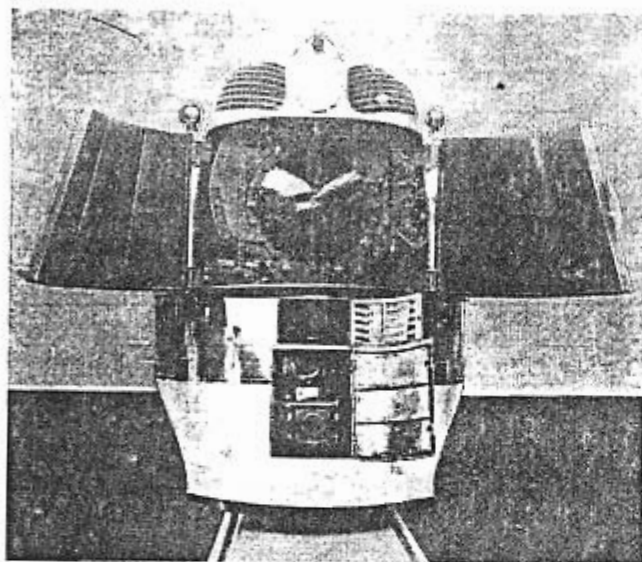


Milwaukee Streamlined High-Speed Locomotives

TWO high-speed streamlined passenger locomotives of a new and strictly modern design were delivered to the Chicago, Milwaukee, St. Paul & Pacific in May by the builder, the American Locomotive Company. These locomotives were designed to haul the new "Hiawatha" trains on daylight runs between Chicago and the Twin Cities, 410 miles, with five intermediate stops, on a six and one-half hour schedule—an average start-to-stop speed of 63.1 m.p.h. or an average running speed of 66 m.p.h. These trains of six cars each weigh 340 tons, exclusive of passengers and baggage. All cars are of new design and built by the road for this service. One of the locomotives, on a trial

Advanced 4-1-2 type built by American Locomotive Company to handle "Hiawatha" trains on 410-mile run from Chicago to Twin Cities in six and one-half hours



Front doors and grille opened for access to front end, coupler and bell

trip before being placed in service, made the run from Milwaukee to New Lisbon, 141 miles, in 113 min., or at an average speed of 74.9 m.p.h. The maximum speed reached was 111.5 m.p.h. On the return trip the

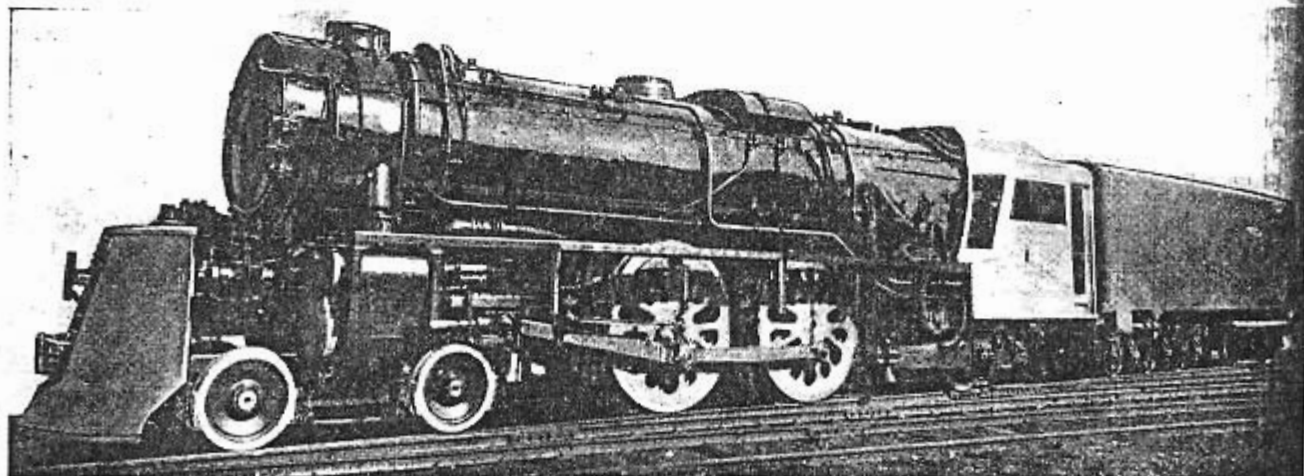
train, consisting of the locomotive, a dynamometer car and five coaches, was stopped from a speed of 100 m.p.h. in 6,600 ft.

A striking and pleasing appearance was obtained by shrouding the upper portion of the locomotive and using a partial skirting below the running boards, the skirting being extended downward at the front to replace the pilot. No attempt was made to conceal the running gear. The smooth appearance and clean lines are enhanced by the color scheme adopted for the locomotive and tender and by a touch of appropriate ornamentation at the front end. The finish includes black, gray, orange yellow, maroon and brown, with lettering in gold leaf and the conventionalized Indian head design on the shrouding front in polished chromium. In arranging the shrouding and skirting to permit ready access to all concealed apparatus great care and ingenuity were exercised to keep the exterior surfaces free from bolt heads, nuts or other projections.

These locomotives are of the 4-1-2 type; weight 280,000 lb., of which 140,000 lb. is on the drivers, and have a rated tractive force of 30,700 lb. The driver wheels are 84 in. in diameter, the cylinders are 19 in. by 28 in., and the oil-fired boiler carries a pressure of 300 lb. per sq. in.

The Boiler

The straight top boiler, which is of generous capacity, embodies a conventional stayed firebox and fire-tube shell. The barrel is rolled in two courses, the door being located on the forward course, 7 ft. back from the



View of the Milwaukee locomotive before the shrouding was applied

front tube sheet. The front shell course is 13/16 in. in thickness and has an inside diameter of 79-11/16 in. The second and larger shell course, which is 80 in. in diameter outside, is rolled from plate 27/32 in. in thickness. The boiler-shell courses, including the welt strips and the firebox wrapper, sheets, are of Lukens silicon-manganese steel.

