MAINTENANCE INSTRUCTIONS

for

OK-4616
OK-4630
DRK-4516
DRK-4530
DSK-4530
OK-4625
OK-4740

VAPOR-CLARKSON

Steam Generators

VAPOR "OK" CONTROLS

INTENSO-FLAME!

VAPOR INTENSIFIED COMBUSTION

BULLETIN No. 2-203 Rev. "A"

VAPOR HEATING CORPORATION
RAILWAY EXCHANGE · CHICAGO 4

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VAPOR HEATING CORPORATION
RAILWAY EXCHANGE
CHICAGO 4

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Bulletin No. 2-203
Revision "A"

MAINTENANCE INSTRUCTIONS

for

OK-4630	DRK-4530	OK-4625
OK-4616	DRK-4516	OK-4740
	DSK-4530	

VAPOR-CLARKSON STEAM GENERATORS

INTRODUCTION

This second edition of "Maintenance Instructions" contains information for the guidance of personnel engaged in the maintenance and repair of the OK, DRK and DSK series of Vapor-Clarkson steam generators. It has been enlarged to include the OK-4625 and OK-4740 units, and is divided into three section as explained below:

Section I — Contains a table of performance data, and outlines the fuel system, the water system and electrical circuits for all steam generators discussed in this book.

Section II — Contains recommended lubrication and inspection maintenance procedures, and special instructions covering feed water treatment, hydrostatic test of the coils, washing out the coils, and directions for draining and laying up the steam generator.

Section III — Describes the function of all important assemblies and devices, and the maintenance necessary to keep each device and assembly in good condition.

It is suggested that the Operator's Manuals for the various units under discussion may also be of value to the maintainer; they contain a brief description of the unit in operation, step-by-step operating instructions, a trouble-shooting section and a schematic piping chart.

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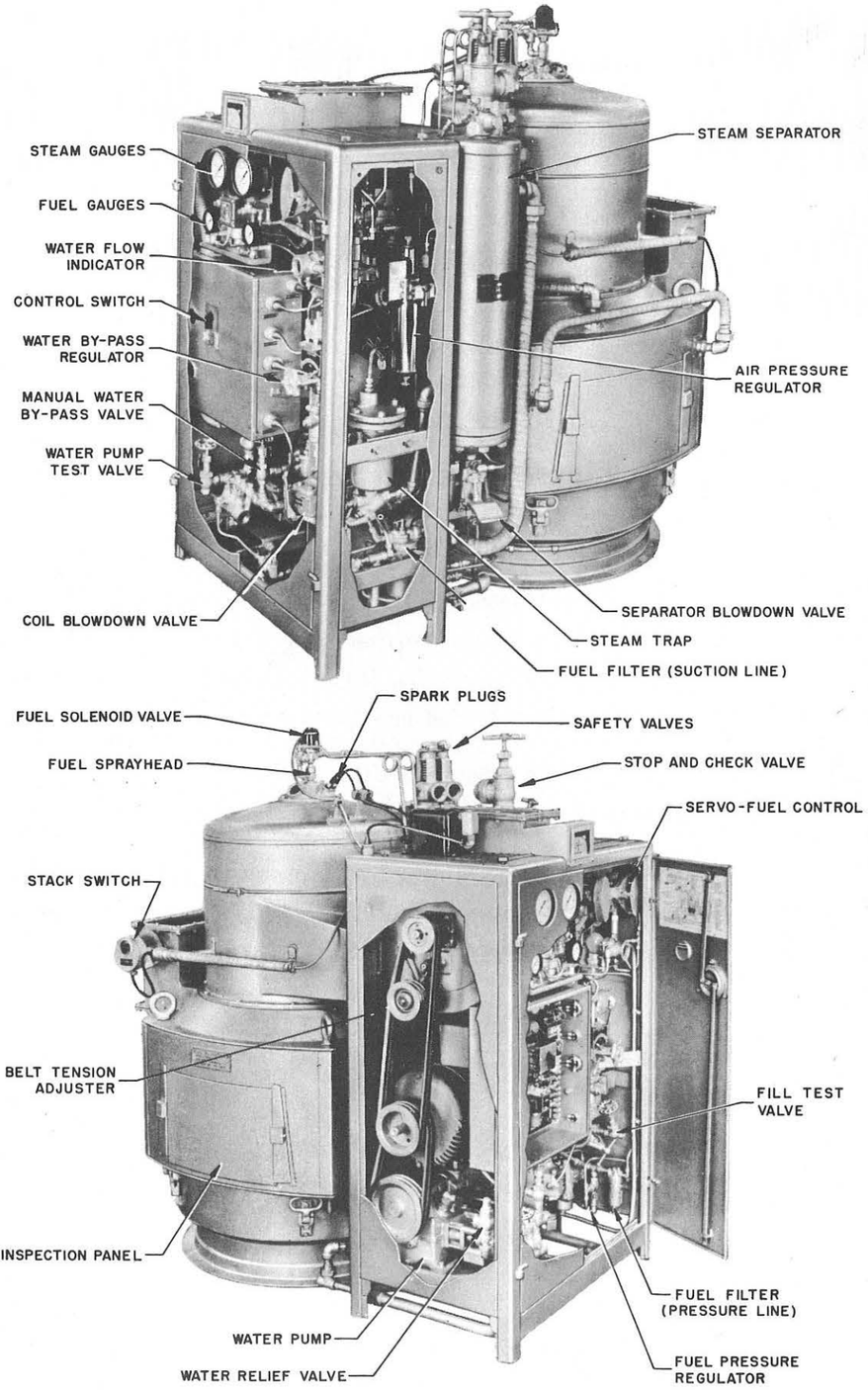

Fig. 1 — OK-4625 Steam Generator.

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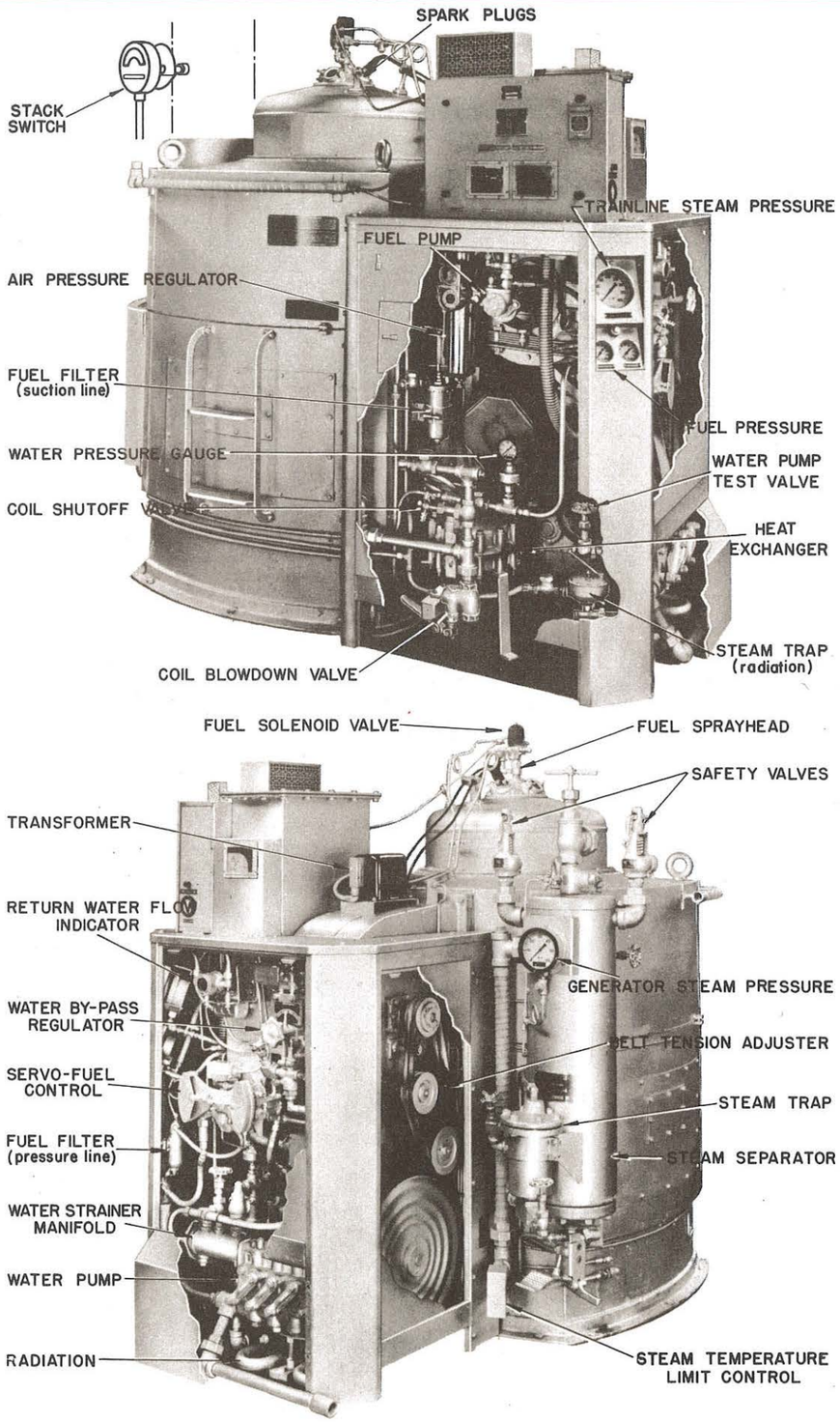


Fig. 2 — OK-4630 Steam Generator.

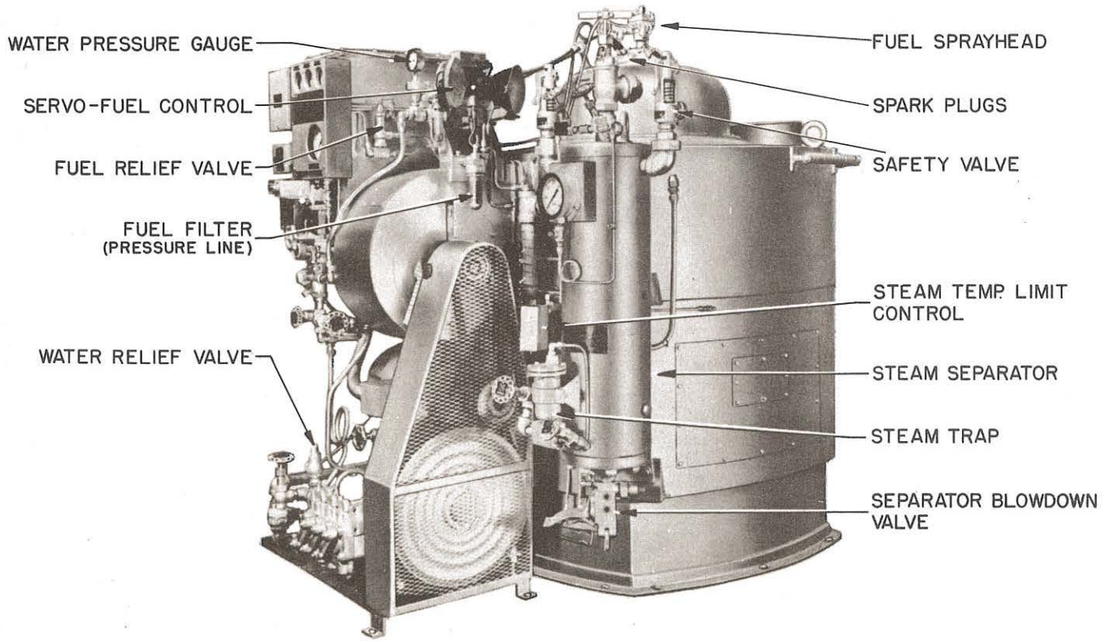


Fig. 3 — DRK-4530 Steam Generator.

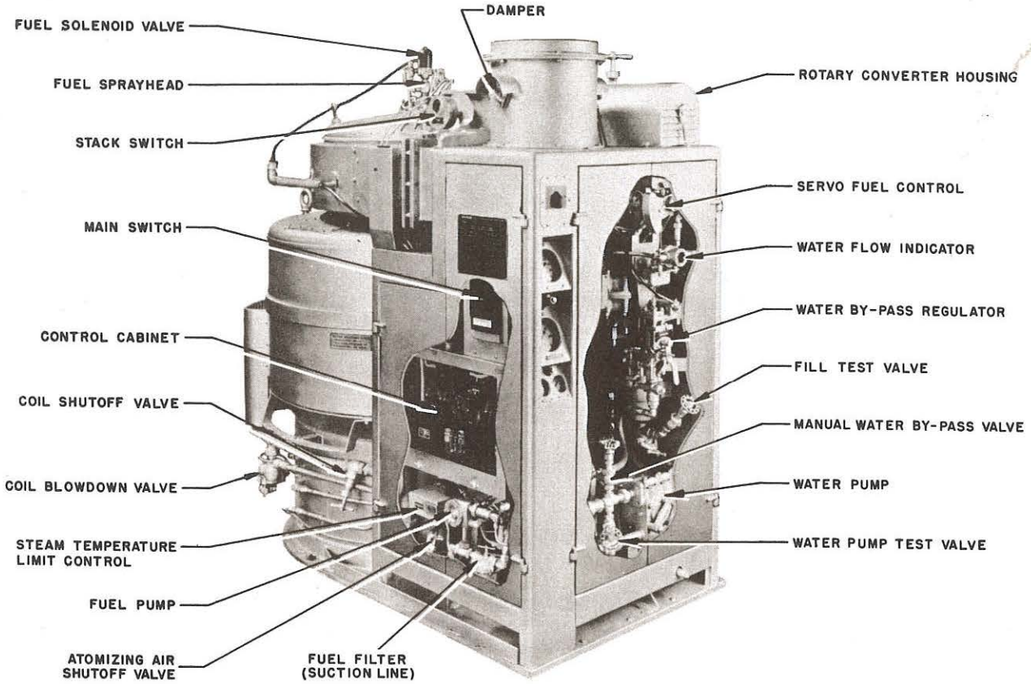
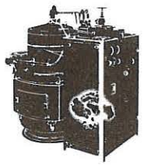


Fig. 4 — OK-4740 Steam Generator.

general information



PERFORMANCE DATA

	4516 & 4616	4625	4530 & 4630	4740
Rated Evaporative Capacity,				
lbs. per hr.	1700 lbs.	2750 lbs.	3250 lbs.	4500 lbs.
gal. per hr.	204 gal.	330 gal.	390 gal.	539 gal.
Equivalent Horsepower	61 BHP	95 BHP	115 BHP	150 BHP
Water Relief Valve — unloading setting	550 lbs.	550 lbs.	550 lbs.	800 lbs.
Fuel Pressure Regulator — set at high fire to give manifold pressure of	150-155 lbs.	150-155 lbs.	150-155 lbs.	150-155 lbs.
Air Pressure Regulator — atomizing air pressure	30-35 lbs.	40-45 lbs.	70-75 lbs.	70-75 lbs.
Normal Steam Temperature, at 200 lbs. pressure	388° F.	388° F.	388° F.	388° F.
Steam Temperature Limit Control — operates at approximately	438° F.	438° F.	438° F.	450° F. (first stage) 550° F. (second stage)
Stack Temperature	600°-700° F.	525°-600° F.	700°-750° F.	650°-700° F.
Stack Switch —				
high temperature cutout	900° F.	900° F.	900° F.	900° F.
low temperature cutout	300° F.	300° F.	300° F.	300° F.
Outfire Relay — time delay is	43-47 sec.	43-47 sec.	43-47 sec.	43-47 sec.
Motor Speed (high fire)	1750-1800 R.P.M.	1750-1800 R.P.M.	1750-1800 R.P.M.	2850-2950 R.P.M.
Blower Speed (high fire)	2750-2800 R.P.M.	2500-2550 R.P.M.	2150-2200 R.P.M.	2850-2950 R.P.M.
Water Pump Speed (high fire)	970-995 R.P.M.	1400-1425 R.P.M.	365-390 R.P.M.	525-550 R.P.M.
Water Pressure Range (low to high fire)	225-350 lbs.	225-350 lbs.	225-350 lbs.	225-450 lbs.
Amperage Draw (74 V.D.C.)	30-40 amp.	45-55 amp.	50-70 amp.	65-100 amp.
Lowest Steam Generating Rate Without Cycling (low fire output)	600-800 lbs.	800-1000 lbs.	800-1000 lbs.	1100-1300 lbs.
Fuel Consumption (per hour at rated output)	21 gal.	32 gal.	40 gal.	51 gal.
Water Volume	14.3 gal.	24.5 gal.	26.3 gal.	37.7 gal.

WATER SYSTEM DRK STEAM GENERATORS

Figure 3 diagrams the water and steam flow in DRK steam generators. Successive stages of the flow are listed below:

1. The water pump draws water from the supply tank, through the water strainer tank or water treatment tank.
2. From the discharge side of the pump, the water flows to the water relief valve and the water pump test valve, and through the "Y" type strainer; the water relief valve is set to unload at 550 lbs. water pressure.
3. Three water lines lead from the "Y" type water strainer: the feed water line to the servo-fuel control, a by-pass line through a shutoff valve and through the water by-pass regulator, and the manual by-pass water line which passes through the manual water by-pass valve and joins the by-pass return line leading from the water by-pass regulator to the suction side of the water pump. The water by-pass regulator is operated by steam pressure and controls the amount of feed water admitted to the coils by regulating the amount of water by-passed back to the suction side of the pump; the servo-fuel control admits fuel and combustion air to the sprayhead and fire pot in direct proportion to the amount of feed water flowing through the servo diaphragm chamber.

   The manual water by-pass valve, in the by-pass return line, is normally closed and allows manual control of the amount of water by-passed if the water by-pass regulator should become inoperative. The shutoff valve directly before the water by-pass regulator is used to cut the regulator out of the water circuit if it becomes necessary to manually control the amount of water by-passed by opening and adjusting the manual by-pass valve.
4. The feed water passes through the servo and on through the spring loaded 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.
5. From the heat exchanger the feed water flows through a small lift check valve (prevents generator steam pressure from backing into the heat exchanger). Then it flows 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 the coils and is carried over with the steam into the steam separator.

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

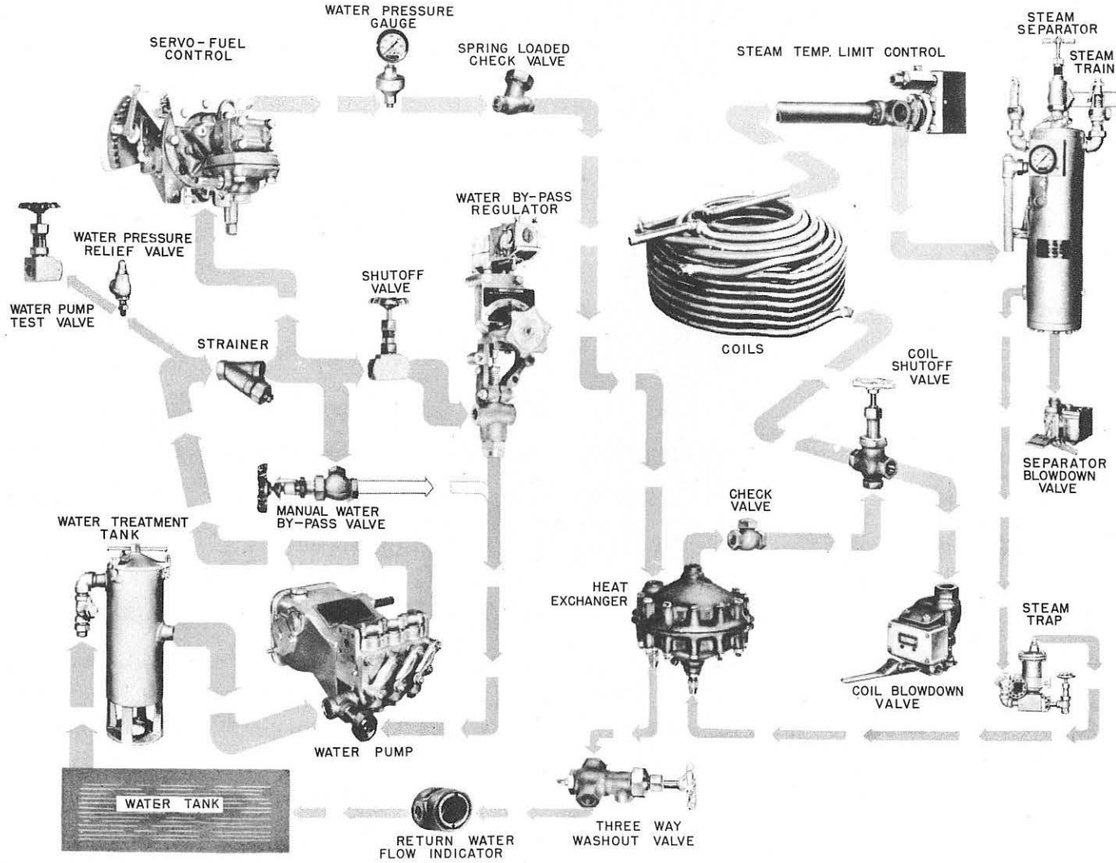


Fig. 5 — DRK-4530 Water Flow Diagram.

Steam Flow:

6. Steam passes from the coil outlet through the steam temperature limit control; this device acts to cut down the flow of fuel to the sprayhead if excessive steam temperatures develop.
7. The steam flow continues through the steam separator and the 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.

Return Water Flow:

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

WATER SYSTEM OK AND DSK STEAM GENERATORS (Except OK-4740)

This discussion simultaneously considers the DSK, OK-4616, OK-4630 and OK-4625 units; they have similar water systems with the following minor exceptions:

1. The water strainer manifold leading from the pressure side of the water pump on the OK-4630 and OK-4616 models is not applied on DSK and OK-4625 steam generators.
2. The steam outlet is at the top of the coils on DSK units — not at the bottom as shown for OK models.

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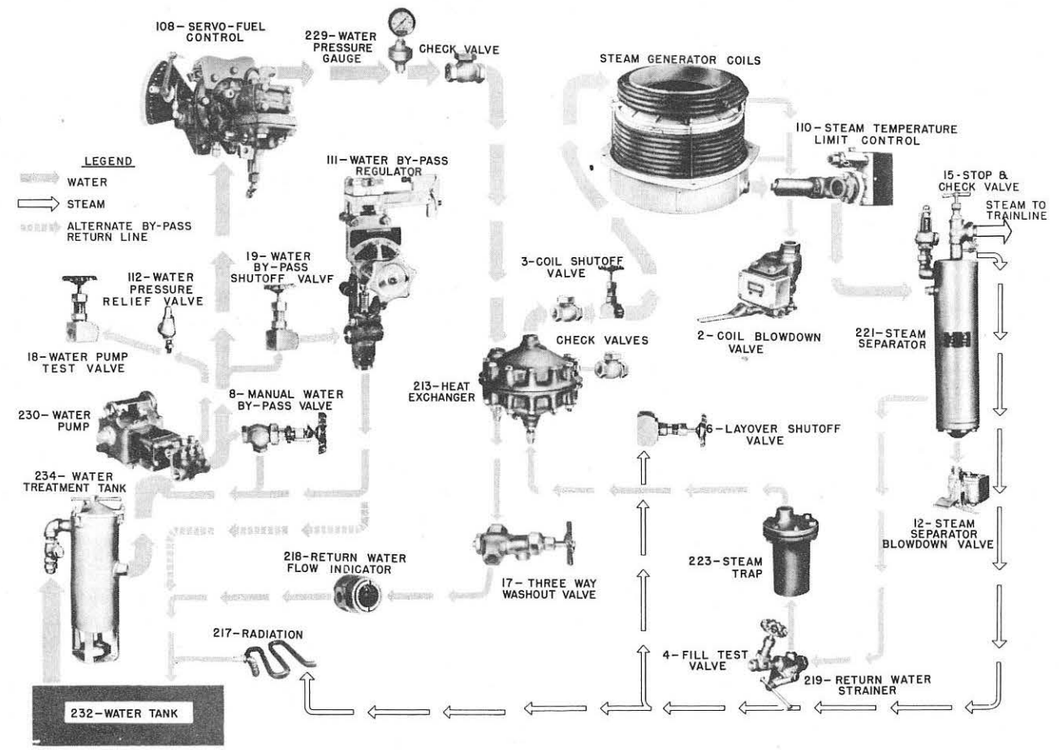

Fig. 6 — OK-4625 Water Flow Diagram.

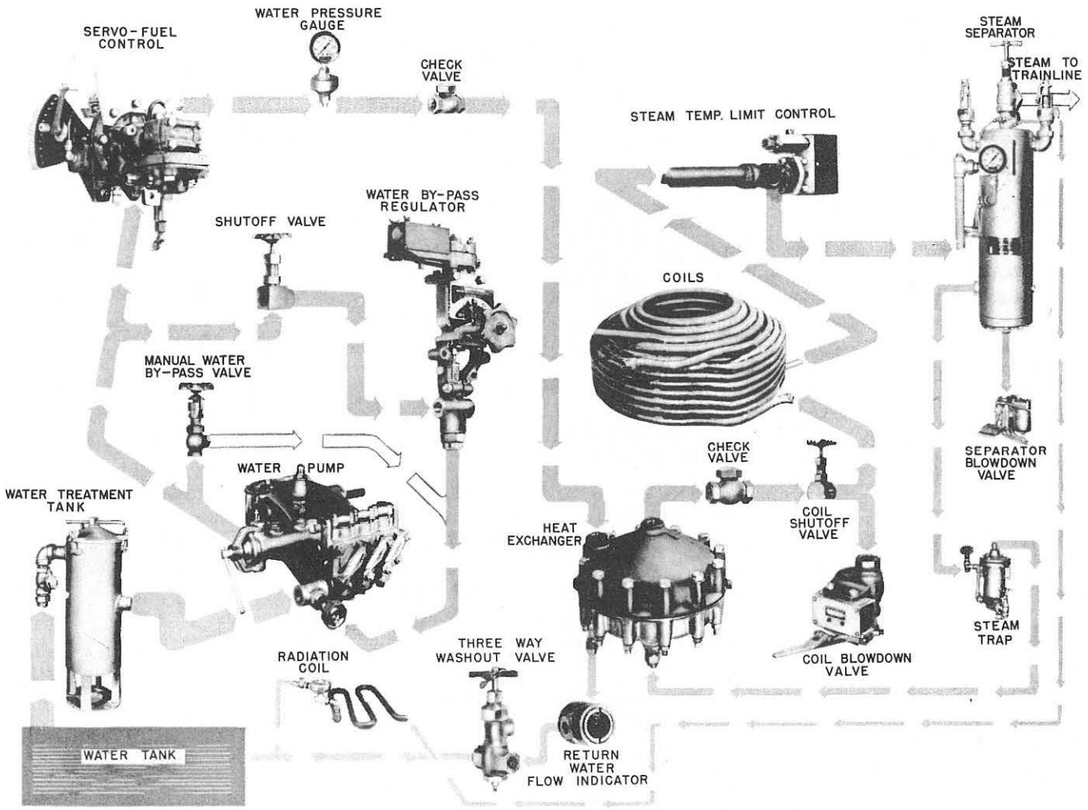

Fig. 7 — OK-4630 Water Flow Diagram.

The adjoining diagrams illustrate the water and steam flow in the OK series (except OK-4740) of steam generators. Successive stages of the flow are outlined below:

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 550 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 is lead 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.

   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 the 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.

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.

