Steam Generator Instruction Manual

MODEL E-100

Step-fire • Fireye ESC

CLAYTON INDUSTRIES

City of Industry, California

Since 1930

Model No.: _____

Serial No.: _____

R009884L
07-2007

WARRANTY

Clayton warrants its equipment to be free from defects in material and/or workmanship for a period of one (1) year from date of original installation, or 15 months from the factory shipping date, or for the period as specified in the warranty attached to such equipment, whichever is shorter. Upon the expiration of such warranty period or in the event such goods are subjected to improper installation, misuse, negligence, alteration, accident, improper repair, or are operated contrary to Clayton's printed instructions, all liability of Clayton shall immediately cease. THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXCEPT TITLE AND DESCRIPTION, WHETHER WRITTEN, ORAL OR IMPLIED, AND CLAYTON MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE. No representative of Clayton has any authority to waive, alter, vary, or add to the terms hereof without prior approval in writing executed by two officers of Clayton.

If within the period of such warranty, the purchaser promptly notifies Clayton's Service Department Attention: Warranty Repairs, in Cincinnati, Ohio, in writing of any claimed defect and, if requested by Clayton, returns such as part or parts as are claimed defective, transportation charges prepaid, to Clayton, and it appears to Clayton that such parts are defective, Clayton will, at its option, repair such defective part or parts, or replace same with like or similar part or parts, or provide credit provided, however, that the purchaser shall be responsible for all transportation and labor charges relating to installation of any replacement part or removal of a defective part.

It is expressly understood that the repair or replacement of such defective part or parts by Clayton shall constitute the sole remedy of purchaser and sole liability of Clayton whether on warranty, contract or negligence and that Clayton shall not be liable for any other expense, injury, loss or damage, whether direct, incidental or consequential.

Upon the expiration of such warranty period, or in the event such equipment is subject to improper installation, misuse, negligence, alteration, improper repair, or is operated contrary to Clayton's printed instructions, all liability of Clayton shall cease.

With respect to any part or parts supplied hereunder which are not manufactured by Clayton, the warranty of the manufacture thereof shall apply and be exclusive.

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for
Steam Generator
Model E-100

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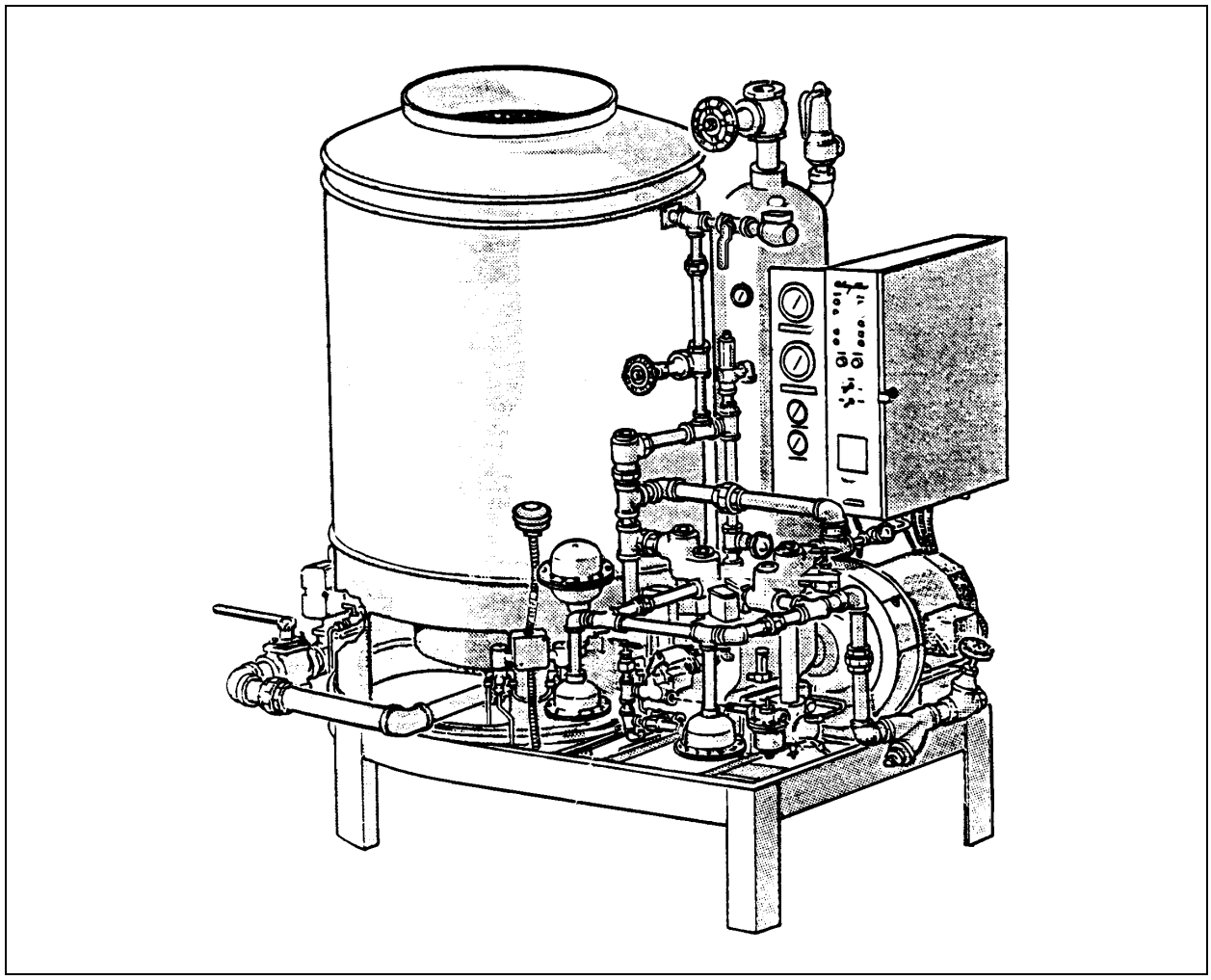

The CLAYTON STEAM GENERATOR is manufactured in conformance with the American Society of Mechanical Engineers (ASME) Power Boiler Code, Section I. Construction and inspection procedures are regularly monitored by ASME certification officials and by authorized inspectors commissioned by the Jurisdiction and the National Board of Boiler and Pressure Vessel Inspectors (NBBI). The NBBI is responsible for enforcement of all ASME code sections applicable to steam boiler manufacturing.

The NBBI is a nonprofit organization. Its chief boiler and pressure vessel inspectors are responsible for administering the boiler and pressure vessel safety laws of their jurisdiction.

CLAYTON STEAM GENERATORS are designed with electrical and combustion safeguards which comply with Underwriters Laboratories (UL), CE and other such agency requirements as specified in a customer's order.

NBBI certification and UL compliance assures that a CLAYTON STEAM GENERATOR is reliable and capable of producing the high quality steam it was designed to deliver. All Clayton Steam Generators are built to comform to the rules and practices for safety and durability of the highest recognized regulatory authority.

NOTES:

SAFETY SUMMARY

WARNING, CAUTION and **NOTE** paragraphs appear in various sections of this Manual

WARNING

Paragraphs must be observed to prevent personal injury to yourself and others.

CAUTION

Paragraphs must be observed to prevent damage or destruction of equipment or loss of operating effectiveness.

NOTE

Paragraphs must be observed for essential and effective operating procedures, conditions, and as a statement to be highlighted.

It is the responsibility and duty of all personnel involved in the operation and maintenance of this equipment to fully understand and abide by the WARNING, CAUTION, and NOTE procedures inserted throughout this Manual. Personnel must become thoroughly familiar with all aspects of safety and proper operating and maintenance procedures prior to operation or maintenance of this equipment.

IMPORTANT INFORMATION

PLEASE READ THIS PAGE CAREFULLY

1. Read this instruction manual and the installation manual carefully before installing, operating, or servicing this unit. Keep instructions in legible condition and posted near steam generator for reference by owner and service personnel.

2. All fluid heaters/steam generators must be installed in accordance with ASME, national, state and local plumbing, heating and electrical codes and regulations. Authorities having jurisdiction should be consulted before installations are made.

IN ALL CASES, REFERENCE SHOULD BE MADE TO THE FOLLOWING STANDARDS:

USA FLUID HEATERS/STEAM GENERATORS

A. Current edition of American National Standard ANSI Z223.1/NFPA54, National Fuel Gas Code or ANSI/NFPA 31, "Installation of Oil Burning Equipment," for clearances between heating unit, vent connector and combustible material.

B. Current edition of American National Standard ANSI/NFPA 211, "Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances," for Chimney requirements, types of venting material and clearances between vent connector pipe and combustible materials.

C. Current edition of American Society of Mechanical Engineers ASME CSD-1, "Controls and Safety devices for Automatically Fired Boilers," for assembly and operations of controls and safety devices.

CANADA FLUID HEATERS/STEAM GENERATORS

A. Current edition of Canadian Standards Association CSA B139, "Installation Code for Oil Burning Equipment," for recommended Installation Practices.

B. The equipment shall be installed in accordance with the current installation code for gas burning appliances and equipment, CGA B149, and applicable provincial regulations for the class, which should be followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

3. All heating systems should be designed by experienced contractors; only persons knowledgable in the layout and installation of boiler systems (including ASME code) should attempt installation of such equipment.

4. The fluid heater/steam generator must be properly vented in accordance with national fuel gas code and local codes. Serious property damage could result if the steam generator ventilation requirements are not adhered to.

5. It is the responsibility of the installing contractor to see that all operating and safety controls are correctly installed and are operating properly when the installation is completed.

6. DO NOT tamper with the unit or controls. Retain a competent service personnel to assure that the unit is properly adjusted and maintained.

7. Keep the area clean and free of fire hazards. Keep all flammable debris, such as, oily rags, paper, and wood scraps, clear of the fluid heater/steam generator at all times.

Table of Contents

SECTION I

INTRODUCTION

1.1 GENERAL

This manual contains step-by-step instructions for the installation, operation and maintenance of the Clayton Steam Generator. Recommendations given herein result from many years of experience in the manufacture and service of this type of equipment. The efficiency and service of your Clayton Steam Generator will depend upon strict adherence to these instructions. It is important that the operator study all sections of this manual to gain a working knowledge of the operation and maintenance requirements of the Clayton Steam Generator.

1.2 GAS AND OIL FIRING

Information in this manual applies to gas, oil, and gas/oil combination steam generators. Descriptive information and service instructions for both gas- and oil-fired machines are combined in the proper sections with separate explanations given where necessary to differentiate between the two types. A parts catalog is included in the Appendix of this manual. The parts catalog consists of illustrations of generator assemblies and a corresponding parts list. When ordering replacement parts, consult the parts catalog for part ordering information.

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SECTION II

DESCRIPTION

2.1 GENERAL

The Clayton Steam Generator will deliver its rated output of 99 percent quality steam (containing less than one percent moisture) per hour from 60^{o} F feedwater. Refer to Table of Specifications in Appendix B. The machine will develop its full rated pressure within five minutes from a cold start.

Standard equipment includes safety devices for protection against water failure, burner failure, excessive pressure, and electrical overload. Automatic controls regulate the flow of feedwater and stop and start the burner in accordance with steam load demand. The operator must, however, perform the specified maintenance, as prescribed in this manual, on the machine to ensure its continued performance and dependability.

2.2 WATER AND STEAM SYSTEM

(See Figure 2-1.)

2.2.1 FLOW

Supply water and condensate returns blend in the Condensate Receiver and then flows, either by gravity or by booster pump, into the Feedwater Pump. The feedwater, which was chemically treated in the Condensate Receiver, is pumped directly into the Heating Coil. The water flows through the spiral single-passage section (generating section) of the Coil in a direction opposite that of the combustion gases (counterflow principle). The water is gradually heated to saturation temperature[1] as it flows through the generating section. The resulting steam mixture leaves the generating section and passes through the helically wound, lower water wall section into the Steam Separator. The steam is delivered from the discharge outlet of the Separator. The surplus liquid is returned to the Condensate Receiver through the Steam Trap(s), which is mounted adjacent to the Steam Separator.

2.2.2 WATER PUMP

The Feedwater Pump is positive displacement, diaphragm-type Pump designed to deliver a fixed volume of water into the system to sufficiently maintain a wet tube Heating Coil under all load conditions. The Pump is directly driven by the Electric Motor and contains no packing

[1] Saturation temperature is the temperature where liquid water turns to water vapor (steam) at a given pressure.

boxes. The Pump is arranged in two sections; one section is controlled by the Water Pump Solenoid (WP1) to bypass on half-fire operation; the other Water Pump Solenoid (WP2) controls the other section to bypass water during burner-off cycles.

The Pump Diaphragms are operated hydraulically by oil displaced by reciprocating Pistons within the Pump. The built-in, solenoid operated By-pass Valves are incorporated in the Oil Cylinders of each section which bypasses and stops this section from pumping when the Valve is open. The Water Pump Solenoid (WPl) is actuated by the Modulating Pressure Switch (MPS), the Water Pump Solenoid (WP2) is actuated by the Steam Pressure Switch (SPS). The Modulating Pressure Switch operates in accordance with steam demand. The Steam Pressure Switch operates when maximum steam pressure is reached and secures the burner until steam is again required.

Corrosion-resistant Springs, Discs, and Seats are used in the Check-valve Housings. Water-filled Tubular Columns (standpipes) separate the Check-valve Housings from the Pump Heads to protect the Diaphragms from excessive feedwater temperatures. When extra Diaphragm protection is needed, jacketed Pump Heads are used through which cooling water is automatically circulated when the machine is in operation (optional).

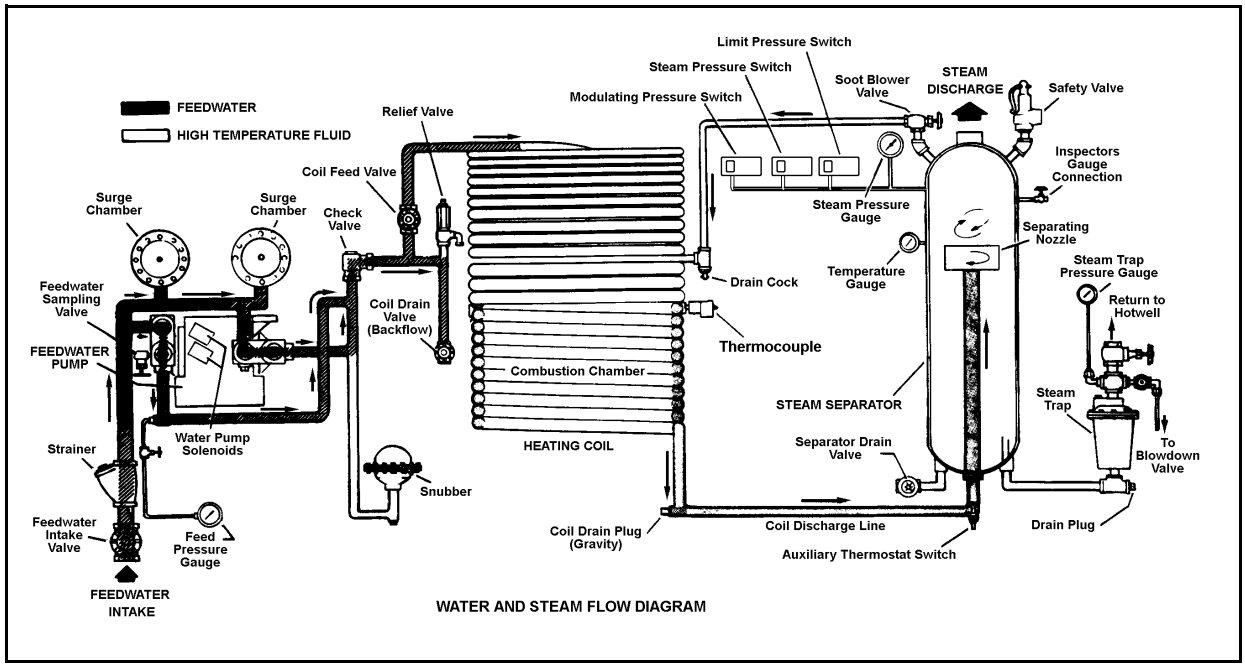


Figure 2-1 Water and Steam Flow Diagram

Discharge Snubbers absorb pressure pulsations to ensure stabilized Pump delivery. A Relief Valve protects the Pump against excessive pressure. A float actuated Oil Level Switch (optional equipment) is mounted to the Water Pump with a sensing tube plumbed to the Pump Crankcase. This Pump Oil Level Switch will secure the Unit if there is an improper oil level in the Water Pump, either too low or too high.

2.2.3 CONDENSATE RECEIVER

The Condensate Receiver is the make-up water tank from which chemically treated feedwater is supplied to the Feedwater Pump(s), and to which steam trap and system condensate returns are introduced. There are three primary Condensate Receiver systems used with Clayton Steam Generators:

- Open (Hotwell) or atmospheric
- Deaerator
- Semi-Closed

2.2.4 HEATING COIL

The Heating Coil consists of a series of carbon steel, spirally wound tube sections (commonly referred to as pancakes or pancake sections). It is constructed in a single-pass, mono-tube design. To provide maximum heat transfer, the Coil Assembly is designed with a counterflow fluid circulation, at controlled velocities. The combustion gases flow upward around the tubes of the Heating Coil while the fluid inside the tubes is circulating in a downward direction. The Heating Coil is mounted to allow free expansion.

2.2.4.1 Primary Main Temperature Limit Controller (MTLC2)

This over-temperature Safety Controller uses one-half of the dual element thermocouple sensor shown in Figure 2-2. The Safety Controller has a fixed trip-point[1] which is set slightly lower (usually 25^{o} F) than that of the Secondary Main Temperature Controller. It will interrupt the motor and burner control circuits on a severe over-temperature condition. *The controller must be reset manually by resetting the control system before normal operation can resume.* The Thermostat/Low Water Indicating Light (ILT) on the Electrical Control Box will illuminate and an audible alarm will sound in the event of an MTLC2 trip condition.

2.2.4.2 Secondary Main Temperature Limit Controller (MTLC1)

This redundant over-temperature Safety Controller uses the other half of the dual element thermocouple sensor, as described above. This Controller has a fixed trip-point[1] which is slightly higher (usually 25^{o} F) than the Primary Main Temperature Controller MTLC2. It will also interrupt the motor and burner control circuits on a severe over-temperature condition. *The controller must be reset manually by resetting the control system before normal operation can resume.* The Thermostat/Low Water Indicating Light (ILT) on the electrical control box will illuminate and an audible alarm will sound in the event of an MTLC2 trip condition.

NOTE

The MTLCs are manually reset by pushing in the STOP button and waiting until the temperature has dropped to a safe level (below the limit). The STOP button may then be pulled out and the Unit restarted.

[1] See the Table of Reference Values in Appendix B for MTLC trip-point value.

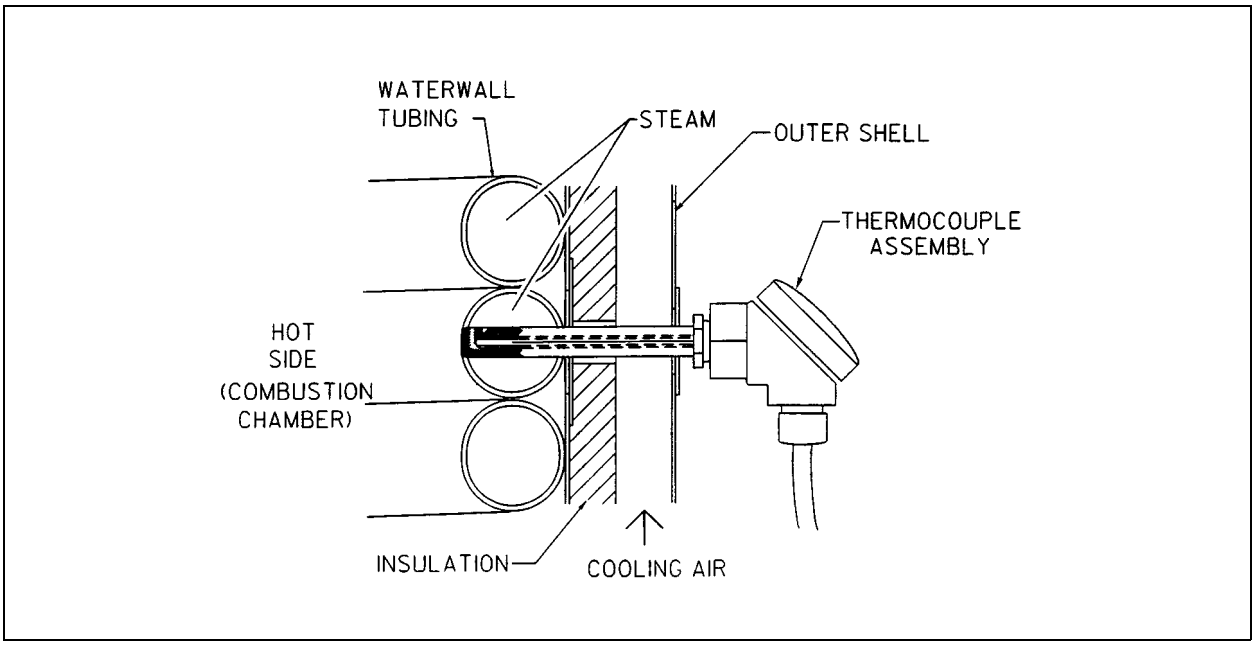


Figure 2-2 Thermocouple Assembly

2.2.4.3 Auxiliary Thermostat Switch (ATS)

The Auxiliary Thermostat Switch (ATS) functions as an additional over-temperature control device. It responds to an increase in fluid temperature above the saturation temperature for the specific operating pressure at the Separator. When actuated, it also interrupts the motor and burner control circuits, requires a manual reset, and results in a "Thermostat-Low Water" annunciation and audible alarm signal (similar to the MTLC's). The sensing bulb for this switch is located in the body of the Separator.

IMPORTANT

The cause of any "Thermostat-Low Water" condition must be determined and effectively corrected before re-initializing the burner control circuit. An adequate cool-down period must be allowed to prevent thermal stress of the heating coil.

2.2.5 STEAM SEPARATOR

A saturated fluid mixture, entering the Separator from the Heating Coil, is discharged through a Separating Nozzle causing the excess condensate to be centrifugally separated; thus, this produces a high quality steam. This high quality steam is discharged from the top of the Separator into the main header. The excess condensate cascades down the Separator wall to the lower section where it is trapped back to the Condensate Receiver. This positive control of separation prevents carryover of liquid into the steam lines.

STEAM PRESSURE-TEMPERATURE TABLE

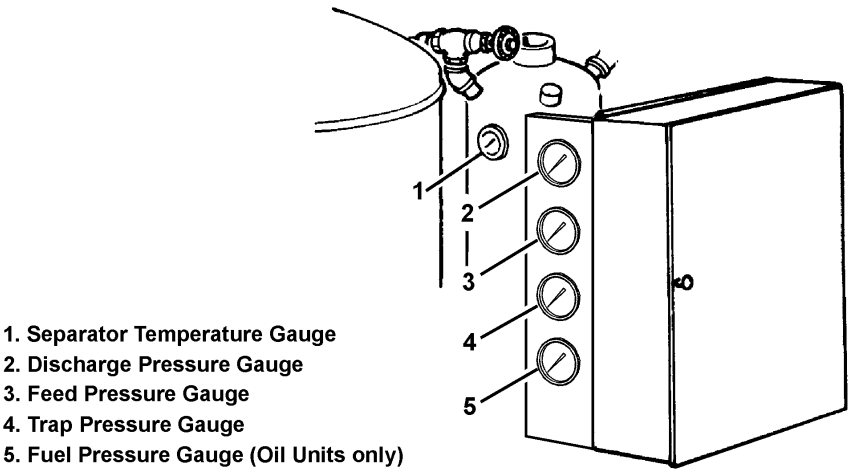
GAUGE PRESSURE PSIG	TEMP F	TEMP C	GAUGE PRESSURE PSIG	TEMP F	TEMP C	GAUGE PRESSURE PSIG	TEMP F	TEMP C
5	228	109	170	375	191	320	428	220
10	240	115	180	380	193	330	431	222
15	250	121	190	384	196	340	433	223
			200	388	198	350	436	224
60	308	153	210	392	200	360	438	226
70	316	158	220	396	202	370	441	227
80	324	162	230	399	204	380	443	228
90	331	166	240	403	206	390	445	229
100	338	170	250	406	208	400	448	231
110	344	173	260	409	209	410	450	234
120	350	177	270	413	212	420	453	236
130	356	180	280	416	213	440	457	237
140	361	183	290	419	215	460	462	239
150	366	186	300	422	217	480	466	241
160	370	188	310	425	218	500	470	243

A Dial Thermometer (optional equipment, Figure 2-3) on the Separator indicates the steam temperature. In normal operation, the relative temperature will agree with the steam pressure. (See Steam Pressure-Temperature Table above). If the temperature is higher than that shown on the Table for corresponding pressure, the Unit is over-fired or the water rate is inadequate. A correction must be made immediately. Reduce firing rate or correct water shortage as required. Damage to the Coil could result if operation were allowed to continue.