The firebox sheets are of Lukens firebox steel built up on a solid cast-steel mud ring and stayed with Lewis Special staybolt iron. The stays are 1 in., 1-1/16 in. and 1 1/8 in. in diameter and include a liberal application of flexible stays at the breakage zones. A Thermic syphon is fitted in the firebox.

There are 160 tubes, 2 1/4 in. in diameter and 43 flues, 3 1/2 in. in diameter, the length over tube sheets being 19 ft. The firebox measures 132-1/16 in. by 75-3/16 in. inside, and provides an equivalent grate area of 69 sq. ft. The combined heating surface is 4,274 sq. ft., of which 294 sq. ft. is in the firebox and syphon, 2,951 sq. ft. in the tubes and flues, and 1,029 sq. ft. in the Type A superheater. The gas area through the tubes and flues is 1,078 sq. in. and the area under the table plate in the smokebox is 1,770 sq. in.

The firebox is of welded construction throughout. Welding is also used for 12 in. from the ends along the longitudinal shell seams and the edges of the wrapper sheets are welded at all corners 12 in. up from the bottom of the mud ring. Both the firebox and wrapper sheets are also seal welded to the mud ring behind obstructions which would make access for calking difficult.

The locomotive is equipped with a Wilson water-conditioner, feed pump, sludge remover and blow-off cocks. A Hancock Type W non-lifting injector is also provided. The Hancock boiler feed check valves are located on the upper quarters midway between the dome and the front bue sheet. Washout plugs are of the T-Z pattern. A Barco low-water alarm is also included.

The boiler is supported on sliding shoes at both the front and back ends of the firebox. Between the driving wheels and at the guide yoke are waist sheets which have sliding fits on the boiler shell.

The Front End

An unusual feature of the front end is the exclusion of the volume in front of the diaphragm and above the

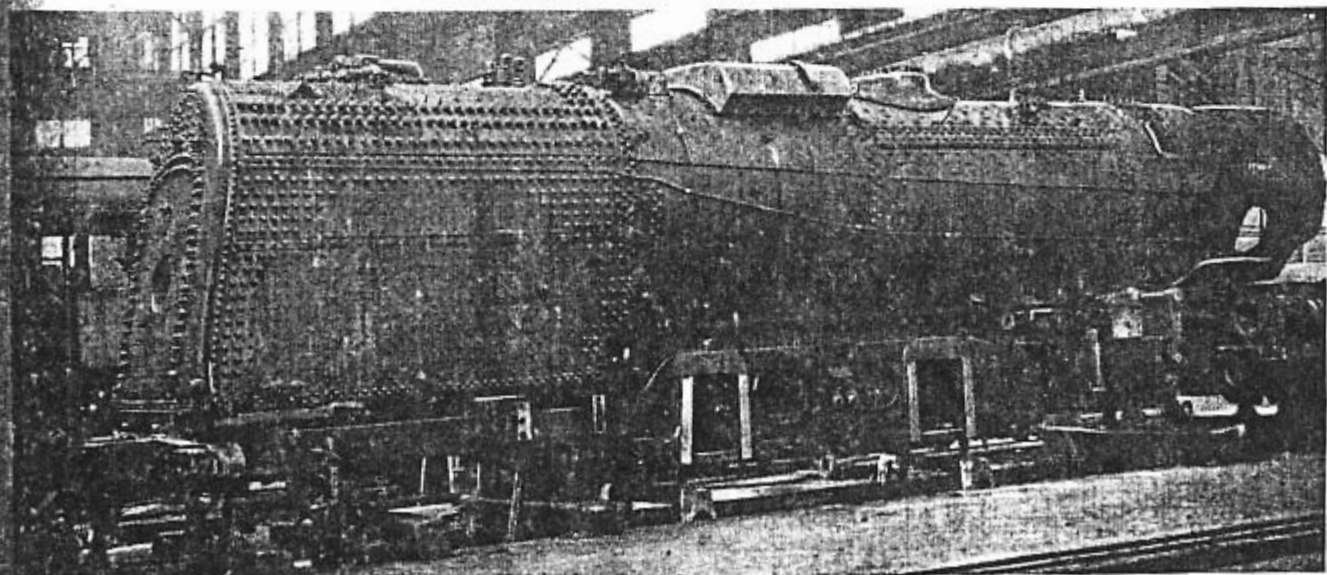
table plate from the smokebox proper. The table plate which extends forward to the smokebox front is provided with an opening to which the bottom of the stack extension is fitted. Since the fuel is oil, no front-end screen is needed. The exhaust nozzle is relatively low, the Goodfellow tip standing 19 3/4 in. from the bottom of the smoke arch and 12 1/8 in. below the bottom of the stack extension and table plate. The smokestack has a diameter of 18 1/2 in. at the choke and a total height of 60 3/16 in., the top being 14 ft. 4 in. above the rail.

Advantage has been taken of the fact that the smokestack is concealed to use it as a support for the shrouding, the necessary bolting lugs being cast on it, both in front and at the rear. A vertical passage of circular section which extends up to the top of the stack also forms an integral part of the casting at the rear. This is provided with a suitable connecting flange at the base and serves as an exhaust pipe for the feedwater pump and the turbo-generator. The moisture from these exhausts is thus kept out of the smokebox. The air-pump exhaust is piped into the main exhaust passage in the cylinder saddle. Grilles at the top of the front of the shrouding admit air to a duct which has an outlet behind the stack where it serves as a smoke lifter. The entire front end is lagged and jacketed to keep down the temperature inside the shrouding. The smokebox front is swung on Okadee hinges.

