

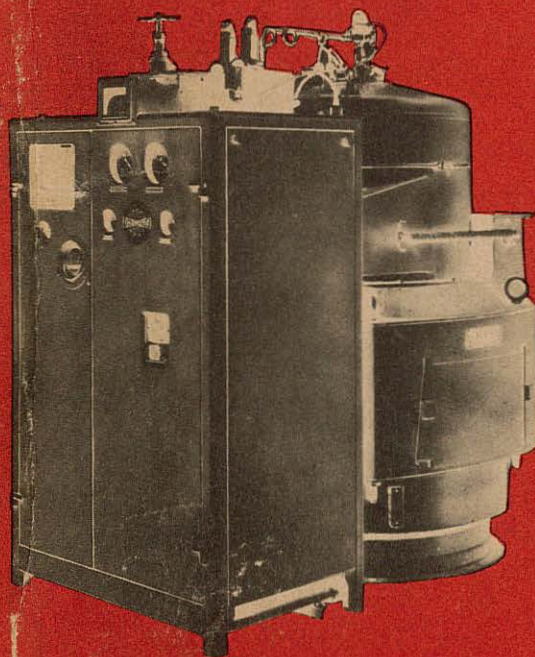


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32502 VV
running repair

redbook

BOOK 255
JULY, 1955



MODEL NO.
OK-4625

VAPOR HEATING CORPORATION

RAILWAY EXCHANGE BUILDING, CHICAGO 4, ILLINOIS

VAPOR CAR HEATING OF CANADA, LTD.
65 DALHOUSIE ST., MONTREAL, CANADA

$1 \text{ kg/cm}^2 \sim 14,223 \text{ lbs/sq inch}$

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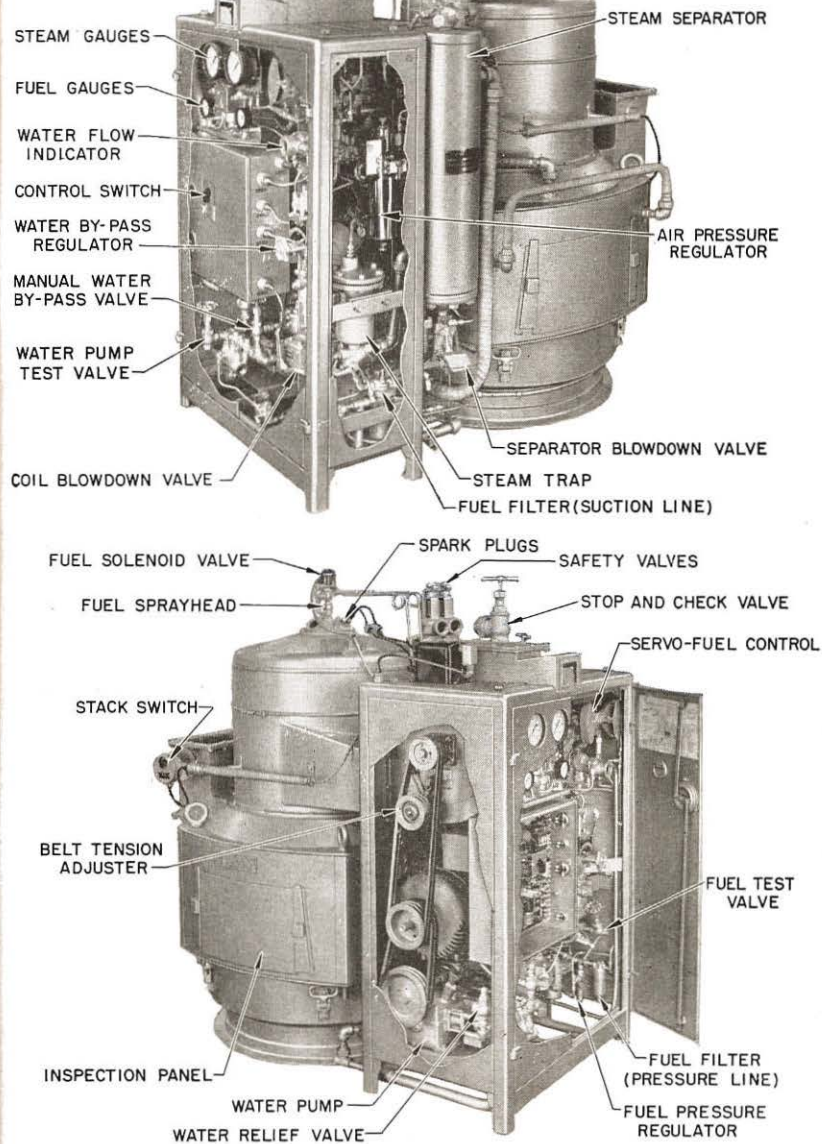


Fig. 1. OK-4625 Steam Generator.

RUNNING REPAIR REDBOOK

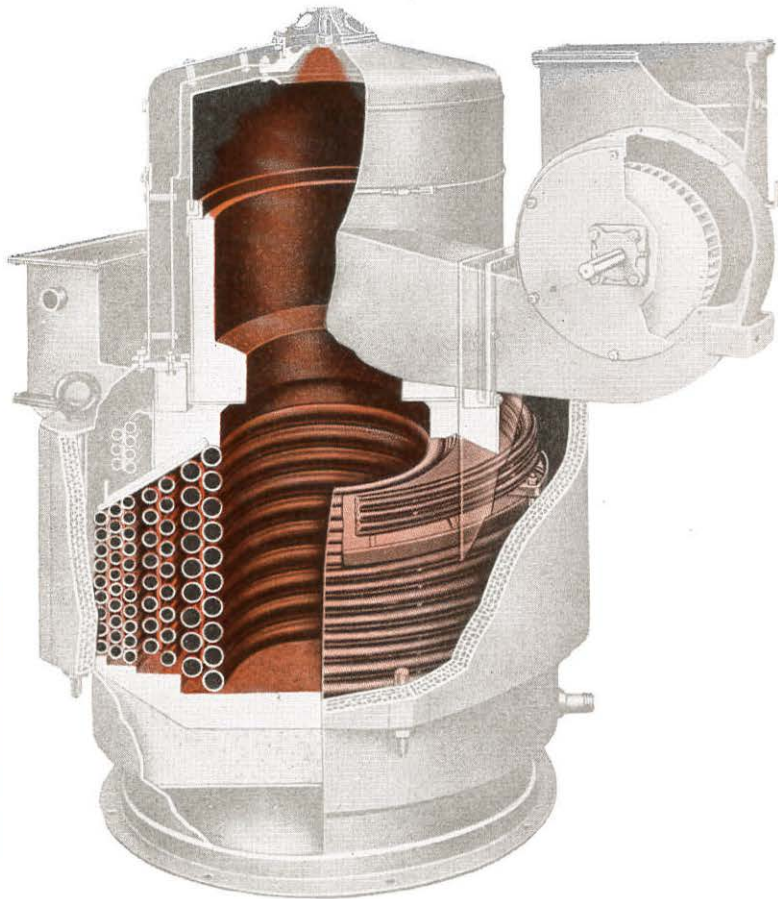
OK-4625

Vapor Clarkson Steam Generator

HOW TO USE THE REDBOOK

This manual is intended as a complete guide to maintaining and understanding the operation of the Vapor-Clarkson Model OK-4625 steam generator. If the function of each of the systems outlined here are carefully studied, the analysis and correction of any operating difficulty will become a matter of common sense deduction. For your help in locating operating problems quickly, the "Find It and Fix It," Chart II, at the back of the manual, should be consulted first. This will guide you in locating the particular system, and probably, the particular control needing inspection or adjustment. Every control mentioned in the "Find It and Fix It" chart and in the schematic piping diagram which accompanies it, is explained in detail in the body copy and can be referred to by looking up its key number in the component devices index, page 97.

A study of this manual will soon indicate the simple, logical construction of the Vapor generator and, by conscientiously following the suggestions offered here, you will receive the best service from your units for the least personal effort.



OK-4625 BOILER AND BLOWER

GENERAL SPECIFICATIONS

OK-4625 STEAM GENERATOR

Water Relief Valve--unloading setting	575 lbs.
Fuel Pressure Regulator--set at high fire to give manifold pressure of . .	150-155 lbs.
Air Pressure Regulator--atomizing air pressure	40-45 lbs. - On Dual Installations. 70-75 lbs. - On Single Installations.
Water Pressure Range (low to high fire)	225-350 lbs.
Normal Steam Temperature, at 200 lbs. pressure	388° F.
Steam Temperature Limit Control--operates at approximately	425°-450° F.
Stack Temperature	525°-600° F.
Stack Switch--	
high temperature cutout	900° F.
low temperature cutout	250° F.
Outfire Relay--time delay is	43-47 sec.
Motor Speed (high fire)	1750-1800 R.P.M.
Blower Speed (high fire)	2500-2550 R.P.M.
Water Pump Speed (high fire)	915-935 R.P.M.
Amperage Draw (74 V.D.C.)	45-55 amp.
Maximum Evaporative Capacity (High Fire)	3000 lbs. per hr.
Lowest Steam Generating Rate Without Cycling (low fire output)	800-1000 lbs. per hr.
Fuel Consumption (per hour at maximum output)	236 lbs.
Water Volume	24.5 gal.
Dry Weight	4000 lbs. net.

VAPOR HEATING CORPORATION

80 E. JACKSON, RAILWAY EXCHANGE, CHICAGO 4, ILLINOIS

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VAPOR HEATING CORPORATION
RAILWAY EXCHANGE BUILDING, CHICAGO 4

WATER SYSTEM

The colored piping schematic diagram in the back of this manual illustrates the flow of feed water, steam, and return water through the generator. The successive stages of flow are outlined as follows:

WATER FLOW:

1. The water pump draws water from the supply tank through the water strainer tank or water treatment tank.
2. Then the water pump test valve and the water relief valve (set to unload at 575 lbs. water pressure) are taken off the pressure side of the pump, the manual water by-pass valve return line is piped from the pressure side to the suction side of the pump, and the feed water line leads to the water by-pass regulator and the servo control.

The water by-pass regulator controls the amount of feed water admitted to the servo-fuel control by regulating the amount of water by-passed back to the suction side of the water pump; it is operated by trainline steam pressure. The manual water by-pass valve allows manual control of the amount of water by-passed, and is normally closed; it is used only if the water by-pass regulator does not function properly, or in setting the servo fuel control.

The servo-fuel control admits fuel to the sprayhead, and combustion air to the firepot, in direct proportion to the amount of feed water flowing through the servo.

3. The feed water passes through the servo, and on through a lift check valve (prevents washout solution from backing into the servo during washout procedure) and the heat exchanger chamber, where the feed water absorbs heat from the hot return water flowing back to the supply tank.
4. From the heat exchanger, the feed water flows through a lift check valve (prevents generator steam pressure from backing into the heat exchanger) and on through the coil inlet valve into the steam generator coils where 90% to

95% of the feed water is converted into steam. The excess water flushes scale and sludge from the coils and is carried over with the steam into the steam separator.

The coil blowdown valve leads from the coil inlet. It is a normally closed valve, and is used to back-blow the coils.

STEAM FLOW:

5. Steam passes from the coil outlet through the steam temperature limit control; this device cuts down the flow of fuel to the sprayhead if excessive steam temperatures develop.
6. The steam flow continues through the steam separator and remote control trainline shutoff valve into the steam trainline. The steam separator removes the excess water and sludge from the steam; sediment collecting in the bottom of the separator is blown out periodically through the separator blowdown valve.
7. A small steam line and shutoff valve leads from the outlet nipple of the steam separator to radiation under the water pump. Condensate from the radiation flows through a small steam trap to the water supply tank. The shutoff valve should be opened only in freezing weather.

Another small steam line and shutoff valve leads from the outlet nipple of the steam separator to the diaphragm of the water bypass regulator. This line allows steam generator pressure to act against the diaphragm in operating the regulator.

RETURN WATER FLOW:

8. The water separated from the steam in the steam separator flows back through the steam trap, heat exchanger coil, three-way washout valve and return water flow indicator into the water supply tank.

STANDBY OPERATION:

9. Water flow in standby operation follows the same path as in normal operation with the following exceptions. The stop and check valve at the top of the steam separator is

closed, preventing the entrance of any water or steam into the trainline. Most of the output of the generator is forced through the standby return line valve and relief valve which are open in this type of service. The standby relief valve develops a small amount of back pressure in the steam separator which assures some flow of hot water through the steam trap, heat exchanger and other water return line devices.

10. The standby circulating pump operates continuously when the steam generator is in standby. During those intervals when the system is calling for heat and the fire is burning, the regular feedwater pump will be in operation and will completely over-ride the action of the small circulating pump. As soon as temperature conditions are satisfied, the feed water pump shuts down and allows the standby pump to continue circulating hot water throughout the steam generator piping system.

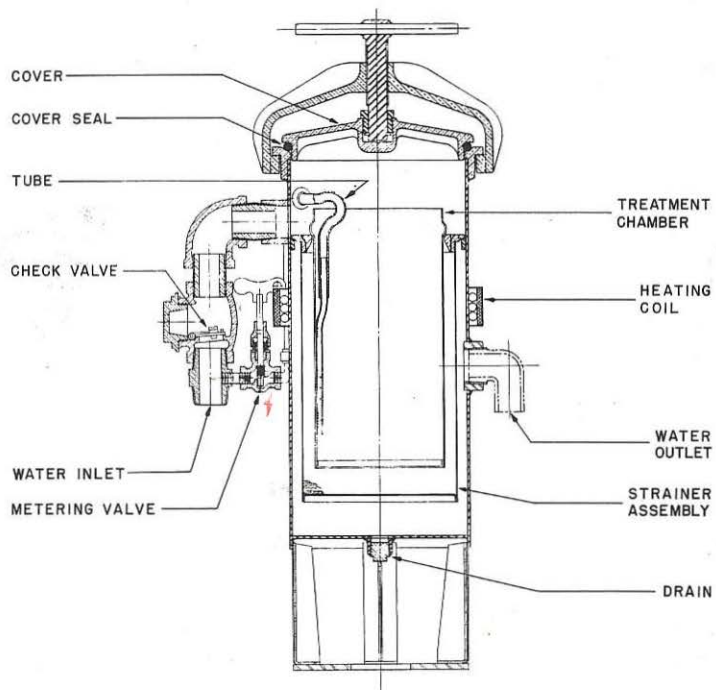


Fig. 2 - Feed Water Treatment Tank

FEED WATER TREATMENT TANK (234)

This device is placed in the water suction line between the water supply tanks and the feedwater pump, to provide a method of adding treatment to the raw feedwater entering the steam generator.

OPERATION:

To fill the treatment tank, remove the cover by loosening the C-clamp at the top of the tank. Solid water treatment in stick or ball form is placed in the treatment chamber and the cover replaced and secured. Be careful not to twist the O-ring seal when replacing the cover.

When the feed water pump is operated, water is drawn by suction from the supply tanks and spilled into the strainer section of the treatment tank. A weighted check valve is placed in the suction line at this point to create a slight back pressure which forces part of the water flow to be drawn through the metering valve line and empty into the treatment chamber where it dissolves the solid treatment. This check also serves to keep the suction line primed. The exact percentage of the total feed water flow which is utilized for water treatment can be regulated by the setting of the treatment metering valve.

The position at which this valve is set should be determined by your water chemist.

MAINTENANCE:

By virtue of its position in the water circuit the treatment tank must be kept completely air tight. Otherwise, loss of suction head will prevent feed water from being drawn from the supply tanks. The points at which suction leaks can most readily occur are at the cover seal and the drain valve at the bottom of tank. These items should be inspected carefully whenever loss of suction head is indicated.

Feed water flow will also be reduced if the treatment tank strainer is allowed to become clogged with dirt. Clean the strainer thoroughly whenever water treatment is added or off-tener if necessary.

STANDBY CIRCULATING PUMP (240)

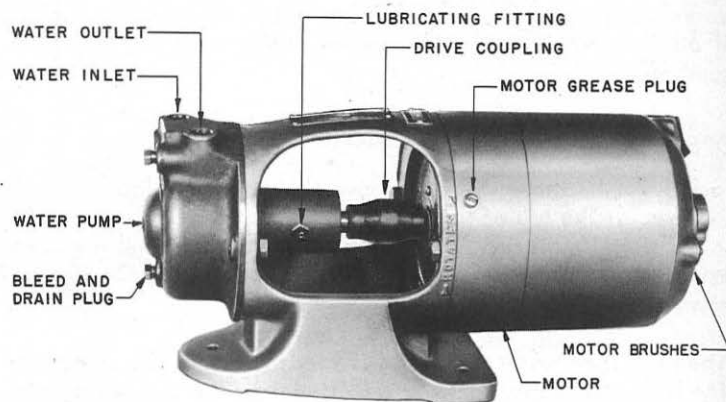


Fig. 3 - Standby Circulating Pump and Motor (No. 240)

This is a small 2 stage centrifugal water pump and drive motor which circulates warm water throughout the piping system during the "off fire" intervals of stand by operation. It is piped into the water suction line across a one inch check valve and is in parallel with the suction line. When the generator feed-water pump is running, water is drawn through the check valve from the treatment tank, over-riding the action of the circulating pump. Shutting down the feed-water pump allows the centrifugal pump to take over and keep the system continually flooded with warm water.

MAINTENANCE:

1. Lubricate the pump bearings every 30 days with a good grade of water pump grease. Force enough grease through the bearing chamber to purge out any water or oxidized lubricant which may have accumulated.
2. Any suction leak which may develop through the pump gaskets or mechanical seal will reduce the feed-water flow to the generator. These items should be inspected if a suction leak is suspected.

3. Inspect the pump motor brushes and commutator every 30 days.
4. Excessive noise from the circulating pump may indicate worn bearings or impingement of the impellers on the pump body. The pump should be dismantled and these items inspected for wear.
5. If the circulating pump is found inoperative the normal operation of the steam generator will not be affected. It is not advisable, however, to operate the unit in standby if this is the case. The circulating pump should be repaired as soon as possible.

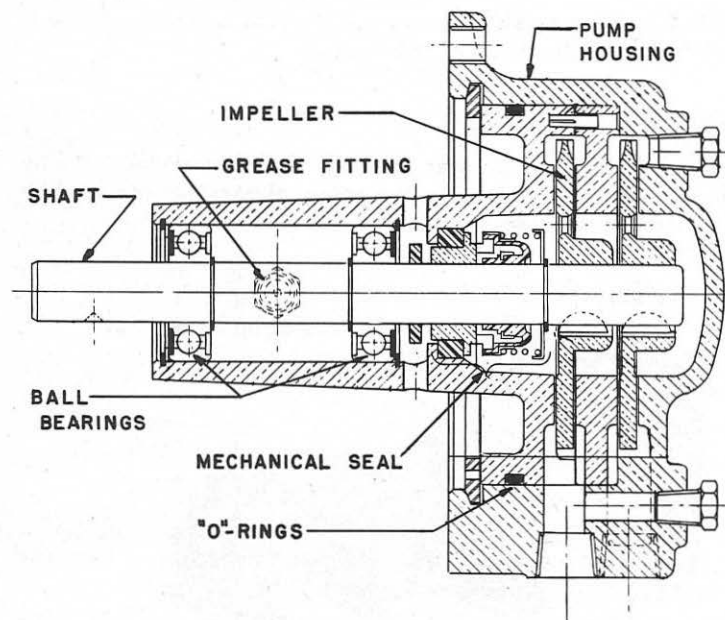


Fig. 4 - Internal Construction of Standby Pump

FEED WATER PUMP

(230)

This is a three cylinder pump with flat discharge and suction valves. Its normal working pressure, with 250 lbs. generator steam pressure, should not be over 450 lbs. -- any pressure over 450 lbs. indicates a restriction in the steam generator coils and should be taken care of immediately. The pump is protected by a water relief valve set to open at 575 lbs.

The flow of water should be steady at all times; violent fluctuation of the water pressure gauge indicates lack of water in the tanks, air in the suction line, treatment or strainer tank cover loose, a clogged screen, or failure of a pump valve. Open the water pump test valve, or bleeder plugs, while the pump is in operation to bleed the water line of air or vapor.

If this condition persists, trace your trouble using the "Find it Fix it" chart in the back of the manual.

REPACKING PLUNGER:

Leakage through the plunger packing can be corrected only by determining and eliminating the cause of packing wear and by replacing the packing.

