THE PENNSYLVANIA RAILROAD

LOCOMOTIVE MAINTENANCE INSTRUCTIONS NO. L-58

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INSTRUCTIONS FOR OPERATING AND MAINTAINING WORTHINGTON LOCOMOTIVE BOILER FEED PUMP AND FEED WATER HEATER, TYPES SA AND SAS, SIZE 6½

GENERAL

A typical arrangement of the Worthington Type "SA" and "SAS" Locomotive Feedwater Heating Equipment on a locomotive is shown in Fig. 1, page 12.

The cold water pump, "A", takes water from the tender and delivers it to the heater, "B", which is set into the top of the smoke box. Here the water is heated by mixing with the exhaust steam from the locomotive cylinders and hot water pump. From the heater, the hot water flows down to the hot water pump, "C". The hot water pump forces the heated water into the boiler through the boiler check.

COLD WATER PUMP

The cold water pump, "A", consists of a Pyle-National Steam Turbine and a Worthington Centrifugal Pump combined in one casing. The steam which runs this pump is controlled by the float operated valve on the cover of the feedwater heater. The pump will deliver as much or as little water to the heater as is permitted by the opening of this steam valve on the heater cover which is governed by the float.

Fig. 2, page 13, shows a section through the "SA" cold water pump, the turbine being equipped with a single steam nozzle head.

The "SAS" equipment operates the same as the "SA" equipment; however, it is a higher capacity system in that the cold pump turbine, Fig. 3, page 14, is fitted with a two-nozzle head, the steam supply to the second nozzle being controlled by a piston valve, a bellows, and the cold pump discharge pressure. The second nozzle goes into operation when the cold pump water discharge pressure reaches a point between 12 lbs. and 20 lbs.

The steam control valve body (Fig. 4, Ref. 47) on the "SAS" heater has a larger port area than the "SA" body and 1" instead of 3/4" connections. The steam line used to supply the steam to the cold pump turbine is increased from a 3/4" to a 1" line. These changes and the modification of the turbine to include the two nozzles are the only changes in the Feed Water Heating Equipment of the "SA" type which results in the type designated of "SAS".

The nozzles in the "SAS" cold pump are not interchangeable with those in the "SA" equipment.

HEATER

The cold water is delivered by pump, "A", to the heater, "B", through a spring loaded spray valve (Fig. 4, page 15, part ref. 28). The amount of water passing through the spray valve depends upon the level of the water in the heater. When the water level in the heater is low and the float is down,

the steam control valve which supplies steam to the cold water pump is open and the cold water pump delivers water to the heater. As the water level rises, the float rises, gradually closing the steam control valve, causing the cold water pump to deliver less water to the heater. If the water level is then lowered, the float descends and opens the steam control valve again. The water level in the heater determines the position of the float, the opening of the steam control valve and finally the amount of cold water entering the heater.

Exhaust steam from the locomotive, entering the heater through pipe (part 26, Fig. 1), passes upward through the exhaust check valves (Fig. 4, part ref. 4). Exhaust steam from hot water pump also enters the heater.

Air vent pipes (20, 20A and 24, Fig. 1), permit the escape of the air which separates from the water as it is heated. The open end of pipe "20A" should be in a convenient position near the track where it will be visible for inspection.

HOT WATER PUMP

The hot water pump, "C", is a single horizontal long stroke piston pump, having an enclosed type steam valve gear. The speed of the hot water pump, and the amount of water it takes from the heater and delivers to the boiler, is controlled by the operating valve, (part 33, Fig. 1), conveniently located in the cab. This operating valve is opened just enough to supply the boiler with the amount of water desired.

This hot water pump and its discharge pipe to the boiler are the only parts of the Worthington equipment which are subjected to boiler pressure.

DRIFTING CONTROL VALVE

The drifting control valve, "F", Fig. 1, is placed on the steam inlet to the hot water pump. It is a device which prevents the pump from being run fast while the engine is standing or drifting, and therefore supplying little or no exhaust steam to the heater to heat the feed water. This valve limits the amount of only partly heated water that can be delivered to the boiler should the pump be operated when the locomotive is standing or drifting. This valve is controlled by live steam pressure from one of the locomotive cylinder steam pipes led to the valve by a 3/8" pipe.

The drifting control valve, Fig. 6, page 17, is adjusted at the factory to open when the locomotive steam pipe pressure reaches 50 pounds and to close when the pressure is reduced to slightly below 50 pounds. It requires no attention as the spring is so adjusted that the valve opens when the steam pipe pressure is slightly above locomotive drifting throttle pressure. When the drifting control valve is open, the hot water pump can be run at full speed. When it is closed the hot water pump runs about one-half speed.

In some cases drifting control valves are decommissioned and are open all the time, in which case pump can be operated at full capacity at any time without the action of automatic control. If the pump is fitted with the standard drifting control valve it will run at about one-half speed with locomotive throttle closed, as the drifting control valve automatically closes, but permits sufficient steam to pass through the valve to keep pump operating at this reduced speed on account of a small by-pass port and a loose fitting valve in the drifting control valve assembly. When locomotive throttle is open, as before stated, the drifting control valve is open and pump can be run at full speed. If the pump is equipped with the decommissioned drifting control valve, it will run up to full speed any time that the operating valve in cab is opened.

CAB GAUGE

The cab gauge, "J", Fig. 1, is connected to the cold water pump discharge pipe, and registers the pressure developed by the cold pump, in delivering water to the heater.

STEAM STRAINER

Steam strainers are furnished with each equipment. One with coarse screen, "M", Fig. 1, is located in the steam pipe to the cold water pump, and another, "N", Fig. 1, with fine screen, is located in the steam pipe to the steam control valve in the heater cover.

OPERATION

The height of water in the boiler is regulated by the operating valve, (part 33, Fig. 1), which controls the speed of the hot water pump and the amount of water it delivers to the boiler.

In preparation for starting pumps, all valves, such as tank valve, boiler check, steam turret valve, etc., should be in proper working position. Open cold pump air vent (part 38, Fig. 1), in cab for one-half minute or so to prime pump with water. It is well to run the pump slowly for a few minutes some time before starting out to free the steam pipes and steam cylinder of the hot water pump of condensation in order that the pump may start promptly when required.

In order to get pumps started promptly, open operating valve (part 33, Fig. 1), one-half turn, and as soon as cab gauge indicates pressure, regulate the operating valve so that it feeds water to the boiler at the desired rate. When starting up the equipment, some seconds will elapse between the opening of the operating valve and the indication of pressure on the cold pump gauge. This is because the hot pump must start first, and take some water from the heater, lowering the heater water level, causing the float to open steam control valve and start the cold pump.

The equipment should be run continuously while the locomotive is using steam, and the hot water pump should be operated continuously at the speed necessary to maintain the desired water level in the boiler.

When the locomotive is running light it may be necessary to start and stop the hot water pump instead of operating it continuously. However, an endeavor should be made to take advantage of such times as the locomotive throttle may be open to run the pump in order to recover maximum amount of heat from the exhaust steam.

In connection with the operation of the cab gauge. The cab gauge being connected to the cold water discharge pipe, registers the water pressure developed by the cold pump in delivering water to the heater. This pressure is largely determined by the pressure of the exhaust steam in the heater. A change of the pressure indication of the cab gauge does not necessarily indicate a change in the capacity at which the pumps are delivering water to the boiler. If the tender screen is plugged up, or the tank valve not opened, or if the cold pump is filled with air or steam instead of water, the cold pump gauge will show little or no pressure, or at least somewhat less pressure than is usual for the particular locomotive operating condition. If these conditions exist, they should be corrected.

During freezing weather keep the suction heater pipe valve, (part 31, Fig. 1), cracked open at all times, except when pumps are to be started. Previous to starting pumps, open air vent valve, close the suction heater (anti-freeze) valve and when pumps have started and are pumping water, the anti-freeze valve should again be cracked open. This results in the anti-freeze pipe being protected and also in furnishing a small amount of heat to the cold pump at all times.

During long drifting periods of the locomotive in freezing weather, the anti-freeze valve in suction heater pipe should be opened enough to prevent the tender hose and cold water pump from freezing. If after a very long drifting period it is found that the suction hose has been over-heated and pump will not handle water, shut off pumps, close anti-freeze valve for a short period, and open cold water pump air vent valve in gauge line in cab.

This will vent all air and steam, and pump will prime with water, after which pumps can again be started. In the event that something occurs to the system which prevents engineman from using it to pump water, all drain valves on the hot water pump should be opened, making sure that they are not plugged up with dirt.

The anti-freeze valve in suction heater pipe should always be left open if engine is to stand outside unprotected in cold weather. If the weather is severely cold, the pump operating valve should also be cracked open. This last protective measure should be followed in cold weather of any severity, if hot water pump is on front deck of locomotive.

In the case of a locomotive which has its fire dumped, either on the road or at a terminal, and the engine is to remain outside for a period long enough to permit boiler to get cold, the pumping system should be thoroughly drained. All drain valves should be opened and investigated to see that they are not plugged with dirt. If equipment is drained while boiler is hot, extra care must be taken to prevent leaky boiler checks from permitting water to leak from boiler into pump.

With feedwater heating equipment it is not necessary to fill the boiler while locomotive is standing in order to be ready for a start. The smaller steam requirement of the hot water pump as compared with injector makes it possible to start the pump when the locomotive is started, without losing steam pressure. This method of operation yields the best results both from the heater and the locomotive.

If it is necessary to run the pump at a speed which seems excessive for the work it is doing, this indicates worn piston packing, leaky valves, or choked tank valve, tank strainer or suction strainer.

The sound of the exhaust from the locomotive is softer when using the heater. Allowance should be made for this in judging the amount of work the locomotive is doing and in determining the position of the reverse lever.

Because of the heat recovered from the exhaust steam, and because of the improvement in boiler conditions due to the reduced firing rate, the heater saves from 10 to 20 percent of the coal which otherwise would be required while running. Unless more work is to be done by the locomotive because of the heater, less coal should be fired than when using the injector.

MAINTENANCE

General: During shopping periods the feedwater heating equipment should be dismantled and thoroughly cleaned. Parts should be inspected for excessive wear and reconditioned or replaced, if necessary. Generally, this can be determined by comparing the clearance of the parts with the allowable wear tolerances contained in the various cross-sections and diagrams contained herein.

Cold Water Pump (Fig. 2, Page 13)

As the cold water pump is driven by a Pyle-National steam turbine, for information in regard to it and its lubrication see Locomotive Maintenance Instructions No. L-29.

Once a week an inspection of the oil in the turbine should be made and if necessary enough clean oil of medium or heavy consistency of the grade used for Pyle-National generators should be poured into the two oil cups on the side of the turbine to bring the oil level up to the top of the cups while the pump is not running. Make sure there is no water in the oil chamber.