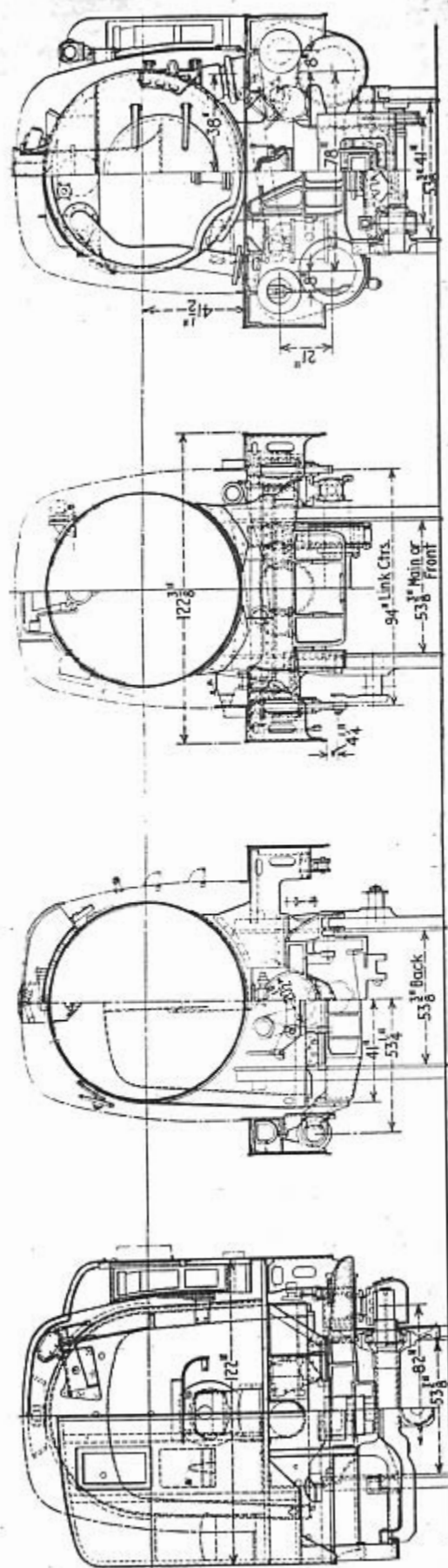
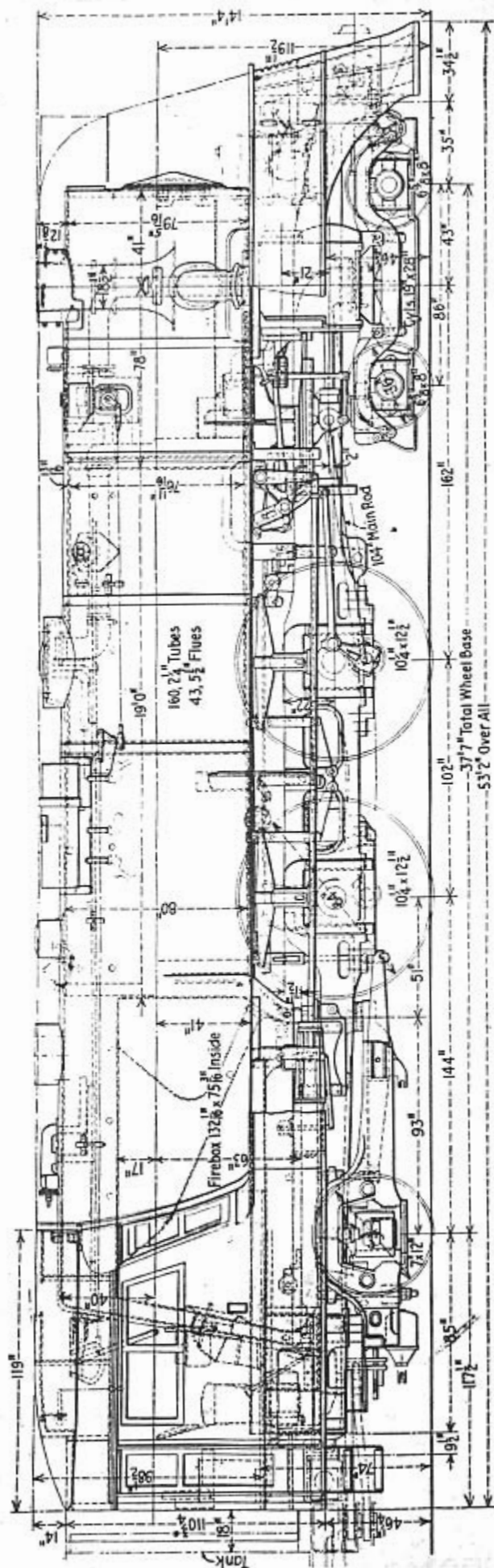
Foundation, Running and Driving Gear

The locomotive is assembled on a cast-steel bed, of which the cylinders, back cylinder heads, saddle and main air reservoir are integral parts. Provision is also made for the support of the running boards on the bed casting, either directly or from waist-sheet and other bed-casting connections. The shrouding and skirting are, in turn, supported from the running boards. In front of the cylinders the casting includes suitable brackets for the air pump, turbo-generator and bell. The bed terminates at the front in a deep vertical bolting face, to which are attached the front coupler pocket and the pilot or nose structure of the shrouding. No bumper beam is provided.

The driving wheels have Boxpok cast-steel centers which are mounted on hollow-bored axles. The driving journal boxes are fitted with SKF roller bearings. The engine truck is the Commonweal four-wheel type, with



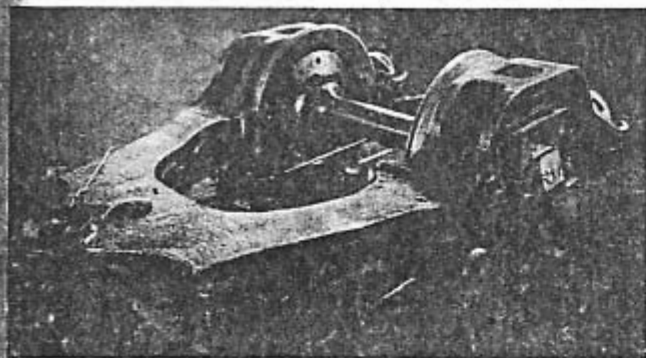
The boiler mounted on engine bed—Note application of flexible staybolts



Elevation and cross-sections of the Chicago, Milwaukee, St. Paul & Pacific high-speed streamlined locomotive

inside journals. The trailing truck is the Commonwealth Delta type with a single axle. SKF bearings are applied on the hollow-bored axles of the engine truck, while the trailing truck has an American Steel Foundries roller-bearing axle assembly fitted with Timken roller bearings.