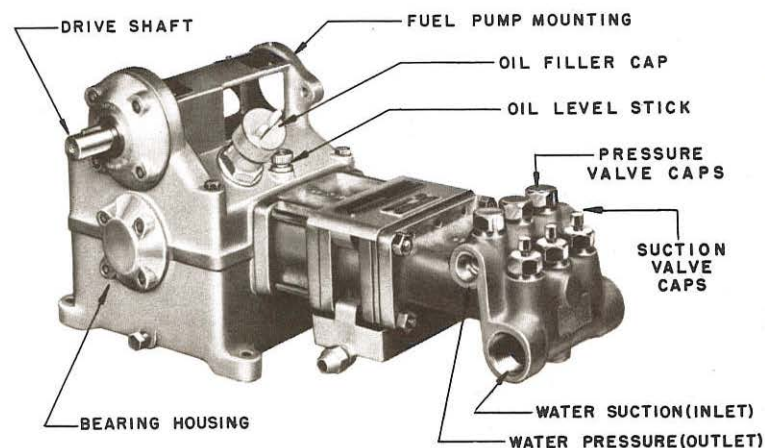


Fig. 5 - Feed Water Pump (No. 230)

To replace the packing, break the union fittings in the pump piping and then remove the four hex-nuts holding the pump cylinder body to the plunger guide. The cylinder body can now be moved forward and will slip off of the pistons to expose the packing. The packing is a spring loaded homogenous chevron type and is mounted on the end of the piston.

Removing the allen cap screw from the end of the piston will free the entire packing assembly and permit its removal. At this time, carefully examine the condition of the cylinder walls. There should be no roughness or corrosion on their surfaces and no accumulation of dirt or grit. Conditions such as these are the main cause of packing wear and should be corrected as soon as possible.

The grooves in the packing should be filled with water pump grease before assembling. Be careful when replacing and tightening the cylinder block. The studs must be tightened evenly on all sides to prevent binding.

PLUNGERS AND CONNECTING RODS:

If the plunger sleeves show wear or scoring, the sleeves should be replaced.

Wear in the wrist joint can be taken up by tightening the adjustment screw snugly -- be sure to resolder.

Wear in the connecting rod bearing can be taken up by removing some of the bearing shims.

The overall length of the plunger rods should be adjusted to give from 1/16" to 1/8" clearance at the cylinder end. The length can be adjusted by screwing the rod in or out of the crankshaft bearing after loosening the rod nut.

VALVES:

When it is necessary to grind the flat valves, the valve and seat can be removed and lapped. Use our valve seat removing tool No. 21319. To grind the valve in place, use a pencil with a rubber eraser which can be fitted into the guide hole, and move the valve more or less concentric with the seat. The rubber eraser gives flexibility and allows the valve to seat itself. A fine valve grinding compound should be used.

(Continued on Page 15.)

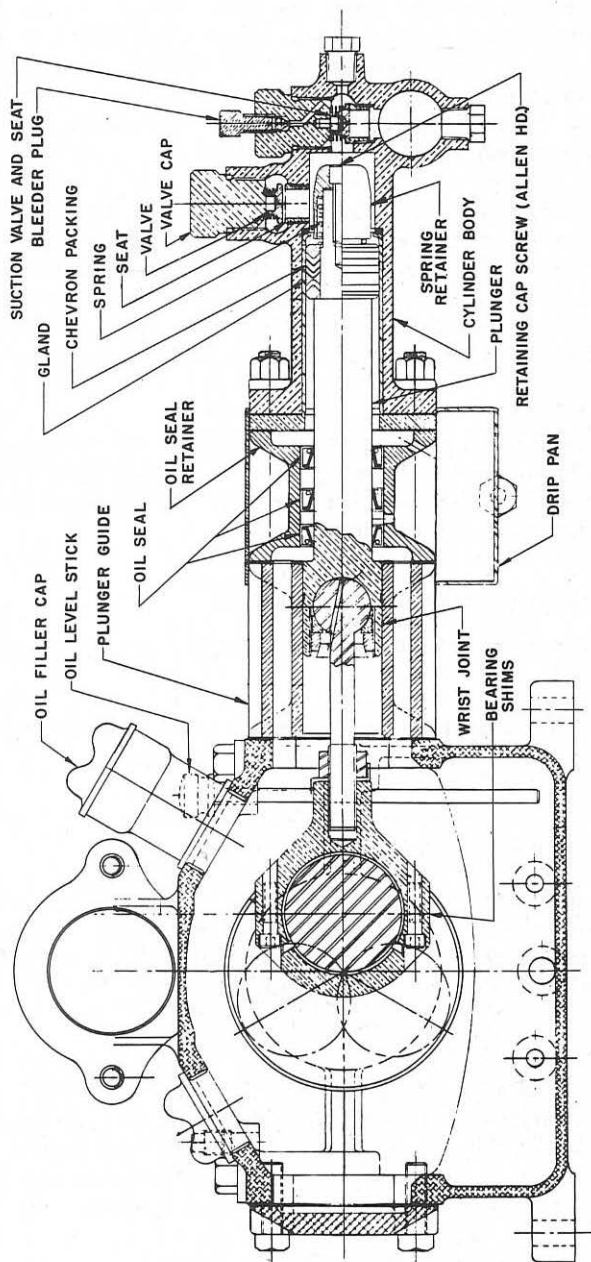


Fig. 6 - Internal Construction of Feed Water Pump (No. 230)

When replacing the valve caps be sure the valve guide pin enters the guide hole in the valve. The cap should be screwed in all the way by hand before putting a wrench to it. In failing to observe this precaution you may burr the guide pin and jam the valve.

LUBRICATION

Keep the pump filled to capacity (2 Qts.) with SAE #20 lube oil. The oil should be clean and free from grit and moisture. (Moisture in the oil will give it a milky appearance. Change this oil as soon as possible and inspect the pump packing for leaks.)

OVERHAUL:

Once a year this pump should be completely disassembled, cleaned and inspected. Worn parts should be replaced and gaskets renewed.

WATER RELIEF VALVE
(112)

The water relief valve is placed in the pressure side of the water line to protect the water pump against excessive back pressure. The valve is adjusted to open at 575 lbs. water pressure.

Leakage from the valve may be caused by dirt or scale settling between the valve disc and seat bushing, or by scoring or improper seating. If necessary, the disc and bushing should be replaced.

Water leakage will also result if the spring is broken.

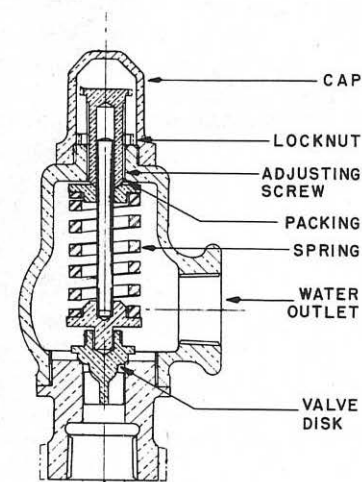


Fig. 7 - Water Relief Valve

WATER BY-PASS REGULATOR

(111)

The water by-pass regulator controls the admission of feed water to the steam generator coils by regulating the amount of water by-passed back to the suction side of the water supply line. The regulator is operated automatically by generator steam pressure acting against spring tension which is manually adjusted for the desired steam pressure. When this pressure is attained, a diaphragm overcomes the spring tension on the operating rod and pushes it down; the downward movement is transmitted to the valve, which opens and by-passes feed water back through the suction side of the water supply line.

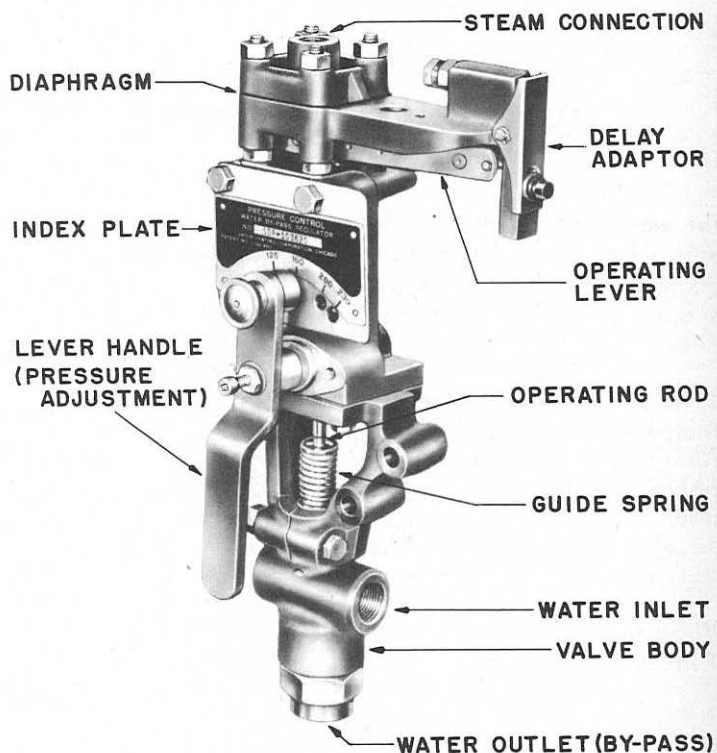


Fig. 8 - Water By-Pass Regulator (No. 111)

DIFFERENTIAL DELAY ADAPTER:

The differential pressure delay adapter delays the full opening of the by-pass valve in the regulator enough to move the servo cam plate directly from about the low fire adjusting screw to the no fire position when the unit cycles "off."

The operating lever of the delay adapter is secured to the diaphragm button by a pin, and it swings on a second pin in the adapter body as the diaphragm moves up and down. A roller pin is attached to the end of the operating lever. This roller pin must pass over a lip on the friction block, before the regulator will by-pass enough water to move the servo to the off position. The travel of the servo cam plate when the delay adapter roller first engages the lip of the friction block should be approximately at the second cam plate adjusting screw position. (First pin.) The friction block can be positioned to meet this condition--by loosening the allen set screw holding the block and moving the block up or down as is necessary. (See adjusting procedure.) The increase in steam pressure necessary to force the roller over the friction block lip should produce a 35 pound total pressure differential from the point of firing to the point of cut-off when the steam generator is cycling. (Alternating firing and shutting down under low steam demand.)

Thus, as the steam generator approaches the "off" cycle, the diaphragm button moves down until the roller pin is stopped by the lip on the friction block. The steam generator continues to operate at low fire until about 35 lbs. pressure differential is built up. Then, the roller pin snaps over the lip, the operating rod completes its downward travel, and the valve in the by-pass regulator opens completely; all the feed water is by-passed and the servo cam plate moves to the block and shuts down the fire.

Similarly, coming into the "on" cycle as trainline pressure drops, the lip on the friction block engages the roller pin and keeps the by-pass valve in the regulator open until a pressure differential is established sufficient to snap the roller over the friction block, giving enough initial feed water flow through the servo to move the cam plate directly from the no fire position to about the second pin of the fire position.

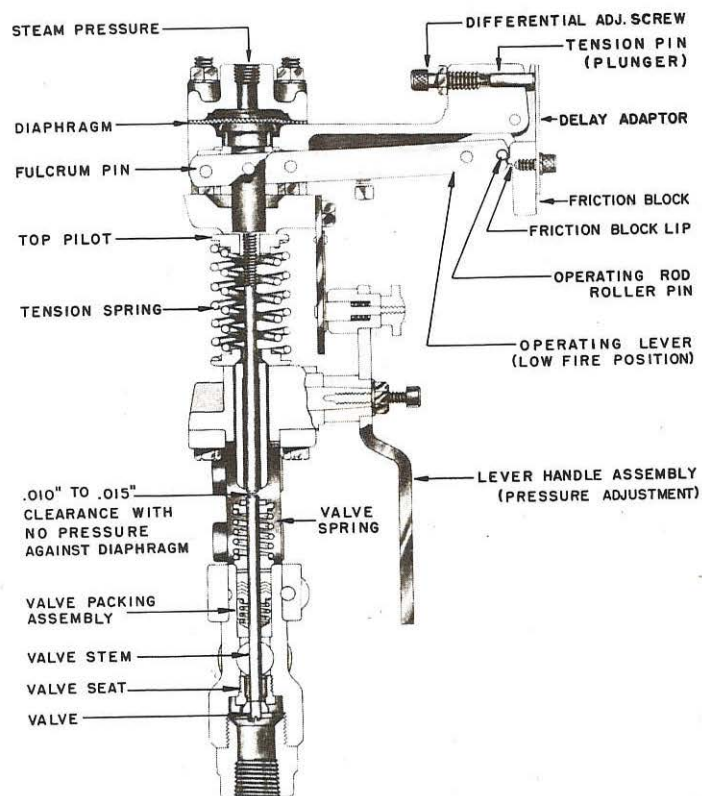


Fig. 9 - Internal Construction of Water By-Pass Regulator (No. 111)

It is very important to the operation of the steam generator that the delay adaptor be set properly. If the operating lever roller does not snap over the lip of the friction block when the generator cycles off, the water by-pass regulator will bring the servo in and out of the firing position very slowly, and with very little travel of the cam plate. The tendency will be for the servo to "hang" at the point at which the servo switch operates. As a result of this condition, almost as much feed water will be entering the generator coils when the fire is "off" as when it is "on". If the trainline shut-off valve or stop and check valve is closed when this condition exists, the generator will soon flood with water and produce a hydraulic lock which will batter the water-by-pass regulator open and closed at every pulse of the water pump. The diaphragm in this control will be ruptured very quickly unless proper correction is made.

ADJUSTING PROCEDURE:

Before adjusting the delay adaptor be sure that the servo fuel control admits fuel and combustion air to the firepot in the proper proportions, and be sure that the cutout switch opens just when the center of the fuel metering valve roller is in line with the lower edge of the first hole in the cam plate (see illustration). Then follow the procedure given below:

1. With the steam generator in operation, set the water by-pass regulator to hold 230 lbs. steam pressure and throttle the stop and check valve until the steam generator begins to cycle frequently. Loosen the adjusting screw to release the spring tension against the plunger and friction block.

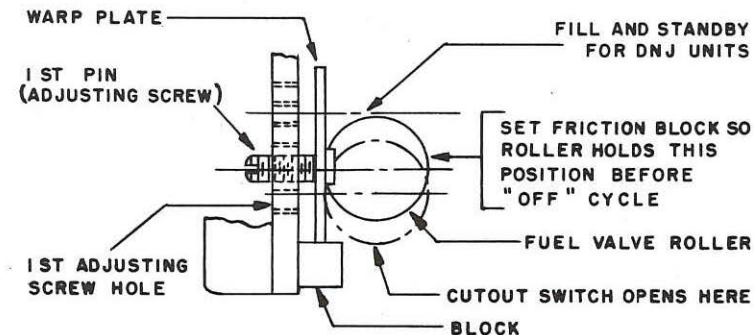


Fig. 10 - Servo Cam Roller Positions

2. When coming into the "off" cycle, the lip on the friction block should engage the operating lever roller when the center of the first pin in the cam plate is in line with the center of the fuel valve roller. Hold the friction block in as the servo cam plate comes down in the "off" cycle and observe the position of the first pin in relation to the fuel valve roller; if the center lines of the pin and the roller are not in alignment, loosen the locking screw and adjust the position of the friction block as follows:

- a. Lower the friction block if the center of the first pin travels beyond the center of the fuel valve roller.
- b. Raise the friction block if the center of the first pin does not travel up to the center of the fuel valve roller.

NOTE: The safety valve will pop if the friction block is held in too long.

3. After the friction block is properly positioned and secured with the locking screw, tighten the spring adjusting screw until the tension on the plunger is sufficient to maintain 35 lbs. pressure differential between the actual generator pressure and the pressure for which the water by-pass regulator is adjusted. The gauge pressure should build up to 265 lbs. before the servo cam plate moves to the block, and at 230 lbs. the cam plate will move off the block as the steam generator cycles "on."

NOTE: Slight lubrication on the spring plunger, delay adaptor spring, operating lever roller and diaphragm button shaft is advisable.

MAINTENANCE:

1. Valve and Seat: Check for sludge formation, improper seating and wear. Be sure that the packing around the valve stem is snug and in good condition.
2. Diaphragm: Renew every six months.
3. Operating Rod: The clearance between the operating rod and the valve stem should be kept between .010" and .015". When overhauling a water by-pass regulator check this clearance before assembling any parts above the yoke.

SERVO FUEL CONTROL

(108)

The servo control is a hydraulically operated device designed to meter fuel to the sprayhead and regulate the amount of combustion air delivered to the firepot in direct proportion to the amount of feed water entering the coils. The following steps outline the servo operation:

1. Feed water comes into the lower side of the diaphragm chamber and pushes the diaphragm up; as the diaphragm comes up, the feed water passes through the opening between the diaphragm collar and the tapered metering pin. The height to which the diaphragm is raised varies in direct proportion to the amount of feed water passing through the diaphragm collar. It is not water pressure that regulates the servo -- the volume of water flowing through the diaphragm chamber regulates the control.
2. As the diaphragm is raised it turns the operating rod assembly against tension of the clock spring and retainer can; this motion is transmitted through the drive coupling assembly to the slot valve inside the shaft.
3. As the slot valve turns inside the shaft, it uncovers a port in the shaft carrying fuel at manifold pressure. This fuel is directed against the right hand hydro-piston. Because the hydro-piston is linked to the shaft, fuel pressure acting against the piston turns the shaft in the same direction as the slot valve until the fuel port feeding the hydro-piston is once more covered. While one side of the slot valve is uncovering the pressure port to the right hand piston, the other side of the valve is venting fuel out of the left hand piston.
4. The servo cam-plate is attached rigidly to the shaft. In this way, the cam-plate exactly follows the motion of the slot valve which is being turned in proportion to the volume of water flowing through the diaphragm chamber.
5. The adjusting screws on the cam-plate are set to decrease the cam contour at progressively further distances from the "off" position. As the cam-plate turns, it regulates the position of the fuel metering valve and the combustion air damper through the roller linkage.

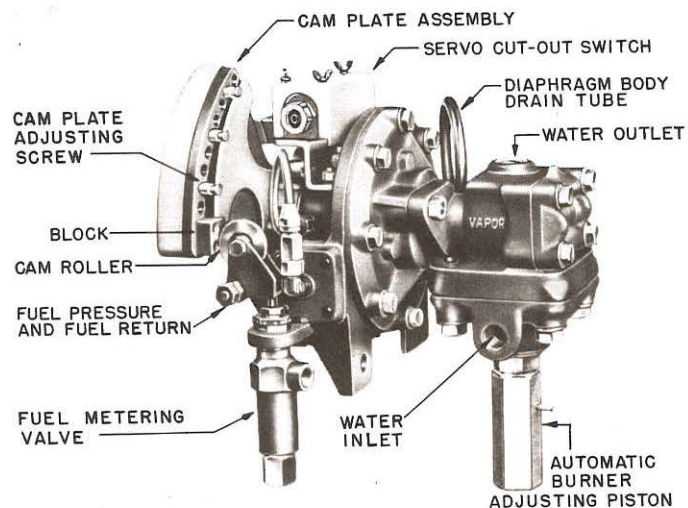


Fig. 11 - Servo Fuel Control (No. 108)

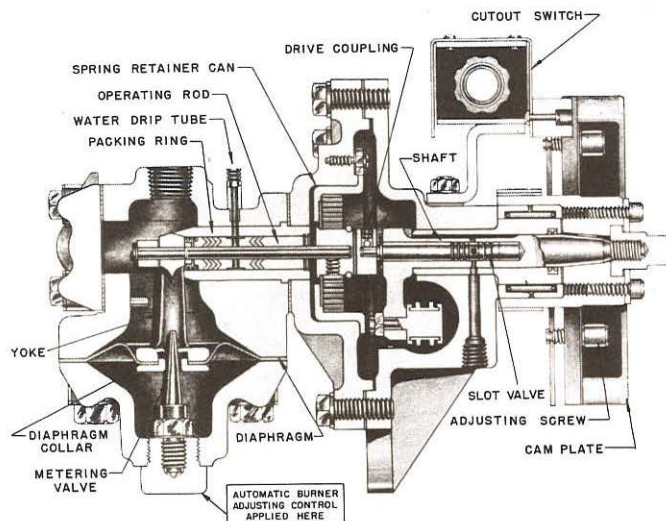


Fig. 12 - Internal Construction of Servo Fuel Control (No. 108)

- If the volume of water flowing through the diaphragm chamber is decreased, the diaphragm will take up a proportionately lower position. This will cause the slot valve to turn in the opposite direction to that induced by increasing water flow. Now, the fuel pressure port in the shaft will be opened to the left hand hydro-piston and the right hand hydro-piston will be vented. The motion of the hydro-piston will again turn the shaft in the same direction as the slot valve until the fuel port in the shaft is once more covered. At this point, the hydro-pistons are locked hydraulically until increased or decreased water flow changes the position of the diaphragm and slot valve.

MAINTENANCE

Good maintenance of the servo calls mainly for checking the gaskets and pipe fittings for leaks. The damper and fuel valve linkage on the control should be kept well oiled and free to move.

A small leak in the diaphragm will cause faulty operation of the servo and unbalance the fuel-water ratio in the steam generator. The cam plate will remain completely stationary if the diaphragm develops a fairly large leak.

The diaphragm should be renewed every six months. A complete overhaul is recommended every year, renewing the packing and cleaning and examining the parts for wear.