WATER SYSTEM OK-4740 STEAM GENERATORS

The accompanying illustration shows the water and steam flow in OK-4740 steam generators. Successive stages of the flow are given below:

1. The water pump draws water from the supply tank through the water strainer tank or water treatment tank.
2. The water relief valve (adjusted to unload at 800 lbs. water pressure), water pump test valve, manual water by-pass valve, and feed water line to the water by-pass regulator and servo control are taken off the pressure side of the water pump.

   The water by-pass regulator controls the amount of feed water admitted to the coils by regulating the amount of water by-passed back to the suction side of the water pump; it is automatically controlled by trainline steam pressure. The servo control admits fuel and combustion air to the fire pot in direct proportion to the amount of feed water flowing through the servo diaphragm chamber.

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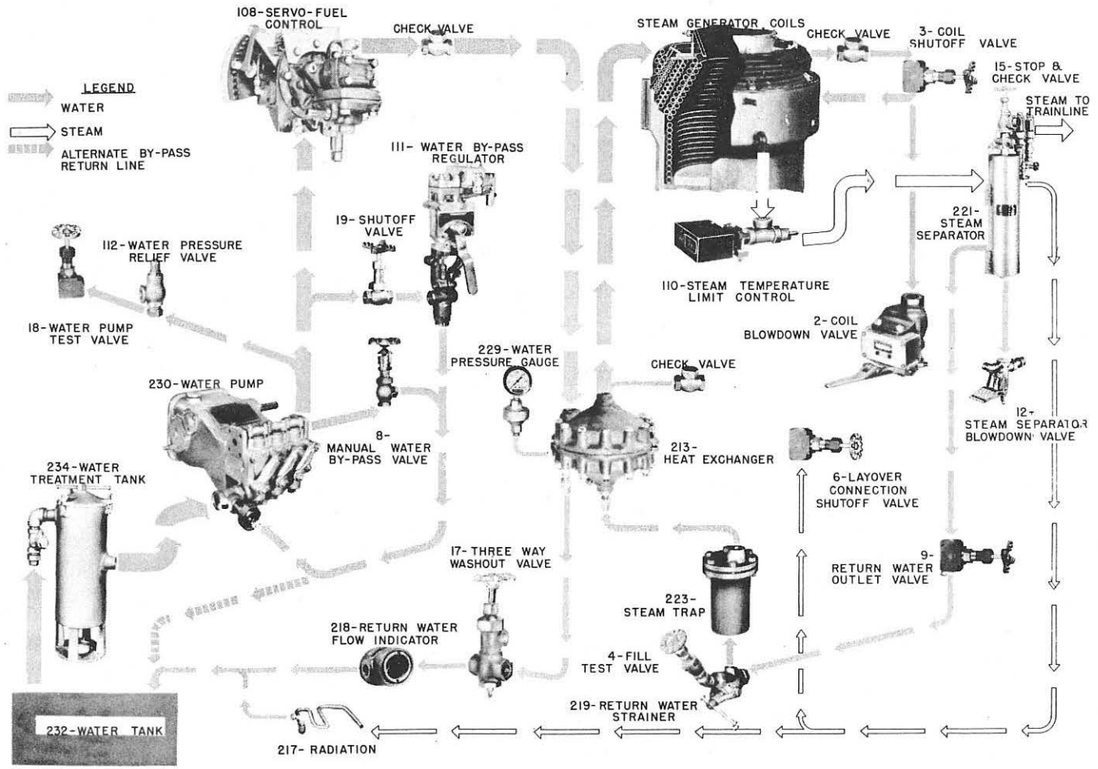

Fig. 8 — OK-4740 Water Flow Diagram.

The manual water by-pass valve is normally closed and is used only when manual control of water feed to the coils is necessary. The shut-off valve directly before the water by-pass regulator must be closed to cut the regulator out of the water circuit when the manual water by-pass valve is in use.

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 the coils and is carried over with the steam into the steam separator.

The coil blowdown valve leads from the outlet of the economizer coil and the inlet to the inner coil. It is a normally closed valve and is opened 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 the 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 leads from the outlet nipple of the steam separator to radiation under the water pump. Condensate from the radiation flows through a small orifice to the water supply tank. The steam admission valve to this radiation should be open only in freezing weather.

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.

FUEL SYSTEM DRK STEAM GENERATORS

The diagram given here illustrates the fuel flow on DRK steam generators. Those DRK units that have been revised to conform with the system in use on OK models will have a fuel solenoid valve inserted in the fuel line just before the sprayhead — this solenoid valve is not shown in the diagram. The flow analysis is outlined below:

1. The fuel pump brings fuel up from the supply tank through a horizontal check valve (keeps the pump primed when the steam generator is off) and through the suction line oil filter.
2. The fuel then flows through the fuel pressure regulator, a spring loaded relief valve which maintains a fuel manifold pressure of 150 pounds; about half of the fuel oil pumped is by-passed back to the supply tank.
3. Two fuel oil lines lead from the fuel pressure regulator — one contains oil for combustion and the other serves purely as hydraulic pressure fluid to actuate the servo-fuel control. The servo actuating oil flows through the pressure line oil filter, into the servo hydro-piston chamber, and drains back to the supply tank.

   The oil for combustion flows through the manifold pressure gauge and through the fuel valve assembly on the control switch; this valve is open when the switch is on RUN, and closed when the switch is on FILL or OFF.
4. The fuel then flows through the fuel valve assembly on the steam temperature limit control, which cuts down the flow of fuel to the sprayhead if excessive steam temperatures develop in the coils.
5. From the steam temperature limit control, the fuel flows through the fuel metering valve on the servo-fuel control. The servo admits fuel to the spray nozzle, and combustion air to the firepot, in direct proportion to the amount of feed water entering the steam generator coils.

6. Then, the metered fuel flows through the fuel nozzle pressure gauge and the fuel strainer into the fuel sprayhead, where it is sprayed by compressed air through an atomizing nozzle into the fire pot. (DRK units with the revised fuel sprayhead have a fuel solenoid valve in the fuel line just before the sprayhead.)

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

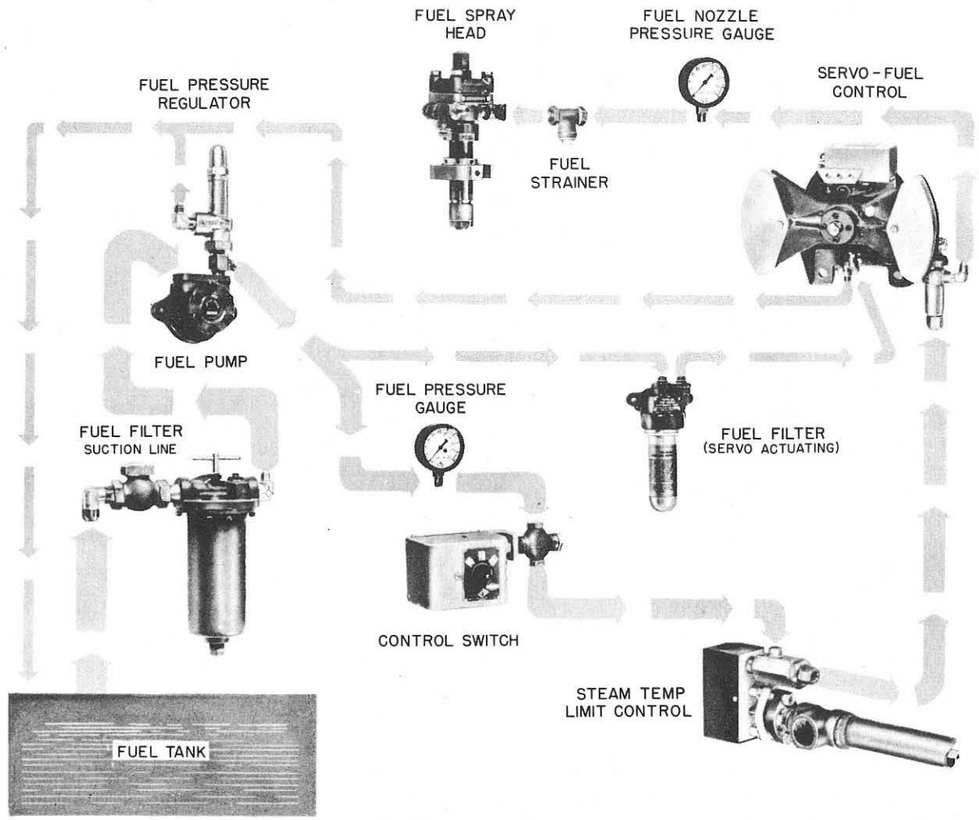

Fig. 9 — DRK-4530 Fuel Flow Diagram.

FUEL SYSTEM DSK AND OK STEAM GENERATORS (Except OK-4740)

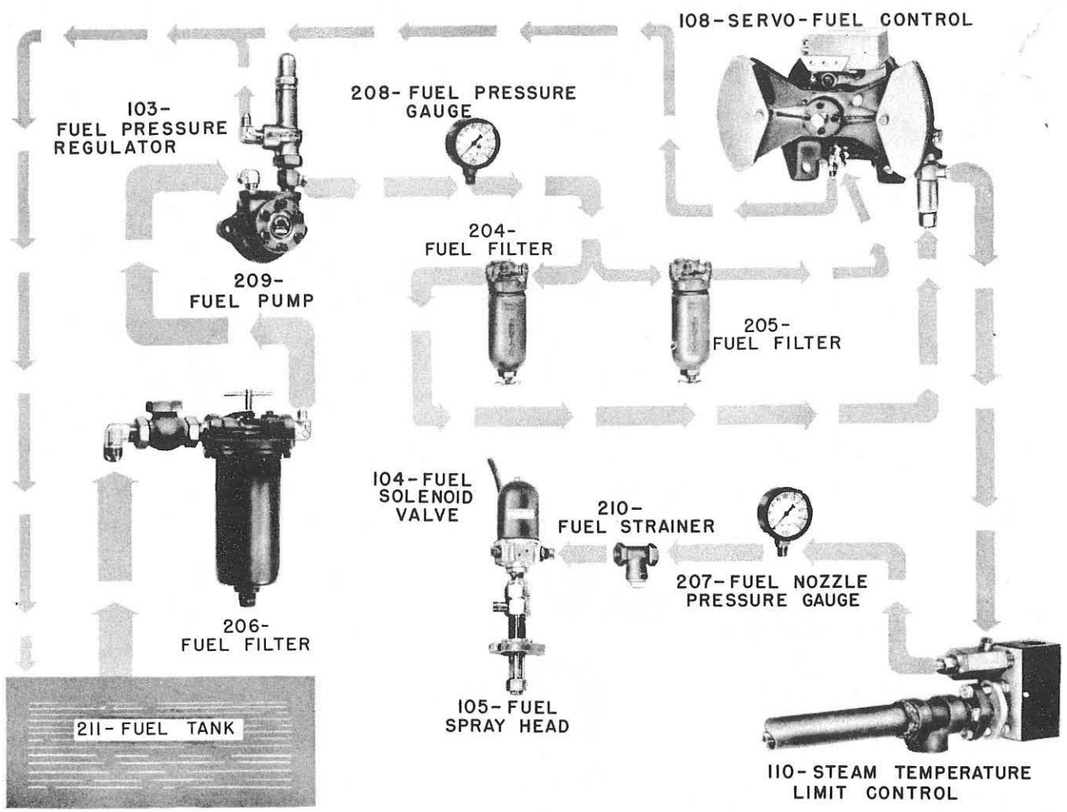

Fig. 10 — OK-4630 Fuel Flow Diagram.

The illustrations given here diagram the fuel systems in the OK series of steam generators (except OK-4740 units, which are discussed under the next heading in this section). The diagram for DSK models is not shown because the fuel system is similar to the OK-4625 steam generators, with two variations: the fuel solenoid valve is located just before the fuel nozzle pressure gauge — not directly above the sprayhead; and the fuel sprayhead is the same type that is applied on DRK units. The following text outlines successive stages of the fuel flow:

1. Fuel is brought up from the supply tank through a horizontal check valve (keeps fuel pump primed when the steam generator is not in operation). Then the fuel flows through the suction line fuel filter and through the fuel pump.
2. Then the fuel flows through the fuel pressure regulator, fuel pressure gauge and pressure line fuel filter (one pressure line filter on OK-4625 — two on OK-4630 and OK-4616). The pressure regulator is a spring-loaded relief valve which maintains a fuel manifold pressure of 150 lbs.; the excess fuel oil delivered by the pump is bypassed back to the supply tank.
3. Two oil lines lead into the servo control — one for combustion and the other for hydraulic pressure necessary to operate the servo. This servo actuating fluid flows into the hydro-piston chamber and drains back to the supply tank; the oil for combustion flows through the fuel 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.
4. The metered fuel then flows through the fuel valve assembly on the steam temperature limit control. This control cuts down the flow of fuel to the sprayhead if excessive steam temperatures develop in the coils.

5. And in the last stage, the fuel flows through the fuel nozzle pressure gauge and the fuel strainer into the fuel sprayhead, 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.

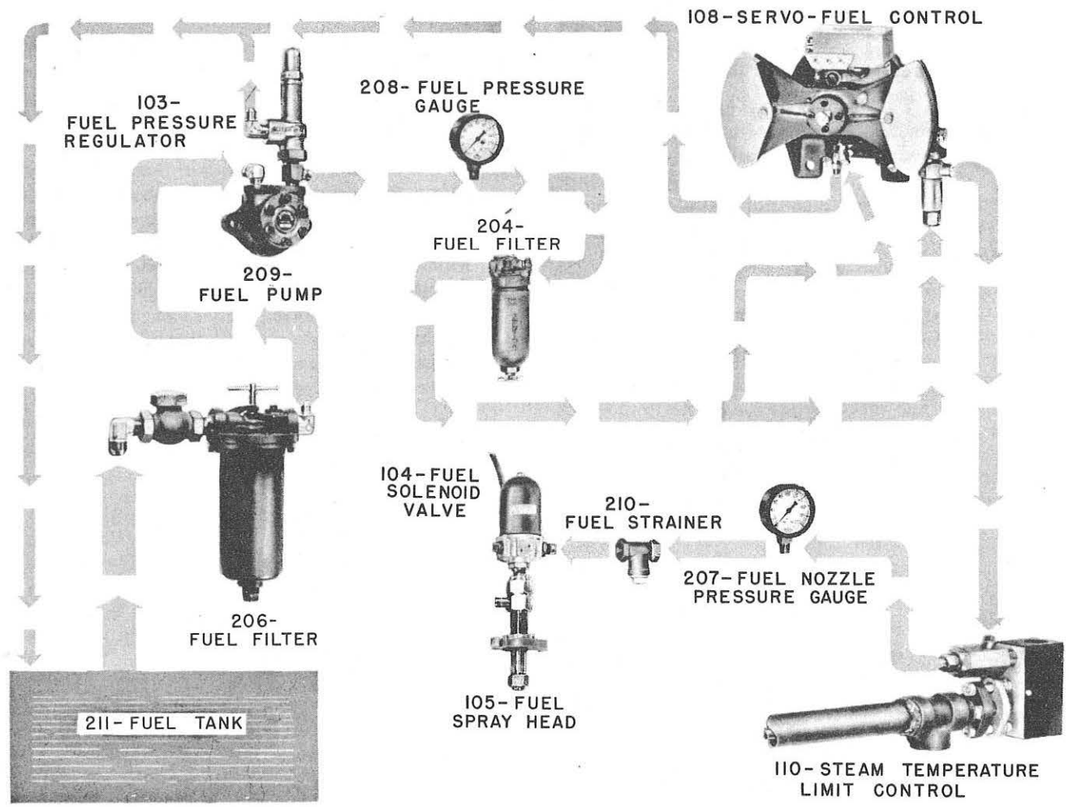

Fig. 11 — OK-4625 Fuel Flow Diagram.

FUEL SYSTEM OK-4740 STEAM GENERATORS

The diagram included here illustrates the fuel flow in OK-4740 steam generators. Successive stages of the flow are outlined below:

1. The fuel flows from the supply tank through a horizontal check valve and the suction line fuel filter to the fuel pump. (The check valve keeps the pump primed when the steam generator is not in operation.)
2. Next, the flow is through the fuel pressure regulator, fuel pressure gauge and pressure line fuel filters (2). The pressure regulator is a spring-loaded relief valve which maintains a fuel manifold pressure of 150 lbs; the excess fuel oil delivered by the pump is by-passed back to the supply tank.
3. Two oil lines lead into the servo control — one for combustion and the other for the hydraulic pressure necessary to operate the servo. The servo actuating fluid flows into the hydro-piston chamber of the servo and drains back to the supply tank; the oil for combustion flows through the fuel metering valve on the servo. The servo automatically regulates the amount of fuel and combustion air admitted to the fire pot in direct proportion to the quantity of feed water flowing through the servo diaphragm chamber into the coils.
4. A fuel by-pass line is taken off the feed line just after the fuel metering valve on the servo; it leads to the by-pass fuel pressure regulator and the fuel by-pass solenoid valve. The by-pass solenoid valve is controlled by the low limit snap switch on the steam temperature limit control. When the solenoid valve is opened, all but sufficient fuel to maintain a minimum fire is by-passed back to the supply tank. (The steam temperature limit control is fitted with a low limit snap switch and a high limit reset switch, operating at two temperature ranges to protect the coils against over heating as follows: (1) by opening the fuel by-pass solenoid, and (2) by completely shutting down the steam generator.)

   The by-pass fuel pressure regulator is fitted with a 25 lb. spring, and 25# is stamped on its body — it is placed in this by-pass line to ensure accurate by-pass of fuel when the solenoid valve is opened by the steam temperature limit control in its first stage of operation.
5. The feed line continues to the fuel nozzle pressure gauge, the fuel strainer and the fuel sprayhead, where the fuel is sprayed by compressed air through an atomizing nozzle into the fire pot.

   The fuel nozzle pressure gauge indicates pressure at the sprayhead; the fuel pressure gauge shows pressure maintained by the fuel pressure regulator in the line from the pump.

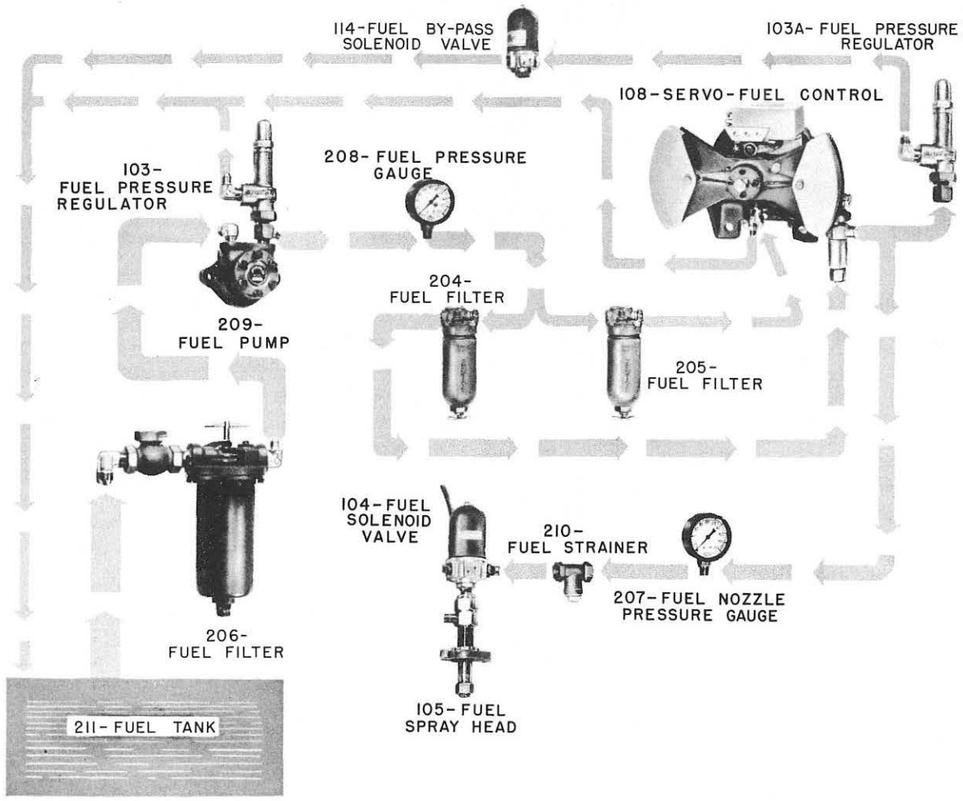

Fig. 12 — OK-4740 Fuel Flow Diagram.

ELECTRICAL SYSTEM DRK, DSK, OK STEAM GENERATORS (Except OK-4740)

The schematic wiring diagrams included here cover the DSK-4530, ADRK-4530 and 4516, OK-4630 and 4616 DSN, OK-4625-DN, ABDRK-4530 and 4516, OK-4625-DNB, and OK-4630 and 4616 DBN steam generators. The circuits are almost identical and are discussed simultaneously in the following text, with the few differences explained as they occur in the discussion. OK and DRK units in the field are equipped with either a double contact switch or a mechanical pressure differential delay adapter on the water by-pass regulator — schematic diagrams are given for each circuit.

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.
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 blowdown switch, overload relay and control switch No. 1 (and "B" contacts of by-pass regulator switch if steam generator is equipped with this switch).

   Closing the line relay contacts completes the circuit through the motor converter — the armature is energized through the starting resistor and, on some units, 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.
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 (on some units, the water by-pass regulator switch "A" contacts are initially open in the outfire relay circuit). As water flow develops, the servo cam plate moves off the block — the servo "A" contacts close and energize the fuel solenoid valve (and air solenoid on DSK models) 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:

   On units with differential delay adapter — 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 fuel and 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

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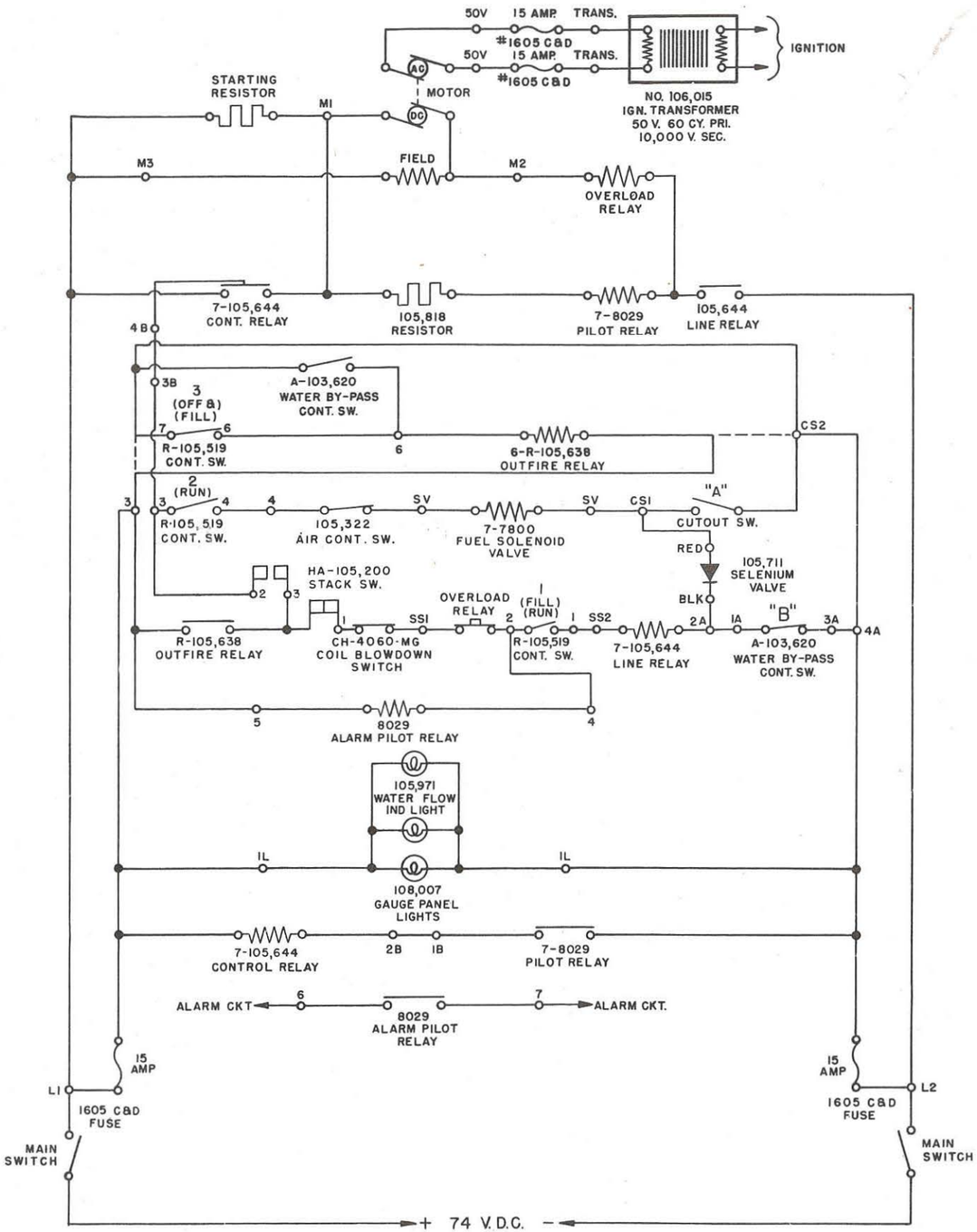


Fig. 13 — ADRK-4530 and 4516, Schematic Wiring Diagram.

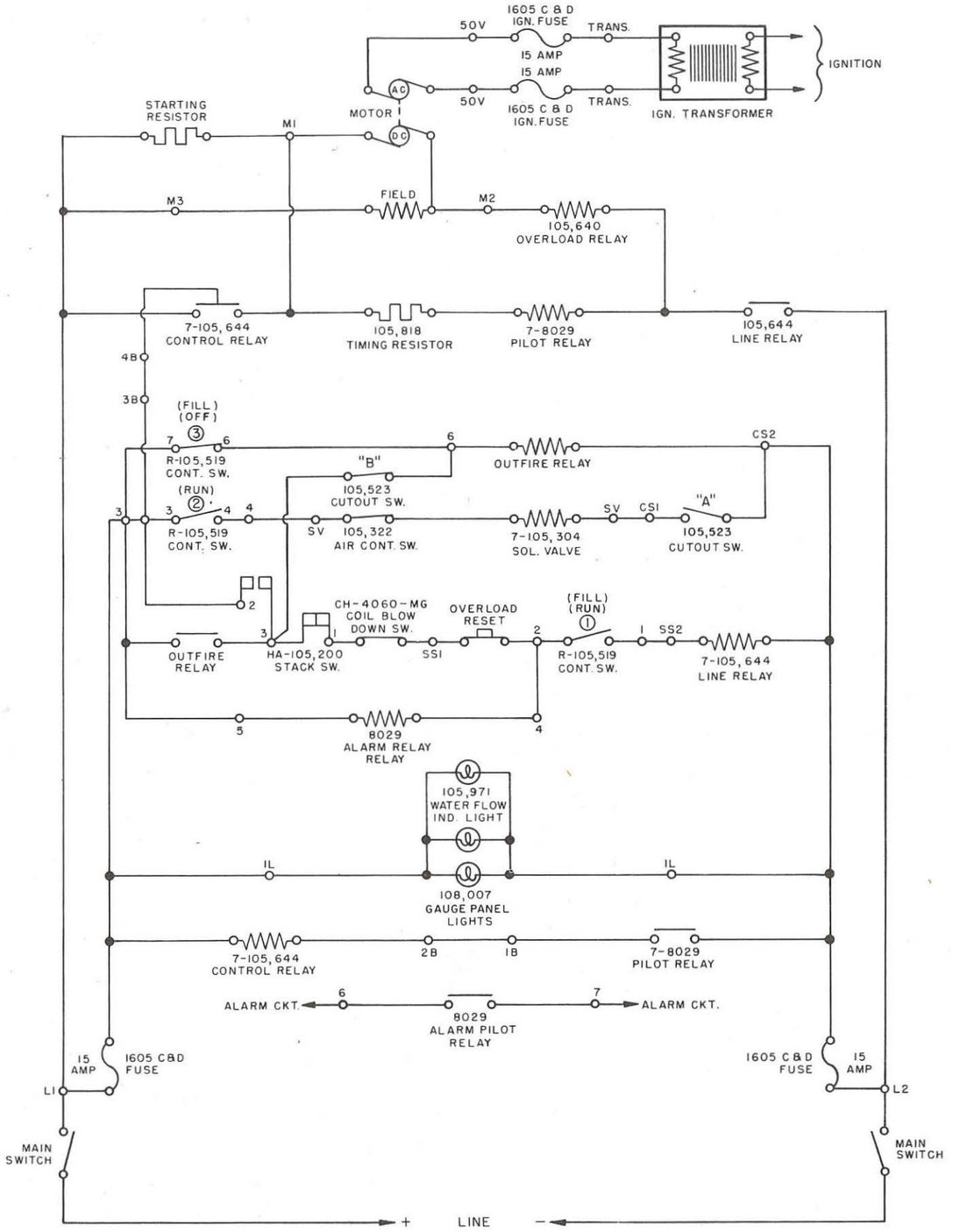


Fig. 14 — ABDRK-4530 and 4516, Schematic Wiring Diagram.