2.2.6 STEAM TRAP

The Steam Trap returns excess water from the Separator to the Condensate Receiver. Some trapping is necessary to ensure that dissolved solids are being carried through the Heating Coil and back to the Condensate Receiver. The actual amount of trapping depends on operating conditions - steam pressure, feedwater temperature, pump condition, and firing rate. For a given installation, the Trap rate serves as a good indicator of Pump condition (rate) as long as the other factors remain consistent.

A Pressure Gauge (see Figure 2-3) is provided to indicate when the Steam Trap is either open or closed. A rising pressure reading on the Gauge indicates that the Steam Trap is discharging condensate. When the pressure begins to drop, the Trap is closed. If the Steam Trap is not opening and closing in a normal manner, this would indicate a malfunctioning of the Trap or some other component in the Steam Generator, also the Water Pump may not be discharging its normal capacity.



1. Separator Temperature Gauge
2. Discharge Pressure Gauge
3. Feed Pressure Gauge
4. Trap Pressure Gauge
5. Fuel Pressure Gauge (Oil Units only)

NOTE: Gauge Panel and Thermometer are optional equipment.

Gauges are mounted locally if the Gauge Panel option is not applied.

Figure 2-3 Pressure and Temperature Gauges

On initial start of the Unit, after the correct air-fuel and water rates have been established, a record of the operating temperature and Trap opening time should be recorded. Periodically, these figures can be checked to assure the operator that the Plant is operating properly.

If the Steam Generator is connected to an open system where the feedwater temperature is 180^{o} to 190^{o} F, the Steam Trap should be open approximately 20 to 30 minutes (accumulated) of each hour at high fire operation. At steady half-fire, the accumulated time should be about half this amount.

By checking and recording the operation of the Steam Trap under normal conditions, it is then easy to determine if a component such as the Feedwater Pump (which has a fixed pumping rate) is not functioning properly by noting the change in time that the Steam Trap remains open. A reduction in the firing rate will increase the trapping time. A decrease in the Pump rate will likewise decrease the trapping time. Trap open-time should not fall below 10 minutes per hour at high-fire and 5 minutes per hour at low-fire (accumulated) under any condition.

2.3 FUEL SYSTEM (GAS-FIRED UNITS)

(See Figure 2-4.)

Burner control is accomplished by an electrically-operated, three position (off, low-fire, and high fire) main gas valve and the electronic safety burner circuit. After manual start, burner operation is fully automatic during "on-off" cycling and all controls are arranged to "fail-safe". Main gas will enter the burner only after a 7-second purge period and ignition and Pilot flame have been proven. Flame failure will cause automatic burner shut-off within one second after

failure and if flame is not reestablished within about 10 seconds thereafter, the controls will "lock-out" the burner, requiring a manual reset. The Air Pressure Switch (APS), actuated by Blower air pressure, is provided to shut off the burner if the blower or motor fails.

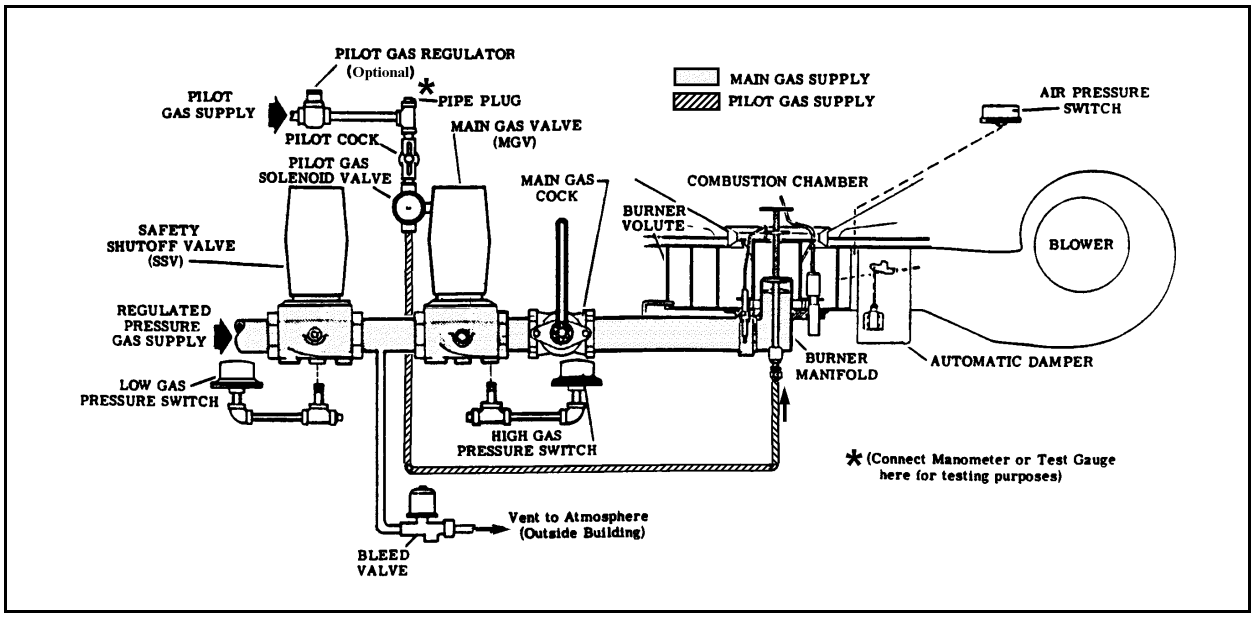


Figure 2-4 Flow Diagram, Fuel System (Gas-fired Units)

2.3.1 AUTOMATIC BURNER MODULATION

Automatic burner modulation prevents frequent "on-off" cycling of the burner and provides stable operation during periods of light steam loads. This is accomplished by the electrically operated, three-position (off, low-fire, high-fire) Main Gas Valve with an adjustable low-fire position. The Valve is actuated by hydraulic pressure developed by its own Motor-driven Pump. When steam pressure rises to the adjusted modulation point, the Valve will close to the low-fire position, allowing about one-half rate. When the burner modulates, the solenoid operated Air Damper restricts the burner air supply to maintain proper air- fuel ratio. The machine will automatically return to high-fire operation if low-fire operation will not carry the steam load. The Auto/Low Fire Switch (ALFS) on the electrical panel prevents high-fire operation when desired or when making certain burner adjustments.

2.3.2 BURNER MANIFOLD

Air, entering the burner volute from the blower, is centrifugally directed at high velocity to the burner manifold where it blends with gas at the burner tip and is ignited by pilot flame. Pilot gas is directed upward through a small tube at the center of the manifold, emerging at the burner tip, where it is automatically ignited by a high-potential electrical spark. A flame sensor is incorporated to detect flame presence and energize the Electronic Safety Burner Control (see paragraph 2.6.10).

2.4 FUEL SYSTEM (OIL-FIRED UNITS)

(See Figure 2-5.)

Fuel is delivered to the forced draft burner under pressure. Maximum fuel pressure is governed by an adjustable Fuel Pressure Regulator With the Fuel Control Valve open, all fuel is bypassed back to the Fuel Tank and fuel pressure is at a minimum. Closing the Fuel Control Valve (when starting the burner) causes fuel pressure to rise and actuate the controls to start the burner. After manual start, burner operation is fully automatic during "on-off" cycling and all controls are arranged to "fail-safe." Flame failure will cause automatic fuel shut-off within one second and the controls will "lock out" the burner requiring manual reset. (See paragraph 2.5 for electrical control of Fuel System.)

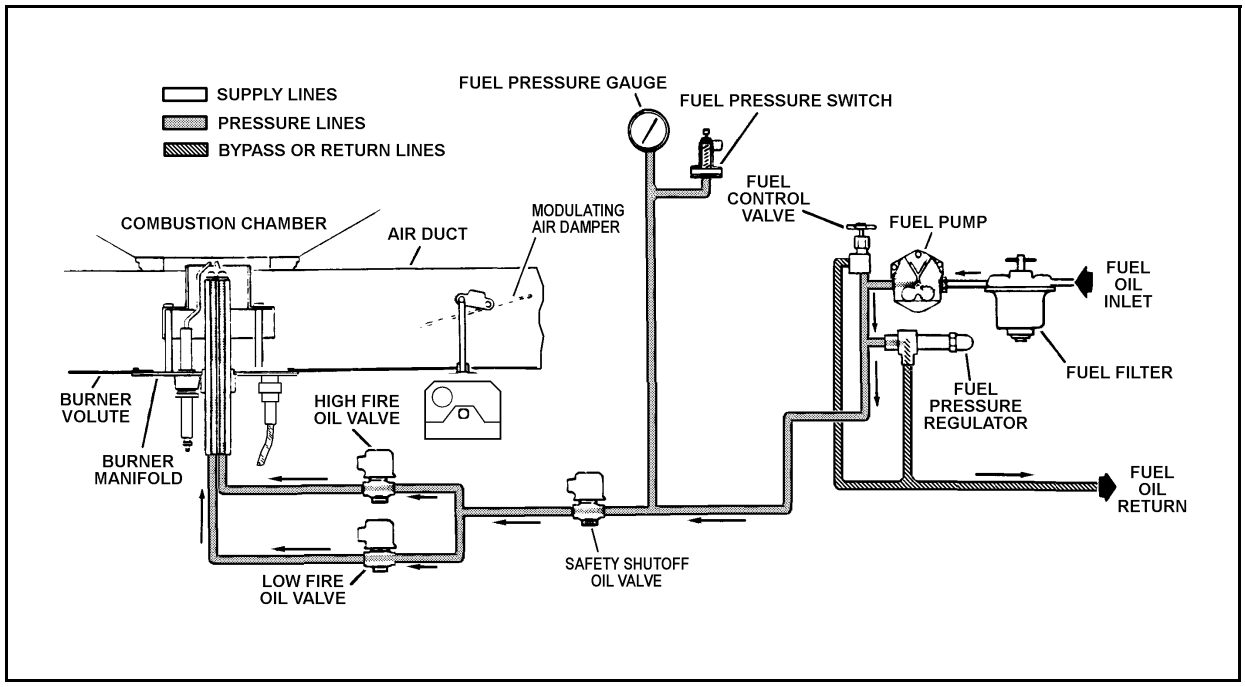


Figure 2-5 Flow diagram, fuel system (oil-fired machines)

2.4.1 AUTOMATIC BURNER MODULATION

Automatic burner modulation prevents "on-off' cycling of the burner and provides stable operation during periods of light steam loads. This is accomplished by using two burner nozzles; one controlled by the low-fire oil solenoid valve and the other controlled by the high-fire oil solenoid valve. When steam pressure rises to the adjusted modulation point, the high-fire oil valve closes and shuts off fuel to one of the burner nozzles, thus modulating (reducing) burner operation to about one-half rate. When the burner modulates, the solenoid-operated air damper restricts the burner air supply to maintain proper air-fuel ratio. The machine will automatically return to high-fire operation if low-fire operation will not carry the steam load. A manually operated switch on the electrical panel prevents high-fire operation when desired, or when making certain adjustments.

2.4.2 BURNER MANIFOLD

Air, entering the burner volute from the blower, is centrifugally directed at high velocity to the burner manifold where it blends with the fuel spray from the burner nozzles. Fuel is automatically ignited by a high-potential electrical spark. A flame sensor is positioned below the manifold to detect flame presence and maintain safe burner operation. (See paragraph 2.6.11.)

2.5 ELECTRICAL SYSTEM

2.5.1 GENERAL

Gas-oil combination machines are equipped with selector switches (GOS1 and GOS2) to transfer the electrical controls and adapt the electrical system to the type of burner operation required. When the switches are in the GAS position, controls applicable to gas-fired operation are connected into the circuit and controls used only for oil-firing are disconnected. Conversely, only the controls necessary for oil- fired operation are used when the selector switches are in the OIL position. In either position, however, the electrical operation is similar to a corresponding Oil or Gas-fired machine without dual controls.

2.5.2 ANNUNUCIATOR SYSTEM

The annunciator system consists of a group of indicator lamps located on the control panel. They provide a convenient means of identifying the current operating state and indicating a safety shutdown of the machine.

Each safety shutdown annunciator (ILM, ILB, ILP, ILT, and ILA) includes a neon glow lamp that will light when failure occurs. (See paragraph 5.1 for explanation of Annunciator usage.)

2.5.3 MOTOR CIRCUIT

Momentarily pressing the START Pushbutton energizes the Magnetic Controller (M), starting the Motor which drives the Blower and Feedwater Pump, and energizes the Electrical Control Circuit. The Holding Relay, located in the Stop-Start Button Circuit and the Limit Pressure Switch (LPS) maintain the Magnetic Controller Holding Circuit after the START Pushbutton is released. Should the Motor Overload Annunciator Light (ILM) illuminate when the START Pushbutton is pressed, manually reset the Overload Relay (OL). Should the Water Pump Oil Level Annunciator Light (ILP) illuminate when the START Pushbutton is pressed, corrections must be made to bring the Water Pump oil level to operating condition. Should the Contact (M) in the Fuel Control Circuit open during operation all Fuel Valves will be de-energized, a Burner lock-out will follow. Note that the Electrical Controls Box Door must be tightly closed to allow electricity to flow through the Electric Interlock Switch (EIS), which secures power when the Door is open.

2.6 DESCRIPTION - ELECTRICAL DEVICES

2.6.1 AUDIBLE ALARM (AA)

The Alarm Horn is mounted to the Electrical Control Box. The Horn will sound whenever a low water condition occurs. The Horn is electrically powered by the Main Temperature Limit Controller (MTLC) or the Auxiliary Thermostat Switch (ATS). The Alarm can be silenced by placing the RUN/FILL Switch in the FILL position. On Universal Alarm applications the Alarm Horn will also sound to indicate a safety shutdown occurrence.

2.6.2 AIR DAMPER SOLENOID (ADS)

This solenoid valve controls the action of the damper cylinder. It is activated when the MGV is energized into the high-fire position to allow compressed air to flow to the damper cylinder, placing the Air Damper in the high-fire position to provide maximum air for combustion.

2.6.3 AUTO/LOW-FIRE SWITCH

This Selector Switch permits either manual or automatic Burner control. With the Switch in the AUTO HI-LOW position, automatic Burner modulation is achieved by the Modulating Pressure Switch (MPS). When the Switch is placed in the LOW ONLY position, the Unit remains in the minimum (50%) firing position. The Switch can be used to keep the Controls in a Low-fire position until the system warms up or when making Burner adjustments.

2.6.4 AIR PRESSURE SWITCH (APS)

Actuated by Blower air pressure, the Air Pressure Switch (APS) will open and interrupt the burner controls if there is insufficient combustion air for operation. An insufficient combustion air condition will result in the illumination of the Air Pressure Annunciator Light "ILA." The Annunciator Light "ILA" will stop glowing when proper air flow is restored.

2.6.5 ALARM TERMINALS (AT)

A coil over-temperature condition can be verified from the Alarm Terminals on the Main Terminal Block (refer to the Electrical Drawings supplied with Generator for Alarm Terminals) in the Electrical Control Box. These terminals are electrically energized whenever a low water condition occurs as sensed by either the Main Temperature Limit Controller (MTLC) or the Auxiliary Thermostat Switch (ATS). Electrical power to these terminals can be disconnected, silencing the alarm, by placing the RUN/FILL Switch (RFS) in the FILL position.

2.6.6 AUXILIARY THERMOSTAT SWITCH (ATS) (SEE PARAGRAPH 2.2.4.3)

2.6.7 BLEED VALVE (BV) - GAS OPERATION

This Valve vents the gas trapped between the Safety Shutoff Gas Valve (SSGV) and the Main Gas Valve (MGV) to atmosphere (outside building) during burner-off cycles. This Solenoid Valve is normally open, energized to close when the Safety Shutoff and Main Gas Valves are energized to open, and vice versa.

2.6.8 COOLING WATER SOLENOID VALVE (CWS) (SPECIAL APPLICATION)

This Valve controls the water flow through the Pump Head cooling water jackets. It is located at the bottom of the Electrical Control Box and opens whenever the Control circuit is energized. The CWS is used on high temperature or high pressure applications.

2.6.9 ELECTRICAL INTERLOCK SWITCH (EIS)

This Door Switch will de-energize all control circuit (115 VAC) electrical power in the Control Box whenever the Door is opened, completely securing the Unit. The Switch has an override position (pulled out) that enables troubleshooting or control adjustments while the door is open. The Switch will reset itself whenever the door is closed and the Steam Generator can be restarted with the START Pushbutton.

2.6.10 ELECTRONIC SAFETY CONTROL (ESC)

The Electronic Safety Control (ESC) is a microprocessor-based, burner management, control system designed to provide proper burner sequencing, ignition, and flame monitoring protection. In conjunction with limit and operating controls, it programs the Burner, Blower Motor, ignition, and fuel valves to provide for proper and safe burner operation. The control monitors both pilot and main flames. It also provides current operating status and lockout information in the event of a safety shutdown.

The programmer module, a component of the ESC, provides functions such as pre-purge, recycling interlocks, high-fire proving interlock, and trial for ignition timing of the pilot and main flame. Burner flame is monitored by a flame sensor mounted in the Burner Manifold Assembly. The flame signal is sent to the amplifier module in the ESC. An optional display module may be added to provide read-outs of main fuel operational hours and the flame signal.

2.6.11 FLAME SENSOR

The flame sensor detects the presence of pilot and main burner flame. Depending on the type of sensor, the sensor detects for physical flame presense or monitors for the radiation produced from the flame. The amplified flame signal is measured at the Test Jacks (Red and Black) on the ESC. A minimum amplified Scanner voltage of two volts DC is required to hold in the Flame Relay. Saturation voltage is 5 volts DC.

2.6.12 FUEL PRESSURE SWITCH (FPS) - OIL OPERATION ONLY

The FPS closes, energizing the Oil Solenoid Valves only when the Fuel Pump is operating and sufficient fuel pressure is established for Burner operation. If the Switch fails to close during the Pilot Trial for Ignition Period, the ESC will lock out. Burner lock out will also occur if the Switch opens during normal Burner operation.

2.6.13 GAS-OIL SWITCH (GOS)

Gas-Oil Combination Units are equipped with a Selector Switch to transfer the Burner Electrical Controls and adapt the electrical system to the fuel selected. When the Switch is in the GAS position, Controls applicable to gas-fired operation are connected into the Control Circuit and Controls used only for oil-fired operation are disconnected. Conversely, only Controls used for oil-fired operation are connected when the Switch is in the OIL position.

2.6.14 GAS PRESSURE SWITCH - HIGH (GPSH) - GAS OPERATION ONLY

This normally closed Safety Switch is connected in series with the Combustion Control Circuit. It will open, and interrupt Burner operation, in the event of high burner gas pressure. This Switch requires a manual reset after each interruption. The Switch is installed between the Main Gas Cock and Main Gas Valve (MGV). The Pressure Switch has an adjustable range of 1/2 to 5 psi.

2.6.15 GAS PRESSURE SWITCH - LOW (GPSL) - GAS OPERATION ONLY

This normally open Safety Switch is also connected in series with the Combustion Control Circuit and will open, preventing burner operation, in the event of low supply gas pressure. This Switch requires a manual reset whenever gas supply is interrupted to the Unit and at the time of initial firing. This Switch is installed upstream of the Gas Pressure Regulator. The Switch has an adjustable range of 1–10 psi.

2.6.16 GRAVITY FILL VALVE (OPTIONAL EQUIPMENT)

The Gravity Fill Valve opens to allow flooding of the Heating Coil during wet lay-up. The Valve is pneumatically actuated closed when its solenoid switch is energized. This Valve is part of the wet lay-up Auto Shutdown option.

2.6.17 HIGH-FIRE OIL VALVE (HFOV) - OIL OPERATION ONLY

The High Fire Oil Valve (HFOV) is energized by the Modulating Pressure Switch (MPS) when system steam load dictates high fire (maximum output) operation.

2.6.18 HOUR METER (HM)

This is an electrical elapsed time indicator, indicating total operating time. It is a useful indicator for scheduling preventative maintenance inspections.

2.6.19 HOLDING RELAY (HR)

This Relay is used to maintain power to the Control Circuit after the START Pushbutton (momentary contact) is depressed. Whenever the Holding Relay is energized, the Power Indicating Light (ILPO) is illuminated.

2.6.20 IGNITION ELECTRODE (IE)

The Ignition Electrode provides a high voltage arc used to ignite the Pilot fuel for both gas and oil-fired operation.

2.6.21 IGNITION TRANSFORMER (IT)

This Transformer supplies high voltage (10,000 V) to the Ignition Electrode. The Ignition Transformer remains energized only during the ten second Trial for Ignition Period. The ESC will de-energize the Transformer after the Pilot is proven.

2.6.22 INDICATING LAMP (AIR PRESSURE) (ILA)

The Air Pressure Lamp indicates when insufficient combustion air is being supplied to the Burner Manifold.

2.6.23 INDICATING LAMP (BURNER) (ILB)

The Burner Lamp will light in the event of a Burner related failure (ESC Burner lock out).

2.6.24 INDICATING LAMP (BURNER PURGE) (ILBP)

The Purge Lamp will stay lit during the timed Purge period of each firing cycle.

2.6.25 INDICATING LAMP (GAS) (ILG)

After the Pilot Flame has been proven, this Lamp will remain lit as long as power is applied to the Main Gas Valve (MGV), Safety Shutoff Gas Valve (SSGV) and Bleed Valve (BV).

2.6.26 INDICATING LAMP HI-LOW GAS PRESSURE (UNIVERSAL ALARM ONLY) (ILHLG)

Lamp is lit when either a high or low gas pressure condition causes a Unit shutdown.

2.6.27 INDICATING LAMP (OIL) (ILO)

This Lamp is lit while power is being applied to the Oil Solenoid Valves (LFOV), (HFOV) and (SSOV) after the Pilot Flame has been proven.

2.6.28 INDICATING LAMP (PUMP OIL LEVEL) (ILP) - OPTIONAL EQUIPMENT

This Lamp will light whenever an abnormal, high or low, oil level is sensed in the Feedwater Pump crankcase by the Pump Oil Level Switch (PLS).

2.6.29 INDICATING LAMP (POWER ON) (ILPO)

The Power On Lamp will remain lit during the entire normal operating period. It indicates that the holding circuit is complete.

2.6.30 INDICATING LAMP (PILOT) (ILPT)

This Lamp will remain lit only during the Trial for Ignition Period. It indicates that the Pilot Circuit is energized.

2.6.31 INDICATING LAMP (THERMOSTAT-LOW WATER) (ILT)

This Lamp will light only when a low water condition occurs. The Light is energized by the Main Temperature Limit Controller (MTLC) or by the Auxiliary Thermostat Switch (ATS).

2.6.32 LIMIT PRESSURE SWITCH (LPS)

This Safety Limit Switch is connected in series with the Holding Relay. In the event of excessive steam pressure, the LPS will open, removing power from the Unit. A manual reset is required before the Unit can be restarted.

2.6.33 LOW FIRE START RELAY (LFSR) - GAS OPERATION ONLY

This Relay provides three normally open interlock contacts for the Combustion Control, Fuel Valve, and Auxiliary Pressure Control (when applicable) circuits. One contact is used to maintain power to Terminal 7 of the ESC when the MGV Proof of Closure Switch opens. The other contact is used to energize the fuel valves once power has been transferred to Terminal 5 of the ESC.

2.6.34 MAGNETIC CONTROLLER (M)

This Contactor has three main power Contacts and an Auxiliary Contact. Momentarily pressing the START Pushbutton will energize the Circuit to the Magnetic Controller and start the Blower Motor. Motor operation is continuous during normal operation. The Auxiliary Contact is located in the Burner Control Circuit and will de-energize the Fuel Valves in the event of a Blower Motor malfunction.