ADJUSTING THE SERVO

Once the servo fuel control is adjusted on a generator it is seldom necessary to readjust the device. If an unbalanced condition in the fuel-air-water ratio develops while the generator is in service, it is more than often the result of improper functioning of controls or appurtenances other than the servo. Therefore, before attempting to adjust the fuel-air-water ratio by changing the servo cam-plate setting, be sure all other portions of the generator are in proper operating condition. (This is especially true if a servo is replaced with a new control.) Use the following list as a guide in checking your generator before attempting to set the servo:

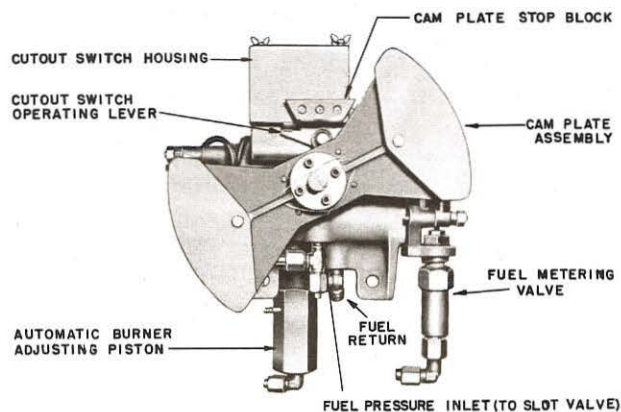


Fig. 13 - Servo Fuel Control (Front View)

- a. Remove any soot which may be deposited on the outside of the steam generator coils. Wash the coils internally with acid as described in the coil washing section.
- b. Remove the air dome and examine the refractory, sealing cements, and coil pads for holes which may by-pass the flue gases around the generator coils.
- c. Examine the fire pot, air ring and stabilizing cone for warping or deterioration.
- d. Clean the fuel sprayhead and nozzle. Check the nozzle ports for wear.
- e. Set the electrodes and sprayhead with the recommended gauge. (No. 109,986).
- f. Inspect the blower fan and blower bearings. Be sure the fan is intact and turns freely.
- g. Check the blower and water pump belts for proper tension.
- h. Be sure that the damper moves freely.

- i. Clean the treatment tank strainer, feedline, check valves, steam trap and trap strainer.
 - j. Adjust the atomizing air pressure to the proper setting. (See Specification Table)
 - k. Calibrate the fuel and steam pressure gauges.
- Turn the control switch to fill and fill the coils. Check the following items:
- l. Check the motor and blower for speed and adjust to the figures listed in the specification table.
 - m. Examine the water pump for packing leaks. Be sure there is no suction or valve leakage. (Servo travel and water pressure should be steady - not fluctuating.)
 - n. Check the heat exchanger coil and coil blowdown valve for leaks.
 - o. Fuel manifold pressure should be about 155 to 160 pounds on Fill. (Adjust to 150 pounds when generator is fired.)

If a new servo is being applied to the generator, it is best to make as close a visual adjustment as possible before lighting the fire. Set the following items as accurately as you can with the control switch in the off position.

- 1.) Set the adjustable cam step ring to operate the micro switches when the center of the fuel cam roller is abreast of the first cam plate adjustment hole. (See diagram) You will be able to hear the micro switch click in and out by turning the cam plate with your hand.
- 2.) Set the damper so that its edge will be about $3/4$ " from the side of the damper duct in low fire position and $1-7/8$ " from the side of the damper duct in high fire position. Be sure that the damper spring is under tension through the full travel.

With the damper opening and closing through this approximate setting, the low fire adjusting screw should be at about the mid-point of its adjusting range.

- 3.) On the fuel metering side of the servo, the face of the warp plate should lie about 1/16" below the edge of the cam plate stop block in low fire and about 5/16" from the cam plate in high fire. The warp plate should slope gradually toward the cam plate as travel progresses from low to high fire on both fuel and air adjustments.

These approximate settings will bring the balance of the air, fuel and water in close enough range to proceed with the final setting as follows:

Final Adjustment

- a.) Open the stop and check valve, remote control trainline shut off valve and end valve. (CAUTION: Steam will blow from end of trainline.) The orifice valve, if applied, should not be used in this test as it will not discharge enough steam at high fire operation to bring the pressure down to 150 pounds.
- b.) Be sure the coils are filled with water. Set the water bypass regulator lever at 230 pounds. Latch the separator blowdown valve open and turn the control switch to run.

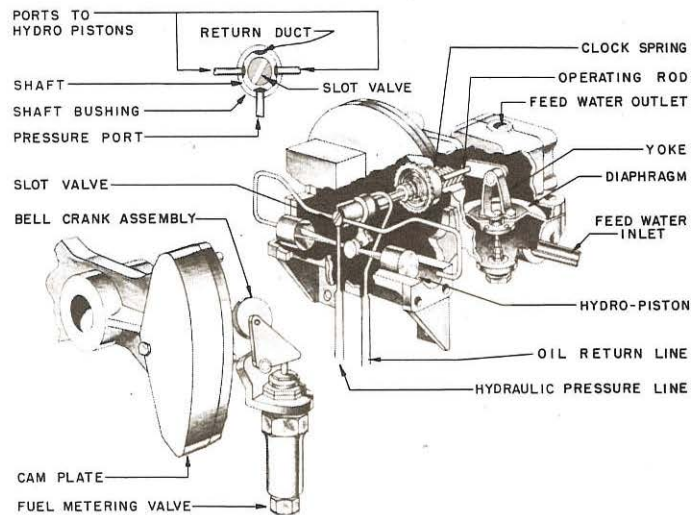


Fig. 14 - Diagrammatic of Servo Fuel Control

- c.) The action of the servo cam-plate should be to fire the generator and continue to the high fire position. (Almost to the stop on the micro-switch housing.) Be sure the cam-plate travels its full distance.
- d.) As the servo cam-plate rises to high fire, adjust the nozzle fuel pressure to 50 pounds as quickly as possible. (Turn the high fire adjusting screw clockwise to reduce the pressure or counter clockwise to increase the fuel pressure.) If the 50 pound nozzle fuel pressure setting cannot be reached within the adjusting range of the screw, shut the generator off immediately. Remove the locking nuts from the fuel metering valve if the fuel pressure is too great; lower the valve if the limit of your adjustment is less than 50 pounds nozzle pressure.)
- e.) With the nozzle pressure at about 50 pounds, look to see if there is smoke coming from the stack. (If white smoke is present, turn the high fire damper adjusting screw clockwise; if black smoke is present turn the same adjusting screw counter clockwise until the stack clears.)
- f.) Making the previous checks of fuel pressure and combustion air will only take one or two minutes. A sufficient steam cushion will develop in this time to allow closing the separator blowdown valve. Close this valve and let the steam pressure build up to 150 pounds. Hold the generator pressure at 150 pounds by regulating the stop and check valve.
- g.) Open and close the separator blowdown valve several times as the generator warms up. This will rapidly discharge excess water accumulating in the separator without waiting for the return water system to carry it off.
- h.) Watch the discharge of the steam trap through the return water indicator carefully during the first few minutes of firing. The flow should be strong at first and then taper off to a steady cycle of opening and closing of the indicator flapper. (About 12 times per minute.) If the water return is weak or absent, reduce the fuel nozzle pressure slightly by turning the high fire fuel adjusting screw on the servo. (Turn clockwise to reduce pressure.)

- i.) If the generator is returning water properly, the stack gases are clear, and the fire is burning with a strong bright yellow flame; let the unit run for at least 15 minutes without further adjustment. Maintain 150 pounds steam pressure during this period by adjusting the stop and check valve.
- j.) Remove the cap from the fuel manifold pressure regulator, loosen the lock nut, and adjust the manifold pressure to exactly 150 pounds. (Turn the adjusting screw "in" to increase pressure or "out" to decrease pressure.)
- k.) Close the water by-pass regulator shut-off valve No. 19. This valve is closed to prevent any feed water from bypassing through the control during the servo setting. (CAUTION: The generator will now have to be modulated manually -- it will no longer shut itself off if steam pressure rises above the regulator setting.)
- l.) The steam generator should now be up to temperature and ready for fine adjustment of the servo. Count the number of discharges of the steam trap. (If the trap is discharging at about 12 times per minute, proceed to the next step.) If the trap is discharging more than 12 times per minute or if water is flowing steadily through the flow indicator, turn the high fire adjusting screw counter clockwise. (The adjustment is delicate, about an eighth of a turn should be enough at one time.) Turning the adjusting screw in this direction will increase the fuel being burned, drying out the steam and reducing the amount of water being returned.

If the trap is discharging less than 12 times per minute or if there is no water flow through the return indicator, turn the high fire adjusting screw clockwise. Turning the adjusting screw in this direction will decrease the fuel being burned, increasing the moisture content of the steam and consequently the water return.

The steam pressure will have to be readjusted to 150 pounds with the stop and check valve everytime the servo adjustment is changed. After each adjustment, let the generator settle out thermally for about 5 minutes before making further corrections.

- m.) When the water return is about 12 cycles per minute in high fire, open the manual water by pass valve (No. 8) slowly. The servo cam plate will turn as water is bypassed away from the servo. Continue opening the manual by pass valve until the center of the low fire adjusting-screw comes abreast of the center of the fuel cam plate roller. This servo position must be maintained throughout the low fire adjustment.
- n.) As a result of decreasing the fire, steam pressure will drop rapidly. Readjust this to 150 pounds by turning down on the stop and check valve handle. A quick check of the fuel nozzle pressure gauge should show 5 pounds fuel pressure or less.
- o.) The increase in steam pressure caused by the stop and check valve adjustment will change the position of the servo cam. Reposition with the No. 8 valve as described in paragraph "m". Repeat the adjustments of the servo position and steam pressure if necessary.
- p.) Watch your return water flow. The sudden drop from high to low fire will dry out the steam considerably until the residual heat is dissipated. However, some return water should show through the indicator.
- q.) When the generator is operating at 150 pounds steam pressure once more, with the servo at low fire position and some water returning through the indicator, let the unit run in this condition for about 15 minutes. Adjust the damper as in paragraph "e", if the stack gases are smoky. If the steam generator air dome is too hot to touch, increase the air damper opening slightly. (Turn low fire damper adjusting screw counter clockwise.
- r.) Adjust the low fire position of the servo cam plate as in paragraph "l". For low fire, the discharge of the steam trap should be about 4 times per minute rather than 12 as in high fire.
- s.) When the low fire position is properly set, close the No.8 valve slowly until the center of the intermediate fire adjusting screw is abreast of the center of the cam roller.

STAND-BY OPERATION

The cut-away picture of the servo fuel control (Fig. 12), illustrates the position of the water metering pin when the control switch is turned to "RUN". Fuel manifold pressure (150 pounds) is assumed to be acting against the piston of the automatic burner adjusting control, forcing the metering pin into its normal position in the diaphragm chamber. When the control switch is turned to "FILL" or "STAND-BY" the three-way solenoid valve relieves fuel pressure operating the adjusting control piston and allows the metering pin to drop to a lower balance of the servo, so that full flow of water through the device only sets the cam plate at low fire position. This provides low fire start. When the control switch is turned from "FILL" to "RUN" and in "STAND-BY", the generator will only produce very wet, low quality, steam for heating the water tanks and allied piping.

In "STAND-BY" or "FILL", the center of the fuel cam plate roller should be abreast of the center of the camplate assembly. (Between the 3rd and 4th adjusting screw holes.) This distance of servo travel can be varied by changing the number of shims under the metering pin. Adding shims will increase the servo movement, removing shims will decrease the movement. (Be careful that the piston cup does not touch the bottom of the cylinder if shims are removed.)

If there is any fuel leakage past the piston cup in the burner adjusting control, this fuel will be discharged through the bleed hole in the side of the cylinder. Never plug this bleed hole in the event of leakage as it will lock the piston hydraulically and keep the generator on stand-by fire.

Readjust the stop and check valve to hold 150 pounds steam pressure.

- t.) Balance the generator to hold 150 pounds steam pressure at the intermediate fire cam plate position. Be sure there is some water return and that the stack gases are clear. Hold the generator at this point without further adjustment for about 15 minutes.
- u.) Set the intermediate fire position of the servo cam plate as in paragraph "l". For intermediate fire the discharge of the steam trap should be about 7 to 9 times per minute.

- v.) When the intermediate fire position is set properly, open the No. 8 valve until the micro switch on the servo operates to de-energize the fuel solenoid valve. Be sure the switch operates at the point described in ADJUSTING THE SERVO, Paragraph 1.
- w.) The servo fuel control is now adjusted for proper operation. Prepare the generator for service by first opening the No. 19 valve and then closing the No. 8 valve completely.

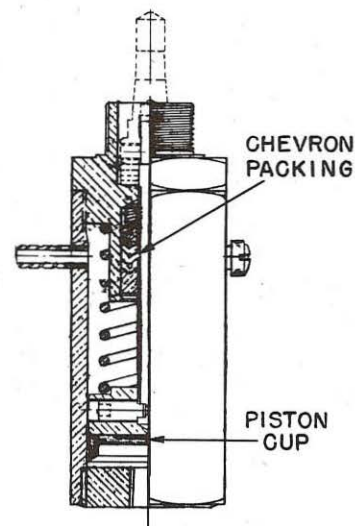


Fig. 15 - Automatic Burner Adjusting Control

(See Fig. 12, Page 22)

HEAT EXCHANGER

(213)

This device is designed to cool the return water, and preheat the feed water before it enters the steam generator coils. The feed water flows through the inside of the heat exchanger casing and absorbs heat from the hot return water flowing through the coils.

Use the following instructions as a maintenance guide:

1. Leaks: If leakage through the casing is evident, check the cap screws and nuts to see that they are securely tightened, and replace worn or defective gaskets.

Leakage through the coil of the heat exchanger causes the steam generator to go into superheat, because it cuts down the amount of feed water pumped into the generator coils. A leaky coil must be repaired or replaced.

To test for a leak in the heat exchanger coil, close the return water valve between the steam separator and the steam trap, open the separator blowdown valve, and operate the steam generator on FILL. Partially close the coil inlet valve until the water pressure approaches 400 lbs. If no water return is visible through the flow indicator, the heat exchanger coil is not leaking.

2. Hot Return Water: Scale and sludge in the casing makes for inefficient heat transfer -- the return water will be too hot, and the generator feed water will be too cold. The feed water should be heated to at least 135 degrees when it leaves the heat exchanger.

The heat exchanger should be dismantled every six months and the accumulated sludge and scale cleaned from the casing. The rubber coil pads should be replaced at this time if they are worn.

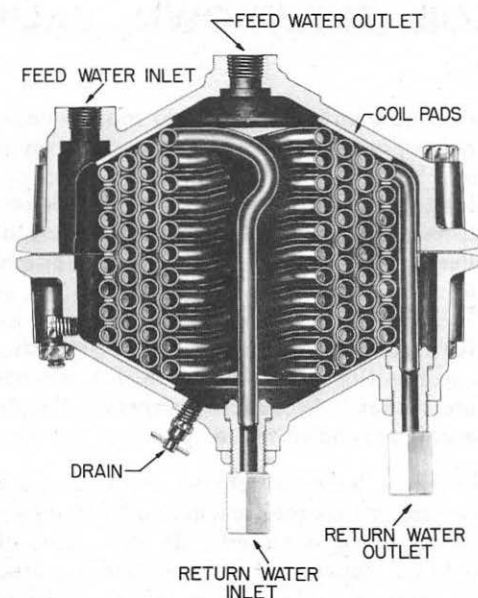


Fig. 16 - Heat Exchanger, Cutaway View

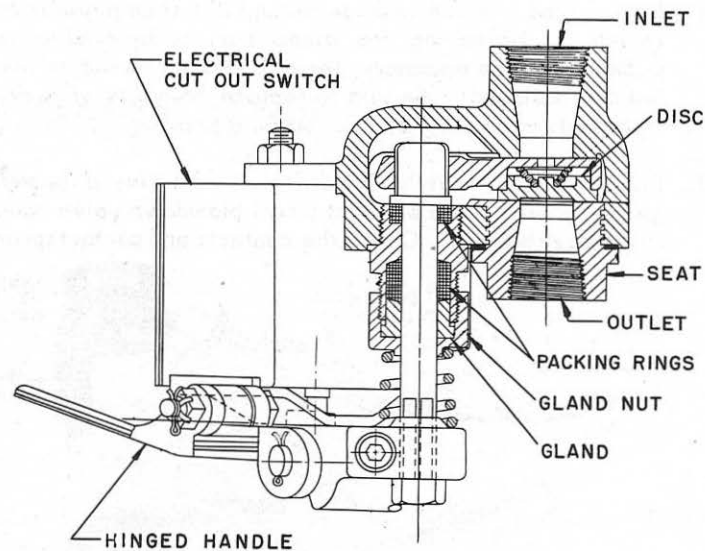


Fig. 17 - Coil Blowdown Valve, Cross Section View

COIL BLOWDOWN VALVE

(2)

This is a swing-gate valve designed to rapidly back blow steam when it is necessary to blow down the steam generator coils.

The valve is opened by depressing the handle lever and moving it to the open position; the locking pin is part of the hinged handle -- the handle must be depressed to open the blowdown valve.

The valve is fitted with an electrical cutout switch which breaks the current to the line relay when the valve is opened. This safety feature makes it impossible to operate the steam generator with the coil blowdown valve open.

1. **Seat and Disc:** Improper seating of the disc and seat is indicated by steam leakage from the coil blowdown valve outlet when the valve is closed. In this case, the disc and seat should be lapped. If they are badly scored, it may be necessary to replace them. Unscrew the disc seat from the valve body and lift out the disc. Be sure the disc spring is not broken; then install a new disc and seat.
2. **Stem Gland:** Steam leakage through the stem gland is corrected by tightening the gland nut, or by adding more packing. When necessary, the old packing should be taken out and replaced. Be sure to replace both sets of packing -- the gland packing and the bushing packing.
3. **Electric Cutout Switch:** The switch is defective if the steam generator will operate with the coil blowdown valve handle in the open position. Check the contacts and contact spring.

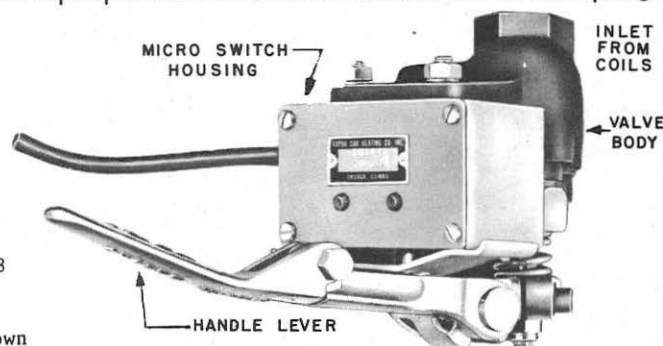


Fig. 18

Coil
Blowdown
Valve

STEAM SEPARATOR

(221)

This device separates the water from the steam flowing into it from the steam generator coils. The inlet is set off-center to give the steam a whirling motion when it enters the separator, which forces the water particles to cling to the sides and settle to the bottom of the separator. The dry steam escapes upward through a tube to the steam outlet nipple. The water settled to the bottom of the separator flows through the trap and return water outlet back through the heat exchanger and return water flow indicator into the supply tank. Sediment collects at the bottom of the sump in the separator and is blown out when the separator blowdown valve is opened.

Good maintenance of the steam separator calls mainly for constant checking against leaks through the union connections and through the bottom flange gasket. The separator should be blown down at least once each hour of operation. Remote control of the blowdown valve is provided in the engine cab -- it is not necessary for the fireman to leave the cab to perform this operation.

SEPARATOR BLOWDOWN VALVE

(12)

The steam separator blowdown valve is used to blow out the sludge that settles in the bottom of the separator. It can be operated by pushing the separator blowdown button on the remote control panel, or it can be operated manually with the foot pedal at the bottom of the separator.

Use the following list as a maintenance guide:

1. **Leaks:** The seat and valve should be overhauled or replaced if the valve leaks through the outlet when closed.