In the rods and motion work weight reduction was an important consideration in view of the high speeds for which this locomotive was designed. The drive is



The two-wheel trailer truck

through Tandem main rods, with the cylinders spread 78 in. between centers. The rods are of high-tensile nickel steel and are light I-sections. For stiffness the parallel rod is fish-belly in form. The eccentric rod and crank are also channeled to keep down the weight on the main crank pins. The counterbalancing of the locomotive is such that the dynamic augment at the rail at a speed of 100 m.p.h. is 10,800 lb. The total reciprocating weights on one side of the locomotive amount to



Six-wheel truck on front of tender

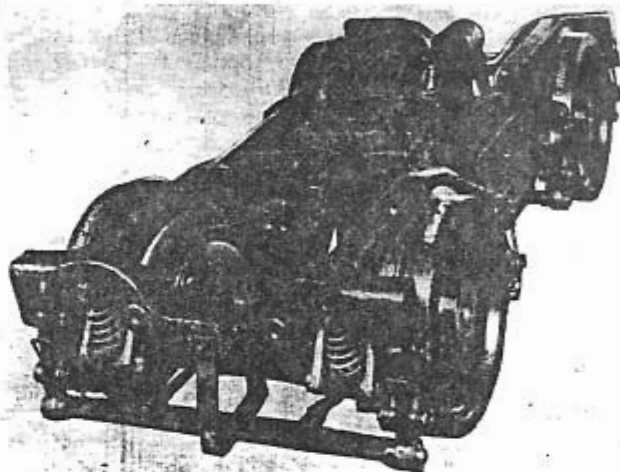
1,003 lb., of which one-third are balanced. The low dynamic augment is due in part to the care in design to keep the weights of reciprocating parts as low as possible and also to the greatly reduced overhang of the pin-borne weights due to the relatively narrow cylinder spread.

The crank-pin bearings are bronze floating bushings,

inside of Hunt-Spiller gun iron bushings pressed in the rods at the rear pins and in the steel articulating bushings of the rods at the front pins. The crank pins are of carbon steel, hollow bored.

The suspension is of the customary three-point type. In addition to the main driving and trailing-truck springs, each side suspension includes two coil cushioning springs—one lever-connected to the front driving-spring hanger and the other interposed directly between the end of the rear trailer-spring hanger and the Delta trailer-truck frame. The driving springs have a slight reverse camber.

The pistons are light Z-section, open-hearth-steel forgings fitted with Hunt-Spiller Duplex packing. Bronze wearing faces are provided at the bottom. The crossheads and guides are of the Dean three-bar type,

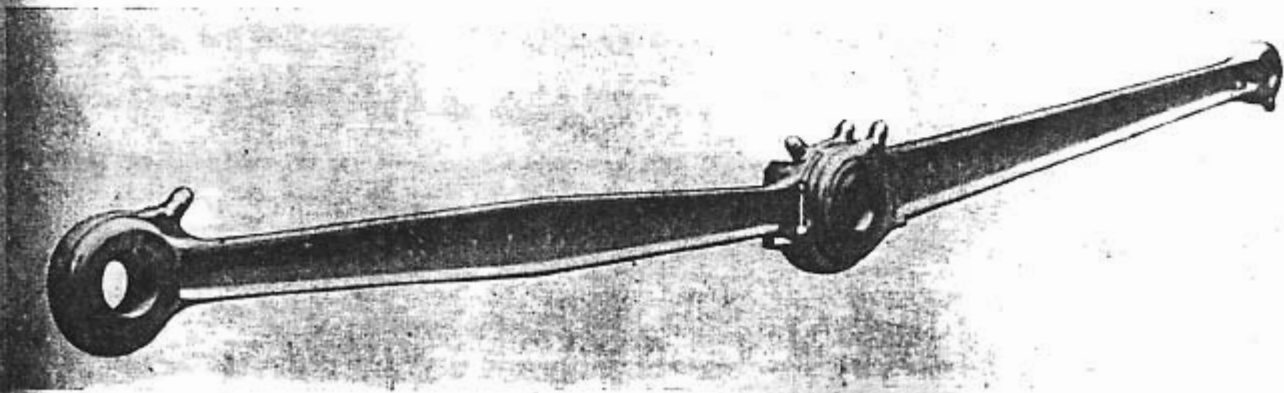


The engine truck is equipped with clasp brakes operated by two brake cylinders

Ampco bronze shoes being fitted to the crosshead. Diamond-Crescent packing is used for piston rods and valve stems, the packing for the piston rods being suitable for steam temperatures of 750 deg. F.

The locomotive is fitted with Walschaert valve motion and 10-in. piston valves which have a maximum travel of 6½ in. An American multiple throttle is fitted in the type A superheater header. The latter is connected to the valve chambers by the usual outside steam pipes and Flextite casings. The Alco reverse gear is located at the side of the firebox, behind the skirting below the running board, and is supported directly from the engine bed.