2.6.35 MAIN GAS VALVE (MGV)

This valve is an electrically operated, three-position (High/Low/Off) Hydramotor Gas Valve. It is piped in series and wired in parallel with the Safety Shutoff Gas Valve (SSGV). It provides positive gas shutoff within one second.

2.6.36 MAIN TEMPERATURE LIMIT CONTROLLER (MTLC)

This over-temperature safety controller uses half of the dual element Thermocouple Sensor described under Auxiliary Temperature Controller. This controller will interrupt the Motor and Burner Control Circuits on overtemperature and must be manually reset. (See also paragraphs 2.2.4.1 and 2.2.4.2.)

2.6.37 BLOWER MOTOR

The Blower Motor directly drives the Blower Wheel, as well as the Feedwater Pump. It runs continuously once the START Pushbutton is pressed. It will be secured if the Motor protection device is activated or when the STOP Button is pressed.

2.6.38 MODULATING PRESSURE SWITCH (MPS)

The Modulating Pressure Switch (MPS) is actuated to reduce Burner capacity to “low-fire” operation when system pressure rises to a predetermined point. This prevents frequent on-off cycling of the Burner during light loads and provides stability of operation.

2.6.39 STEAM PRESSURE SWITCH (SPS1)

This pressure-operated Switch is connected in series with the Burner Circuit. It will open and secure the Burner Controls only in the event that steam load drops below the Steam Generators’ minimum rated capacity. During periods of light load, the steam pressure will rise to cutout pressure and open the Switch. The Burner will restart automatically when pressure drops to the Steam Pressure Switch cut-in point. Thus with light load conditions, the Burner will operate at reduced capacity, cycling on and off as necessary to satisfy the steam demand. When SPS1 opens, the Post Fill Timer is energized to continue Feedwater Pump operation, to help maintain a wet-tube condition in the heating coil.

2.6.40 PILOT VALVE (PV)

The Pilot Valve is electrically actuated by the ESC. The valve provides pilot fuel to initiate the ignition sequence.

2.6.41 POST-FILL TIMER (PFT)

This timer maintains water flow to the Heating Coil for a predetermined period of time after each Burner off cycle, to prevent possible Coil overheating problems during periods of frequent on-off cycling.

2.6.42 PUMP OIL LEVEL SWITCH (PLS) - OPTIONAL EQUIPMENT

This Safety Interlock Switch ensures that the correct operating oil level is in the Feedwater Pump Crankcase. Should the oil level become too low, or too high, the PLS will open, interrupting the Burner and Main Motor Circuits. Safety shut down will be indicated by the Pump Oil Level Indicating Lamp (ILP). Before operation can be resumed, the cause of the oil level change must be determined and corrected. The oil level must then be restored to normal operating level.

2.6.43 PUSHBUTTON(S) (PB1, PB2) (STOP/START)

These momentary contact pushbuttons are used to start and stop the Unit.

2.6.44 PUSHBUTTON, AUTO SHUTDOWN (PB3) - OPTIONAL EQUIPMENT

Pressing the Auto Shutdown Pushbutton initiates the wet shutdown process for the Unit. The wet shutdown process will shut off the Make-up Water Valve to the Hotwell Tank, initiate a post run time delay to cool the Heating Coil, and open the Gravity Fill Valve to flood the Heating Coil.

2.6.45 REMOTE STOP SWITCH (RSS) (CUSTOMER OPTION)

A Remote Stop Switch (normally closed contact) can be used to stop the Unit from a remote location. It can be wired into the Control Circuit by removing the jumper at Terminal Board TB1 and TB2.

2.6.46 RUN-FILL SWITCH (RFS)

This is a four-pole, double-throw (4PDT) Switch used to control the Burner, water fill and Alarm Circuits. A Contact is in the Burner Circuit to silence the Audible Alarm (optional). When the Switch is placed in the RUN position, the Burner Purge Period is initiated.

2.6.47 SAFETY SHUTOFF GAS VALVE (SSGV) - GAS OPERATION ONLY

This valve is an electrically operated, two-position (ON/OFF), hydramotor Gas Valve. It is piped in series an wired in parallel with the Main Gas Valve (MGV), with both closing and opening at the same time. It provides positive gas shutoff within one second.

2.6.48 SAFETY SHUTOFF OIL VALVE (SSOV) - LIGHT OIL OPERATION ONLY

This redundant oil shutoff valve is plumbed in series, and wired in parallel, with the Main Oil Valve (MOV). It acts as a safety shutoff device in the event of a malfunction of the MOV to ensure that no oil is admitted to the Burner during the off-cycle.

2.6.49 STEP-DOWN TRANSFORMER (ST1) (115 VAC)

This is a 440/115 VAC, 0.500 kva Stepdown Transformer used to supply the 115 VAC control circuit voltage. (See Figure 2-6 for connection points.)

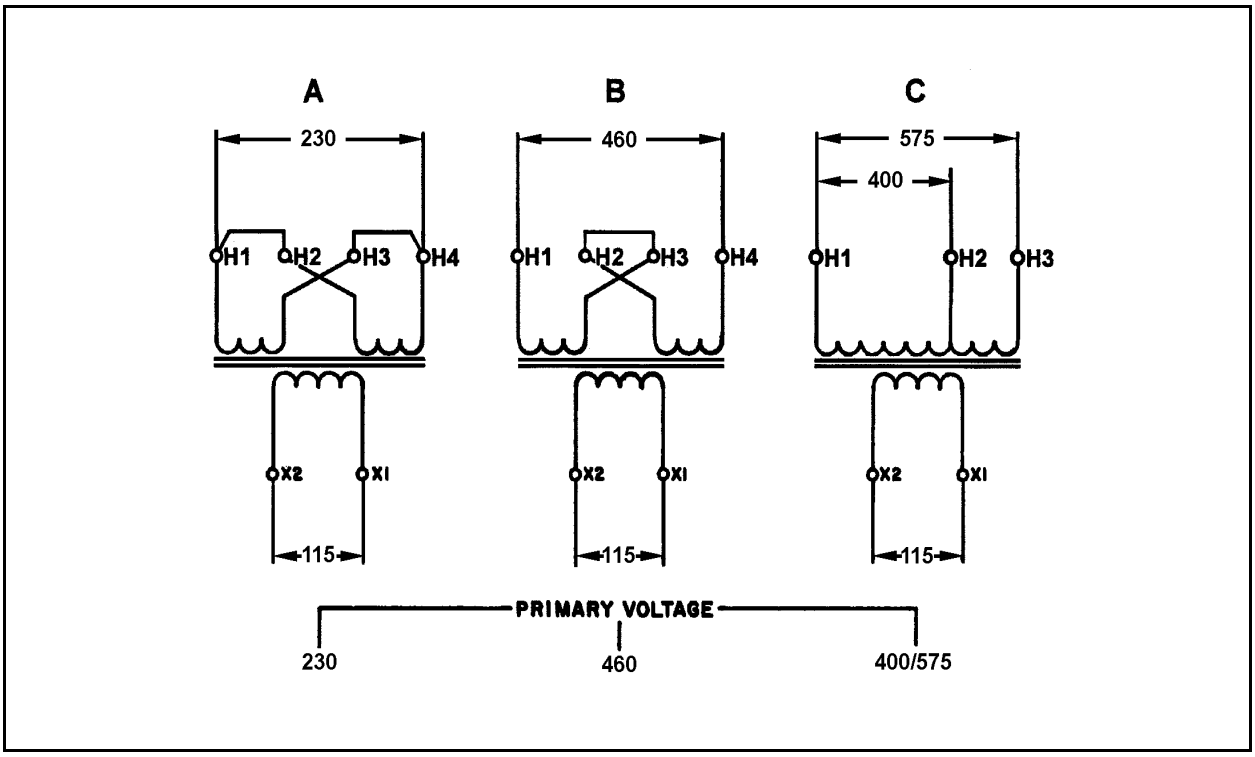


Figure 2-6 Wiring Diagram - Power Supply Connections

2.7 SEQUENCE OF OPERATION (GAS-FIRING)

Pressing the START Pushbutton energizes the Control Circuit and the Magnetic Starter Coil (M) is energized to start the Electric Motor (MOT). On Gas-Oil Units, the Gas-Oil Switch (GOS) must be placed in the GAS position to place all gas devices in service.

The Electrical Circuit is complete to Terminal 7 of the ESC when the Motor is running, the Blower is functioning properly and the following operational and safety devices are closed:

(EIS)	Electric Interlock Switch
(ATS)	Auxiliary Thermostat Switch
(OL)	Motor Overload
(LPS)	Limit Pressure Switch
(PLS)	Pump Level Switch (Optional Equipment)
(TS)	Thermostat Switch
(GPSL)	Gas Pressure Switch - Low
(GPSH)	Gas Pressure Switch - High

(SPS) Steam Pressure Switch
(SSGV) Safety Shutoff Gas Valve
(RFS) Run-Fill Switch (in RUN position)

Approximately 7 seconds after the ESC has been energized (Purge Period), Terminal 4 will be energized. Starting the pilot trial for ignition period, energizing the Pilot Gas Valve (PV), and Ignition Transformer (IT). The Pilot Light (ILBP) and the Burner Indicator Lamp (ILB) lights are energized at the end of the purge period.

The RUN-FILL Switch (RFS) de-energizes the Burner Circuit while the Plant is being filled. This Switch also de-energizes the Water Pump Solenoid Valves (WP1 and WP2) permitting the Heating Coil to be filled at maximum pumping rate.

Following a flame failure during a firing cycle, the Safety Shutoff Gas Valve (SSGV) and the Main Gas Valve (MGV) will be de-energized, closing both valves within one second. After the 7-second purge period, if Pilot Flame is not established within 10 seconds, total safety shutdown and lockout will occur requiring a manual reset of the ESC before operation can be resumed.

When the flame sensor detects Pilot flame, the Flame Relay in the ESC transfers power from Terminal 4 to Terminal 5. Indicator Light (ILBP) turns off indicating that Pilot flame has been extinguished and the transfer is made. The Ignition Transformer (IT) and Pilot Valve (PV) are disconnected. The SSGV is energized to a full open position. The MGV is energized into the low-fire position. If the system requires it, the Modulating Pressure Switch (MPS) closes, energizing the MGV high-fire circuit and placing it in high-fire position.

After the Burner starts, steam will be generated and steam pressure will rise to operating level. During moderate steam demand, steam pressure will rise sufficiently to open the Modulating Pressure Switch (MPS), disconnecting Terminal 8 on the MGV from the line. This places the MGV in the low-fire position, reducing Burner capacity to low-fire operation (see also paragraph 2.3.1). When the MGV reaches the low-fire position, it actuates the Auxiliary Switch in the Gas Valve to close and energize the Air Damper Solenoid (ADS) and Water Pump Solenoid (WPl). This places the Automatic Damper in the low-fire position to partially restrict the air supply to the Burner and maintain proper air-fuel ratio. By placing the Auto/Low-Fire Switch (ALFS) in the "low only" (open) position, high-fire operation can be prevented, since the circuit is broken to the high-fire controls.

If steam demand is such that pressure cannot be maintained with modulated operation, decreasing steam pressure will again close the MPS to return the controls to full capacity operation. Thus with moderate to heavy steam loads, operation will be continuous or the Burner will automatically cycle between partial and full capacity, depending upon demand.

On light steam loads, steam pressure will rise to maximum and open the Steam Pressure Switch (SPS). This disconnects the circuit to the ESC which in turn disconnects the fuel circuit to stop the Burner. The Burner will restart automatically when steam pressure drops to the Steam Pressure Switch cut-in point. Thus with light steam demand, the Burner will operate at reduced capacity, cycling on and off as necessary to supply the demand. The same ignition sequence is repeated with each automatic restart.

2.8 SEQUENCE OF OPERATION (OIL-FIRING)

Momentarily pressing the START Pushbutton energizes the Control Circuit and the Magnetic Starter Coil (M) is energized which starts the Electric Motor.

On initial start only, the Burner is started by closing the Fuel Valve, thus closing the Fuel Pressure Switch (FPS) and energizing Terminal 7 on the ESC. Approximately 7 seconds after Terminal 7 has been energized, Terminal 4 will be energized, thus starting the trial for ignition. The Trial For Ignition Timer (TFIT) will close for 3 seconds energizing the Low-Fire Oil Valve (LFOV) and the Oil Ignition Transformers (ITO) or the Gas-Oil Ignition Transformer (ITGO) on Plants equipped to use gas. The Burner Purge Indicator Lamp (ILBP) lights up during the purge period. Oil Indicator Lamp (ILO) lights up when the Low-Fire Oil Valve is energized.

When the flame sensor Burner flame, the flame relay in the ESC will transfer power from Terminal 4 to Terminal 5. This energizes the Low-Fire Start Relay (LFSR), disconnecting the Oil Ignition Transformer, holding the Low-Fire Oil Valve (LFOV) through the Low-Fire Start Relay (LFSR). If the system requires it, the Modulating Pressure Switch (MPS) will close, energizing the Relay (MPSR). The High-Fire Oil Valve (HFOV) is energized by the Modulating Pressure Switch Relay (MPSR) which closes, placing the Burner in full (High-fire) operation. The Modulating Pressure Switch Relay (MPSR) opens, de-energizing the Water Pump Solenoid (WP1) and the Air Damper Solenoid (ADS), opening the Damper and placing the System in full water pumping rate and maximum air flow rate.

Flame failure will de-energize the ESC to disconnect the Oil Valves within one second and stop fuel flow to the Burner. A Safety Switch in the ESC will lock out the Burner circuit. In this case, the reset on the front of the Control must be manually actuated before an attempted Burner restart can be made.

After the Burner starts, steam will be generated and steam pressure will rise to operating level. During moderate steam demand, steam pressure will rise sufficiently to open the Modulating Pressure Switch (MPS) and de-energize the Modulating Pressure Switch Relay (MPSR) and High-Fire Oil Valve (HFOV), thus modulating (reducing) Burner capacity to low-fire operation. Simultaneously, Contact (MPSR) closes to energize the Air Damper Solenoid (ADS) which partially restricts the air supply to the Burner and maintains proper air-fuel ratio, desired. High-fire operation can be prevented by placing the Auto/Low-Fire Switch (ALFS) in the LOW ONLY (open) position. This opens the circuit to the High-Fire Oil Valve.

If steam demand is such that pressure cannot be maintained with modulated operation, decreasing steam pressure will again close the Modulating Pressure Switch and return the Controls to full capacity operation. Thus, with moderate to heavy steam loads, operation will be continuous at full capacity, or the Burner will automatically cycle between partial and full capacity depending upon demand.

On light steam loads, steam pressure will rise to maximum and open the Steam Pressure Switch (SPS). This disconnects the circuit to the ESC which in turn disconnects the circuit to stop the Burner. The Burner will restart automatically when steam pressure drops to the Steam Pressure Switch cut-in point. Thus, with light steam demand, the Burner will operate at reduced capacity, cycling on and off as necessary to supply the demand. The Safety Burner starting cycle is repeated with each automatic start.

SECTION III

INITIAL FIRING

3.1 BEFORE FIRING

Every steam generator is thoroughly tested and all necessary adjustments are made under actual operating conditions prior to shipment from the factory. Rough handling during shipment may cause loosening of plumbing connections or change some of the adjustments. It is recommended that the following procedures be carried out before initial starting to ensure satisfactory operation.

- Visually inspect and tighten any loose plumbing and electrical connections. Verify that the machine has been installed in accordance with the Clayton Installation Manual and any special installation instructions provided by Clayton Industries.
- Check the oil level in the feedwater pump crankcase.
- Check flexible coupling located between water pump, blower and drive motor. To avoid excessive vibration and wear of coupling, motor, and pump shafts must be within .005 inch of true axial alignment. A steel straight-edge may be used across the coupling halves to check for correct alignment. A gap approximately 1/8-inch should be maintained between the metal coupling halves. Avoid metal-to-metal engagement.

NOTE

If water pump, blower or drive motor have been removed for any reason, replace any shims to original position. If necessary, remove or add shims under motor as required to maintain coupling alignment to tolerance specific.

- Check the blower motor rotation before placing the machine in service.
- Remove the feedwater pump strainer plug and all check-valve caps. Apply a non-seizing compound to the threads, then re-install.
- Check the operation of water softener. Suitable water treatment equipment and chemicals should be installed and available. *Proper feedwater treatment must be used from the time the steam generator is first placed into service.*

It is *important* that the temperature safety controls be tested after the steam generator has been initially started and brought up to operating pressure. The controls should be tested periodically to ensure continuous protection (See Section VI, “Periodic Maintenance.”)

3.2 CONDITIONING OF NEW INSTALLATIONS

To remove residual mill scale, oil and contamination in the heating coil developed during manufacture, the heating coil should be “boiled out” prior to initial starting of the machine.

3.2.1 PROCEDURE

a. Using soft water, flush out the hotwell and steam generator system.

b. Refill with soft water and then add 5 gallons of Coil Guard 1 to the hotwell. The product may be added through any opening in the hotwell or pumped in with a transfer pump or the chemical feed pump. (Using the chemical feed pump may take 4–8 hours to add the product)

c. Short fire the steam generator to raise the water temperature to about 180^{o} F.

d. Recirculate the water for 2 hours. Keep steam header closed but the atmospheric vent open.

e. Shut down the machine, drain the hotwell and steam generator. Fill with soft water and rinse again. Continue to rinse until the water is clear with no visible sediment.

f. With the machine full of water, add Coil Guard 2 (about 1 gallon per 100 bhp). Recirculate and then start the unit for normal operation.

g. Start the normal chemical treatment with the appropriate chemical treatment chemicals.

NOTE

Refer to Feedwater Treatment Manual for detailed instructions.

SECTION IV

OPERATING INSTRUCTIONS

4.1 BEFORE STARTING

(See Figure 4-1.)

Different burner manifolds are used on oil and gas machines. The manifold must be exchanged prior to changing fuel supply on combination gas/oil machines (EOG models). (See paragraph 4.6 for the manifold exchange procedure.)

a. Verify that the water softener and feedwater chemical treatment systems are operating. NOTE: Test the feedwater for proper chemical treatment levels prior to filling the heating coil.

b. **CLOSE**: The separator discharge valve (A), coil blowdown valve (J), coil gravity drain valve (O), the soot blower valve (Q) (if equipped), and all drain cocks. On machines without the auto shutdown feature, close the gravity fill isolation valve (K).

   OPEN: The separator drain valve (E) and trap discharge valve(s) (P)

c. If so equipped, open continuous blowdown shutoff valve (L) and partially open continuous blowdown valve (M).

NOTE

Follow the instructions as shown on the Clayton feedwater treatment skid panel (if so equipped) prior to filling.

If the machine is in wet shutdown mode, the feedwater intake valve (D), coil feed valve (B), trap discharge valve (P), and gravity fill isolation valve (K) would already be open.

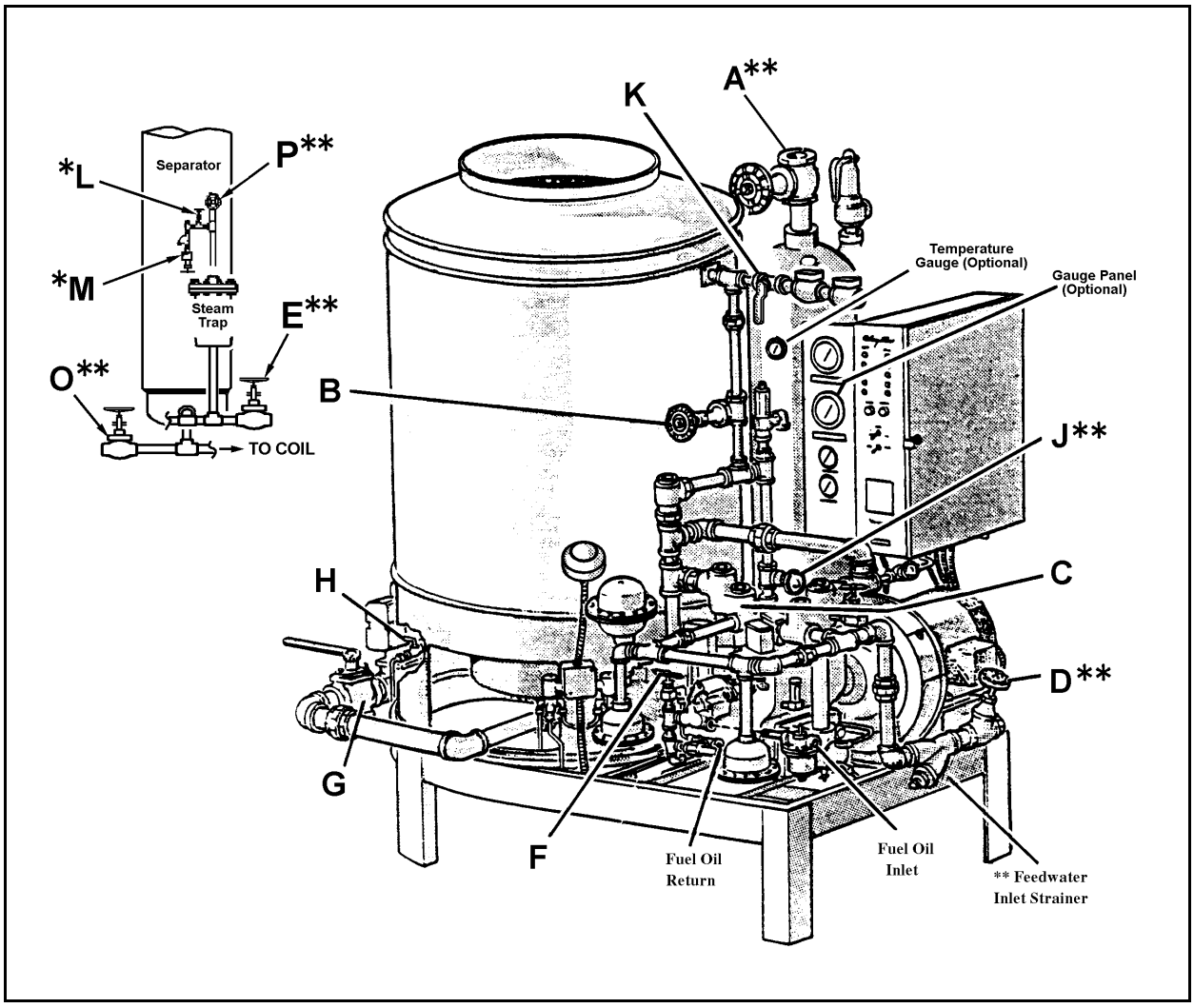


Figure 4-1 Operating Controls

A. Separator Discharge Valve**
B. Coil Feed Valve
C. Feedwater Pump Housings
D. Feedwater Intake Valve**
E. Separator Drain Valve**
F. Burner Oil Valve
G. Main Gas Cock
H. Pilot Gas Cock
J. Coil Blowdown Valve**
K. Gravity Fill Isolation Valve
L. Continuous Blowdown Shut-off Valve*
M. Continuous Blowdown Valve*
O. Coil Gravity Drain Valve**
P. Trap Discharge Valve(s)**
Q. Sootblow Valve (not shown)*

*Optional Equipment
**Optionally available or else Customer Furnished

4.2 FILLING PROCEDURE

a. Verify the feedwater intake valve (D), coil feed valve (B), and the gravity fill isolation valve (K) are open.

b. Pull out the STOP button.

c. Place the Run/Fill Switch (RFS) in the FILL position.

d. Place the Auto/Low-fire switch in the LOW ONLY position.

e. Press the START pushbutton.

f. Check feedwater pump prime by throttling coil feed valve (B) until feed pressure rises to 100 psi. If unable to achieve 100 psi during the prime verification process, loosen check-valve caps to expel excess air.

g. When a steady water flow is evident at the separator drain valve (E) or the blowdown tank outlet, the coil is full.

4.3 INITIAL STARTING

a. **For Oil-Fired Operation:** verify that all fuel oil supply system valves are open. Open burner oil valve (F). Place the gas/oil switch (GOS) in the OIL position. Engage the fuel oil pump drive coupling.