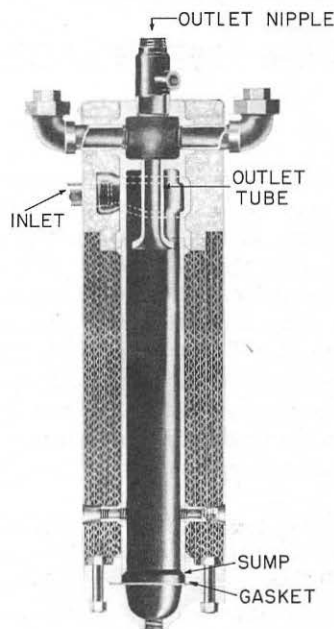


Fig. 19 - Steam Separator, Cutaway View

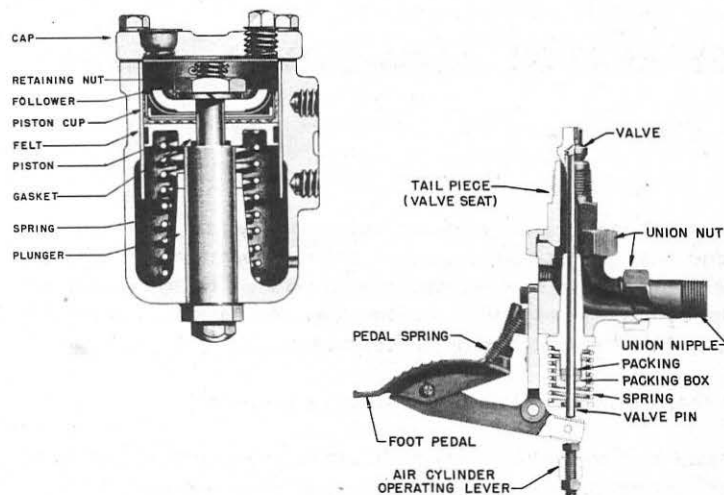


Fig. 20 - Separator Blowdown Valve with Air Cylinder, Cutaway View

Particular attention should be given the stuffing box packing at the bottom of the valve pin. If it is allowed to leak it will rust the air cylinder. The packing box should be re-packed each month.

When replacing the packing, check to make sure that the valve stem is clean and straight, and that the valve guide is not worn excessively -- rust and corrosion on the stem will distort the new packing.

2. Manual Levers: Make sure the manual levers operate smoothly; keep the latch pin on the foot pedal properly adjusted. When the pedal is depressed, this pin should wedge against the outside bracket and force the foot pedal lever against the valve pin to open the valve. The lever should not lock when the separator blowdown valve is operated by remote control.
3. Air Cylinder: The air cylinder should be tested periodically for leaks while the valve is operated from the remote control panel. It may leak through the cap gasket, or through the plunger at the bottom of the cylinder. If the plunger leaks, the piston cup and the piston felt should be renewed.

CAUTION: The spring tension under the piston assembly is strong -- when taking off the retaining nut be careful that the piston assembly does not spring out of the cylinder.

SAFETY VALVES (107)

Two safety valves are installed on the steam separator to prevent the steam pressure from rising above the safe working pressure of the steam generator. One valve is set to pop at 295 lbs. and the other at 300 lbs. steam generator pressure.

To make certain that the safety valves will blow, it is important that the lever is pulled manually when the steam generator is up to working pressure. This test should be made daily.

Use the following instructions as a maintenance guide:

1. **Testing:** A pressure test must be given these valves during the quarterly steam generator inspection. Place test gauge in one of the steam lines leading from the separator outlet nipple when testing the blowoff point of the safety valves. If the indicated pressures on the test gauge and on the generator steam pressure gauge vary more than three pounds, the gauges must be removed and corrected before the safety valves can be tested.
2. **Adjusting:** When necessary to adjust the relief setting, break the seal and remove the cap locking screw. Remove the lever and cap, and loosen the locknut on the adjusting screw. To raise the blow-off pressure, turn the adjusting screw downward; to lower the blow-off pressure, turn the adjusting screw upward. Tighten the locknut on the adjusting screw, replace the lever and cap and attach a new seal.
3. **Leakage:** The valve and valve seat or sealing ring should be kept clean and properly seated.

REMOTE CONTROL TRAINLINE SHUT-OFF VALVE (7)

This assembly consists of a No. 238 valve, and a solenoid operated pilot valve assembly. The main valve is held open by steam pressure. Depressing the "Trainline shut-off" button on the remote control panel energizes the solenoid on the pilot valve, which trips the latching lever, closes the pilot valve, and shuts off the flow of steam to the piston chamber on the main valve. When the steam pressure against the piston is shut off, the valve springs operate to close the main valve.

Steam is again admitted to the trainline by manually depressing the latching lever to open the pilot valve, which admits steam to the piston chamber and opens the main valve.

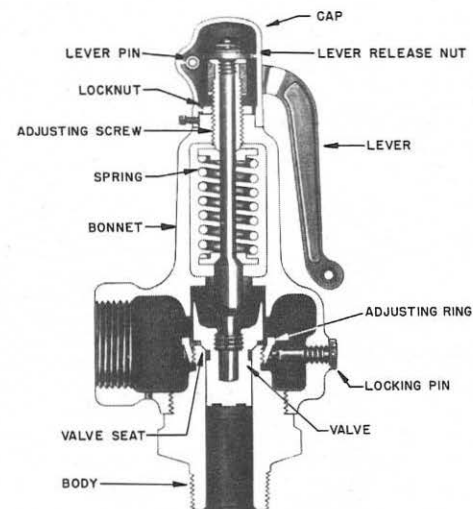


Fig. 21 - Safety Valve, Cutaway View

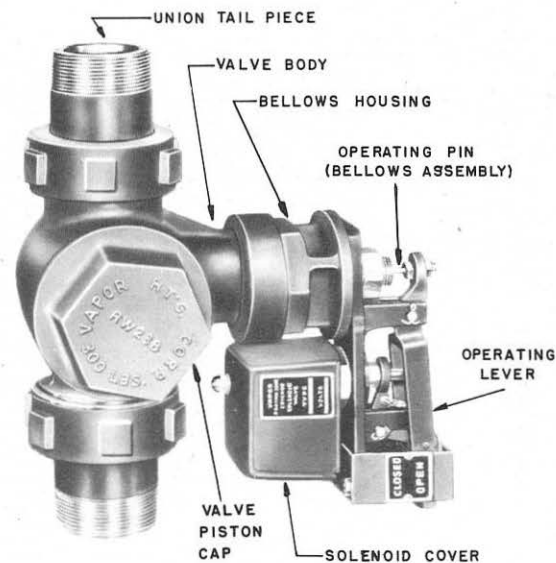


Fig. 22 - Remote Control Valve, Exterior View

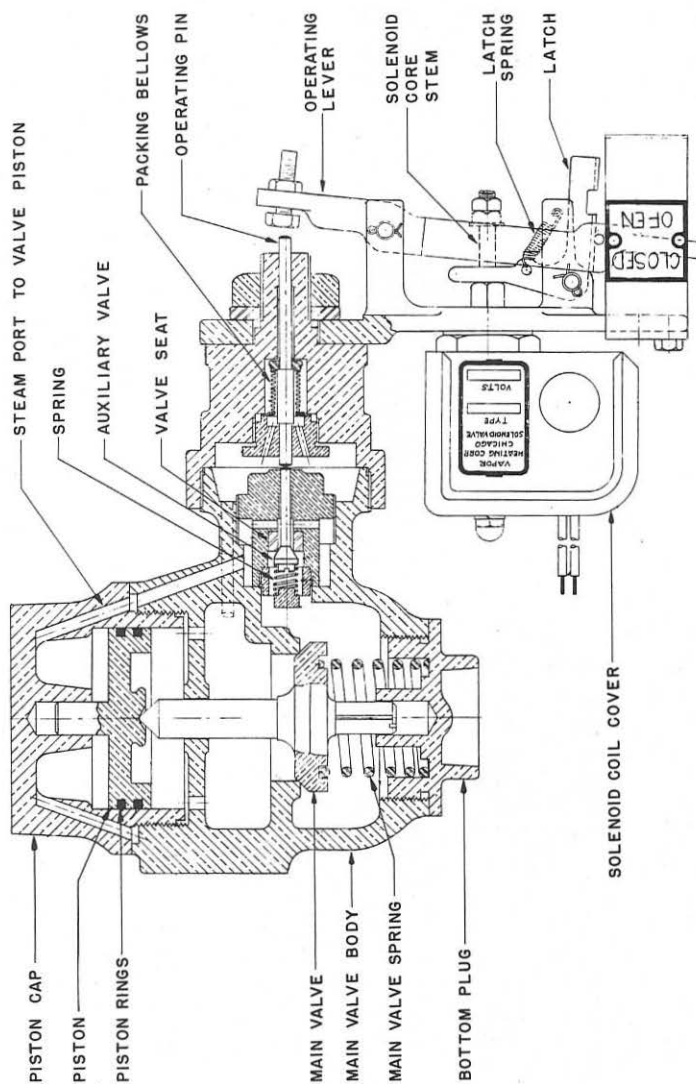


Fig. 23 - Remote Control Valve, Cross Section View

PILOT VALVE:

The pilot valve is equipped with a bellows packing located in the upper portion of the valve body away from the direct path of steam flow. It will not bind the valve stem and, if a leak should develop, the bellows assembly can be easily replaced. The maintenance of this pilot valve is covered by the following schedule:

1. Valve stem sticking: Dirt or scale may have accumulated around the valve stem causing it to bind, or stem and guide may be warped due to excessive heat.
2. If main valve cannot be shut off, pilot valve and seat may be dirty or not seating properly. Pilot valve spring may be broken.
3. Steam leakage around the bellows housing indicates a ruptured bellows.

MAIN VALVE:

The following is a guide list for checking faulty operation of the trainline valve:

1. Valve will not close under remote control: The piston rings may be worn or broken; or the main valve stem may be sticking.
2. Leakage--Bad seating of the main valve. Broken or faulty spring on the main valve.

STEAM TRAP (223)

These are bucket type steam traps used in the return water line near the outlet from the steam separator. The inverted bucket has a small vent at the top and is suspended from the valve lever; the valve closes when the bucket is lifted. The steam trap inlet leads into the inside of the inverted bucket. If steam comes through the inlet, the bucket is forced upward and closes the steam trap outlet valve; as the steam condenses the bucket drops, opens the valve, and permits water to flow out into the return line. Water coming into the trap inlet tends to trap vapor in the bucket, lifting the bucket and closing the valve momentarily. As the vapor escapes through the vent in the inverted bucket, the bucket sinks and opens the valve.

The trap discharges intermittently when in normal operation. However, when there is very little condensate coming into the trap, the discharge may be semi-continuous.

MAINTENANCE:

For trouble-free operation it is best to check the trap after each monthly coil washout. Take the cap off the steam trap and check the valve, valve seat and orifice for scale accumulation. Remove scale and dirt that may have settled in the valve body, see that the bucket vent is not plugged and that the valve mechanism is not worn or defective.

STANDBY RELIEF VALVE (121)

This spring loaded relief valve is placed in the stand-by feed line between the steam separator and the water supply tanks. It is located in this line on the down stream side of the #56 shut-off valve so that in normal operation, no steam pressure will be exerted against the valve.

The purpose of this valve (set at 15 pounds opening pressure) is to provide enough back pressure in the separator during stand-by operation to force some water flow through the return water piping.

MAINTENANCE:

1. Remove and inspect the valve every 6 months. Be sure the spring is in good condition and that the valve and seat are not pitted or steam-cut. Clean the valve thoroughly.

RETURN WATER FLOW INDICATOR (218)

Moisture removed from the steam in the steam separator is returned to the water tanks through the steam trap and heat exchange coil. Before this collected moisture is piped into the water tank, it passes through a visual indicator, giving the operator accurate information as to how efficiently the generator is converting the feed water into steam. As the flapper in the indicator will open at every discharge pulse of the steam trap, it will also give an indication of the operating condition of this device.

NO WATER RETURN:

During normal operation of the generator, the indicator flapper should open and close at intervals closely approximating those described in the section on the servo fuel control. If no water return is seen through the indicator, it may be that the steam trap, return line strainer or return line piping are clogged with sediment. This can be determined by operating the generator on fill for a few minutes to charge the coils and separator with water. If no water return is noticed then, look for plugging in the return line. (Usually at the strainer or at the valve between the steam separator and the strainer.)

Absence of water return may also indicate that the amount of fuel being burned is greater than necessary to convert the feed water flow into steam. In this case, the generator will produce a dry, high temperature, steam which can be very damaging to the coils, valves and trainline equipment. This superheating, as it is called, should be corrected as quickly as possible.

If your generator is superheating and there is no water return look for leaks in the water system at any point past the servo fuel control. (Coils, coil blowdown valve, or water feed piping.) Mis-adjustment of the servo fuel control can also produce superheating (see section on servo) but be sure all other conditions are investigated before attempting to adjust this device.

HEAVY WATER RETURN:

A large, steady water flow through the return water indicator may be caused by a leak in the heat exchanger coil. As can be seen in the schematic piping diagram (Chart II), a leak here will cause feed water to be discharged directly into the return line. Because this water has already been measured by the servo fuel control, its loss will immediately send the generator into superheat. (See heat exchanger section for method of checking for leaks in the coil of this device.) Other conditions which can produce a heavy water return are as follows:

1. Heavy deposits of soot on the coils or accumulations of scale inside the coils which retard the transfer of heat from the fire to the water. Soot deposits will be indicated by an excessively hot dome on the generator, while scale deposits will produce abnormally high feed water pressures. Soot removal can be accomplished by removing the inspection doors and blowing the coils off with steam or compressed air. (Coked soot may have to be scraped off.) Scale deposits can only be removed by acid washing the coils. (See section on coil washing.)
2. Faulty coil pads which allow part of the hot combustion gases to by-pass the coils. This condition will also produce a high stack temperature and can be corrected only by replacing the coil pads with new material.
3. Any condition which will retard the fuel flow to the spray-head, such as a plugged nozzle, faulty fuel pump or fuel pressure regulator. (Check fuel pressures.)

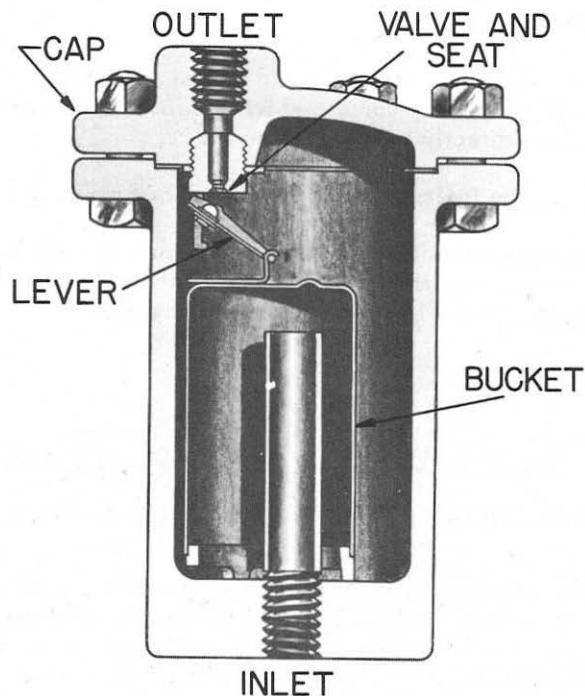


Fig. 24 - Steam Trap, Cutaway View

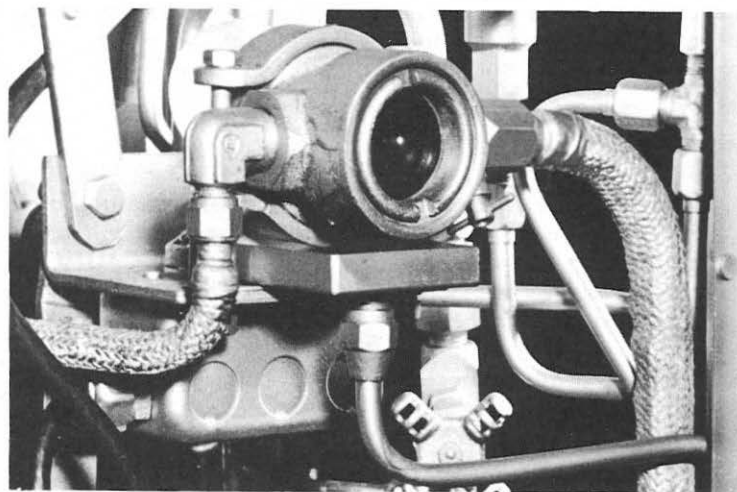


Fig. 25 - Water Flow Indicator

MAINTENANCE:

1. Keep the water return indicator free from leaks. Water leaking here may cause a short circuit in the light socket mounted directly behind this device.
2. Be sure the indicator flapper is intact and moves freely.
3. If the generator is shut down and drained in cold weather, be sure to open the drain cock under the indicator as water pocketed here will freeze and break the glass.

RADIATION STEAM TRAP

(WHEN USED, REPLACES ORIFICE NIPPLE 222)

This steam trap is placed at the outlet end of the radiation in the winterization cabinet. A thermal bellows diaphragm operates against adjustable spring tension to close the valve as it expands when it comes into contact with steam. When steam passes through the inlet into the bellows chamber, the diaphragm bellows expands and closes the valve to shut off the steam flow into the water return line. As the steam condenses, the bellows contracts and the spring tension opens the valve, permitting the condensate to flow through the steam trap.

MAINTENANCE:

1. If the trap blows steam continuously, remove the trap body cover plate and examine the valve and seat for pitting or cutting. Be sure the diaphragm is not leaking. **CAUTION:** Never remove the diaphragm while it is hot or heat it when it is removed from the trap.
2. Keep the strainer screen clean.
3. If the trap valve and diaphragm are in good condition, steam blow may be corrected by turning down on the adjusting screw.

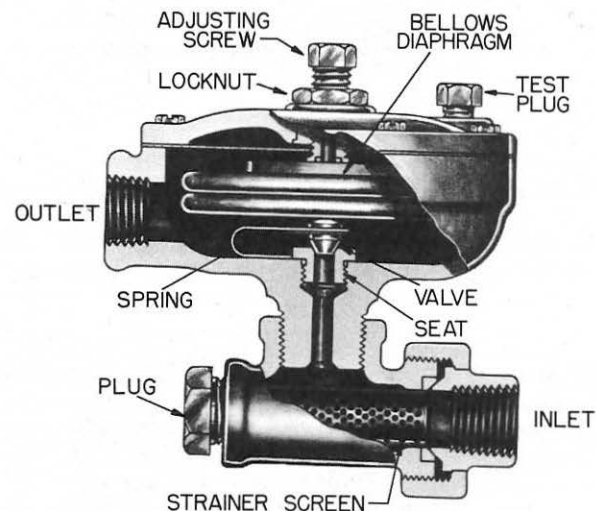


FIG. 26 - Radiation Steam Trap, Cutaway View

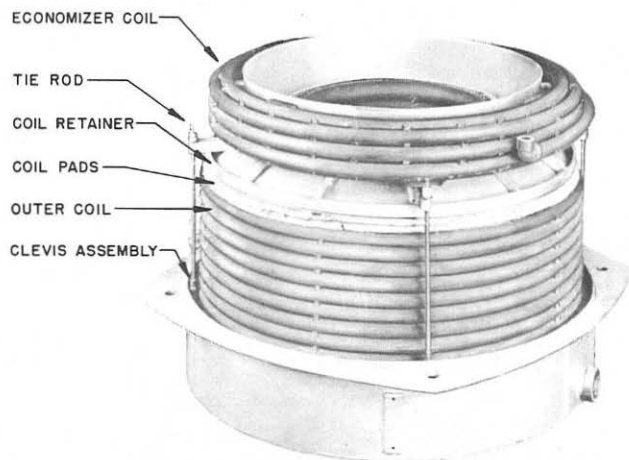


Fig. 27 - OK-4625 Coil Assembly

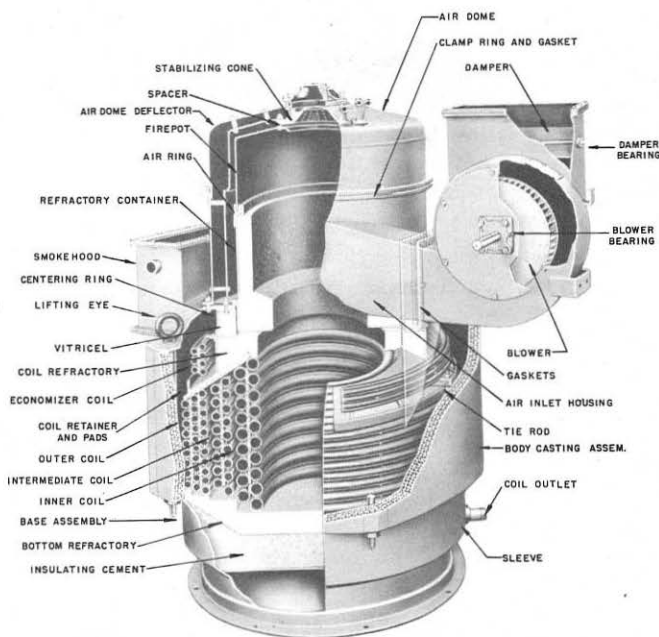


Fig. 28 - OK-4625 Boiler and Blower Assembly

BOILER AND BLOWER

Descriptively, the Vapor steam generator is a vertical, down fired, mono-tube unit, completely packaged as to controls and appurtenances.

The fuel spray head, mounted on top of the air dome, sprays fuel oil down through the stabilizing cone into the fire pot where it mixes with primary combustion air entering through and around the stabilizing cone. Compressed air from the locomotive main reservoir is used to atomize the fuel as it leaves the sprayhead and also forms part of the primary combustion air.

