

Assembly and Operating Instructions of USRA Light Mikado



1. HISTORY

On January 1, 1918, control of the U.S. railroads was taken over by the United States Railway Administration (USRA). The USRA employed top locomotive designers from several locomotive manufacturers and railroads to develop a standard line of locomotives of various sizes which would share certain basic parts to reduce production, maintenance and operating costs. Eventually, 12 standard designs were settled on. These designs included wheel arrangements from 0-6-0 to 2-8-8-2. Three sizes of tenders were developed with 8,000, 10,000, & 12,000 gallon capacities. Some locomotives were developed in both light and heavy versions. While the heavy Mikados ran on about 23 railroads, the light version was used by over 50 different railroads in both freight & passenger service. The first, for the Baltimore & Ohio Railroad, was completed in July 1918, numbered #4500. The light Mikados had 63 inch drivers, 26x30 inch cylinders, carried 200 lbs/sq inch in boiler pressure and weight 290,800 lbs. They developed a tractive effort of 54,600 lbs and originally cost \$53,600. These locomotives were produced by several other builders included ALCO, Lima & Baldwin. A total of 625 light Mikados were build under the USRA, with a further 641 copies built after the end of the USRA's control.

2. SPECIFICATIONS

SCALE/GAUGE	1/32, NO.1 (45 mm) GAUGE
DIMENSIONS LENGTH OB mm)	770 mm (ENGINE 454 mm + TENDER 304 mm)
WIDTH	102 mm
HIGHT	164.8 mm
WHEEL ARRANGEMENT	2 - 8 - 2 Mikado
DRIVING WHEEL	DIA.50 mm, ECCENTRIC CAM for axle pump mounted.
PILOT TRUCK WHEEL	DIA. 26 mm
TRAILER TRUCK WHEEL	DIA. 34 mm
TENDER WHEEL	DIA. 26 mm
WEIGHT	7.1 KG.
AXLE DRIVEN PUMP	MOUNTED ON MAIN DRIVERS' AXLE PUMP RAM 5 MM X STROKE 5 MM
ENGINE TWO CYLINDERS	WITH D-SLIDE VALVE BORE 13 mm X STROKE 20 mm
VALVE GEAR	WALSCHAERT'S VALVE TRAVEL 6 mm, CUT-OFF 75 %
BOILER TYPE	SMOKE TUBE BOILER
WATER CAPACITY	400 CC AT 70% FULL
WORKING PRESSURE	3 - 4 KG/CM2
FITTINGS	REGULATOR VALVE, BLOWER VALVE, CHECK VALVE, GAUGE GLASS, PRESSUR GAUGE,
BURNER/FUEL	WICK TUBE ALCOHOL BURNER
BURNER WICKS	GLASS FIBRE WICKS.
TENDER ALCOHOL TANK	CAPACITY 200 CC

WATER TANK
MINIMUM RADIUS

HAND PUMP MOUNTED
2.0 METER (dia.4 meter)

SUBJECT TO CHANGE WITHOUT NOTICE

3. GENERAL ASSEMBLY NOTES

The instructions contained in this booklet are correlated with the assembly instructions, i.e., the instructions in Section 1 are to be used with illustration 1. Review the instructions and illustrations carefully before beginning assembly. Part numbers are listed in the parts list by first giving the section number which is followed by the item number, i.e., part 1-19, which is a part of the section 1 package, is shown on the illustration 1 as the item 19 pilot. In some instances, parts are shown on illustrations listing both section number and item number, such as the 3-1 steam chest cover callout on illustration 7. This occurs when it is necessary to identify that a part from a difference section, in this example Section 3, is installed using illustration 3.

The right and left hand sides of the locomotive correspond to the common definitions of right and left for a person facing forward while standing at the rear of the locomotive.

Assembly should be accomplished section by section in accordance with the instructions contained in this booklet otherwise there may be installation difficulties. When assembling a section, remove only the parts needed for the particular operation being undertaken. Small hardware items can be handled more easily by using a pair of tweezers. Practice picking up small items, such as the screws and nuts with tweezers, and setting them in place. You will soon become proficient in handling them and gain confidence in your assembly skills.

Check each part and de-burr if necessary. Be sure any parts which have been accidentally bent are straightened.

Packing compound is required to seal certain assemblies. Use an acrylic silicon compound such as WHITE CAULK, which is available in most hardware stores. Loctite Gasket Eliminator #510 is also an acceptable packing compound. Be careful not to let any packing compound get into a bearing or steam/water passage or line. Keep a small wet cloth nearby when using packing compound to remove excess material and to clean your fingers so as to avoid spreading the compound. The packing compound should also be used as the adhesive for installing the ceramic insulation blankets.

When installing small screws, nuts and bolts, use a drop of thread locker, such as **LOCTITE 222**, on the threads and tighten until the fastener is seated; then tighten no more than 3 to 4 additional degrees. After the thread locker cures, the fastener will be firmly held in place. **BE CAREFUL NOT TO OVER-TIGHTEN SMALL SCREWS AND TWIST OFF THEIR HEADS.** Some thread lockers secure a fastener so tightly that heat must be applied before the fastener can be removed. Loctite 222 is made for small diameter fasteners and provides sufficient "break away" torque to retain the fastener under normal operating conditions however the fastener can easily be removed with hand tools without the application of heat.

Small slotted screws can be "stuck" to the blade of a screw driver with instant adhesive or a dab of grease to aid in their installation in tight locations.

Occasionally “**tolerance build-ups**” will cause miss-alignment which may require minor filing and fitting. **NEVER FORCE OR “SPRING” A PART INTO POSITION; A BIG HAMMER IS SELDOM THE CORRECT SOLUTION FOR AN INTERFERENCE PROBLEM.** Remove the interference by adjustment or filing.

Lay the locomotive on a soft pillow when it is necessary to position it on its side during assembly or maintenance. This will protect the finish and avoid damage to the running gear.

The following tools and supplies are required:

Needle nose pliers	Tweezers
Metric scale (1 mm = 0.0394 in.)	Fine flat files (flat & round)
Small blade screw drivers	Scissors
Assorted small metric wrenches	Magnifying glass
Thread locker such as Loctite 222	Packing Compound such as
Wrench	White Caulk
Soft pillow	Distilled water
Steam cylinder oil	Machine oil

The tools and supplies furnished with the kit are as follows:

Hex. Wrench for P4 set screws	Injector with nozzle
Small Screwdriver	#1000 sand paper (for kit only)
Packing Compound (for kit only)	

Be careful not to damage or lose any of the parts. If you have never assembled an ASTER KIT before, allow yourself adequate time to complete each section and do not push yourself beyond a comfortable limit. Patience and care are the most precious tools of a skilled model engineer; a well assembled and maintained locomotive will serve you faithfully for many years. If you find any defective or missing parts, contact your dealer listing the part numbers and stating if the parts were missing, defective or damaged during assembly. Assembling the locomotive is not difficult but does represent a challenge. If you should encounter an obstacle during assembly, it is usually best to stop work and continue at a later time. Never become discouraged if problems arise. We will gladly work with you so that you will have the pleasure of seeing your locomotive come to life when it is first steamed.

Name	Description	1	2	3	4	5	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	GT
Neoprene O-Ring																						
φ 3.2-1mm	PN3.2-1						1															1
φ 5-1.9mm	PN5-1.9						1			1												2
φ 6-1mm	PN6-1						1	1	2													4
φ 7-1.9mm	PN7-1.9																		1	1		2
Silicone O-Ring																						
φ 3-1.9mm	PS3-1.9							1												1		2
φ 4-1.9mm	PS4-1.9				4					2									1			7
Fluoride O-Ring																						
φ 2-1.5mm	PF2-1.5			2																		2
φ 3-1.9mm	PF3-1.9			2					2													4
Grand Nipple																						
M5.5 Valve spindle gland nipple	GP5.5			2																		2
M7.0 Piston rod gland nipple	GP7			2																		2
Gland Nut																						
M5	GN5-3						2		2													4
M8	GN8-6B						1	1	2													4
Lock Nut																						
M5	LN5-7A							2	1													3
M6	LN6-8B								3				1									4
M8	LN8-10B							1														1
Piston Ring																						
φ 4mm	SB-φ 4							2												2		4
φ 3mm	SB-φ 3								1													1
Piston Ring																						
φ 13mm	PR-φ 13			4																		4
Pressure gauge																						
φ 20mm	PG20								1													1
Fluoride/Silicone Tube																						
I.D. φ 2.5mm Fluoride tube	BT-φ 5						1													2		3
φ 7mm Silicon tube	ST-φ 7																			1		1
Ceramic sheet																						
Ceramic sheet (Insulation)	CS								○	○	○	○										○
Wire																						
Phosphor Bronze Wire	PbW φ 1						2							4								○
Copper Wire	CuW φ 2								2	1												○
Brass Wire	BSW φ 1									4												○
Hose Clip																						
Hose Clip	HC5																			2		2