The secondary nozzle control unit as used with the type 6½ SAS cold water pump turbine should be tested during general repairs to the equipment to be sure there is not excessive steam leakage between piston valve and bushing, that bellows is in good order and to be sure spring does not permit valve to open at less than 12 lbs.

Periodically, a test should be made to ascertain the speed of the pump at which the over-speed control brake shoe contacts its housing. This test can be made in either one of the ways described as follows:

Shop Test:

1. This test is strictly for shop use where pump steam supply can be manually controlled.

Remove the pump casing and use a revolution counter on the shaft. If the shoe contacts with the housing at a speed lower than 5300 R.P.M. or higher than 7000 R.P.M., the brake shoe or its housing, or both, should be renewed.

Unless a revolution counter is used, do not make brake shoe test without water in the pump suction chamber..

Locomotive Test:

2. This test should be the method used wherever possible.

Operate the pump with a positive head of water on the suction and with the discharge blanked. The brake shoe should not contact at a discharge pressure of less than 55 lbs., but must contact before the pressure reaches 90 lbs. If necessary, renew parts as directed above. When making the test note the highest pressure at which shoe contacts the housing, and then quickly discontinue the test to avoid unnecessary wear on the shoe.

If the housing diameter (See Fig. 7, page 18), has not increased more than 1/32 inch in diameter, and it is not excessively scored, it will be necessary to renew shoe only.

If a burr has accumulated on the tip of the brake shoe, it should be removed. If the shoe heads have expanded, the wear should be measured by noting increase of openings, Fig. 7, page 18, at the end of slots. If the opening of any one slot has increased 1/16 inch the shoe should be renewed. Examine the shoe for cracks or defects in the neck which joins the head to the body. The shoes are heat treated.

Impeller: If the hub of the impeller is not smooth it should be refinished, See Fig. 8, page 19, for tolerances. If the clearance between the impeller suction inlet and the pump casing is more than 1/16 inch on the diameter, the casing should be fitted with guide rings so that the difference in diameter of the impeller and guide ring will be between .020 and .030 inch. The stuffing box should be packed so that it is not leaking excessively. Four (4) rings of 1/4" packing are used for the stuffing box.

Heater (Fig. 4, Page 15)

The heater shell and air vent passages should be thoroughly cleaned by removing all scale and other loose matter. Heater assembly with float should not be subjected to more than 75 lbs. hydrostatic pressure. If float is removed, 100 lbs. pressure may be used.

Exhaust check valve service: The tolerances as shown in Fig. 9, page 19, should be followed for limits of wear.

Steam Control Valve: This control valve complete with float, as well as the spray chamber, can readily be removed for inspection or adjustment.

The adjustment of the steam control valve can be properly made by following the procedure specified on Fig. 10, page 20, Steam Control Valve Assembly Diagram, which also indicates limits of wear.

Spray Valve: This valve should be re-ground to its seat. Clearance between the bore and the valve stem should be between .010 and .015 inch when new. The parts should be renewed or reconditioned if the clearance exceeds 1/32 inch. The valve lift should be 5/8 inch, spring initial compressed length 2-7/32 inches with initial compression strength of 18 pounds. Clearance between shoulder around bottom of valve stem and body guide should be 1/4 inch.

Should it ever be desired to wash scale from the heater, this can be done readily by removing the heater cover and spray chamber from the heater and removing the clean-out cover (Fig. 5, page 16, part 20) from the hot water pump. The heater can then be washed out through the hot water suction pipe and clean-out cover opening.

Hot Water Pump (Fig. 5, page 16)

When about to start up new equipment or equipment that has just been overhauled, make sure that the steam strainers (Fig. 1, page 12) items "M" and "N", are in place. The strainer screens also should be occasionally removed and cleaned.

If a newly installed hot water pump refuses to operate, the cause is usually lack of lubrication or dirt has found its way into the reversing valve chest from the steam piping of the locomotive. To correct this, examine lubricator feed and pipe connections to assure oil feeding to pump. If after obtaining proper lubrication, pump does not operate, remove reversing valve and open pump operating valve slightly to blow out dirt. Thoroughly clean reversing valve before replacing.

Steam Cylinder: Dimensions and tolerances for steam cylinder are shown in Fig. 11, page 21. If clearance between the steam piston and cylinder exceeds 3/64 inch, rebore cylinder and fit with over-size piston.

Side clearance of steam cylinder piston rings should be .002 to .004 inch when new and rings should be replaced if the side clearance exceeds .010 inch. Steam cylinder should not be rebored more than 3/16 inch over-size.

Steam Valve Gear: The valve gear is of the enclosed type and is entirely steam actuated - See Fig. 11, page 21. There is only one moving part which is the reversing valve itself. It is actuated by steam pressure which flows to one end of the reversing valve chest through a port that is opened when the steam piston moves to the end of its stroke. Because of the differential areas of the reversing valve, the pressure forces the valve to the opposite position of its travel, thus reversing the admission and exhaust of steam to and from the steam cylinder.

The clearance between reversing valve and steam bushing should be between .006 and .009 inch. If this clearance exceeds .024 inch, renew bushing or regrind to provide an over-size valve. The side clearance of valve rings should be between .002 and .004 inch. If side clearance exceeds .008 inch, the rings should be renewed. In renewing steam chest bushings, press into position with a force between 11 and 20 tons.

Pump Cylinder: Remove all scale and foreign substances from the pump cylinder passages. The clearance between the pump piston and cylinder bore when new should be between .025 and .035 inch. If this clearance exceeds 3/32 inch, or if the liner becomes wore 3/32 inch on the diameter, the cylinder liner should be rebored and fitted with an over-size piston. Over-size pistons should be in 1/16 inch step sizes and liners should not be rebored for more than 1/4 inch over-size.

When replacing a pump cylinder liner, use a press fit requiring a force of from 25 to 35 tons. The liner should be pressed into cylinder until the end is below the extreme cylinder face 4-1/8 inches with a permissible variation of 1/16 inch.

Pump Valve Service: Follow the valve lifts and tolerances as shown in Fig. 12, page 22. To adjust the suction valve lift "A" to compensate for wear of the discharge valve stem, build up the discharge valve stem with stainless steel rod. To adjust the discharge valve lift "B", build up the pump valve cap stem with Stellite, or cast iron rod.

When necessary apply over-size suction valve seats in 1/16 inch step sizes to a maximum of 3/8 inch over-size. Also apply over-size discharge valve seats, when necessary, in 1/16 inch and 1/8 inch over-size. When applying 1/8

inch over-size discharge valve seats, the pump cylinder valve chest opening will have to be increased from 4-7/8 inches to 4-15.16 inches diameter.

Pump Piston and Rod: In truing up piston rods, they should not be refinished smaller than 3/32 inch in diameter under original size. When refinishing the rod, do not reduce the length of the taper on the pump end. After rod has been reduced in size, apply a new gland to fit, bored 1/32 inch larger than diameter of rod. Also apply a solid throat ring with an inside diameter 1/64 inch larger than rod. See Fig. 13, page 23 for dimensions of piston rod stuffing boxes and packing.

The distance between faces of steam and pump pistons should not vary more than plus or minus 3/16 inch.

The pump piston is of the so-called solid or snap ring type and packed with two formed packing rings, Fig. 14, page 24. These rings are soaked in boiling water until thoroughly pliable and sprung into place. The rings are furnished 1/8 inch over diameter size, uncut, for cylinder of approximately standard size, and should be cut only as and when used. Cut ring ends square and so that when sprung into place there will be a gap of 3/32 inch between ends.

Remove any packing rings that are broken or have a gap more than 3/8 inch when in position in cylinder bore.

Stuffing boxes of the piston rod on the steam and water ends should be packed with six rings of 3/8 inch packing. This packing cut in sets to fit the different size rods can be obtained from Worthington. The packing for both stuffing boxes is identical. As obtained from Worthington, one complete set or box contains sufficient for both boxes of one hot water pump.

Drifting Control Valve: This valve, shown in Fig. 6, page 17, is bolted directly to the steam inlet of the hot water pump and all the steam which runs the pump must first pass through this valve.

The clearance between piston and its bore should be between .005 and .007 inch. If this clearance exceeds .020 inch, the bore should be refinished to provide for an over-size piston. The side clearance of piston ring should be between .002 and .004 inch and gap clearance between .005 and .010 inch. If side clearance exceeds .008 inch, or if gap exceeds 3/32 inch, ring should be renewed.

See that operating pipe is not restricted where it connects to locomotive cylinder steam pipe.

When drifting control valve feature is decommissioned, the internal parts and the 3/8" operating pipe are removed, and a plug threaded into the small hole in the lower face of the valve.

If for any reason the water valve caps on hot water pumps must be taken off, it is positively necessary that the pump and heater first be drained of water. If heater and hot pump are not drained, the pressure of the water will unseat the pump suction valves when caps are removed and suction valves may drop into pump cylinder. Always lift discharge valves and make sure suction valves and springs are in proper position.

Caution: Open drain valves, and particularly valve shown on the end of the pump, (Fig. 5, page 16), to release pressure and dispose of hot water before loosening pump valve caps.

PROCEDURE FOR LOCATING TROUBLE

1. Make sure tank valve, steam turret valve, and boiler ckeck stop valve are open.
2. Observe cold water pump -
   (A) If not running, check as follows:
   Pump shaft should turn freely by hand.
   Examine steam strainer at entrance to cold pump and at control valve in heater cover.
   Examine turbine brake shoe.

(B) If pump is running overspeed and producing a shrill tone, indicating that brake shoe is contacting.
Feel pump casing; if hot, the pump casing may be overheated by too much anti-freeze heating steam, or pump may be full of air instead of water. Open the drain cock in the pump discharge pipe or the air vent valve in cab. If pump is noisy and does not show proper water pressure, examine for defective brake shoe or noisy ball bearing which may be worn or broken. Make sure suction strainer is clean.

3. Observe hot water pump -
(A) If not running:
Remove and examine the reversing valve.
(B) If racing, and steam is flowing from the air vent with the cold water pump not running, the control valve in the heater cover may be stuck in the lowest or closed position. If the control valve is free and the pump continues to race, it indicates that both the boiler check valve and the pump valves leak enough to allow steam or water from the boiler to overheat the pump cylinder. The pump cylinder can be re-primed by opening water cylinder drain valves. If pump is delivering some water, but an excessive amount of steam is blowing from the air vent, the pump water cylinder packing probably needs replacing.
If the pump speed is slow, it may be on account of lack of lubrication, insufficient boiler check valve lift, foreign matter in the steam cylinder, in reversing valve, or in the steam cylinder choke located under the drifting control valve.