Fuel is ignited by an electric spark as it enters the stabilizing cone. Turbulent mixing with primary combustion air takes place in the fire pot where the combustible mixture is partially burned. Secondary combustion air enters the furnace through the air ring at the base of the fire pot, and complete combustion is accomplished throughout the refractory container section.

The hot combustion gases continue downward through the neck of the refractory container and enter the heat transfer section of the steam generator. Here, the hot gases spread out laterally and wipe over the individual loops of the coils. Maximum heat transfer from the combustion gases to the water flowing through the coils is accomplished by the time the gases pass the economizer coil and are discharged into the stack ducting.

MAINTENANCE:

Maintenance of the boiler and blower section can practically be summed up in one phrase "keep it clean." The entire balance of generator operation will be affected if accumulations of soot are allowed to build up on the coil surfaces or if sludge deposits are not removed from inside the coils.

Soot forming on the coil surfaces will produce two immediate results. The heat transfer will be retarded causing heavier water return than normal and the coils will offer greater resistance to the passage of flu-gases. This increased resistance will tend to force the fire back up into the fire pot and will cause the air dome and fire pot to become overheated. (The same result will be produced if the combustion air is cut off by obstructions in the blower ducting or if there are other obstructions to the flow of combustion gases through the generator.)

Sludge formations will also cut down the heat transfer and produce a heavy return water flow. This condition will also be accompanied by high feed water pressures. (Feed water pressures more than 100 pounds above generator steam pressure.)

Soot deposits can be removed by opening the inspection doors on the sides of the unit and cleaning the coils with a compressed air lance. Sludge can only be removed by acid washing. (See Special Instructions Section.)

Points other than this which may require periodic inspection and maintenance are as follows:

1. Warped or burned fire pot, air ring or stabilizing cone due to excessive temperatures.
2. Broken or deteriorated refractory container, coil refractory or coil pads. (Broken coil refractory or bad coil pads will cause high stack temperatures.)
3. Loose gaskets at inspection doors, smoke hood or body casing, or loose packing around coil nipples may cause flu-gases to escape into the locomotive. These should be repaired or replaced as becomes necessary.
4. Blower fan bearings require periodic lubrication. Bearing should run freely and noiselessly or they should be replaced.
5. Blower wheel must be in balance or damaging vibrations will result. If blower wheel is repaired or straightened, it should be rebalanced dynamically. (Be sure not to break off balancing solder when cleaning blower wheel.)
6. Damper bearings must be kept free and well lubricated.

FIRE POT AND REFRACTORIES

Poor combustion results if any components of the combustion chamber are chipped, cracked, burned or out of shape. Inspection every thirty days is suggested to determine the condition of the upper section of the steam generator.

TO DISASSEMBLE FOR INSPECTION:

1. Disconnect the ignition wires, oil and air lines to the fuel spray head, and fuel solenoid valve leads.
2. Take off the air dome.

3. Remove the fire pot and air ring.
4. Lift out the refractory container assembly by means of the two lifting handles on the refractory casing.
5. Examine the fire pot, air ring and the refractory container for burning or distortion. Examine all three as well as the stabilizing cone at the top of the fire pot for any signs of damage, and repair or replace with new parts.

REASSEMBLY:

Before reassembling the fire pot, examine the coil refractory cement covering the top of the coils, immediately below the refractory container. If it is chipped or disintegrated, it can be repaired with plastic fire brick. The plastic fire brick comes in one gallon cans, 18 lbs. to the can; it contains the proper amount of moisture for use, and will remain in this condition if the container is kept sealed. It should not be allowed to freeze. However, if it becomes frozen, allow it to stand in a warm place for at least twelve hours.

Chip off all loose cement and cut back the coil refractory around the chipped surfaces to form recesses to hold the plastic fire brick. Wet all surfaces to be patched, and fill all recesses with the plastic fire brick. **IMPORTANT:** Maintain $\frac{3}{8}$ " clearance between the top of the coil refractory and the refractory container assembly. Do not fill in the four cuts across the face of the refractory. They prevent cracking as the refractory expands under heat.

NOTE: If the plastic fire brick has hardened before use, add 10% to 12% (by weight) of water to it and let it soak in the container for about 24 hours. The material should then be about the consistency of putty.

If the refractory cement is badly deteriorated, break it up entirely and rebuild with new plastic fire brick. Procure a mold constructed to form the inside diameter of the coil refractory flush with the inside diameter of the inner coil. (Centralizing and leveling fixtures are manufactured and sold by the Vapor Heating Corporation.) Put plastic fire brick into the form, tamp it solid with a hammer, and level off the top at the necessary height for proper clearance of the refractory container assembly.

Next, reinstall the refractory container assembly, air ring and fire pot.

Replace the air dome, and connect the spray head fuel and air lines, and the spark plug ignition cables. Reconnect the fuel solenoid valve leads.

STEAM GENERATING SECTION

General Disassembly

1. Take out the fire pot and refractory container as instructed in the previous section.
2. Loosen and remove the ten bolts holding the exhaust ducting together and remove a stack section.
3. Remove the six cap screws securing the air inlet housing to the blower housing.
4. Unscrew the 12 nuts holding the air inlet housing to the smoke hood and remove the air inlet housing. (Disconnect the stack switch).
5. Disconnect the copper tube leading to the economizer coil inlet and remove the pipe tee and patch plate from the inlet nipple.
6. Disconnect the union fitting at the economizer coil outlet and remove the sealing sleeve and outlet nipple.
7. Loosen and remove the lifting eye-bolts.
8. Remove the 8 nuts holding the smoke hood to the centering ring assembly and remove the smoke hood.
9. Mark the position of the coil retainer with respect to the body casing assembly and the coils. Remove the nuts and washers from the four tie-rods anchoring the coil retainer.
10. Break out the sealing cement around the top of the inner coil. Remove the coil retainer cone, economizer coil and coil pads as a unit. Be careful to keep the padding intact for re-use in case new coil pads are not available. (The economizer coil may be unclamped and removed separately if necessary.)

The steam generating coils will now be exposed for work or for further disassembly.

TO REMOVE THE INNER COIL:

1. Break the steam temperature limit control steam and fuel connections. Take out the control by unscrewing the long extension tube from the inner coil outlet.

2. Break the union connection to the inner coil inlet and screw out the inlet nipple.
3. Break out any bottom refractory holding the coil and remove the coil by lifting it straight up.

TO REMOVE THE OUTER COIL:

1. Remove the inlet and outlet sleeves and nipples from the outer coil.
2. Break out some of the bottom refractory from directly above the coil outlet.
3. Lift out the coil.

TO REMOVE THE INTERMEDIATE COIL:

1. Remove the outer coil as previously outlined.
2. Remove the intermediate coil tie-plate retaining cap screw. Unscrew the inlet and outlet nipples.
3. Break out some of the bottom refractory directly above the tie plate and inlet and outlet pipes.
4. Lift out the intermediate coil.

NOTE: Small leaks in the coils can be repaired by welding. If the coils are badly deteriorated they should be replaced. Coils must be given a hydrostatic test after repair or replacement. (See special instructions section.)

Coil Replacement

Both the inner and outer coils may be replaced without disturbing the rest of the coil assembly. In removing or replacing the intermediate coil, the outer coil must first be removed. Some general instructions for replacing coils are as follows:

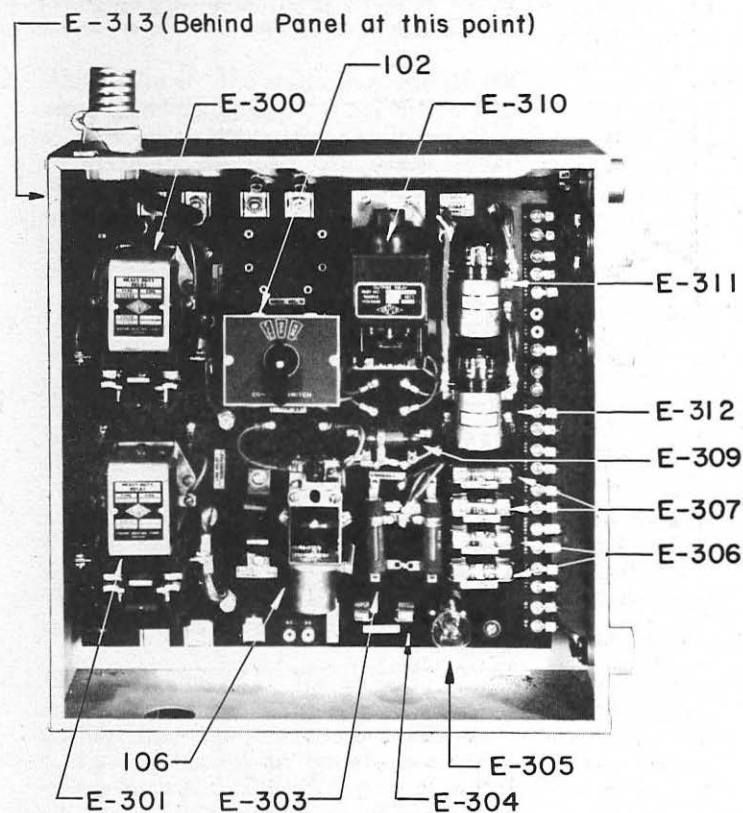
1. Clean the bottom refractory, removing all loose cement. For proper clearance under the coils, the cement must be just level with the metal step webs.
2. Place the coils so that the coil openings line up exactly with the openings in the base and body casing assemblies. Be sure that the coils rest equally on the support step webs and that the intermediate coil tie-plate is properly aligned with the tie-bolt hole in the base assembly.

3. Use steam pipe dope when re-assembling the inlet and outlet nipples to the coils.
4. Patch the refractory where it has been broken around the coil openings.
5. Wait until all the coils are in place before replacing the jumper pipes and other connections.
6. Soak six segments of asbestos coil padding in water until soggy. Place three sections around the top of the coils, and then place the other three sections on top of the original three so that the centers of the upper segments cover the butted joints of the first layer. Allow none of the padding to lap over the sides of the coils.
7. Replace the coil retainer, setting its four extending anchoring brackets over the four tie rods secured to the base. Place a washer and two nuts on each tie rod and pull down the coil retainer until it is perfectly level. The second nut is used as a locknut.
8. Using a suitable fixture, build the coil refractory up to the required height with plastic fire brick. Cover the tops of the coils, and pack the cement tightly around the joints to prevent gas passage. Smooth and level off with a trowel, and cut the refractory across in four equidistant lines to prevent cracking as it expands under heat.

Prints giving dimensions for suitable coil leveling and centralizing fixtures may be obtained from the Vapor Heating Corporation.

9. When replacing the centering ring (if removed), the smoke hood gasket and the smoke hood, do not tighten into place immediately. First make sure that the centering ring is level, that the inner smoke hood shell rests directly on the centering ring flange, and that the studs on the flange are properly aligned with the holes on the inner shell of the smoke hood.
10. Use vitricel sealing cement to fill in the sides between the lower outer coil and the base; about 5 to 10 lbs. will be required.
11. With vitricel sealing cement, fill in the space between the top of the coil refractory and the centering angle to a point just flush with the inside edge of the centering ring.
12. Replace the upper refractory container. The air space between the bottom of the upper refractory and the top of the coil retainer refractory should be $\frac{3}{8}$ ".

ELECTRICAL SYSTEM



STEAM GENERATOR CONTROL PANEL

102..... Control Switch	E-306..... Control Fuses
106..... Motor Overload Relay	E-307..... Ignition Fuses
E-300... Control Relay	E-309..... Timing Resistor
E-301... Line Relay	E-310..... Outfire Relay
E-303... Adjustable Field Resistor	E-311..... Alarm Relay
E-304... Fuse Test Clips	E-312..... Pilot Relay
E-305... Fuse Test Light	E-313..... Starting Resistor

The schematic wiring diagrams included here cover the OK-4625-DNB and OK-4625-DNJ type steam generators. The circuits are almost identical and are discussed simultaneously in the following text. The special features of the DNJ circuit are covered in the paragraph on Standby Operation.

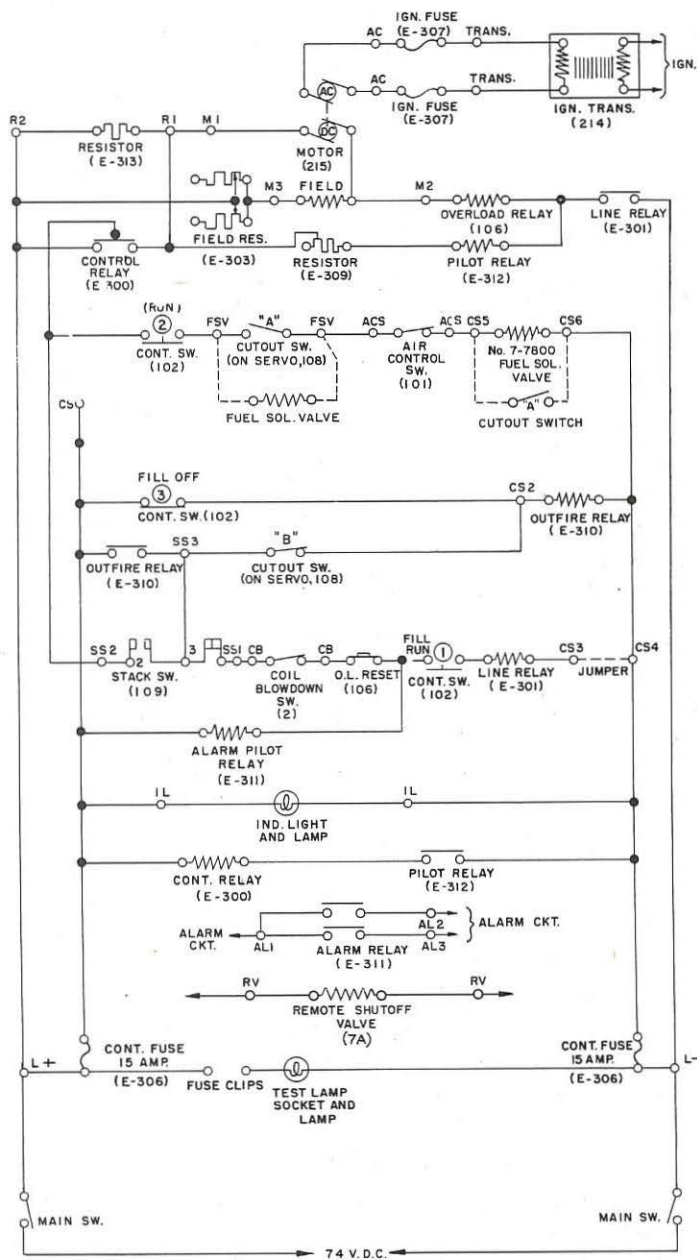


Fig. 29 - OK-4625-DNB Schematic Wiring Diagram

The various safety features are specifically considered under "Safety Controls," and the analysis of current flow during the successive stages of steam generator operation is given below:

1. **Alarm Circuit:** The alarm rings when the alarm relay contacts close. On FILL or RUN, if any of the protective devices are open (stack switch, outfire circuit, coil blowdown valve switch or magnetic overload relay) the current flow is shunted through the alarm pilot relay coil, which has enough resistance to de-energize the line relay coil. The alarm rings immediately, and the line relay contacts open to shut down the motor converter.
2. **Ignition Circuit:** Ignition current is supplied at all times when the motor converter is in operation. The converter portion transforms D.C. current into A.C. current; the A.C. current flows through the ignition transformer, where it is stepped up to the high voltage necessary for effective ignition spark. (12,000 volts.)
3. **Main Switch Closed — Control Switch OFF:** Current flows through the control fuses and the instrument light circuit; the outfire relay is energized through control switch No. 3. The lights are on, the alarm bell does not ring and the motor converter does not operate.
4. **Control Switch FILL:** The outfire relay is energized through control switch No. 3; the line relay is energized through the outfire relay contacts, stack switch high temperature contacts, coil blow-down switch, overload relay and control switch No. 1.

Closing the line relay contacts completes the circuit through the motor converter — the armature is energized through the starting resistor and the motor field is energized through a field adjusting resistor. As the motor converter gathers speed its armature resistance increases and shunts enough current through the timing resistor to energize the pilot relay, which in turn energizes the control relay. The current then flows around the starting resistor through the control relay contacts to the motor converter — it now runs at full speed.

On DNJ units, the fuel flow valve will be energized through the No. 4 contacts of the control switch. This will keep the servo cam plate at a lower position than would be expected for full water flow.

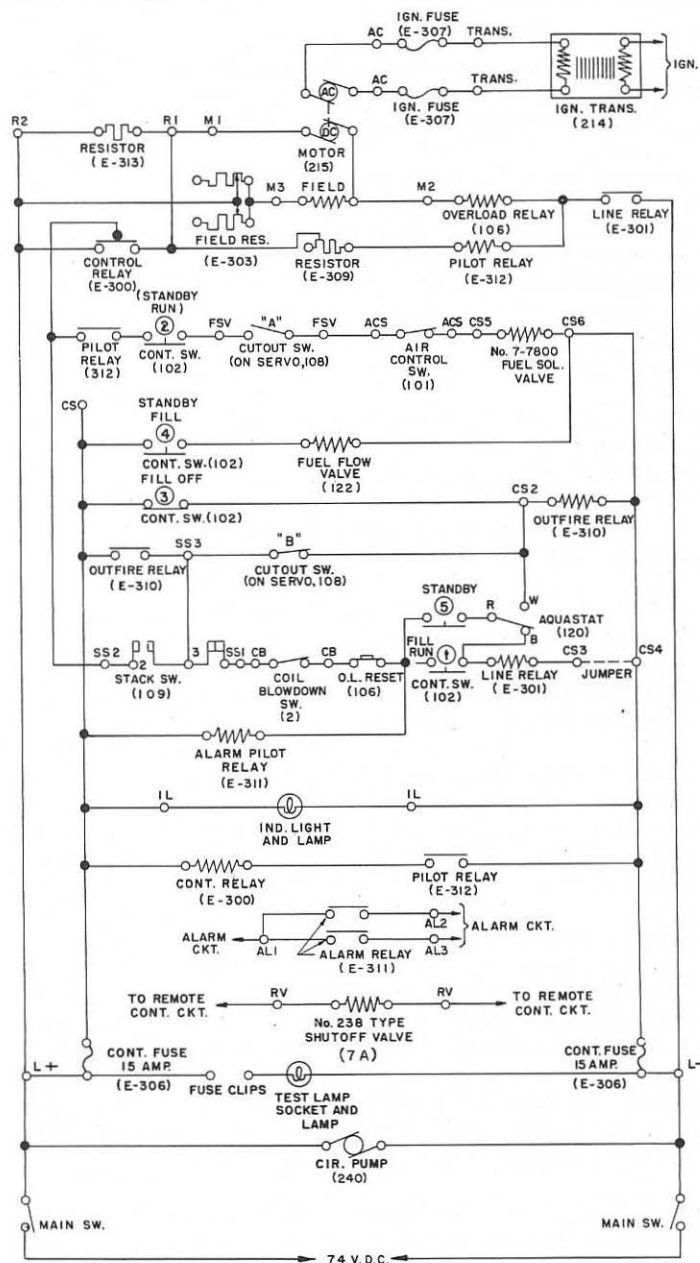


Fig. 30 - OK-4625-DNJ Schematic Wiring Diagram

5. Control Switch RUN: The line relay is held energized through control switch No. 1 just as in the FILL position, and the motor starting sequence begins. As water flow develops, the servo cam plate moves off the block — the servo "A" contacts close and energize the fuel solenoid valve through control switch No. 2 and the air control switch — the "B" contacts open to de-energize the outfire relay.

Fuel, atomizing air, ignition spark, combustion air and feed water are now flowing into the unit and steam generation begins.

6. Cycling: As trainline steam pressure builds up, the water by-pass regulator diverts an increasing amount of water away from the servo into the by-pass return line; when trainline pressure is satisfied, all the feed water is by-passed, and the unit cycles "off" as follows:

The servo cam plate moves to the block, opening the "A" contacts and closing the "B" contacts of the servo cutout switch. Opening the "A" contacts breaks the circuit through the fuel solenoid valve and shuts down the fire. Closing the "B" contacts energizes the outfire relay, which keeps the line relay circuit closed after the low temperature contacts of the stack switch open up. Only the fire is shut down — the motor converter continues to operate with complete by-pass of feed water.

Then when the trainline steam pressure drops, the by-pass valve in the regulator begins to close and the servo cam plate moves off the block, reversing the servo cutout switch action. The fuel solenoid opens permitting fuel flow to the sprayhead, and steam generation is resumed.

7. Control Switch STANDBY (DNJ Circuit):

The control of the steam generator is shifted from pressure to temperature when the control switch is at standby. The No. 4 contacts of the control switch energize the fuel flow valve, which blocks fuel pressure from the automatic burner adjusting piston and drops the servo metering pin to a lower position. (Servo fuel control will now be balanced for production of very wet, low quality steam.)