NOTE

On combination gas/oil machines, close the main gas cock (G) and pilot gas cock (H).

b. **For Gas-Fired Operation**: verify that all gas supply system valves are open. Open main gas cock (G) and pilot gas cock (H). Place the gas/oil switch (GOS) in the GAS position.

NOTE

On combination gas/oil machines, close all fuel oil system valves. Close burner oil valve (F) and disengage the fuel oil pump drive coupling.

c. Place the run/fill switch (RFS) in the RUN position. The machine will go through its preset purge period, then energize the pilot circuit. If a stable pilot flame is successfully established, the main burner control circuit will be activated.

NOTE

A stable flame must be achieved within the pilot trial for ignition period or the burner Electronic Safety Control (ESC) will lockout, requiring a manual reset.

d. As the pressure rises and approaches the Operating Pressure Switch (OPS) set-point, gradually open the separator discharge valve (A). Allow machine to operate at minimum firing until steam header is full. Place the auto/low-fire switch in the AUTO HI-LOW position.

NOTE

During this process, leave the separator drain valve (E) open until the excess water has been expelled (observe the trap pressure gauge for proper trap timing). Then close.

NOTE

Never allow the discharge pressure to drop below minimum design operating pressure.

e. When the separator discharge valve (A) is completely open, the machine is in a fully automatic operating mode.

4.4 SHUTDOWN PROCEDURES

4.4.1 WET SHUTDOWN[1] - ELEVATED WATER SUPPLY SYSTEMS

An elevated water supply system provides a positive coil feed pressure through the feed line from the receiver tank (or Head Tank) to the heating coil gravity fill connection during wet shut-down. Sufficient head pressure must be available throughout the shutdown period. Leaking plumbing and components must be repaired or replaced immediately to prevent damage to the heating coil—refer to installation manual for head tank height requirements. See to Figure 4-1, page 4-2, for parenthetical callout references.

NOTE

Prior to wet shutdown procedure, verify that the gravity fill isolation valve (K) is open.

4.4.1.1 Automatic Shutdown

a. Select “manual” mode by placing the burner toggle switch in LOW ONLY to return the firing rate to the minimum rate.

b. Press the AUTO SHUTDOWN pushbutton. The burner will shut off; the make-up water valve (S) and continuous blowdown valve (T) solenoid (if so equipped) will close; feed-water will be pumped through the head tank orifice, filling the head tank. Excess water supply will return to the feedwater receiver tank.

c. Close the separator discharge valve (A).

[1] Freeze protection required (See Section 4.5 for procedures.). Where freezing temperatures are a factor, a backdraft damper must be installed in the exhaust stack to prevent coil freeze-ups.

d. Close all fuel valves.

The feedwater pump(s) will circulate treated feedwater until the coil temperature drops to the receiver tank temperature, then all pumps will stop. Head tank supply water will flow through the gravity fill connection into the heating coil to maintain a filled coil.

4.4.1.2 Manual Shutdown

a. Select "manual" mode by placing the burner toggle switch in LOW ONLY and the run/fill switch to BURNER OFF.

b. Close the make-up water valve (S) and the continuous blowdown valve (T).

c. Open the gravity fill isolation valve (K), allowing feedwater to fill the head tank. Excess water supply will return to the receiver tank.

d. Close the separator discharge valve (A).

e. Close all fuel valves.

Allow the feedwater pump(s) to circulate treated feedwater until the coil temperature drops to the receiver tank temperature.

f. Press the STOP button to shut down the feedwater pump.

The gravity fill isolation valve (K) will remain open, allowing the head tank to supply water through the gravity fill connection into the heating coil.

4.4.1.3 Notes

1. Maintain power to all systems until the feedwater pump(s) are stopped.
2. Periodically check the system for leaks throughout the wet shutdown period.
3. It is important that the coil drain valves, coil blowdown valves, separator blowdown/ drain valve, and separator discharge (A) remain tightly closed during wet shutdown.
4. Perform any scheduled blowdown operation at least one hour before starting a wet shutdown procedure.
5. During a wet shutdown, the feedwater must contain sufficient chemical to maintain a minimum of 100 ppm residual oxygen scavenger and a pH of 10 or more. To maintain these feedwater conditions throughout extended periods of wet shutdown, it may be necessary, in some installations, to periodically (manually or through use of a timer) run the chemical pump(s).

4.4.2 DRY SHUTDOWN (BLOWDOWN) PROCEDURE

The preferred method of shutdown for extended periods is a dry shutdown. See Figure 4-1, on page 4-2, for parenthetical callout references.

a. Close the gravity fill isolation valve (K).

b. Run the machine at maximum firing rate for a minimum of three minutes. To achieve the maximum rate while maintaining operating pressure:

1. Fully open the separator discharge valve (A) and, if necessary, throttle (open) the Atmospheric Test Valve (not shown).
2. Verify the burner toggle switch is set to AUTO HI-LOW.
3. Verify the run/fill toggle switch is set to BURNER ON.

c. Open the separator blowdown/drain valve (E) and the coil blowdown valve (J).

d. Close the feedwater intake valve (D).

e. Start a 60-second time check.

f. Begin to progressively close the separator discharge valve (A) and the atmospheric test valve, if equipped, to maintain the pressure *just below* the OPS cutout setpoints, as noted above.

g. Allow the machine to continue firing at the maximum rate until the prescribed time (step e) has expired.

h. Push in the STOP button immediately to secure the machine once the prescribed time has expired.

i. Open all coil drain valve(s) (J) (O).

j. Verify that only a whisper of vapor or a very small amount of water is visible from any coil drain valve when opened. If a considerable amount of water is discharged from the coil drain valve(s), the shutdown is considered "unsuccessful" and must be repeated.

   NOTE: In some occurrences, the high temperature alarm will shutdown the machine before the prescribed time expires; this is acceptable.

k. After a 45-minute cool-down period, close the following valves:

   - separator blowdown/drain valve (E)
   - trap discharge valve (P)
   - coil blowdown valve (J)
   - continuous blowdown shut-off valve (L), if so equipped

4.4.3 RESTART AFTER WET SHUTDOWN

a. The condensate receiver may first be drained if an excessive amount of precipitated sludge is present. Refer to paragraph 6.6.5 in Section VI for maintenance procedure.

b. Open the make-up water supply valve to the condensate receiver.

c. A manual blowdown, open the separator drain valve (E), should be accomplished after start-up to control the dissolved solids in the system.

4.5 FREEZING PRECAUTIONS AND EXTENDED SHUTDOWN

a. Perform shutdown procedure.

b. Close the pilot gas cock (H), main gas cock (G) or burner oil valve (F).

c. Remove the intake and discharge check-valves from the feedwater pump housings (C).

d. Open the drain cocks at the base of the feedwater pumpheads.

e. Remove and drain all tubes in the system in which a low sump may contain water. Remove the pipe plug from the feedwater strainer.

f. Be sure all water is drained from the heating coil and steam separator.

g. After making sure that all water has been drained from the machine, replace all tubes that were removed and reinstall the intake and discharge check-valves in the feedwater pump check-valve housings (C).

h. Close all drain cocks at the base of feedwater pump.

NOTE

It is imperative that all valves are tightly closed to prevent air from entering the system during the cooling of the steam generator.

4.6 CHANGING FROM GAS TO OIL FIRING (GAS-OIL COMBINATION MACHINES ONLY)

4.6.1 GAS MANIFOLD REMOVAL

a. Shut off supply gas to the machine and turn the manual gas valve on the machine to the off position. Remove the inspection mirror from the burner manifold.

b. Disconnect the ignition wire from the ignition electrode, the banana plug wire, and the scanner rod wire.

c. Disconnect and remove the pilot gas supply tube.

d. Loosen the three screws on the packing ring and remove the gas inlet line to the burner elbow.

e. Unscrew and remove the wing nuts that attaches the manifold to the burner volute and carefully lower and remove the manifold from the volute.

IMPORTANT

To prevent damage, store the parts in a safe place.

4.6.2 OIL MANIFOLD INSTALLATION

NOTE

Before installing the manifold, clean off any debris which may have collected while the manifold was in storage. Make sure the burner nozzles a clean of obstructions.

a. Carefully raise the oil manifold assembly up into the volute. Make sure the manifold is positioned correctly in the volute. Screw in and tighten the wing nuts to secure the manifold.

b. Connect the oil supply tubes to the tube elbows at the manifold stem assembly. Make sure tubes are connected to the appropriate elbow—high-fire tube to high-fire elbow and low-fire tube to low-fire elbow.

c. Connect the ignition wire to the ignition electrode. Connect the flame scanner to the scanner nipple.

d. Engage the fuel pump coupling with the end-slot on the crankshaft, located in the crankcase. Tighten the two coupling setscrews to lock the coupling in place.

CAUTION

When engaging the coupling, leave 1/32-inch between the crankshaft slot and coupling to allow crankshaft end-play. Damage to feedwater pump crankshaft could result without proper clearance.

SECTION V

TROUBLESHOOTING

5.1 ANNUNCIATOR SYSTEM

The following chart lists the Annunciator Lamps together with the cause and remedial procedure to follow in the event one of the Annunciators is found glowing after a Burner or Plant interruption.

Trouble	Possible Cause	Remedy
PUMP LEVEL (OPTIONAL)	The Pump Oil Level Switch has secured the Unit due to improper oil level in Water Pump Crankcase.	Check oil level in Water Pump. If oil level is too low, check for ruptured Diaphragm in Feedwater Section of Pump.
MOTOR OVERLOAD	Electrical overload has caused the Overload Relays in the Magnetic Controller to secure the Unit.	Check for and correct cause of overload in the Motor circuit. The Overload Relay can be reset and the Annunciator Lamp will stop glowing after the overload element cools (2–3 minutes) and is manually reset. See paragraph 7.14 for adjusting the overload to prevent nuisance interruption in hot weather.
THERMOSTAT	The Main Temperature Limit Controller (MTLC) or Auxiliary Thermostat Switch (ATS) stops Motor and Burner due to Coil overheat caused by low water condition or improper ATS adjustment.	Correct cause of low water or water failure condition.* Test Thermostat for proper control (see paragraphs 6.6.4 and 6.6.5). The Thermostat Annunciator Lamp will stop glowing when the condition is corrected and Switch is reset *Possible Causes: 1. Empty Condensate Receiver 2. Clogged inlet Strainer 3. Worn Check Valve Seats & Discs. 4. Malfunctioning Booster Pump(s)

BURNER	The Burner Controls have been "locked out" by the Electronic Safety Control due to Burner failure.	Check causes and remedies of Burner failure in section 5.3 or 5.4. The Electronic Safety Control must be manually reset before an attempted Burner restart can be made.
AIR PRESSURE	The Air Pressure Switch has interrupted Plant operation due to Blower failure or clogged air line.	Check to be sure Blower Rotor is tightly secured to Motor Shaft. Check and clean air line to Air Pressure Switch.
PUMP FAILING TO MAINTAIN PROPER FEED VOLUME TO HEATING COIL, CAUSING THERMOSTAT INTERRUPTION	Low oil level in Water Pump, causing reduced Pump capacity.	Be sure oil is maintained at proper level.
	Pump Check-valves not operating properly.	Clean and inspect Check-valves (see paragraph 7.1.1).
	Vapor lock of Pump due to abrupt steam demand causing low pressure in the Separator.	On installations where there are sudden heavy steam demands, a Back Pressure Valve should be installed to retain a normal steam pressure in the Separator during these periods.
	Pump not primed.	Prime Pump.
NOISY WATER PUMP OPERATION	Pump Intake Surge Chamber fouled.	Check and Clean Intake Surge Chamber.
	Water Pump Discharge Snubbers fouled.	Clean or replace Discharge Snubbers (see paragraph 7.3).
	Flexible Coupling loose between Motor and Pump.	Tighten Set Screws in Flexible Coupling.
	Worn Bearings or lack of oil in Crankcase.	Replace Bearings if necessary. Add oil to proper level. (See paragraph 6.7.4).
	Restricted Heating Coil causing excessive back pressure.	Check feed pressure for Coil restriction (see paragraph 6.6).
	Feedwater boiling or too hot.	Correct cause of excessive heat in condensate return line from steam system. Inspect Valves and Traps on steam equipment.
OVERHEATING HOTWELL	Water Pump Solenoid(s) failure.	Partially open Separator Drain Valve until Water Pump Solenoid(s) can be replaced.
STEAM TRAP DISCHARGE PRESSURE GAUGE READS ZERO PRESSURE	Steam Trap closed. - improper firing rate - improper pumping rate - defective internals	Ensure Water Pump is discharging at normal capacity.
		Blowdown Valve partially open. Close it.
		Check for possible malfunctioning of Steam Trap.

STEAM TRAP DISCHARGE PRESSURE GAUGE REGISTERS FIXED PRESSURE READING	Steam Trap open, due to: - defective internals - improper pumping rate - improper firing rate	Ensure Water Pump is discharging at normal capacity. Check for possible malfunctioning of Steam Trap.
WEEPING STEAM RELIEF VALVE	Contamination of the seating surfaces of the Seat or Disc.	Replace Valve. The Valve may be resurfaced by an authorized repair shop if the damage is not extensive. NOTE - Valve NOT to be tampered with by an unauthorized person.

5.2 WATER SYSTEM

Trouble	Possible Cause	Remedy
PUMP FAILING TO MAINTAIN PROPER FEED VOLUME TO HEATING COIL, CAUSING THERMOSTAT INTERRUPTION	Low oil level in Water Pump, causing reduced Pump capacity.	Be sure oil is maintained at proper level.
	Pump Check-valves not operating properly.	Clean and inspect Check-valves (see paragraph 7.1.1).
	Vapor lock of Pump due to abrupt steam demand causing low pressure in the Separator.	On installations where there are sudden heavy steam demands, a Back Pressure Valve should be installed to retain a normal steam pressure in the Separator during these periods.
	Pump not primed.	Prime Pump.
NOISY WATER PUMP OPERATION	Pump Intake Surge Chamber fouled.	Check and Clean Intake Surge Chamber (see paragraph 7.4).
	Water Pump Discharge Snubbers fouled.	Clean or replace Discharge Snubbers (see paragraph 7.3).
	Flexible Coupling loose between Motor and Pump.	Tighten Set Screws in Flexible Coupling.
	Worn Bearings or lack of oil in Crankcase.	Replace Bearings if necessary. Add oil to proper level. (See paragraph 6.7.4).
	Restricted Heating Coil causing excessive back pressure.	Check feed pressure for Coil restriction (see paragraph 6.6).
	Feedwater boiling or too hot.	Correct cause of excessive heat in condensate return line from steam system. Inspect Valves and Traps on steam equipment.

OVERHEATING HOTWELL	Water Pump Solenoid(s) failure.	Partially open Separator Drain Valve until Water Pump Solenoid(s) can be replaced.
STEAM TRAP DISCHARGE PRESSURE GAUGE READS ZERO PRESSURE	Steam Trap closed. - improper firing rate - improper pumping rate - defective internals	Ensure Water Pump is discharging at normal capacity.
		Blowdown Valve partially open. Close it.
		Check for possible malfunctioning of Steam Trap.
STEAM TRAP DISCHARGE PRESSURE GAUGE REGISTERS FIXED PRESSURE READING	Steam Trap open, due to: - defective internals - improper pumping rate - improper firing rate	Ensure Water Pump is discharging at normal capacity.
		Check for possible malfunctioning of Steam Trap.
WEEPING STEAM RELIEF VALVE	Contamination of the seating surfaces of the Seat or Disc.	Replace Valve. The Valve may be resurfaced by an authorized repair shop if the damage is not extensive. NOTE - Valve NOT to be tampered with by an unauthorized person.

5.3 FUEL SYSTEM—GAS UNITS

Trouble	Possible Cause	Remedy
PILOT FAILS TO IGNITE[A]	Gas shut off at supply.	Open gas service Cocks.
	Pilot Cock closed.	Open Pilot Cock.
	Pilot Solenoid Valve failing to open.	Check for burned out Solenoid Coil.
	Faulty ignition.	Check and adjust Ignition Electrode.
		Test Ignition Transformer and Ignition Cable.
PILOT IGNITES BUT SAFETY SHUTDOWN OCCURS	Main Gas Cock closed.	Open Main Gas Cock.
BURNER FAILS TO IGNITE WHEN MAIN GAS COCK IS OPENED	Pilot flame failure.	Check cause and remedies under "Pilot Fails to Ignite."
	Main Gas Valve inoperative.	Check circuit to Main Gas Valve.
DELAYED SHUT-OFF OF BURNER DURING AUTOMATIC OPERATION	Main Gas Valve not seating properly.	Check Main Gas Valve.

PARTIAL OR IMPROPER BURNER OPERATION CAUSING LOW STEAM PRESSURE AT NORMAL LOAD	Low gas service caused by heavy gas demand or small service connection.	See Installation Manual for proper gas service installation.
	Burner equipment not suited to type of gas being used.	Burner equipment must be altered if gas service does not comply with gas specification plate.
	Improper air-fuel mixture.	Clean cupped sides of Blower Rotor Blades (paragraph 6.6.6).
	Insufficient air to boiler room.	Adjust Air Supply (see paragraph 7.12).
		Check flue pipe for improper installation or restriction (see Installation Manual).
		Install Air Duct from outside air to Blower.
BURNER SHUTS OFF BEFORE MAXIMUM STEAM PRESSURE IS REACHED OR DURING NORMAL OPERATION	Main Temperature Limit Controller (MTLC2 or MTLC1) interruption due to low water condition.	Correct cause of low water condition immediately. Also check for improper adjustment of ATS (a manual reset is required) (see paragraph 7.7)
	Auxiliary Thermostat Switch (ATS) has actuated and stopped the Unit.	
	Operating Pressure Switch (OPS) Defective or Sensing Line Obstructed.	Check Sensing Line and clear. Replace OPS if defective.

[a] Following outage period of 7 seconds, pilot light will illuminate indicating gas pilot has been established. If pilot flame is not established within 10-second trial for ignition period after the purge period, the ESC will lock out the Burner controls.

5.4 FUEL SYSTEM—OIL UNITS

Trouble	Possible Cause	Remedy
LOW OR NO FUEL PRESSURE CAUTION: STOP PLANT IMMEDIATELY TO AVOID DAMAGE TO FUEL PUMP	Fuel supply exhausted or supply lines restricted.	Check fuel supply. Be sure all Valves in supply line are open.
	Fuel bypassing through Burner Control Valve.	Burner Control Valve must be fully closed for maximum fuel pressure.
	Fuel pressure not adjusted properly.	Adjust fuel pressure (see paragraph 7.13).
	Air leak in supply line causing loss of prime.	Suction line must be airtight and air pockets eliminated.
	Fuel Pump failure.	Replace Fuel Pump.

BURNER FAILS TO IGNITE	Faulty Ignition.	Check and adjust Ignition Electrodes.
		Check Ignition Transformer and Ignition Cable.
		Check for temporary or intermittent low voltage condition which may cause weak spark from Transformer. Install heavier feeder lines to Unit if necessary.
	Fuel Pressure Switch failure.	Check and adjust Fuel Pressure Switch.
	Insufficient fuel pressure.	
	Burner Nozzle not replaced in Burner.	Be sure to replace Burner Nozzle after cleaning Manifold.
	Low-fire Oil Valve failing to open.	Check for burned-out Solenoid.
PARTIAL OR IMPROPER BURNER OPERATION CAUSING LOW STEAM PRESSURE AT NORMAL LOAD	Low fuel pressure.	See causes and remedies under "Low or No Fuel Pressure."
	High-fire Oil Valve failing to open.	Check Oil Valve for burned out Solenoid.
SMOKE FROM FLUE OUTLET[A]	Improper air supply to Burner.	Check air adjustment (see paragraph 7.12).
	Fuel pressure not adjusted properly.	Clean cupped sides of Blower Rotor Blades. (See paragraph 6.6.6.)
	Carboned, loose, or worn Burner Nozzle.	Adjust fuel pressure (see paragraph 7.9).
	Heating Coil sooted.	Clean and tighten Burner Nozzle. Replace if worn.
	Dirt or sludge in fuel oil or wrong grade of fuel used.	If soot cannot be satisfactorily removed with soot blower, perform a Coil Water Wash. See Supplemental Instruction in Appendix A.
		Be sure fuel is clean. See Installation Manual or Specification Table for details.
DEAD OR FLUTTERING BURNER SHUT-OFF DURING AUTOMATIC OPERATION	Oil Valve not seating properly.	Check and clean Oil Solenoid Valve.
OIL DRIP FROM BURNER	Oil Valve not seating properly.	Check and clean Oil Solenoid Valve.
	Loose Burner Nozzle.	Tighten Nozzle.
	Carbon on Burner Nozzle causing deflection of oil spray.	Remove and clean Nozzle.

DEAD OR FLUTTERING FIRE	Restricted or sooted flue pipe causing back pressure in Combustion Chamber.	Remove soot or restriction. Be sure Flue Pipe is installed correctly (see Installation Manual).
	Heating Coil sooted.	If soot cannot be satisfactorily removed with soot blower, perform a Coil Water Wash. See Supplemental Instruction in Appendix A.
	Insufficient air to boiler room.	Install Duct from outside air to Blower.
	Improper air adjustment to Burner.	Check air adjustment (see paragraph 7.12).
	Burner Nozzle carboned over.	Remove and clean Nozzle.
BURNER SHUTS OFF BEFORE MAXIMUM STEAM PRESSURE IS REACHED OR DURING NORMAL OPERATION	Main Temperature Limit Controller (MTLC2 or MTLC1) interruption due to low water condition.	Correct cause of low water condition immediately. Also check for improper adjustment of ATS (a manual reset is required) (see paragraph 7.7)
	Auxiliary Thermostat Switch (ATS) has actuated and stopped the Unit.	
	Operating Pressure Switch (OPS) Defective or Sensing Line Obstructed.	Check Sensing Line and clear. Replace OPS if defective.

[a] This condition must be corrected immediately to prevent Heating Coil and Burner sooting.

5.5 ELECTRICAL SYSTEM

Trouble	Possible Cause	Remedy
MOTOR FAILS TO START, OR STOPS DURING OPERATION	Power failure or blown fuse.	Check fuses in lines to Unit.
	Safety shutdown caused by Thermal Overload Relays.	Wait 2 or 3 minutes for Elements to cool: then manually reset. Check cause of overload. Check Motor for overheat due to possible shorted or grounded winding. Also see paragraph 7.14 if shutdown persist for no apparent reason.
	Check for low voltage.	Correct cause.
MOTOR NOISY OR RUNNING HOT	Motor running single phase.	Check for blown fuse in feeder lines.
	Insufficient lubrication or Bearing Failure.	Lubricate Bearing. Check for worn Bearing.
	Motor End Bells misaligned causing bind on Shaft.	Align End Bells. Rotor should turn freely by hand.

MAGNETIC CONTROLLER FAILS TO CONTACT	Operating Coil failure. (Also see troubles and remedies under "Motor Fails to Start".)	Replace Coil. Be sure Coil of correct voltage and Hertz is installed.
	Contact failure caused by poor contact pressure, dirt, arcing, or low voltage.	Replace contact.
MAGNETIC CONTROLLER FAILS TO DISCONNECT	Welded contacts, due to arc, or mechanical binding.	Replace contacts. Correct cause of binding.
MAGNETIC CONTROLLER NOISY	Poor alignment, wrong Coil, mechanical binding, or gummy guide surfaces.	Check and clean Magnetic Controller.

5.6 BURNER SAFETY CONTROLS—GAS UNITS

Trouble	Possible Cause	Remedy
GAS PILOT AND BURNER FAIL TO IGNITE. (ALSO SEE PARAGRAPH 5.3.)	Safety Switch in Electronic Safety Control locked out.	Actuate reset on Control. (If safety Switch contacts are dirty, actuating the reset several times will tend to clean them).
	Loose Terminal (mounting) Screws in Electronic Safety Control.	Disconnect power and tighten Captive Screws which secure control to Mounting Base.
GAS PILOT AND BURNER FAIL TO IGNITE. (ALSO SEE PARAGRAPH 5.3.)	Insufficient or no Pilot gas reaching Burner.	Check Pilot Solenoid Valve. Also check for clogged Pilot Restrictor (see paragraph 7.10.3). (Flame Signal Circuit must be strong enough to allow about 12 to 17 volts at the positive and negative Test Jacks located in the Electronic Safety Control Relay Circuit Board.)