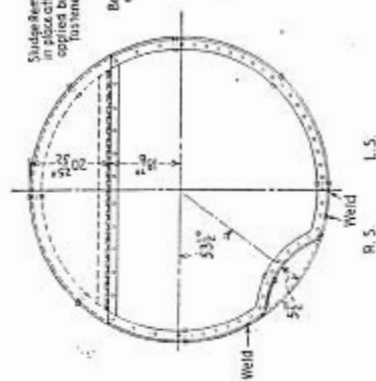
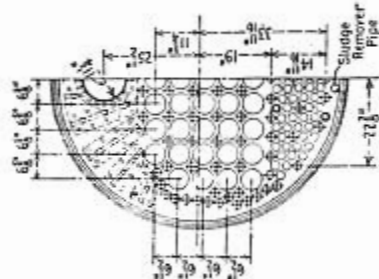
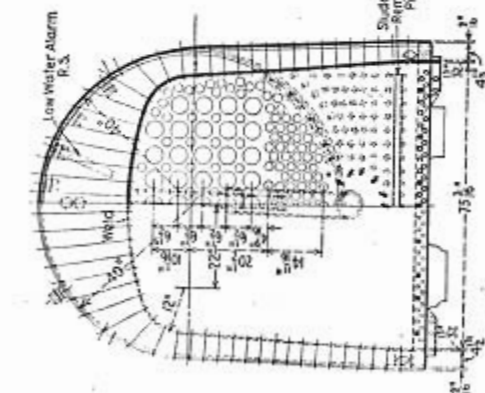
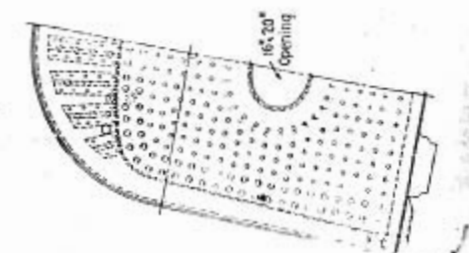
The cylinder and valve chambers are lubricated by a



The tandem rods are of light section



Outside View of Side Sheet
at Throat



Section "X-X'"



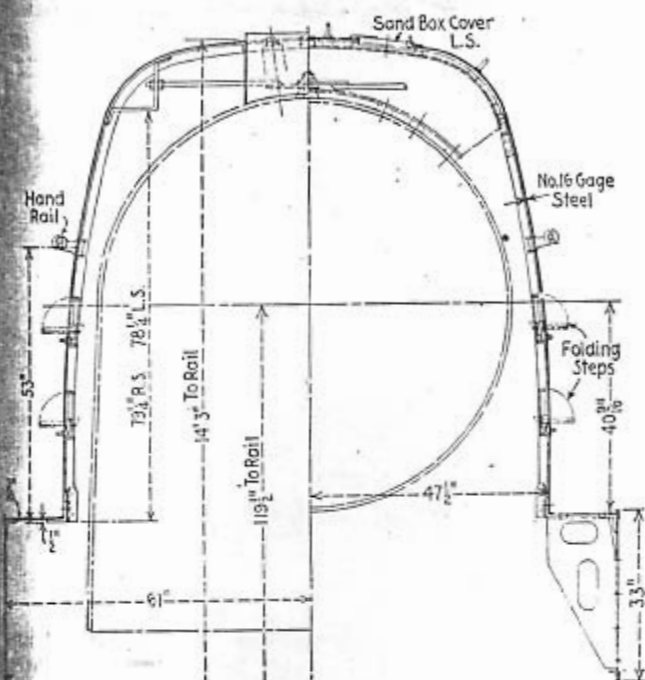
Enlarged Detail of Sludge Remover
Boss - L.S. only at Throat Corner

Longitudinal and transverse sections of the boiler of the Milwaukee 4-4-2 type locomotive.

Nathan DV-4 24-pint force-feed lubricator. A Nathan Type L.B. mechanical lubricator supplies oil to the steam cylinders of the air compressor, the air cylinders being lubricated by Westinghouse Type B oil cups. The valve motion, rods, spring rigging and brake work are fitted for Alemite lubrication throughout.

Brakes and Brake Rigging

The locomotives are fitted with Westinghouse 8 ET air-brake equipment and one 8½-in. c.c. air compressor. The main reservoir, which is a part of the backbone of



Section through shrouding and skirting

the engine bed, is divided into three compartments. Between the air compressor and the first compartment of the reservoir and between the first and second compartments are radiating pipes. The rear compartment, which is small, is connected to the second by a cored

passage near the top of the dividing wall and serves as a final moisture settling chamber before the compressed air is drawn into the brake system.

A new and unusual development embodied in these locomotives is the foundation brake, designed by the American Brake Company. This is particularly adapted to the dissipation of the large amount of energy stored in the locomotive when moving at speeds of 90 m.p.h. and upward. Clasp brakes are applied on every wheel under the locomotive. The engine truck is provided with two brake cylinders, one of which applies the brake shoes against the front and the other against the rear of all four wheels. To steady the truck frame against the tilting action of the brake application the ends of the equalizers are extended beyond their bearings on tops of the journal boxes to support the seats for coil cushioning springs under the four corners of the engine-truck frame.

The driver brakes are operated by three cylinders. The front brake shoes on all four driving wheels are applied by a single cylinder through mechanical equalization, while the rear shoes on each side of the locomotive have separate cylinders, the equalization between the two sides of the locomotive being effected pneumatically. One brake cylinder applies all four shoes on the trailing-truck wheels.