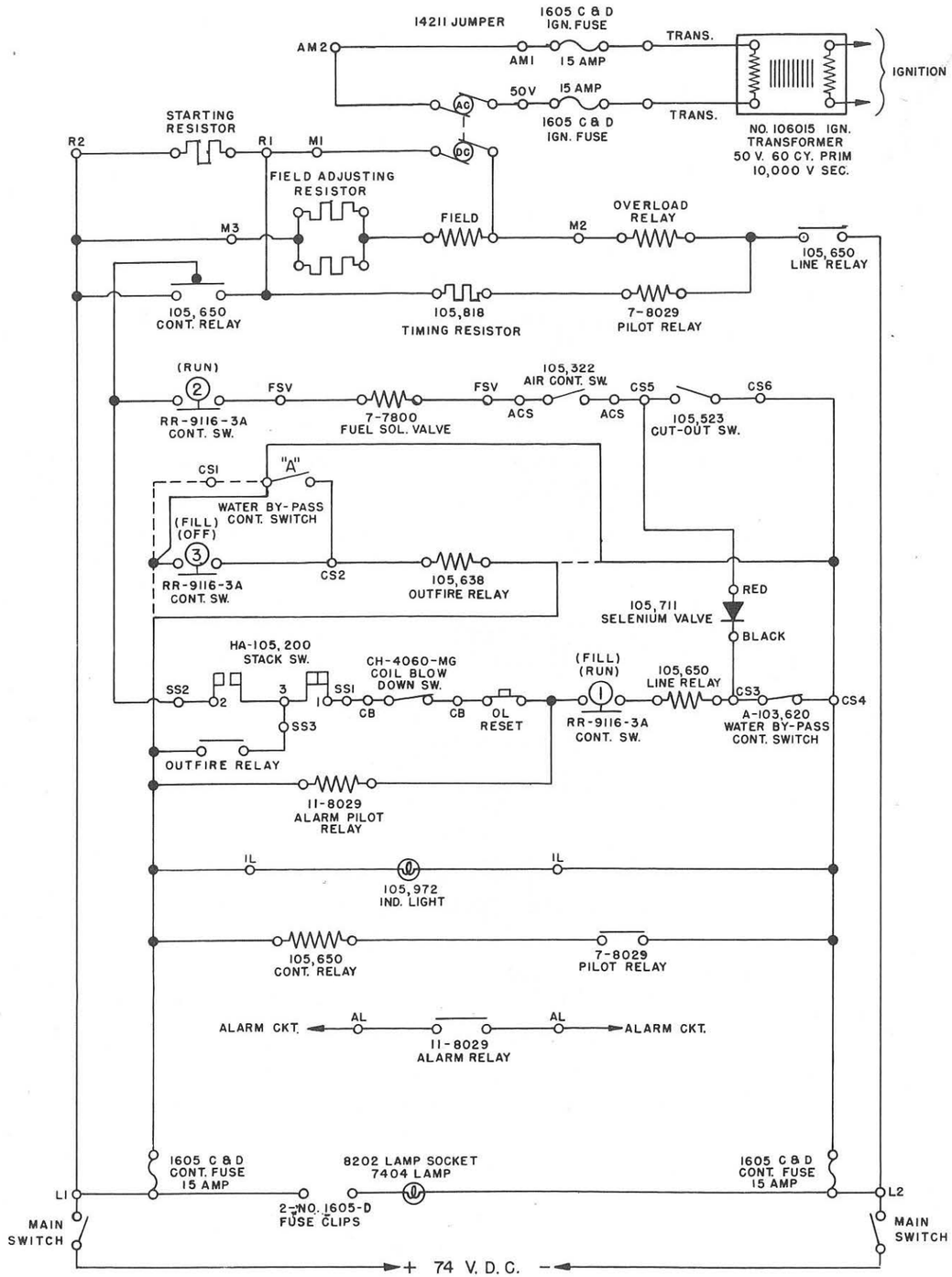


Fig. 15 — OK-4630 and 4616-DSN, Schematic Wiring Diagram.

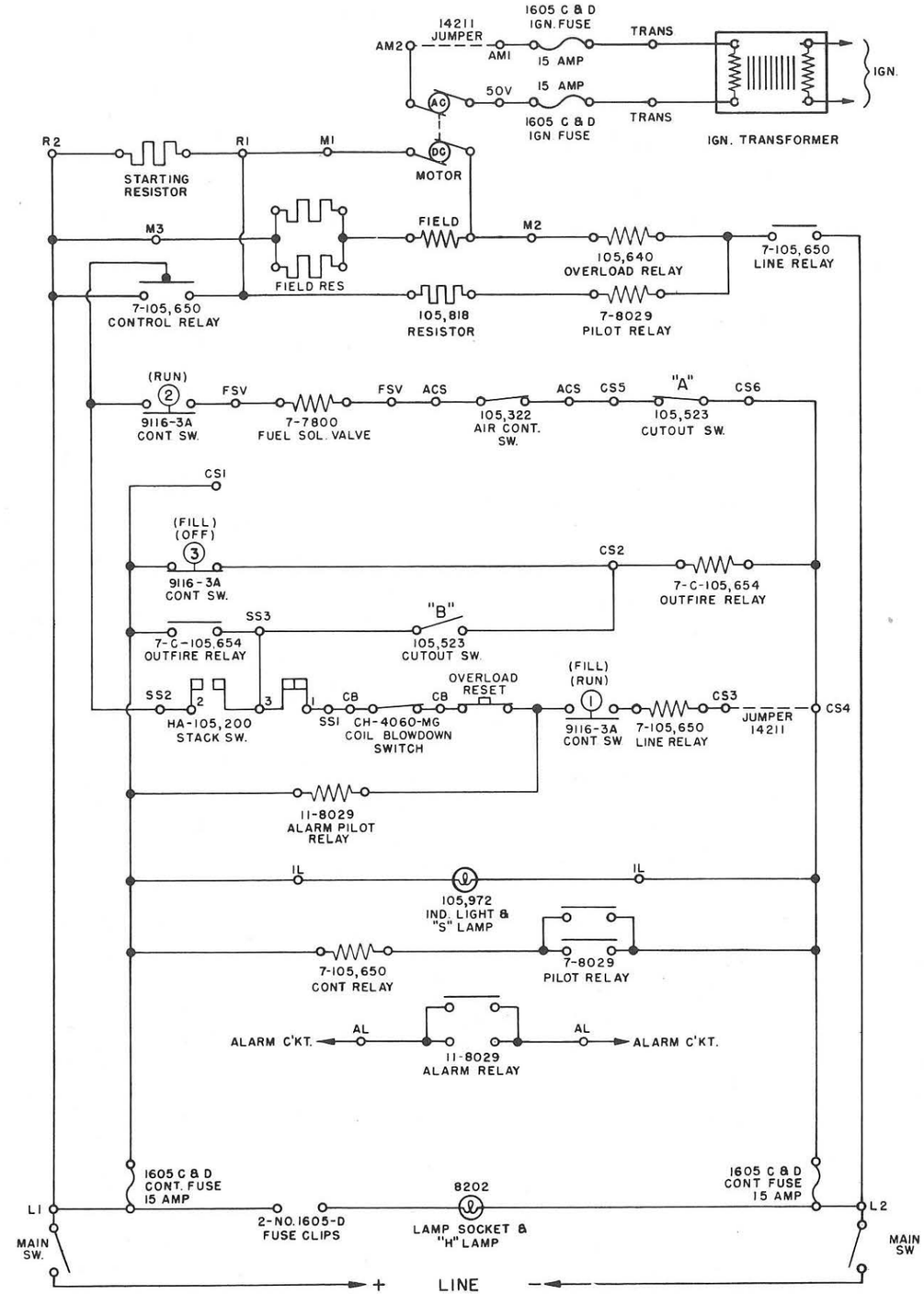


Fig. 16 — OK-4630 and 4616-DNB, Schematic Wiring Diagram.

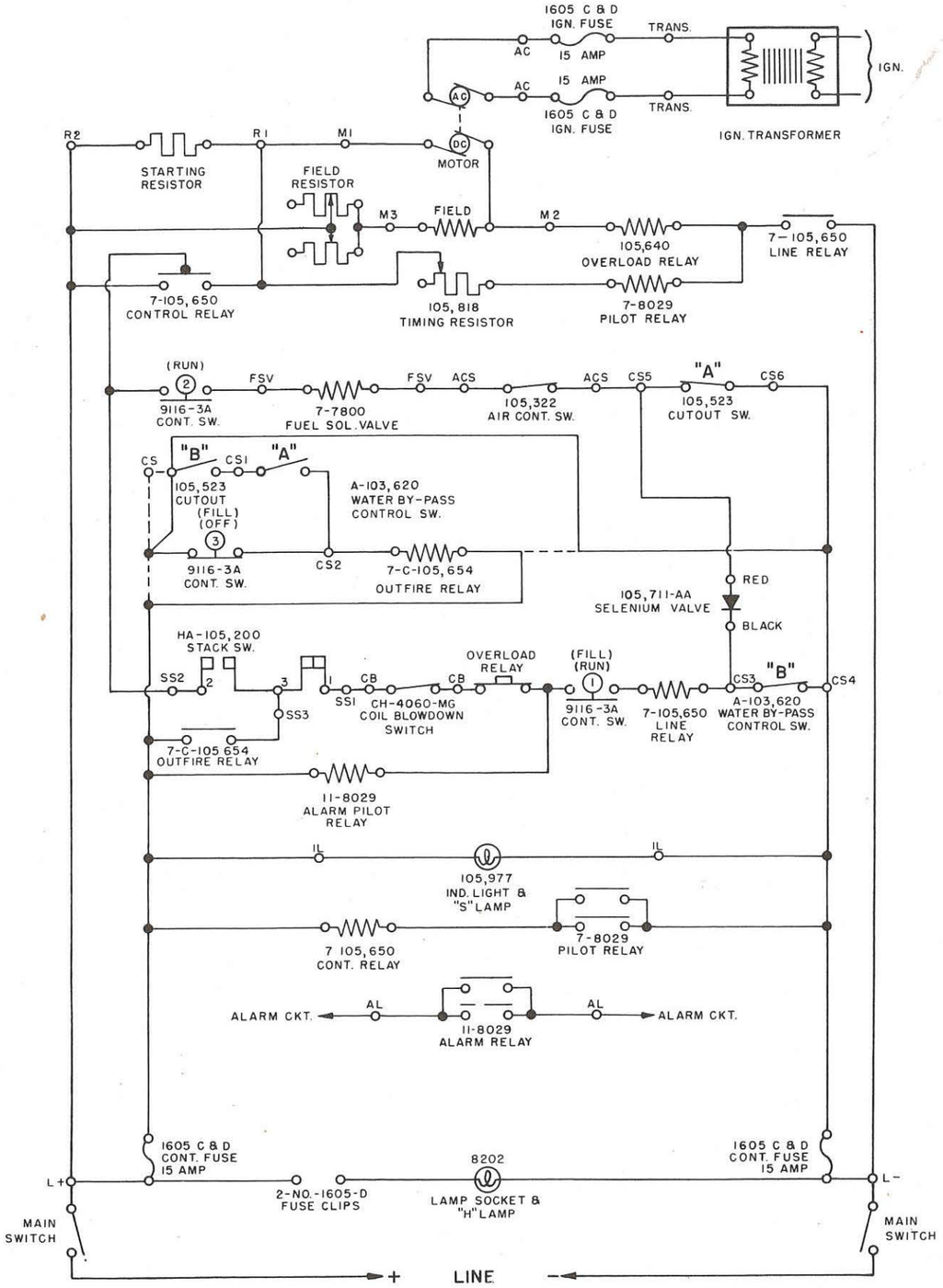


Fig. 17 — OK-4625-DN Schematic Wiring Diagram.

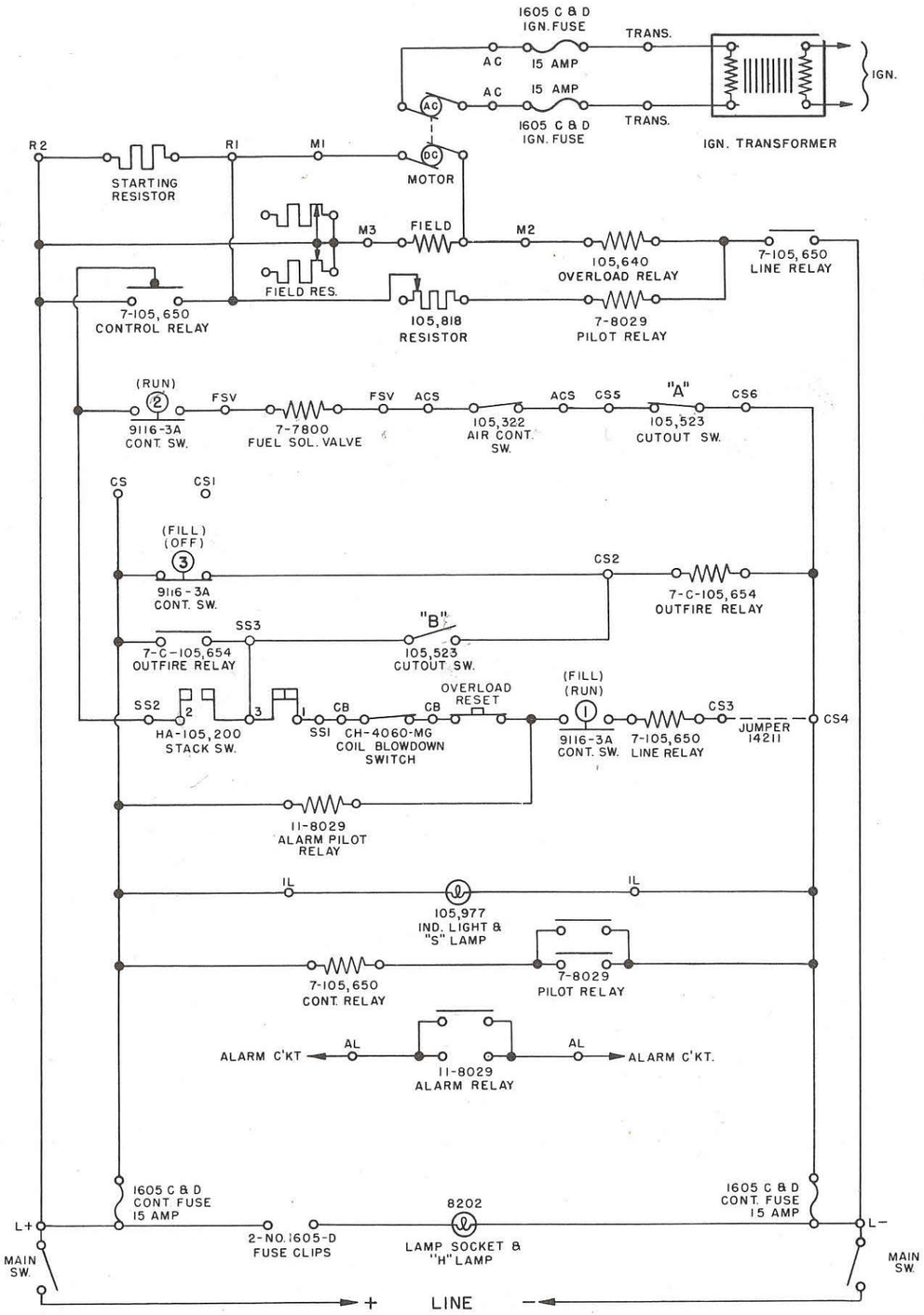


Fig. 18 — OK-4625-DNB Schematic Wiring Diagram.

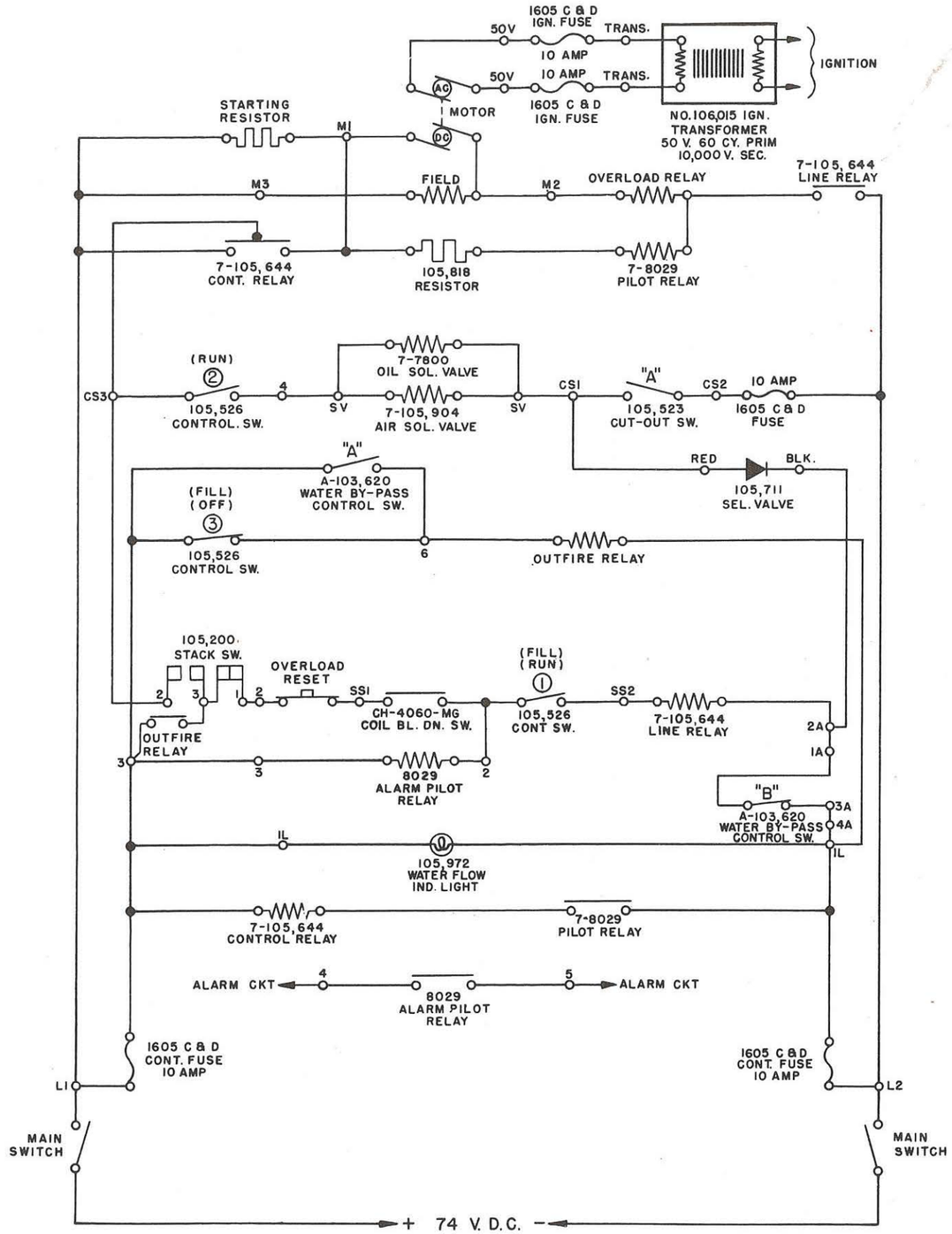


Fig. 19 — DSK-4530 Schematic Wiring Diagram.

(continued from page 17)

solenoid opens permitting fuel flow to the sprayhead, and steam generation is resumed.

On units with water by-pass regulator switch — The "B" contacts of the regulator switch open, shunting the line relay coil circuit through the selenium valve and the "A" contacts of the servo cutout switch — the "A" contacts of the regulator switch close.

The servo "A" contacts remain closed and steam generation continues for just a few seconds until the servo cam plate moves to the block — then the servo "A" contacts open to de-energize the fuel solenoid valve and the line relay coil, and the unit shuts down completely. OK-4625 steam generators have the "B" contacts of the servo cut-out switch included with the by-pass regulator "A" contacts in the outfire relay circuit — these contacts close in the "off" cycle.

When trainline steam pressure drops sufficiently, the valve in the water by-pass regulator begins to close, the "B" switch contacts close to energize the line relay coil circuit, and the "A" contacts open in the outfire relay coil circuit. The motor converter starts, and when feed water begins to flow through the servo diaphragm chamber the cam plate moves off the block. The servo "A" contacts close, energizing the fuel solenoid valve and again permitting fuel flow to the sprayhead — steam generation is resumed (on some units, the servo "B" contacts open in the outfire relay circuit).

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 — through the "A" contacts of the water by-pass regulator switch (also servo "B" contacts on some units).

   If the fire fails to light, the low temperature contacts in the stack switch remain open and, after the 43 - 47 second time relay, 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 20 lbs. on 4516 and 4616 units — below 40 lbs. on the others), 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 stored, and the control switch turned to OFF or FILL to reset the outfire relay, before the unit can be started again.

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.

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.

ELECTRICAL SYSTEM OK-4740 STEAM GENERATOR

The schematic wiring diagram included here gives the control circuit for OK-4740 steam generators. 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 bell rings when the alarm relay contacts close — whenever the alarm relay coil is energized through the safety relay contacts. These contacts close when the safety relay coil is de-energized; they open when the coil is energized. Thus, the alarm rings in any position of the control switch whenever the circuit through the safety relay coil is broken.

   The "no water" alarm circuit is explained under "Safety Controls."

2. *Ignition Circuit:* Spark is supplied at all times when the rotary converter is in operation — whenever the main switch is ON and converter circuit breaker is closed. The converter transforms D.C. current to A.C. current; the A.C. current flows through the ignition transformer where it is stepped up to the 12,000 volts desirable for effective ignition spark.

3. *Main Switch Closed — Control Switch OFF:* The rotary converter is energized through the converter circuit breaker, the safety relay is energized through control switch No. 4 and the motor overload relay contacts, and the outfire relay is energized through the auxiliary, normally closed contacts of line relay No. 2.

4. *Control Switch FILL:* The safety relay is energized through control switch No. 3, the coil blowdown switch and the motor overload relay contacts. Line relays No. 1 and No. 2 are energized through control switch No. 1 and the safety relay contacts.

   With both line relay contacts closed, the motor field is energized through the field adjustor resistor, and the armature is energized through the starting resistor. The motor starts and gathers speed until the increasing armature resistance shunts enough current through the timing resistor and pilot relay coil to close the contacts in the pilot relay. The accelerating relay coil is then energized through the pilot relay contacts and control switch No. 8, and the current flows around the starting resistor through the accelerator relay contacts to the motor — the motor runs at full speed. The duration of this accelerating sequence should be from 2 to 3 seconds; it can be regulated by adjusting the timing resistor in the pilot relay coil circuit.

5. *Control Switch RUN:* The safety relay is now held energized through the steam temperature limit control "A" contacts, outfire relay, stack switch high temperature contacts, air cutout switch, coil blowdown valve switch and motor overload relay. The line relays are energized through control switch No. 1 and the safety relay contacts, and the motor starting sequence begins.

   As water and fuel pressure builds up, the servo cam plate moves off the block, closing the "A" contacts of the servo cutout switch; the fuel solenoid valve is energized through control switch No. 6, line relay No. 2 and the servo "A" contacts — the fire starts, and the "B" contacts open to de-energize the outfire relay and start the outfire time delay period.

   The motor accelerates until the pilot relay is energized through the timing resistor and the starting resistor; then current flows through control switch No. 8 and the pilot relay contacts to energize the accelerating relay. Closing the accelerating relay contacts shunts the current around the starting resistor, and the motor runs at full speed.

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 "B" contacts of the regulator switch open (in alarm relay coil circuit). The servo cam plate moves to the block and activates the servo cutout switch — the "A" contacts open, de-energizing the fuel solenoid valve to cut off the fuel supply to the sprayhead and shut down the fire, and the "B" contacts close in the outfire relay coil circuit and the "no water" alarm circuit. The motor continues to operate but no steam is generated.

   When trainline pressure drops, the by-pass valve in the water by-pass regulator begins to close, permitting feed water to flow through the servo. The servo cam plate moves off the block, the cutout switch "A" contacts close, the fuel solenoid valve is energized and fuel flow is resumed to the sprayhead. The cutout switch "B" contacts open to de-energize the outfire relay and start the outfire time delay period; the servo switch "B" contacts in the alarm relay circuit also open, and from one to several seconds later the water by-pass regulator switch "B" contacts in this circuit close.

