and cross-section of the Milwaukee 4-6-4 type passenger locomotive

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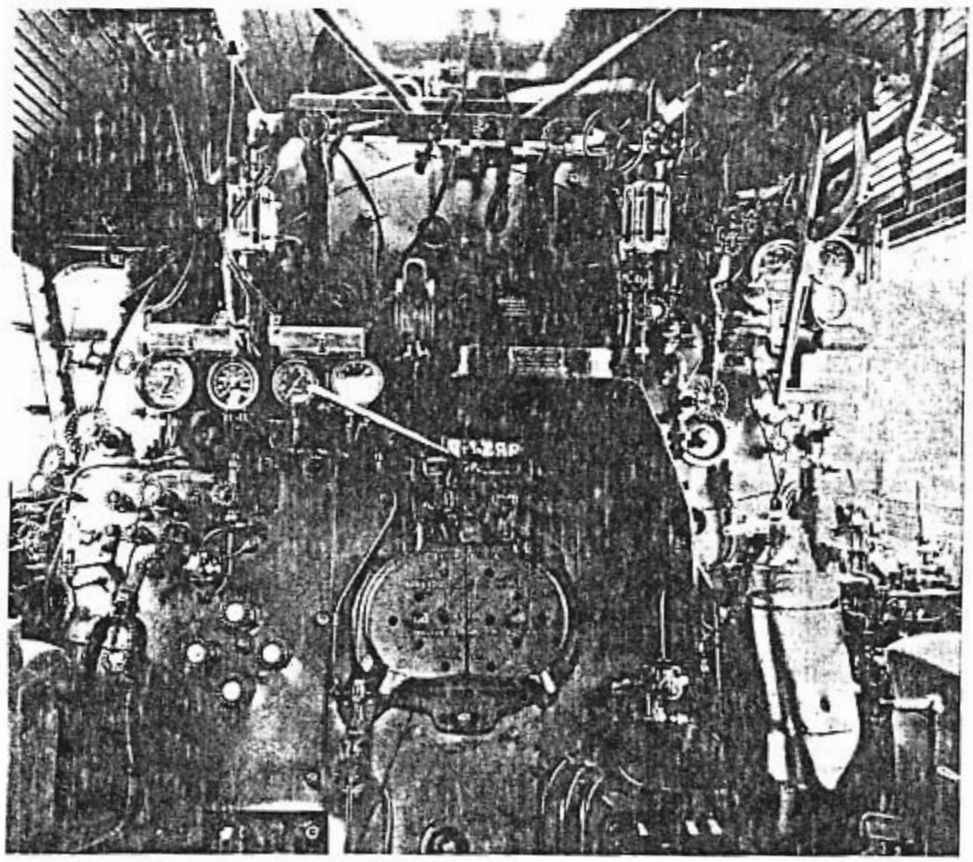
fed by means of a Standard modified type B stoker. The ash pans are of welded steel plate with cast-steel hoppers.

The fireboxes of these locomotives are completely welded. The firedoor flange, inside door sheet, inside throat sheet and back tube sheet, as well as the longitudinal seams which join the crown and inside firebox side sheets are welded butt joints.

Alco flexible stays have been used extensively. Flexible expansion stays of the WZ type are used in the first six rows across the front of the combustion chamber. Two rows of flexible radials of the WY type are used at the edge of the crown sheet. WZ type sleeves

General Dimensions, Weights and Proportions of the C. M. St. P. & P. 4-6-4 Type Locomotives