4. Check control valve in heater cover -
(A) See that top of flattened section of the control valve is flush with the top of the bushing, when the valve is forced all the way down. This setting should cause the top of the round section on the valve to be nearly flush with the top of the bushing when the valve is all the way up. The valve travel should be between 19/32 inch and 21/32 inch.
(B) Check for free movement of valve.
If the valve is all the way down (an indication that the heater is full of water) pull up on the nut with pliers; if the valve stays part or full way up, it indicates that the valve is sticking. Remove and clean the valve with oil. After setting make sure that it is free. To thoroughly test the valve for free movement, lower the water level in the heater so that the valve is located at about half its travel. If, after forcing the valve down slightly, it immediately returns to its exact former position, it shows that the valve is free, and that float is working properly.

WORK REPORTS

Reports should state as clearly as possible what troubles are encountered on the road. If cause is known it should be reported. If not known, the trouble should be carefully described in work report.

A group of possible troubles, the causes and test used to determine cause, as well as procedure necessary to correct the troubles, follows:

Report: Pump will not work.

Test: Test pumps by opening pump operating valve in cab and observing performance.

Cold water pump - If it does not run:

1. Examine for restricted steam supply which may be located in stuck float valve, disconnected float, dirty steam line strainers, or plugged turbine nozzle.

2. Examine pump stuffing box, which may be pulled up too tight and binding shaft. There should be slight water leak from this box and pump shaft should spin freely with the fingers.

3. Examine turbine brake shoe, which may be binding in housing.

4. Turbine exhaust pipe should have no restrictions.

Hot water pump - If it does not run:

1. Check steam supply to pump.
2. Examine steam valve gear for lack of lubrication, worn rings, broken parts, or foreign matter binding reversing valve.
3. Examine cylinders for an obstruction.
4. Boiler check valve must be open.
5. Disconnect steam cylinder exhaust and check sound of exhaust for steam ring blow.

Report: Pumps run but will not pump water.

Test: Test pumps by opening pump operating valve in cab and observing performance. Take particular notice to see that cold pump speed varies somewhat, which indicates proper movement of float valve in heater.

Cold Water Pump:

1. If cold water pump runs at an extremely high speed, and gives off a high vibrating tone, pump is not getting water. Tank valve may be closed, tank strainer may be dirty, tender may be empty, tank hose lining may be loose and plugging inlet to pump, or pump may be air-bound or over-heated with steam from anti-freeze valve.

If pump is air or steam-bound, stop pump. Open cold water pump air vent valve in cab. Air vent valve must be open long enough to let all air or vapor out of pump casing while pump is not running, to permit pump to completely and properly fill with water.

Hot Water Pump:

1. If cold water pump operates satisfactorily and there is plenty of water in heater, and hot water pump runs but does not pump water, examine hot water pump cylinder packing. If this is cause of trouble, there will be an unusually heavy flow of steam from both vents during running test.

Report: Pump will not supply boiler.

Test: Test pumps by opening pump throttle and observing performance. The drifting control valve, if one is used, should be moved to wide open position and hot pump run at full speed.

Hot Water Pump:

1. If pump responds, and promptly increases its speed when drifting control valve is opened and makes rated speed, the drifting control valve can be eliminated as a possible cause.
2. If pump pounds severely during this test it indicates lack of water and trouble will be located in cold pump end of system. (See Cold Water Pump instruction below). Steam control valve in heater cover will be in wide open (top) position and float in bottom position.
3. If pump jumps on one stroke only, it indicates a leaking or blocked open water valve.
4. If pump makes a fast stroke in both directions but pumps very little water, it indicates cylinder packing in poor condition. If this is the cause, there will be an unusually heavy flow of steam from vent pipes. Poor cylinder packing or leaking valves can also be detected by placing ear next to pump casting and listening for the noise of rushing water.
5. If pumps makes only one-half speed, thoroughly examine drifting control valve and its connection to locomotive steam pipe. Also check turret valve, and boiler check stop valve, and boiler check valve lift. Pump operating valves in cab have been found with stems badly worn, causing erratic pump speeds and undependable control of pumps. See if pump is properly lubricated.

Cold Water Pump:

1. Examine tank valve, tank strainer, and discharge pipe check valve. Examine steam supply to cold pump, which may be restricted by partially plugged nozzle, steam strainers or stuck float valve in heater. Examine cold pump stuffing box packing, which may be binding the shaft. Examine brake shoe, which may be binding in housing. If report still persists, examine clearance between impeller hub and strainer box fit.

2. Examine turbine blades and steam nozzle re-entry tube for wear.

3. If water supply to cold pump is restricted, the gage hand will waver and be very unsteady, when pump is operated at high capacity.

Report: Pump loses prime.

If cold pump gets air or vapor-bound with steam, stop pump, open air vent valve and allow pump to become flooded with water before starting. This may occur directly after a tank hose has been disconnected, or suction strainer cleaned.

If this occurs on the road it is possibly because suction anti-freezing valve is feeding too much steam to suction line, or because tank has become dry of water. If tank runs dry and is filled at a water plug, open cold water pump air vent valve in cab. If this trouble persists, report "Air vent valve does not prime pump". It may also be due to a spray valve blocked wide open with stray material.

Report: Water wastes from heater vent pipes.

The cause is a stuck or loose float valve in the heater, which can usually be detected by removing the small cap over this valve on heater cover and either pushing or pulling valve carefully with a pair of pliers. If float is disconnected, steam control valve will be in lower position and will offer no resistance to being lifted with pliers. If valve lock nut has become loosened so valve is turning on stem, adjust valve by screwing valve up or down on the threaded rod.

Report: Pump pounds.

If hot water pump pounds it is usually due to lack of water and the same remedies apply as described under - "Report: Pump will not supply boiler. Cold Water Pump".

Report: Cold water pump gage pressure very high but hot water pump pounds and won't supply boiler.

Under this condition, the cold water pump is primed with water, but is having difficulty in delivering it to the heater. Causes of this trouble are, possibly, sticking cold pump pipe line check valve, sticking spray valve, and plugged vent pipes. Frequently this trouble is not evident unless pumps are tested at full speed, as line check or spray valve may be stuck partially open. Vent pipe separator nipple in heater cover should be examined and the hole in heater cleaned out.

Report: Hot pump will not run at full speed.

(A) Examine drifting control valve.

(B) Examine steam turret, pump operating valves, and steam pipe line for restrictions.

(C) Examine boiler check lift.

Report: Pump fails at times to pick up water if started after locomotive throttle is opened.

Trouble may be due to spray valve stuck open, see above.

If this is the case, pumps should be started before engine throttle is opened.

MONTHLY INSPECTION

The following items of work should be performed at Monthly Inspection:

1. Screens for steam line strainers "M" and "N", Fig. 1, must be removed and cleaned, or replaced if necessary.
2. Examine tank valve to see that passage is entirely clear.
3. Remove and clean cold water pump suction strainer screen.
4. Examine boiler check internally. See that boiler check spring is in good condition and the lift is 7/32".

5. The heater cover should be removed and a careful examination made of the exhaust valves, spray valve and steam control valve with its float.

REPAIRS TO THE PUMPS AND HEATER AT ENGINEHOUSES

Parts to be repaired or renewed at enginehouses must be limited to the following: All other repairs must be made at central repair points.

Cold Water Pump:

1. Ball bearings.
2. Impeller shaft packing (pump end).
3. Packing rings (turbine end).
4. Drain valves.
5. Suction strainer.
6. Tank strainer.
7. Line check valve in discharge pipe.
8. Turbine steam strainer.
9. Examination of turbine wheel for wear of buckets and renewal if necessary.

Heater:

1. Steam control valve adjustment.
2. Exhaust check valves.
3. Renewal of control valve float springs, providing the proper size and material of rivets is used.
4. Renewal of the various gaskets used in connection with the cover, providing standard gaskets are used.
5. Control valve steam strainer.

Hot Water Pump:

1. Renewal of reversing valve (Repairs to be made at Back Shops).
2. Hot water pump piston packing.
3. Piston rod packing, steam and water ends.
4. Suction and discharge valve and springs.
5. Drain valves.

H. T. COVER,
Chief of Motive Power.

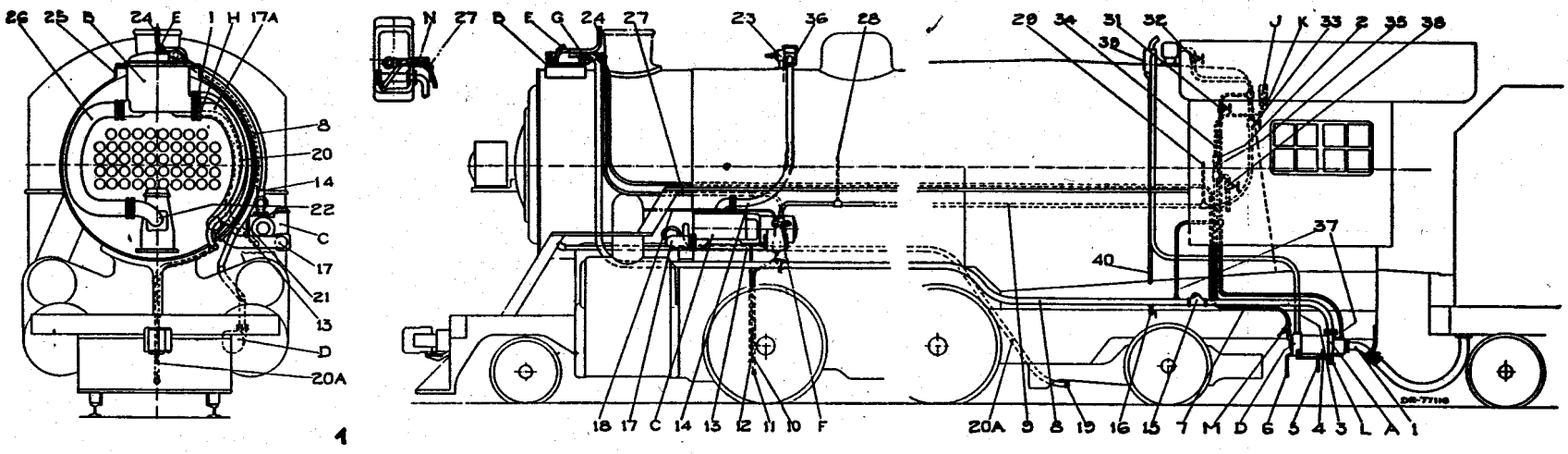


FIG. 1. Typical Installation of the Worthington Types SA and SAS Locomotive Feedwater Heating Equipment.

(12)

Cold water pump "A", takes water from the tender and delivers it to heater "B" where it is heated by mixing with the exhaust steam from locomotive cylinders and hot water pump. The heated water then flows down to the hot water pump "C" which forces it into the boiler.