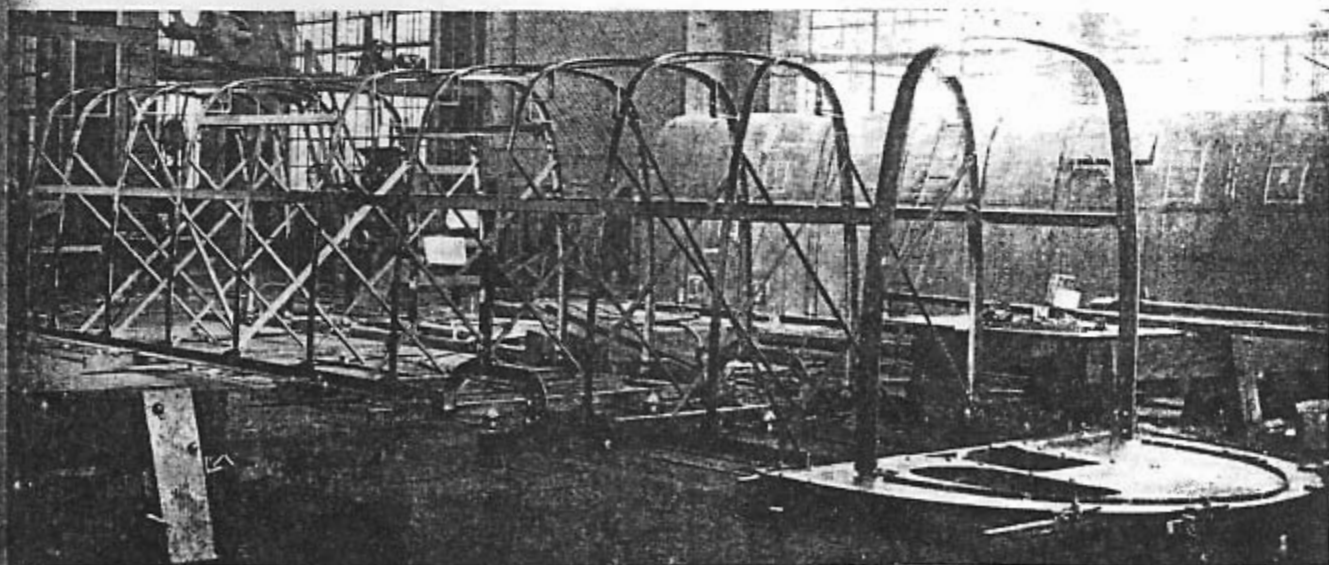
The braking ratios of the three brake systems are, respectively, 45 per cent for the engine truck, 60 per cent for the trailing truck, and 78 per cent for the driving wheels, based on 50 lb. brake-cylinder pressure.

The tender trucks are equipped with Simplex unit type clasp brakes.

The Tender

The rectangular tender is built up by welding upon a General Steel Castings water-bottom frame. As it is designed to be used in oil-burning service only, the fuel tank is built in integrally. The hot-water compartment of the Wilson water conditioner is located on the left side of the water tank at the front and receives exhaust steam from the back end of the cylinder exhaust ports through pipes which are carried between the frames and under the draft pan to the tender.

The top of the tank is shrouded to conform with the contour of the roofs of the new cars with which these locomotives will be operated. A single opening in this shrouding provides access to both water and oil-filling



Shrouding frame in foreground with nearly completed shrouding in background

holes. The rear end of the tender is fitted with a dummy vestibule connection. The tender is carried on a six-wheel truck in front and a four-wheel truck at the back. Both trucks are of General Steel Castings construction and fitted with American Steel Foundries

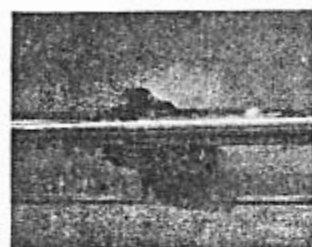
Principal Dimensions, Weights and Proportions of the C. M. St. P. & P. streamlined Locomotives

Railroad	C. M. St. P. & P.
Builder	American Locomotive Co.
Type of locomotive	"Hiawatha" 4-4-2
Road numbers	1-2
Service	High-speed pass.
Height to top of stack	14 ft. 4 in.
Width	10 ft. 2 1/4 in.
Cylinders, diameter and stroke	19 in. by 28 in.
Valve gear, type	Walschaert
Valves, piston type, size	10 in.
Maximum travel	6 1/2 in.
Steam lap	1 1/2 in.
Exhaust clearance	3/4 in.
Lead	3/4 in.
Cut-off in full gear, per cent	85
Weights in working order:	
On drivers	140,000 lb.
On front truck	75,000 lb.
On trailing truck	65,000 lb.
Total engine	280,000 lb.
Tender	247,500 lb.
Wheel bases:	
Driving	8 ft. 6 in.
Total engine	37 ft. 7 in.
Total engine and tender	78 ft. 10 1/2 in.
Wheels, diameter outside tires:	
Driving	84 in.
Front truck	36 in.
Trailing truck	51 in.
Journals, diameter and length:	
Driving, both axles	10 1/2 in. by 12 1/2 in.
Front truck	6 1/2 in. by 8 in.
Trailing truck	7 in. by 12 in.
Boiler:	
Type	Straight-top
Steam pressure	300 lb.
Fuel	Oil
Diameter, first ring, inside	76 1/16 in.
Diameter, largest, outside	80 in.
Firebox, length and width	132 1/16 in. by 75 7/16 in.
Height mud ring to crown sheet, back and front	80 in.
Syphons	One
Tubes, number and diameter	160—2 1/2 in.
Flues, number and diameter	43—5 1/2 in.
Length over tube sheets	19 ft. 0 in.
Total gas area through tubes and flues	1,078 sq. in.
Grate area	69 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	254 sq. ft.
Syphon (1)	40 sq. ft.
Firebox, total	294 sq. ft.
Tubes	1,781 sq. ft.
Flues	1,170 sq. ft.
Tubes and flues	3,951 sq. ft.
Total evaporative	3,245 sq. ft.
Superheating (Type A)	1,029 sq. ft.
Combined evap. and superheat	4,274 sq. ft.
Water conditioner	Wilson
Tender:	
Style	Built-in fuel tank
Water capacity	13,000 gal.
Fuel capacity (oil)	4,000 gal.
General data estimated:	
Rated tractive force, 85 per cent	30,700 lb.
Speed at 1,000 ft. piston speed	53.55 m.p.h.
Piston speed at 10 m.p.h.	186.5 ft. per min.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	50
Weight on drivers ÷ tractive force	4.56
Total weight engine + comb. heat. surface	65.5
Boiler proportions:	
Tractive force ÷ comb. heat. surface	7.18
Tractive force × dia. drivers ÷ comb. heat. surface	603
Firebox heat. surface, per cent comb. heat. surface	6.87
Tube and flue heat. surface, per cent comb. heat. surface	69.05
Superheat. surface, per cent comb. heat. surface	24.08
Firebox heat. surface ÷ grate area	4.26
Tube and flue heat. surface ÷ grate area	42.77
Superheat. surface ÷ grate area	14.92
Comb. heat. surface ÷ grate area	61.94
Gas area, tubes and flues ÷ grate area	0.109

engine and tender, with T-Z tank valves and hose connections for water. Barco brake-cylinder connections are also used on the engine, trailer and tender trucks.