Railroad	C. M. St. P. & P.
Builder	American Locomotive Co.
Type of locomotive	4-6-4
Road class	F-7
Road numbers	100-105
Date built	1938
Service	Passenger
Dimensions:	
Height to top of stack, ft.-in.	15- 3
Height to center of boiler, ft.-in.	15- 6
Width overall, ft.-in.	10- 6½
Cylinder centers, in.	91
Weights in working order, lb.:	
On drivers	216,000
On front truck	82,500
On trailing truck:	
Front	53,000
Back	63,500
Total engine	415,000
Tender	375,000
Wheel bases, ft.-in.:	
Driving	14- 8
Rigid	14- 8
Engine, total	42- 4
Engine and tender, total	89- 10
Wheels, diameter, outside tires, in.:	
Driving	84
Front truck	36
Trailing truck:	
Front	38
Back	44
Engine:	
Cylinders, number, diameter and stroke, in.	2-23½x30
Valve gear, type	Walschaert
Valves, piston type, size, in.	12
Maximum travel, in.	7½
Steam lap, in.	1 9/16
Exhaust clearance, in.	¼
Lead, in.	3/16
Cut-off in full gear, per cent	84
Boiler:	
Type	Straight top
Steam pressure, lb. per sq. in.	300
Diameter, first ring, inside, in.	82½
Diameter, largest, outside, in.	94
Firebox length, in.	144½
Firebox width, in.	96 1/16
Height mud ring to crown sheet, back, in.	73½
Height mud ring to crown sheet, front, in.	88 13/16
Combustion chamber length, in.	44½
Arch tubes, number and diameter, in.	2- 3½
Thermic syphons, number	3
Tubes, number and diameter, in.	60- 2¼
Flues, number and diameter, in.	164- 3¼
Length over tube sheets, ft.-in.	19- 0
Fuel	Bituminous
Grate area, sq. ft.	96.5
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	348
Arch tubes	19
Thermic syphons	91
Firebox, total	458
Tubes and flues	3,708
Evaporative, total	4,166
Superheating	1,695
Combined evap. and superheat	5,861
Tender:	
Type	Rectangular
Water capacity, gal.	20,000
Fuel capacity, tons	25
Trucks	6-wheel
Rated tractive force, engine, lb.	50,300
Weight proportions:	
Weight on drivers ÷ weight engine, per cent	52.1
Weight on drivers ÷ tractive force	4.29
Weight of engine ÷ evaporation	99.6
Weight of engine ÷ comb. heating surface	70.8
Firebox heat. surface, per cent comb. heating surface	78.1
Tube-flue heat. surface, per cent comb. heating surface	63.3
Superheat surface, per cent comb. heating surface	28.9
Firebox heating surface ÷ grate area	4.75
Tube-flue heating surface ÷ grate area	38.4
Superheat. surface ÷ grate area	17.6
Comb. heat. surface ÷ grate area	60.8
Evaporation ÷ grate area	43.2
Tractive force ÷ grate area	521.0
Tractive force ÷ evaporation	12.1
Tractive force ÷ comb. heating surface	8.58
Tractive force x diameter drivers ÷ comb. heating surface	721.0