Parts referred to by Letters are furnished by Worthington

Parts referred to by Numbers are furnished by customer

LIST OF PARTS

REF.	NAME OF PART	REF.	NAME OF PART	REF.	NAME OF PART	REF.	NAME OF PART
A	Cold water pump	1	Cold water suction pipe	14	Hot water pump discharge pipe	25	Heater saddle
B	Heater	2	Heating pipe	15	Swing check valve	26	Locomotive exhaust pipe to heater
C	Hot water pump	3	Turbine exhaust pipe	16	Cold water discharge drain cock	27	Turbine steam pipe to control valve
D	Steam turbine	4	Cold water pump bracket	17	Hot water pump suction pipe	28	Connection for mechanical lubrication
E	Control valve	5	Stuffing box drain pipe	17A	Hot water pump suction pipe (inside smoke box)	29	Connection for hydrostatic lubricator
F	Drifting control valve	6	Turbine drain pipe			31	Pipe valve (anti-freeze valve)
G	Cold water inlet flange	7	Turbine steam pipe	18	Drifting control valve actuating pipe	32	Steam turret valve
H	Hot pump exhaust inlet flange	8	Cold water discharge pipe			33	Operating valve
I	Air vent flange	9	Steam pipe to pumps	19	Heater air vent choke	34	Cab gauge connection pipe
J	Cab gauge	10	Hot water pump exhaust drain pipe	20	Air vent drain pipe in smoke box	35	Cab gauge pipe
K	Cab gauge cock	11	Hot water pump exhaust drain pipe choke	20A	Air vent drain pipe	36	Thermometer well connection
L	Drain valve			21	Hot water pump bracket	37	Suction heater pipe chokes
M	Turbine steam strainer	12	Stuffing box drain pipe	22	Loco exhaust pipe connection	38	Valve for air vent and wetting down hose connection
N	Control valve steam strainer	13	Hot water pump exhaust pipe	23	Boiler check valve		
				24	Heater air vent pipe	39	Turbine exhaust header
						40	Turbine exhaust header drain

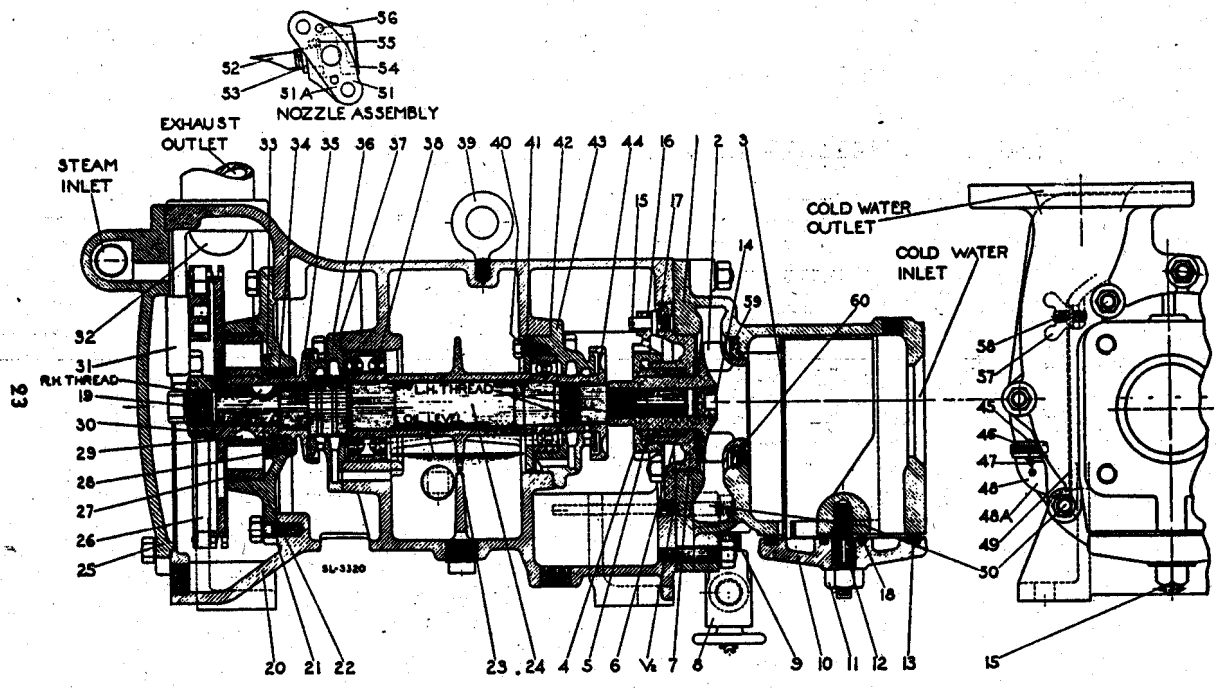


FIG. 2. Type SA - Cold Water Pump.

Pump parts to be ordered from Worthington.

Ref. No.	Part No.	NAME OF PART
1	28939	Pump casing
	29780	Steam Lines Strainer at Entrance to Turbine (¼") SARCO Fitted with Screen #29782 having 3/32 Holes for 6½-SA only
	29801	Steam Lines Strainer at Entrance to Turbine (1") SARCO Fitted with Screen #29797 having 3/32 Holes for 6½-SAS only
2	28959	Impeller
3	28943	Strainer
4	28942	Stuffing box cap
5	28740	Stuffing box gland
6	29060	Packing for impeller shaft
7	28940	Stuffing box
8	29384	Drain valve
9	15493	Drain valve nipple
10	28945	Strainer cover
11	356	Nut for strainer cover
12	28843	Stud for strainer cover
13	29030	Packing for strainer cover
14	20706	Socket pipe plug
15	2316	Cotter pin
16	29300	Locking pawl
17	29301	Locking pawl pin
18	29169	Packing for strainer cover
59	28746	Guide ring ¼" undersize
60	19209	Screw for guide ring
V2	28714	Gasket for pump stuffing box

Turbine parts to be ordered from Pyle-National Co.

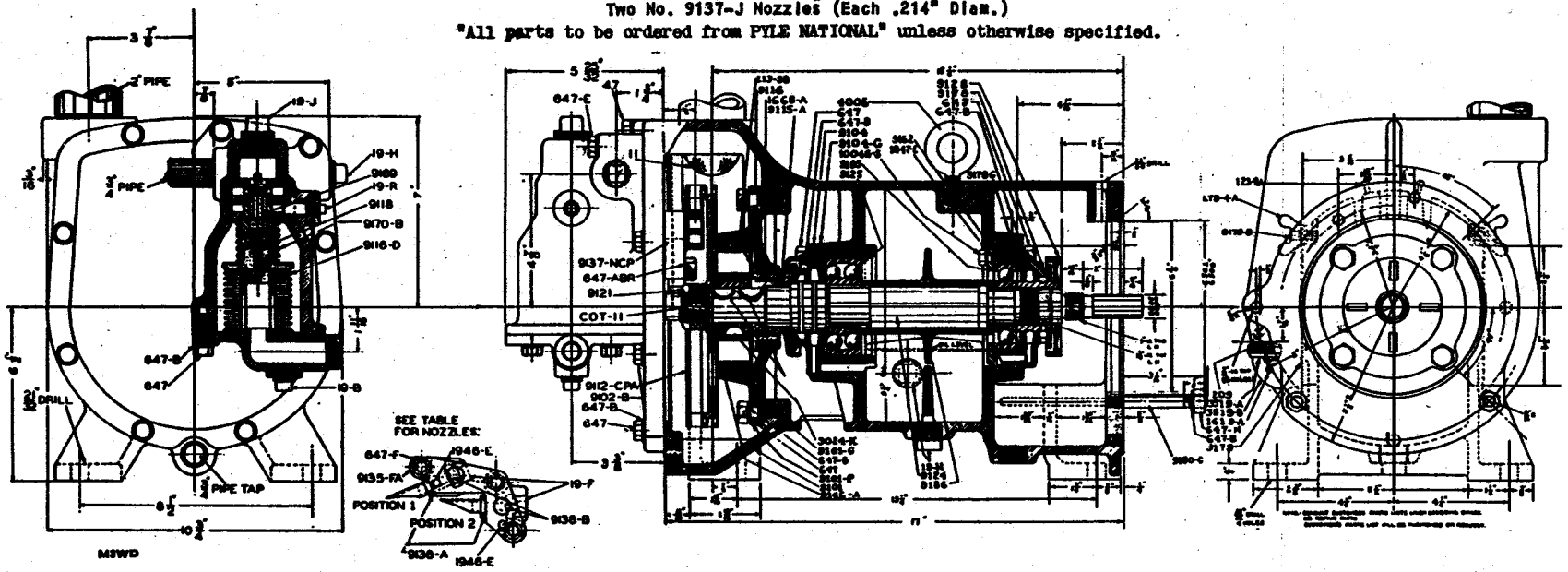
Ref. No.	Part No.	NAME OF PART
19	PN-COT-11	Cotter pin for turbine wheel nut
20	PN-9101	Turbine casing
21	PN-9101-G	Gasket for brake shoe housing
22	PN-9101-P	Turbine brake shoe housing
23	PN-9186	Oil slinger
24	PN-9124	Shaft and key
25	PN-9102	Turbine cover
26	PN-9112-ACP	Turbine wheel
27	PN-9146-A	Brake shoe
28	PN-213-SB	Flat head brass machine screw
29	PN-3024-K	Key
30	PN-9121	Wheel retaining nut
31	PN-9137	Guide passage
32	PN-11	Exhaust screen
33	PN-9116	Outer packing sleeve
34	PN-1668-A	Packing ring
35	PN-9115-A	Retainer and packing ring PN-1668-A
36	PN-9104	Ball bearing housing cap
37	PN-9104-G	Ball bearing cap gasket
38	PN-9125	Turbine end ball bearing
39	PN-4006	Eye bolt
40	PN-9185	Pump end ball bearing
41	PN-9162	Ball bearing retaining plate
42	PN-9178-G	Ball bearing housing gasket
43	PN-9178	Pump ball bearing housing
44	PN-9128	Ball bearing nut
45	PN-209	Oil cup cover chain screw
46	PN-3519-A	Oil cup cover
47	PN-1619-A	Oil cup cover chain
48	PN-3519-B	Oil cup body
48A	PN-3519-BCP	Oil cup complete
49	PN-9179-A	Stuffing box cover
50	PN-9180-C	Hinge pin 7 5/8" long
51	PN-9135-AC	Nozzle block with dowel pins
51A	PN-9135	Nozzle block complete with nozzle PN-9137-B
	PN-9135-C	Nozzle block complete with nozzle PN-9137-C
	PN-9135-D	Nozzle block complete with nozzle PN-9137-D
52	PN-9137-D	Nozzle .236 inch diameter
53	PN-9131-N	Nozzle lock nut
54	PN-19-JC	Countersunk pipe plug
55	PN-559	Dowel pin
56	PN-1946-E	Dowel pin
57	PN-LTB-4-A	Thumb nut
58	PN-9179-B	Thumb nut screw

The steam turbine parts are the same for all size equipments, with the exception of steam nozzle part No. PN-9137-D, the size of which depends upon the locomotive boiler pressure.