(continued on page 28)

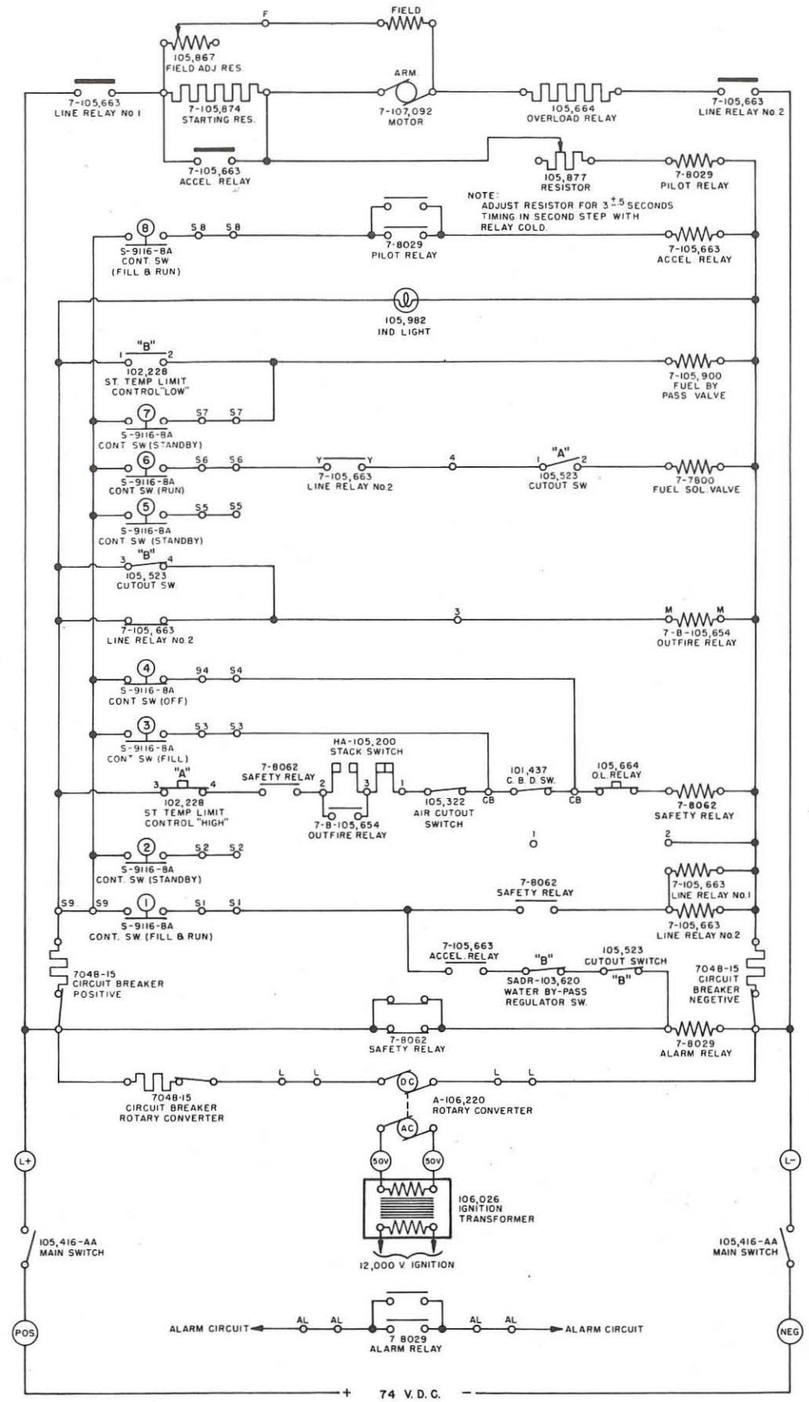


Fig. 20 — OK-4740 Schematic Wiring Diagram.

(continued from page 26)

Safety Controls

1. *Outfire Relay:* This is a pneumatic type of time delay relay, opening its contacts in from 43 to 47 seconds after the circuit through the relay coil is broken; the contacts of this relay are in parallel circuit with the low temperature contacts of the stack switch.

   The circuit through the outfire relay coil is completed through the auxiliary contacts of the No. 2 line relay when the control switch is OFF, and through the "B" contacts (when closed during "off" cycle) of the servo cutout switch when the control switch is on RUN. On FILL or RUN the line relays are energized, the auxiliary No. 2 contacts open, the servo moves off the block to open the "B" contacts of the cutout switch, and the circuit through the outfire relay coil is broken.

   If the fire fails to light, the low temperature contacts in the stack switch will not close, and after the 43-47 second time delay, the outfire relay contacts will open and break the stick circuit to shut down the unit and energize the alarm relay. 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 back to OFF to reset the outfire relay and close the safety relay stick circuit before the steam generator can be restarted.

2. *Stack Switch — high temperature contacts:* These contacts open when the temperature of the exhaust gases exceeds 900° F. — this breaks the safety relay stick circuit, shutting down the unit and energizing the alarm relay. The stack temperature must be reduced before the switch contacts can be reset, and the control switch must be turned OFF to reset the safety relay before operation can be resumed.

3. *Air Switch:* This simple cutout switch is held closed by the pressure in the atomizing air line; when the air pressure drops below 40 pounds, spring tension opens the switch contacts and breaks the safety relay stick circuit — the alarm rings and the steam generator shuts down. Air pressure must return to normal and the control switch must be turned OFF before the steam generator is restarted.

4. *Coil Blowdown Valve Switch:* When this switch is open, the safety relay stick circuit is broken and the steam generator will not operate; the alarm rings if the control switch is on RUN or FILL, and does not ring when the control switch is OFF. The safety relay stick circuit must be reset by turning control switch OFF before unit can be restarted.

5. *Motor Overload Relay:* Under overload conditions, the excessive current passing through the motor into the overload relay coil will open the relay contacts to break the safety relay stick circuit — the steam generator shuts down and the alarm rings. The main switch must be opened to shut off the alarm, and after the condition is corrected the overload contacts must be manually reset.

6. *Steam Temperature Limit Control:* This control protects the coils against excessive steam temperature by first (at 450° - 475°) opening the fuel by-pass solenoid valve and limiting the flow of fuel to the sprayhead, and then (at 550° - 575°) by shutting down the steam generator completely.

   In the first stage of high steam temperature the "B" contacts of the temperature limit control close to energize and open the fuel by-pass solenoid valve, which by-passes the major portion of the fuel back to the supply tank — just enough fuel continues to the sprayhead to maintain a minimum fire. Since the feed water and combustion air flow remains normal, the steam temperature goes down, the "B" contacts open, and fuel flow and steam generator operation return to normal.

   However, if the steam temperature should continue to rise after the by-pass solenoid valve opens, then the "A" contacts also open; this breaks the safety relay stick circuit to energize the alarm relay and shut down the steam generator. Control switch must be turned OFF before unit will restart.

7. *"No Water" Alarm Circuit:* The auxiliary contacts of the accelerating relay, and the "B" contacts of the water by-pass regulator switch in this circuit, are closed during normal operation of the steam generator. If the water supply fails during operation, the servo moves to the block, shuts off the fuel flow to the sprayhead, and closes the "B" contacts of the servo cutout switch; with all three contacts in this circuit closed, the alarm bell rings although the steam generator does not shut down. When water again flows through the servo diaphragm chamber, the servo cam plate moves off the block and the steam generator resumes normal operation.

8. *Short Circuits:* A short in the control circuit opens the control circuit breakers; they must be manually reset before the steam generator can be restarted.

A short in the ignition circuit opens the converter circuit breaker and shuts down the steam generator after the low temperature contacts in the stack switch open.

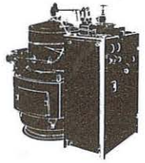
A short in the motor circuit will blow a fuse in the main locomotive control panel.

Field Adjusting Resistor

The field adjusting resistor is placed in the motor field circuit to permit compensation for a maximum two volt 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 3000 RPM (550-560 RPM water pump speed).

special instructions



PREVENTIVE MAINTENANCE SCHEDULE

The maintenance and lubrication schedules given in this section are based on the national average of locomotive service time and milage; either time or milage 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 both suction and pressure line water strainers. 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.

GEAR REDUCER: Check oil level in gear case.

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).

TREATMENT INJECTOR FILTER: Clean.

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.

GEAR REDUCER: 600 W. or S.A.E. 160.

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.

IGNITION TRANSFORMER: Megger test.

HYDROSTATIC TEST: Test at hydrostatic pressure 25% above working steam pressure.

SEPARATOR BLOWDOWN VALVE: Repack and test.

BLOWER FAN: Clean and inspect bearings.

MOTOR CONVERTER: Overhaul.

ROTARY CONVERTER: Overhaul. (Applied only on OK-4740).

COIL BLOWDOWN VALVE: Inspect and test.

COIL RETAINER AND PADS: Inspect.

STACK SWITCH: Replace helix and test.

AIR PRESSURE REGULATOR: Overhaul.

GEAR REDUCER: Overhaul. (Applied only on OK-4740).

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.

GEAR REDUCER: Check oil level in gear case.

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.

GEAR REDUCER: Drain and refill with 600 W. or S.A.E. 160, or equivalent.

FEED WATER TREATMENT

Correct treatment of the feed water before it enters the steam generator coils is essential for long life. Proper conditioning of the feed water causes the scale forming material in the water to form a sludge which is carried over into the steam separator. If the separator is not blown down frequently, this sludge will return to the water supply tank and unbalance the proportion of treatment given the feed water. Your railroad chemist will specify the correct compound to use for your particular water conditions.

Two systems of water treatment are used on the Vapor-Clarkson steam generator; the water treatment tank, and the water treatment injector.

Water Treatment Tank: A stick or brick type of water treatment compound is used in the water treatment tank. The key metering valve on this tank controls the amount of treatment metered into the feed water and should be set by your railroad chemist after analysis of the water supplies along the route.

Note: Compounds in powder form cannot be used in the treatment tank because they will not dissolve properly.

Before putting in the compound stick, close the water suction valve ahead of the water treatment tank and then remove the cover of the tank. Inspect the strainer and clean if necessary, then put the compound stick into the inner can. Fill with water to within three inches of the top, then replace the cover. Be sure the gasket is properly placed and in good condition; screw the cross bolt down tight and lock the cover into place with the cover fasteners, and re-open the water suction stop valve. To protect the gasket, apply powdered graphite (dry).

Water Treatment Injector: The treatment solution is made by dissolving the recommended compound in a chemical tank of from 100 to 600 gallons capacity. Some types of solution must be thoroughly stirred to make sure that all of the compound dissolves.

Allow the solution to settle, then take the liquid off the top, so that any undissolved particles of the compound will remain at the bottom of the tank. It is best to avoid making up and mixing the solution in the supply tank on the locomotive; it should be prepared in a separate mixing tank. The strength of the solution depends on the water conditions encountered on your railroad, and is best determined by your railroad chemist.

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 on OK-4625 and OK-4740 steam generators must be closed.
4. On DRK units, close the steam admission valve to the water by-pass regulator. Keep the valve to the generator steam pressure gauge open; the gauge can be used to register water pressure.
5. On OK and DSK units 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 375 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.

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 water wall coil (OK-4740 only), the inner coil and the steam separator, in the order named.

Secondly, the solution is circulated through the heat exchanger casing, economizer coil (OK-4625 and OK-4740), outer coil, intermediate coil, water wall coil (OK-4740), 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 Connections

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, plug or cap the separator blowdown line.

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, indicating that the coils are clean or that the acid has lost its strength. Add some more acid to the solution and run it through the coils again. If no more foam is evident shut down the pump.

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. After all the foaming has stopped add some acid to the solution and run it through the coils again. If no more foam is evident, shut down the pump.

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.

(continued next page)

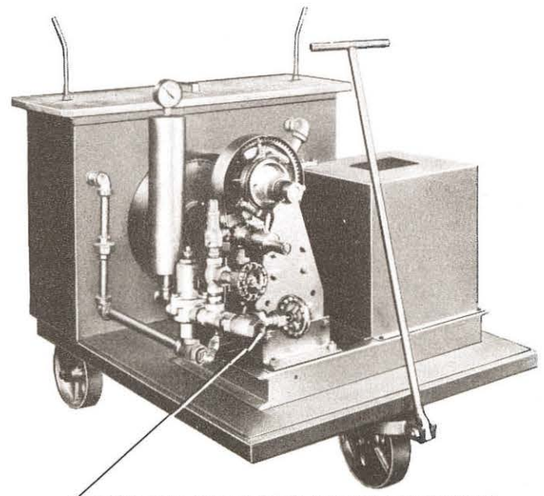


Fig. 21 — No. C-4040-1 Washing Machine.

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 washout pump after foaming and gassing has stopped.

Flushing Out The Steam Generator

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, or take the cap or plug off 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. Fire up 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 descaling may be necessary, particularly if the water is not treated properly. Appreciable scaling 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 scale accumulation.

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 strainer 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 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. Remove the drain plugs at the bottom of the heat exchanger and the steam trap or traps.
10. Disconnect the steam lines leading to the steam pressure gauges and water by-pass regulator, and blow out with compressed air.

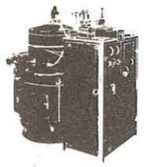
Note: Keep all valves open.

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 scale forming matter to the steam generator coils.

main assemblies and devices



FIRE POT AND REFRACTORIES

(DRK, DSK and OK — except OK-4740)

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, and oil and air lines to the fuel spray head.
2. Take off the air dome.
3. Lift out the fire pot and refractory container assembly by means of the two lifting handles on the refractory casing.
4. Separate the fire pot, air ring and the refractory container. 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 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.

COIL DISASSEMBLY AND ASSEMBLY

(DRK, DSK and OK — except OK-4740)

General Disassembly

1. Take out the fire pot as instructed above.
2. Disconnect the stack switch cable and remove a stack section.
3. Disconnect the cable connections to the air solenoid valve and to the adapter receptacle on the guard rail.
4. Remove the six cap screws securing the blower housing to the smoke hood. The blower housing and all the equipment mounted on it will be supported on the bracket which is anchored to the top frame of the base assembly.
5. Unscrew the lifting eye bolts, then lift off the smoke hood and the asbestos gasket.
6. Mark the position of the centering angle and take it off. Remove the nuts and washers from the four tie rods anchoring the coil retainer.
7. Disconnect and remove the economizer coil, where applied.
8. Break out the sealing cement around the top of the inner coil; remove the coil retainer cone and the asbestos coil pads. Be careful to keep the padding intact for re-use in case new ones are not available.
9. 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.

To Remove The Inner Coil

1. Break the union connection at the inner coil connector pipe and screw out the inlet nipple.
2. Lift out the coil.

To Remove The Outer And Intermediate Coils

1. Take out the inner coil as instructed above.
2. Break the union connection at the outer coil inlet, outer coil outlet and intermediate coil inlet. Remove the patch plates and unscrew the nipples.
3. Remove the intermediate coil tie plate retaining cap screw.
4. Lift out the intermediate coil.
5. Lift out the outer coil.

Note: Small leaks in the coils can be repaired by welding. If the coils are badly deteriorated they should be replaced with new coils. Coils must be given a hydrostatic test after repairing.

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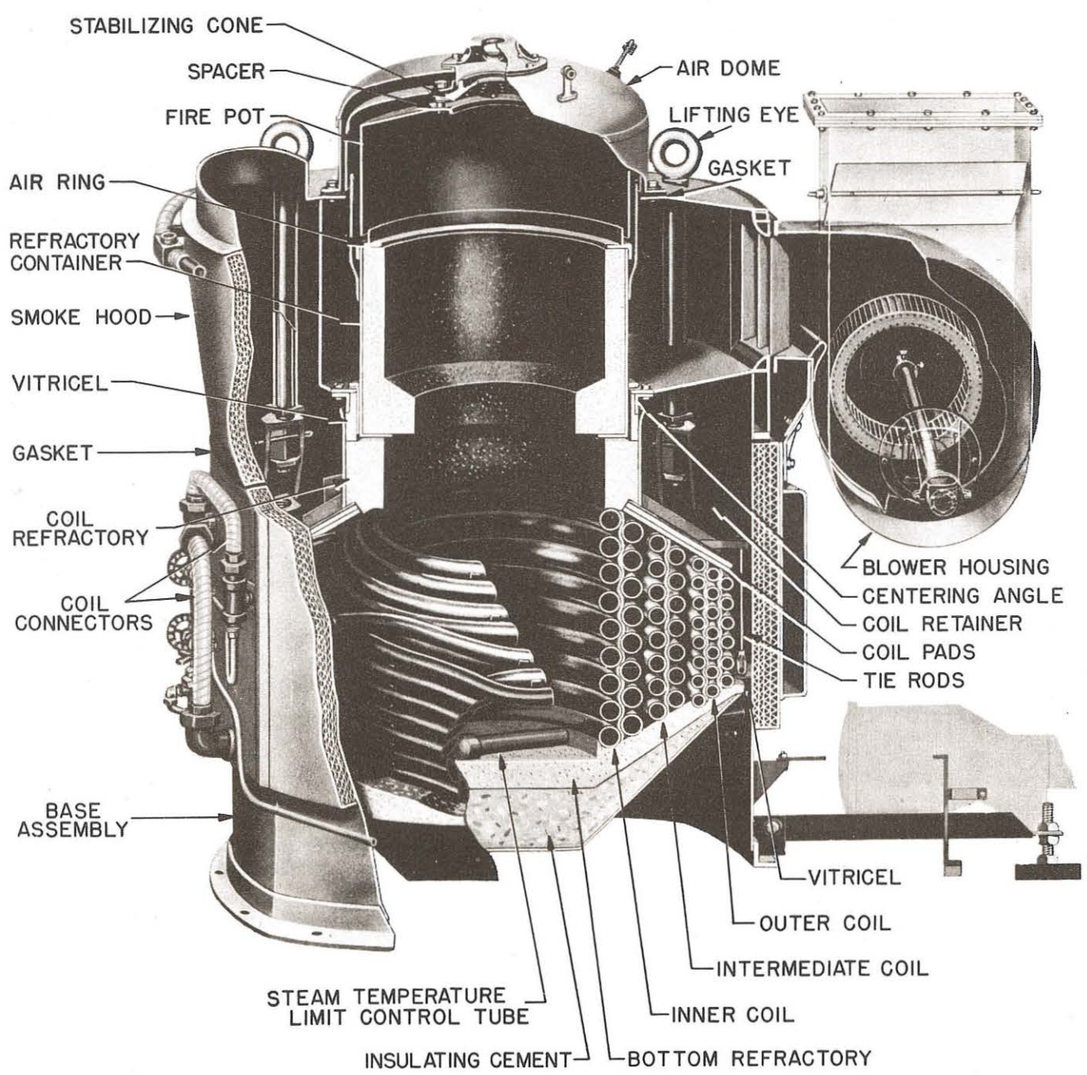

Fig. 22 — OK-4630 Boiler and Blower Assembly.

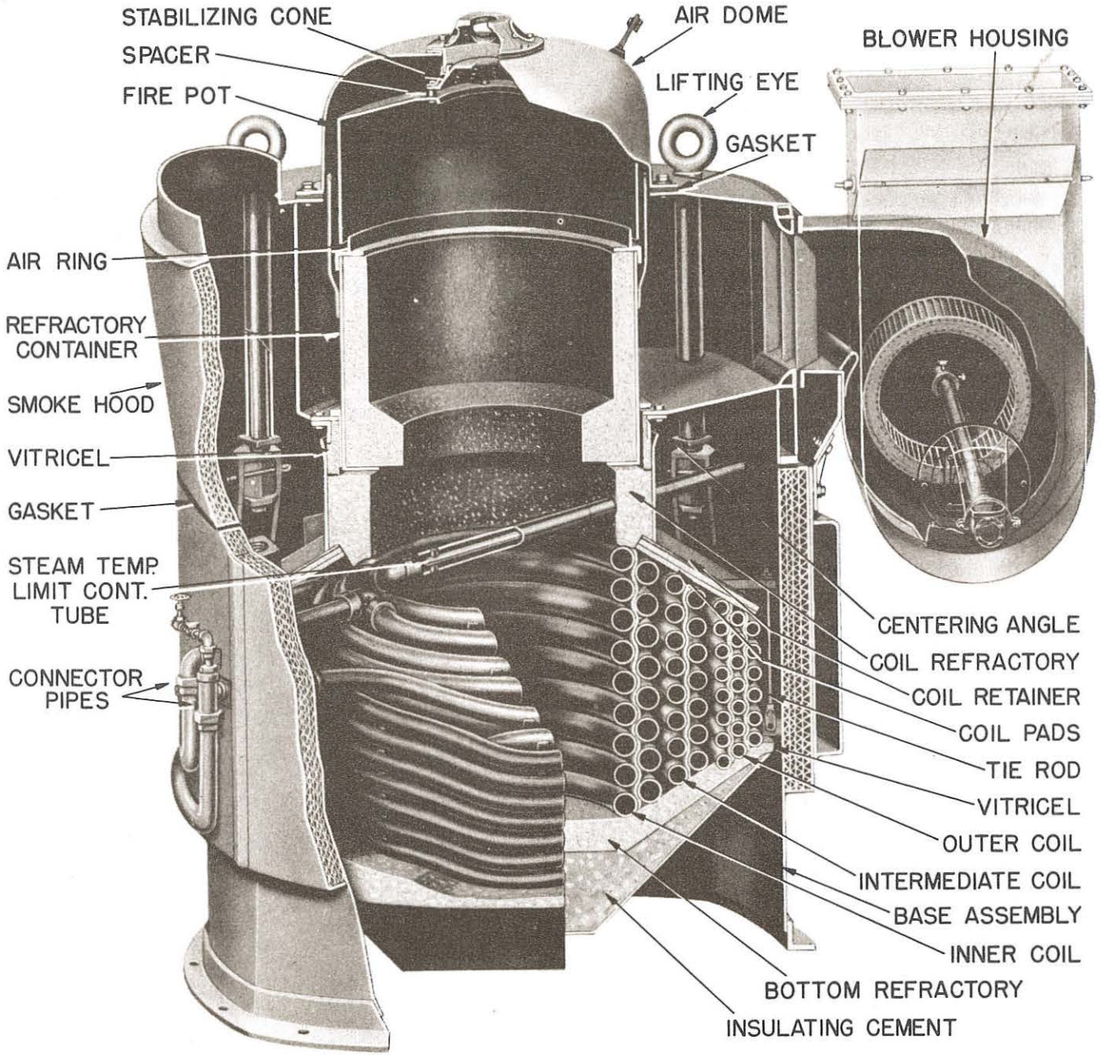

Fig. 23 — DRK-4530 Boiler and Blower Assembly.

To Install Intermediate And Outer Coil

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 outer and intermediate coils into the steam generator base, with the coil ends opposite proper guide holes in the casing. Be sure 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 frame.
3. Replace the intermediate coil tie plate cap screw.

To Install Inner Coil

1. Place the inner coil into position and align the inlet connection with the opening in the base casing.
2. Replace the steam temperature limit control; screw the extension tube into the inner coil outlet. Wait until all of the coils are in place before connecting the fuel lines and steam outlet line.

General Assembly

1. Replace the coil nipples, union ells and tees, and the external coil connector pipes between the outer, intermediate and inner coils.
2. Connect the water feed piping to the outer coil inlet.

3. 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.
4. 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.
5. 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 trowl, 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.
6. Replace and connect the economizer coil, where applied.
7. Replace the centering angle iron, the smoke hood gasket and the smoke hood, but do not tighten into place. Make sure that the centering angle is level, that the inner smoke hood shell rests directly on the centering angle ring flange, and that the studs on the flange are properly aligned with the holes on the inner shell of the smoke hood.

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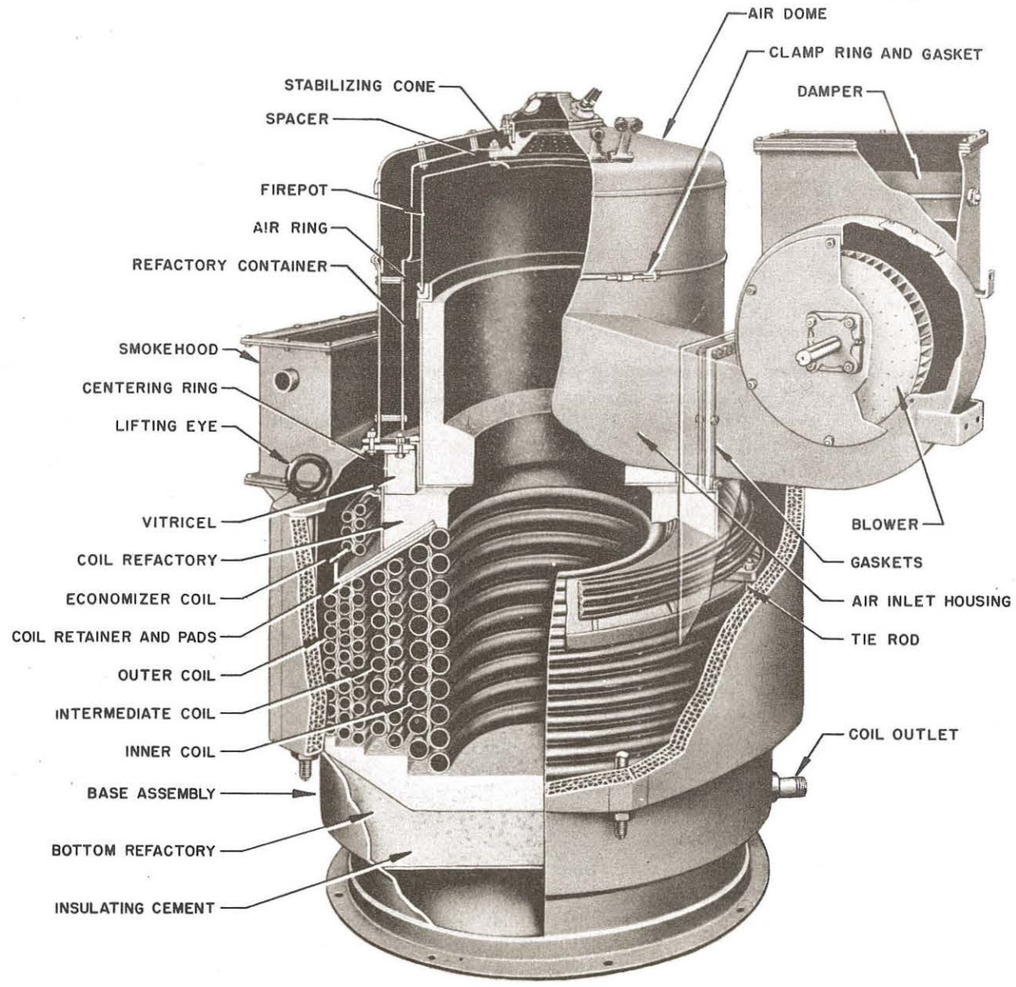

Fig. 24 — OK-4625 Boiler and Blower.

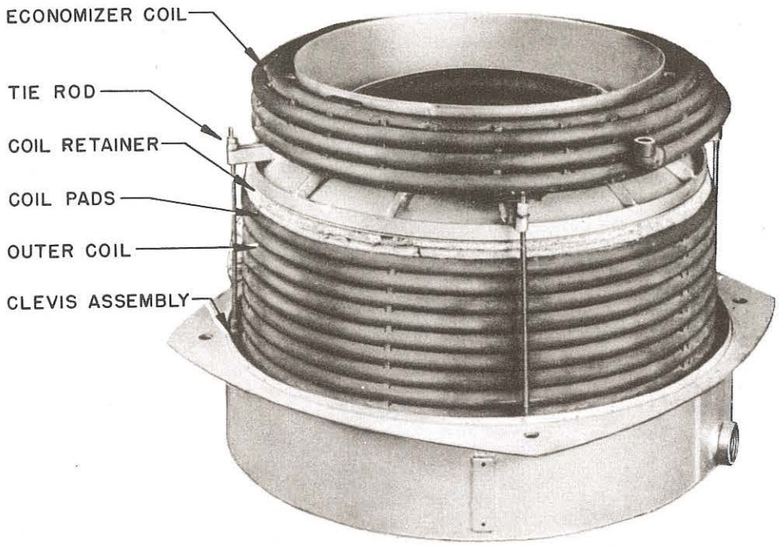

Fig. 25 — OK-4625 Coil Assembly.

8. 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.
9. Anchor the smoke hood into place on the centering angle ring studs.
10. Replace the six cap screws securing the blower fan housing to the smoke hood.
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 angle.
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 3/8" on DRK-4516 units, 1/8" on OK-4616 units and 3/8" on 4530, 4630 and 4625 units.
13. Replace the air ring, fire pot and the stabilizing cone, in the order named.
14. Replace the air dome and stack; connect the ignition cables, spray head fuel and air lines, and the cable connections to the stack switch, air solenoid valve and junction box.

STEAM GENERATING SECTION

(OK-4740)

The OK-4740 steam generators, as well as other late model Vapor-Clarkson steam generators, have an economizer coil installed in the exhaust chamber. This coil serves a double purpose by increasing the thermal efficiency of the steam generator, and by giving the feed water its initial exposure to heat in a coil that is very easy to replace. The pitting caused by internal oxygen release, and the surface corrosion caused by sweating, are both confined to this smaller, more accessible coil — thereby increasing the service life of the main coils.