section	PART NO. & NAME	§1	§2	§3	§4	§5	§7	§8	§9	§10	§11	§12	§13	§14	§15	§16	§17	§18	§19	§20	§21	§22	Total	
Section 15																								
15	1	Rear Frame													1								×	1
	2	Burner Holder													2								×	2
	3	Burner Wicks													1								×	1
	4	Burner Tube													1								×	1
	5	Trailing Truck Springs													2								×	2
	6	Spring Support Pins													2								×	2
	7	Leading Truck Holder													1								×	1
	8	Leading Truck Wheels													1								×	1
	9	Leading Truck Spring													1								×	1
	10	Trailing Truck Side Frame (R)													1								×	1
	11	Trailing Truck Triangle													1								×	1
	12	Trailing Truck Side Frame (L)													1								×	1
	13	Dummy Truck Spring													2								×	2
	14	Trailing Truck Wheels													1								×	1
	15	Trailing Truck Guide													1								×	1
Section 16																								
16	1	Cab													1								×	1
	2	Dummy Gutter													2								×	2
	3	Hand Rail													2								×	2
	4	Window Shield													2								×	2
	5	Arm Rest													2								×	2
	6	Rear Cover													1								×	1
	7	Roof													1								×	1
	8	Dummy Air Intake													1								×	1
	9	Stopper													2								×	2
Section 17																								
17	1	Tender Truck Wheels														4							×	4
	2	Cross Tie														2							×	2
	3	Truck Frame														4							×	4
	4	Pin														8							×	8
	5	Spring														8							×	8
	6	Leaf Spring														2							×	2
Section 18																								
18	1	Front Step																1					×	1
	2	Tender Frame																1					×	1
	3	Tender Body																1					×	1
	4	Rear Buffer Beam																1					×	1
Section 19																								
19	1	Valve Cap																	1				×	1
	2	Valve Seat																	1				×	1
	3	Link																	2				×	2
	4	Pump Body																	1				×	1
	5	Pump Ram																	1				×	1
	6	Link Pin (L)																	1				×	1
	7	Pump Lever																	1				×	1
	8	Link Pin (S)																	2				×	2
	9	Connector																	2				×	2
	10	N/A																	-				×	-
	11	Water Outlet Pipe																	1				×	1
	12	Water Pipe																	1				×	1
	13	Kingston Valve																	1				×	1
	14	Kingston Pin																	1				×	1
	15	Water Tank																	1				×	1
	16	Kingston Body																	1				×	1

section	PART NO. & NAME	§1	§2	§3	§4	§5	§7	§8	§9	§10	§11	§12	§13	§14	§15	§16	§17	§18	§19	§20	§21	§22	Total		
Section 19																									
19	17	Water Delivery Pipe																		2					2
	18	Extension Handle																		1					1
	19	Union Nut																		1					1
	20	Pipe Union																		1					1
Section 20																									
20	1	Scoop Hump																		1					1
	2	Filler Cap																		1					1
	3	Fuel Valve																		1					1
	4	Alcohol Tank																		1					1
	5	Sump																		1					1
	6	Water Tank Lid																		1					1
	7	N/A																		-					-
	8	Beam																		2					2
	9	Pivot																		2					2
	10	Cover																		1					1
Section 21																									
21	1	Step																		2					2
	2	Draw Bar Pin Spring																		1					1
	3	Draw Bar Pin																		1					1
	4	Ladder																		1					1
	5	Coupler Release Lever																		1					1
	6	Rear Coupler Pin																		1					1
	7	Handrail																		2					2
	8	Rear Step																		2					2

PART I ASSEMBLY INSTRUCTIONS

SECTION 1. CHASSIS

ASSEMBLY SEQUENCE

1. Attach 1-3 frame 1 to 1-2 mainframe R with countersunk screw CM2-5. Attach the three 1-4 frame 2s and 1-5 frame 3 to mainframe R with countersunk screws CM2-5 but only using the bottom holes.
2. See figure 1 to see how the top of each section of the equalized suspension is installed. Use M1.7-5 crosshead screws through the 1-9 equalizer collars to attach the 1-10 equalizer (outside frame) to the 1-8 dummy spring and through to the 1-11 equalizer (inside frame). Assemble the remaining equalizer sections in this manner.
3. Attach each section seen in figure 1 to the 1-1 mainframe L and 1-2 mainframe 2, along with 1-12 spring hangers to the 1-8 dummy springs, using M1.7-5 crosshead screws and 1-9 equalizer collars.
4. Attach 1-7 equalizer fulcrums between the frame and 1-10 outside equalizer arms with 1-6 pivot collar and countersunk screws CM2-5. These screws connect through to the top holes of the three 1-4 frame 2s.
5. Connect the hanging 1-10 and 1-11 equalizers with the 1-7 equalizer fulcrum with a 1-9 collar and M1.7-5 crosshead screw.
6. Repeat with 1-1 mainframe L and connect with the right side.
7. Mount the 1-21 cab floor base to the 1-20 rear frame using M2-8 crosshead screws. Mount the 1-22 cab floor to the cab floor base with M2-8 crosshead screws. Fit the rear frame assembly in the main frame, using M2-5 crosshead screws.
8. Mount 1-14 beam support to 1-13 front truck dummy suspension and then mount 1-15 front deck on top using CM2-3 countersunk screws. Secure this assembly between 1-1 mainframe L and 1-2 mainframe R with CM2-5 countersunk screws.
9. Attach 1-18 side buffer to the rear of 1-26 buffer beam and attach 1-16 F step R and 1-17 F step L to the front. Secure with M1.7-4 crosshead screws.
10. Attach the 1-19 pilot to the 1-26 buffer beam with M2-4 crosshead screws.
11. Attach the 1-24 coupler pocket to the front beam assembly with M2-5 crosshead screws. Attach the 1-23 coupler to the coupler pocket with the 1-25 coupler pin.

SECTION 2. DRIVERS

PRE-ASSEMBLY NOTES:

1. The driving wheels are quite similar each other. It is very important to install the driving wheels in the right order. Distinguish each coupled driving wheel in the following manner:
2-7 Leading Coupled Drivers: The crank pins are shorter than the crank pins of the

2-10 trailing coupled drivers.

2-8 Leading Coupled Drivers: They rest in the 2nd row of the main frame and have the eccentric fitted on the axle for the axle pump.

2-9 Main Coupled Drivers: They have the longest crank pins.

2-10 Trailing Coupled Drivers: Their axle boxes and thinner than those on the leading drivers. This is to allow the trailer drivers to take more side plays.

ASSEMBLY SEQUENCE

1. Fit the 2-4 leading truck pivot pin L and 2-5 leading truck pivot pin S in each hole of the main frame cross tie and fasten in place using N-M4 nuts and SW1 spring washers. Fasten the 2-11 trailer truck pivot pin in place of the main frame.
2. Fit 2-7, 2-8, 2-9, 2-10 driving wheels in each cut out of the main frame. They are a slide fit in each cut out with the axle boxes. Attach 2-6 horn stays under the main frame and secure with M2-4 crosshead screws through the spokes. Check for smooth up and down motions of the axles boxes in the main frame.
3. Fit the 2-1 coupling rods on place, using CM2-4 countersunk screws and 2-3 washers for the leading coupled drivers and using 2-2 connecting rod pins for the trailer drivers.

SECTION 3. CYLINDER BLOCK

PRE-ASSEMBLY NOTES:

1. This section partially assembles the cylinder. The assembly of the right-hand cylinder is explained in this, and the left-hand is to be done in the same manner as the left-hand.
2. Prior to starting assembly, it is necessary to lap the cylinder port face and slide valves to smooth the surfaces and remove all traces of the milling cutters which were used to machine the cylinders. Lapped surfaces provide a good steam tight seal; if not properly lapped, the valves will leak and the cylinders will not operate properly. The lapping procedure is shown in the bottom in figure 2. Cut a piece of #1000 grade emery paper, which is supplied with the kit, and tape it, rough side up, to a flat surface such as a piece of plate glass. Wet the paper and place a cylinder block on it. Using a slight downward pressure, slide the cylinder block back and forth for about 30 strokes. Examine the surface under 10x magnifying glass; the circular traces left by the milling cutter will be starting to disappear. Continue to lap the surface for an additional 70 strokes. Re-wet the emery paper and lap the lower surface of 1-18 slide valve for 300 strokes. After the lapping process is completed for both cylinder assemblies, thoroughly wash all traces of grit from the cylinders and slide valves and allow them to dry. They should be stored in a safe place while they await assembly.
3. When assembling the cylinder, it is necessary to coat the paper gaskets with packing compound so that they will be properly sealed. Apply a thin coat of the compound to both sides of each gasket as indicated by the arrows on the

illustration. Keep a wet cloth handy so that you can wipe your fingers clean and avoid spreading the compound.

4. Use Loctite 222 (or similar low strength thread retaining compound) on all threaded fasteners unless otherwise instructed.