GAS PILOT IGNITES BUT MAIN BURNER FAILS TO IGNITE WHEN MAIN GAS COCK IS OPENED	If Electronic Safety Control locks out (Pilot flame goes out) about 10 seconds after Pilot flame is established, it indicates trouble at the Burner.	Clean and adjust Scanner Electrode (See paragraph 7.10.2).
		Check and clean Pilot Restrictor (see paragraph 7.10.3). Flame Signal Circuit must be strong enough to allow about 12 to 17 volts at the positive and negative Test Jacks located in the Electronic Safety Control Relay Circuit Board.
		Check electrical connections between the ESC and Burner Manifold. Connections must be tight to ensure low resistance.
	If Pilot remains lit (Electronic Safety Control does not lock out), check for open circuit to Main Gas Valve. Tighten captive terminal Screws which secure ESC to Terminal Base.	

5.7 BURNER SAFETY CONTROLS—OIL UNITS

Trouble	Possible Cause	Remedy
BURNER FAILS TO IGNITE	Safety Switch in Electonic Safety Control locked out.	Actuate reset on Control. (If safety Switch contacts are dirty, actuating the reset several times will tend to clean them.)
	Loose Terminal (mounting) Screws in Electronic Safety Control.	Disconnect power and tighten Captive Screws which secure control to Mounting Base.
	Solenoid Coil in Oil Valve burned out.	Replace Coil.

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SECTION VI

PERIODIC MAINTENANCE

6.1 GENERAL

As with all types of mechanical equipment, the Clayton Steam Generator must receive periodic inspection and maintenance to maintain the level of reliability and performance it is designed to provide. The following service recommendations require but a few minutes each day and will help maintain the efficiency of the steam generator as well as minimize unscheduled repairs. Monthly maintenance log sheets (See Figure 6-1.) are included with each steam generator. Proper use of these sheets provides an accurate record and serves as a daily reminder of the routine maintenance requirements. Extra sheets (Part No. R-7517) are available direct from Clayton Industries. Cumulative hours of operation are viewed from either the ESC display or cumulative hour meter in the control box.

6.2 FEEDWATER TREATMENT

The importance of feedwater treatment cannot be overemphasized. Clayton feedwater treatment requirements are discussed in detail in the Feedwater Treatment Manual. To prevent costly repairs due to internal corrosion and/or scale formation, an effective feedwater treatment program must be given serious consideration before placing the Clayton Steam Generator in service.

6.3 CONDITIONING OF NEW INSTALLATIONS

New piping or oily substances entering the water system may cause contamination which will be evident in the feedwater pump and in the steam separator discharge. To cleanse the system, follow the procedure described in paragraph 3.2 of Section III.

6.4 SERVICE DAILY

6.4.1 RECORD STEAM PRESSURE AND TEMPERATURE

A dial thermometer (Optional) on the steam separator indicates the steam temperature.

6.4.2 TEST AND RECORD FEEDWATER

(See Feedwater Treatment Manual.)

6.4.3 MANUAL BLOWDOWN

Manual blowdown is used to control dissolved solids and to remove suspended solids and sludge. Manual blowdown may be eliminated from daily operation as long as continuous or automatic blowdown devices are used and the feedwater is tested daily for Total Dissolved Solids (TDS) content. If chemical tests are not made on a daily basis (so that blowdown frequency can be determined more accurately), the manual blowdown operation should be performed every 10–12 hours of operation. If the dry shutdown method is being used, it can be considered as the manual blowdown. If a wet shutdown is used, the blowdown may be performed any time during the day, but at least one hour before final shutdown. Manual blowdown can be performed with the generator in operation by opening the steam separator drain valve for approximately 20 seconds. Allow the machine to stabilize, then take another TDS measurement. Continue this procedure until TDS limits are within the desired range.

6.4.4 SOOTBLOW - OIL FIRED ONLY

Also see Exhaust Stack Monitor (ESM) Supplemental Instruction.

A soot blow is recommended twice per day. To remove soot from heating coil, operate the machine at normal pressure. Close the drain cock located in the soot blower line to the heating coil. Open the soot blower valve and throttle the separator discharge valve (A) (Figure 6-2). This will direct the maximum output into the soot blower. Soot blow for 30 seconds. Allow the machine to recover for two minutes, then soot blow for another 30 seconds. Close the soot blower valve and the drain cock. After completing the soot blow procedure and with the machine back to normal operation, open the drain cock to determine that the soot blower valve is fully closed and sealed, then close it tightly. This operation must be repeated at more frequent intervals if a bad sooting condition persists. If excessive soot has been allowed to gather on the coil, refer to the Coil Water Washing Supplemental Instruction in Appendix A.

NOTE

On multiple installations, with the header pressure being maintained by the other steam generators, the soot blow operation can be conducted without throttling the separator discharge valve (A).

6.4.5 WALK-AROUND INSPECTION

Perform a walk-around inspection. Check for leaks, unusual noises, stack smoke, oil level, etc. Hot lines on the manual blowdown discharge is an indication of valve leakage.

PERIODIC MAINTENANCE LOG

Refer to Instruction Manual for details of maintenance procedures.
It is the responsibility of the owner to ensure proper care of the Unit(s).
Service work, parts replaced may be documented on thr reverse side.
Some of the items described may not apply to each Model.

MODEL _____
SERIAL NO. _____
MONTH _____

DATE	DAILY DAY/TIME	OPER-ATING PRESS. (psi)	COIL FEED PRESS. (psi)	STACK TEMP (deg F)	FEEDWATER TREATMENT					CONDENSATE		SOOT BLOW	WALK AROUND INSP.
					HARD-NESS (0)	PH (10.5-12)	SULFITE (50-100) (ppm)	TDS (3000-6000) (ppm)	CHEM PUMP RATE (stroke/speed)	8.0 ph min.	CHEM PUMP RATE (stroke/speed)		
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
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31													

WEEKLY	ROTATE FUEL FILTER	PARTIAL DRAIN COND REC	CHECK MOTOR ALIGN	CHECK BELT TENSION	CHECK CPLG ALIGN	WATER METER (gals)	WEEKLY RUN HOURS
1							
2							
3							
4							
5							

ANNUAL OR SEMI-ANNUAL
(indicate dates)

REPLACED:
- Burner Nozzle(s) _____
- Pump Check Valves _____
- Pump Diaphragms/Washers _____
- Crankcase Oil _____
- Burner Electrode _____
- Burner Photocell _____

TESTED:
- Pump Relief Valve _____
- Safety Relief Valve(s) _____

MONTHLY	OPERATING							SHUTDOWN					
	VOLUTE PRESS (w.c.i.)	ATS SETTING (deg F)	FLAME SAFE-GUARD	TEMPERATURE CONTROLLERS MTC (deg C)	ATC (deg C)	RING THERM (secs)	STACK TEMP (after wash)	STRAINERS/FILTERS (remove & clean)			DRAIN & FLUSH	BLOWER		BURNER		PUMP LEVEL SWITCH	COIL WASH
								PUMP FEED	BOOSTER PUMP(S)	CONT BLOW-DOWN	FUEL OIL	ATOMIZING AIR	HOTWELL	PUMP HEADS	CLEAN VANES	GREASE MOTOR	CLEAN NOZZLE(S)	ELECTRODE GAP		

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Figure 6-1 Monthly Maintenance Log

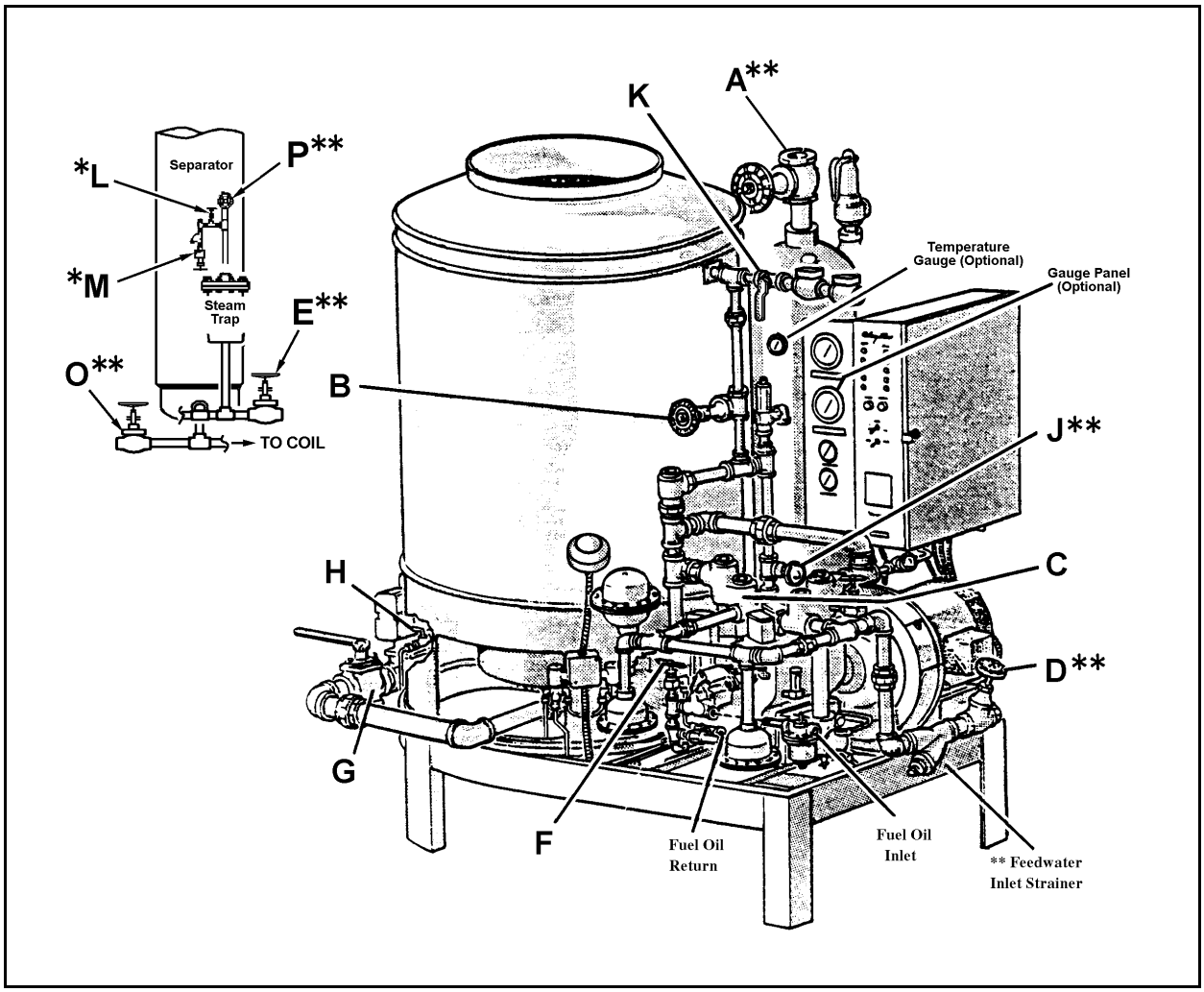


Figure 6-2 Operating Controls

A. Separator Discharge Valve**
B. Coil Feed Valve
C. Feedwater Pump Housings
D. Feedwater Intake Valve**
E. Separator Drain Valve**
F. Burner Oil Valve
G. Main Gas Cock
H. Pilot Gas Cock
J. Coil Blowdown Valve**
K. Gravity Fill Isolation Valve
L. Continuous Blowdown Shut-off Valve*
M. Continuous Blowdown Valve*
O. Coil Gravity Drain Valve**
P. Trap Discharge Valve(s)**
Q. Sootblow Valve*

*Optional Equipment
**Optionally available or else Customer Furnished

6.5 SERVICE WEEKLY

Rotate the fuel filter (Oil-fired only). Clean the element in the fuel filter (located on Fuel Oil Inlet) by turning the T-handle one (1) complete in turn either direction. This rotates an internal cartridge and combs out accumulated solids. If the handle turns hard, rotate the handle back and forth until it is free. Do not use a wrench to force the handle. Clean more often if necessary. A sudden change of fuel pressure indicates dirt has caused restriction of flow.

Partially drain the drain condensate receiver. Open the drain valve fully for about one minute (may be done while in operation). Do not allow water to drop out of sight in the gauge glass. This flushes loose solids from the tank bottom.

Check the alignment of the feedwater pump, blower, and motor pulleys with a straight-edge and secure all set screws in pulley hubs.

6.6 SERVICE MONTHLY

Check the coil feed pressure at the high-fire rate. Record and compare with the original reading for an indication of internal scaling. (The normal feed pressure may vary slightly with each installation and it is advisable to note carefully the pressure immediately after the steam generator is installed so that an accurate check of coil restriction can be made for the particular Unit.) Always note the feed pressure after the steam generator has operated for a several minutes and is thoroughly heated, and always at the same steam pressure, feedwater temperature and at full load.

Record the pressure reading on the feed pressure gauge. A pressure reading of 30 psig or more above the normal feed pressure, noted immediately after installation of the machine or after the coil has been completely cleaned, indicates coil restriction. For example, it is noted that feed pressure was 300 psi at a given steam pressure when the machine was new. Perform scale removal on the heating coil if this pressure has risen to 330 psi. (See paragraph 7.5.1 in Section VII.)

If rising feed pressure is noted within 10–30 days after initial installation, take steps immediately to correct the cause and to prevent future trouble. Carefully consider the following measures:

- Carefully check to be sure the feedwater treatment is adequate and is being used properly and consistently. See that the Water Softener is being regenerated at regular intervals. To be effective, feedwater treatment must be consistent and continuous.
- Blowdown the machine more frequently. It is sometimes necessary to blowdown more often than specified in this manual to remove solids which are precipitated in the form of sludge. The blowdown operation is not a cure-all, but it will remove some scale and thereby delay coil restriction.

NOTE

The Feedwater Treatment Manual contains detailed information with regards to the importance of feedwater treatment and the recommended procedures and equipment necessary to prevent scale and corrosion within the steam generator.

6.6.1 CHECK VOLUTE PRESSURE

A 1/4-inch diameter tube stub is located on the left-hand side of the burner volute. This is a convenient 1/4-inch hose connection to operate a manometer for periodic or continuous monitoring of the volute pressure. A 10-inch range water column instrument can be used for this purpose. An economical model may be constructed from plastic tubing. Compare readings to those documented at the time of initial commissioning. Variations may be indicative of combustion problems and/or a dirty blower wheel.

6.6.2 FLUSH FEEDWATER PUMP HEADS AND COLUMNS

Open the drain cocks at the base of the feedwater pump until clear water appears. If heavy accumulations of sludge are indicated, repeat this operation frequently. If the drain cocks are plugged, remove the cocks and use a stiff wire to dislodge sediment. (Feedwater pump may be operated and coil feed valve throttled to provide pressure to purge cock if not severely plugged.)

CAUTION

Stop the machine before attempting to remove drain cocks.

6.6.3 CHECK TEMPERATURE CONTROLLERS (MTLC1 & MTLC2)

(See Section VII, paragraph 7.7.)

6.6.4 CLEAN FEEDWATER STRAINERS

Secure the machine. Close the feedwater intake valve (D). Remove the Screen from the Strainer and clean thoroughly. Reassemble the screen and cap and re-open the feedwater intake valve (D). (See Figure 6-2.)

6.6.5 DRAIN AND FLUSH CONDENSATE RECEIVER

CAUTION

Secure the machine before performing this maintenance procedure.

a. Open the drain valve at the base of the condensate tank and allow the water to completely drain.

b. Close the drain valve.

c. Fill the tank with clean potable water.

d. Open the drain valve to drain the tank. Verify the water draining from the tank is clean and free of sludge. Repeat the steps above until the rinse water runs clean.

e. Close the drain valve.

f. Fill the tank to the proper level with chemically treated water.

6.6.6 CLEAN BLOWER ROTOR

If dirt or lint is allowed to accumulate on the cupped side of the blower rotor blades, shortage of air to the burner will cause reduced burner efficiency. The frequency of cleaning will depend on the amount of dirt or lint in the air at the particular installation. To clean, remove the nut and remove the blower inspection cover. Insert the curved end of the cleaning tool (UH-15252) under the rotor blade (See Figure 6-3.) and move the tool back and forth until the entire under surface of the blade is cleaned. Repeat on all blades. The volute pressure, at high fire, is a good indicator of blower condition (if no change in damper adjustment has been made).

6.6.7 CLEAN AND ADJUST BURNER

(See paragraphs 7.10 and 7.11.)

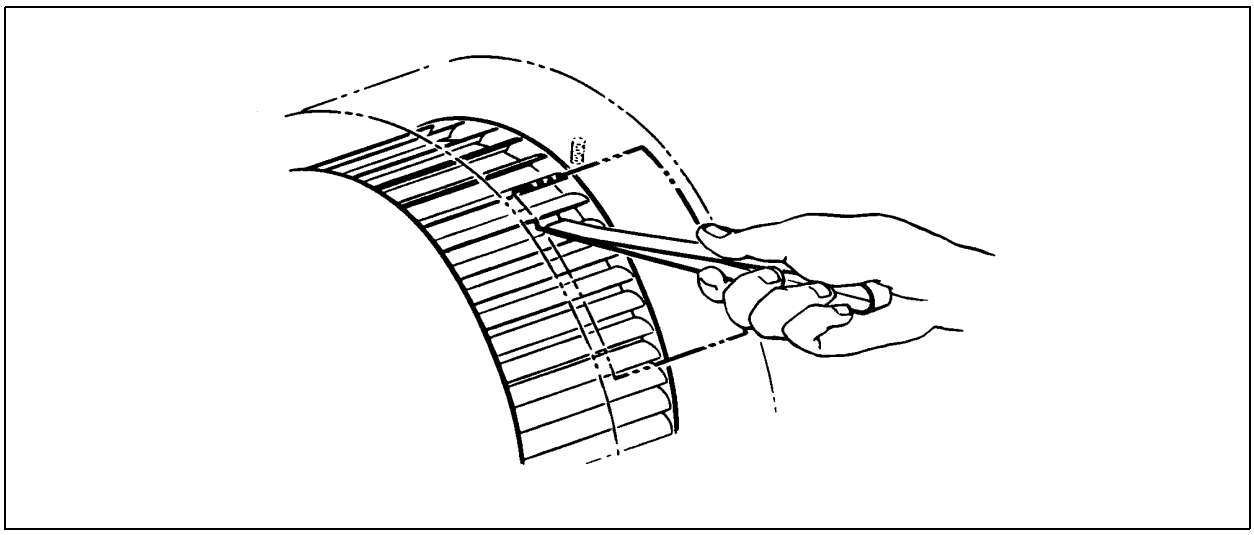


Figure 6-3 Use of Clayton blower rotor cleaning tool (UH-15252)

6.7 SERVICE ANNUAL (OR SEMI-ANNUAL FOR 24-HOUR, 7-DAY OPERATION)

6.7.1 REPLACE OIL BURNER NOZZLES

(See paragraph 7.11.1 in Section VII.)

6.7.2 INSPECT FEEDWATER PUMP CHECK-VALVES

Replace the seats and discs if worn. (See paragraphs 7.1.1 and 7.1.2 in Section VII.)

6.7.3 INSPECT FEEDWATER PUMP DIAPHRAGMS

Replace at about 7000 hours of operation, or sooner, during scheduled preventative maintenance shutdowns (See paragraph 7.1.3 in Section VII). Torque down diaphragm nuts regularly, as needed.

6.7.4 REPLACE OIL IN CRANKCASE

Replace crankcase oil once a year (more often under severe conditions), drain and refill the feedwater pump crankcase with new hydraulic oil (approximate capacity 3 1/2 quarts). Use a hydraulic oil with a viscosity of 735 to 840 SUS at 100^{o} F. The following list are oils recommended by Clayton Industries:

Chevron Machine Oil AW-150 (Standard Oil of California). . . . . 735 SUS @ 100^{o} F
Shell Tellus Oil 150 (Shell Oil Company). . . . . 802 SUS @ 100^{o} F
Texaco Rando Oil HD-150 (Texaco, Inc.). . . . . 751 SUS @ 100^{o} F
Mobil DTE Extra Heavy Hydraulic Oil (Mobil Oil Co.) . . . . . 767 SUS @ 100^{o} F
Exxon Teresstic Oil 150 (Exxon Oil Co.) . . . . . 840 SUS @ 100^{o} F

Inspect all air and fuel control linkages (where applicable) for wear, loose screw, free movement, and other potential maintenance issues.

6.7.5 TEST SAFETY RELIEF VALVES

Set the Steam Pressure Setting (SPS) and the Limit Pressure Switch (LPS) to exceed the safety relief valves pressure setting. Allow pressure to increase by throttling the separator discharge valve (A) until the safety relief valves actuate.

CAUTION

Open the separator discharge valve (E) immediately if the valves do not actuate after exceeding the pressure setting.

WARNING

The high noise level from the safety valves actuating may cause damage to hearing. Hearing protection is highly recommended when conducting this test.

After the test is accomplished, regulate the steam pressure to the desired working pressure. Reset the Steam Pressure Switch (SPS) and Limit Pressure Switch (LPS). (See paragraphs 7.19, Section VII, for LPS setting instructions.) Open the separator discharge valve (A) completely. Service or replace the safety relief valve(s), as necessary, if test fails.

6.8 LUBRICATION

Check the electric motor lubrication. If the motor is equipped with sealed bearings, the bearings are pre-lubricated for the life of the motor. When greasing bearings, wipe the grease fittings clean and use clean equipment. If the motor is equipped with pressure grease fittings, remove the plug below the motor shaft and pump the grease in slowly until grease appears at the plug outlet. To prevent rupture of grease seals, run the motor for 4–5 minutes before replacing the plug. Use a good quality rust inhibited polurea-based grease, such as Chevron SR1.

SECTION VII

COMPONENT MAINTENANCE

7.1 FEEDWATER PUMP

7.1.1 CHECK-VALVE MAINTENANCE

(See Figure 7-1.)

a. Unscrew the Check-valve Caps (2) from the Check-valve Housing (7) and disassemble the Discs (4) from the Caps.

b. Remove any scale and pits from the Discs (4). Place a piece of fine grit sandpaper (#400 grit, or finer, wet/dry) on a plate glass and rub the Disc on the sandpaper in a "figure 8" motion. The Discs must be smooth and flat for proper Water Pump operation.

c. Inspect the Intake and Discharge Springs for distortion and for free length. The Free length of the Discharge Springs (3) should be 31/32 inch; the free length of the Intake Springs (5) should be 25/32 inch. Replace any broken or distorted Springs.

d. Inspect the Valve Seats (1) for scored or damaged condition. Replace damaged Seats as instructed in paragraph 7.1.2.

e. Remove scale from inside the Check-valve Housings (7) with a 2:1 solution of KleenKoil, or other properly inhibited, scale-removing acid. Mix two parts water to one part KleenKoil and fill the Check-valve Housings and Pump Columns with this solution.

f. Remove scale on the Springs and Discs by immerging them in the KleenKoil solution. Once scale has dissolved, thoroughly flush the parts with water.

g. Open Drain Cocks (14) and drain the acid solution after scale has dissolved; then, flush the Housings and Columns with clean, potable water.

NOTE

When assembling the Springs and Discs, first assemble the Spring to the Disc by inserting a finger through the center of the Spring and pressing the end of the Spring over the Button on the Disc. Then, attach the Spring to the Valve Cap. This will prevent unnecessary distortion and possible deformation of the Springs. Remove and process Check-valves one-at-a-time to avoid interchanging parts.