To maintain good combustion at all times, be sure that none of the combustion chamber components are chipped, cracked, burned or out of shape. This part of the steam generator should be inspected every thirty days.

Fire Pot Disassembly

1. Be sure that the main switch is "off". Disconnect the ignition wires, the oil and air lines to the fuel sprayhead, the cable to the fuel solenoid valve, and the air dome clamp ring. Lift off the air dome.
2. Take out the fire pot, and with a strong light examine the accessible parts of the combustion chamber; repair any that show sign of damage, or replace with new parts.

To Expose The Coils

1. Take out the fire pot as instructed above.
2. Take off the plate covering the leads to the resistors mounted inside the air inlet housing. Disconnect these leads. Remove the stack switch cable.
3. Remove the machine screws that secure the air inlet housing, and lift off this housing.
4. Unscrew the nuts that secure the air ring deflector skirt and the inverted cone, and take out these parts. Unscrew the lifting eye bolts. Remove the center clamping ring to expose the bolts securing the smokehood to the base assembly; remove these bolts and lift off the smokehood, taking care not to damage the gasket.

To Remove The Coils

1. Take the pipe guards off the base assembly. Then break the union connections to all the coils and unscrew the inlet nipples and coil connector pipes. (Loosen the set screws on the spacer bushing and remove these bushings if necessary.)
2. Loosen the inverted capscrews holding down the economizer coil and take out this coil; then take off the nuts on the coil tie rods and lift out the coil retainer. (The coil retainer need not be removed if just the economizer coil is to be taken

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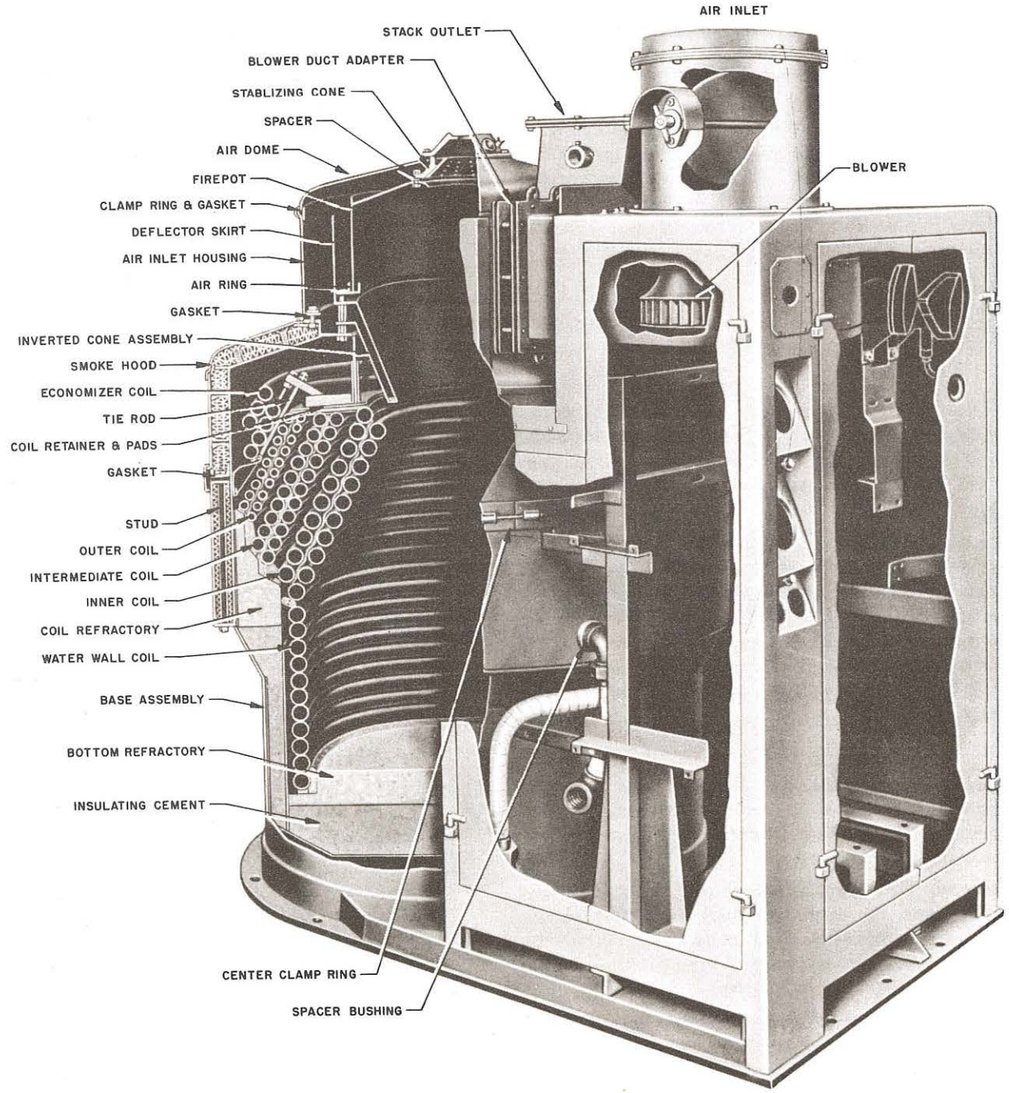

Fig. 26 — OK-4740 Boiler, Blower and Cabinet Assembly.

out.) Take care to kéep the coil pads intact for re-use in case new ones are not available.

3. Lift out the outer coil, intermediate coil and inner coil, in the order named. The water wall coil is sealed in the bottom refractory midway to the second coil layer from the bottom, as illustrated in the cutaway view of the steam generating section. This portion of the bottom refractory must be chipped away before taking out the water wall 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 any repair work is done on them.

To Repair The Refractories

Examine the refractory cement in the coil refractory and in the bottom refractory; if chipped or disintegrated it can be repaired with our refractory cement No. CB-4225-A-62. Chip off all loose cement and form recesses to hold the new cement by cutting back the refractory around the chipped surfaces. Wet these surfaces and fill with new cement.

If badly deteriorated, break up the refractory entirely and rebuild it. The coil refractory extends one inch below the step web for the inner coil, and is built up in three steps flush with the coil step web. The bottom refractory forms a layer 2½" thick over the bottom insulating cement. The lowest water wall coil is completely embedded in the bottom refractory and, in addition, the outer edge of the bottom refractory is built up sufficiently to seal off the lower portion of the second water wall coil from the bottom.

The refractory cement should be mixed with water — to the consistency of putty — and tamped solidly in place with a hammer or similar instrument, and then leveled off at the proper heights. Be sure to pack the cement tightly around the openings in the base assembly for the inlet and outlet nipples. Then, after the coils are back in place and secured with the coil retainer, enough additional refractory cement must be packed around the inside of the base assembly to seal off the lowest of the exposed outer coils.

AIR PRESSURE REDUCING VALVE

No. 102,700 (DRK) — No. 245 (DRK-4516) — No. 102,701 (DRK-4530)

This device is placed in the atomizing air line to reduce and regulate the locomotive reservoir air pressure; from 70 to 75 lbs. atomizing air pressure is required on the 4530 steam generators, and from 30 to 35 lbs. is required on the 4516 steam generators.

A movable seat is attached by a yoke to the spring backed diaphragm; the air pressure in the valve body lifts the diaphragm and raises the valve seat, bringing it closer to the nozzle and cutting down the flow of air into the valve. In operation, the valve assumes a balanced position and meters the flow of air to maintain a uniform atomizing air pressure.

Use the following list as a maintenance guide:

1. *Adjusting:* Release the locknut, and turn the adjusting screw out to decrease atomizing pressure; turn the adjusting screw in to increase the atomizing air pressure.
2. *Screen:* The strainer screen must be kept clean. Disconnect the union on the inlet pipe to reach the screen on the No. 245 and No. 102,701 valves. Take off the strainer plug to take out the strainer screen on No. 102,700 valves.
3. *Valve Nozzle and Seat:* The nozzle and seat plate must seat properly. Wear is most likely to occur on the composition seat.
4. *Diaphragm:* A leaky diaphragm is indicated if air leaks through the small relief port in the bonnet. The diaphragm is soldered to the body on No. 245 and 102,201 valves. Melt the solder and install a new diaphragm. The diaphragm is not soldered on the No. 102,700 air reducing valve. Take off the bonnet and unscrew the diaphragm plate to replace the diaphragm

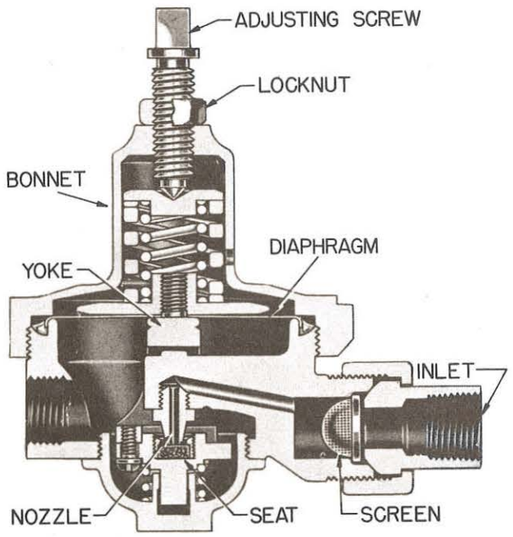

Fig. 27 — No. 245 Air Reducing Valve.

AIR PRESSURE REGULATOR

No. 102,702
(OK and DSK)

This air pressure regulator is used in the atomizing air line of OK and DSK steam generators to reduce and regulate the locomotive reservoir air pressure, and to filter dirt, oil and water out of the compressed air. From 30 to 35 lbs. atomizing air pressure is required on 4616 units, 40 to 45 lbs. on 4625 units, and from 70 to 75 lbs. pressure is required on 4530, 4630 and 4740 units.

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.

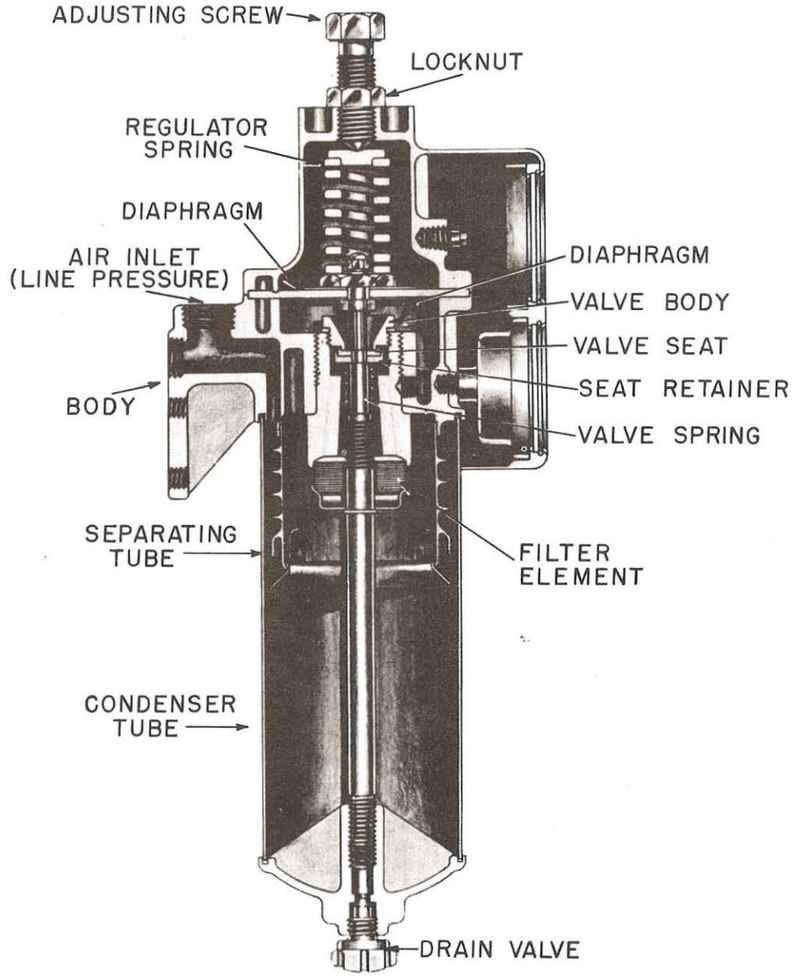

Fig. 28 — No. 102,702 Air Pressure Regulator.

AIR SOLENOID VALVE

No. 7-105,904
(DRK and DSK)

FUEL BY-PASS SOLENOID VALVE

No. 7-105,900
(4740)

The air solenoid valve is an electrically operated shut-off valve in the atomizing air line; it is operated by the cutout switch on the servo-fuel control. A small hole (No. 55) is drilled through the valve seat, which permits a constant flow of air through the spray nozzle to keep it free of sediment. When the servo cam plate comes down past the low fire position, it opens the cutout switch contacts on the servo and breaks the current flow to the air solenoid valve. In operation, current flows through the solenoid coil, draws up the armature and keeps the valve open. When the circuit is broken, the magnetic coil is de-energized, the armature drops and seats the valve and shuts off most of the atomizing air flow to the sprayhead. About 15 lbs. air pressure continues to flow through the hole in the valve seat to keep the sprayhead nozzle clean.

The fuel solenoid valve is an electrically operated fuel shutoff used on OK and DSK units. On DSK units it is controlled by the cutout switch on the servo; on OK units it is controlled by the air cutout switch and by the servo cutout switch in the same circuit. Energizing the fuel solenoid valve opens the fuel line to the sprayhead and permits admission of fuel oil to the firepot; de-energizing the fuel solenoid completely shuts off the flow of fuel to the sprayhead — there is no bleed hole similar to the one in the air solenoid valve seat.

The fuel by-pass solenoid is applied on OK-4740 steam generators; it differs from the standard fuel solenoid only in orifice size in the valve seat. When the low contacts of the electric steam temperature limit control close, the by-pass solenoid valve is

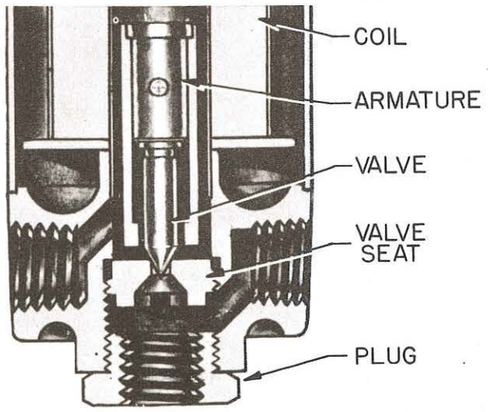

Fig. 30 — Fuel Solenoid Valve.

FUEL SOLENOID VALVE

No. 7-7800
(OK and DSK)

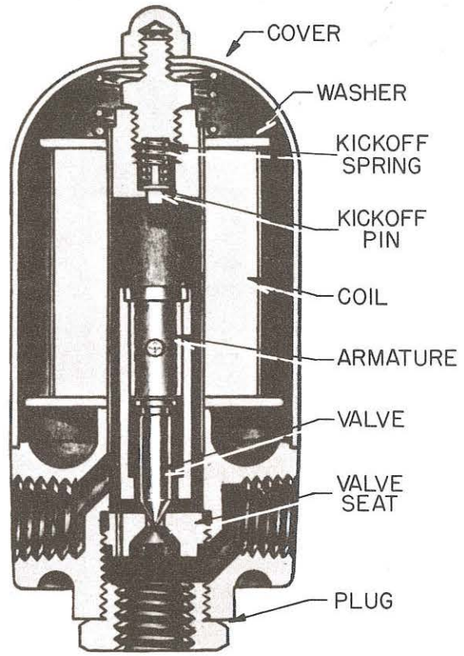

Fig. 29 — No. 7-105,904 Air Solenoid Valve.

energized and opens to by-pass most of the fuel back to the supply tank — just enough fuel flows to the sprayhead to maintain a minimum fire.

Note: Only the air solenoid valve has the small bleed hole in the valve seat.

The following is a guide list for checking faulty operation of this device:

1. *Sticking:* Keep the armature and inside of the coil clean. Remove the hexagon plug, and the valve seat. The armature should then drop out, and the interior of the coil can be washed and wiped clean. The kickoff pin must be free and the kickoff spring in good condition.
2. *Valve Seat:* Keep dirt and grit from the valve pin and seat, and make sure the valve and seat are not scored or seating improperly.
3. *Coil:* If the valve is inoperative, check the coil electrically. When replacing the coil, be careful not to loosen the leads when pulling them out from the solenoid valve body.

COIL BLOWDOWN VALVE

CH-4060-ATT TYPE (DRK and DSK) 101,437 TYPE (OK)

These are swing-gate valves designed to rapidly back blow steam when it is necessary to blow down the steam generator coils. The CH-4060-ATT type is opened by pulling down the plunger knob and shifting the handle lever to the open position; it is locked in the closed position by the locking pin which is forced by a spring into the locking socket. The 101,437 type 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.

Both types are fitted with an electrical cutout switch which breaks the current to the motor converter when the valve is opened. This safety feature makes it impossible to operate the steam generator with the coil blowdown valve open.

Use the following list as a maintenance guide:

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.

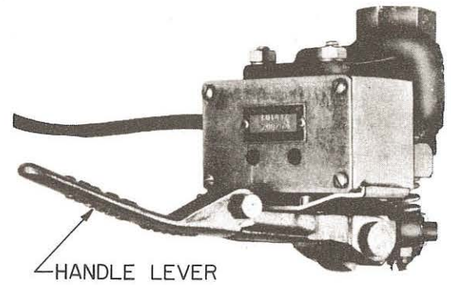

Fig. 31 — No. 101,437 Coil Blowdown Valve.

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 the contact spring. If the valve handle is bent down on the CH-4060-ATT type, the locking pin will not come up high enough to close the switch contacts.

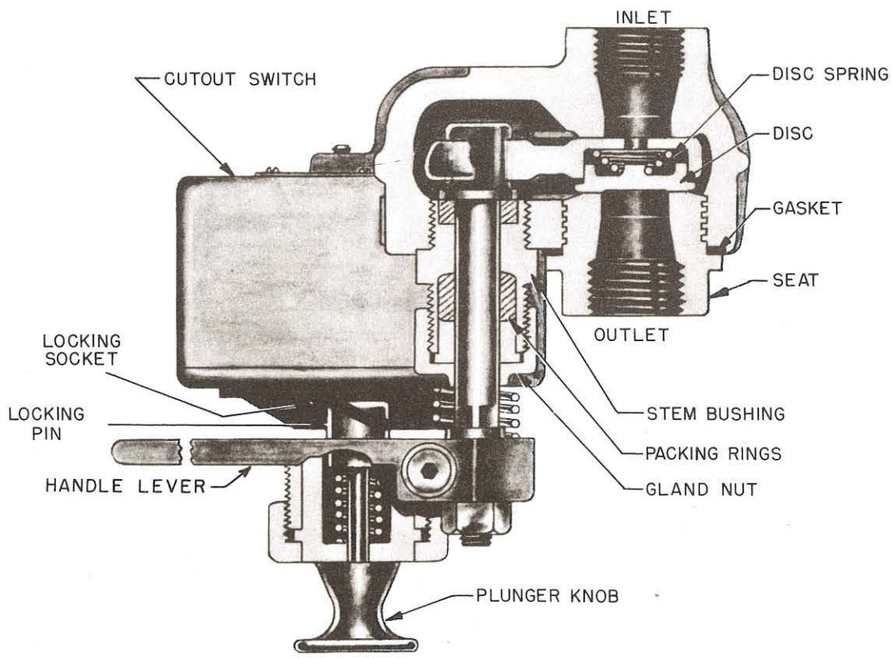

Fig. 32 — No. CH-4060-ATT Coil Blowdown Valve.

CONTROL SWITCH

No. R-105,519
(DRK)

This control switch is used on DRK steam generators; it is a double cam switch controlling the current flow to the motor and providing a positive shutoff in the fuel line when the switch is on OFF or FILL. Listed below are three positions of the switch and each corresponding phase of steam generator operation:

"OFF" — No current to the motor converter — the fuel valve is closed.

"FILL" — Current to the motor and the fuel valve still closed. This position is used to fill the coils with water.

"RUN" — Current to the motor. The fuel valve opens and the steam generator goes into operation.

Maintenance of this device consists primarily in keeping the fuel valve packing in good condition, and in checking the fuel valve and seat for wear and leakage. The packing should be kept tight enough to prevent leakage around the operating rod without binding movement of the rod.

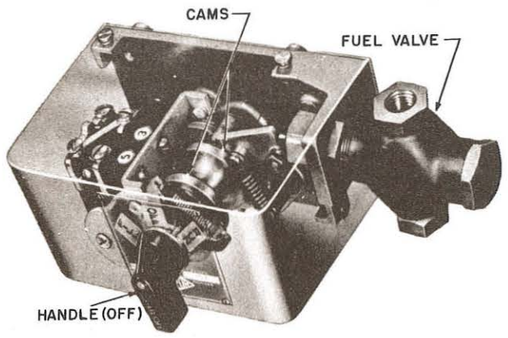

Fig. 33 — No. R-105,519 Control Switch.

ELECTRO PNEUMATIC CONTROL VALVE

No. 7630-AA
(DRK, OK, DSK)

This is a magnetic type compressed air valve located in the electro pneumatic control cabinet; it is operated electrically by a push button marked "Separator Blowdown" on the remote control panel. When the coil is energized the electro-magnetic force in the core pulls down the armature lever. This downward movement is transmitted through the push rod to the valve, which then opens on the inlet side and closes on the vent side, allowing the compressed air to flow through the valve outlet into the air cylinder on the separator blowdown valve.

When the coil is de-energized, the spring in the cap nut pushes the valve and armature lever up, closing the lower valve and opening the upper valve leading to the vent. This shuts off the flow of air to the separator blowdown valve air cylinder and releases the pressure on the air cylinder to provide instant shutoff when the remote control button is released.

If air escapes from the vent with the remote control switch "off", remove the cap nut and check the spring for weakness and check the lower valve for bad seating or for dirt that may have lodged between the valve and seat.

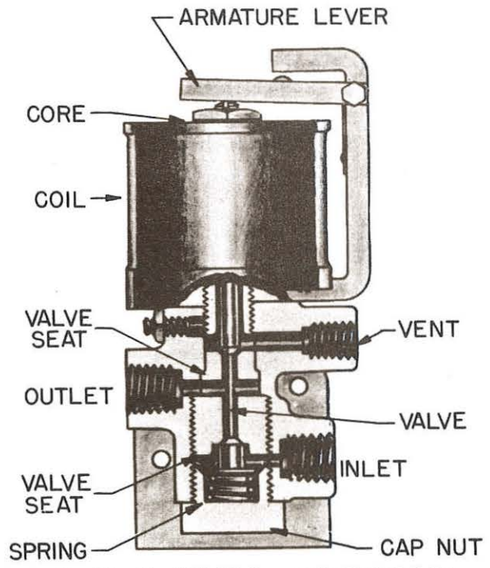

Fig. 34 — No. 7630-AA Pneumatic Control Valve.

FUEL FILTERS (Suction Line and Pressure Line)

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.

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. *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. 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.

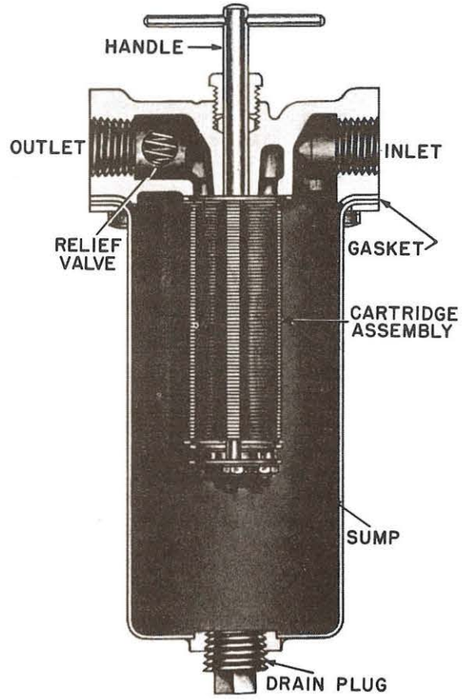

Fig. 35 — No. 104,107 Fuel Filter.

FUEL RELIEF VALVE (Manifold Pressure Regulator)

No. 104,802 (DRK, OK, DSK) No. 104,804 (OK-4740)

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 bypass, port at the desired pressure.

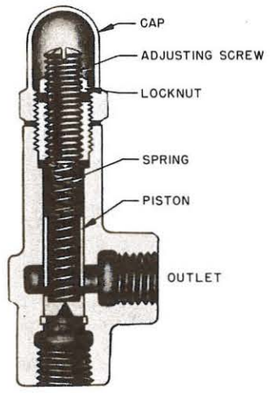

Fig. 36 — No. 104,802 Fuel Relief Valve.

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 SPRAYHEAD

No. B-104,415
(DRK and DSK)

This fuel sprayhead is designed to discharge atomized fuel oil spray into the firepot; fuel oil is brought to the spray nozzle under pressure and sprayed out of the nozzle tip by compressed air. The compressed air flowing into the sprayhead exerts pressure on the diaphragm located in the upper portion of the sprayhead and opens the needle valve to the spray nozzle. The adjustable spring tension on the diaphragm should be set so that the needle valve opens at approximately 35 lbs. atomizing air pressure on 4530 units, and at 20 lbs. atomizing air pressure on the 4516 units. At pressures below these, the spring tension closes the needle valve and shuts off the flow of oil through the spray nozzle.

Use the following instructions as maintenance guide:

1. *Nozzle:* Six distinct sprays should be discharged from the nozzle at normal fuel nozzle pressure. The nozzle tip and transfer plate should be taken out and cleaned if the nozzle fuel pressure gauge reads high, or if six distinct sprays are not visible through the peep hole glass.

   Take the fuel sprayhead off the steam generator, unscrew the nozzle nut and remove the nozzle and transfer plate. The nozzle should be replaced if the orifices are out of round or show considerable wear. To clean the nozzle and transfer plate, soak in carbon tetrachloride and blow out with compressed air; if necessary, use a wooden splint to clean these orifices — **never** use a metal probe.

   Tighten the nozzle nut — then loosen the body nut and move the nozzle assembly so that a line drawn through opposite orifices of the nozzle tip would be parallel to a line drawn through the center of the fuel and air inlets, as illustrated in fig. 38. The spark plug electrodes should be positioned between two of the fuel spray jets as shown in the illustration on page 49.

   After replacing the sprayhead, start the steam generator and check the nozzle spray for height. Fig. 40 illustrates the correct dimensions to maintain between the spray nozzle tip, stabilizing cone and spark plug electrodes. The height of the spray nozzle should be adjusted by turning the capstan nut to keep the fire slightly below the stabilizing cone — no burning should occur above the stabilizing cone. The spark plugs should be set just high enough so that the incoming combustion air carries the spark down into the fuel spray.
2. *Diaphragm:* Tension on the diaphragm spring should be set so that the needle valve opens at 35 lbs. atomizing air pressure on the 4530 steam generators, and at 20 lbs. atomizing air pressure on the 4516 steam generators.