ASSEMBLY SEQUENCE – CYLINDER BLOCK

1. Apply a thin coat of packing compound to both sides of a 3-7 gasket and set it in place on the front face of the 3-9 cylinder block using tweezers. Set the 3-8 front cylinder cover in place and install it using M2-6 crosshead screws. Tighten the screws evenly.
2. Carefully fit two PR-13 piston rings over the 3-11 piston. Slip the 3-13 rear cylinder cover, a PF3 O-ring and a GP-7 piston gland over the piston rod using a drop of light machine oil as a lubricant. Press the O-ring in the rear cylinder cover stuffing box and screw the gland nut in place. In screwing the gland nuts in place, **finger tight** is OK as the O-ring keeps steam tight. Put several drops of Loctite 222 on the threads of the piston rod; wrap a protective cloth around the rod and grip it with a pair of pliers. Firmly screw the 3-14 cross-head onto the piston rod. Be careful not to bend or damage the piston rod while gripping it with the pliers: Remove any burrs using a fine emery paper.
3. Apply a thin coat of packing compound to both sides of the 3-7 gasket and set it in place on the back face of the 3-9 cylinder using tweezers. Put a few drops of light machine oil on the piston and also in the cylinder bore; next slip the piston into the cylinder. This is most easily accomplished by compressing the piston rings into their grooves as they begin to slip into the bore
4. Check the 3-12 slide bars for straightness on a flat bench. The sliding surface of the slide bar should be flat and straight. If not straight, straighten and flatten it on a flat bench, using a wooden hammer or similar. Fit the 3-12 slide bars on both faces of the cross-head and slip the 3-12 slide bars into place on the 3-13 rear cylinder cover; remove the burrs as necessary. Secure the slide bars in place using M2-4 crosshead screws but do not tighten them firmly now.
5. Add a drop of light machine oil to the crosshead and check the piston for smooth operation; it should slide freely without binding. If it does not, loosen the screws and let the 3-13 rear cover align itself by sliding the piston rod for a few strokes. When the piston slides freely, evenly tighten the screws and re-check for smooth operation. Do the same on the other side of the cylinder/piston assembly.
6. Firmly screw the 3-6 cylinder studs into the cylinder.
7. Apply a thin coat of packing compound to both sides of a 3-5 square gasket and slip it onto place over the studs.
8. Fasten the 3-15 steam inlet pipes into each 3-4 valve chest, applying packing compound on the threaded parts. Fasten the 3-10 exhaust branch pipes into each cylinder block, applying packing compound.
9. Set the 3-4 valve chest on place over the studs.
10. Set the GP-5 valve spindle gland and PF-2 O-ring in place on the 3-18 valve spindle. Set the 3-3 slide valve in place and set the 3-2 slide valve block in place after first installing P1 set screws in it, as shown in the illustration, noting the correct position of the slide valve. Carefully remove any burrs. Slip the 3-18 valve

spindle in place through the 3-2 valve block and lightly tighten the set screws. The end of the spindle should just slightly protrude from the front surface of the valve block.

11. Fit the 3-16 cylinder back plate and the 3-17 valve spindle guide on place using a P4 set screw. Fasten the 3-19 valve spindle cross-head firmly on place of the valve spindle.
12. Put the 3-5 square gasket on place without applying packing compound, and temporarily fit the 3-1 cover on place and lightly fasten N2 nuts.
13. Do the same on the right-hand cylinder block assembly.

SECTION 4. MOUNTING THE CYLINDER BLOCKS IN THE MAIN FRAME

PRE-ASSEMBLY NOTES

- 1) The 4-1 & 4-3 side motion plates: The right and left-hand motion plates are quite similar. Distinguish the right from left by the shape of the bush. The flanged side is facing outside. Otherwise, the expansion links of the section 5 will not function correctly.
- 2) Take note that the stem for the oil delivery pipe is pointing leftward by about 45 degrees to direct the oil pipe from the 4-7 exhaust nozzle.

ASSEMBLY SEQUENCE

1. Fit the 4-4 front motion plate on the front face of the first cross tie and the 4-2 rear motion plate on the rear face of the second cross-tie of the main frame, using M2.6-4 crosshead screws. Fit the 4-1 & 4-3 inside motion plates in place loosening the screws as needed. Make sure that each side motion plate is fitted in place with the flanged bush outside and then tighten the screws.
2. Mount the cylinder assemblies on the main frame using HM4-6 hex bolts and SW1 spring washers, fitting the 3-12 slide bars in the 4-4 front motion plate. Do not tighten the HM4-6 hex bolts before fitting the steam and exhaust pipes.
3. Slip PS4-1.9 O-rings onto each end of the 4-6 steam branch pipe and 4-7 exhaust nozzle, and fit these pipes in the cylinders.
4. Now, adjusting the cylinder blocks in a level position and the slide bars in place of the front motion plate, tighten the cylinder blocks and secure the slide bars in the front motion plate using M2-4 crosshead screws.
5. Temporarily fit the 4-5 & 4-8 connecting rods over each main crank pin and in each cross-head.

SECTION 5. VALVE GEAR PARTS

PRE-ASSEMBLY NOTES :

1. Different sizes of shouldered pins are used in this section. Reference Fig.4 to use the

right pins to the right parts.

ASSEMBLY SEQUENCE

1. Expansion link and radius rod assembly: Refer to Fig. 3. Fit the 5-3 die block in the 5-4 radius rod, and temporarily secure the block in the radius rod using the 5-2 shouldered pin. As the shouldered pin will protrude from the inside face of the radius rod, file off the protruded end, using a fine file. Then, disassemble the radius rod and the die block assembly.

Put together the two expansion links. Using M1.4-8 crosshead screws, fit one 5-5 outer expansion link (H) with one 5-1 expansion link and 5-6 inner expansion link (T). Use 5-7 collars as spares between each link.

Fit the die block in the middle link slot of the 5-1 expansion link and fit the 5-4 radius rod over the middle slotted link. Secure the radius rod and the die block in the expansion link, using the 5-2 pin through one of the holes of the 5-5 expansion link (outside).

2. Putting the front end of the radius rod through the slot of the front motion plate, attach the expansion link assembly on place of the 4-1 & 4-3 side motion plates. Fit the 5-12 & 5-18 outside motion plates over the expansion link and attach to the front/rear motion plates using M2-4 crosshead screws. Fit 5-11 & 5-19 dummy motion plates over 5-12 & 5-18 motion plates using M1.4-3 crosshead screws.
3. Fit the front end of the 5-4 radius rod to the peg on the middle of the combination lever. Fit the 5-16 combination lever in the 3-19 valve spindle cross-head using the 5-17 pin into the upper hole of the combination lever.
4. Fit the 5-15 union link on place of the 3-14 cross-head using the 5-13 cross-head pin. Put together the combination lever and the union link using the 5-14 pin.
5. Insert the 5-22 reverse shaft through the holes of the inside motion plates and through the hole of the 5-23 reverse arm. The 5-23 reverse arm rests on the back of the 4-3 right-hand motion plate. Fit the 5-21 & 5-24 lifting arms on each end of the reverse-shaft. Taking both arms at the same angle, firmly secure them on place with P4 set screws. Temporarily tighten the 5-23 reverse arm on place of the shaft at 90 degrees from the 5-21 & 5-24 lifting arms, using P4 set screws. Fit the 5-20 lifting links on the inside of each lifting arm using the 5-14 pins. Fit the bottom ends of the lifting links in the fork end of each radius rod using the 5-2 pins.
6. Temporarily fit the 5-25 return cranks over each main crank pin using P4 set screws. The angle of the return cranks shall be set in the Valve Setting Section. Do not tighten the P4 set screws.
7. Fit the fork end of the 5-9 eccentric rods over the bottom end of each expansion link using 5-10 pins. Fit the rear ends of the eccentric rods on each return crank using 5-8 crank pins.
8. Finally check for smooth function of the valve gear parts.

SECTION 6. VALVE SETTING

Refer to illustration 5 on this section. The valve gear sequences the relative position of the slide valves with the pistons so that steam is admitted and exhausted at pre-determined intervals causing the pistons to reciprocate. When the steam expands in the cylinder and forces the piston to move, a portion of its thermal energy is converted into mechanical energy which can be used to perform work and is evidenced by a decrease in the temperature of the steam after it has been expanded. By changing the position of the radius rod in the expansion link from bottom to top, the direction of the driving wheel rotation can be changed. Steam consumption is also controlled by varying the position of the radius rod in the expansion link from neutral to a point between the bottom or top as this changes the valve cut-off position. When setting the valves it is first necessary to set the 5-25 crank angle and then adjust the relative positions of the 5-21 & 5-24 reverse arms. Finally the slide valves are adjusted so that they open or uncover the steam ports equally as the piston reciprocate.

SEQUENCE OF VALVE SETTING

(A) SETTING THE ANGLE OF RETURN CRANK (5-25).

1. Loosen the P4 set screws on the 5-23 reverse arm and the 5-25 cranks. Starting with the left-hand side, rotate the wheels until the crank pin is at rear dead center as shown in view (1). Adjust the crank angle so that the small end of the return crank comes just above the wheel axle. Make sure that the expansion link should be in a vertical position, irrespective of the position of the reverse arm.
2. Set the reverse arm in a vertical position and adjust the angle of the reverse arm so that the radius rod is resting in the middle of the expansion link. Then, tighten the P4 set screw for the reach rod arm. Do the same for the right-hand crank.

(B) SLIDE VALVE SETTING

The illustrations of this section show the left-hand view of the cylinder and wheels. First make the slide valve setting for the left-hand. Then, do the same on the right-hand.

1. See the view (1). Set the reach rod arm at forward running position (F) on the illustration. Rotate the wheels forward until the piston rests at rear dead center. Adjust the position of the 3-3 slide valve so as to close both the steam ports. Temporarily tighten P1 set screws.
2. Further rotate the wheels until the piston rests in the middle of cylinder, i.e., the wheels rotated by 90 degrees. See the View (2). Align the rear edge of the slide valve to the front edge of the rear steam port by loosening the P1 set screws and tighten the P1 set screws again.
3. Rotate the wheels further by 90 degrees. See the view (3). The piston is at the front dead center. Make sure that the slide valve is closing both the steam ports again.
4. Rotate the wheels further by 90 degrees. See the view (4). The piston comes back to the middle of the cylinder. Make sure that the front edge of the slide valve is aligning to the rear edge of the front steam port.
5. Reverse the reach rod arm to the backward rotating position, (R) on the view (5). Rotate the wheels clockwise and locate the piston at rear dead center. The slide valve should be closing both the steam ports.