* For boiler pressures below 200 lb. use PN-9137-C, .257 inch diam., For 200 to 275 use PN-9137-D, .236 inch diam., For 275 and above use PN-9137-B, .214 inch diam.

When ordering, give part numbers. Do not use reference numbers.

FIG. 3. Turbine for Cold Water Pump.
Size 6½ - SAS
Two No. 9137-J Nozzles (Each .214" Diam.)
"All parts to be ordered from PYLE NATIONAL" unless otherwise specified.



Part No.	Name of Part
PN- 11	Exhaust Screen
PN- 19-B	Pipe Plug
PN- 19-F	Pipe Plug
PN- 19-H	Pipe Plug
PN- 19-J	Pipe Plug
PN- 19-R	Pipe Plug
PN- 47	Hexagon Head Cap Screw
PN- 123-BA	Round Head Screw
PN- 209	Oil Cup Cover Chain Screw
PN- 213-SB	Flat Head Screw
PN- 647	Hexagon Head Cap Screw
PN- 647-AER	Hexagon Head Cap Screw
PN- 647-B	Lock Washer
PN- 647-E	Hexagon Head Cap Screw
PN- 647-F	Hexagon Head Cap Screw
PN- 647-N	Hexagon Nut
PN- 1619-A	Oil Cup Cover Chain
PN- 1668-A	Packing Ring
PN- 1847-E	Lock Washer
PN- 1946-E	Dowel Pin
PN- 3024-K	Shaft Key
PN- 3519-A	Oil Cup Cover
PN- 3519-B	Oil Cup Body
PN-*3519-BCP	Oil Cup Assembly
	1 - 209 Oil Cup Cover Chain Screw
	1 - 1619-A Oil Cup Cover Chain
	1 - 3519-A Oil Cup Cover
	1 - 3519-B Oil Cup Body
PN- 4006	Eyebolt
PN- 9101	Turbine Casing
PN- 9101-G	Turbine Packing Housing Gasket
PN- 9101-P	Turbine Packing Housing
PN-*9102-A	Turbine Cover
	1 - 19-B Pipe Plug
PN- 9102-A	Turbine Cover
PN-*9102-CPB	Turbine Cover Complete
	2 - 647-AER Cap Screw
	3 - 647-F Cap Screw
	1 - 9102-A Turbine Cover
	1 - 9135-K Nozzle Block Assembly
	1 - 9137-NCP Guide Passage Assembly
PN- 9104	Ball Bearing Housing Cap
PN- 9104-G	Ball Bearing Housing Gasket
PN-*9112-ACP	Turbine Wheel Assembly
PN- 9112-CPA	Turbine Wheel and Brake Shoe Assembly
	*1 - 9112-ACP Turbine Wheel Assembly
	1 - 9146-A Brake Shoe
PN- 9115-A	Packing Ring and Retainer Assembly
	3 - 1668-A Packing Ring
	*1 - 9115 Retainer
PN- 9116	Outer Packing Sleeve
PN- 9116-D	Bellows and Plates Assembly
PN- 9118	Lock Nut
PN- 9121	Wheel Retaining Nut
PN- 9124	Shaft Assembly
	2 - 3024-K #8 Woodruff Key
	*1 - 9124-A Shaft
PN- 9125	Turbine Ball Bearing
PN- 9128	Ball Bearing Nut
PN- 9135-FA	Nozzle Block
PN- 9135-K	Nozzle Block and Nozzles Assembly
	2 - 19-F Pipe Plug
	2 - 1946-E Dowel Pin
	1 - 9135-FA Nozzle Block
	2 - 9137-J Nozzle
	2 - 9138-A Retaining Nut
	2 - 9138-B Aligning Pin
PN- 9137-J	Nozzle
PN- 9137-NCP	Guide Passage Assembly
PN- 9138-A	Retaining Nut
PN- 9138-B	Aligning Pin
PN- 9146-A	Brake Shoe
PN- 9162	Ball Bearing Retaining Plate
PN- 9169	Valve and Stem Assembly
PN- 9170-B	Spring
PN- 9178	Pump Ball Bearing Cap
PN- 9178-G	Ball Bearing Cover Gasket
PN- 9179	Stuffing Box Cover Assembly
	*1 - 9179-A Stuffing Box Cover
	1 - 9179-B BStuffing Box Cover Stud
	1 - LTB-4-A Wing Nut
PN- 9179-B	Stuffing Box Cover Stud
PN- 9180-C	Hinge Pin
PN- 9185	Pump Ball Bearing
PN- 9186	Oil Agitator
PN-10046-S	Hexagon Head Cap Screw
PN-COT-11	Cotter Pin
PN-LTB-4-A	Wing Nut

*Not shown in cut

29801 Steam Strainer at entrance to turbine 1" SARCO fitted with screen #29797 having 3/32" holes - (This to be ordered from Worthington.)

PART NUMBERS Ref. No.		NAME OF PART
1	29192	Heater shell
2	29193	Heater cover
3	28834	Exhaust check valve seat
4	28832	Exhaust check valve
5	29194	Exhaust check valve guard
6	29137	Stud for check valve guard
6A	29717	Spacer for check valve guard stud
7	29716	Nut for guard stud
8	34894	Wire for check valve guard stud
9	28633	Control valve bushing - 6½ SA only
	29808	Control valve bushing with increased port area - for 6½ SAS only
10	28634	Control valve
11	28638	Control valve cover
12	29195	Control valve rod with bushing #29330
13	74	Lock washer
14	223	Nut for valve rod
15	28636	Valve rod link with bushing #29330
16	28639	Valve rod pin
17	2316	Cotter pin
18	29411	Float with shank
19	28767	Rivets for float spring
20	28868	Float spring
	†29409	Spray valve sleeve
21	28689	Float lever
22	28657	Bushing for float lever
23	28601	Float lever pin
24	28336	Nut for float lever pin
25	28539	Cotter pin for float lever pin
27	29196	Spray chamber with ¾" conduit pipe and fittings
28	28804	Spray valve
29	28826	Spray valve seat
30	29117	Spray valve spring
31	29233	Spray valve guard
32	28539	Split pin for spray valve
36	28194	Eye bolt
37	28642	Cold water inlet flange (two bolt)
38A	28994	Ball joint ring for cold water inlet flange (two bolt)
39A	28450	Bolts for cold water inlet flange
39B	29329	Bolt for pump exhaust flange
40	28007	Nuts
41	28453	Pump exhaust and air vent flange
41		Air vent flange
42	28978	Ball joint ring for pump exhaust and air vent
43	28452	Bolts for air vent flange
47	29305	Control valve body with ¾" connections - 6½ SA only
	29794	Control valve body with 1" connections - for 6½ SAS only
48	29307	Air vent plug
49	29308	Air vent pipe
E	29197	Gasket for heater cover
E2	28818	Gasket for spray valve seat
E3	28800	Gasket for control valve cover
G3	29306	Gasket for control valve body
50	29638	Cold water connection (two bolt)
51	29637	Spray valve plate
K3	29639	Gasket for spray valve plate
L3	29640	Gasket for cold water connection
	† 476	Lock washer for spray valve seat stud nut
	†29779	¾" steam strainer at heater cover with screen 29781 with 1/32" holes for 6½ SA only
	†29791	1" steam strainer at heater cover with screen 29798 with 1/32" holes for 6½ SAS only

† Not shown in cut.
When ordering, give part numbers. Do not use reference numbers.