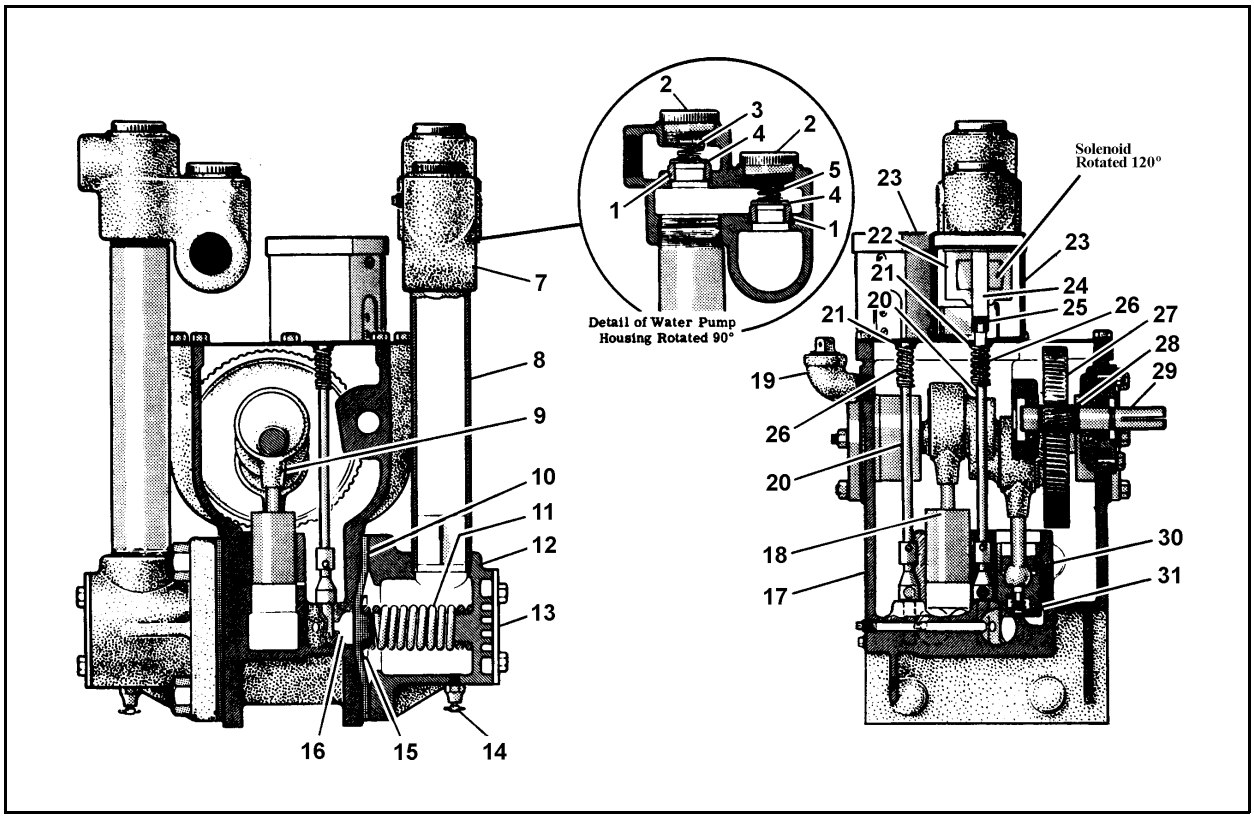


Figure 7-1 Water Pump (Sectional View)

1. Valve Seat
2. Check-valve Caps
3. Discharge Springs
4. Discs
5. Intake Spring
6. (not used)
7. Check-valve Housing
8. Stand Pipe
9. Connecting Link
10. Diaphragm
11. Return Springs
12. Pump Head
13. Water Jacket Cover (semi-closed only)
14. Drain Cock
15. Diaphragm Washers
16. Hydraulic Chamber
17. Crankcase
18. Pump Piston
19. Oil Filler Elbow
20. Bypass Rod
21. Packing
22. Solenoid
23. Solenoid Cover
24. Solenoid Armature
25. Solenoid Pin
26. Spring
27. Main Gear
28. Pinion Gear
29. Pinion Shaft
30. Piston and Link
31. Vacuum-breaker Valve

7.1.2 VALVE SEAT REPLACEMENT

(See Figure 7-2.)

To replace Valve Seats, it will be necessary to use a special Seat Puller (Part No. UH-25257) and a special Seat Driving Tool (Part No. UH-18389). The Seat Puller will remove both the Check-valve Seat and the Seat Assembly.

a. Adjust Puller Stem counterclockwise until jaws can be retracted into the Body. Unscrew Body Nut sufficiently to allow retracted Jaws to extend below Valve Seat when Puller is inserted into Check-valve Housing (see inset A).

b. Insert Puller into Check-valve Housing and turn the Stem clockwise in the Body until the jaws are fully extended below bottom of the Valve Seat (see inset B).

c. Hold Body with wrench and turn Body Nut clockwise until the Valve Seat is free of the Check-valve Housing (see inset C). Remove Puller and turn Stem counterclockwise to free the Seat.

d. Drive in Seat Assembly using the Seat Driving Tool (see inset D) using care to avoid damaging the Seat Face.

e. After Seats have been properly installed, assemble new Springs to existing Check-valve Caps with new Check-valve Discs. Install correct Springs and Caps in proper ports of Check-valve Housings.

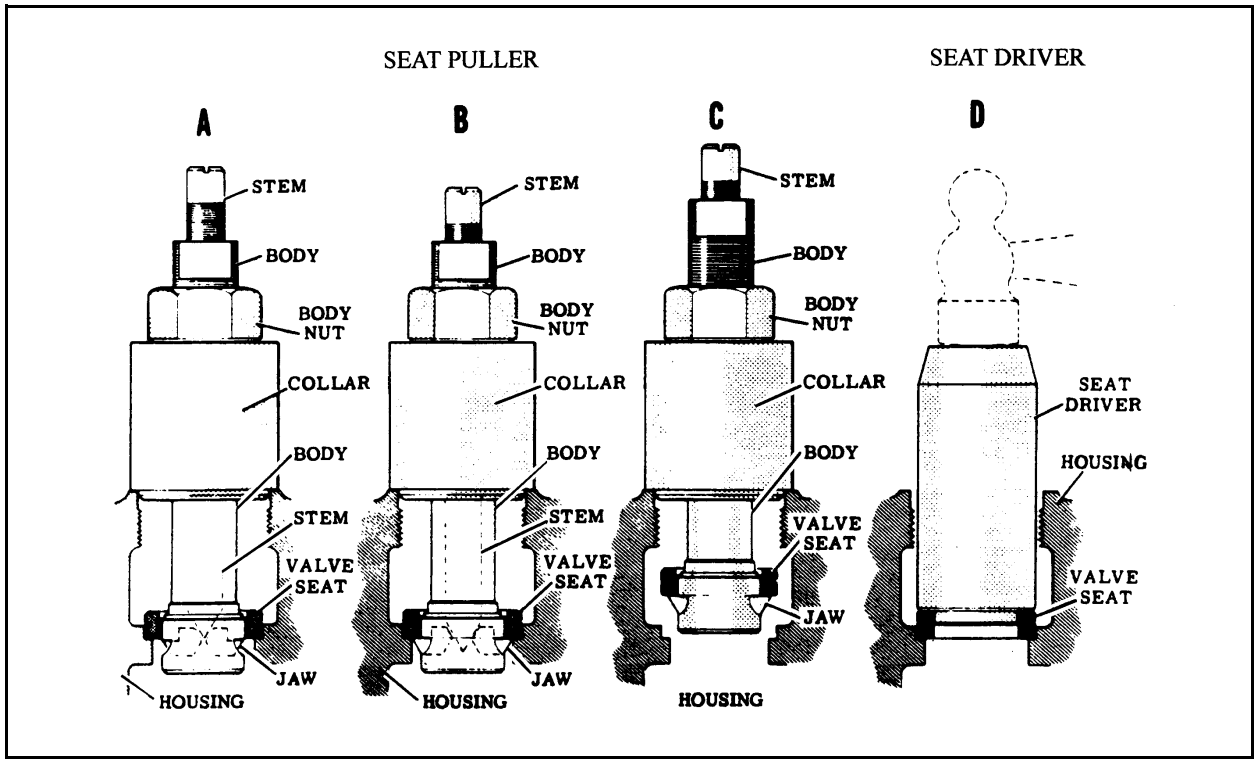


Figure 7-2 Use of seat puller and seat driver

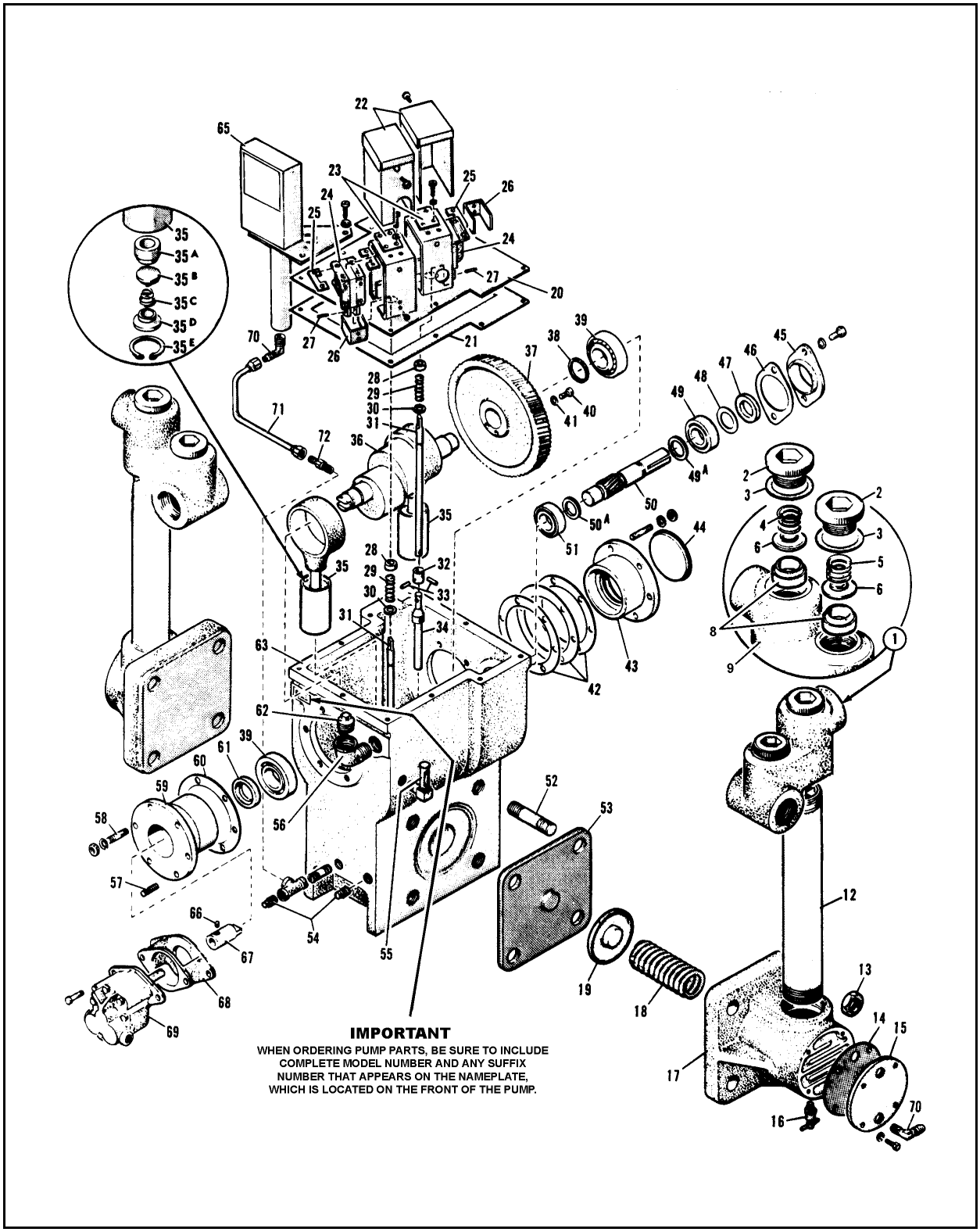


Figure 7-3 Water Pump, Exploded View

Figure 7-3 Pump Parts Identification List

1. Check-valve Housing
2. Check-valve Cap
3. Gasket
4. Discharge Spring
5. Intake Spring
6. Disc
7. (not used)
8. Seat
9. Housing
10. (not used)
11. (not used)
12. Standpipe
13. Hex Nut
14. Plate Gasket (Semi-Closed)
15. Cover Plate (Semi-Closed)
16. Drain Cock
17. Pump Head
18. Diaphragm Spring
19. Diaphragm Washer
20. Cover Plate
21. Gasket
22. Cover Assembly
23. Solenoid Plate
24. Solenoid
25. Mounting Plate
26. Retainer Bracket
27. Rod Pin
28. Packing Ring
29. Retainer Spring
30. Retaining Ring
31. Upper Bypass Rod
32. Coupling
33. Pin
34. Rod
35. Piston and Link Assembly
35A. Valve Seat
35B. Valve Disc
35C. Valve Spring
35D. Spring Retainer
35E. Retaining Ring
36. Crankshaft
37. Main Gear
38. Bearing Spacer
39. Roller Bearing
40. Cap Screw
41. Lock Washer
42. Gasket
43. Rear Bearing Cap
44. Plate
45. Pinion Bearing Retainer
46. Retainer Gasket
47. Oil Seal
48. Shaft Shim
49. Ball Bearing
*49A. Bearing Spacer
50. Pinion Gear
*50A. Bearing Spacer
51. Ball Bearing
52. Stud
53. Pump Diaphragm
54. Pipe Plug
55. (not used)
56. Pipe Elbow
57. Stud
58. Bracket Stud
59. Front Bearing Cap
60. Gasket & Seat
61. Oil Seal
62. Pipe Plug
63. Pump Crankcase
64. (not used)
65. Oil Level Switch
66. Set Screw
67. Fuel Pump Coupling
68. Bracket
69. Fuel Pump
70. Tube Connector
71. Switch Tube
72. Tube Elbow

7.1.3 PUMP DIAPHRAGM REPLACEMENT

7.1.3.1 Removal

(See Figure 7-3.)

a. Remove Drain Cock (16) and drain water from Pump. Remove Pipe Plug (54) and drain Oil from Pump.

b. Disconnect piping from Pump. Unscrew Hex Nuts which secure Pump Heads (17) to Crankcase and remove Check-valve Housings (1), Pump Heads (17) and Standpipes (12) as a unit from each side of Crankcase.

c. Remove Diaphragm Return Springs (18), Diaphragm Washers (19) and Diaphragms (53).

d. Replace worn or deteriorated Diaphragms. Replace broken or distorted Springs (18). Free length of Springs should be about 5 3/16 inches.

7.1.3.2 Reassembly

(See Figure 7-3.)

a. Position Diaphragms to Pump Case and install Pump Heads. Tighten Stud Nuts evenly until secure. If a Torque Wrench is used, tighten Nuts to about 150 foot-pounds. Be sure Springs (18) and Diaphragm Washers (19) remain in correct position during assembly.

b. Fill Pump Crankcase with hydraulic oil (with viscosity of 735 to 840 SUS at 100^{o} F) to proper level (about 5 1/2 quarts required). (Also, see paragraph 6.7.4 in Section VI.)

c. **Important!** After installation, operate Plant normally for at least 24 hours. Then shut down Plant and allow to completely cool. Retighten all Pump Head Nuts while Pump is cold to take up set in Diaphragms and prevent leakage.

7.1.4 PUMP DISASSEMBLY AND REPAIR

(See Figure 7-3.)

7.1.4.1 Disassembly

a. Disconnect piping and tubing from Pump at unions. Unscrew attaching screws and remove Pump from Generator frame.

b. Remove Water Pump Heads, Check-valve Housings and Diaphragms from Pump as instructed in paragraph 7.1.3. Remove Oil Level Switch (65) from Pump Case.

c. Unscrew sheetmetal screws and remove Covers (22). Remove Retainer Brackets (26) and slide Pins (27) from Solenoid Armatures.

d. Unscrew Cap Screws and remove Cover Plate (20) and Gasket (21) from Pump Case (63). Remove Packing (28), Spring (29) and Bypass Rods (31 and 34) from Pump Case.

e. On Oil-fired Units, remove Fuel Pump (69) and Bracket (68) from front of Pump.

f. Unscrew the Nuts which attach the Bearing Caps (43 and 59) to the front and rear of case. Insert 3/8-16 Screws into tapped holes in the Bearing Caps and carefully jack the Caps away from the Pump Case.

CAUTION

Use a shield to protect the seating member in Oil Seal (61).

g. With the Bearing Caps removed, the Crankshaft (36) and attached parts can be removed through the top of the case.

h. Pull Bearings from each end of Crankshaft Unscrew Cap Screws (40) and remove Main Gear (37).

i. Slide Pump Piston and Links (35) from Crankshaft. Note location of each Piston and Link to be sure they are installed into the same location when reassembling.

j. Remove Retaining Ring (35E) from Feedwater Pump Piston (35). Disassemble Spring Retainer (35D), Spring (35C) and Disc (35B) from Piston.

k. Remove Bearing Retainer (45) and slide Pinion Shaft and Gear from Case.

7.1.4.2 Inspection

a. Inspect all Bearings and Bearing surfaces for worn or scored condition. Inspect Pistons and Cylinder walls for worn or scored condition.

b. Inspect Valve Disc (35B) and Seat (35A) for scores or pits. Inspect Spring (35C) for distortion or damage. Free length of Spring should be 3/4 inch.

c. Inspect Pinion and Main Gear for worn or damaged teeth.

d. Inspect Oil Seals (47 and 61) and Packing (28) for worn or deteriorated seating members.

7.1.4.3 Repair

a. Use a Bearing puller to remove damaged Bearings (49 and 51) from Pinion Shaft. When installing new Bearings, place pressure on inner race of Bearing only. Spacers (49A and 50A) are used on 60-Hz Units only.

b. Replace Piston and Link Assemblies (35) if Links or Pistons are worn or damaged. Replace worn or scored Crankshaft (36).

c. Scored Disc (35B) may be resurfaced by rubbing it in a "figure 8" motion on a piece of fine sandpaper (wet or dry No. 400 or finer) placed on plate glass. See paragraphs 7.1.1 for cleaning and inspection of Water Pump Check-valves.

d. Replace all other worn, scored, or damaged Bearings and parts.

7.1.4.4 Reassembly

a. Install Pinion Shaft and Gear (50) with Bearings assembled into Pump Case and secure with Bearing Retainer (45). Check endplay of Pinion shaft. Endplay must be 0.009 inch (minimum) to 0.018 inch (maximum). If necessary, remove Bearing Retainer (45) and add or remove Shims (48) to maintain this tolerance.

CAUTION

Use care to prevent damage to sealing member in Oil Seal (47).

b. Assemble Disc (35B, Spring (35C) and Spring Retainer (35D) into Feedwater Pump Piston (35) and secure with Retaining Ring (35E).

c. Slide Pump Piston and Link (35) on the end of the Crankshaft.

d. Assemble and secure Main Gear (37) to Crankshaft Screws (40) must be tightened securely (30 foot-pounds torque). Press Cone sections of Bearings (39) on ends of Crankshaft Spacer (38) is installed at gear end of Crankshaft only.

e. Press cup sections of Bearings (39) into Bearing Caps (43 and 59). Place one 0.015-inch aluminum Gasket (60) on front Bearing Cap (59). Place one or more Gaskets (42) on Bearing Cap (43). These Gaskets are used for clearance purposes and are available in three thicknesses—0.005 inch, 0.010 inch and 0.015 inch. As a trial, the first stack-up should total at least 0.015 inch in thickness.

f. Carefully lower the Crankshaft and attached parts into the Crankcase while guiding the Pistons into the Cylinders.

g. Position Bearing Caps (43 and 59) to Crankcase and align Crankshaft with Bearing Caps; then tap Caps into place and secure Caps to Crankcase.

h. Crankshaft endplay should be checked with a dial indicator as follows: Place pressure on front end of Crankshaft to be sure rear Bearing (39) is completely seated into its Cup. Set indicator on flat front face of Main Gear (37) and adjust indicator to zero. Remove pressure from front end of Crankshaft and reverse the procedure by placing pressure on rear end of Shaft to seat Cone of front Bearing (39) in its cup, then read indicator. Endplay must not be less than 0.003 inch nor more than 0.007 inch. If endplay does not fall between these limits, remove Bearing Cap (43) and add or remove Gaskets (42) to compensate and bring endplay within the accepted tolerance.

i. Assemble upper and lower Bypass Rod parts (28 through 34) and position the assembled parts into Pump Case. Install The Plate (20), Oil Level Switch (65) and Gasket (21) to top of Pump.

j. Position Solenoid (24) into Housing and secure with Plate (23) and Screws and Washers. Secure Bypass Rod to Solenoid Armature with Pin (27). Secure Pin Retainer Bracket (26) to Solenoid Housing. Install Cover (22) to Solenoid Housing.

NOTE

Before completely tightening Screws on Plate (23), check Solenoid Armature and Bypass Rod for alignment and freedom of movement. The Feedwater Pump will not operate if Linkage binds. Loosen Screws and adjust position of Solenoid if necessary.

k. Install Diaphragms and add oil as instructed in paragraph 7.1.3.2.

l. Reconnect Pump to Steam Generator. After starting Plant, inspect for leaks and tighten if necessary. Watch Plant carefully for the first few hours of operation to be sure Pump is maintaining a fully charged system.

7.1.5 PUMP OIL LEVEL SWITCH ADJUSTMENT (OPTIONAL EQUIPMENT)

(See Figure 7-4.)

a. Secure the Steam Generator and disconnect main electrical power.

b. Manually move Lever Arm up and down and check actuation by listening for Switch "clicking" sound or use a self-powered test lamp. Switch should be de-energized at both the top and bottom points of the Switch actuating limits.

c. Adjust Switch actuating points by loosening both Mounting Screws and move bottom of Switch to the right to increase actuating limits, or to the left to decrease actuating limits. The bottom mounting hole is slotted and the Switch will pivot about the top Mounting Screw.

d. After adjustment, tighten Mounting Screws and recheck Switch actuation.

CAUTION

Do not adjust Switch by bending extension.

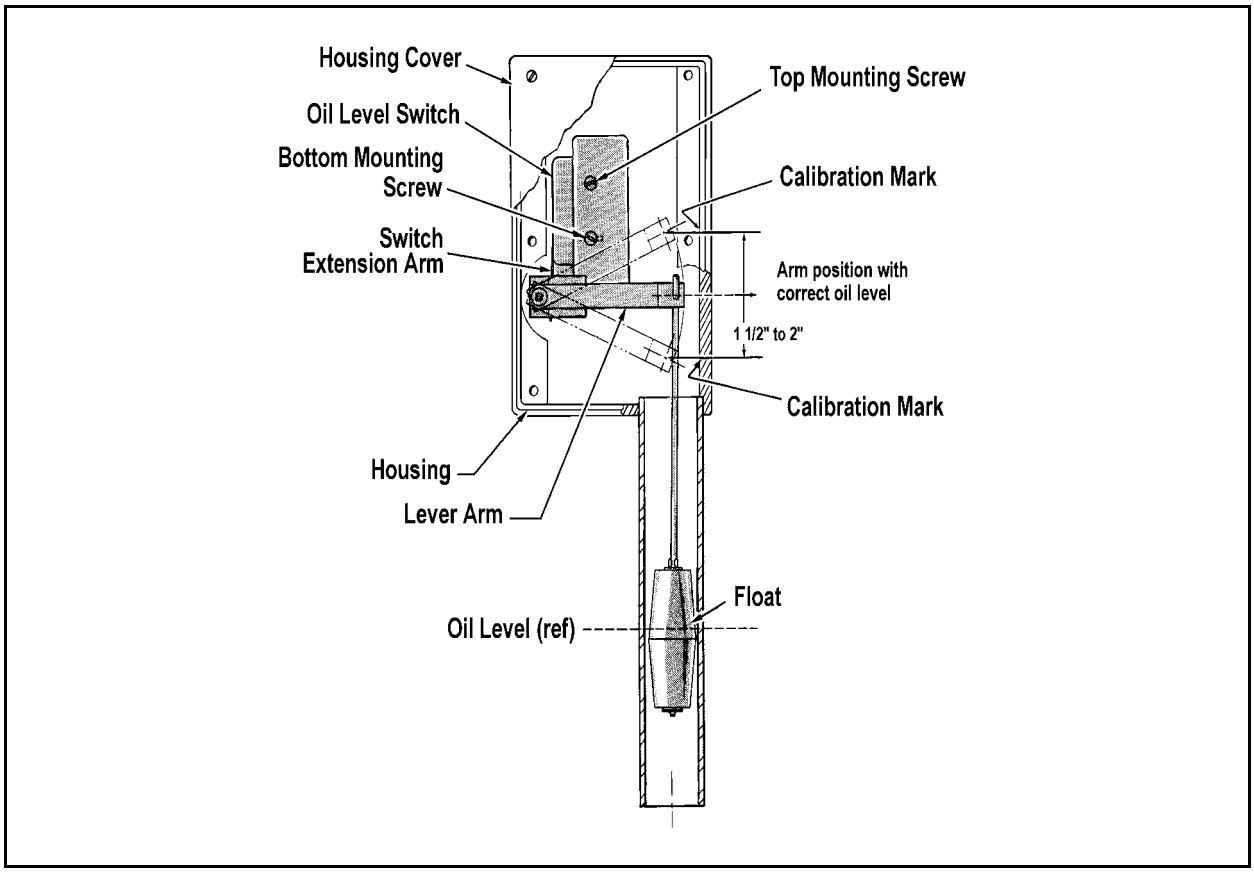


Figure 7-4 Water Pump Oil Level Float Switch (optional equipment)

7.2 WATER PUMP RELIEF VALVE

(See Figure 7-5.)