6. When the piston comes in the middle of cylinder by further rotation of the wheels by 90 degrees, the rear edge of the slide valve will be aligning to the front edge of the rear steam port or opening the rear steam port. See the view (6).
7. Further rotate the wheels by 90 degrees clockwise. The piston comes at front dead center. See the view (7) The slide valve should be closing both the steam ports.
8. The view (8) shows the slide valve will be opening the front steam port with the piston located at the middle of cylinder by further rotation of the wheels clockwise.
9. It is not necessary to let the slide valve open each port fully, but it is important to make the slide valve open each port evenly.
10. It's possible that the slide valve motion may not realize accurate valve timings.

SECTION 7 CYLINDER FITTINGS & OILTANK

PRE-ASSEMBLY NOTES : As the air-test of the chassis assembly is not done yet, do not apply adhesive to the 3-5 square gaskets at this stage. After the air-test of engine assembly, apply packing compound to both sides of the steam chest gaskets.

ASSEMBLY SEQUENCE

1. Temporarily place the 3-5 square gaskets on each face of the steam chests without applying packing compound, and temporarily place the 3-1 covers on place using N2 nuts.
2. Fit the 7-1 front cylinder plate over each steam chest and fit each 7-2 valve chest cover in place on the steam chests using P4 set screws.
3. Put the 7-3 brake arms on both sides of the main frame using M2-2.5 crosshead screws. Attach the 7-4 brake shoes on the bottom of the brake arms and screw M1.7-4 crosshead screws into each 7-5 brake rod through the arm and the shoes. Put the 7-6 wires through the 7-5 brake rods.
4. Fasten the 7-10 oil tank cap in place on the 7-11 oil tank, using a PN-5-1.9 O-ring. Attach the 7-13 oil pipe to the oil tank by tightening a GN5-3 nut over the pipe and a 7-12 joint. Fasten the oil pipe to the 4-6 steam pipe with another nut and 7-12 joint.
5. Fit the 7-8 draw bar under the frame, using a 7-7 draw bar pin.
6. Attach 7-9 black tube to 7-14 wash out plug body. Screw in 7-15 wash out valve with a PN3.2-1 O-ring. Attach to the rear assembly with a M2.6-4 screw, allowing the top pipe of the of washout plug body to go through the hole in the cab floor. Place a GN8-6 nut and PN6-1 O-ring on this pipe.

AIR TEST OF THE CHASSIS

The air test of the chassis demonstrates two important facts:

1. The chassis has been correctly assembled.
2. There are no leaks in the sealed joints.

The following items are required:

- 1) A small air compressor or bicycle pump.
- 2) Test Rollers (available from Accucraft&Aster) or small wooden blocks to support the chassis during the test.
- 3) Rubber tubing and suitable attachment sundries.
- 4) Soapy water and a brush.

1. Put about 15 drops of light machine oil in the top opening of the cylinder assembly before installing the parts required for the air-test;
The hose from the air supply source is fitted to the steam pipe
Apply machine oil to all the moving parts such as valve gear parts, wheel bearings, etc.
2. Set the reverse arm in the full forward position. Block up the chassis so that the wheels clear the bench surface by about 10 to 20 mm or set the chassis on the test rollers
3. Turn on the air supply. If the wheels do not immediately begin to rotate, turn them by hand until the cylinders are able to drive them. Let the chassis run by itself for two minutes. While it is running, brush soapy water on the gasket edges of the steam chest and cylinder covers to detect any leaks. If leaks are found, tighten the appropriate fasteners and/or reseal.
4. Set the reverse in the full reverse position and turn on the air supply. Let the chassis run for two minutes. Performance in forward and reverse should be approximately equal. If it is not, the valve setting is incorrect; re-check your assembly.
5. If squeaking can be heard, some parts are binding. Identify where the binding is occurring and adjust accordingly to eliminate it. If it takes more than 3 kg/sq.cm pressure to drive the wheels, check the cross-heads to be sure that they are not binding after they have been running for two minutes.
6. Be sure to add more oil to the cylinder assembly at three minute intervals if you wish to continue to run the chassis.
7. If your assembly would not run by air pressure, go back to the valve setting section and check again the valve events.
8. When your assembly does run successfully by air pressure, unscrew the N2 nuts on the steam chest covers and remove the steam chests and the gaskets. Apply packing compound on both faces of the gaskets and put them back on the steam chest. Tighten the N2 nuts.

SECTION 8. AXLE PUMP

1. Put the SB4 balls in each valve box of the 8-10 pump body. Fit the 8-11 water pipe on the top (longer) valve box, applying packing compound on the top face, and screw the 8-12 banjo bolt into the longer valve box.
2. Fit a PS3-1.9 O-ring over the 8-15 by-pass valve needle, and screw the needle into the by-pass valve box. Fit the 8-14 ring over the end of the needle and fasten the 8-13 handle and a P4 set screw in place.
3. Fit the 8-6 valve holder over the by-pass valve body and fasten the LN5-7 lock nut to place temporarily.
4. Fit the 8-9 water delivery pipe on the suction valve box (short), applying packing compound on the face, and fasten the 8-8 banjo bolt in place of the suction valve box. Fit the end of the 8-9 suction pipe in place of the 8-5 water inlet holder using a

LN5-7 lock nut.

5. Temporarily fasten the LN8-10B lock nut over the 8-10 pump body.
6. Fit a PN6-1 O-ring over the groove of the 8-3 pump ram. Insert the pump ram into the pump body, applying machine oil on the O-ring and the ram. Fasten the GN8-6 gland nut over the ram and the pump body.
7. Fit the small end of the 8-2 axle pump arm in place of the pump ram, using a 8-4 shouldered pin.
8. Put the chassis assembly up side down and mount the axle pump assembly in place of the second cross-tie from the back, in the cross-tie located between the 3rd and 4th driving wheels, and tighten the LN8-10B lock nut to the cross-tie, keeping the pump assembly in a vertical position. Take note that the longer valve box of the pump body comes on top and the shorter valve box rests at the bottom in the main frame.
9. Fit the front end of the eccentric rod over the eccentric cam, which is factory-fitted on the second drivers' axle. Wrap the 8-15 teflon strip around the eccentric cam. Fit the 8-1 front half of the eccentric ring on place, using M2-6 crosshead screws.
10. Attach the 8-6 & 8-5 holders to the 1-21 cab floor base using M2-4 crosshead screws.

SECTION 9. BOILER ASSEMBLY

PRE-ASSEMBLY NOTES

1. The 9-1 boiler is made of copper tubing and plates with silver soldered joints. It must be handled with care so that it is not damaged during assembly. Examine it carefully for dents or other damage and if, any contact your dealer for replacement.
2. The arrows on the illustration show where packing compound must be applied. When sealing threads, apply enough compound so that the threads are filled. **Be careful that excess compound does not block steam or water passages.** Keep a wet cloth handy to wipe any excess compound. **Delay the air test of boiler assembly until the compound is cured for 24 hours.**
3. Prepare a wooden stick to align the upper and lower gauge glass holders in a straight line. Otherwise, the gauge glass will easily be broken when you'll force the glass to fit in each holder.

ASSEMBLY SEQUENCE

A) Check Valve, Blower/Regulator Valve Manifold (9-13) Assembly

1. Fasten a LN5-7 lock nut over the 9-11 check valve, applying packing compound to the threads of the inlet pipe. Insert into the boiler and screw to a proper length. Tighten the lock nut to the boiler back-head when the water inset pipe is pointing downward. Place a SB-3 ball into the top of 9-11 check valve and fasten the 9-12 cap, applying packing compound to the thread.
2. Slip PS-3-1.9 O-rings over each 9-14 valve needle, and screw the 9-14 valve needles

into each hole of the 9-13 valve manifold to full depth. Fit the 8-14 lever rings over each needle using P4 set screws and screw the 9-15 levers in each ring at a proper angle.

3. Fasten a LN6-8 lock nut over the steam inlet pipe to full depth, applying packing compound to the threads of the inlet pipe. Insert the 9-13 blower/regulator manifold assembly into the boiler and screw it to a proper depth. Tighten the LN6-8 lock nut to the boiler back-head when the steam inlet pipe is pointing upward.
4. Fit the 9-9 & 9-10 steam pipes over each 9-2 blower/regulator pipe. Insert the blower/regulator pipes into the boiler and fasten them in place, applying packing compound on the threads and to the joint faces of each steam pipe.
5. Fasten the 9-9 & 9-10 steam pipes into each protruded joint of the 9-13 manifold.

B) Gauge Glass Assembly

1. Fasten a LN6-8 lock nut over the 9-5 lower holder to full depth and apply packing compound to the threads. Screw the lower holder into the back-head to a proper depth temporarily.
2. Fasten a LN6-8 lock nut over the 9-8 upper holder to full depth and apply packing compound to the threads. Screw the upper holder into the 9-17 manifold to a proper depth temporarily. Apply packing compound on the flanged face of the boiler and to the threads of the 9-16 banjo bolt. Place the manifold on the boiler and fasten the banjo bolt into the boiler through the manifold.
3. See Fig. 5. Inserting a wooden stick through the upper and lower holders, adjust the depth of the lower and upper holders so that they align in a straight line, and fasten each lock nut to the back-head and to the manifold.
4. Fit two of the GN8-6 nuts over the 9-7 glass and fit PN6-1 o-rings over each end of the glass. Fit the glass in each holder and fasten the gland nuts over each holder. Fasten the 9-6 cap to the top of 9-8, applying packing compound to the thread.
5. Bend the 9-3 pressure gauge pipe in reference to the illustration and fasten one end of the pipe into the manifold using a GN5-3 nut and 7-12 joint. Fit the pressure gauge to the other end of pipe the same way.