Cab, Fittings and Shrouding

Since the locomotive and tender are built for oil-burning service only, there was no need for access to the tender through the arch at the rear of the cab. The back of the cab has, therefore, been completely enclosed and provided with side doors. The cab is of welded construction with one thickness of American hair felt insulation between the outside sheets and the inside wood lining. The engineman's and fireman's seats are Gustin-Bacon type with Spongex cushions. Two auxiliary dry



Hand rail column in closed and locked position at left and in opened position at right

seats are also provided at the back and are fitted with the same type of cushions. The cabs are fitted with Prime clear-vision windows.

Because of the inaccessibility of the tender while the locomotive is running the cab is fitted with water-and-oil-level indicators, accompanying which is a calibration chart showing the gallons per inch of fuel and water heights. There is also a dial type pyrometer which shows the temperature of the fuel oil in the tank.

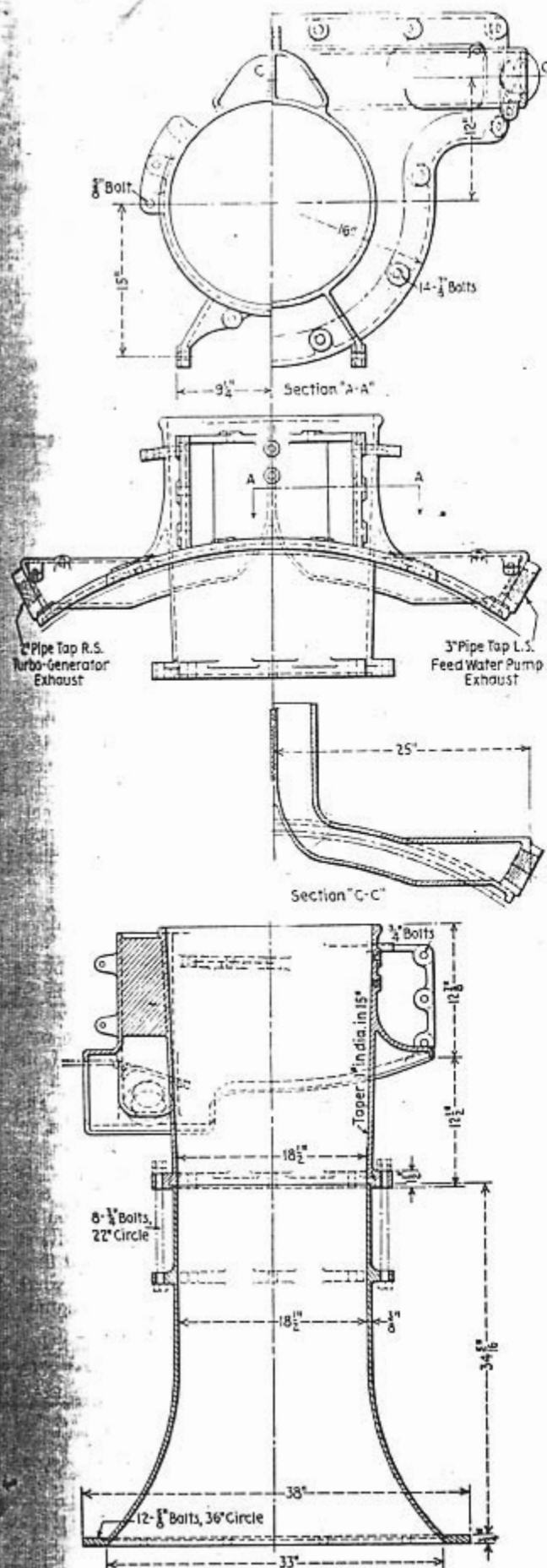
There are two steam turrets. That for superheated steam is located on the smokebox near the superheater header and supplies steam for the air pump, the turbo-generator, the blower line, the oil burner and the cylinder cocks. The saturated-steam turret is placed in the conventional location just ahead of the cab and supplies the injector, steam heat for the train and cab, the power reverse gear, the feedwater pump and the lubricator heater. The locomotive is equipped with an Ashcroft back-pressure gage, a Loco Recorder, reading up to 120 m.p.h., and Union Coded continuous cab signals.

The headlight is the Pyle-National submerged type, with a 14-in. glass reflector, arranged to swing out. The special oval front goggle is mounted in a cast aluminum frame. The locomotive has a Leslie Tyfon whistle fitted for operation by air or steam. The single horn is enclosed within the cowling immediately above the headlight. The sand box which is concealed by the shrouding is of rectangular form, welded construction and has a capacity of 25 cu. ft. Brewster-White remote-control type sanders are applied, the control valves being located at the sand traps with direct air connections from the main reservoir and a pneumatic operating valve in the cab. This arrangement is designed to provide a flow of sand immediately on the operation of the cab valve.

The shrouding completely encloses the boiler and all apparatus customarily suspended from the boiler, as mounted on the locomotive bed. Extending down to the running board, it is built of No. 16 gage material—Toncan steel for the doors ahead of the smokebox and Republic double-strength steel for the remainder. The sheets are carried on a frame consisting of angle car-

roller-bearing wheel-and-axle units having Timken bearings. Davis cast-steel wheels are applied.

Franklin radial buffer and Unit safety engine and tender drawbar are fitted. Miner A-94-XB draft gear is installed at the rear end of the tender. Barco steam, air and fuel-oil connections are applied between the



Smokestack and extension with auxiliary exhausts and support for shrouding

lines which are supported from the running board and braced to the top of the boiler. The shrouding is fitted with doors, opposite all washout plugs, sand trap, boiler checks, etc. The entire front is enclosed in swinging doors, the opening of which gives access to the front end and the equipment mounted on the front deck.