The cab window arrangement of these locomotives provides a well lighted interior

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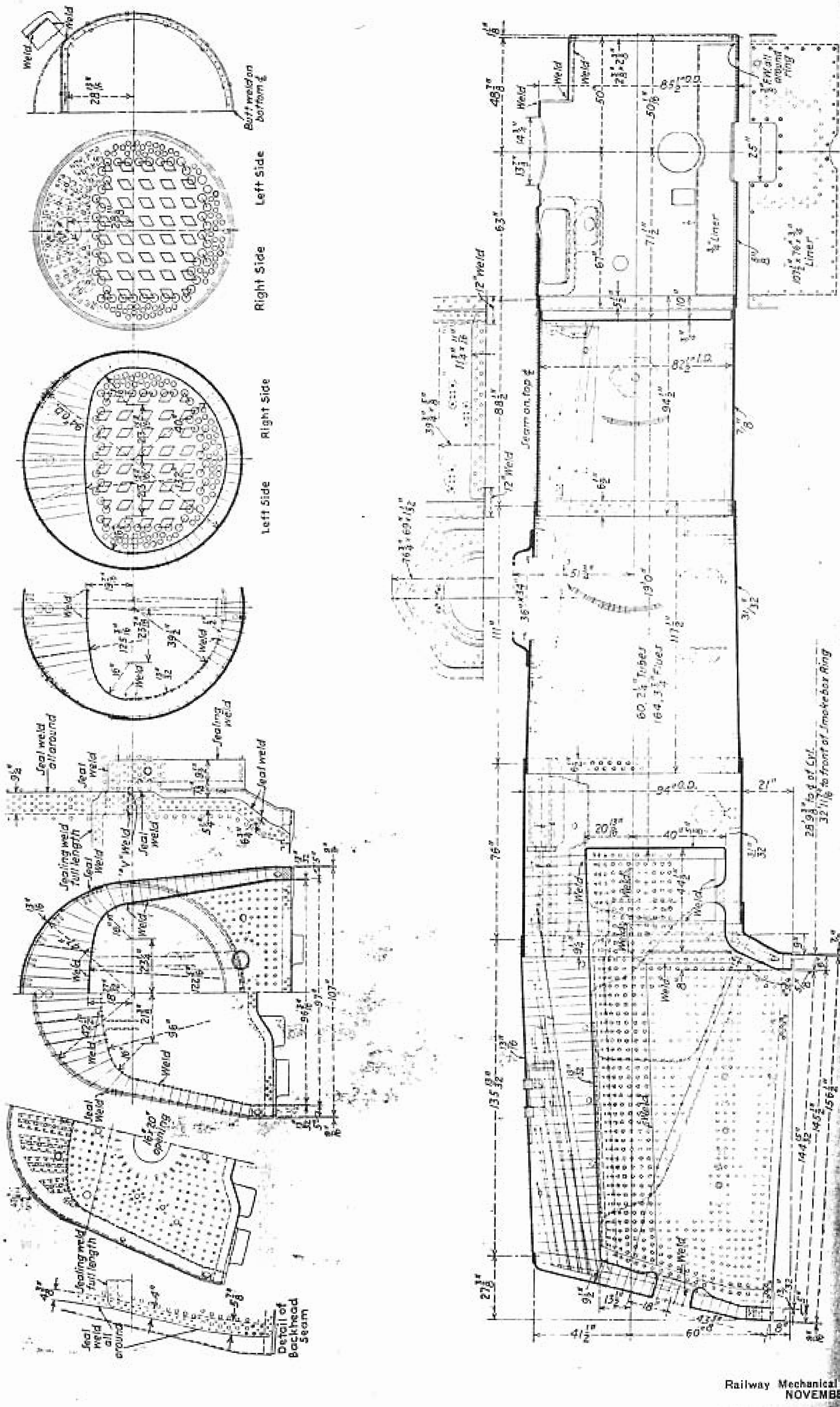

Boiler cross-sections and elevation of the Milwaukee 4-6-4 locomotives.

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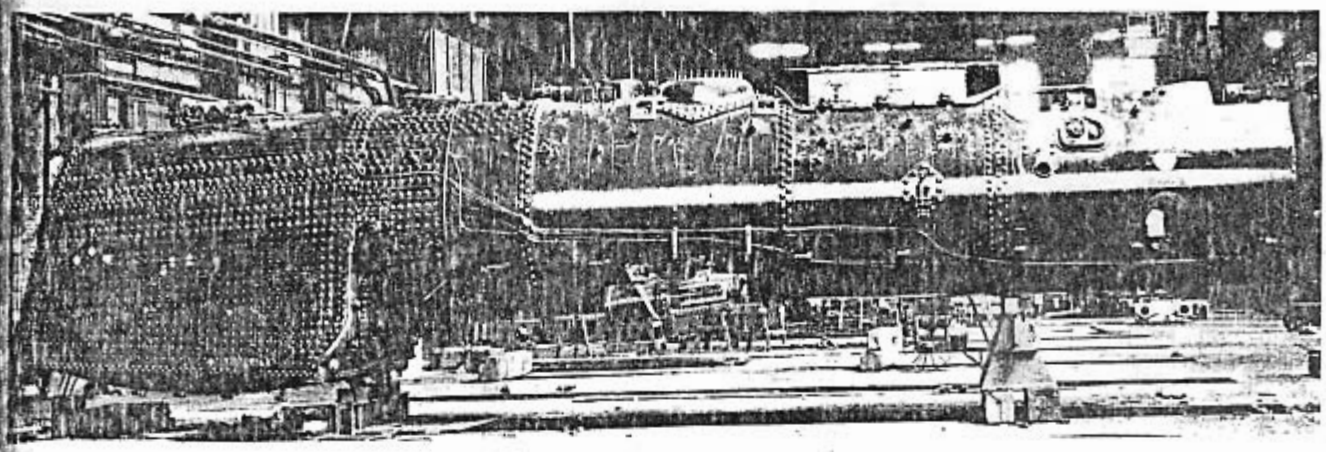

One of the boilers ready for the erecting floor

and caps are used for the flexible water space stays in the combustion chamber as well as a complete installation in the throat sheet. WZ type flexible water space stays are used in the breaking zones of the side and back head. There are four 2-in. combustion flues on each side of the firebox.