C) Fire Box (9-4) Assembly

1. Cut the ceramic sheet to make two rectangular sheets of 28 mm x 85 mm and 28 mm x 31 mm. Make two each of the sheets. Adhere the sheet on each inside wall of the 9-4 firebox, using packing compound.
2. Fit the firebox assembly under the boiler using M2.6-4 crosshead screws.

SECTION 10. BOILER CASING LEFT-HAND

PRE-ASSEMBLY NOTES

1. This section assembles the left-hand of the casing while section 11 assembles the right-hand.

ASSEMBLY SEQUENCE

1. Temporarily screw the 10-2 handrail stanchions in place of the 10-1 casing to almost full depth. In Section 14, the rails are to be put through all the stanchions.
2. Fit the 10-13 dummy generator and 10-12 dummy manifold in place of the casing using M2-4 crosshead screws.
3. Fit the 10-18 delivery pipe in the 3 square holes on the boiler casing and spread the inserts inside of the casing.
4. Insert 10-17 air filter and 10-22 control lever and spread the inserts inside the casing.
5. Attach the 10-14 dummy stays to the casing using M1.4-3 crosshead screws.
6. Attach the 10-15 and 10-16 steps to the casing using M1.4-3 crosshead screws.
7. Slip the end of the 10-4 stays into each rectangular hole of the casing and secure them in place of the casing using M2-4 crosshead screws. Fit the 10-9 smaller stays and the 10-10 medium stay in the rear side of the casing the same way, using M2-4 crosshead screws.
8. Fit the 10-7 compressor stay in the larger square hole of the casing using two M2-4 crosshead screws.
9. Put the 10-3 running board on the stays using CM2-3 countersunk screws.
10. Place the 7-11 oil tank under the 10-3 front running board using the 10-6 collars and secure with CM2-8 countersunk screws. Place the 10-5 dummy air reservoir under the front running board using the collars and secure with CM2-8 countersunk screws the same way as the oil tank.
11. Fit the 10-8 compressor on the 10-7 holder using a M2-5 crosshead screw.
12. Attach the 10-21 dummy radiator under the front running board with M1.4-3 crosshead screws. Push the rear end of the dummy pipe line in place of the 10-8 dummy compressor.
13. Attach 10-20 hose holder to the casing with a M1.7-3 crosshead screw.
11. Cut the 2Cu wire to a proper length and bend properly in according with the contour of the casing, attaching the wire to the dummy 10-12 dummy manifold and to the 10-17 dummy filter. Attach another bent 2Cu wire from the filter to the 10-20 holder.
12. Put the 10-19 long wire through the 10-18 dummy pipe and push it into the 10-20 holder.
13. Attach the 10-11 rear running board to the rear stays using CM2-3 countersunk screws, keeping the 2Cu wire and the 10-19 wire in the gap between the running board and the casing.

SECTION 11. BOILER CASING RIGHT-HAND & INSERTION OF THE BOILER

ASSEMBLY SEQUENCE

A) RIGHT HAND FITTINGS

1. Temporarily screw the 10-2 handrail stanchions in place.
2. Fit the 10-18 dummy pipe on the square holes on the right-hand of the casing, the same way as the left-hand.
3. Insert 11-16 control lever and spread the inserts inside the casing.
4. Repeat steps 5-7 from section 10 but for the right side of the casing.
5. Mount the 11-9 dummy power reverse on place of the 11-6 holder using M2-4 crosshead screws. Fit the 11-7 reverser arm in place using the 11-8 reverser pin. Mount the power reverse assembly under the casing using M2-4 crosshead screws.
6. Attach the 11-18 holder to the casing with a M1.7-3 crosshead screw. Bend the 2Cu wire and attach from the 10-12 manifold to the holder.
7. Attach the 11-17 wire from the 10-18 pipe through to the 11-18 holder.
8. Fit the 11-5 rear and 11-10 front running boards on the stays using CM2-3 countersunk screws.
9. Fit the 10-5 dummy air reservoir under the 11-10 front running board using the 10-6 collars and CM2-8 countersunk screws.
10. Secure the 11-15 dummy radiator under the right-hand of the running board using M1.4-3 crosshead screws.

B) INSERTING THE INNER BARREL INTO THE CASING

1. Carefully insert the inner barrel assembly into the casing.
2. Screw the 11-2 filler plug into the boiler using a PN5-1.9 o-ring in between. Fit the 11-14 dummy whistle to the 11-3 steam dome using a M1.7-8 crosshead screw. See Fig 6. Fit the 11-3 dome to the casing using a CM2.6-10 countersunk screw.
3. Screw the 11-4 safety valves into the boiler with PS4-1.9 o-rings.
4. Cut and bend the provided black brass wire/pipe and insert into both sides of the 11-1 sand dome. Then, fit the sand box in place using a CM2.6-20 countersunk screw through into the boiler. Take care to keep the boiler centered inside the casing.
5. Cut the ceramic sheet to (3) segments 10mm x 207 mm, adhere it on the inside wall of the front edge of the casing, using packing compound, to seal the boiler and the casing for air-tightness. It is important to seal this part for good drafting.
6. Apply packing compound on the threads of the blower and regulator pipes and on the back of the 11-11 lock nuts. Fasten the lock nuts over each blower and regulator pipe ends.
7. Fit the 11-12 blower nozzle over the blower pipe end and tighten with the 11-11 lock nut. Fit the 11-13 steam pipe over the regulator pipe end and tighten with 11-11 lock nut.

SECTION 12. SMOKE-BOX

ASSEMBLY SEQUENCE

1. Cut the ceramic sheet to (2) segments of 70 mm x 202 mm. Adhere it on the inside wall of the 12-3 smoke-box using packing compound. Cut the chimney hole on the ceramic sheet.
2. Place the 12-2 chimney base over the hole and put the 12-1 chimney through the base and the smoke-box. Fasten the 12-5 inner chimney over the chimney with a 12-4 square washer in between.
3. Fit the 12-8 dummy steam pipes on both sides of the smoke box using M2-10 crosshead screws.
4. Fit the 12-7 running board stays in place of the smoke box using M2-4 crosshead screws.
5. Fit the 12-6 ladders on the front end of each 12-9 & 12-11 step using M2-2.5 crosshead screws from the underside. Mount the running board assemblies to the stays using CM2-3 countersunk screws.
6. Depending on the livery of your model (Fig 7), fit the 12-10 or the 12-13 builder's plates in place on either side of the smoke box and spread the inserts inside. Temporarily screw the 10-2 handrail stanchions into the casing.

SECTION 13. MOUNTING BOILER IN THE FRAME

ASSEMBLY SEQUENCE

1. Put the smoke-box assembly into the boiler casing and tightly secure them using M2-2.5 crosshead screws.
2. Mount the boiler/smoke-box assembly on the main frame, aligning the 9-4 fire box flange on the holes of the 1-22 cabin saddle, and slipping the smoke-box between the frame. Line up the water gauge with the top of the blow down assembly from section 7. Tighten the 7-GN8-6 gland nut with o-ring to the water gauge. Fasten M2-4 crosshead screw to secure the rear and M2.6-4 crosshead screws to secure the smoke box in the frame.
3. Fit the 13-2 rectangular washer over the 4-7 exhaust and 4-6 steam pipes of the cylinders and fasten the LN6-8 lock nut over the 4-6 steam pipe. Fasten the steam pipe from the regulator pipe to the steam pipe from the cylinder.
4. Connect the end of 13-1 water pipe to the 9-11 boiler check valve and to the top end of the 8-11 bypass valve. Temporarily tighten the nuts until positions are set. Tighten the LN5-7 lock nut holding the bypass valve to the 8-6 holder. Tighten the nuts on the water pipe to secure.
5. Fit the 13-3 and 13-4 smoke box supports to the front deck with M1.4-3 crosshead screws and insert the tops into the holes in the smoke box.

SECTION 14. REVERSER & SMOKE BOX DOOR

ASSEMBLY SEQUENCE

A) REVERSER ASSEMBLY

1. See Fig. 9. Using a 14-5 shouldered pin, attach the 14-8 reverse lever to the back of the 14-7 reverse frame through to the 14-6 reverse lever support. From the other side, screw the 14-3 shouldered pin through the 14-6 support to the 14-8 lever.
2. Hook the 14-4 reverse lever spring on the lever and over the stem of the frame.
3. Fit the 14-1 rear reach rod on the frame using a 14-5 pin. Mount the reverse frame assembly on place of the cab saddle and fasten with M2-4 crosshead screws.
4. Remove the rear right side M2-4 crosshead screw from the cab floor and use to attach the 14-21 stopper.
5. Fit the front end of the rear rod on the 11-7 arm using the 5-14 shouldered pin.
6. Fit the 12-2 front reach rod on the 11-7 arm and on the 4-19 reverse arm using the 5-14 shouldered pins.
7. Fit the 14-9 cylinder laggings on place of both cylinders using 14-24 dummy drain valves. Cut and insert a black wire through the drain valves.