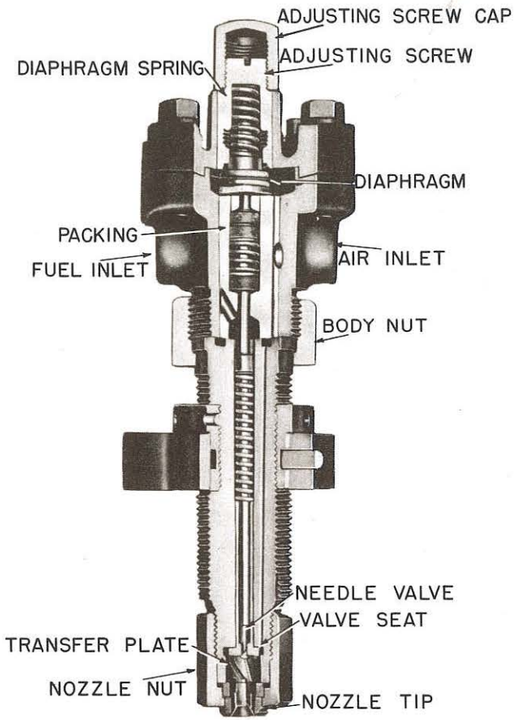

Fig. 37 — No. B-104,415 Fuel Sprayhead.

Air leaking through the bleed hole in the adjusting screw cap indicates that the diaphragm has developed a leak and should be replaced.

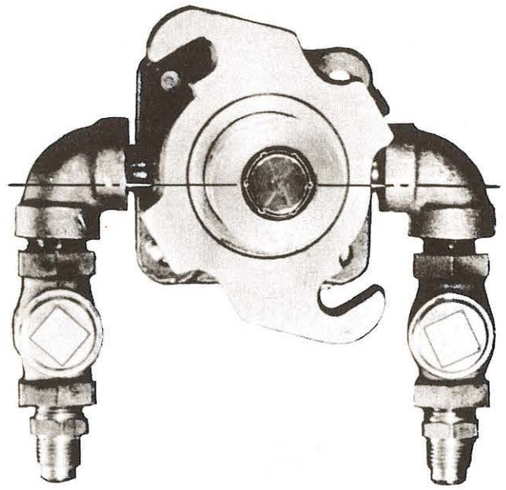

Fig. 38 — Position of Nozzle Tip.

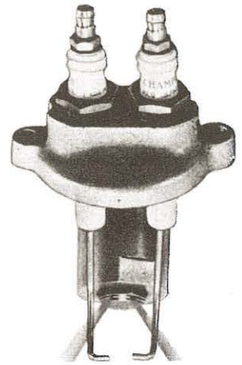

Fig. 39 — Fuel Spray Jets.

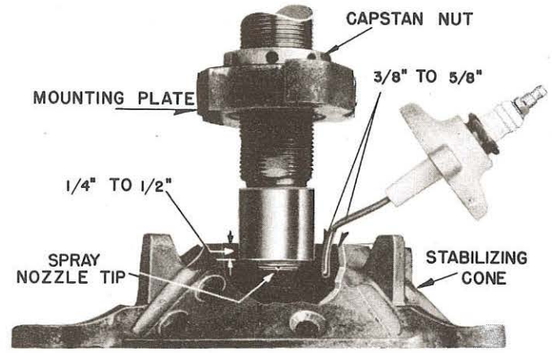

Fig. 40 — Spray Nozzle Height.

FUEL SPRAYHEAD

No. 104,425
(revised DRK)

This fuel sprayhead is a revision of the 104,415 sprayhead originally supplied on DRK steam generators. It is revised by removing the diaphragm assembly, needle valve assembly and the diaphragm spring, and by placing a small spring-loaded ball check valve and seat in the bottom of the body assembly. Fuel pressure overcomes the spring tension on the ball check valve, releasing fuel to the nozzle. When used, a fuel solenoid valve is inserted in the feed line to the sprayhead as in the OK units, and the 105,322 air switch replaces the air solenoid valve.

Operation and care of this sprayhead is exactly the same as for the 104,421 fuel sprayhead, with one additional precaution. Fuel seepage through the nozzle may be caused by faulty seating of the check valve on the "off" cycle. Check the spring tension and the ball and seat if fuel seepage is present.

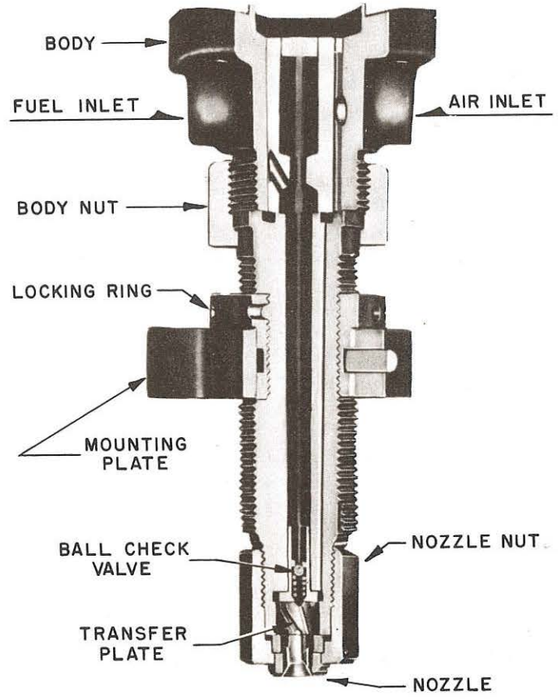

Fig. 41 — No. 104,425 Fuel Sprayhead.

FUEL SPRAYHEAD

No. 104,421
(OK)

As used on the OK steam generators this 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 tetrachloride. Blow out the orifices with compressed air; if necessary, use a wooden splint to clean these orifices — **never** use a metal probe.
2. *Nozzle Height Adjustment:* 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, as illustrated in fig. 38. The spark plug electrodes should be positioned between two of the fuel spray jets as shown in the illustration on page 49.
   Fig. 40 illustrates the correct dimensions to maintain between the spray nozzle tip, stabilizing cone and spark plug electrodes. The height of the spray nozzle should be adjusted to keep the fire slightly below the stabilizing cone — no burning should occur above the stabilizing cone. The spark plugs should be set just high enough so that the incoming combustion air carries the spark down into the spray.

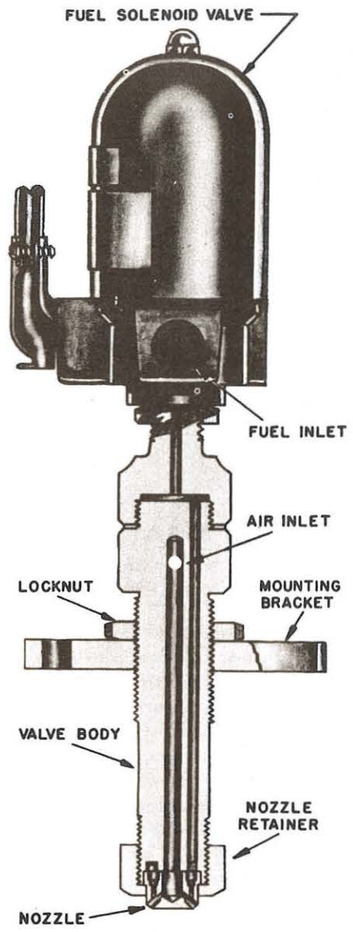

Fig. 42 — No. 104,421 Fuel Sprayhead.

HEAT EXCHANGER

No. CB-4225-KKA (4530 and 4630) | No. C-4050-KK (4516 and 4616) | No. CB-4225-KKA (4625, 4530, 4630, 4740)

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, 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.
   A rubber dough sealing compound is packed around the top and bottom cross-overs. Repack these cross-overs after dismantling.

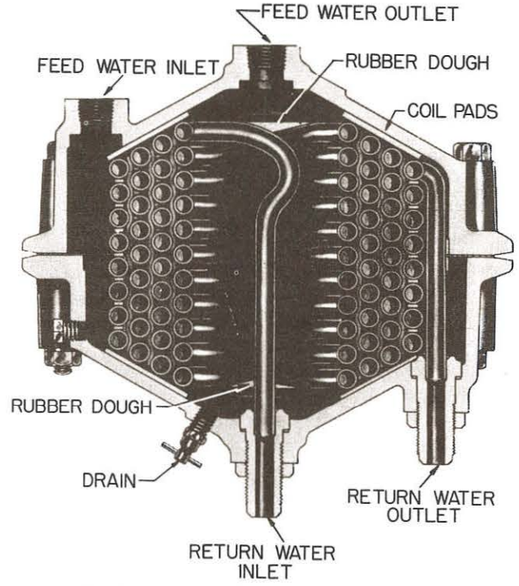

Fig. 43 — No. CB-4225-KKA Heat Exchanger.

SAFETY VALVES

No. 101,206 (DRK, OK, DSK) | No. CB-4225-CLL (DRK-4530) | No. 101,217 (4740, 4625)

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.

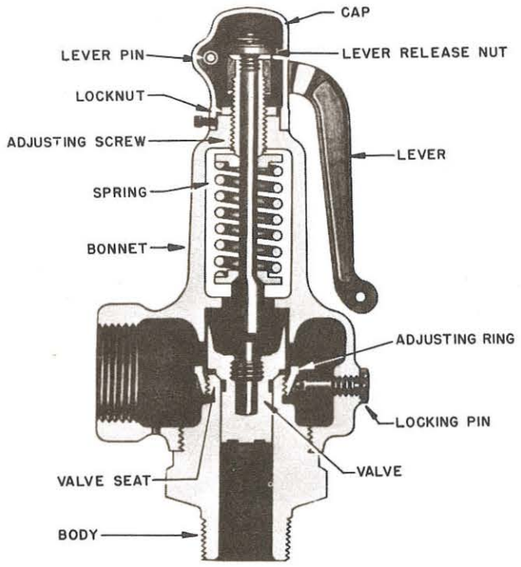

Fig. 44 — No. 101,217 Safety Valve.

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

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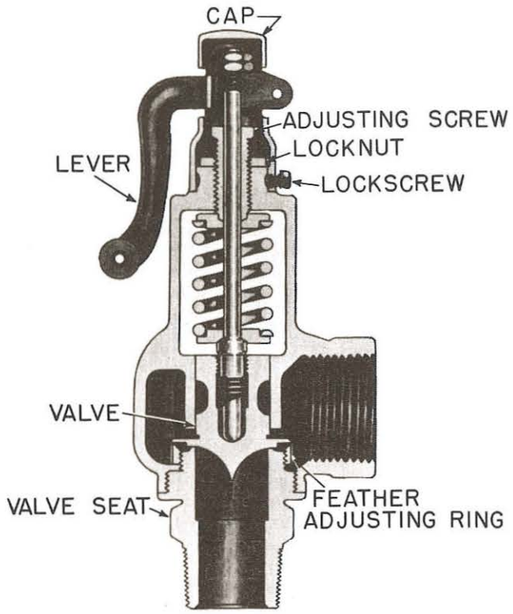


Fig. 45 — No. 101,206 Safety Valve.

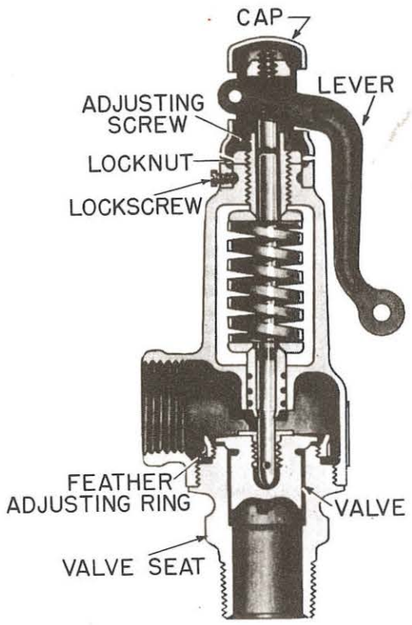


Fig. 46 — No. CB-4225-CLL Safety Valve.

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.

SEPARATOR BLOWDOWN VALVE

No. 101,424 (4516)	No. 101,439 (4616)	No. 101,443 (4616)	No. 101,433 (4530)	No. 101,412 (4630)	No. 101,441 (4625, 4630)	No. 101,444 (4740)

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 or hand lever 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.

   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 stuffing box should be repacked 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

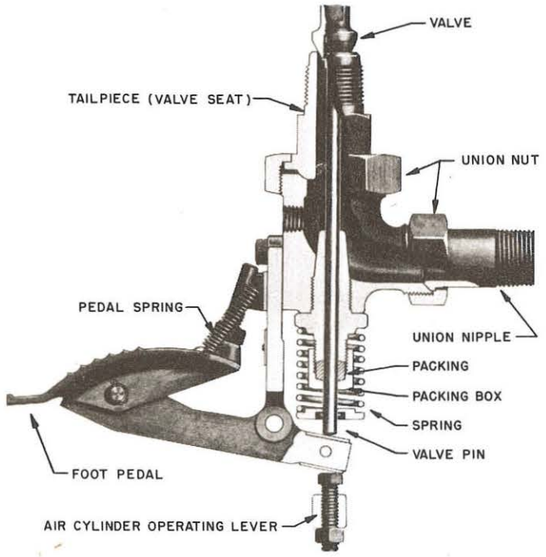
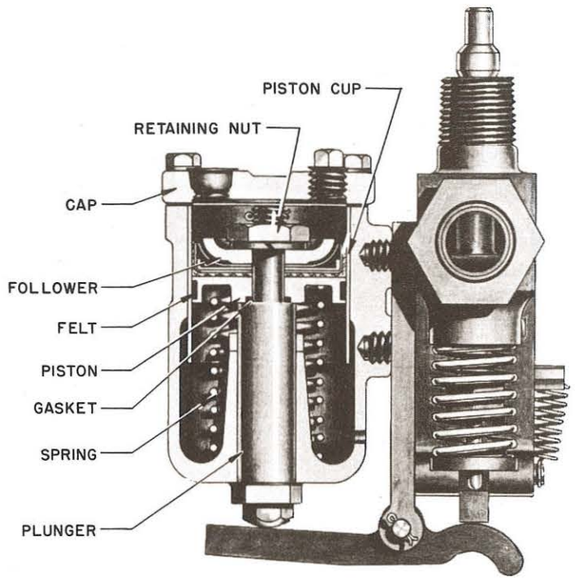


Fig. 47 — No. 101,441 Separator Blowdown Valve.

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.



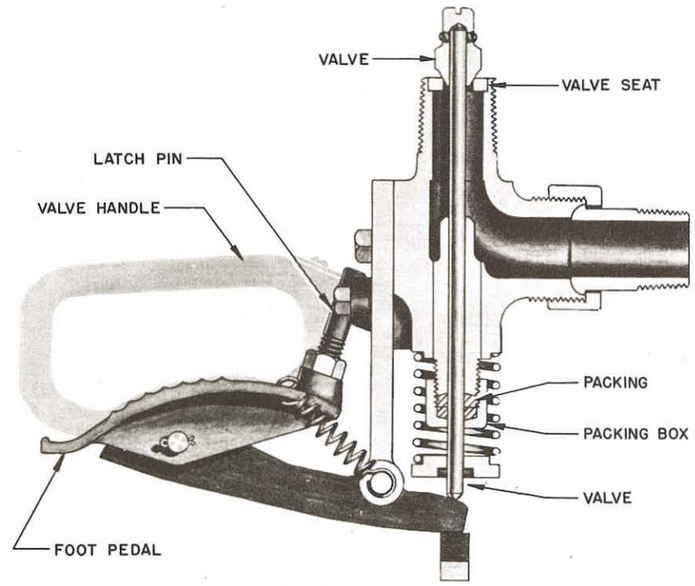


Fig. 48 — No. 101,412 Separator Blowdown Valve.

SERVO-FUEL CONTROL

Nos. 102,029 and 102,030 (DRK-4530) (DRK-4516) | Nos. 102,036 and 102,037 (4530 and 4630) (4516 and 4616) | No. 102,042 (4625) | No. 102,043 (4740)

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. On the 102,029 and 102,030 servos, the feed water flows into the diaphragm chamber, exerts pressure on the diaphragm and pushes it up. As the diaphragm comes up it lifts the tapered metering valve stem and allows feed water to pass through the metering valve and feed water outlet into the steam generator coils. The metering valve stem has a small vertical hole through its center, which allows water to pass up to the top of the diaphragm chamber above the diaphragm assembly, and equalizes the water pressure on both sides of the diaphragm. As a result, the diaphragm and metering valve stem are lifted in accordance with the amount of water flowing through the diaphragm chamber. It is not water pressure that regulates the servo — the amount of water flowing through the diaphragm chamber regulates the control.

   The 102,036, 102,037, 102,042 and 102,043 servos have a slightly different construction in the diaphragm chamber, although the basic operation remains the same as in the 102,029 and 102,030 servos. As illustrated here, 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 valve. The height to which the diaphragm is raised varies in direct proportion to the amount of feed water passing through the diaphragm collar.
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. Oil from the hydraulic pressure line is admitted to the hydro-pistons through the slot valve and the ports in the shaft.
4. As the hydro-pistons move under hydraulic pressure, they turn the shaft and revolve the cam plate on its axis. This action also moves the shaft ports away from the valve slots and shuts off the hydraulic pressure to the hydro-pistons.
5. The adjusting screws on the cam plate are set progressively at further distances from the cam plate — as the cam plate swings it regulates the position of the fuel metering valve and the combustion air damper through the roller linkage.

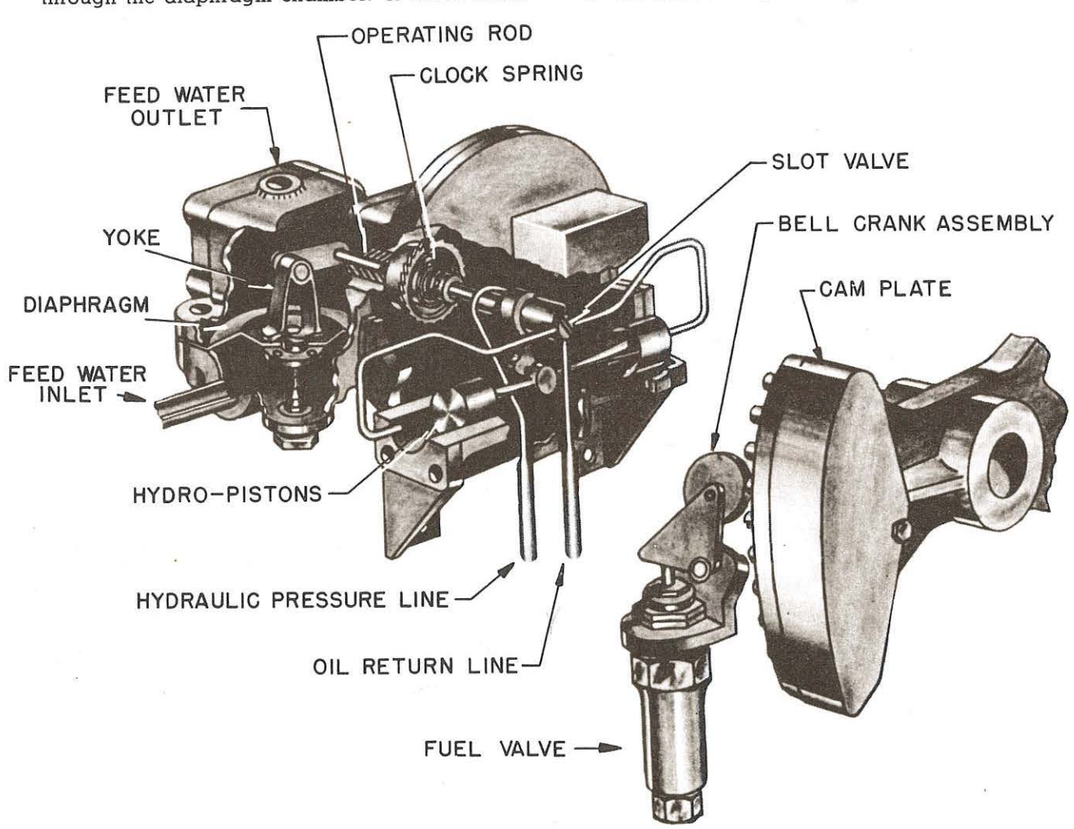


Fig. 49 — Diagrammatic of No. A-102,036 Servo-Fuel Control.

Maintenance

Good maintenance of the servo calls mainly for checking the gaskets and pipe fittings for leaks. The linkage on the control should be kept well oiled and tight.

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

The servo needs adjusting when the operation of the steam generator is not in balance — when the return water flow indicator does not cycle properly, or when it is hot to the touch.

Before adjusting the servo, the steam generator should be thoroughly checked. Use the following list as a guide for determining the condition of your steam generator:

a. Check the condition of the coils (a coil wash is always advisable). Inspect the exterior coils for soot or foreign material lodged around or between the layers of coils.

b. Check sealing cements and refractory for cracking or burning away.

c. Check condition of the firepot, air ring and centralizing cone. Also the height of the firepot should be checked.

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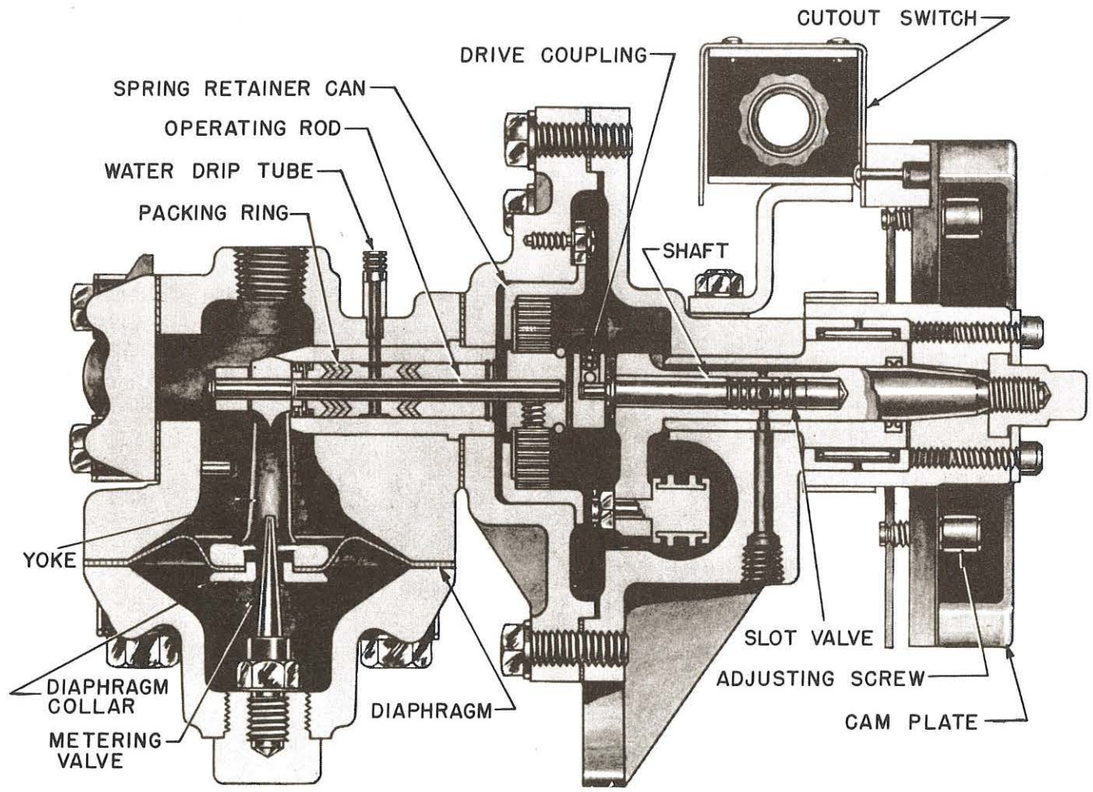

Fig. 50 — Cross Section of No. A-102,037 Servo-Fuel Control.

d. Clean the fuel sprayhead, and check the nozzle.

e. Check electrodes for spark and proper adjustment.

f. Check condition of the blower fan.

g. Check belts for proper tension.

h. Check water pump for excessive packing leaks, or suction leaks in the line.

i. Check motor RPM.

j. Clean traps and strainers and check the heat exchanger.

k. Check gauges (fuel, water, air and steam).

l. Check the damper — see that it moves freely.

m. Check adjustment of the steam temperature limit control.

n. Fuel manifold pressure should be 150 lbs.

Check the travel on a new servo before adjusting it, do not use an orifice in the trainline and — **important** — always start the servo adjustment on high fire and maintain about 150 lbs. generator steam pressure throughout the entire adjustment procedure by throttling the stop and check valve. The following steps outline the correct procedure for adjusting the servo:

1. Operate the steam generator at maximum output. Open the stop and check valve and the remote control and manual trainline stop valves, and let the steam escape into the atmosphere.

   Close the water by-pass regulator shut-off valve, so all of the feed water flows through the servo; keep this valve closed during the entire adjustment procedure — regulate the steam generator output by opening and throttling the manual water by-pass valve.

2. With the steam generator operating at maximum output, set the adjusting screw on the fuel metering valve side of the cam plate and the adjusting screw on the damper regulating side of the cam plate, so that the fire burns clean and shows neither black smoke nor white smoke, and so that the air dome does not overheat.

   Watch the return water flow indicator; it should cycle normally and feel cool or luke warm to the touch. The flow indicator normally cycles from 4 to 12 times a minute.

   Allow the steam generator to run at this setting for ten minutes. If the fire continues to burn clean, and the return water flow indicator continues to cycle properly and stays cool, the servo is properly adjusted for operation at maximum output.

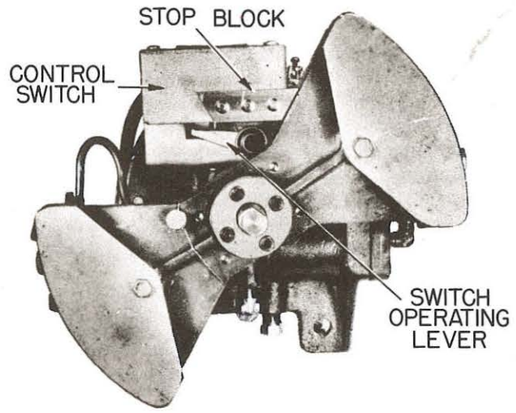

Fig. 51 — Servo on Stop Block.

3. This procedure is followed for the succeeding adjustments of the servo, as the output is reduced. To reduce the steam generator output, it is necessary to cut down the amount of feed water entering the coils. Open the manual water by-pass valve slightly — just enough to bring the servo cam plate down so the next adjusting screw contacts the damper control arm on one side, and the bell crank assembly on the other side.

   Turn the adjusting screws inward to slightly reduce the amount of fuel and combustion air delivered to the fire pot. Reduce the fire just enough to bring the cycling of the return water flow indicator to normal. Allow the steam generator to operate at this setting for at least ten minutes. If it maintains a clean fire and the return water flow indicator continues to cycle normally, the servo is correctly adjusted.

4. Continue this method on all successive adjustments, by-passing more and more feed water. At low fire on the 4516 steam generators the return water flow indicator will normally feel warmer than on the preceding adjustments of the servo.

   The cam step ring should be set to trip the servo cutout switch at the stop block.

5. The late model servo-fuel controls are fitted with only two adjusting screws on each cam plate, one for the high fire adjustment and one for the low fire adjustment. Adjust these servos for high and low fires only — the intermediate stages of steam generator output are automatically regulated to give accurate proportioning of fuel, water and combustion air.

SOLENOID VALVE ASSEMBLY (Magnetic Trainline Shut-Off Valve)

No. MV-238-V (OK, DRK, DSK) No. EVE-238-V (4625, 4740)

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, opens 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.

The No. 238 valve is so designed that an auxiliary valve opens first as the piston comes down under steam pressure. Then, as the piston continues downward it contacts the main valve stem, pushing it down to open the main valve.

PILOT VALVE — No. RV-238-B1 — The following is a guide for checking faulty operation of the solenoid pilot valve:

1. Valve stem sticking — the packing gland should be screwed in hand tight and then backed off enough to allow the stem to operate freely.
2. Valve and seat dirty or not seating properly.
3. Core pin sticking.