7.2.1 ADJUSTMENT

The Relief Valve should be adjusted to open at about 600 psi feed pressure but remain drip-tight during operation. Leakage from this Valve will result in insufficient water to the Heating Unit and cause overheating.

NOTE

Under certain conditions, when starting the Unit, feed pressure may temporarily rise sufficiently to cause the Relief Valve to release a small amount of water. Feed pressure will return to normal, however, after the Unit heats and the system becomes stabilized.

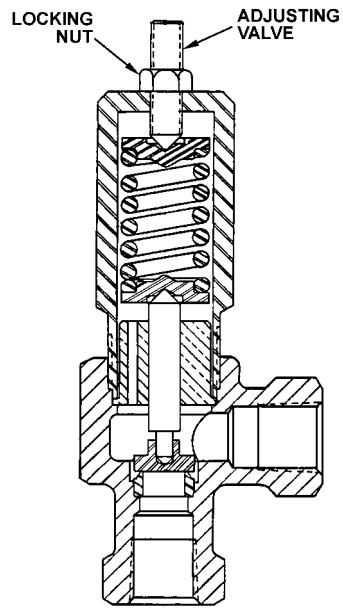


Figure 7-5 Water Pump Relief Valve

a. Start Plant without Burner operation and slowly close Coil Feed Valve (B, Figure 7-2) until Relief Valve just begins to discharge and check pressure on Feed Pressure Gauge at that point.

b. To raise pressure adjustment, turn Adjusting Screw (1) clockwise; to lower pressure adjustment, turn Screw counterclockwise. Secure Adjusting Screw with Lock Nut (2) after adjustment.

c. Fully open Coil Feed Valve. Inspect Relief Valve for leakage during normal operation.

7.2.2 REPAIR

(See Figure 7-5.)

a. Loosen Adjusting Screw (1) and unscrew Housing (3) from Body (10). Inspect Disc (8) and Seat (9) for scored or damaged condition. Replace damaged Seat.

b. If Disc is scored, it may be resurfaced by rubbing it on a piece of fine sandpaper (wet-dry No. 400 or finer) placed on a perfectly flat surface.

c. When reassembling, be sure Spring Washers (4) are not cocked in housing.

7.3 WATER PUMP DISCHARGE SNUBBER

(See Figure 7-6.)

If replacement of the rubber insert (3) is necessary, the old insert must be cut away from the Retainer (2). To facilitate assembly, lubricate the new insert with glycerin (do not use oil) to allow it to be pushed into the retainer and bottom housing (4).

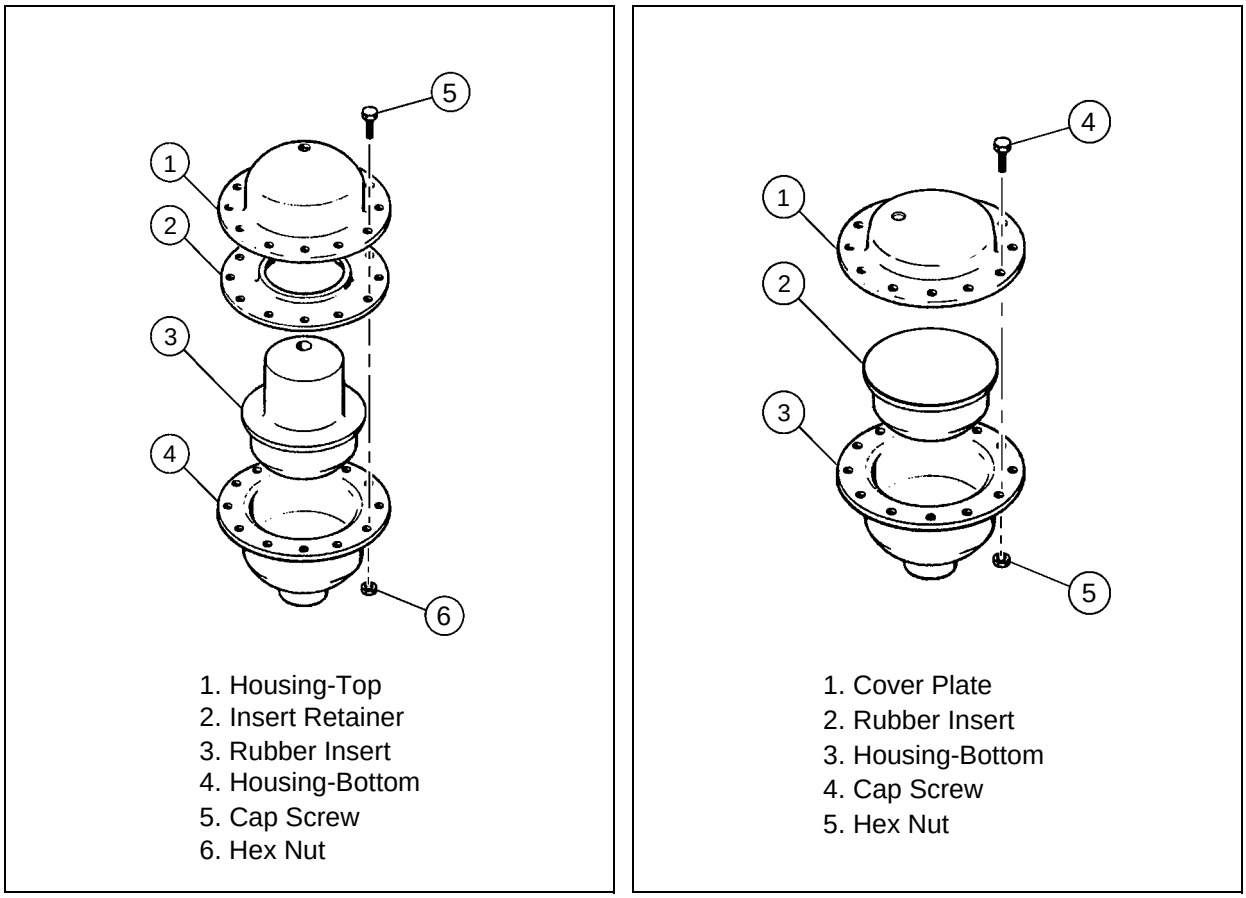


Figure 7-6 Discharge Snubber, left; Intake Surge Chamber, right

7.4 WATER PUMP INTAKE SURGE CHAMBER

(See Figure 7-6.)

The Water Pump Intake Surge Chamber absorbs pulsations at the Water Pump Intake, reducing the possibility of vapor lock with high-temperature feedwater. If replacement of the rubber insert (2) is necessary, the old insert must be cut away from the Cover Plate (1). To facilitate assembly, lubricate the new insert with glycerin (do not use oil) to allow it to be pushed into the and Bottom Housing (3).

7.5 HEATING COIL

7.5.1 RESTRICTED COIL SCALE REMOVAL

Improperly treated feedwater often leads to Coil scaling—a mineral buildup inside the coils—over time. The following is the procedure for descaling restricted Evaporator coils. The large container used in this procedure facilitates the adding of the acid solution and the monitoring of how the descaling is progressing. A feed-and-bleed process is employed during the descaling procedure. Refer to Figure 6-3, in Section VI, for the corresponding parenthetical callouts.

a. Obtain one non-galvanized, acid-resistant, 50-gallon container. Place the container near the Feedwater Pump. If possible, provide a pipe outlet 1–2 inches from the bottom of the container for acid suction. Elevate the container to provide a 12-inch gravity feed to the Feedwater Pump.

b. Start the Unit in the FILL mode, without Burner operation. Allow cold water to circulate through the entire system until it is cooled; then stop the Unit and close the Feedwater Intake Valve.

c. Remove and replace the Intake Surge Chamber with a suction hose. *Make sure the hose is manufactured from acid-resistant materials.*

d. Attach the opposite end of the suction hose to the outlet at the bottom of the 50-gallon container. If there is no outlet at the bottom of the container, fasten a fine mesh screen over the end of the hose and place that end of the hose inside the container. Secure the hose to the container to prevent it from slipping out.

e. Fill the container with 4–5 inches of water. Make sure the suction hose or suction outlet is below the water level.

f. Remove the Coil Gravity Drain Valve (O). Attach a second acid-resistant type hose to the Coil Gravity Drain outlet. A flange adapter may have to be fabricated to attach the hose. This hose must be long enough to reach the container.

g. Securely fasten the opposite end of the hose to the container so that it will not dislodge during the descaling operation. Considerable pressure can develop in the hose.

h. Close the Trap Discharge Valve (P). Close the Separator Drain Valve (E).

i. Start the Unit without Burner operation. Add or remove water from the container until a steady circulation can be maintained through the system and back to the container with about 4–5 inches of water remaining in the container. Be sure both Feedwater Pump Housings are primed.

WARNING

Wear protective clothing. If acid is used improperly, it may cause serious personnel injury.

j. Mix one can of KleenKoil to one gallon of hydrochloric acid. *SLOWLY* add this acid solution to the container until a total of 10 gallons has been added. For heavy scaling, use 25 gallons.

CAUTION

Adding the acid too rapidly could cause bubbling in the Feedwater Pump Check-valve Housing and could result in the loss of Pump prime.

Initially add the acid solution slowly until the circulation can be maintained without excessive bubbling from the discharge hose. For example, add about 1/2 cup and wait for the reaction to subside, then add another 1/2 cup, repeat. As the cleaning operation progresses, acid can be added in gradually increasing amounts. In extreme cases, it is possible to completely block the passage through the Coil with loosened scale if acid is added too rapidly.

k. Continue the circulation for 4–6 hours. A longer circulation time is required if bubbling still occurs in the discharge solution.

NOTE

During this period, frequently check to be sure that the Feedwater Pump is primed. The only way to make sure that the Pump is primed is to slowly throttle Coil Feed Valve (B) until the pressure rises on the Feed Pressure Gauge. If the pressure fails to rise, the Pump will require priming. Reopen the Coil Feed Valve after check.

l. Test the acid at regular intervals by adding a pinch of sodium bicarbonate (baking soda) into the container. If no foaming reaction takes place, the acid has been neutralized and it will be necessary to increase the acid concentration in the acid solution.

m. When the bubbling subsides, *SLOWLY* heat the solution by intermittently starting and stopping the Burner until the solution temperature rises to no more than 150^{o} F. Continue circulation for an additional 2 hours, cycling the Burner whenever necessary to keep the solution hot.

WARNING

DO NOT allow the solution to boil, as injury to personnel and damage to equipment may result.

n. Shut down the Unit. Carefully remove the suction and discharge hoses from the acid container and direct them into a drain. Open Separator Drain Valve (E). Allow as much of the solution to drain to waste as possible; then remove the suction hose and reinstall the Feedwater Pump Intake Surge Chamber.

IMPORTANT

Discharging the acid solution into a local sewage system may be in violation of municipal regulations. Verify with local government regulatory agencies for the proper method of disposal.

o. Close the Separator Drain Valve (E) and open the Feedwater Intake Valve. With the discharge hose still directed to the drain, start the Unit without Burner operation and allow the Unit to run for at least 10 minutes to flush the system of the acid solution. Be sure the Feedwater Pump remains primed. Flush the Standpipes by opening the Drain Cocks to allow water to run until clear.

p. Stop the Unit and remove the discharge hose. Reinstall the Coil Gravity Drain Valve (O) and plumbing. Inspect and clean the Pump Check-valves (See paragraph 7.1.1).

q. Open the Separator Drain Valve (E). Open the Trap Discharge Valve (P).

IMPORTANT

Start the Unit and blowdown the Unit thoroughly four to five times (see paragraph 4.4.2, Section IV) before resuming normal operation. This will dislodge and remove much of the loosened scale.

7.5.2 HEATING COIL REMOVAL

(See Figure 7-7.)

The Heating Coil has been designed to enable its removal without disassembling the Coil, Inner Shell, and Insulation Assembly.

a. Disconnect piping from the feedwater inlet and outlet connections and all interferences.

b. Remove the Sealing Plate, the Thermocouple Assembly, and piping to avoid interference with the Heating Coil removal.

c. Disassemble the removable section of the Exhaust Stack above the Outer Heater Cover (1).

d. Remove the two top Outer Clamp Bands (3) which secure the Outer Shell Extension. Remove the Outer Heater Cover (1) and the Shell Extension.

e. Remove the Inner Clamp Band (17) which secures the Inner Heater Cover (2). Remove the Inner Heater Cover.

f. Remove the lower Clamp Band (3) which secures the Outer Shell (4) of the Heating Coil to the Burner Base (5).

g. Remove the sheetmetal screws from the Heating Coil's Outer shell (4) and remove the Outer Shell sections.

h. Loosen castable insulation, it may be necessary to remove some, or all of the insulation. Soaking the castable insulation in water (insulation is water soluble) may be required overnight, prior to lifting Coil Assembly.

i. Remove the Hold-down Bolts, located at the bottom of the shell at the Anchor Brackets.

j. Lift the Heating Coil and Shell Assembly completely from the Burner Base using the Lifting Lug (16). The Burner Base and Frame must be bolted down while lifting the Coil Assembly.

1. Outer Heater Cover
2. Inner Heater Cover
3. Outer Clamp Band
4. Outer Shell
5. Burner Base
6. Burner Manifold
7. Burner Volute
8. Refractory Insulation
9. Cap Screws
10. Castable Insulation
11. Water Air Passage
12. Air Passage
13. Heating Coil
14. Coil Insulation
15. Cap Screws
16. Lifting Lug
17. Inner Clamp Band

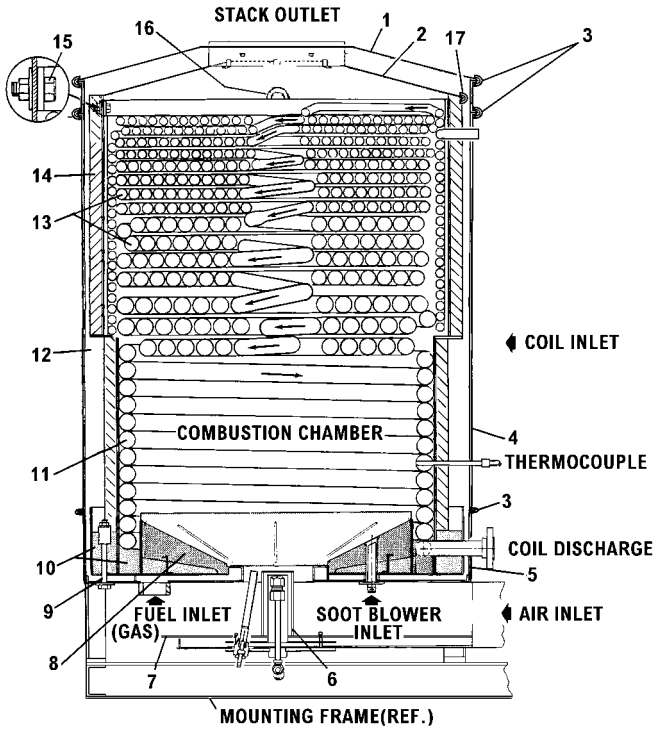


Figure 7-7 Heating Unit (Typical)

7.5.3 HEATING COIL REPAIR

(See Figure 7-7.)

Hydrostatically test the Coil for leaks. If suitable welding cannot be made, the Coil must be replaced. To replace Coil, remove the Coil according to procedure in paragraph 7.5.2, above. Install new Coil according to procedure in paragraph 7.5.4, below.

7.5.4 HEATING COIL INSTALLATION

Hydrostatically test the Heating Coil for leaks. If the Code proper weld repairs cannot be made in the field, the Coil must be sent to Clayton Industries factory repair facility or replaced. To replace the Coil, proceed as follows:

a. Seal the Vent opening around the top of the Burner Base and Coil Discharge outlet with masking tape. This will prevent insulating material from entering the cooling air passage.

b. Fill the Coil recess in the Burner Base with mixed castable insulation (only enough water to dampen the mixture). Lift the Coil and position it on the Burner Base, allowing the Coil to settle into the insulation. Secure the Coil to the Burner Base with the four (4) Hold-down Bolts. Remove the masking tape seal from the vent opening when the insulation dries sufficiently.

c. Replace the Thermocouple Assembly and plumbing. Re-install all Outer Shells (4), and Inner (2) and Outer Heater Covers (1). Replace the Upper and Lower Clamp Bands (3). Replace the removable section of the Exhaust Stack.

d. Replace the Cap Screws which attach the Separator to the Bracket on the Coil. Reconnect the Heating Coil inlet and outlet piping connections.

e. Verify all piping and electrical connections are attached correctly.

7.5.5 REMOVAL OF EXCESSIVE SOOT

Where an Oil-fired Steam Generator has been operated with improper air adjustment for any amount of time or where uniform periodical soot blowing has not been followed, it may be necessary to wash the Coil with water to remove the excessive soot accumulation. Wash the Coil as follows:

a. If the Generator has been in operation immediately before preparing to wash the Coil, operate the Blower (Burner off) for about 15 minutes to cool the Unit before the washing is started.

b. Disconnect and remove Stack Section immediately above the Heater Cover.

c. Remove the Burner Manifold.

d. Provide a trough under the Burner Volute opening to drain off water used for washing the Coil.

e. Use preferably a 3/4-inch hose (large garden hose which can supply water at a minimum of 5 gallons per minute) and insert the discharge of the hose (no nozzle) through the Stack opening and under the Inner Heater Cover. Move the hose discharge to direct the water supply evenly over the entire top surface of the Heating Coil.

f. Soot removal will be obvious by the dark color of the water draining into the trough from the Burner opening. When water runs clear, it will indicate that the soot has been removed.

g. When the Heating Unit has drained, operate the Blower for a few minutes to remove water which may have collected in the Volute and Air Duct.

h. After washing, it is preferred that the Unit stand overnight to drain thoroughly before the Burner is replaced. If it is necessary to start the Unit as soon as possible after washing, the Burner should be operated with short interval firings several times before it is put back into service under full operation. It is suggested that four 30-second firing periods (spaced at three-minute intervals) be used to gradually dry out the Combustion Chamber and thus avoid any refractory deterioration.

7.6 BURNER BASE

7.6.1 INSULATION REPLACEMENT

(See Figure 7-8.)

Remove Heating Coil as instructed in paragraph 7.5.2. Repair small breaks in the insulation with a mortar of high temperature refractory cement and water. If complete replacement is necessary, proceed as follows:

a. Break up and remove refractory from Burner Base. Plastic vermiculite may be reused if kept clean. Approximate quantities of insulation required for complete re-insulation are given below:

Refractory Cement (#11297) . . . . . 110 lb
Castable Insulation (#18506) . . . . . 40 lb

b. Mix Castable Insulation with enough water to make a damp (not wet) pliable mixture. Fill Burner Base bottom with this mixture. Fill Burner Base bottom with this mixture and tamp firmly to about the dimensions shown in Figure 7-8.

c. Mix refractory cement with water to a consistency equal to an ordinary concrete mixture and pour this on top of the vermiculite insulation. Carefully trowel the cement, sloping the surface from about 3/4-inch above the Insulation Ring at the outside of the Choke Ring at the center.

d. Allow just enough time for the cement to set firmly. Then trowel six grooves (90^{o}) 1/4-inch deep in surface of refractory, equally spaced, running radially from the opening in the center of the Burner Base to the outside edge.

e. Allow to dry for approximately 24 hours before reinstalling Heating Coil.

CAUTION

When initially starting Generator after insulating Burner Base, use a very low intermittent fire until insulation is cured (low-fire for 10–20 seconds, off for five minutes, repeated several times). Insulation will crack due to moisture content if heat is applied too rapidly.

1. Fiberglass Insulation
2. Heating Coil
3. Refractory Cement
4. Castable Insulation
5. Burner Base
6. Coil Shell (Outer)
7. Vent Opening
8. Castable Insulation
9. Gas Burner Ring
10. Outer Refactory Band
11. Coil Shell (inner)

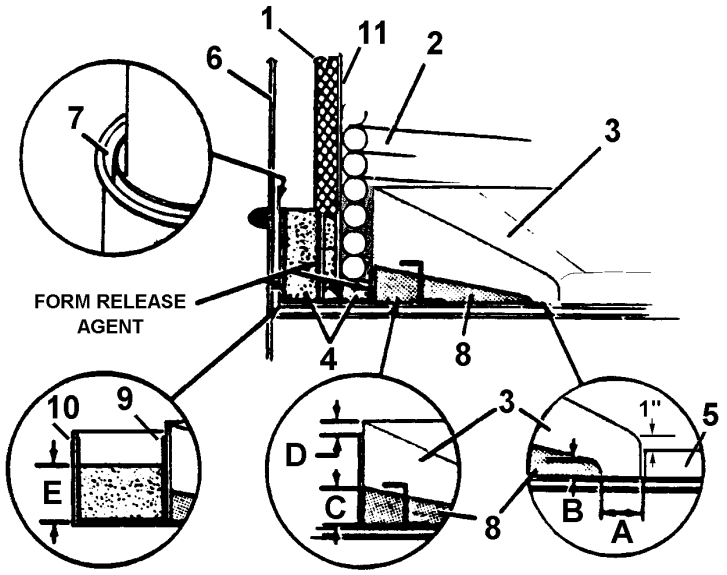


Figure 7-8 Burner Base

7.6.2 COIL WATER WASHING

See the Coil Water Washing (CW) Supplemental Instruction in the Appendix A.

7.7 TEMPERTURE CONTROLS

7.7.1 CHECK AND SET AUXILIARY THERMOSTAT SWITCH (ATS)

(See Figure 7-9.)

a. Operate the Unit at the highest expected pressure (20% rate).

b. Dial the ATS set point slowly down to the point of interruption. Note the reading and adjust the temperature to 25^{o} F above this point.

c. Push the ATS Reset Lever.

d. If the Dial reading at the shut off point is within 15^{o} F of the saturated temperature for the operating pressure at shut off, the ATS is operating properly; if it is not within 15^{o} F, replace the Switch. (Refer to the Pressure - Temperature Table on page 2-5 in Section II.)

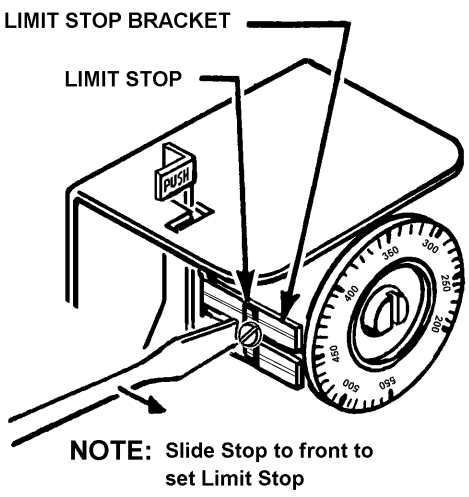


Figure 7-9 Auxiliary Thermostat Switch (ATS) Limit Stop Adjustment

7.7.2 LIMIT STOP ADJUSTMENT

(See Figure 7-9.)

After setting the Dial to the desired cut-off temperature (25^{o} F above normal operating temperature), remove the Switch cover and slide the Dial Limit Stop (left-hand side below Dial) out against the step behind the dial.

NOTE

This adjustment will limit the high-end temperature adjustment to within 5^{o}–15^{o} F of the cut-off setting. This reduces the possibility of the Switch being accidentally set at a higher temperature after checking the Switch.

7.7.3 CHECK THE MAIN TEMPERATURE LIMIT CONTROLLERS (MTLC)

a. Remove one Thermocouple lead wire from the MTLC.

b. Verify that a shutdown occurs and an alarm is initiated within one minute.

c. Replace the Thermocouple lead wire.

d. Repeat steps a, b, and c for the other MTLC.