B) SMOKE-BOX DOOR

1. Fit the 14-13 bell in the 14-12 bell hanger using a M1.7-3 crosshead screw. Insert the bell hanger into the 14-14 bell holder. Secure the bell holder on the 14-16 smoke-box door using M2-5 crosshead screws.
2. Attach the 14-15 marker lights to the door with M1.4-3 crosshead screws. Attach the 14-17 steps to the door with M1.7-3 crosshead screws.
3. Using double sided tape, adhere the 14-22 larger number plate to the front of the 14-10 head light stand. The number plate will overhang from the edges of the stand. Adhere the 14-23 number plates to both sides of the 14-11 head light.
4. Put the 14-11 head light on the 14-10 stand with a M2-4 crosshead screw. Mount the head light stand to the smoke box using a M2-5 screw from the back.
5. Cut a circle of ceramic sheet and apply to back of smoke box door with packing compound.
6. Fit the 14-6 smoke box door assembly in the smoke box and secure with M2-4 crosshead screws.
7. Now put the 1mm wire handrails through all the stanchions on both sides of the boiler and smoke-box.
8. Insert the 14-18 coupler handle through the 14-19 & 14-20 handle holders and attach to the front buffer beam with M2-4 crosshead screws.

SECTION 15. BURNER, PILOT & TRAILER TRUCKS

PRE-ASSEMBLY NOTES

This model uses fiber glass strands as the alcohol burner wicks. Use about 35 to 40 strands of the glass fiber in each wick tube. This number of the glass fibre strands may be a little tighter in each tube, which is better, since the fiber glass absorbs alcohol better than the asbestos wicks. (In case of the asbestos wicks they used to be packed loose in each tube for better absorption, while the fibre glass wicks absorb alcohol better than the asbestos wicks and thus they are to be packed in each tube a little tighter for reasonable and well balanced absorption of alcohol.

For ease of handling the wicks, each strand contains a very fine wire, i.e., around the wire the fiber glass is wound. Care must be taken so that you'll not hurt your finger by these wires when you'll put the strands in each tube. The wicks can be cut easier than the asbestos wicks by scissors.

The best height of the fiber glass is about 12 mm above the tube ends for optimum combustion of alcohol according to our test result.

ASSEMBLY SEQUENCE

1. Burner Assembly: Put about 35 to 40 strands of the 15-3 fiber glass wicks in each 15-4 burner tube to almost full depth, and cut the wicks at about 12 mm from the edge of the tubes, as illustrated. Fit the front end of the burner into the hole of the main frame. Fit the 15-2 burner holders over the burner rear and hold together with a M2-4 crosshead screw and N-M2 nut. Secure the holder under the frame using M2-4 crosshead screws. Fit the 15-1 rear frame on the back of the frame, putting the burner through the hole, and secure with M2-4 crosshead screws.
2. Pilot Truck Assembly: Fit the 15-8 pilot truck wheels in the 15-7 pilot truck frame and push the bearings into each cut-out. Fasten E5 clips in each groove of the axle. Fit the 15-9 spring and a W5 washer over the guide pin of the main frame. Fit the oval hole of the truck frame over the guide pin and fasten an E4 clip in the end groove of the guide pin. Fit the rear hole over the center pin of the frame and clip with an E4 clip.
3. Trailing Truck Frame Assembly. See Fig. 12. Loosely fasten the 15-12 & 15-10 side frames onto the 15-11 triangle frame using M2-4 crosshead screws. Fit the 15-14 wheels in the frames. Loosely fasten the 15-15 truck guide to the rear of the side frames with M2-4 crosshead screws. Attach the 15-13 dummy truck springs to the side frames with M2-5 crosshead screws. Tighten all the screws on the frame. Fit the trailing truck assembly over the center pin of the frame and clip with an E4 clip. Put the 15-6 guide pins through the long hole of the end beam, fitting W3 washers and 15-5 springs over the guide pins, and fasten the guide pins into the frame.

SECTION 16. CAB

ASSEMBLY SEQUENCE

1. Attach the 16-8 dummy air intake to the 16-7 roof with CM2-4 countersunk screws going into the 16-9 stoppers.
2. Insert 16-2 gutters to the top holes of the 16-1 cab and spread the inserts inside. Insert the 16-4 window shields to the sides of the cab and spread the inserts inside. Attach 16-3 hand rails to the cab with M1.4-3 crosshead screws. Attach the 16-5 arm rest to the cab with M1.4-3 crosshead screws.
3. Fitting the 16-6 rear cover under the cab foot plate, mount the cab assembly through the foot-plate aligning the holes and fasten the M2-4 crosshead screws at the front and M2-5 crosshead screws in the rear.

SECTION 17. TENDER TRUCKS

ASSEMBLY SEQUENCE

1. There is no necessary order of putting these parts in place. Attach the 17-2 cross-tie and the 17-6 leaf spring in the 17-3 truck frame, and fitting the 17-5 springs between the tie and the leaf, fasten the 17-4 pins all the way through the frame, cross-tie, spring, leaf and the frame.
2. Fit the 17-1 wheels in the frame and fit another frame to the assembly. Tighten the 17-4 pins.

SECTION 18. TENDER ASSEMBLY PART 1

ASSEMBLY SEQUENCE

1. Place the lip of 18-1 front step inside the 18-3 tender body and secure with M2-3 crosshead screws.
2. Attach the 18-4 rear buffer beam to the 18-2 tender frame with a M2.6-4 crosshead screw from the bottom. Align the outer holes.
3. Attach the tender body to the frame with M2.6-4 screws. Secure the front step to the frame with M1.7-3 crosshead screws.

SECTION 19. TENDER ASSEMBLY PART 2

PRE-ASSEMBLY NOTE: Be sure to apply packing compound to the threaded parts indicated by arrows for water tightness.

ASSEMBLY SEQUENCE

1. See Fig. 13 for hand pump assembly. Apply a thin coat of packing compound to the threads of the 19-1 & 19-2 valve caps, being careful not to get any compound on the

- end of the caps which screw into each valve box. Place the SB4 balls in each valve box and fasten the caps in place to full depth.
2. Fit the 19-3 links to each side of the 19-4 pump body and the 19-7 pump lever, using the 19-8 link pins and N-M2.6BS nuts.
 3. Using a drop of oil as a lubricant, slip the PN7-1.9 O-ring over the 19-5 pump ram. Slip the ram into the pump body, using a drop of oil as a lubricant.
 4. Fit the 19-7 pump lever in place of the ram using a 19-6 pin and N-M2.6BS nuts.
 5. Put the 19-16 water tank in place of the tender. Install the pump assembly in place of the water tank, aligning the holes of the tank and the tender frame. Secure the pump in place using M2.6-6 BS crosshead screws. Do not forget to apply packing compound to the threads for water tightness.
 6. Fit the 19-17 water pipes under the front row of the holes of the water tank in the tender, and fasten the 19-9 pipe unions into the water pipes, applying packing compound to the bottom half of the threads. The water pipes should run between the narrow space between the tender bottom plate and the 20-8 truck holders.
 7. Fasten the 19-12 water pipe to the hand pump and to the left-hand water pipe union. Fasten the 19-11 returning water pipe to the right-hand pipe union.
 8. Fit the 7-9 black rubber tubes over each end of the water pipes and tighten the left hand end with a HC-5 hose clip. At the front end of the left-hand rubber tube, fit another HC-5 hose clip and the 19-20 pipe union and 19-19 union nut.
 9. Install the 19-16 Kingston body to the water tank with M2-4 BS crosshead screws. Screw the 19-14 pin into the 19-13 Kingston valve. Slip the PS4-1.9 o-ring onto the valve and insert into the 19-16 body.

SECTION 20. TENDER ASSEMBLY PART 3

ASSEMBLY SEQUENCE

1. Fit the 20-5 sump under the tender frame applying packing compound to the threads of the M2-2.5 screws. Fit the 20-7 silicone tube over the sump nozzle.
2. For each truck, put the 20-9 truck pivot pin through the 20-8 truck beam and fasten with a SW4 spring washer and N-M4 nut, keeping the shoulder of the pin pointed down. Attach the truck to the pivot pin and secure with a W4 washer and a N-M4 nut. Fit the truck assemblies under the tender frame using M2-4 crosshead screws.
3. Install the 20-10 water tank cover using M2-2.5 crosshead screws.
4. Alcohol tank assembly: Install the 20-1 scoop hump to the 20-4 alcohol tank with M1.7-3 crosshead screws. Slip the PN7-1.9 o-ring onto the 20-2 tank cap and insert into the tank. Slip the PS3-1.9 o-ring onto the 20-3 fuel valve and screw into the tank. Slide the alcohol tank into the tender.

SECTION 21. TENDER FITTINGS

ASSEMBLY SEQUENCE

1. Put the 21-3 draw bar pin through the hole of the tender frame and slipping the 21-2 spring and a W4 washer over the pin, clip the E3 in the groove of the draw bar pin. Check for smooth up and down motion of the draw bar pin.
2. Fit the 21-1 front steps under the frame using M2-4 crosshead screws. Fit the 21-8 rear steps under the frame using M2-4 crosshead screws.
3. Install the 21-7 hand rails with M1.4-3 crosshead screws.
4. Fit the 21-4 ladder on the back of the tender using M2-4 crosshead screws.
5. Fit the 1-23 knuckle coupler in place using the 21-6 rear coupler pin.
6. Fit the 14-19 coupler release rod through the 14-20 & 14-19 holders and attach to the rear beam with M2-4 crosshead screws.

PART II. OPERATING INSTRUCTIONS

Owners who have purchased factory built models; be sure to read carefully all of these operating instructions.

1. FUNCTIONAL DESCRIPTION

It is important for the driver to understand the function of each basic component so that optimum performance can be obtained consistent with safety. Brief descriptions are as follows:

SAFETY VALVES: They are located on top of the boiler and prevent the boiler pressure from exceeding working pressure, 60 psi. It consists of a spring loaded ball set in a housing and is installed in a threaded bushing located at the top of the boiler. When boiler pressure reaches the safety valve's "pop" pressure, the valve spindle lifts and steam is released until a predetermined pressure drop is achieved and the spindle drops. The safety valves should be frequently checked, to assure it is not stuck shut by gently lifting up the valve spindle with tweezers.