The boilers are equipped with the Barco type F3a low-water alarm, Wilson sludge remover together with Wilson blow-off cocks and muffler. Franklin butterfly type firedoors, Superior flue blowers and T-Z smoke consumers constitute part of the equipment.

Saturated steam passes through a Tangential steam dryer in the dome, through a 10-in. diameter steel dry pipe to an American multiple throttle built into the header of the Type E superheater.

Cab and Auxiliary Equipment

The brake equipment on these locomotives consists of the Westinghouse No. 8ET schedule with two 8½-in. cross-compound compressors. The main reservoirs are cast as part of the engine bed and have a capacity of 55,000 cu. in. The braking ratio on the engine truck is 45 per cent, on the drivers 60 per cent, and on the trailer 43 per cent. The engine truck brakes are operated by two 10-in. by 8-in. cylinders, the driver brakes by two 16-in. by 10-in. cylinders and the trailer brakes by four 8-in. by 8-in. cylinders. The train-control equipment is the Union Switch & Signal two-element type with three-indication cab signals. The locomotives are fitted with Valve Pilot speed recorders.

The air compressors are mounted under the streamline shrouding just back of the pilot. The air-compressor exhausts, together with the exhaust from the feedwater-heater pump, enter a header on the outside of the smokebox which is connected to a tunnel on the inside of the smokebox. The upper end of this tunnel discharges into a cavity cast integral at the rear of the stack. The generator is on a cast-steel bracket back of No. 3 driver on the right side.

The generator and headlight equipment were furnished by the Pyle-National Company.

The main cab turret is just forward of the cab under the cowling. It is connected inside the boiler with two 3-in. pipes leading from the dome. Saturated steam from this turret is supplied to the flue blowers, cab heaters, stokers, injectors, water conditioner and steam heat. Superheated steam is supplied to the whistle, air pumps and generator from a separate turret.

The cab is of the vestibule type, of welded copper-bearing steel, wood lined and insulated with Hairinsul. A recess in the exterior of the cab sides provides a toe hold for passing from the cab to the running board. Steam radiators have been installed on both sides of the cab and in the gangway. There are two seats, with Spongex cushions, on either side and drop seats are mounted on the rear vestibule wall on both right and left sides.

The metal cab-window sash were supplied by the O. M. Edwards Company and have shatter-proof glass in all sash.

On the front of these locomotives is a Buckeye type E folding coupler with a 6-in. by 8-in. shank. The Franklin Type E2 radial buffer is installed with the Unit Safety drawbar. Barco flexible connections are used between the engine and tender.

Lubrication

Mechanical lubricators supply the force-feed oil lubrication. A Nathan DV5 26-pint lubricator on the right side distributes oil to the valves and cylinders as well as the stoker and air pumps. A five-feed lubricator of 24 pints' capacity on the left side distributes oil to the driving boxes and guides. Three of the locomotives in this order have Detroit lubricators on the left side and the other three have Chicago lubricators. Both lubricators are driven from connections at the top of the combination levers.

Pressure grease lubrication is used extensively. Altogether 236 Alemite fittings are used on the engine and tender. The engine truck has 27 fittings, the crossheads, guides, motion work and reverse gear 42 fittings, the trailer truck 21 fittings, and the tender truck 58 fittings. Additional fittings on lubricator drives, valve-stem and crosshead guides, throttle rigging, motion, side rods and crank pins, spring and brake rigging, and wheels and boxes total 74 fittings. Rex fittings are used at 12 points on the driving boxes.

Streamlining

The streamlining on this locomotive follows the general theme of the first Hiawatha locomotive as far as the front end is concerned, which is at an angle of 16 deg. to the vertical. Every effort was made to adapt the form of the shrouding to established structural lines.