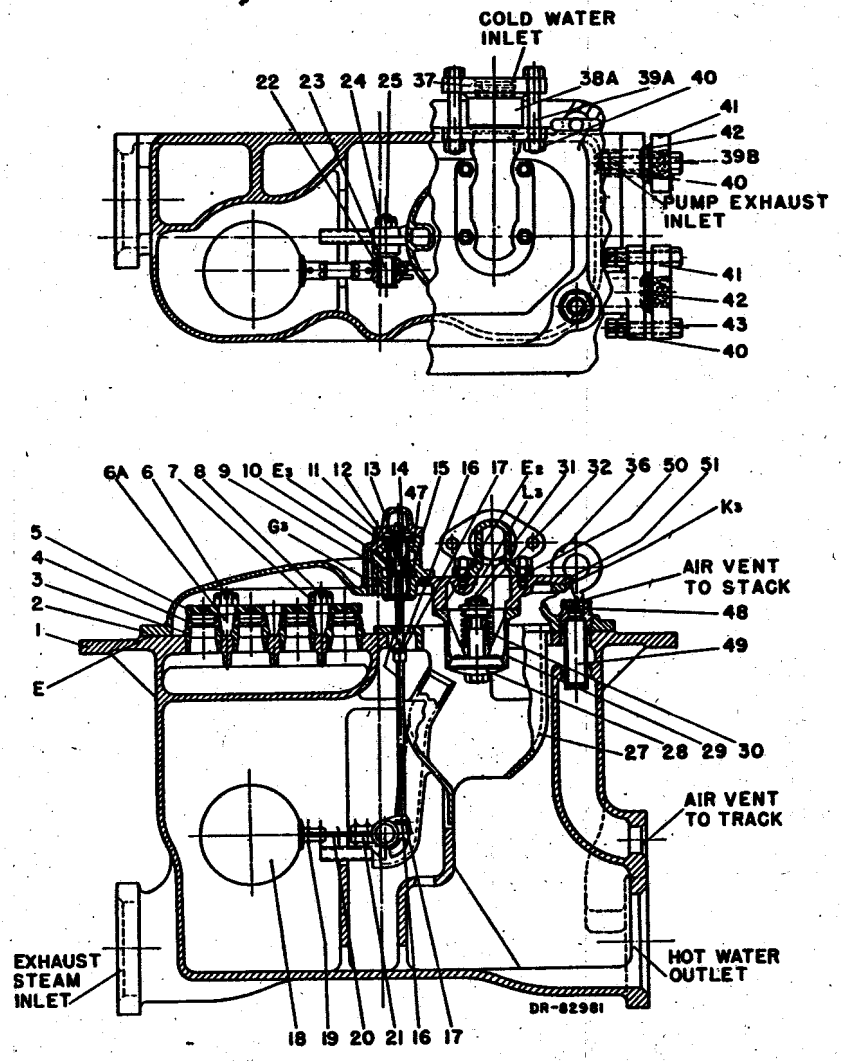


FIG. 4. Heater

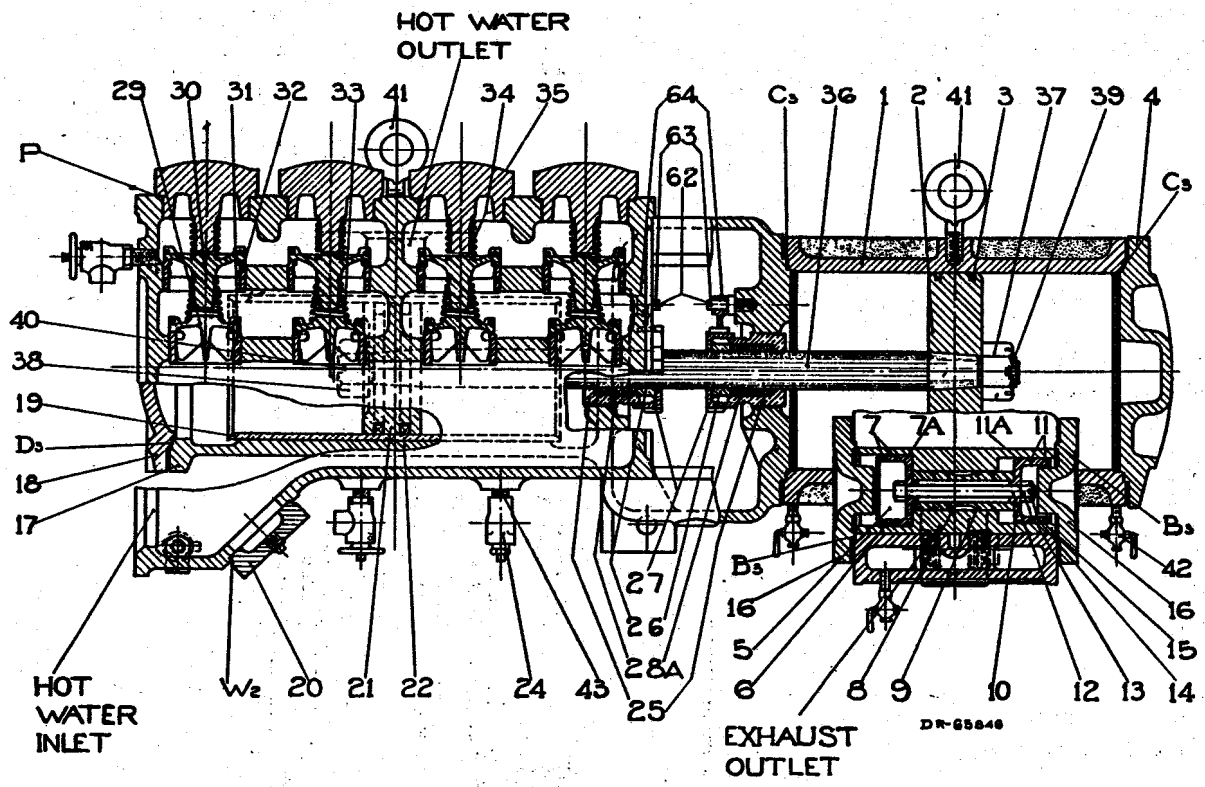


FIG. 5. Hot Water Pump

Ref. No.	Part No.	NAME OF PART
1	29361	Steam cylinder
2	29362	Steam piston
3	29380	Steam piston ring
4	29363	Steam cylinder head
5	29455	Reversing valve complete
6	29367	Reversing valve, large end
7	29371	Valve steam ring, large end
7A	29372	Valve compression ring, large end
8	29369	Reversing valve, center
9	29375	Valve exhaust ring
10	29368	Reversing valve, small end
11	29373	Valve steam ring, small end
11A	29374	Valve compression ring, small end
12	29370	Reversing valve bolt
13	28567	Nut for valve bolt
14	28535	Cotter pin for valve bolt
15	29364	Valve chest bushing
16	29365	Valve chest cover
17	++29376	Pump cylinder - SA
18	29381	Pump cylinder head
19	29377	Pump cylinder lining
20	28266	Clean-out cover
21	29378	Pump piston
22	29379	Pump piston packing ring
24	29384	Drain valve
25	29178	Stuffing box
26	29179	Stuffing box gland
27	28476	Stuffing box cap
28	*†28583	Piston rod packing (Sea-Ro)
28A	29443	Piston rod packing (chevron)
29	29180	Suction valve
30	29181A	Discharge valve
31	29182	Suction valve seat
32	29183	Discharge valve seat
33	28786	Suction valve spring
34	28787	Discharge valve spring
35	29382A	Pump valve cap
36	29383	Piston rod
37	29005	Piston rod nut, steam end
38	29002	Piston rod nut, pump end
39	28890	Cotter pin, steam end
40	28889	Cotter pin, pump end
41	28194	Eye bolt
42	28064	Drain cock
43	15493	Pipe nipple for drain valve
62	29316	Locking pawl pin
63	2316	Cotter pin, for locking pawl pin
	29723	Reducing bushing
	29760	Nut for inside steam head
	29764	Complete set steam valve gear rings
64	29315	Locking pawl
B3	29387	Gasket for steam chest cover
C3	29388	Gasket for steam cylinder head - copper
D3	29389	Gasket for pump cylinder head
P	29188	Gasket for pump valve cap
W2	28216	Gasket for clean-out cover

++ 29688 Pump cylinder with feet on bottom of cylinder for C3 SAS
*Parts supplied only when specified.
†Not shown in cut.
When ordering, give part numbers.
Do not use reference numbers.

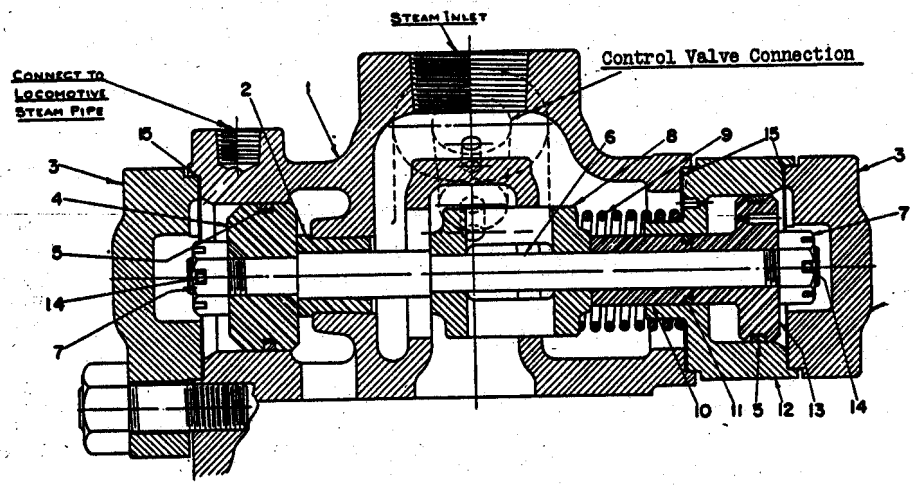


FIG. 6. Drifting Control Valve (Cushion Type)

Ref. No.	No. Req.	Part No.	Size Unit	NAME OF PART
1	1	29385	6½SA	Valve body(¾"control connection)
1	1	29795	"	Valve body(1"control connection)
2	1	28932	"	Bushing
3	2	28928	"	Piston cover
4	1	28787	"	Piston
5	2	28935	"	Piston ring
6	1	29788	"	Piston rod
7	2	36176	"	Slotted nut
8	1	28604	"	Valve
9	1	29789	"	Spring
10	1	29785	"	Cushion sleeve
11	1	29786	"	Cushion ring
12	1	29783	"	Cushion chamber
13	1	29784	"	Cushion piston
14	2	222	"	Cotter pin
15	3	28937	"	Gasket

It is preferable that the brake shoe be placed so that the direction of rotation is as shown in view "B". The brake shoe will also give good service if it should be placed as shown in view "A".

If the housing is not excessively scored and the diameter has not increased more than 1/32 inch the brake shoe only should be renewed.

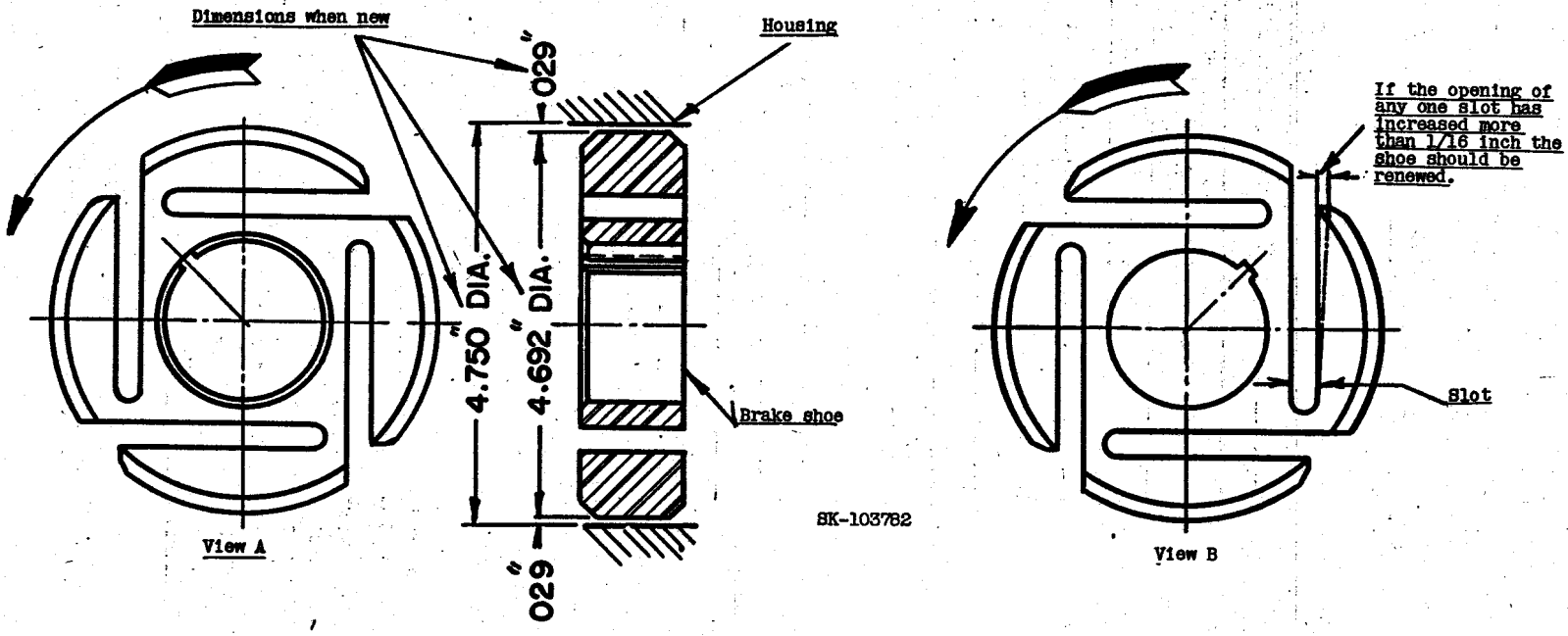


FIG. 7. Locomotive Feedwater Heater Brake Shoe Tolerances.