REGULATOR: This is a needle valve with a lever handle fitted on the right-hand of the valve manifold block. It controls the steam flow into the cylinders and governs the locomotive's speed and power. As the locomotive rolls and pitches along the track, water droplets are tossed about inside the boiler and may be picked up and held in mechanical suspension by the steam. In this stage the steam is known as wet steam and can do damage to the running gear if it should cause the cylinders to "lock". To prevent this from occurring, the regulator's steam inlet is positioned in the boiler so that it picks up dry steam.

BLOWER: The USRA Mikado requires a forced draft to maintain a proper fire. The exhaust blast usually creates sufficient draft to do this while moving, but, when stopped, the locomotive's blower system must be activated. When the locomotive is being steamed up, an external suction fan set in the chimney must be used so that the fire can be lit and steam raised. When the pressure in the boiler reaches to 15-20 psi, the suction fan can be removed and the locomotive's blower system can be used to maintain the draft. It is located on the left-hand of the valve manifold on the boiler back-head.

CHECK VALVE: The check valve provides a means of supplying water to the boiler while the locomotive is under steam. It consists of a valve body with a seat upon which rests a stainless steel ball. A filler line fitting is attached to the valve body. When the boiler is pressurized, the ball is forced tightly on its seat and steam cannot leak past it. If a water pump is connected to the filler line fitting, water can be pumped into the boiler, since the water, which is incompressible and is being pumped in at a pressure

higher than that of the boiler, forces the ball off its seat. The check valve is located under the boiler connected to the valve box of the axle pump.

BY-PASS VALVE: It is a needle valve located on the right-hand bottom in the cab. It is connected to the check valve and switches the flow of water between the boiler and the axle pump. With this needle valve closed, water is fed into the boiler, and with this valve opened water circulates between the axle pump and the tender water tank. You'll learn by experience the proper setting which will maintain the volume of water pumped into the boiler consistent with steam consumption.

BLOW-DOWN VALVE: This valve located on the left-hand bottom of the cab connected to the water gauge. When opened quickly it releases water from the gauge and can be used to recheck the actual water level in the boiler. After a run, while the boiler is still pressurized, it can be used to remove remaining water from the boiler. Be careful of hot steam coming from the valve, which can cause injuries.

CYLINDERS: The cylinders are located on both sides of the main frame. Their function is to convert the thermal energy contained in the steam into mechanical energy which can be used to perform useful work. The cylinders are phased at 90 degrees so that the locomotive will start with the wheels in any position.

BOILER: A smoke-tube type is used on this model and consists of a copper tube with end plates and five fire tubes. Thermal energy from alcohol fuel converts the boiler's water supply into steam. A portion of the thermal energy contained in the steam is next converted into mechanical energy when the steam is expanded in the cylinders.

BURNER: The alcohol burner is fitted at the bottom of the fire-box. The condition of the wicks affects the firing force. When you'll replace the wicks with new ones, be sure to follow the instructions of Section 15. On this model, **fiber glass strands** are used as the burner wicks.

WATER GAUGE: The function of the water gauge is to show the amount of water in the boiler so that the driver can maintain the proper level. Small water gauges tend to be inaccurate so it is necessary to roll the locomotive back and forth to make sure that the reading is correct. Never let the water level fall to a point that it cannot be seen in the glass.

PRESSURE GAUGE: The function of the pressure gauge is to show the steam pressure in the boiler. A dial type gauge is provided which connects to the boiler by means of a "U" tube and fittings.

LUBRICATOR: A Roscoe displacement lubricator is used which consists of an oil tank and a tube that connects to the valve chest and feeds both cylinders. It is located under the left-hand running board. When the steam enters the boiler tank, it

condenses into water and sinks to the bottom of the tank. This is because a unit amount of water weighs more than an identical unit amount of oil. The oil is “displaced”, i. e., forced out of the tank, through the same line by which the steam entered, and is picked up by the steam flow where it enters the cylinders and lubricate them. This process is repeated until the supply of oil is exhausted.

2. PREPARATIONS FOR OPERATION

OIL: Steam cylinder oil, which can be obtained from most live steam clubs, should be used in the lubricator. Straight mineral oil can be used if steam cylinder oil is not available. Do not use automobile oil since it may contain abrasives which will damage the cylinders; it may also leave deposits in the steam passages and lines which will eventually cause them to become clogged. Light machine oil should be used to lubricate all bearings, valve motion, axles, etc.

WATER: Distilled water, manufactured by the steam process, is recommended. **DO NOT USE DE-IONISED WATER AS IT MAY ATTACK FITTINGS AND SOLDERED JOINTS.** If distilled water is not available, city tap water can be used but may result in poor performance. Tap water usually contains minerals which will be deposited inside the boiler and in steam passages. If tap water must be used, bring it to a vigorous boil, in a tea kettle or similar vessel, and hold it at boiling temperature for at least one minute. Good water quality is extremely important for successful operation and longer life of the boiler and fittings.

FUEL: Use only anhydrous ethyl or methyl alcohol which can be obtained at a scientific supply house. **DO NOT USE RUBBING ALCOHOL SINCE IT CONTAINS A LARGE PERCENTAGE OF WATER AND IS TOTALLY UNSUITABLE FOR USE AS A FUEL.**

Be sure to recap the supply can of alcohol as soon as possible since it will absorb water from the atmosphere and become contaminated. It is a good idea to add a few drops of red cake coloring to the alcohol so that it will not be accidentally mistaken for water and used to fill the boiler.

SAFETY PRECAUTIONS: THINK SAFETY FIRST, LAST AND ALL OF THE TIME WHEN OPERATING THIS LOCOMOTIVE. HAVE ALL FIRE FIGHTING EQUIPMENT AVAILABLE PRIOR TO STEAMING UP; IT IS USUALLY TOO LATE TO SEARCH FOR IT AFTER A FIRE HAS STARTED. TO PREVENT ACCIDENTS WHICH COULD CAUSE SEVERE INJURIES, OBSERVE THE FOLLOWING PRECAUTIONS;

① ADD A FEW DROPS OF RED COLORING TO THE ALCOHOL SUPPLY SO THAT

IT WILL NOT BE ACCIDENTALLY MISTAKEN FOR WATER AND USED TO FILL THE BOILER. THE ALCOHOL SUPPLY SHOULD BE LABELED "POISON" AND BE STORED IN A COOL LOCATION AWAY FROM THE IMMEDIATE VICINITY OF THE TRACK AND OUT OF THE REACH OF MINOR CHILDREN.

- ② If alcohol is spilled when filling the tender fuel tank, lift the tender from the track and wipe up the spill.
- ③ Operation should always be conducted OUT OF DOORS AND NEVER INDOORS.
- ④ Have a bucket of water, wet towels and/or a spray bottle of water handy at all times to extinguish fires which may result if the locomotive derails. It is very difficult to see and alcohol fire in direct sunlight however it is a good idea to assume that one has been started if the locomotive derails. Smother any fire with the set towels or spray water on it until it goes out.
- ⑤ The safety valves on this model are pre-set at our factory to pop at 60 psi. Do not attempt to adjust it or repair it if it is damaged. New safety valves are always available from ASTER.
- ⑥ Your track should be as flat as possible on straight runs and slightly banked to the inside on all curves. This will prevent derailments and lower the probability of accidents.
- ⑦ On extremely hot days, the alcohol tank may overheat when the tender is left exposed for long hours to direct sunlight causing the fuel to vaporize and possibly start fires along the track.
- ⑧ Wear gloves when operating and handling the locomotive. The valve handles are hot enough to burn your fingers while raising steam and running the locomotive.

TOOLS: Have small screw drivers, nut drivers, wrenches and pliers available to tighten any looser fasteners and make small repairs which may be necessary.

SPECIAL EQUIPMENT: The following items will be necessary to service and steam the locomotive:

1. A SUCTION FAN for firing up the boiler. It is usually battery operated and sits at the top of the chimney.
2. AN OIL INJECTOR which is used to fill the lubricator.
3. GLOVES to protect the driver's hands.
4. A FUNNEL to pour alcohol in the fuel tank.

3. OPERATING PROCEDURES

- ① Lubricate all moving parts such as sliding surfaces, rods and links, using light machine oil. Silicone anti-seize lubricant can also be added.
- ② Fill the lubricator, which is located under the left-hand running board, with steam

cylinder oil using an oil injector. Replace the filler cap and tighten it until the O ring starts to distort.

- ③ Inspect the water gauge glass and replace it if it is cracked. Lift the safety valve spindle with tweezers to assure that it is not stuck shut. Use distilled water in the boiler. Fill the tender water tank with distilled water.
- ④ Pump water into the boiler using an extension handle over the pump lever in the water tank. Open the throttle valve before starting to pump. When the water level in the gauge glass shows that the boiler is 60% full, stop pumping water and roll the locomotive back and forth to confirm gauge glass reading. After gauge glass reading is confirmed and there are no air bubbles showing in the gauge glass, continue to fill the boiler with water until the gauge glass is 60% full. Close the throttle valve (left-hand on the boiler back head) and refill the water tank with distilled water.

Note: When the boiler is pressurized, the water level in the glass may go up to 80% level.