The No. 1 contact of the control switch will open and the No. 5 contact will close, allowing the aquastat to start and shut down the generator as the water temperature demands.

When the water temperature is lower than the aquastat setting, the R-B circuit is made; the line relay is energized; the generator fired; and the water temperature increased. When the water temperature reaches the aquastat setting, the R-W circuit is completed, energizing the outfire relay and holding the control circuit in readiness for the next firing cycle. The standby circulating pump is wired directly across the line and will run continuously whenever the main switch is closed.

Safety Controls

1. **Outfire Circuit:** The outfire relay automatically opens its contacts in from 43 to 47 seconds after the circuit through the relay coil is broken; the contacts are in parallel circuit with the low temperature contacts of the stack switch.

With the main switch closed and the control switch on OFF or FILL, the outfire relay coil is energized through the control switch No. 3 contacts. On RUN, the coil is energized only during the "off" cycle.

If the fire fails to light, the low temperature contacts in the stack switch remain open and, after the 43 - 47 second time delay, the outfire relay contacts open, energizing the alarm pilot relay and de-energizing the line relay. The alarm rings and the steam generator shuts down. If the fire should fail during operation, the low temperature stack switch contacts will open with the same results. The control switch must be turned to FILL or OFF to reset the outfire relay.

2. **Stack Switch — high temperature contacts:** These contacts open when the temperature of the exhaust gases exceeds 900° F., energizing the alarm pilot relay and de-energizing the line relay. The contacts must be manually reset after the stack temperature is reduced.
3. **Air Switch:** The switch contacts are held closed by the pressure in the atomizing air line; when this air pressure drops below 25 pounds, spring tension opens the contacts, and breaks the circuit through the fuel solenoid valve, cutting off the supply of fuel to the sprayhead. The fire goes out immediately, but the motor converter continues in operation until the line relay coil circuit is broken when the low temperature contacts of the stack switch open. Atomizing air pressure must be restored, and the control switch turned to OFF or FILL to reset the outfire relay, before the unit can be started again. (See Air Cutout Switch-Air System.)

4. **Coil Blowdown Valve Switch:** This manually operated switch breaks the line relay coil circuit when it is open. With the control switch turned to FILL or RUN, the alarm rings and the motor converter will not operate. (See Coil Blowdown Valve-Water System.)
5. **Motor Overload Relay:** Under overload conditions, the excessive current passing through the motor into the overload relay coil will open the relay contacts and break the line relay circuit — the alarm rings and the unit shuts down. The control switch must be turned OFF to stop the alarm, and after the condition is corrected the overload contacts must be manually reset before the unit can be restarted.
6. **Short Circuits:** A short in the control circuit will blow a control fuse, a short in the ignition circuit will blow an ignition fuse, and a short in the motor converter circuit will blow a fuse in the locomotive main control panel.

Field Adjusting Resistor

The field adjusting resistor is placed in the motor field circuit to permit compensation for a maximum of two volts drop in line voltage because of resistance in the locomotive wiring. It should be adjusted for zero resistance and not used unless necessary.

If adjustment is required, run the motor at full line voltage under load conditions until it has reached normal operating temperature, then increase the resistance until motor speed is approximately 1800 R.P.M.

STACK SWITCH (109)

The stack switch is an electric safety device with high temperature contacts and low temperature contacts; the high temperature contacts are set to open at 900° F.; the low temperature contacts are set to close at 250° F.

The high temperature contacts operate to shut down the steam generator when the temperature of the stack exhaust gases exceeds 900° — an indication that the coils have become sooted or sludged-up, impairing the heat transfer through the coils to the feed water, or that the normal flow of the combustion gases has been short-circuited or by-passed away from the coils and out the stack.

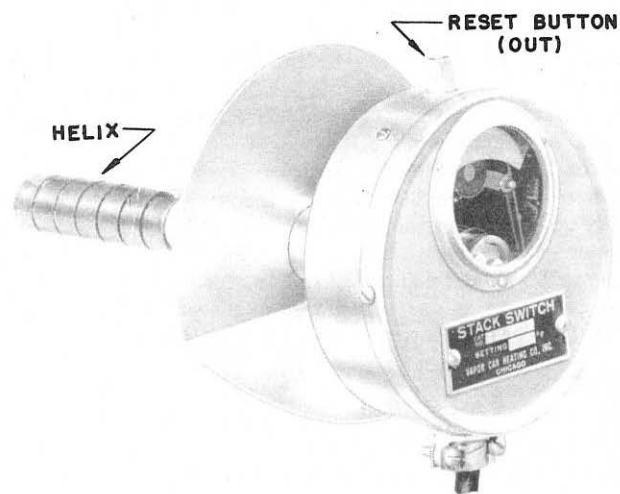


Fig. 31 - Stack Switch External View

The low temperature contacts of the stack switch are in parallel circuit with the contacts of the outfire relay which remain closed for the duration of the time delay only — about 45 seconds. If the fire fails to light in that period, the low temperature contacts of the stack switch do not close to hold the line relay circuit and the motor shuts down.

The following list should be used as a maintenance guide:

1. **Helix:** The stack switch is equipped with a rod to which is fastened a temperature sensitive helix. This rod and metal spiral are installed in the stack, in the path of the hot exhaust gases. The metal helix expands with rising temperature, turns the rod to which it is fastened, and at 900° opens the switch contacts to shut down the steam generator. The reset button on the stack switch will trip out and the alarm bell will ring.

It is recommended that the helix be changed annually. Remove the helix screws and install a new helix, and be sure to peen over the screws after assembly. The helix should be cold when the stack switch is taken off the stack.

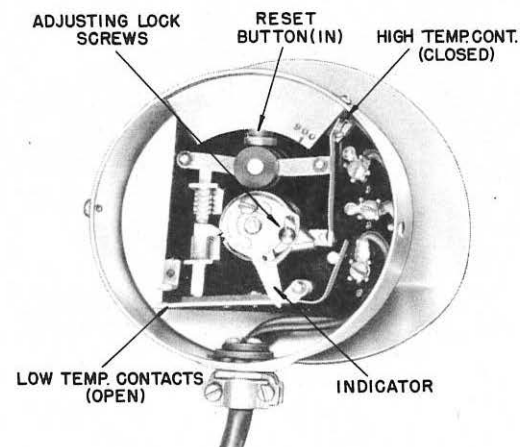


Fig. 32 - Stack Switch Internal View

2. **Contacts:** The shaft of the stack switch should operate freely. Check it for binding and for indicator play on the shaft, by manually moving the indicator. The contacts should open at the 900° mark on the indicator plate. The contacts should have good pressure, and they must be kept clean and in good alignment. A light coating of vaseline should be given the bearing and other moving parts. Never oil the stack switch parts.
3. **Adjusting:** The setting can be checked by placing the helix in a suitable testing device, such as the Vapor Heating Corporation's No. G-4041 or O-4041. At 900° the high temperature contacts should open and the indicator should point to the 900° mark. If the contacts and indicator are improperly set, the adjustment lock screw should be loosened, the contacts opened, and the indicator set at 900°. Be sure to tighten the lock screw after the indicator is set.

The low temperature contacts are set in the same manner.

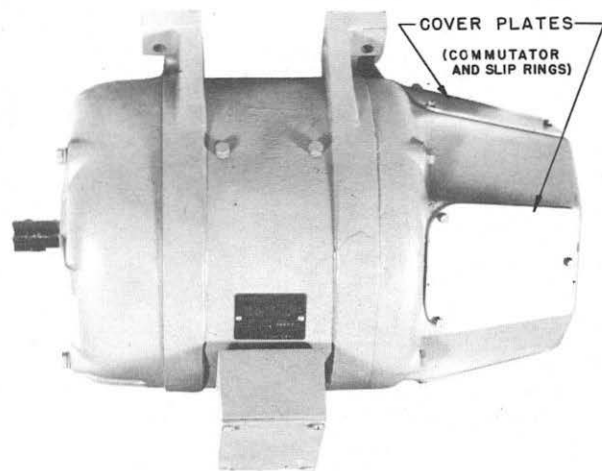


Fig. 33 - Motor Converter

MOTOR CONVERTER (215)

This 5 H.P. direct current motor furnishes the drive power for the water and fuel pumps and the combustion air blower. It also contains a special A.C. generating section to supply power to the ignition transformer (See Ignition System). Under full steam generator load conditions (High fire operation), the motor speed should be 1800 R.P.M. at 74 Volts input. In this condition, the current draw should not exceed 55 Amps.

MAINTENANCE:

1. To inspect brushes and commutator, remove the end cover plate. Commutator should be stoned if it is burned or pitted. Brushes should be replaced if they show considerable wear.
2. Keep the motor free from dirt and grit. Blow out with compressed air or use recommended solvents.
3. If bearings become overheated or noisy, change out the motor. Do not try to lubricate the bearings as they are sealed units.

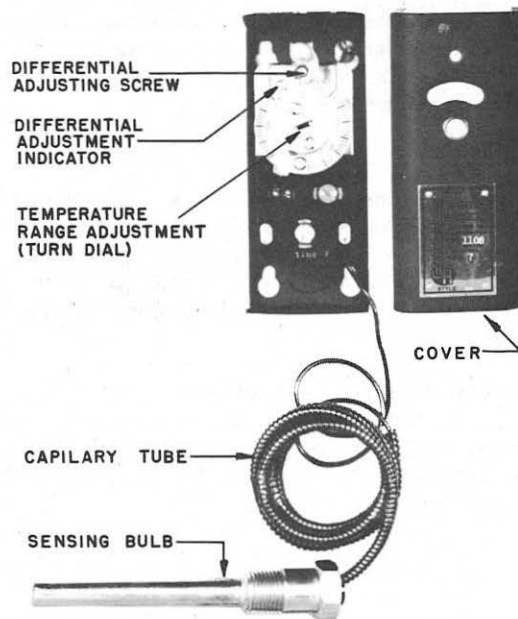


Fig. 34 - Aquastat (Standby Control)

AQUASTAT (120)

The aquastat is a temperature actuated single pole-double throw switch applied to DNJ (standby) units to control the operation of the steam generator on temperature rather than pressure. It is only influential in the control circuit when the control switch (No. 102) is turned to "STANDBY."

The switch is operated by the expansion or contraction of fluid in the sensing bulb and capillary tube.

There are two separate settings on the switch, one for temperature range and one for differential. The temperature dial should first be set so that the indicator points to the temperature at which the steam generator should fire to start heating the water tanks (low temperature limit). This will allow the R-B circuit (see wiring schematic) to close at this temperature. Remove the switch cover and set the high limit temperature (where the fire should cut off) by turning the differential adjusting screw clockwise to

increase the temperature or counter-clockwise to decrease the temperature. The differential indicator will point to the temperature at which the R-W circuit will close and the R-B circuit will open. (See wiring schematic.)

MAINTENANCE:

1. If the switch becomes inoperative in field service, it is best to replace it rather than to attempt field repair. The generator will operate independently of this switch when the control switch (No. 102) is at "RUN," "FILL" or "OFF," so normal operation of the generator will not be affected by a bad order Aquastat.
2. Be sure that the excess loops of capillary tube are not hanging free. Secure the extra loops to a solid cabinet member or control so that they will not vibrate and break. (If tube breaks, switch will not shut off fire when high temperature limit is reached.)

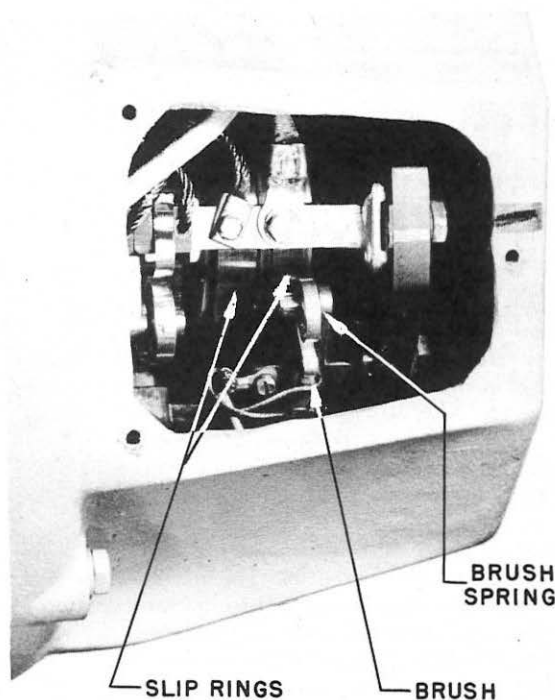


Fig. 35 - A. C. Section of Motor Converter (No. 215)

IGNITION SYSTEM

The ignition system is a sub-division of the Electrical System which provides a high voltage spark for igniting the fuel as it emerges from the sprayhead. The system is shown schematically in the Electrical System wiring diagrams. The operation of the system is as follows:

1. Alternating current is generated by the converter section of the motor (No. 215) and taken off by two slip-ring and brush assemblies.
2. The alternating current is fed to the transformer (No. 214) where the voltage is increased.
3. High tension leads from the transformer secondary carry current to the electrodes (No. 220) mounted near the sprayhead (No. 105).
4. High voltage spark between the electrode tips ignites the fuel as it leaves the sprayhead nozzle.

IGNITION TRANSFORMER (214)

The primary windings of the transformer receive alternating current generated by the motor converter (No. 215) at 50 volts A.C. and 60 cycles per second. The secondary windings step the voltage up to 12,000 volts A.C. for ignition purposes. The transformer is totally enclosed, with lead connections recessed within the housing and well separated to prevent arcing. The ignition leads are clipped to the secondary terminals for easy removal and secured to the transformer housing by a rubber grommet and retaining nut assembly.

MAINTENANCE:

1. An open or grounded circuit in the transformer windings will necessitate replacement of the transformer.
2. Steam leaks which will allow moisture to accumulate on the transformer or ignition leads should be repaired as soon as possible.

3. Keep ignition leads well away from the steam generator air dome or excessive heat may cause the insulation to fail. Replace burned or broken electrode leads.

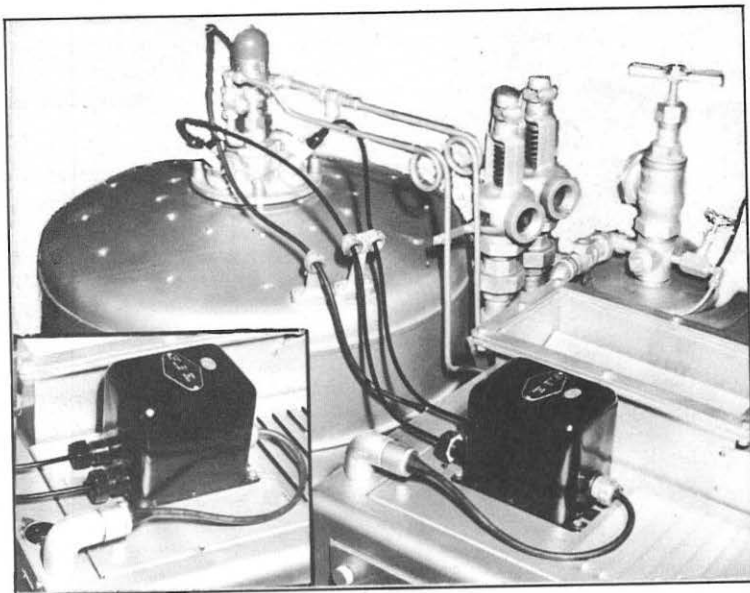


Fig. 36 - Ignition Transformer (No. 214) and Leads

SPARK PLUGS (ELECTRODES) (220)

Two porcelain insulated spark plugs with single electrodes furnish spark for ignition of the fuel oil. Use the following list as a maintenance guide for the electrodes:

1. **Electrodes:** The gap between electrodes should be set at exactly $3/16''$. Keep electrodes clean and free of carbon. Be sure the locking nuts are tight so that the electrode will not turn out of position due to vibration.
2. **Grounding:** Broken or cracked insulators will cause the plugs to short out. Replace broken or cracked plugs. Keep insulators free of carbon, oil and moisture.

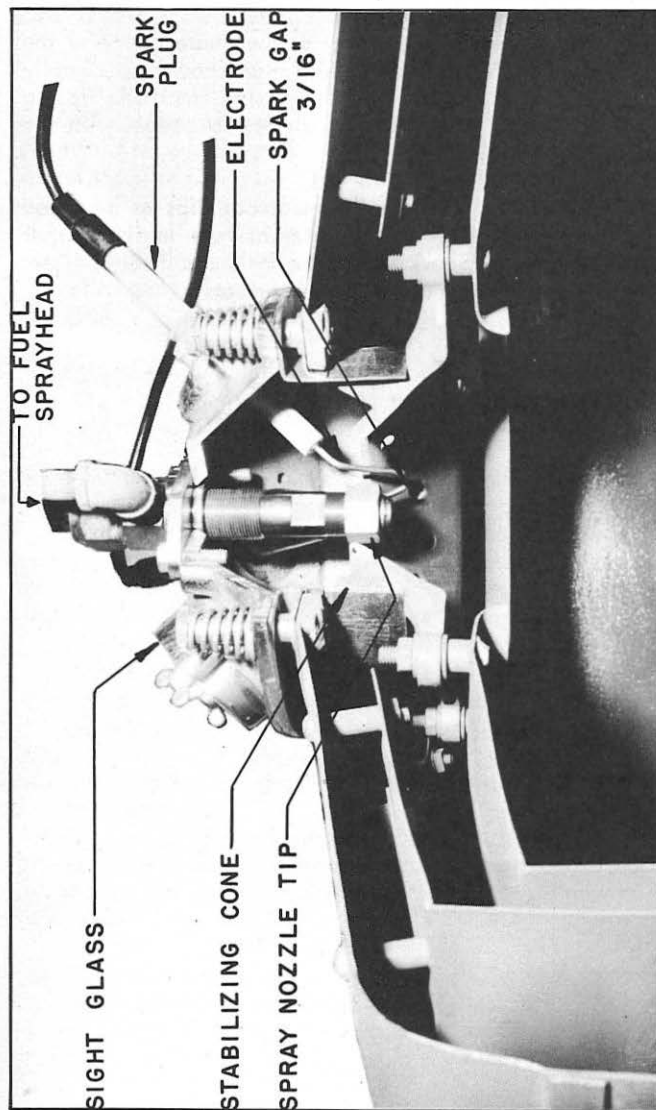


Fig. 37 - Curaway View Showing Position of Electrodes and Fuel Nozzle Tip

3. Adjustment: Use the No. 109,986 adjusting gauge when positioning the electrodes. Remove the entire burner assembly by unscrewing the spring-loaded bushings holding the burner mounting plate. Turn the burner assembly over and place the gauge across the center of the guide flange at the bottom. The center notch of the gauge should be directly over and facing the nozzle tip. Adjust the electrode tips so that they will just touch the drill hole in the gauge, with the gauge between them.

If no gauge is available, position the electrode tips as best you can by observation through the peep sight hole in the burner mounting plate. Note: Spark should be between two fuel jets and just outside but not touching the spray cone.

FUEL SYSTEM

The fuel system piping and controls are outlined in red on the schematic piping diagram in the back of this manual. The flow of fuel through the system is outlined as follows:

1. The centrifugal pump (No. 209) draws oil from the fuel tanks through the suction line check valve (keeps fuel pump primed when generator is not in operation) and the suction filter (No. 206).
2. Fuel in excess of that necessary to maintain 150 pounds pressure at the pump discharge is by-passed through the relief valve (No. 103) and returns to the supply tank.
3. Fuel flow splits into two branches, one furnishing fuel for combustion and the other furnishing pressure to operate the hydro pistons of the servo fuel control (No. 108).
4. On units with standby, a second pressure line leads to the automatic burner adjusting control beneath the water portion of the servo. Flow through this line is controlled by a three-way solenoid valve (No. 122). This valve allows fuel to act against the burner adjusting control piston when the control switch (No. 102) is at "Run."
5. The fuel for combustion flows through the metering valve on the servo.
(The servo admits fuel to the spray nozzle, and combustion air to the fire pot, in direct proportion to the amount of feed water flowing through servo diaphragm chamber into the coils.)
6. The metered fuel then flows through the fuel valve assembly on the steam temperature limit control. (No. 110) This control cuts down the flow of fuel to the sprayhead if excessive steam temperatures develop in the coils.
7. And in the last stage, the fuel flows through the fuel nozzle pressure gauge into the fuel sprayhead, (No. 105) where it is sprayed by compressed air through an atomizing nozzle into the firepot.

The nozzle fuel pressure gauge indicates pressure at the fuel spray nozzle, and the fuel manifold pressure gauge shows the fuel pressure maintained by the fuel pressure regulator.

FUEL SUCTION FILTER (206)

The Cuno or Purolator oil filters used in the suction side of the oil line have a strainer assembly fitted with a revolving knife which scrapes the cartridge when the handle is turned. Dirt scraped from the strainer element drops to the bottom of the filter case and can be cleaned out by taking out the drain plug.