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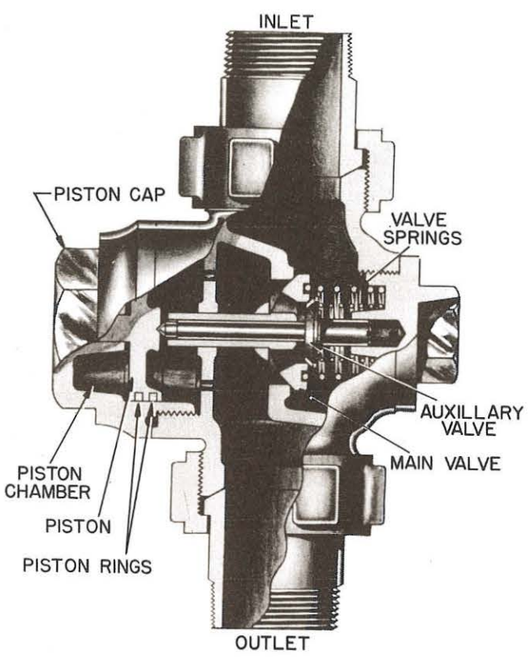


Fig. 52 — No. 238 Main Valve.

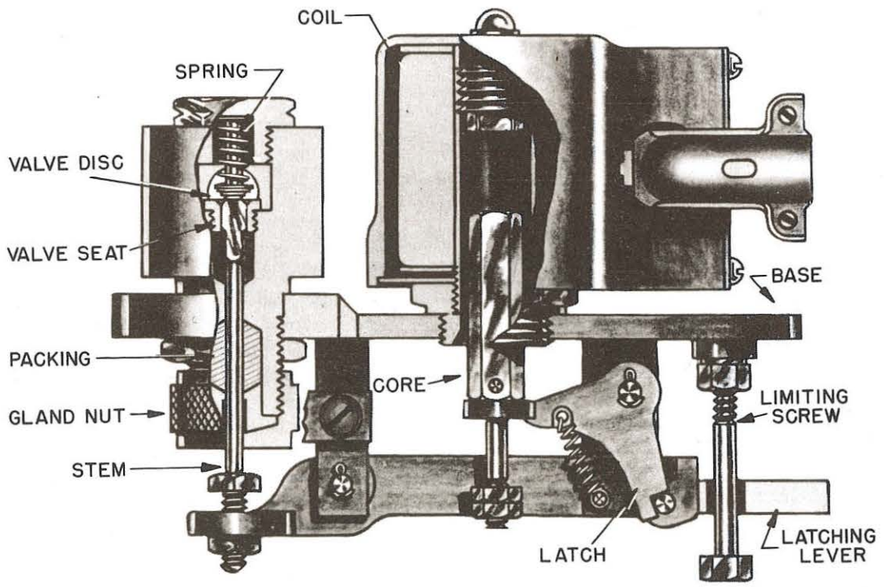


Fig. 53 — No. RV-238-B1 Solenoid Pilot Valve.

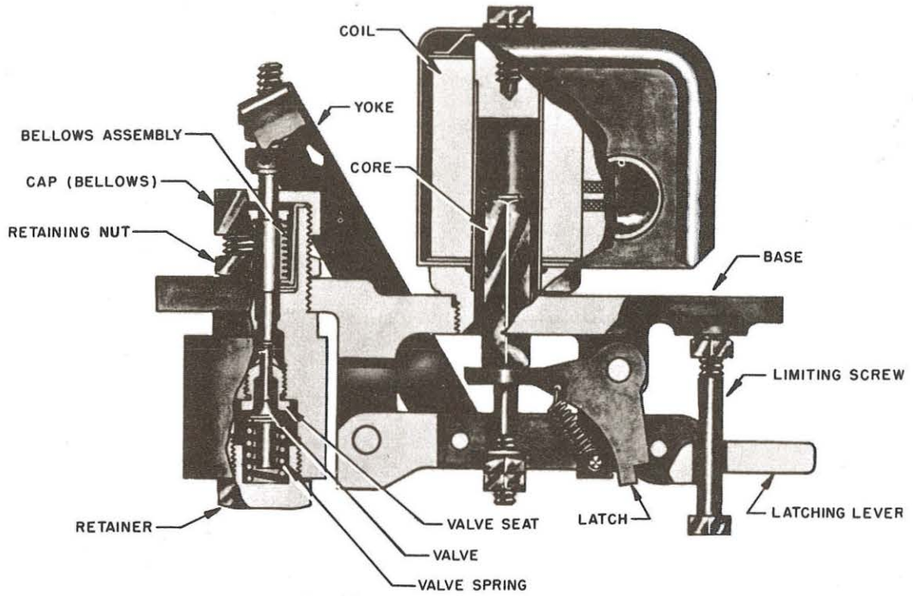


Fig. 54 — No. RV-238-E1 Pilot Valve.

4. Lever catches on the end of the latch. Install limiting feature as illustrated — a ¼" 20 x 2" cap screw with a ¼" lock washer and locking nut. Drill a ⅜" hole in the lever at the center line and $15/16$" from the end, and drill and tap the valve base to accommodate the cap screw.

PILOT VALVE — No. RV-238-E1 — Applied on EVE-238-V assemblies — it 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 similar to that of the RV-238-B1 valve except for the packing, which requires no attention except when replacement may be necessary.

MAIN VALVE — No. 238 — The following is a guide list for checking faulty operation of the train-line valve:

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

STACK SWITCH

No. H-105,200 (DRK and DSK) **No. HA-105,200 (OK)**

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. on both the H-105,200 and HA-105,200 models; the low temperature contacts are set to close at 250° F. on the H-105,200 stack switch, and at 300° F. on the HA-105,200 stack switch.

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 scaled, 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.

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 complete the motor circuit, and the motor shuts down.

The following list should be used as a maintenance guide:

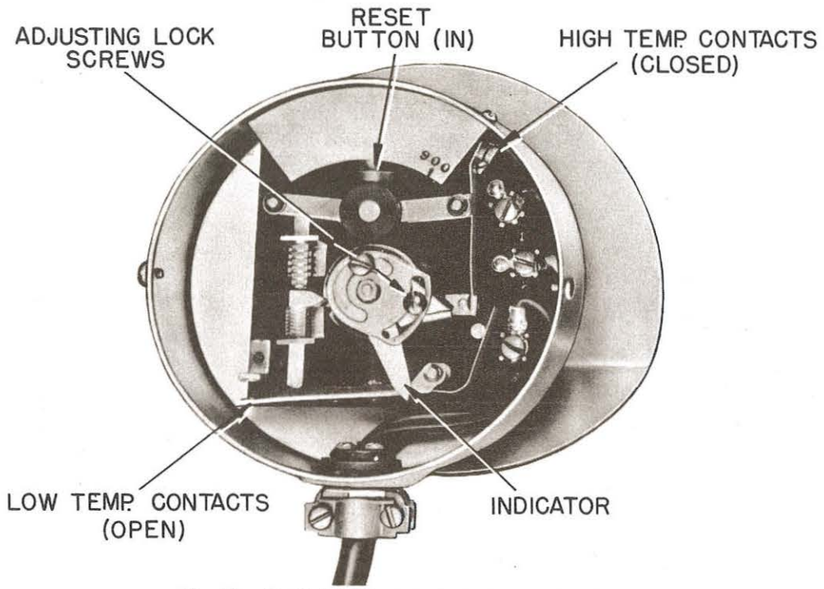


Fig. 55 — No. H-105,200 Stack Switch — Cover Off.

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 stacks switch is taken off the stack.

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 — on the H-105,200 model they should close at 250° F. and on the HA-105,200 switch they should close at 300° F.

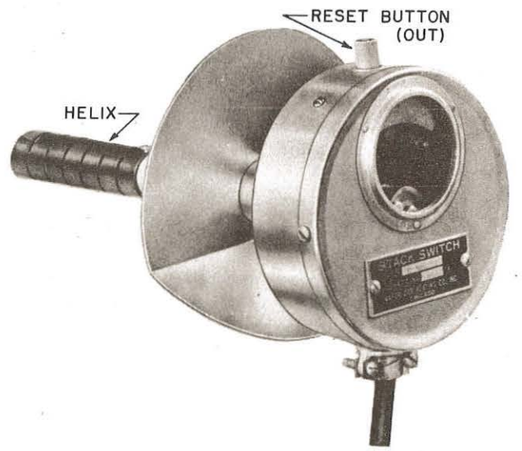


Fig. 56 — No. H-105,200 Stack Switch.

SPARK PLUG ASSEMBLY

No. 106,310 (4630 and 4530) — No. C-4050-BHH (4616 and 4516)

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

1. *Electrodes:* The gap between electrodes should be set at exactly $\frac{3}{16}$". Keep electrodes clean and free of carbon.
2. *Grounding:* Broken or cracked insulators, and chafed or loosened cable connections will cause the plugs to short out. Replace broken or cracked plugs and worn cables. Keep insulators free of carbon, oil and moisture.

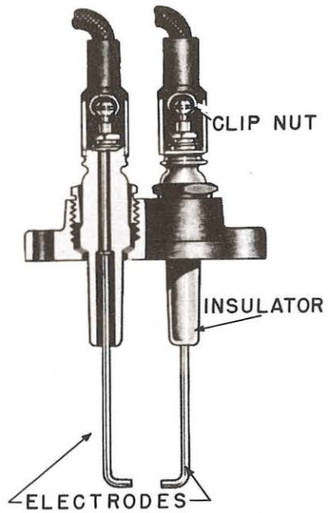


Fig. 57 — No. 106,310 Spark Plug.

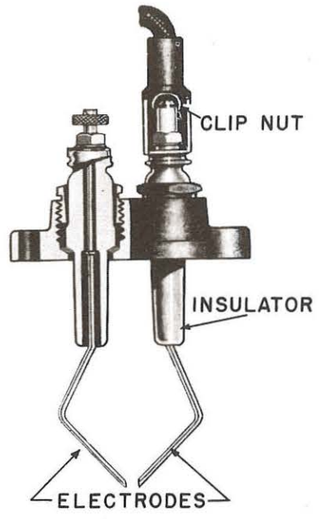


Fig. 58 — No. C-4050-BHH Spark Plug.

STEAM TRAP (Return Water Line)

No. 101,600 (DRK) — No. 101,606 (4530) — No. 101,607 (OK)

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.

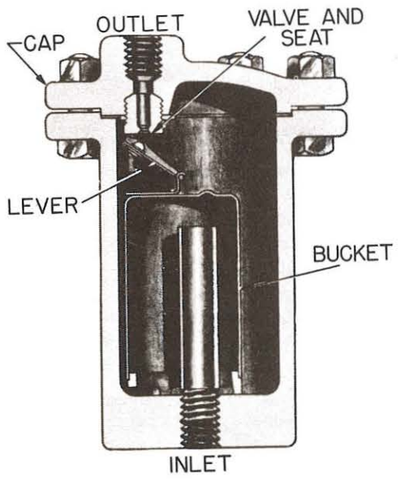


Fig. 59 — No. 101,607 Steam Trap.

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.

STEAM SEPARATOR

No. 101,023 (4530 and 4630) — No. 101,024 (4516 and 4616) — No. 101,026 (4625) — No. 101,030 (4740)

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 traps 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.

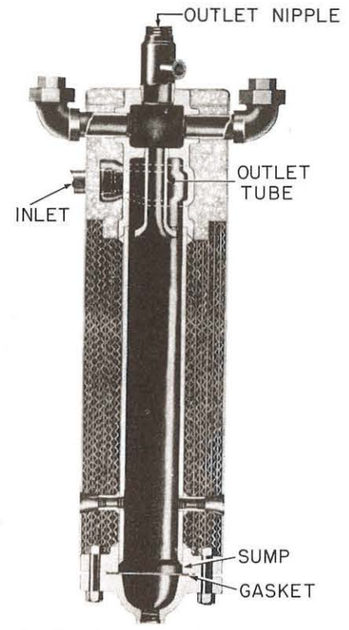


Fig. 60 — No. 101,023 Steam Separator.

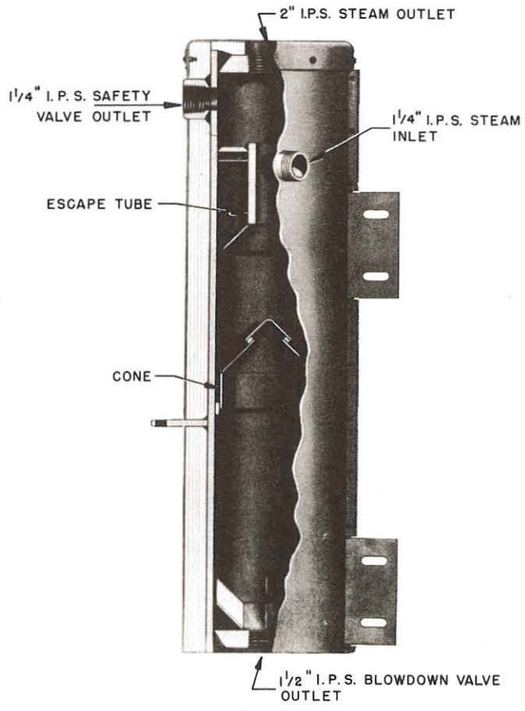


Fig. 61 — No. 101,030 Steam Separator.

STEAM TEMPERATURE LIMIT CONTROL

No. 102,214 (4516 and 4616) No. 102,215 (4530 and 4630)

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 path of the fire 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 compared 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. *Adjusting:* Operate the steam generator at maximum output when setting the steam temperature limit control. To be sure the generator is on high fire, close the water by-pass regulator inlet valve

Fig. 62 — No. 109,959 Gauge.

to divert all of the water flow through the servo-fuel control.

With the steam generator operating at high fire and 250 lbs. steam pressure, place the steam temperature limit control setting gauge No. 109,959 between the operating lever and the adjusting nut on the operating rod. Tighten the adjusting nut at the end of the operating rod so the fuel valve begins to meter the fuel slightly — as indicated by a slight drop in fuel nozzle pressure. Tighten the locknut before removing the gauge; check the fuel nozzle gauge again after tightening the locknut, to be sure the adjustment has not altered. If the adjustment is correct, pull out the gauge and replace the cover and seal.

The No. 109,959 gauge illustrated here, may be purchased from the Vapor Heating Corporation or made from .032" ground annealed tool steel stock, and hardened after machining.

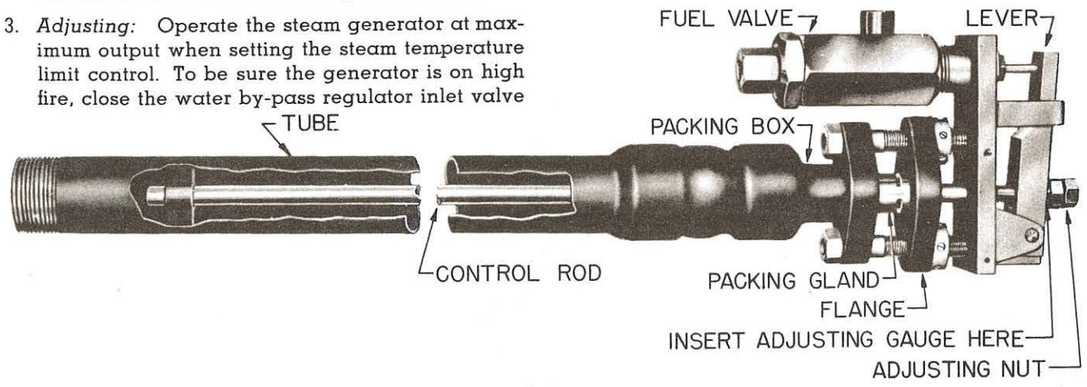


Fig. 63 — No. 102,214 Steam Temperature Limit Control.

STEAM TEMPERATURE LIMIT CONTROL

No. 102,225 (OK-4625)

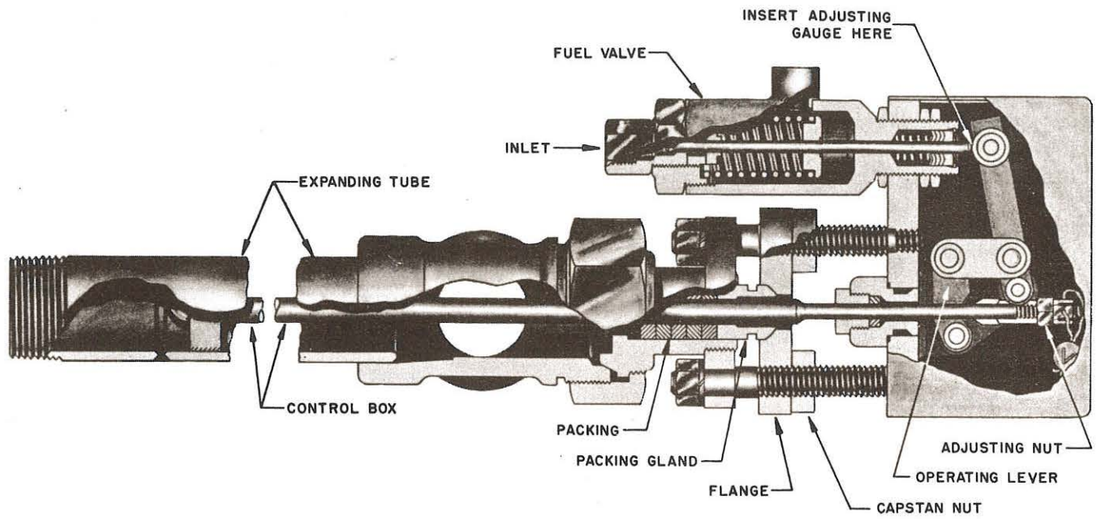


Fig. 64 — No. 102,225 Steam Temperature Limit Control.

This steam temperature limit control is a modification of the 102,214 and 102,215 controls discussed on the preceding page; the chief difference is in the arrangement of the operating levers. Operating characteristics and maintenance care are the same except for the adjusting procedure given below:

To achieve accurate adjustment of this control, the steam generator must be operated at 250 lbs. generator steam pressure with the water flow indicator cycling normally.

Remove the cover of the control and the seal on the castellated 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 No. 102,225 control shows exactly where to insert the gauge. Then tighten the adjusting nut until the fuel valve just begins to meter fuel back to the supply tank — 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 ⅜" bar stock hardened after cutting.

Fig. 65 — No. 109,982 Gauge.

STEAM TEMPERATURE LIMIT CONTROL

No. A-102,228 (OK-4740)

This steam temperature limit control is designed to protect the coils against excessive steam temperatures by first electrically limiting the flow of fuel to the sprayhead, and then by shutting down the steam generator completely. The control is securely held by a union clamp in a tee at the coil outlet; its expanding tube projects into the coil

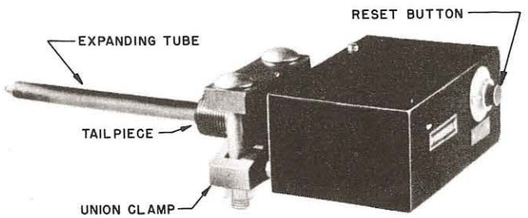


Fig. 66 — No. A-102,228 Control.

about eight inches and is immersed in the steam flowing from the coils into the steam separator. As steam temperature causes the tube to expand it operates two switches at the following control ranges.

1. When the steam temperature ranges between 450° and 475° the low limit snap switch closes and energizes the fuel by-pass solenoid valve, which then opens and by-passes the major portion of the fuel back to the supply tank — just enough fuel continues to the sprayhead to maintain a minimum fire. The feed water flow remains normal, and as the steam temperature at the coil outlet goes down, the tube contracts enough to let the snap switch open and de-energize the fuel by-pass solenoid — fuel flow is then resumed through the sprayhead and the steam generator again operates normally.

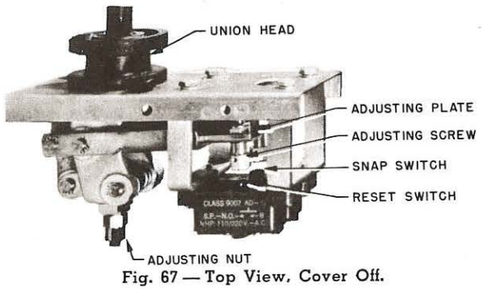


Fig. 67 — Top View, Cover Off.

2. The high limit reset switch in this control functions if the steam temperature should continue to rise above the 450° - 475° range. At from 550° to 575° the tube expands enough to open the high temperature reset switch; when this occurs the steam generator shuts down completely and the alarm bell rings. After the temperature in the coils has dropped, the switch must be manually reset by pushing the reset button in the control cover.

Adjusting Procedure

The gauges required to adjust this control are respectively .040" thick for the low temperature adjustment (Vapor part No. 109,980) and .100" thick for the high temperature adjustment (Vapor part No. 109,981).

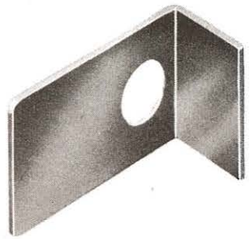


Fig. 68 — No. 109,980 Gauge.

Fig. 69 — No. 109,981 Gauge.

To accurately adjust this control, operate the steam generator at 250 lbs. generator steam pressure with the water flow indicator cycling normally. Then place the low limit gauge No. 109,980 over the switch block as shown in Fig. 70 and slowly tighten the castellated adjusting nut until the snap switch clicks — as the fuel by-pass solenoid opens, the fuel pressure gauge (No. 208 on the schematic piping diagram) will waver and register fuel pressure below normal. Take out the gauge and seal the castellated nut; then test the adjustment again as explained below.

Push in the adjusting plate slightly with a pencil or screw driver, place the gauge into position and let the adjusting plate come back slowly. The adjustment is satisfactory if the plate comes all the way back to its original position before the snap switch clicks and opens the fuel by-pass solenoid.

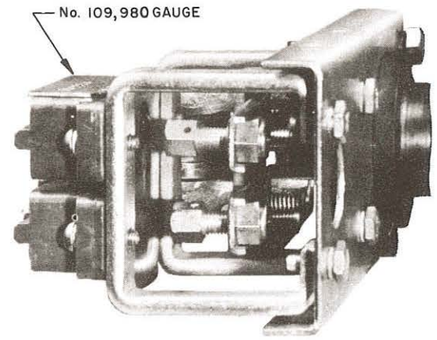


Fig. 70 — Side View No. 109,980 Gauge in Place.

For the second adjustment, place the high temperature adjusting gauge No. 109,981 over the switch block as before (this gauge will reach only to the upper switch button) and turn the upper adjusting screw on the adjusting plate out against the gauge surface. Turn the screw out **slowly** until the reset button just barely clicks out — the steam generator will shut down at this point. Press the reset button immediately to restart the steam generator. Check this adjustment also, in the same manner given in the preceding paragraph. This adjusting screw is secured with a clinch nut and need not be sealed.

STEAM TRAP (Radiation)

No. 4060
(DRK, OK, DSK)

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

Turn the adjusting screw down to eliminate steam blow through the outlet of the trap. Keep the strainer screen clean, and check the valve and seat for corrosion and proper seating. Check the diaphragm for leaks.

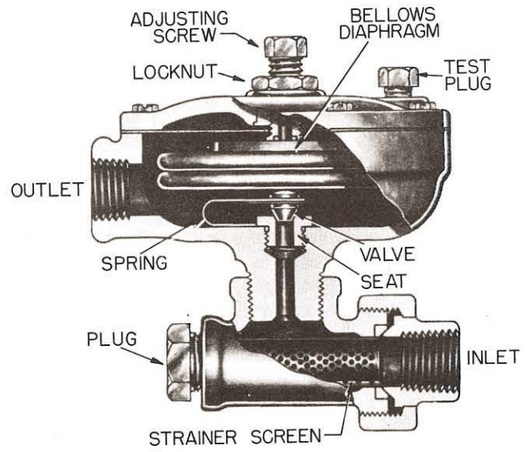


Fig. 71 — No. 4060 Steam Trap.

WATER BY-PASS REGULATOR

No.103,620 (4530, 4630, 4625, 4740) — No. 103,622 (4516, 4616)

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 trainline 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.

Most water by-pass regulators are equipped with either a double contact electric switch or a differential pressure delay adapter — and some regulators are fitted with both the switch and the delay adapter.

Differential Delay Adapter

The differential pressure delay adapter delays the opening of the by-pass valve in the regulator enough to move the servo cam plate directly from about the second pin 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 protrudes from the end of the operating lever. This pin must pass over a lip on the friction block, and the tension lever is adjusted to position the friction block so it engages the roller pin until about 35 lbs. pressure differential is attained between the regulator setting and the actual trainline pressure.

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.

Adjusting Procedure:

Before adjusting the delay adapter 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.
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.

(continued on page 69)

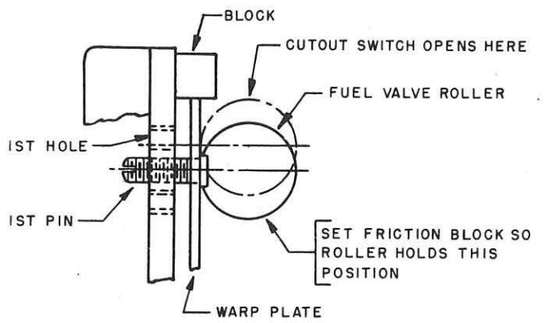


Fig. 72 — Servo Cam Plate and Fuel Valve Roller.

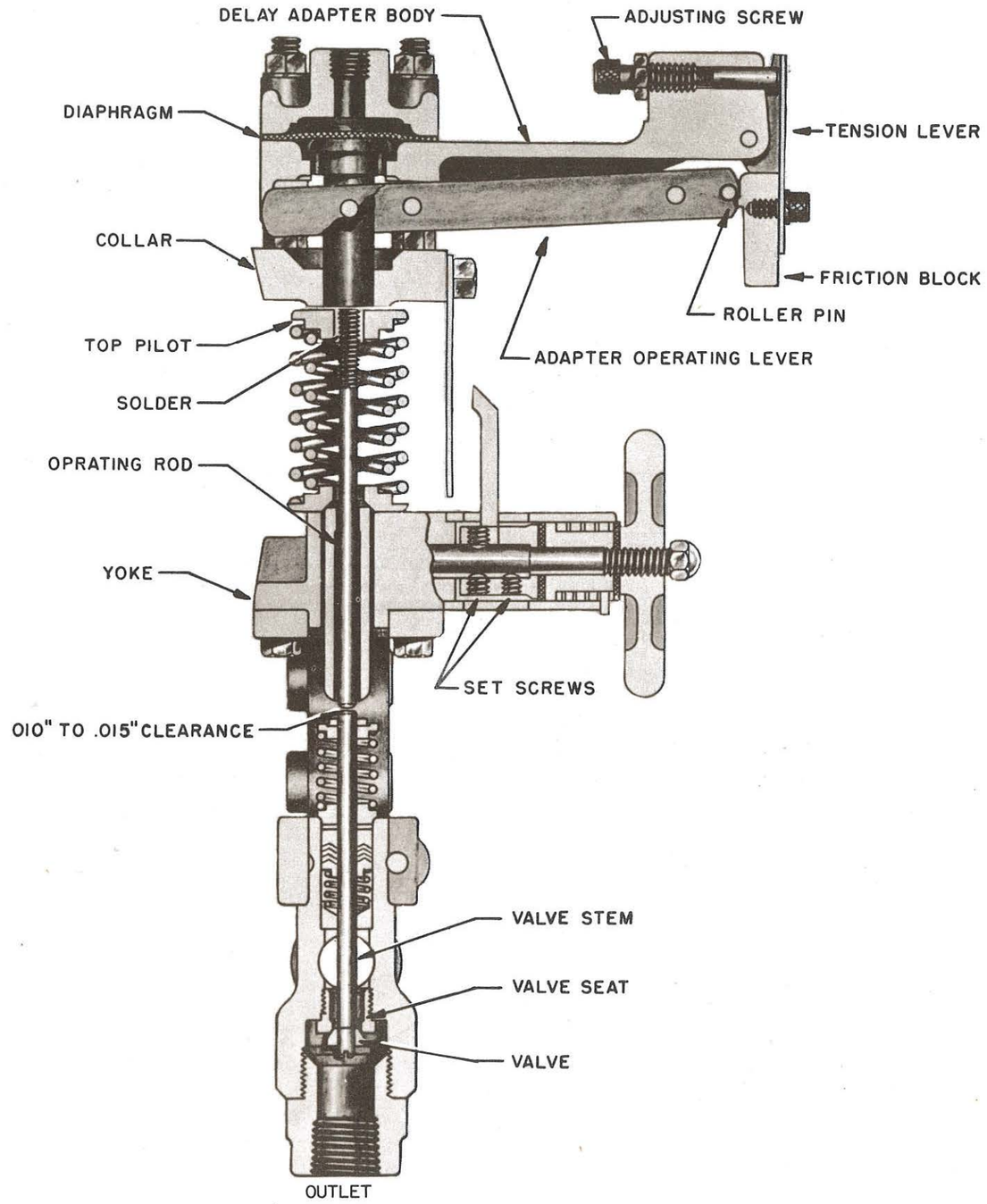


Fig. 73 — Water By-Pass Regulator With Delay Adapter.