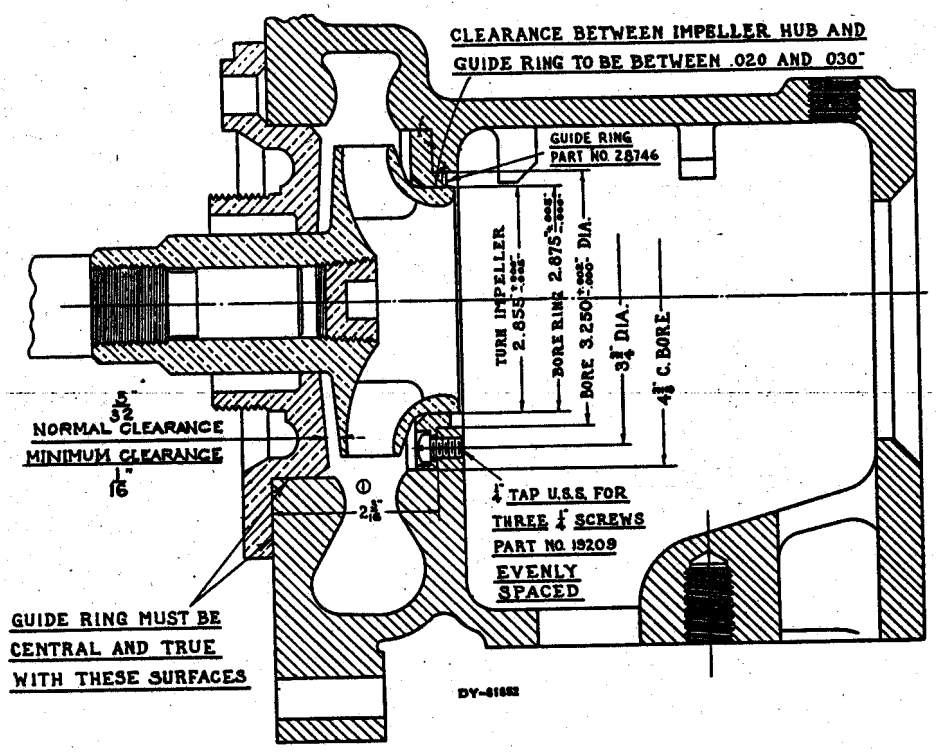


FIG. 8 Guide Ring for Cold Water Pump

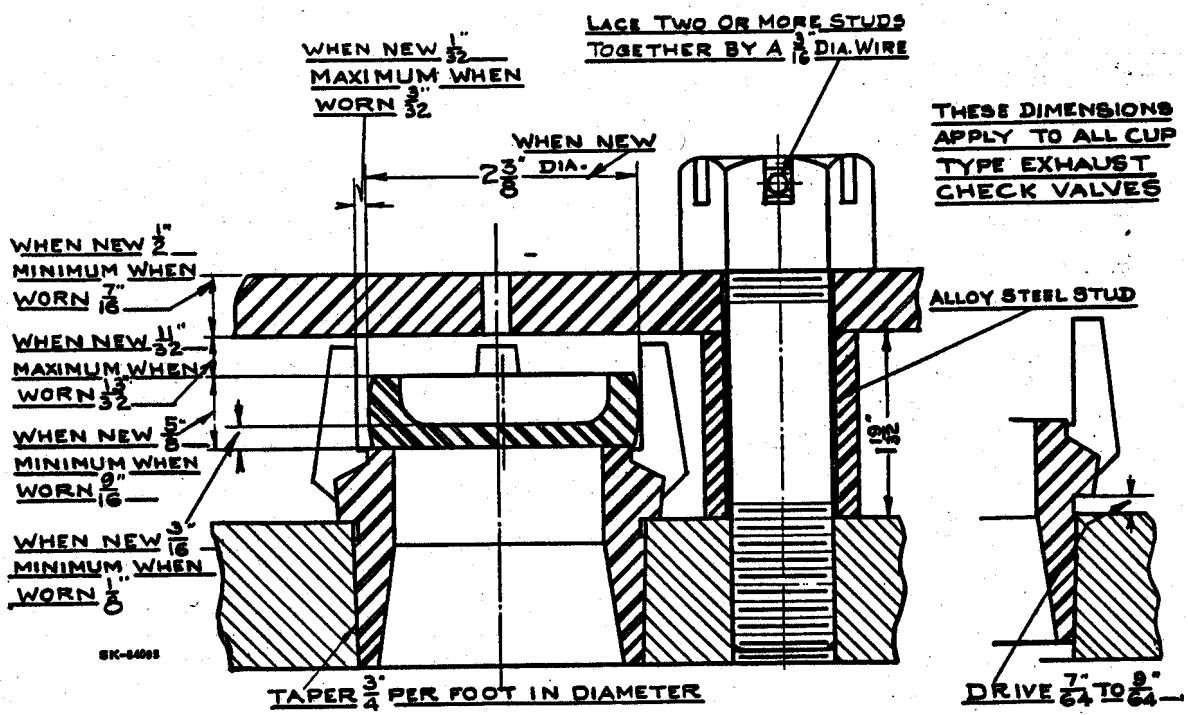


FIG. 9 Exhaust Check Valve Service

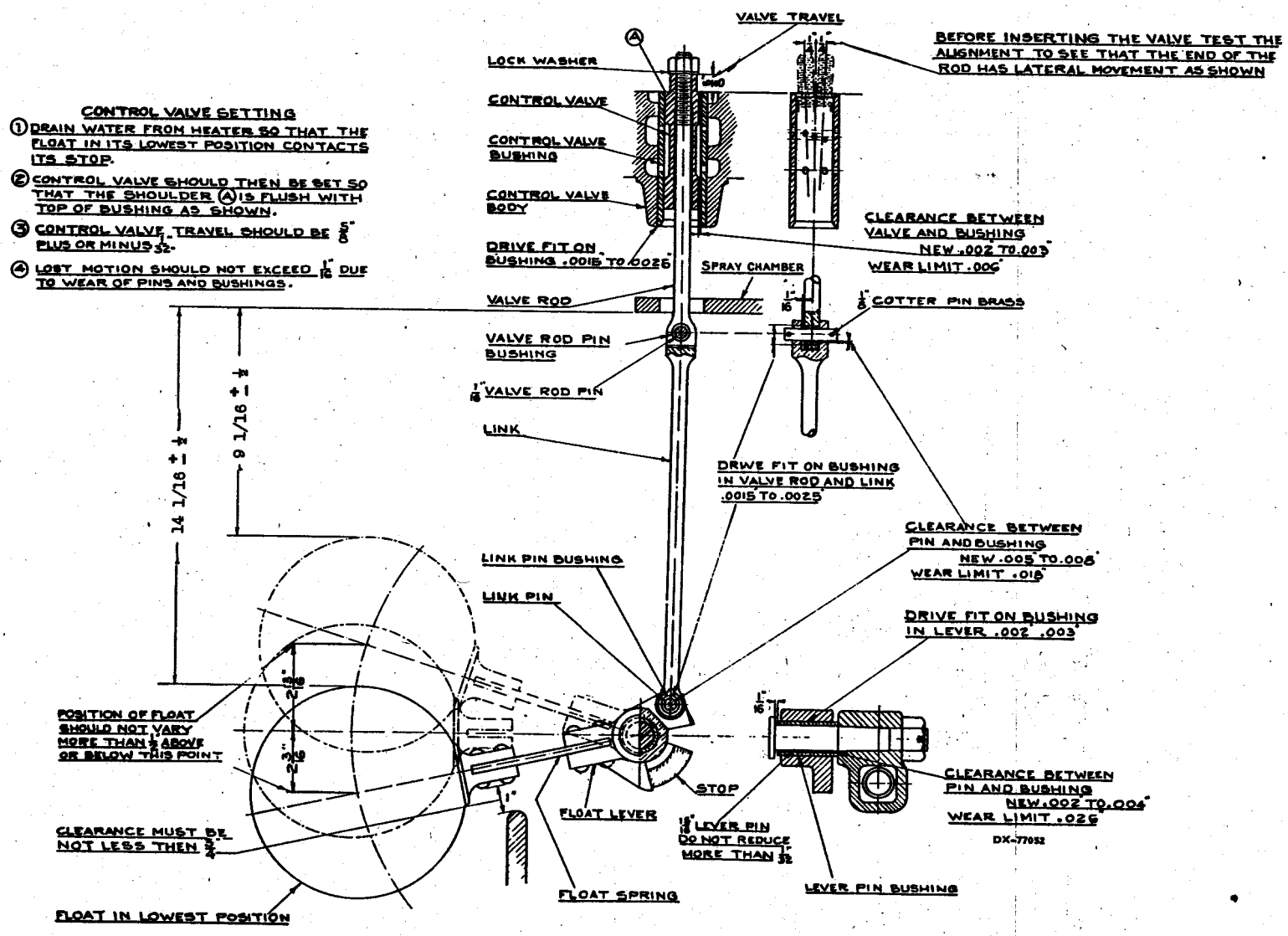
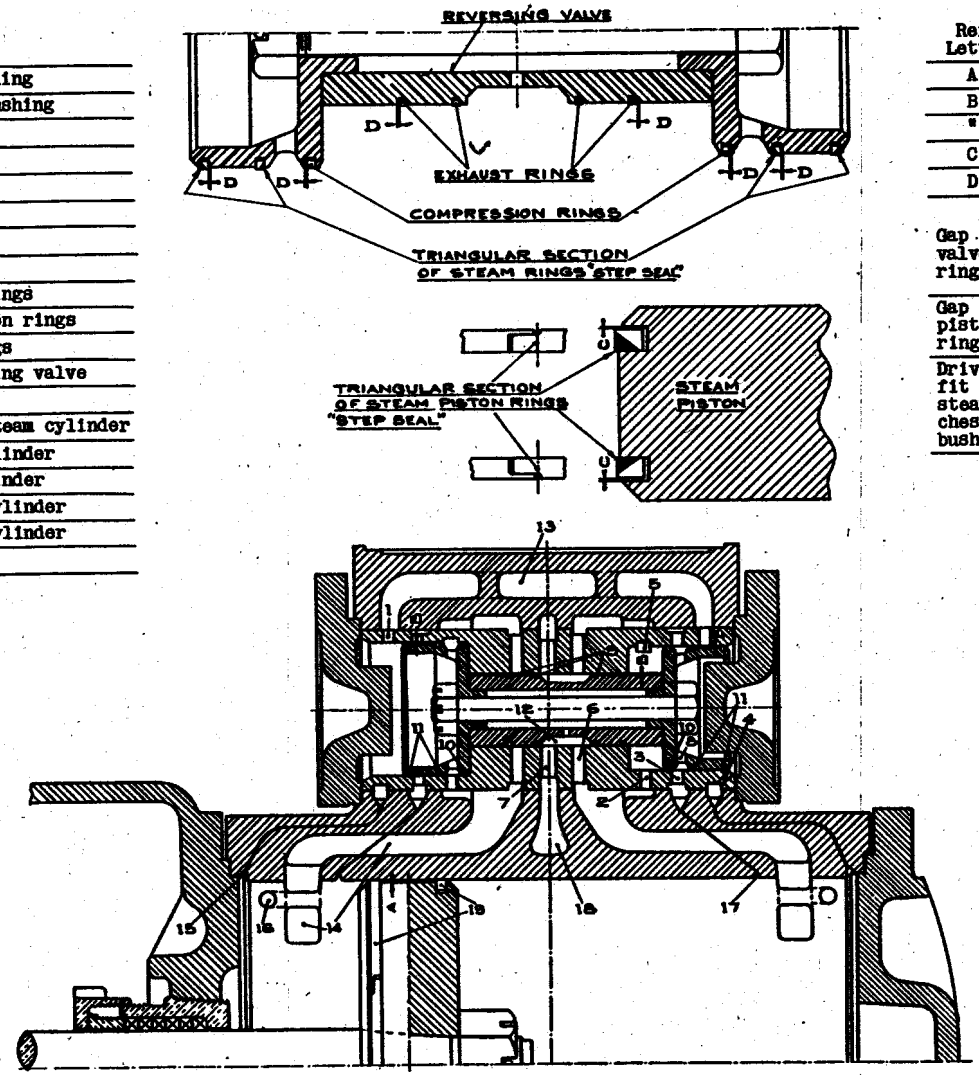