- ⑤ Close the fuel tank needle valve and remove the filler cap. Fill the fuel tank with 250cc of methyl alcohol using a clean funnel. Replace the filler cap and tighten it until the O ring starts to distort. Add a drop of oil around the O ring to assure an air tight seal. Open the needle valve one turn and let the sump fill. Check for fuel leaks. If any are found, they must be corrected prior to lighting the fire. Most small leaks occur because the filler cap is not properly tightened.
- ⑥ Set the suction fan in place on the chimney and start it. Ignite the burner under the firebox. Check the condition of the fire using a mirror under the burner. The flame should burn predominantly blue. An alcohol fire cannot easily be seen in bright light so it is best to light and observe the fire in subdued light. If the fire burns predominantly yellow, the fuel is contaminated and should be replaced.
- ⑦ In a few minutes, approximately 3 in summer and 5 in winter, the pressure gauge will show a reading of 15 psi. At this point, lift up the blower lever on the left-hand of the block on the boiler back-head, and remove the suction fan from the chimney. The pressure should continue to rise and when it reaches about 60 or 65 psi, the safety valve will “pop”.
- ⑧ Set the reverser at the forward full gear position.
- ⑨ Push down the throttle lever slightly and push the locomotive forward. The driver should be wearing gloves at this stage. **BE CAREFUL TO KEEP YOUR HANDS AND FACE CLEAR OF THE EXHAUST FROM THE CHIMNEY TO AVOID BEING BURNED.** When the cylinders have been cleared, she will

run smoothly and can be connected to her train.

- ⑩ Adjust the reverser and regulator settings to suit the track and load being hauled. The blower valve should be closed when the locomotive is running unless a very heavy load is being hauled at a low speed. In this situation, it may be necessary to open the blower valve to maintain sufficient draft. Experience will show how to obtain optimum performance.
- ⑪ The locomotive will run non-stop for about 30 to 40 minutes before it needs to be serviced if the reverser lever and throttle are both set for optimum. If the engine stops, check the fire. If it is out, the fuel supply has been exhausted. Close the blower valve and fuel tank needle valve, let the engine cool for a few minutes and add fuel, oil and water as required. IF THE FIRE IS STILL BURNING, THE WATER SUPPLY HAS BEEN EXHAUSTED. CLOSE THE FUEL NEEDLE VALVE TO EXTINGUISH THE FIRE. WHEN THE DRAFT CEASES, THE FIRE BECOMES OXYGEN STARVED AND DIES OUT ALTHOUGH IT WILL HUNT FOR OXYGEN AND POP OUT FROM UNDER THE BOTTOM OF THE FIREBOX FOR A BRIEF PERIOD. HAVE A SPRAY BOTTLE OF WATER OR A WET TOWEL AT HAND TO EXTINGUISH ANY FIRES WHICH MAY RESULT. LET THE BOILER COOL FOR 20 MINUTES BEFORE ADDING WATER. NEVER ADD WATER TO AN OVERHEATED BOILER AS THIS COULD CAUSE SEVERE DAMAGE. After the engine has cooled, add fuel, oil and water as required.
- ⑫ As the locomotive is operated, it becomes “broken-in” and its performance will improve. This usually takes no more than a few hours of running.

4. TROUBLE SHOOTING

When the ASTER USRA Mikado is in good operating condition, properly lubricated, provided with distilled water for the boiler, a good grade of fuel for the burner and steam cylinder oil.

- ① It can pull its maximum load of 5~8 heavy coaches at a constant speed for about minimum 30 minutes.
- ② It will operate equally in either forward or reverse.

Typical problems and remedies are as follows:

STEAM GENERATION PROBLEMS

If it takes more than seven minutes to generate “pop off” steam pressure, or if the boiler pressure quickly drops during a run of a few meters and the boiler was properly filled with distilled water, proceed as follows:

- ① Check the fuel supply for contamination. Uncontaminated fuel will burn

predominantly blue. Contaminated fuel burns predominantly yellow and should be replaced.

- ② If the problem persists, check to see that there is proper draft as follows;
 - a) Does the suction fan provide sufficient draft? A small fan may not be powerful enough to do the job. Use an ASTER fan and fresh batteries.
 - b) Are the battery leads connected to the suction fan correctly so that the fan is pulling air through the fire-box and is not blowing air into the smoke-box?
- ③ If the suction fan raises pressure but the locomotive's blower system is not able to maintain it, check the following;
 - a) Is the blower pipe nozzle blocked?
 - b) Is the blower pipe nozzle positioned so that the nozzle discharges directly up the chimney?
 - c) Is the smoke-box door properly sealed?

REMEMBER, A FORCED DRAFT BOILER ALWAYS REQUIRES A DRAFT; A SUCTION FAN IS NECESSARY WHEN FIRST RAISING STEAM OTHERWISE, THE FIRE WILL NOT BE INTENSIFIED. ONCE STEAM IS RAISED AND THE SUCTION FAN REMOVED, THE LOCOMOTIVE'S BLOWER MUST BE CRACKED OPEN TO MAINTAIN DRAFT WHEN THE LOCOMOTIVE IS STOPPED. DURING THE RUN, THE EXHAUST BLAST NORMALLY PROVIDES ENOUGH DRAFT TO KEEP THE FIRE BURNING BRIGHTLY HOWEVER IF THE SPEED IS LOW AND THE LOAD HEAVY, IT MAY BE NECESSARY TO CRACK THE BLOWER VALVE OPEN SO AS TO PROVIDE ADEQUATE DRAFT WHILE RUNNING.

STEAM LEAKAGE

- ① If the locomotive will not move and a continuous steam flow comes from the chimney after the regulator is opened, the slide valves may not be in contact with the valve face. Gently tap the slide valve cover plate and open the regulator. If the problem persists, disassemble the locomotive to the point where you can remove the cover plate and inspect the valves. Be sure the valve block and the slide valve surfaces were properly lapped per section 1 of the assembly instructions. Remove any foreign matter, including surplus sealing compound, and check the valves for proper timing. If the slide valves do not seat properly, it may be necessary to file the valve block openings slightly so that the valve block is a slip fit in the valve and the valve rests squarely on the distribution block face. Refer to the section 1 assembly instructions for further details.
- ② Check the steam lines from the regulator to the cylinders to be sure there are no loose fittings which are causing the leak. Worn out O-rings in the stuffing boxers of

pistons and valve spindles cause steam leakage and steam leaks can sometimes be seen coming from the gland nuts on the slide valves. Tighten the gland nuts and/or replace the O-rings per the assembly instructions. It is normal for these glands to have slight steam leak which cannot be completely eliminated. Only if the leak is excessive, tighten the gland nut per the instructions.

- ③ The gaskets used to seal the valve covers and cylinder heads are made of paper and can easily be duplicated by cutting them a long fiber type paper. The packing compound is silicone sealant which is available in most hardware stores. Always be careful not to use an excessive amount of sealant since it can plug steam and water passages.

UN-EVEN PERFORMANCE

- ① If your locomotive runs better in forward than in reverse, or vice versa, check again your valve settings referring to the instructions and illustration of Section 6.
- ② If the rotation of the wheels is stiff at front or rear dead centre, the pistons are not secured tightly to the crosshead, which may be causing the pistons to hit on either the front or rear cylinder cover.
- ③ The reverser is difficult to drive back and forth when the locomotive is stopped. If you force the reverser, an extra load may be imposed on some of the valve gear parts which may break or bend them. If the reverser is too hard to drive, rotate the wheels a bit until it can be more easily driven.
- ④ Metal particles or foreign material in the wheel bearings will cause the wheels to seize. Clean out any foreign material and lubricate the wheel bearings using a light machine oil.

CHECK VALVES

Slight leakage from the check valve filler line fitting is normal while the boiler is developing its working pressure. If the leakage continues after the boiler is developing its working pressure. If the leakage continues after the safety valve has popped causing hot water to back up in the tender water tank, there may be a bit of debris on the valve ball seat which can usually be removed by pumping water into the boiler. If the ball remains stuck, remove the check valve plug and pry loose the ball using a small screw-driver. Clean the inside of the valve body, paying special attention to the seat, and replace the ball with a new one. Add a small amount of packing compound to the threads of the check valve plug before installing it. Be careful not to let any compound get inside the valve body.

FUEL LEAKS

If the burner leaks from any of its joints, return it to your dealer and obtain a

replacement.

5. MAINTENANCE

It is very important to keep your locomotive in good operating condition. Maintenance can be as enjoyable as operations and a well maintained locomotive will reward you with many years of faithful service. Key maintenance points are as follows;

- ① After the day's run is completed, empty the boiler, fuel tank and lubricator and dispose of their contents in an environmentally safe manner. Refill the lubricator with steam cylinder oil.
- ② Wipe the locomotive clean using a soft cloth so that it displays a clean "oily" gloss. Do not use cleaning solutions since they may damage the finish.
- ③ Check for loose or missing fasteners and tighten/replace as necessary.
- ④ Check the condition of the O-rings and replace them if necessary. All filler caps should be installed but not tightened.
- ⑤ If any leaks were noted during operation, eliminate them by tightening the appropriate fittings or re-sealing with the packing compound.
- ⑥ Lubricate all moving parts with light machine oil.
- ⑦ Leave the regulator and blower valve slightly open when storing the locomotive or they may stick shut.
- ⑧ Rotate the wheels of the locomotive a few turns every two weeks to assure that the pistons do not become stuck. When steam cylinder oil is cooled, it becomes more viscous and the slide valves sometimes tend to become stuck in an "off" position since they are located under the distribution block on this model.

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