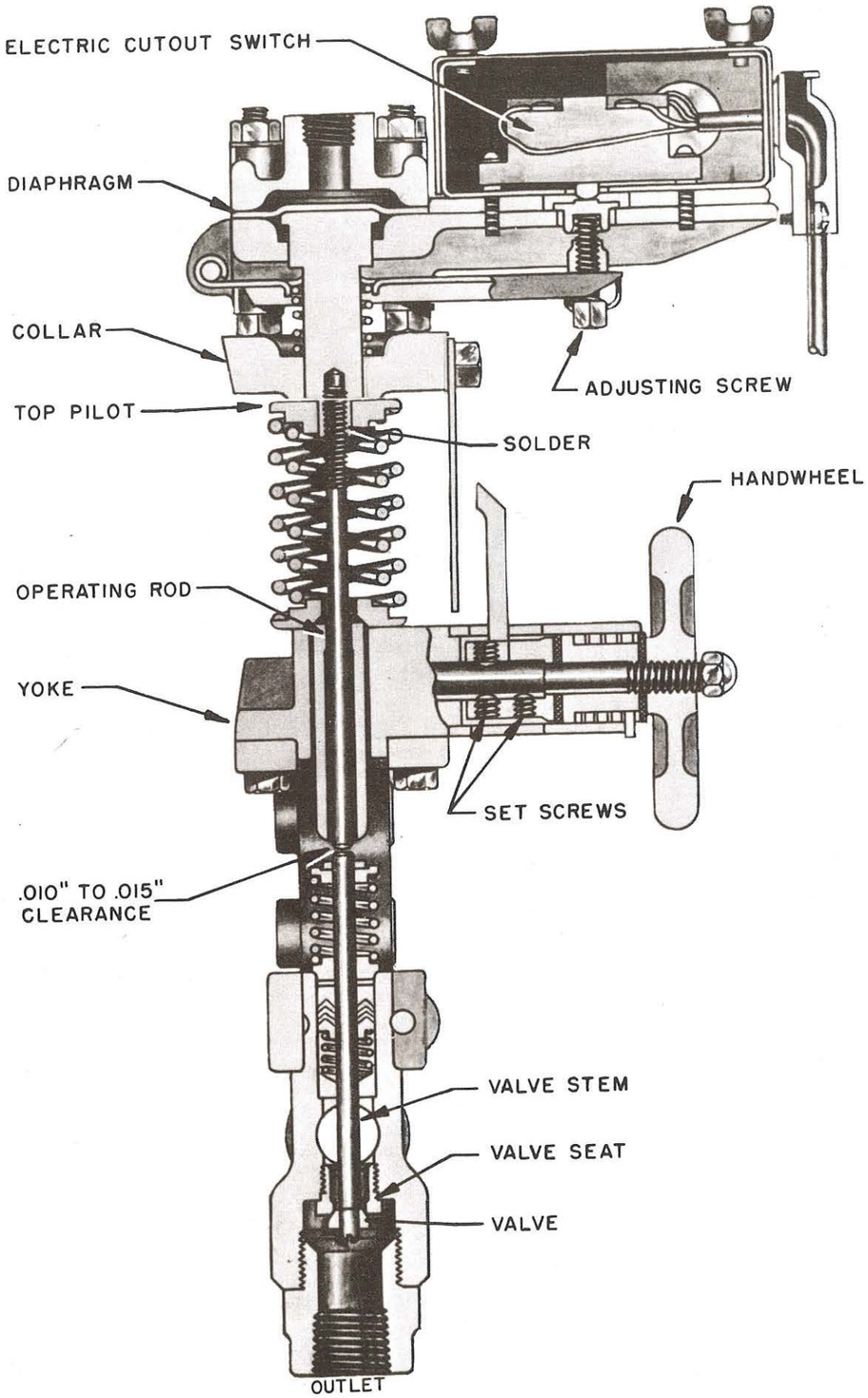


Fig. 74 — Water By-Pass Regulator With Cutout Switch.

(continued from page 66)

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 trainline 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, operating lever roller and diaphragm button shaft is advisable.

Electric Cutout Switch

The operation of the electrical switch on the water by-pass regulator is explained under section I of this book in the control circuit analysis covering your particular steam generator. This switch should be set to open before the servo cutout switch. If adjustment is necessary, follow the procedure given below:

1. Insert a test light in series with the "A" side of the cutout switch — the side in the outfire relay circuit.
2. With the steam generator in operation, set the regulator handwheel at 250 lbs.
3. Throttle the stop and check valve until the steam generator begins to cycle frequently.
4. As the cam plate on the servo comes down through the low fire position to "off," set the adjusting screw for the cutout switch to close the switch when the cam plate is two pins from the stop block.

The points to check in maintenance care of the regulator itself are listed below:

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. If the clearance needs adjustment, melt the solder between the top pilot and the operating rod and thread the rod up or down as needed to obtain the correct clearance. Then solder the top pilot to the operating rod and reassemble the water by-pass regulator.

WATER RELIEF VALVE

No. C-4050-DBB (DRK, OK, DSK) — No. 103,304 (4740)

The water relief valve is placed in the pressure side of the water line to protect the water pump against excessive back pressure. The C-4050-DBB valve is adjusted to open at 550 lbs. water pressure, and the 103,304 valve is adjusted to open at 800 lbs. pressure.

Leakage from this 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.

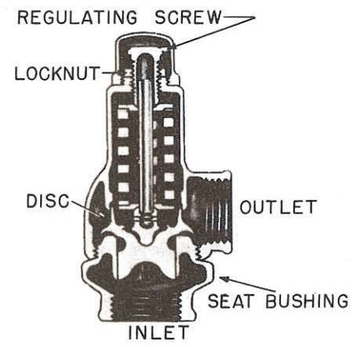


Fig. 75 — No. C-4050-DBB Water Relief Valve.

WATER PUMP

No. 103,032 (4530 and 4630) — No. 103,046 (4740)

This is a three cylinder pump with removable cylinders of steel tubing which are lined with a compact layer of porcelain. Ball type valves are used; the seats are tapered and require no gaskets.

To Replace Plunger Packing

1. Remove nuts "A", take off yoke "B", and cover "C".
2. Remove the hexagon nut from the end of the plunger rod, using wrench "D".
3. Remove the plunger packing and cup assembly — use wrench "E" and turn it to the left.
4. Disassemble the plunger packing and cup nut assembly — turn to the left.
5. Clean the porcelain cylinder walls, using gasoline if necessary.
6. Clean the edges of the cup nut; remove all the corrosion.
7. Install a new plunger packing on the cup nut and assemble reasonably tight.
8. Use a pin grease with a soap base to lubricate the packing. Then insert the packing and cup nut in the cylinder — use wrench "E" and turn the assembled plunger packing to the right to bring it back to the plunger rod.
9. Replace the hexagon nut and tighten with wrench "D".
10. Replace the cover, yoke and nuts.

The packing nut "F" should be tightened about once every 60 hours of pump operation. Remove the cover plate above the nut, insert a screw driver into the notches provided in the nut, and pry it to the right. When the packing nut is turned in as far as it will go, it is necessary to disassemble the pump and replace the packing rings.

Loss Of Pressure

1. Worn plunger packing is indicated by leakage under the pump in between the cylinders and gear case. The packing should be replaced immediately, because leaky packings soon ruin the cylinder walls.
2. Severe pounding in the pump indicates that a clogged strainer, or some other restriction, is preventing free flow of feed water to the pump.

   Wear in a valve cover or cylinder head will make for noisy pump operation because it permits excessive travel of the ball valve. This added travel can damage the guide portion of the valve seat and may create a loss in pressure.

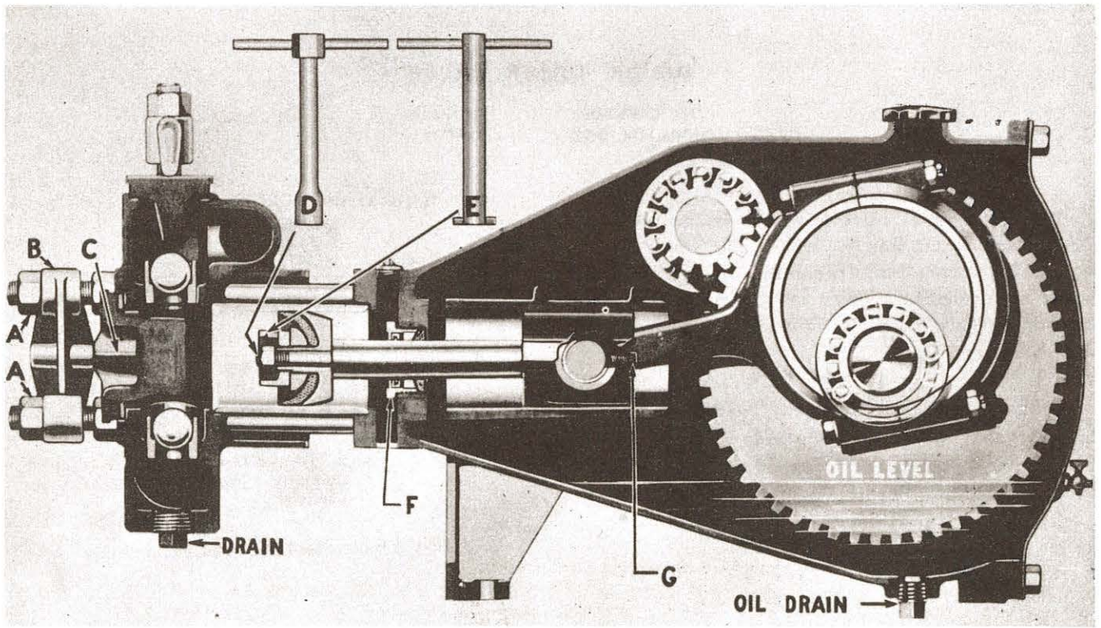


Fig. 76 — No. 103,032 Water Pump.

The valve covers and cylinder heads should be inspected periodically, and valve covers should be replaced if they are worn more than 3/32". Replacement of worn cylinder heads is not necessary because they can be rotated to shift the worn spot away from contact with the ball valve.

3. An air leak in the connections between the storage tank and water pump may cause air lock. Severe clattering in the valves results, the pump seems to miss strokes, and the pressure gauge hand jumps back and forth.
4. Worn or dirty valve balls and seats will cause a loss in pressure. To clean the valves, remove all three upper valve covers and start the pump running slowly. Water will then flush through and clean the upper valves. A faulty lower valve is indicated by irregularity in the amount of water flushing through when the upper valves are open. The valve covers may be worn; if so, the valve balls will come up too high and catch between the top of the seat and the lower end of the cover, and will cause excessive valve noise.

   If the valve ball and seat are pitted or worn they should be replaced. A rubber cup is included in the tool kit to facilitate removal of the steel valve balls. The accompanying illustration also shows the method for using the valve seat removing tool. When replacing valve seats, be sure the surfaces are clean, place the ball on the seat, and using a wooden block, tap firmly into place.

Eccentric Shaft

To remove the bearing housing of the eccentric shaft, take out the cap screws, then insert the long hex head screw included in the pump extras; tighten this screw until the bearing cap comes free from the ball bearing race.

Mark the two halves of the eccentric shafts for identification before taking them off the shaft. An imperfect bearing fit will result if the eccentric straps are not properly mated with their original bearing shell halves, and rapid wear of the bearings will follow. Replace the straps so the set screw "G" will be on the side of the plunger away from the ring gear.

Lubrication

Keep the oil level in the gear case just high enough so the petcock will drip when opened. About 3 quarts are required to fill the gear case. Use a very good grade of lubricating oil; in winter use S.A.E. 20, and in summer use S.A.E. 30 oil.

When the pump is new the oil should be drained and renewed after 50 hours of operation; after the water pump is thoroughly worked in, it is sufficient to drain and renew the oil every 100 hours of pump operation. When changing the oil, remove the

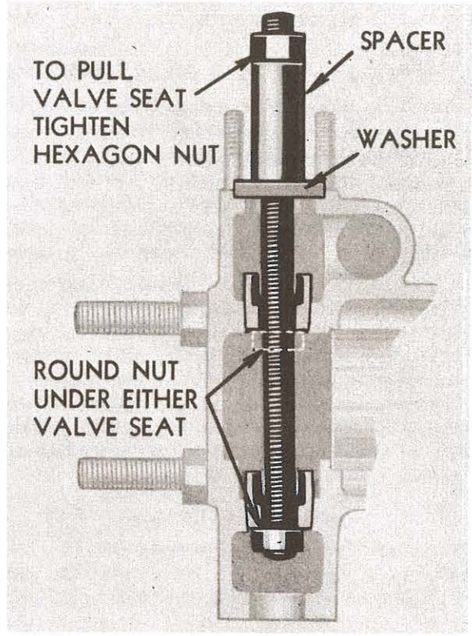


Fig. 77 — Valve Seat Remover.

inspection plate and wipe out the bottom of the gear case to remove any sediment that may have collected.

If the pump is to be laid up for any time it is wise to drain the oil and refill the gear box with medium oil and run the pump cold for a few secor ds to splash this new oil around the working parts. This film of new oil will protect the bearings against rust during the idle period.

V-Belt Drive

Do not run with loose belts — slippage will cause rapid wear, or a sudden strain may snap a slack belt and break it.

The sheaves must be in perfect alignment. Place a short straight edge against the sides of the sheaves to be sure they are exactly parallel. The idler pulley must be parallel to the sheaves, and must revolve evenly in line with the belt travel.

Never treat V-belts with belt dressing. Oil and grease will cause slippage — clean with a rag soaked in gasoline. Never touch a running belt.

V-belts should be replaced in complete sets. Do not pry the new belts over the sheave flanges — you will weaken or rupture the cords.

V-belts should always be replaced in complete sets. The numbers on V-belts are sag numbers and should be used to match a set of belts; a difference of one number up or down is permitted. Do not pry the new belts over the sheave flanges — you will weaken or rupture the cords.

WATER PUMP

No. L-103,034 (4516 and 4616) — No. L-103,045 (4625)

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 550 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.

Repacking Plunger

Leakage through the plunger packing can be corrected by tightening the locknuts on the packing take-up flange. If pulling up the take-up flange does not eliminate excessive leakage it is necessary to renew the plunger packing. Remove the take-up flange, pull the glands off the plunger and clean out the old packing.

The new packing should be inserted with a tool consisting of a rod the same diameter as the plungers, and a sleeve fitting over the rod. Place the glands, packing ring and packing on the rod, insert the rod into the cylinder, and with the sleeve, hold the packings in place while pulling out the rod. The grooves in the packing should be filled with water pump grease before assembling. Be careful when replacing and tightening the cylinder block and take-up flange. 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 complete plunger should be sent to the Vapor Heating Corporation for repair.

Wear in the wrist joint can be taken up by tightening the adjusting screw snugly — be sure to secure with the locknut.

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

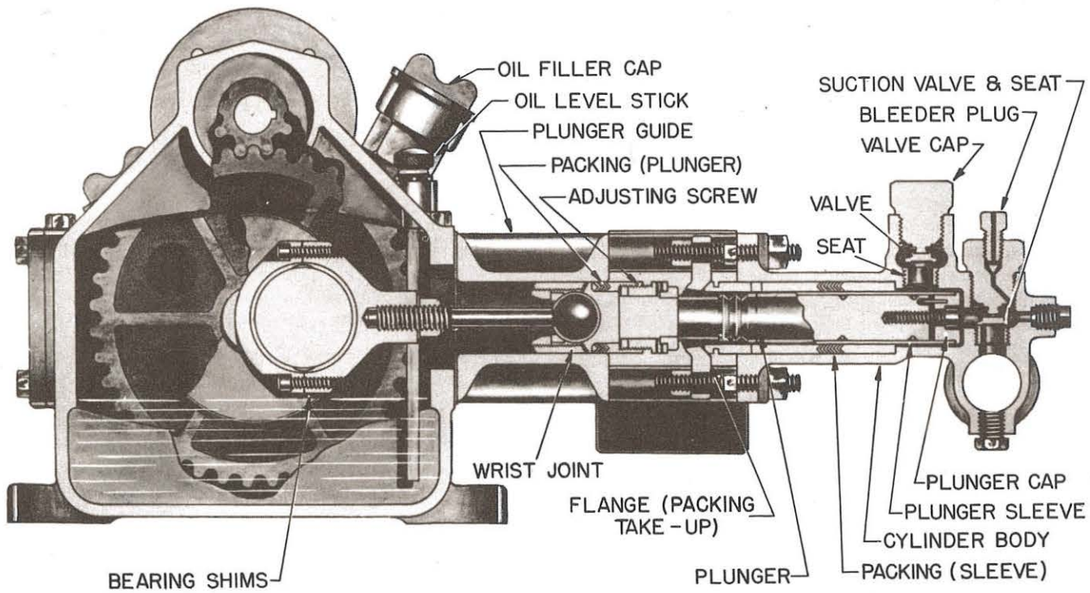


Fig. 78 — No. L-103,034 Water Pump.

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.

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.

Overhaul

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

WATER TREATMENT INJECTOR PUMP

Nos. A-103,621 and B-103,621 (4625, 4630, 4740) (4616) — Nos. A-103,610 and B-103,610 (4530) (4516)

The water treatment injector is a diaphragm pump screwed into the side or front of the steam generator water pump. Pulsations from the pressure stroke of the water pump are transmitted to the diaphragm, and create the pumping action necessary to inject water treatment solution into the generator feed water.

The 103,621 type injector supersedes the 103,610 type. They are basically the same, with the exception that the new type (No. 103,621) is provided with ball type valves — the 103,610 models have tapered valves.

Injector system trouble is indicated by a drop in pressure on the water treatment pressure gauge. The following list is a suggested guide for finding and correcting the trouble:

1. Check the amount of solution in the treatment tank.
2. Turn the filter handle two or three times.
3. Inspect the pipe connections for leaks.
4. Bleed the injector pump by unscrewing the test plug one or two turns. Be sure to tighten the plug after bleeding the injector pump.
5. Unscrew the adapter and plug; remove and clean the valves and seats. A screwdriver slot is provided on the valve stem for lapping if the valve is not properly seated (103,610 series only).
6. To inspect the diaphragm, loosen the four allen head cap screws and remove the diaphragm cap. Replace the diaphragm if it is ruptured.

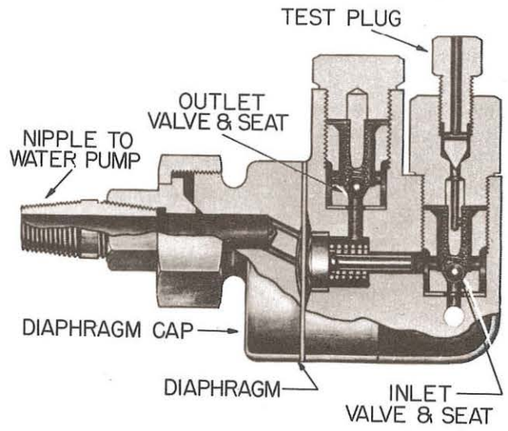


Fig. 79 — No. 103,621 Treatment Injector.

WORM DRIVE ASSEMBLY

No. 107,611
(4740)

This drive assembly consists of a worm connected to the driving motor, and a worm gear connected by universal couplings to the fuel pump and the water pump. The fuel pump shaft extension is threaded into the end of the gear shaft; a left-hand thread is used and the extension shaft can be easily unscrewed if it should need replacing. End-play in either shaft should never exceed .005".

Maintenance of this device consists primarily of keeping the seals tight against oil leakage, keeping the lubricant at the proper level, and changing the lubricant at the quarterly inspection periods — S.A.E. 160, 600W, or equivalent lubricant should be used.

If the worm or worm gear should need replacing, it is recommended that the entire unit be sent to the Vapor Heating Corporation for rebuilding. However, if you find it necessary to repair the drive assembly yourself, the following instructions give the procedure for complete disassembly.

1. Disconnect the universal couplings from the drive assembly shafts. Loosen the four bolts securing the drive assembly to the cabinet frame and lift it out.
2. Drain the oil. Then take out the capscrews holding the gear bearing retainers and pry off the retainers, taking care not to damage the shims. When sliding the retainers off the low speed shaft, take care not to damage the edge of the oil seals. Keep the shims with each retainer.
3. Take off the worm gear retainers, carefully preserving the gaskets and oil seal. Tap the worm shaft lightly and pull the worm shaft and bearings from the housing. To remove the bearings, take the locknut and washer off the thrust bearing end of the shaft and press off both bearings.
4. To remove the bearings from the low speed shaft, block up the gear around its rim, press the heavy end of the shaft and slide off the gear and one

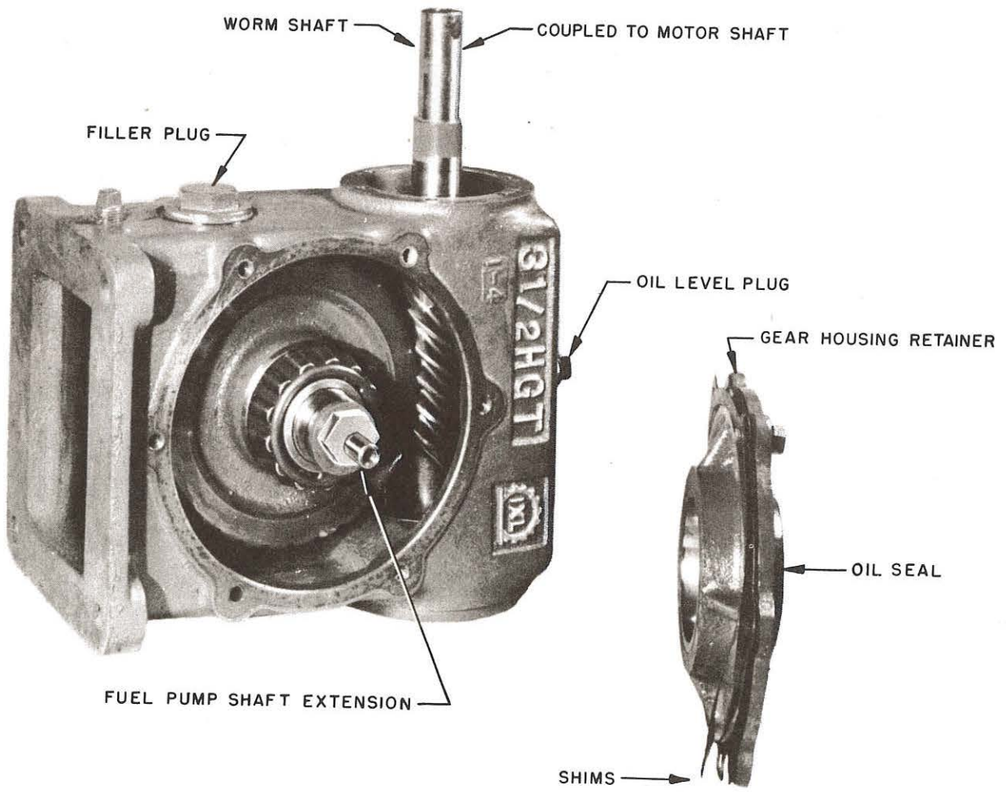
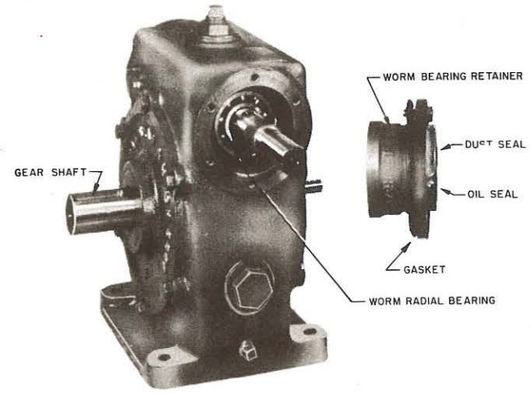


Fig. 80 — No. 107,611 Worm Drive Assembly.



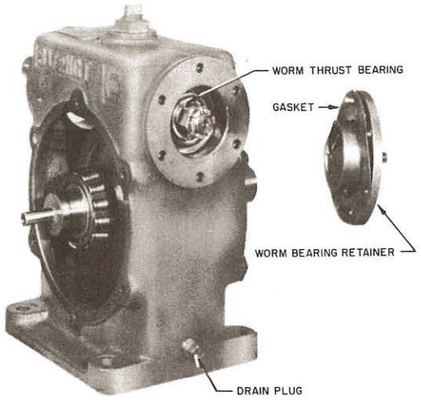


Fig. 81 — Shaft Bearings.

bearing. The other bearing then can be easily pressed off.

All parts must be thoroughly cleaned before the unit is reassembled.

Assembling Worm Shaft and Bearings

Press the bearings on the worm shaft, tightly against the shoulders. Replace the washer and locknut and bring the nut up tight against the thrust bearing; secure the nut with the cotter pin. Replace the bearing caps. After the capscrews are tightened, check the end-play of the worm shaft — it should not exceed .005". If adjustment of the end-play is necessary, add or subtract bearing cap shims until you obtain the correct amount of play. Then carefully press the oil seal into the counterbore of the radial bearing retainer and replace the dust seal.

Assembling Gear Shaft and Bearings

Press the gear on the gear shaft and center it on the maximum diameter of the shaft. Press the bearings against the hub of the gear. Paint several of the gear teeth with prussian blue and place the assembled shaft inside the housing; then replace the gear shaft retainers with the same number of shims used previously. The end-play of this shaft should not exceed .005", and can be adjusted by increasing or decreasing the number of shims on either bearing retainer.

The vertical center of the worm gear should coincide with the vertical center of the worm. Check this by taking off the filler plug and turning the worm through the painted portion of the gear. If the worm does not contact the gear at its center, move enough shims from the heavy side to the light side to equalize the two, then repaint a few teeth and try again. When correctly assembled, refill the gear case with lubricant to the proper level, grease the alemite fitting until grease comes out of the relief fitting, and install the worm drive assembly in the steam generator.