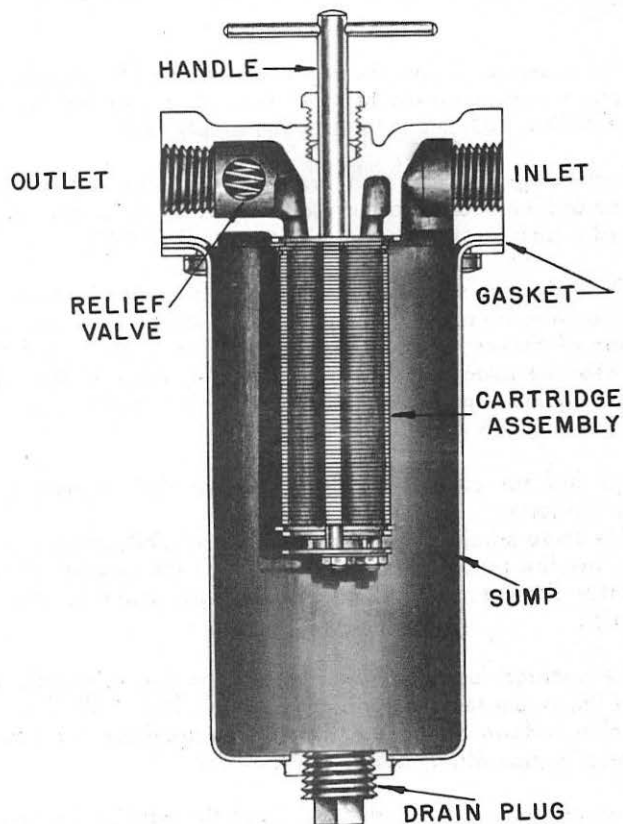


Fig. 38 - Fuel Suction Filter (No. 206)

MAINTENANCE:

1. Priming: The suction line filter must be primed before starting the steam generator after it has been out of service for some time. It can be filled either through the priming plug or through the inlet side of the filter.
2. Leaks: Oil may leak through the gaskets, or air may leak through the packing gland. Keep the gaskets tight and in good condition. Renew the packing around the handle stem as needed, and keep the packing gland nut snugly in position.
3. Cleaning: Regular cleaning will prevent the knife blade from sticking in the strainer assembly. Be sure to refill the filter after draining so that fuel pump will not be run dry.

FUEL PUMP (209)

All fuel used in the generator for combustion and for hydraulic pressure is supplied by a small centrifugal fuel pump. The pump is mounted on the top right of the feed water pump (No. 230) gear and crank shaft housing. Power is supplied to the fuel pump through a spider coupling and gear arrangement driven by the water pump.

1. Leakage around the pump shaft indicates a broken mechanical seal. Replace the seal if this occurs.
2. If 150 pounds fuel manifold pressure cannot be maintained, it is possible that the fuel pump is worn. First try adjusting the pressure at the fuel relief valve. If this is ineffective and the regulator is operating properly, open the fuel return line and discharge the fuel into a container for a few minutes. If air bubbles are present in the fuel return, then a suction leak is responsible for the low manifold pressure — if not, then the fuel pump is probably worn excessively and should be replaced. (Close tolerances prevent any field repair of the fuel pump other than replacing the shaft seal).
3. Check the spider coupling occasionally to be sure it is in good condition.
4. Caution: Never run the fuel pump dry. If the fuel filter is drained in cleaning, be sure to refill it before starting the generator.

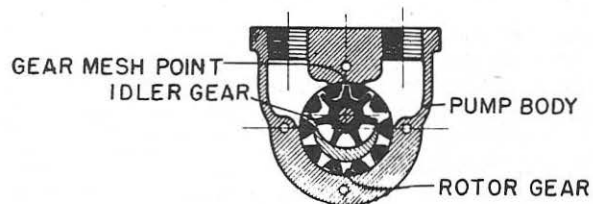


Fig. 39 - Fuel Pump Cross-Section, Front View

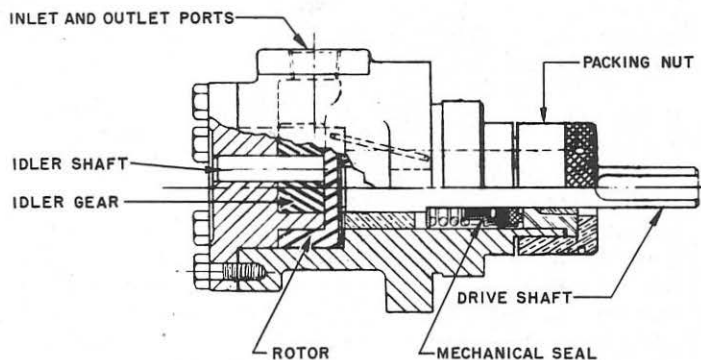


Fig. 40 - Fuel Pump Cross-Section, Side View

FUEL PRESSURE REGULATOR (103)

This is a spring-loaded relief valve set to maintain a manifold fuel pressure of 150 lbs. at high fire. Oil pressure is exerted through its inlet port on a spring backed piston, and the tension on this spring is set so that the piston is forced back into the valve body and oil is released through the outlet, or by-pass, port at the desired pressure.

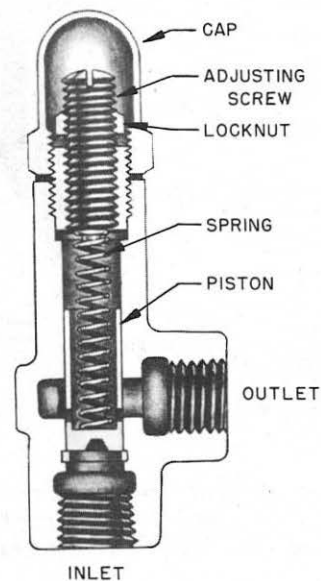


Fig. 41 - Fuel Pressure Regulator, Cutaway View

To reach the adjusting screw it is necessary to break the wire cap seal and unscrew the cap from the top of the valve body; to increase the manifold pressure release the locknut and turn the adjusting screw to the right; to decrease the manifold pressure, turn the adjusting screw to the left. After readjusting the pressure relief setting, be sure that the locknut is securely tightened, and that the wire cap seal is replaced.

If it is found that the piston is sticking because of gum deposit or some other foreign matter, the fuel relief valve must be disassembled and thoroughly cleaned. Use a solvent to wash it clean

and blow the parts off with compressed air. Be sure that the parts are completely free of foreign matter before assembling the relief valve and reinstalling it in the fuel line.

FUEL PRESSURE LINE FILTER (204)

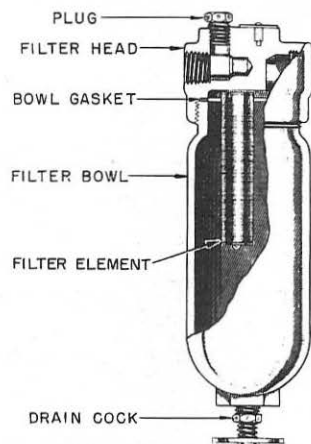


Fig. 42 - Fuel Pressure Line Filter (No. 204) Cutaway View

The Skinner and Zenith oil filters, used on the pressure side of the fuel line have a filter element which must be removed from the bowl for cleaning. Use the following list as a guide in maintaining the oil filters:

1. Leaks: Oil may leak through the gaskets, or air may leak through the packing gland. Keep the gaskets tight and in good condition.
2. Cleaning: The Skinner filter should be washed in a solvent — clean the outside of the filter element assembly, then fill the inside hole of the element assembly with clean solvent and blow it through the element with compressed air.

To clean the Zenith filter, disassemble and wash in clean solvent and blow off with compressed air. Use no tools when replacing the filter element — finger tightness is sufficient since the discs of the element act as lockwashers.

FUEL BY-PASS SOLENOID VALVE (122)

This 3-way solenoid valve is applied to units equipped with standby. It is used to control the position of the water metering pin in the servo fuel control (No. 108) by charging or relieving fuel pressure to the automatic burner adjusting piston.

The valve is energized in "FILL" and "STANDBY" positions of the control switch (102). When the valve is energized, the floating plunger is lifted, blocking the inlet port of the valve and opening the by-pass port to relieve the burner adjusting cylinder of fuel pressure. When the valve is deenergized ("RUN" position), the floating plunger drops, opening the fuel inlet port and closing the by-pass port. The automatic burner adjusting piston will be charged with fuel pressure, forcing the water metering pin into its normal operating position.

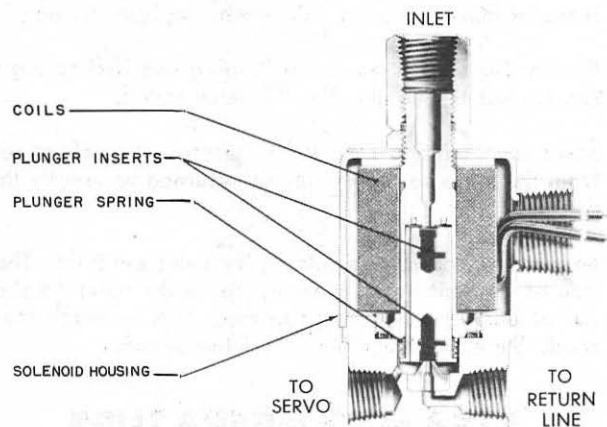


Fig. 43 - Fuel By-Pass Solenoid Valve (No. 122)

MAINTENANCE:

1. If the solenoid coil has an open circuit, the servo cam plate will go to high fire position when the control switch (No. 102) is turned to "STAND BY." Replace the coil. Do not attempt to operate the generator on standby position until this condition is corrected.
2. Keep the valve free from dirt and grit.
3. If the neoprene inserts in the plunger become worn, the valve will not seat properly. Replace the plunger.

FUEL METERING VALVE (ON SERVO-108)

Fuel at 150 pounds manifold pressure is delivered to this valve by the fuel pump. The valve mechanism consists of a plunger with a Vee-notch at the end which can be moved in or out of a circular valve seat against the tension of the valve spring. Pushing the plunger into the valve will progressively cover the Vee-notch, cutting down the cross-sectional area of the notch through which fuel must flow in order to reach the sprayhead. The servo cam plate action positions this valve so that the Vee-notch will be exposed just enough to allow the proper fuel flow necessary to evaporate the amount of water flowing through the servo.

MAINTENANCE:

1. If fuel is leaking around valve stem, replace packing.
2. Be sure the valve stem is not binding and that spring tension can be felt throughout the full valve travel.
3. Mark the height of the valve carefully before removing it from the servo so that it may be returned to exactly the same position.
4. Be sure the locking nuts holding the valve are tight. The vibration of the unit in service may cause the valve to slip down out of position and allow too much fuel to reach the sprayhead. Super heating will result if this occurs.

STEAM TEMPERATURE LIMIT CONTROL (110)

The steam temperature limit control is a safety device designed to protect the coils against excessive steam temperatures by cutting down the flow of fuel to the sprayhead when the steam temperature exceeds the limit setting. The control is fitted with an expansive tube, and operating lever, a control rod, and a fuel shut-off valve. The expansive tube is screwed into the coil outlet elbow; it lies directly across the bottom refractory and is cooled by the wet steam flowing through the coil outlet. The control rod is made of high nickel content steel and has a very low rate of expansion com-

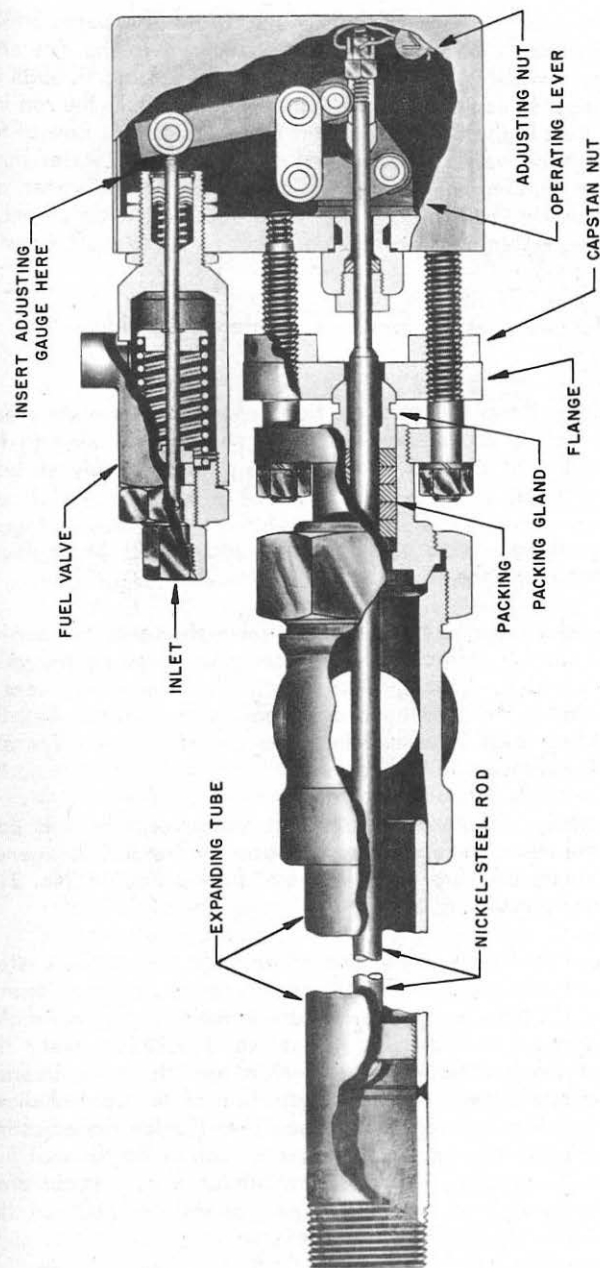


Fig. 44 - Steam Temperature Limit Control (110) Cutaway View

pared to the tube; it extends through the length of expansive tube, is welded to the tube at its inlet and is secured to the operating lever at its outside end. Heat from the steam passing through the tube causes it to expand. As the tube expands it pulls the rod into the tube, pulls in the operating lever, and shuts off the flow of fuel through the fuel valve. The fire will go out, but the water pump and blower fan continue to operate, circulating air and water, and thereby cooling the coils and expansive tube. A drop of only a few degrees in temperature will permit the fuel shut-off valve to re-open.

Use the following instructions as a maintenance guide:

1. **Packing:** Keep the packing tight enough to prevent steam from leaking around the operating rod without binding the movement of the rod. Take up the packing evenly on both flange studs.

The packing around the operating rod should be replaced quarterly, and the control reset.

2. **Fuel Valve:** Leakage through the valve stem into the control cover can be corrected by tightening or renewing the valve stem packing. Leakage through the fuel valve and seat is indicated if the sprayhead continues to receive oil when the operating lever is pushed in; replacement of the valve and seat is necessary in this case.
3. **Adjustment:** To achieve accurate adjustment of this control, the steam generator must be operated at 250 lbs. generator steam pressure with the water flow indicator (No. 218) cycling normally.

Remove the cover of the control and the seal on the cast-ellated adjusting nut. With the generator in balanced operation at 250 lbs. steam pressure, loosen the adjusting nut slightly and insert the adjusting gauge No. 109,982 between the end of the fuel metering valve stem and the roller bearing on the operating lever. The illustration of the control shows exactly where to insert the gauge. Then tighten the adjusting nut until the fuel valve just begins to restrict the flow of fuel to the spray head — this will be indicated by a slight drop in fuel nozzle pressure. Seal the adjustment, pull out the gauge and replace the cover.

The No. 109,982 gauge, illustrated here, may be purchased from the Vapor Heating Corporation, or made from 3/8" bar stock hardened after cutting.

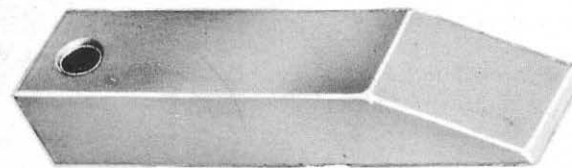


Fig. 45 - Adjusting Gauge, No. 109,982

FUEL SPRAYHEAD (105)

The fuel sprayhead if fitted with a solenoid fuel shutoff valve mounted above the sprayhead body. Fuel under pressure enters the sprayhead body at the top, flows through the fuel channel drilled in the sprayhead body and out through the six orifices in the spray nozzle. The fuel is atomized by compressed air flowing through the center channel in the valve body and out through the orifices in the sprayhead nozzle.

Use the following instructions as a maintenance guide:

1. **Nozzle:** At normal fuel nozzle pressure, six distinct sprays should be visible through the peep hole glass. If not, or if the nozzle fuel pressure gauge reads high, the nozzle should be taken out and cleaned.

Take the fuel sprayhead off the steam generator, unscrew the nozzle retainer, remove the nozzle and clean it with carbon tetrochloride. Blow out the orifices with compressed air; if necessary, use a wooden splint to clean these orifices — never use a metal probe.

2. **Adjustment:** No adjustment of the sprayhead should be necessary as to height. The sprayhead body should be screwed as far into the mounting bracket as the threads will allow. When tightening the nozzle retainer, hold the nozzle tip so a line drawn through opposite orifices would be parallel to a line drawn through the center of the fuel and air inlets. This will position one of the fuel jets on each side of the electrode spark so that the spark will ignite the fine fuel mist between the jets.

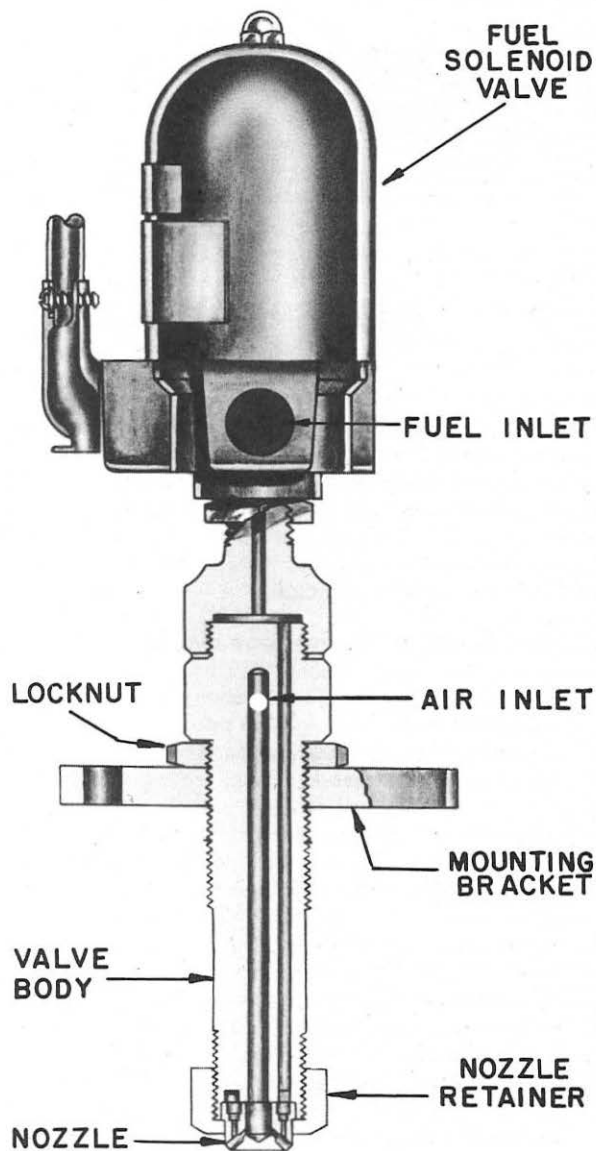


Fig. 46 - Fuel Solenoid Valve & Sprayhead, Cutaway View

AIR SYSTEM

The component devices and piping of the air system are shown in light green on the piping schematic at the back of this manual.

The flow through this system is outlined as follows:

1. Air is taken from the main brake reservoir on the locomotive.
2. Main reservoir air pressure is reduced to the proper atomizing pressure as it passes through the air pressure regulator (No. 100).
3. Atomizing air switch (No. 101) is piped into the air pressure line after the regulator.
4. Air at reduced pressure travels to the sprayhead assembly (No. 105) where it is used to break the fuel oil entering the combustion chamber into a fine mist.

ATOMIZING AIR PRESSURE REGULATOR (100)

This air pressure regulator is used in the atomizing air line of OK steam generators to reduce and regulate the locomotive reservoir

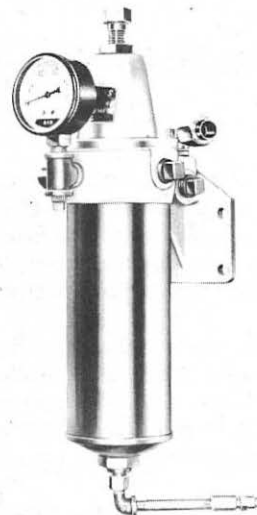


Fig. 47 - Atomizing Air Pressure Regulator No. 100

air pressure, and to filter dirt, oil and water out of the compressed air.