The front of the streamline shrouding opens at the center line on concealed hinges, giving access to the smokebox front, whistle and air-horn mountings. The air pumps are on either side of the front end behind the pilot skirting and are accessible through hinged side panels in front of each cylinder. A removable panel gives access to the hinged-type coupler. There is a grille above the headlight in front of the whistle and horn. This grille is made up of flat rolled-steel bars

Boiler cross-sections and elevation of the Milwaukee 4-8-4 locomotives

with the narrow edge to the front trimmed with Snap-on stainless steel molding. These metal-trimmed bars are arranged in such a manner that the headlight remains the focal point of the front "face" of the locomotive. The original Hiawatha wing ornament has been retained in a somewhat modified form. This ornament is of stainless steel with a satin finish. The front hand rails are fitted to follow the lines of the headlight and wings and thereby become a part of the ornamentation. The road name is attached to the pilot skirting in stainless steel letters.

The pilot skirt is continued around the cylinders for aerodynamic and protective reasons and in order to accentuate the appearance of height and power rather than of width. The ornamental panel of the side cylinder skirting is continued forward so as to be visible from the front. In order further to relieve the appearance of bulkiness, the pilot skirting merges to a point at the bottom.

While the predominating color of the front end is gray, the horizontal striping of maroon and Milwaukee orange yellow as applied to the skirting below the running board has been continued around to the front in the same manner as the black-and-metal-striped panel on the cylinder skirting. On the bottom of the pilot skirt a maroon design breaks up the appearance of width by following the front edge of the striped cylinder panel. In addition to the ornamental value, the colorful appearance of the front of the locomotive has a decided safety value inasmuch as it is possible to observe it at great distances.

The cowling of the stack, sandbox and dome ends in a fishtail shape on the cab. The unbroken contour of this cowling contributes to smooth smoke flow and obviates the necessity of smoke deflectors. This cowling has been painted black. To retain a distinctive characteristic of the steam locomotive, a streamline cap has been shrouded around the stack and a smoke fin blended into the silhouette. The marker lamps are of special design. The stainless steel side hand rail runs back from the marker lamps and follows the contour of the boiler jacket and cab. Streamline brackets secure the hand rail in place. Between the top cowling and the running board the shrouding follows the boiler contour lines and is painted gray. The throttle arm, injector checks and flue blowers have not been covered.

The cab is a decided departure from conventional design. Every effort was made to increase visibility. This has been achieved by a narrow steel corner post permitting an increase in the clear width of the front cab windows. The length of the cab is further emphasized by the use of aluminum sash with narrow horizontal mullions. By this means the glass area is greatly increased, providing a well-lighted cab interior. The vestibule cab door and window which furnishes unusual visibility follow streamline design of the sash.

Recognizing the public's interest in seeing the mechanism of the locomotive in action, the running gear has been exposed to full view by terminating the running board skirting above the tops of the drivers. The lower end of the running board drops down in a curve under the cab to the lower line of the tender and cars. Following the colors of the cars, the running board skirt has been painted in Milwaukee yellow with broad maroon skirts at the upper and lower edge. The wheels are painted gray with maroon rings around the ends of the axles on the hub, and the side, main and eccentric rods are highly polished with maroon in the channels. A chromium-plated builder's name plate is attached to the skirting at the cylinders and the name plate of the speed-line designer has been applied below the builder's plate in the black cylinder panel.

The tender treatment follows the color arrangement of maroon and yellow characteristic of the new 1938 passenger equipment.

The Tender

The tender tank is of all-welded construction and is built up on a Commonwealth water-bottom cast-steel underframe. The water capacity is 20,000 gallons and the coal space carries 25 tons. The hot well for the Wilson feed-water heater is on the left side behind the coal space.

The tender trucks are of the equalized six-wheel Commonwealth type with 38-in. Davis wheels and A. S. F. roller-bearing units. A. S. F. clasp brakes are used with 14-in. by 10 in. brake cylinders mounted inside on each truck. The braking ratio is 80 per cent.

The steam-heat connectors at the rear end of the tender are the Vapor flexible metallic type. The draft gear is the Miner velvet action passenger gear with Buckeye Type E coupler and yoke.

* * *

A good job of smoke prevention—Erie suburban locomotives stored at Jersey City, N. J., with fires banked

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