Among the interesting details of the shrouding are folding steps in the sides which can be let down when access to the sand box or cab turret is desired. The classification lamps are supported on top of the upper hinges of the front shrouding doors and these hinges have been designed so that the wiring is carried through them to the jacket. The handrail columns are fitted with simple spring latches, by means of which the handrail is securely locked in the columns. Each is unlocked by a push button and opened by spring torsion. Closing the latches automatically locks them in place. An entire side section of the handrail can thus be removed and replaced in a few minutes without the use of tools.

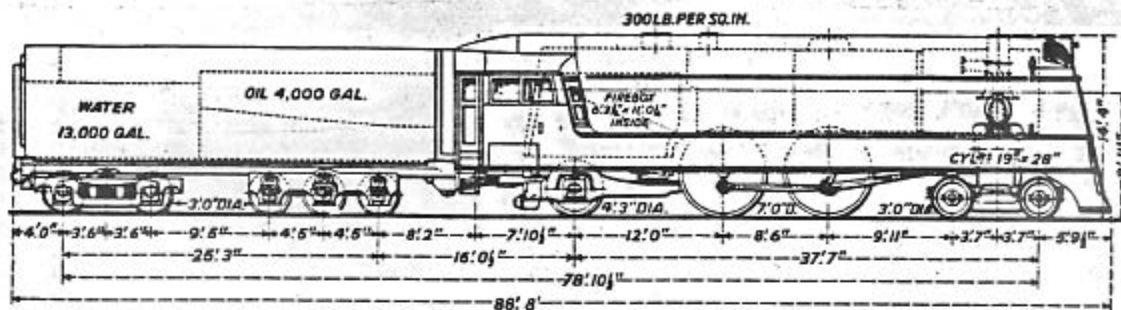
The lower section at the front end of the shrouding serves as a pilot. This is a stiff, welded structure of plates and angles which extends from below the bottom of the front-end shrouding doors. A panel on the center of the pilot conceals the coupler when it is not in use. The coupler is hinged in its pocket to swing upward and when its use is required, on removal of the panel, it can be swung down horizontally. Train-brake and air signal lines are carried to the front of the locomotive, where they terminate inside the shrouding with standard cut-out cocks. The air hose, when not in use, are removed and carried in the concealed tool box.

The skirting is supported from the outer edge of the running boards and extends down about 33 in. This conceals the reverse gear, the boiler feed pump, the spring rigging and most of the valve motion, and forms an unbroken line from the rear of the pilot to the rear of the tender.



Further information furnished by the Editor upon request

4-4-2 CLASS A HIAWATHA



Drawing from Loco Profile No. 26

GENERAL SPECIFICATIONS

Road Numbers - - - - -	1 - 4	Heating surface -	
Type - - - - -	4-4-2	Tubes - - - - -	1781 Sq. Ft.
Class - - - - -	A	Superheater flues - - - -	1170 Sq. Ft.
Year built - - - - -	1935-37	Superheater tubes - - - -	1029 Sq. Ft.
Builder - - - - -	Alco	Syphon - - - - -	40 Sq. Ft.
Cylinders - - - - -	19" x 28"	Firebox - - - - -	254 Sq. Ft.
Valve gear - - - - -	Walschaert	Total evaporating - - - -	3245 Sq. Ft.
Valves - - - - -	10" Piston	Tender journal - - - - -	Roller Bearing
Valve travel - - - - -	6 1/2"	Tender water capacity - - -	13,000 Gals.
Driving wheel dia. - - - -	84"	Tender oil capacity - - - -	4,000 Gals.
Engine truck wheel dia. - -	36"	Weight on drivers - - - - -	142,000 lbs.
Trailing truck wheel dia. - -	51"	Weight on trailing truck - -	72,000 lbs.
Driving wheel journal - - -	Roller Bearing	Weight on leading truck - -	72,000 lbs.
Engine truck journal - - -	Roller Bearing	Weight of tender - - - - -	262,400 lbs.
Trailing truck journal - - -	Roller Bearing	Weight of engine & tender -	548,400 lbs.
Boiler type - - - - -	Straight Top	Weight in working order - -	286,000 lbs.
Boiler pressure - - - - -	300 lbs.	Tractive effort - - - - -	30,685 lbs.
Boiler dia. 1st course inside -	76-11/16"	Factor of adhesion - - - - -	4.64
Tubes - No. & dia. - - - - -	160 - 2 1/4"	Spread of frames (centers) -	42"
Flues, superheater, No. & dia. -	43 - 5 1/2"	Length of main rod - - - - -	8' - 8"
Flues & tubes length - - - - -	19' - 0"	Driving wheel base - - - - -	8' - 6"
Firebox length & width inside -		Total engine wheel base - - -	37' - 7"
- - - - -	132-1/16" x 75-3/16"	Length overall - - - - -	88' - 8"
Firebox type - - - - -	RT	Height overall - - - - -	14' - 4"
Grate area - - - - -	69 Sq. Ft.	Max. ind. hp & speed - - - -	3000 @ 100 mph
Superheating surface (Type A) -	157 Sq. Ft.	Max. service speed - - - - -	100/120 mph

HISTORY

The famous Class A Hiawatha Atlantics were the first steam locomotives designed and built specifically to attain 100 mph every day in regular passenger service. They were the Milwaukee Road's answer to the speed challenge of their two competitors on the Twin Cities-Chicago route. That they were successful beyond expectations is illustrated by their lasting fame even to this day. The Class A's made their final runs in the last days of steam power. No. 3 was the first to go in September, 1949. No. 4 followed in June, 1951 and No. 1 and 2 were withdrawn from service in November, 1951.

REFERENCES

Railway Age, May 11, 1935; Railway Mechanical Engineer, June, 1935; Midland Railroader, Sept. 1935; Railroad Model Craftsman, August, 1959; & Sept. 1962; 1941 Loco Encyclopedia; Loco Profile No. 26