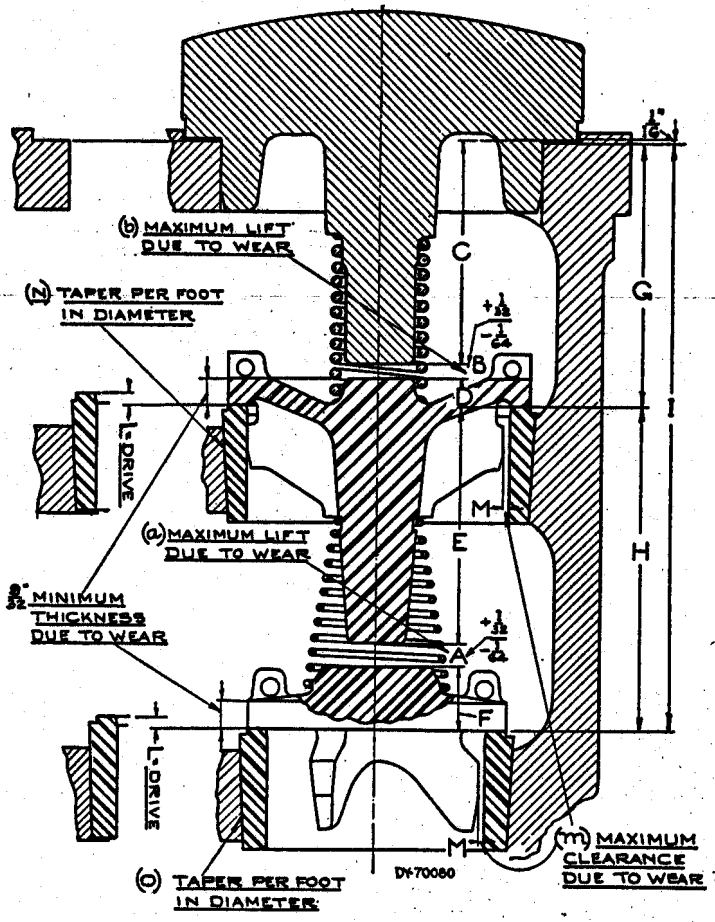
FIG. 10 Control Valve Assembly for Heater

Ref. No.	NAME OF PART
1	Primary steam port in bushing
2	Secondary steam port in bushing
3	Reversing port in bushing
4	Starting port in bushing
5	By pass slot in bushing
6	Exhaust port in bushing
7	Exhaust outlet in bushing
8	Reversing port in valve
9	Reversing valve exhaust rings
10	Reversing valve compression rings
11	Reversing valve steam rings
12	Exhaust passage in reversing valve
13	Passage in steam chest
14	Steam port & passage in steam cylinder
15	Starting port in steam cylinder
16	Cushion port in steam cylinder
17	Reversing port in steam cylinder
18	Exhaust outlet in steam cylinder
19	Steam piston rings



Ref. Letter	New	Wear Limit
A	.008 to .013	3/64
B		.024
"	.007 to .010	
C	.002 to .004	.010
D	.002 to .004	.008
Gap in valve rings	.005 to .010 for 1 7/16, 1 11/16 and 2" dia steel rings	3/32
Gap in piston rings	.020 to .030	5/32
Drive fit on steam chest bushing	.003 to .005	

FIG. 11. Dimensions and Tolerances for Steam Cylinder.



A	a	B	b	C	D	E	F	G	H	I	L	M	m	N	O
7/16	17/32	5/32	±	3 5/32	3/8	2 25/32	29/32	3 5/8	4 1/8	7 3/4	5/32 to 3/16	1/32 to 3/64	1/8	7/8	7/8

FIG. 12. Dimensions and Tolerances for Pump Valve Service

VALVE SPRINGS

Where Used	Part No.	Size B.W.G.	Wire Diameter, Inches	Total Number of Coils	Ins. Diameter Top, Inches	Out Diameter Bottom, Inches	Uncompressed Length, Inches	Initial Compressed Length, Inches	Strength at Initial Length, Pounds	
									When New	Limit Due to Service
Suction	28786	11	.12	13	1 3/16	2 5/16	3 7/8	2 11/16	5½	4
Discharge	28787	7	.18	11	1 5/16		3½	2½	40	28
Drift. control valve	29789	11	.120	9	1 3/8		3 7/16	1 7/8	20	14
Spray Value	29117	9	.148	8	1 13/16		3½	2 5/16	18	13

Rod Dia. A	Box Dia. B	Depth of Box C	D	E	Sea-Ro Packing No. of Rings Per Box	Sea-Ro Packing Part Number	Total Packing Depth	No. of Chevron Rings Per Box	*Chevron Packing Part No. Standard to 1/16" Undersize	*Chevron Packing Part No. 1/16" to 1/8" Undersize	Boxes Per Pump B&BL	Boxes Per Pump S&SA
2¼"	3	2 3/8"	3/16"	13/16"	6	28583	1 7/8"	6	29443	29444	4	2

*In Addition To Adapter Rings

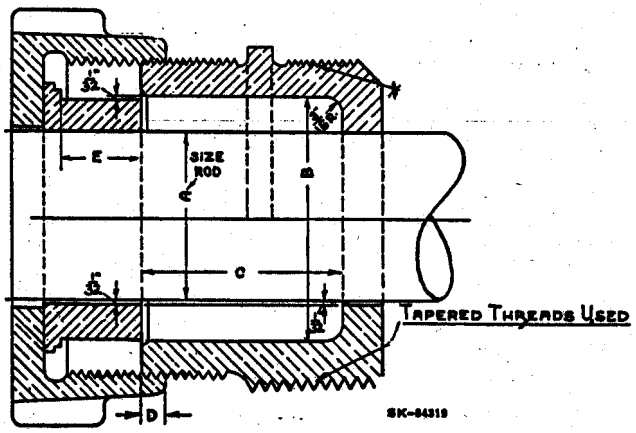


FIG. 13. Dimensions for Piston Rod Stuffing Box and Packing.

Dia. "A"	Dia. "B"	Groove Width "C"	Packing Width "D"	Standard Including 3/32 Oversize "E"	"F"	"G"	Part No.	Between 3/32 And 3/16 Oversize "E"	"F"	"G"	Part No.	Between 3/16 And 9/32 Oversize "E"	"F"	"G"	Part No.
8¼	6 15/16	5/8	5/8 LESS .017 .020	8 7/8	7½	13/16	29379	9	7½	7/8	29445	9 3/32	7½	59/64	29454

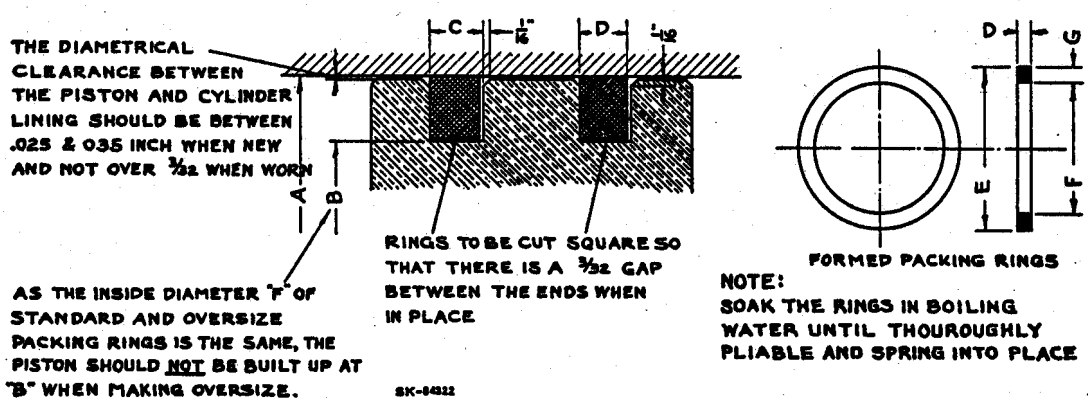


FIG. 14. Dimensions of Piston Groove and Packings, Solid Type Hot Water Pump Pistons.

THE PENNSYLVANIA RAILROAD

LOCOMOTIVE MAINTENANCE INSTRUCTIONS NO. L-58

INSTRUCTIONS FOR OPERATING AND MAINTAINING WORTHINGTON LOCOMOTIVE BOILER FEED PUMP AND FEED WATER HEATER, TYPES SA AND SAS, SIZE 6½

Supplement No. 1

Issued Philadelphia, Pa.
May 23, 1947

The following shall be added to the second paragraph under "OPERATION" on Page 3 of the present issue of the Circular:

On the road when the tender is nearly empty or in using the track trough, the suction pipe may become full of air, and in winter, full of steam, from excessive use of the anti-freeze valve, The cold pump will then be air or steam bound and will not deliver water. The pump should then be stopped and the air vent valve (Part 38, Fig. 1) in the cab, opened and, if necessary, the pet cocks on the top of the cold pump suction line opened.

H. T. COVER
Chief of Motive Power.