The pressure setting of the regulator is 40 to 45 pounds when two steam generators are installed on the same locomotive. The setting is 70 to 75 pounds when only one steam generator is installed on the locomotive.

Operation: Air comes through the inlet at line pressure; it flows around the separating tube into the condenser tube, then through the filter element and out through the regulator valve into the diaphragm chamber on the outlet side of the regulator. Adjustable spring tension on the diaphragm regulates the outlet air pressure; as the diaphragm is lifted, it brings the valve closer to the valve seat and limits the flow of air through the regulator. In operation, the valve assumes a balanced position and meters the flow of air to maintain a uniform atomizing air pressure.

Adjusting: Release the locknut and turn the adjusting screw out to decrease atomizing air pressure; turn the adjusting screw in to increase atomizing air pressure.

Care and Cleaning: Open the drain valve daily to drain the unit. Disassemble twice a year and clean the filter element. At this time check the diaphragm for wear and flexibility, the tension on the springs, and the condition of the valve and valve seat.

ATOMIZING AIR SWITCH (101)

This switch is included in the system to shut off the fire in the event that the atomizing air pressure fails. Electrically the switch is in series with the fuel solenoid valve (see Electrical System Schematic Diagram) and will open to de-energize the solenoid valve (No. 104) when the air pressure drops below 25 pounds.

Periodic maintenance is not required. The snap switch or bellows assembly can be easily replaced if malfunction occurs. As observed in your illustration, the bellows assembly is simply mounted on the bottom of the housing, and the snap switch is exposed for replacement by removal of the front cover assembly.

If it becomes necessary to adjust the closing pressure of this atomizing air switch, turn the adjusting screw on top of the housing

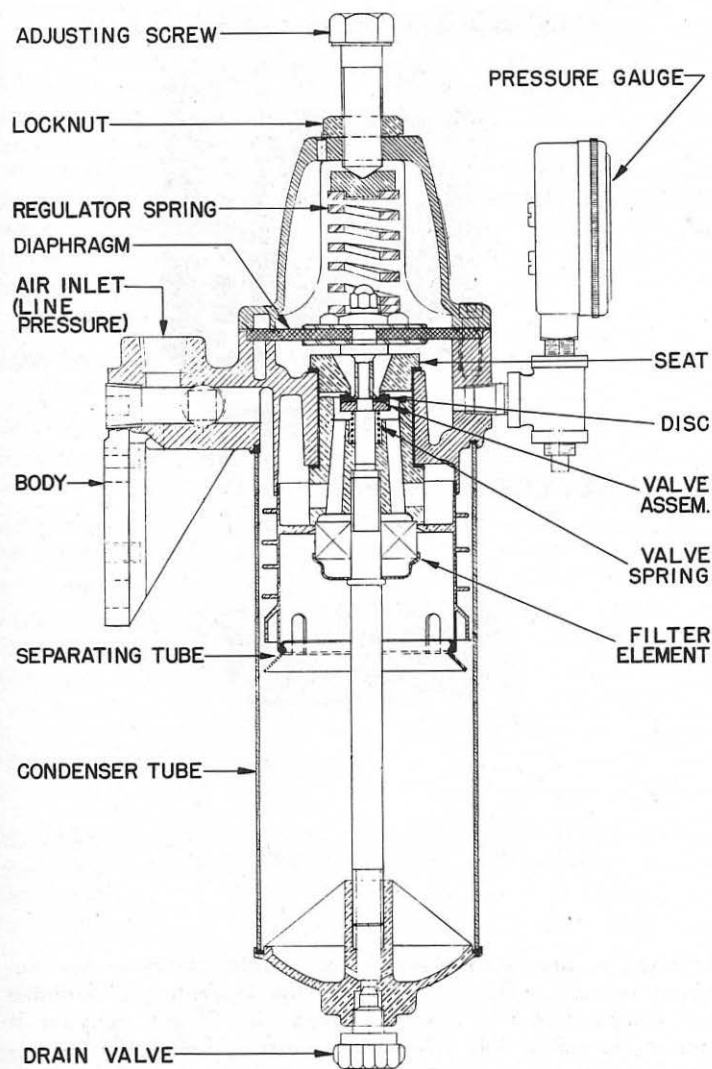


Fig. 48 - Atomizing Air Pressure Regulator, Cross-section View

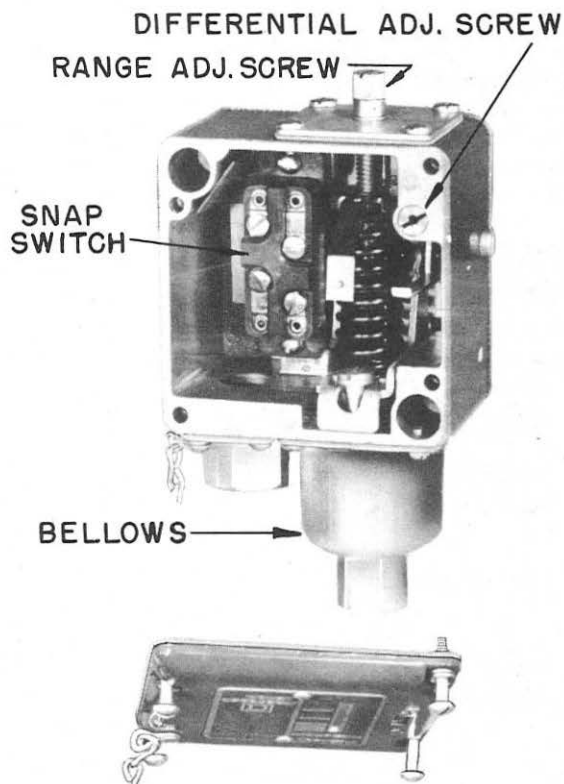


Fig. 49 - Atomizing Air Switch No. 101

clockwise for increased pressure, or counter-clockwise for decreased pressure. This switch has a low operating differential which ordinarily should not be altered. But if you consider it necessary to adjust this differential pressure, follow the instructions given below.

The differential pressure is regulated by the differential adjusting screw on the upper right of the control behind the cover assembly (see illustration). Turn this screw clockwise to increase differential or counter-clockwise to decrease differential.

SPECIAL INSTRUCTIONS

MAINTENANCE SCHEDULE

The maintenance and lubrication schedules given in this section are based on the national average of locomotive service time and mileage; either time or mileage may be used as a basis for scheduling maintenance work. Operating conditions on any particular railroad may warrant a change in the maintenance procedure for any one of the specific items tabulated here, therefore it is suggested that our recommendations be considered with some degree of flexibility.

5,000 MILES (ONE WEEK):

WATER STRAINERS: Clean suction line water strainer. It may be necessary to inspect or clean the water suction strainer on a trip basis — operating conditions should be the governing factor.

RUNNING TEST: Fill and start. If no defects are apparent, back-blow the coils, refill and dispatch.

WATER PUMP: Check oil level in gear case.

PULLEY BEARINGS: No. 2 cup grease.

DAMPER ROD LINKAGE: Lube oil.

DAMPER ROD BEARINGS: Lube oil.

10,000 MILES (TWO WEEKS):

ORIFICE TEST: If the trainline pressure holds within 15 lbs. of normal output pressure, the steam generator is in satisfactory operating condition.

20,000 MILES (30 DAYS):

COILS: Legal boiler wash. Blow soot and hammer test the coils.

STEAM TRAPS: Clean and inspect.

FUEL SPRAYHEAD: Clean.

RELAYS: Inspect.

MOTOR: Inspect commutator, slip rings, brushes and anchor bolts.

FIREPOT AND GENERATOR INTERIOR: Inspect.
BELTS AND PULLEYS: Inspect for alignment and wear.
WATER SUPPLY TANKS: Drain and flush (including transfer lines, protective heating lines, and suction and return lines).
AUTOMATIC TRAINLINE SHUTOFF VALVE: Inspect and test.
FLEXIBLE COUPLINGS: Inspect.
STEAM TEMPERATURE LIMIT CONTROL: Inspect and test.
WATER PUMP: Change lube oil in gear case (after 100 hours of operation).
DASHPOT RELAY: Check and fill with dashpot oil.
BLOWER BEARINGS: No. 2 cup grease.

60,000 MILES (QUARTERLY):

CHECK VALVES: Clean.
LEGAL INSPECTION: As required by I. C. C.
STACK SWITCH: Inspect and test.
STEAM TEMPERATURE LIMIT CONTROL: Repack and test.
WATER PUMP: Inspect for leaks.
FUEL FILTERS: Clean.
RESISTORS: Inspect and clean.
IDLER PULLEY: No. 2 cup grease.

120,000 MILES (6 MONTHS):

DIAPHRAGMS: Replace in servo control and water by-pass regulator.
WATER PUMP: Repack.
WATER RELIEF VALVE: Clean and test.

240,000 MILES (ONE YEAR):

WATER SUPPLY TANK: Wash out water tank, suction line and return lines.
WATER PUMP: Overhaul.
WATER-BY-PASS REGULATOR: Overhaul.
SERVO FUEL CONTROL: Overhaul.
SOLENOID AND RELAY COILS: Megger test.
SOLENOID AND RELAY COILS: Test.
IGNITION TRANSFORMER: Megger test.
HYDROSTATIC TEST: Test at hydrostatic pressure 50% above working steam pressure.
SEPARATOR BLOWDOWN VALVE: Repack and test.

BLOWER FAN: Clean and inspect bearings.
MOTOR CONVERTER: Overhaul.
COIL BLOWDOWN VALVE: Inspect and test.
COIL RETAINER AND PADS: Inspect.
STACK SWITCH: Replace helix and test.
AIR PRESSURE REGULATOR: Overhaul.
COPPER TUBING: Anneal.

LUBRICATION SCHEDULE**5,000 MILES (ONE WEEK):**

WATER PUMP: Check oil level in gear case.
PULLEY BEARINGS: No. 2 cup grease.
DAMPER BEARINGS AND LINKAGE: Lubricating oil.

20,000 MILES (30 DAYS):

WATER PUMP: Change lube oil in gear case (after 100 hours of operation).
DASHPOT RELAY: Check and fill with dashpot oil.
BLOWER BEARINGS: No. 2 cup grease.
60,000 MILES (QUARTERLY):
IDLER PULLEY: No. 2 cup grease.

WASHING OUT STEAM GENERATOR COILS

General Information

This boiler wash is legally required every thirty days. Experience has shown that the best way to carry out the washout procedure is in three stages as outlined below:

First, the washout solution is circulated through the intermediate coil, the inner coil and the steam separator, in the order named. Secondly, the solution is circulated through the heat exchanger casing, economizer coil, outer coil, intermediate coil, inner coil and steam separator, in the order named.

And in the last stage of the washout procedure, the solution is circulated through the steam generating coils and steam separator, and then through the heat exchanger coil.

Preparing The Solution:

We recommend any of the liquid inhibited acid compounds supplied by reputable manufacturers for boiler washing. The steam generator must be cool when using these compounds, because the acid inhibitor is killed at temperatures greater than 120° F.

Make up the solution with one part of compound and four parts of water, or if necessary, one part compound to three parts water. Caution: These compounds and solutions are very corrosive and should not be allowed to contact your clothes or any part of your person. Ship or store the compound only in glass containers crated in wood. Keep fire away from washout pump — the solution gases are inflammable.

Steam Generator Washout Connection

Washout connections are usually provided at the side of the locomotive units. The feed line from the boiler washing machine should be connected to the washout inlet line of the steam generator, and the solution return line should be connected to the steam generator washout outlet coming from the separator blowdown valve line. A three-way valve is usually located at the point where the washout outlet joins the line coming from the separator blowdown valve. Turn this valve to open the washout return line and close the separator blowdown line.

If your installation does not have a three-way valve at this point, disconnect the water return line and use this line as the acid return line during the third stage of washout.

FIRST STAGE OF WASHOUT PROCEDURE:

1. Pre-cool the steam generator if necessary by running with the control switch in the FILL position and with the separator blowdown valve open. This pumps water through the coils and out through the steam separator; the water flow, together with the air flow from the blower fan, combines to cool the steam generator coils.

2. To wash out the intermediate and inner coil, close the washout inlet valve No. 16 leading to the heat exchanger, and open washout inlet valve No. 14 leading to the intermediate coil. (Numbers refer to schematic piping diagram of OK steam generators.)
3. Open the separator blowdown valve. Close the stop and check valve to prevent any washout solution from entering the trainline, and close the steam valves leading from the separator outlet nipple to the steam gauge, water by-pass regulator, layover connection and radiation under the water pump. Be sure that the coil blowdown valve is closed and that the coil shut off valve is open.
4. Close the three-way washout valve handle — the flow from this valve must be to the separator blowdown valve and away from the water supply tank.
5. Run copper tubing or iron pipe from the washout pump outlet to the washout inlet connection on the steam generator.
6. Fit a pipe, tubing or hose to the washout outlet connection of the steam generator and lead it back to the washout solution tank.
7. Start the washout pump. The washout solution will enter the intermediate coil, flow on through the inner coil and steam separator, and will return through the separator blowdown valve and washout solution outlet to the solution tank on the washing machine. As the washout solution is pumped through the coils it forces out whatever water remains in the coils; this water should be dumped, since it will dilute the washout solution if it is allowed to flow into the solution tank. When the washout solution begins to flow from the return line, direct the flow back into the solution tank.

Gas and foam is generated by the chemical action of the solution. Run the washout pump until the foaming subsides. Test the acid by adding some soda to a small sample to see if it has lost its strength.

NOTE: The entire washout will normally take two to three hours depending on the condition of the coils. The foaming of acid is a normal reaction to be expected to some extent even with clean coils and it is important to observe the amount of scum carried with the foam rather than the volume of foam in determining the length of the washout.

Caution: Do not allow the solution to splash on your person or your clothes — it is very corrosive.

SECOND STAGE OF WASHOUT PROCEDURE:

1. Close the solution inlet valve No. 14 leading to the intermediate coil, and open solution inlet valve No. 16 leading to the heat exchanger. (Numbers refer to the schematic piping diagram of OK units.)
2. Be sure the separator blowdown valve is open and the outlet capped or plugged.
3. Start the washout pump. The washout solution will now flow through the heat exchanger casing and all of the coils, and will return to the solution tank by way of the separator blowdown valve and washout solution outlet.
4. When the foaming subsides, shut down the pump and test the strength of the acid. If the acid is good, go on to the third stage of washout.

THIRD STAGE OF WASHOUT PROCEDURE:

1. Keep the same washout connections as in the preceding operation, but CLOSE the separator blowdown valve.
2. Be sure that the flow from the three-way washout valve is to the separator blowdown valve and away from the water supply tank.
3. Start the washout pump. The washout solution follows the same course as given in stage No. 2, except that it does not pass out of the separator blowdown valve — the solution flows from the separator through the steam trap and heat exchanger coil up to the three-way washout valve and then back to the washout outlet.
4. Shut down the pump when foaming subsides.

Flushing Out Procedure

Immediately after the washout procedure is completed, the steam generator should be thoroughly flushed out. It is recommended that the acid pumping system and the coils be flushed out with a strong alkali solution such as soda ash, running the caustic soda solution through the tank of the boiler washing machine. The steam generator should then be flushed out by pumping clear

water through the coils with the washout pump on the boiler washing machine, running the clear water through the tank on the washing machine. Pump the clear water through the steam generator and allow it to flush out on the ground.

The solution valve No. 14 (number refers to piping diagram of OK units) leading to the intermediate coil should be opened last for a few seconds to flush out the piping at the inlet to the intermediate coil.

If it is more desirable to flush out the steam generator with water from the boiler water supply tank, disconnect the washout feed piping and return hoses, turn the three-way valve in the separator blowdown line to close the washout return outlet. Then open the separator blowdown line and turn the control switch to the FILL position. Keep the separator blowdown valve open and flush the water out to the ground.

After flushing the generator it must be thoroughly blown down with steam as outlined below:

1. Disconnect the washout feed and return piping and cap the washout connections.
2. Close both solution inlet valves and see that the trainline stop valve is closed.
3. Open the steam admission valves leading from the separator outlet nipple to the steam gauge, water by-pass regulator, layover connection and radiation under the water pump.
4. Open the separator blowdown valve.
5. Fill and fire the steam generator and allow it to run for about ten minutes with the separator blowdown valve open.
6. Then close the separator blowdown valve and allow steam pressure to build up to 250 pounds.
7. Turn the control switch to OFF and open the coil blowdown valve, using about half of the pressure to blow down the coils; then close the coil blowdown valve and open the separator blowdown valve and blow down the remaining pressure.
8. Refill the steam generator with water and repeat blowdown operation three or four times. Carrying out this procedure several times removes considerable sludge and sediment that would otherwise remain in the coils of the steam generator.

Note: Where steam generators are operating on hard waters, more frequent coil washing may be necessary, particularly if the water is not treated properly. Appreciable sludging-up of the generator coils is indicated by increasing back pressure from the steam generator coils as shown on the water pressure gauge. The storage tank should also be flushed out and cleaned at this time. Keep the feed water free of sludge accumulation.

HYDROSTATIC TEST

The following steps outline the necessary procedure for performing a hydrostatic test of the steam generator coils:

1. Close the separator blowdown valve and return water outlet valve.
2. Take off the safety valves and cap the outlets from the steam separator with a half union and pipe plug — tighten the outlet caps after the air is bled out of the steam generator.
3. Close the stop and check valve, and be sure that the layover connection valve is closed. In addition, the standby steam admission valve #28 and the #56 valve on DNJ units must be closed.
4. Take off the steam line leading from the steam separator outlet nipple to the water by-pass regulator and insert a test gauge in the outlet nipple.

With the above valves closed and the remaining valves in their normal positions, turn the control switch to FILL. Allow the air to bleed through the safety valve elbows, tighten the caps on the safety valve elbows, and then build up the required hydrostatic pressure of 450 lbs. When the required pressure registers on the gauge, close the coil shut-off valve to hold the pressure on the coils and steam separator and turn control switch OFF.

If it is not desirable to use the steam generator water pump to build up the required test pressure, an auxiliary water pump can be connected to the washout solution inlet and the water pumped through the washout solution valve leading to the heat exchanger and through the coils and steam separator.

The side plates should be removed and the coils inspected for corrosion, and the firepot should be taken out to permit inspection of the inner coils for blistering.

DIRECTIONS FOR DRAINING THE STEAM GENERATOR

Before draining the steam generator, it is recommended that a pint of soluble oil be added to the feed water as a rust preventive. Have the unit in normal operation, then shut it down and add one pint of Texaco's No. 810 Soluble Oil "C", or its equivalent, to the water treatment or stainer tank. Restart the steam generator and let it run until the emulsified oil is visible in the return water sight glass. Then blow down the coils as in the regular shutdown procedure and drain the unit, following the procedure outlined below:

1. Close the water supply valve. Open the drain valve of the water strainer tank, or water treatment tank, whichever is used; open the water pump test valve, the coil shutoff valve and the separator blowdown valve.
2. To drain the water pump, open the water pump test valve, turn the control switch to FILL and pump air for a few minutes to blow out the valves and pipes. Then turn the control switch OFF.
3. Take the cover off the water treatment or strainer tank. Lift out the screen mesh strainer and empty the tank of water.
4. Close the stop and check valve at the top of the steam separator, and close the return water outlet valve in the return line from the separator.
5. Connect a compressed air line to the open water pump test valve and blow the remaining water out of the piping, water by-pass regulator, servo-fuel control, heat exchanger chamber, and the steam generator coils. The water is discharged by air pressure through the separator blowdown valve.
6. After the above operation is completed, close the separator blowdown valve and open the return water outlet valve between the separator and the steam trap. Again blow compressed air through the steam generator. This time it will

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blow through the steam trap, the coil within the heat exchanger and the entire water return line, and will discharge the water through the return line into the storage tank and through the tank drain outlet to the ground.

7. Open the separator blowdown valve.
8. Disconnect the return water line from the heat exchanger, and the inlet and outlet water connections on the servo-fuel control.
9. Open the petcocks at the bottom of the heat exchanger and servo, and remove the drain plug from the bottom of the steam trap.
10. Disconnect the steam lines leading to the steam pressure gauges and water by-pass regulator, and blow out with compressed air.

Note: Keep all valves open.

LAYING UP THE STEAM GENERATOR

If necessary to lay up the steam generator for any appreciable length of time, it is good maintenance practice to pump the coils full of oil to prevent them from corroding. Feed the oil through the water treatment tank or the water strainer tank, and turn the control switch to FILL, after opening the separator blowdown valve. Allow the water pump to fill the steam generator with oil until it comes out the separator blowdown valve. Turn the control switch to OFF and close the separator blowdown valve.

This oil is automatically flushed out when the steam generator is filled with water for normal operation. It is not absolutely necessary to use oil for laying up Vapor-Clarkson steam generators, although it does have a very beneficial effect in preventing the adhesion of sludge forming matter to the steam generator coils.

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