NOTE

If any of the MTLCs are suspected of being faulty, remove it and conduct further bench testing. Replace the MTLC if it is faulty.

7.8 MAIN GAS (HYDRAMOTOR) VALVE (GAS-FIRED UNITS ONLY)

(See Figure 7-10.)

7.8.1 LOW-FIRE ADJUSTMENT

The low-fire gas rate should be adjusted to about 25 percent of the high-fire rate. Normally, a low-fire adjustment is not necessary unless a major Burner Orifice adjustment is made. (A major adjustment is defined as more than one full turn of the Manifold Stem.) The Burner Orifice adjustment should be checked before the low-fire adjustment is made.

7.8.1.1 Recommended Method

The recommended method for adjusting the low-fire setting is performing the adjustment without energizing the actuator.

a. Remove the wiring compartment cover. An adjusting wrench is taped to the inside of the Actuator Cover.

b. Stop the Unit.

c. Manually rotate the Cam and Dial Assembly downward until the set screw is accessible.

d. Loosen the setscrew on the low-fire Cam using the adjusting wrench.

e. Set the Cam so that the indicator points to the designated letter for the low-fire setting. This will provide a low-fire rate slightly less than desired. Tighten the setscrew in the Cam.

f. Replace the wiring compartment cover.

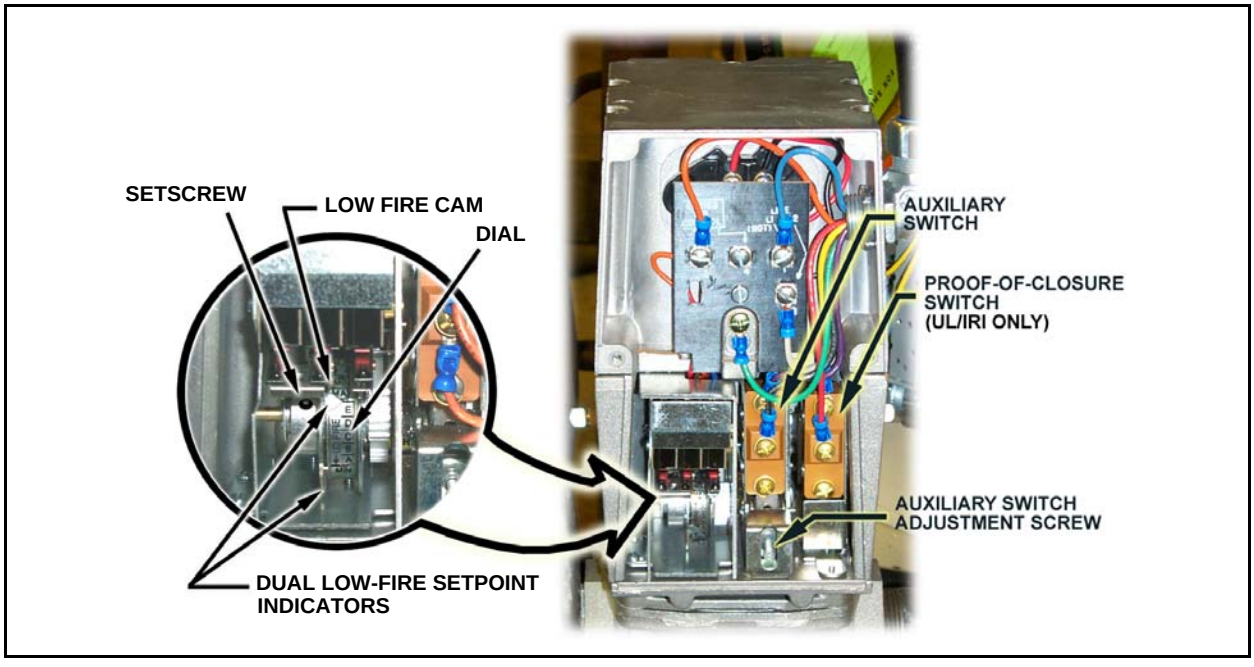


Figure 7-10 Hydramotor Gas Valve

7.8.1.2 Alternate Method

The alternate method for making adjustments to the gas actuator is while it is in operation. Use this method only if the recommended method fails to return proper low-fire gas rate.

a. Remove the wiring compartment cover. An adjusting wrench is taped to the inside of the Actuator Cover.

b. Verify the low-fire adjustment is set at MAX to assure a safe lightoff.

c. Disconnect the firing rate controller leadwire from terminal 4 on the actuator to keep the valve in the low-fire position.

d. Start the Unit and establish main burner flame.

e. Loosen the setscrew in the cam with the special wrench. Keep the wrench seated in the setscrew. Rotate the cam slightly downward to open the bleed valve. The actuator will start to close.

f. When the valve reaches the desired low-fire position, quickly tighten the setscrew and remove the wrench. If the desired low-fire setting is missed, loosen the setscrew and rotate the cam in the opposite direction to the desired setpoint.

g. Shut down the Burner, and then restart. Repeat several times to be sure the low-fire setting is suitable for correct burner lightoff. Readjust, if necessary.

h. Disconnect power and reconnect the controller leadwire to terminal 4 (leadwire removed in step c).

i. Replace the wiring compartment cover.

7.8.2 AUXILIARY SWITCH

(See Figure 7-10.)

The Auxiliary Switch controls the Air Damper. The normally closed contact of the Switch energizes the Air Damper Solenoid, placing the Air Damper Blade in the low-fire position. The Auxiliary Switch must be adjusted to open as the Valve Actuator moves from the low-fire to the high-fire position. At this time the Air Damper Solenoid is de-energized and the Air Damper Blade returns to the high-fire position.

NOTE

Optimum setting of Auxiliary Switch actuation is 1/16 inch below the low-fire Valve Actuator setting. Careful adjustment of this setting is important to prevent the Air Damper from moving to its high-fire position while the Gas Valve remains in the low-fire position.

7.8.3 AUXILIARY SWITCH ADJUSTMENT

This Switch is adjusted after the low-fire adjustment is made. This Switch should be adjusted so that the high-fire Air Damper is actuated as Gas Valve first starts to move from low-fire setting to high-fire.

a. The Auxiliary Switch is adjusted using a 7/64-inch allen wrench. Clockwise rotation causes Switch to operate earlier in the stroke and counterclockwise rotation causes Switch to operate later in the stroke. With Unit operating on low fire, turn the Auxiliary Switch Adjusting Screw clockwise until the High-Fire Damper is actuated, then turn Screw counterclockwise until the Damper returns to low-fire position, continue to turn Adjusting Screw an additional one-half turn.

b. If properly adjusted, the high-fire Damper should be actuated as soon as the Valve begins to move from low-fire to the high-fire position (after approximately 1/16 inch of Valve Stem travel from the low-fire position).

c. To check adjustment, place Burner Control Switch in the high-fire position. The Air Damper should be actuated to the high-fire position within 1/16-inch of Gas Valve travel beyond its low-fire position.

d. If there is too much delay in high-fire Damper opening, it will produce a slight Burner rumble before the Damper opens. Place Burner Control Switch in the low-fire position and check to see that the Damper returns to low-fire position when unit is operating at low-fire rate.

7.8.4 VALVE ACTUATOR REPLACEMENT

If the Valve Actuator fails, it will be necessary to replace the Actuator. Remove and replace as follows:

a. Turn off electric power to Unit.

b. Remove the wiring Cover. Disconnect and tag each external wire from the terminal blocks.

c. Loosen the mounting screws and lift off the Actuator.

d. Place new Actuator in position on the Valve and alternately tighten the mounting screws until the Actuator is secure.

e. Connect wiring.

f. Adjust for low-fire (see paragraph 7.8.1) and Auxiliary Switch actuation (see paragraph 7.8.3), if required.

7.9 FUEL PRESSURE REGULATOR (OIL-FIRED UNITS)

7.9.1 ADJUSTMENT

Excessive fuel pressure will cause the Burner to smoke and result in sooting of the Heating Coil. However, if fuel pressure is too low, the Plant will be slow in coming up to pressure and will not maintain adequate steam pressure during periods of maximum steam demand. For maximum steam output, the Pressure Regulator setting may range from 260–295 psi fuel pressure, depending upon the type and gravity of fuel used. To adjust Regulator, remove Cap and loosen Lock Nut. Turn Adjusting Screw clockwise to raise pressure; counterclockwise to lower pressure. Avoid raising pressure to a point which will cause overfiring and Thermostat interruption.

CAUTION

A maximum fuel input to the Burner must not be exceeded. The total heat content of the fuel entering the Burner must not exceed a rate of 2,479,630 Btu per hour in any event. This is equivalent to a maximum of 17.6 gph of No. 2 fuel oil. In no case should fuel pressure be adjusted above 295 psi.

7.10 GAS BURNER MANIFOLD

7.10.1 CLEANING

(See Figure 7-11.)

a. Loosen three Screws on Packing Ring and remove gas inlet line to Burner Elbow. Disconnect Pilot Line and remove Ignition and Scanner Electrode Cables.

b. Unscrew and remove Nuts which attach Manifold to Burner Volute and carefully lower the Manifold from the Volute.

c. Clean Electrodes and check for proper adjustment (see paragraph 7.10.2).

7.10.2 ELECTRODE ADJUSTMENT

(See Figure 7-11.)

a. The Ignition and Scanner Electrodes should be kept free from carbon and in proper adjustment at all times. Bend and adjust Electrode wires, as required, so that clearances will conform to dimensions given in Figure 7-11.

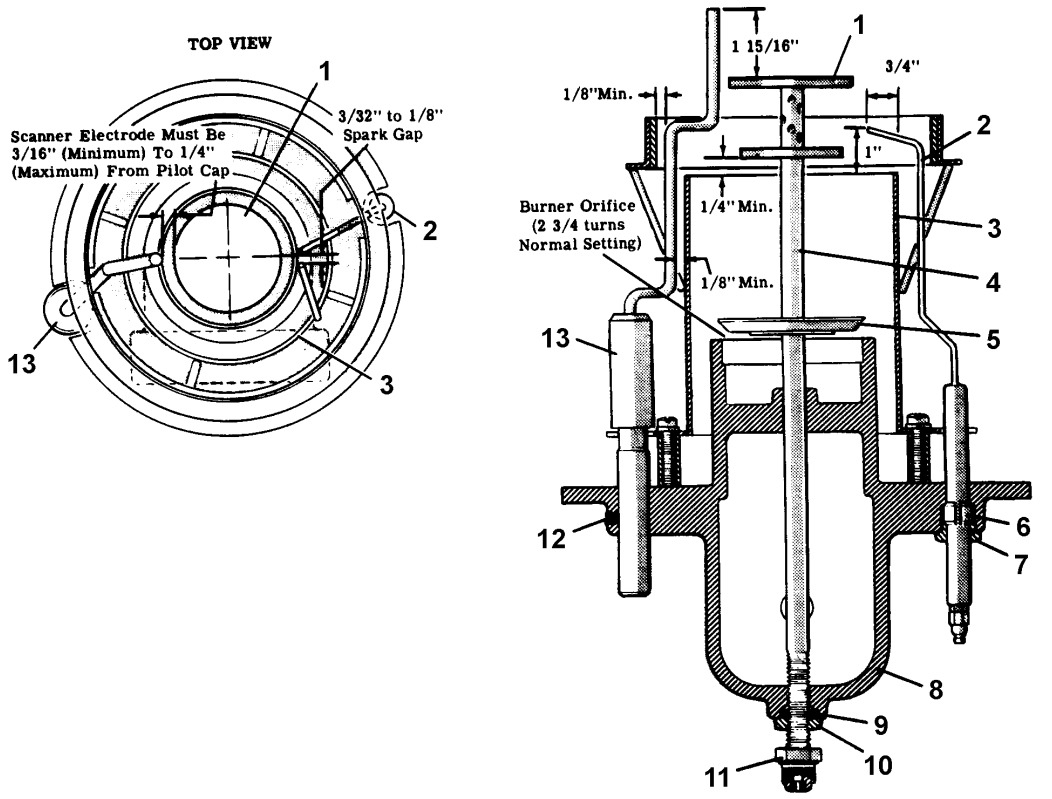
CAUTION

Use care when bending or adjusting Electrodes to avoid cracking the Insulators. The Insulators may develop an invisible short due to such a fracture, resulting in Ignition failure.

b. Vertical adjustment can be made by loosening the Lock Nut (7) on the Ignition Electrode or loosening the Set Screw (12) which holds the Scanner Electrode.

c. If it is necessary to replace the Ignition or Scanner Electrodes, first bend and cut the wire to match the one being replaced; then assemble to the Mounting Plate and adjust to dimensions shown.

d. After starting the Unit, proper adjustment of the Scanner Electrode can be checked by placing a microammeter in series with the Scanner Electrode Circuit On low-fire, a reading of 3 to 4 microamperes should be obtained. A slightly higher reading will be indicated on high fire. The readings should be relatively stable (within 1 microampere).



1. Pilot Cap
2. Ignition Electrode
3. Cone
4. Pilot Tube
5. Disc
6. Sleeve
7. Lock Nut
8. Manifold Elbow
9. Packing
10. Lock Nut
11. Tube Union
12. Set Screw
13. Scanner Electrode

Figure 7-11 Gas Burner Manifold

7.10.3 BURNER ORIFICE ADJUSTMENT

(See Figure 7-11.)

The Pilot Tube (4) is welded to the Disc (5) and is threaded through the Burner Elbow (8). By loosening Lock Nut (10), the Pilot can be turned with the Tube Union (11) to raise or lower the Disc (5) and thus adjust the Burner orifice. For natural gas containing 1,000 to 1,100 Btu per cubic foot, initial adjustment is made by turning the tube downward as far as it will go; then turning it upward 3 1/2 complete turns. Secure Lock Nut (10).

The gas input rate to the Steam Generator should be measured during full load (high-fire) operation to be sure it is sufficient to maintain rated steam output and yet not exceed a point which would cause overfiring. A separate meter can be used, provided all other gas outlets can be shut off during the measuring period. For maximum steam output (100 hp), the input rate must not exceed 2,510,625 Btu per hour.

7.10.4 LOW-FIRE GAS RATE ADJUSTMENT

See paragraph 7.8.1, above, for low-fire gas rate adjustment.

7.11 OIL BURNER MANIFOLD

7.11.1 CLEANING

(See Figure 7-12.)

a. Disconnect fuel lines and remove cables from the Burner Manifold. Unscrew the Nuts that attach the Manifold to the Burner Volute and remove the Manifold.

b. Gently scrape any carbon deposit from the Manifold and Ignition Electrodes.

c. Unscrew Burner Nozzles (1) from the Stem. Unscrew the Strainer (see Figure 7-13) from the Nozzle and remove the Screw. Blow parts out with compressed air jet if available. Be sure all dirt and grit is removed.

CAUTION

Do not use a sharp instrument for cleaning which can scratch or disfigure the Tip Orifice or slots in the Distributor. A slight scratch in these parts can seriously impair Nozzle operation.

d. When reassembling Nozzles, do not overtighten; overtightening can cause galling. Merely tighten snugly.

7.11.2 ELECTRODE ADJUSTMENT

(See Figure 7-12.)

a. Adjust the Ignition Electrode (4) to conform to dimensions given in Figure 7-12. The gap must be positioned as closely as possible to the immediate edge of the Nozzle spray.

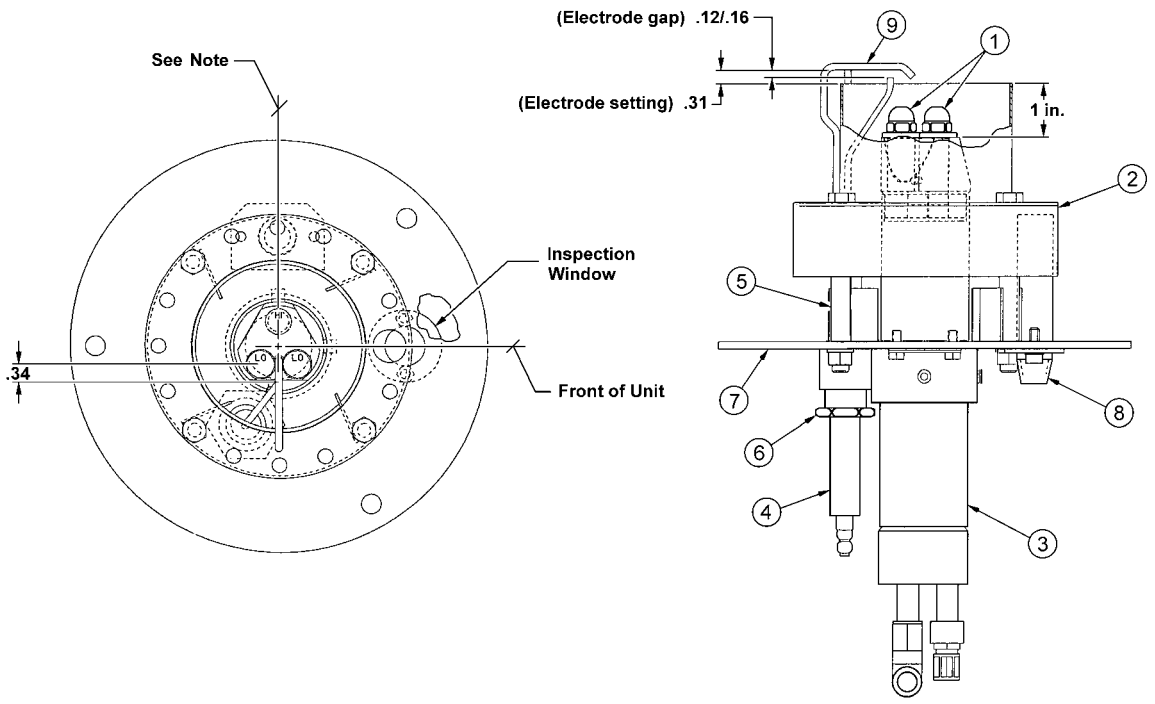
CAUTION

Use care when adjusting Electrodes to avoid cracking the Insulators. The Insulators may develop an invisible short due to such a fracture, resulting in Ignition failure.

Due to slight differences in individual Nozzle spray angles, it may be necessary to position the gap somewhat nearer or farther from the Nozzle than indicated. If points are placed too far into the spray, impingement of fuel on the Electrodes will cause fuel drip

from the Burner. If gap is too far away, erratic ignition or ignition failure will result. Electrodes may be raised, lowered, or rotated by loosening the Lock Nuts attaching them to the Mounting Plate.

b. After starting the Unit, the Flame Sensor can be checked by placing a microammeter in series with wire to Terminal S2 on the Amplifier Module. A normal flame will produce a meter reading of 4–10 micro-amps. The readings should be relatively stable (within 1 microampere).



NOTE: Position high-fire nozzle in-line with UV Scanner and ground electrode.

1. Oil Burner Nozzles
2. Cone Assembly
3. Stem
4. Ignition Electrode
5. Spacer
6. Lock Nut
7. Mounting Plate
8. UV Scanner Nipple
9. Ground Electrode

Figure 7-12 Oil Burner Manifold

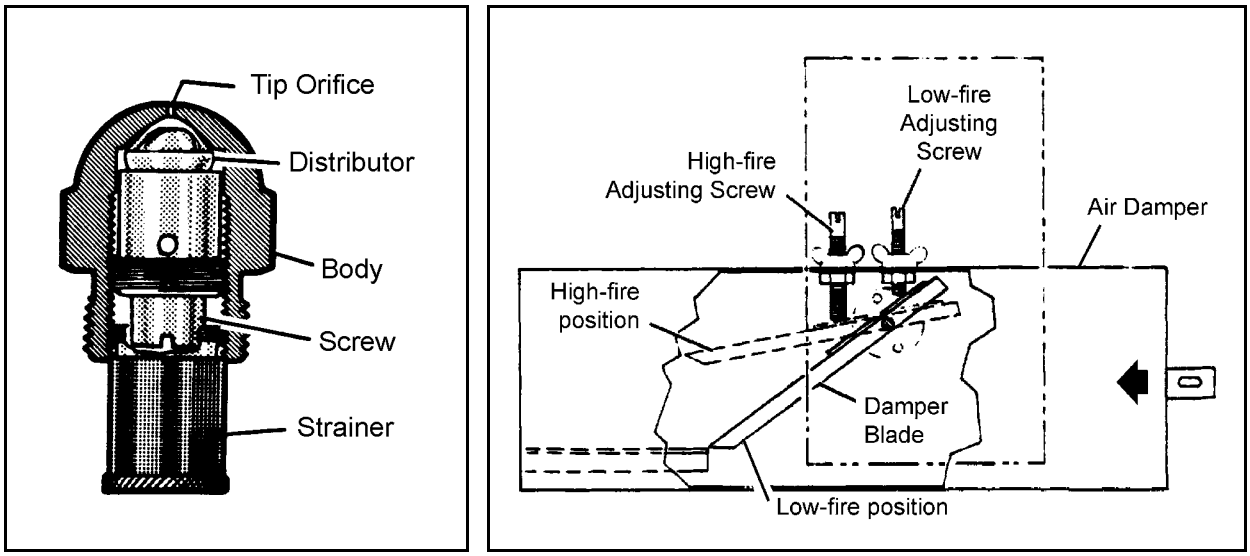


Figure 7-13 Oil Burner Nozzle, left; Air Damper, right

7.12 AIR DAMPER

7.12.1 PRELIMINARY AIR ADJUSTMENT

(See Figure 7-13.)

a. With Plant stopped, loosen the Wing Nut on the low-fire Adjusting Screw and turn the Adjusting Screw out until it no longer touches the Damper Blade.

b. Remove the cover to the Air Damper Solenoid Box. Lift Solenoid Armature manually until the Damper Blade just touches the upper wall of the Air Duct.

c. Turn the low-fire Adjusting Screw in until it touches the Damper Blade. Secure the Adjusting Screw with its Wing Nut

d. Loosen the Wing Nut on the high-fire Adjusting Screw until the Damper Arm is in a horizontal level, with Blade held in the high-fire position. Secure high-fire Adjusting Screw with Wing Nut. See paragraphs 7.12.2 or 7.12.3 for final adjustment.

7.12.2 AIR ADJUSTMENT FOR GAS-FIRED UNITS

(See Figure 7-13.)

7.12.2.1 High-fire Air Adjustment

The high-fire air supply is tuned by adjusting the Damper positioning using the high-fire adjusting screw. The Damper is in the horizontal position when the machine is in high-fire mode. A choice of two methods for adjusting the high-fire air supply are given in the following paragraphs. Air adjustment using a Flue Gas Analyzer is the preferred method if one is available. Making air adjustment based on flame characteristics is another method, but only moderate Burner efficiency can be achieved.

The high-fire air adjustment is made while the Unit is operating in high-fire mode. To maintain hire-fire operation, set the operating pressure to 25 psi below maximum steam pressure.

Flue Gas Analyzer: Tuning the Unit using a Flue Gas Analyzer is the preferred method for obtaining the highest Burner efficiency. The flue gas sampling is taken from the center and just above the stack connection of the Generator. A hole will have to be drilled in the stack to allow the sampling tube to be inserted into this position.

Adjust the Damper positioning to achieve an oxygen (O_2) reading in the range of 4–7 percent. Maintain carbon monoxide (CO) levels below 200 ppm, or below the local government emission limits. In addition, keep the O_2 level high enough to avoid Burner rumble.

Flame Characteristics: Making high-fire air adjustments based on Burner flame characteristics is an alternative method if a Flue Gas Analyzer is not available. An ideal flame will have a transparent blue glow. An orange flame indicates the air supply is too low. A blue flame indicates too much air. Make small incremental adjustments to the high-fire Adjusting Screw until the desired flame characteristic is achieved. The flame can be viewed from the inspection mirror mounted on the Volute.

7.12.2.2 Low-fire Air Adjustment

Place the Unit in low-fire mode by toggling the Burner Control Switch (at the Control Box) to LOW ONLY. The Air Damper Solenoid should have energized to pull the Damper into low-fire position.

Flue Gas Analyzer: Adjust the low-fire Adjusting Screw to an O_2 reading in the range of 6–10 percent and high enough to avoid Burner rumble. Maintain CO levels below 400 ppm, or below the local government emission limits.

Flame characteristics: Adjust the low-fire Adjustment Screw to achieve the best flame characteristic. An ideal flame will have a transparent blue glow. An orange flame indicates the air supply is too low. A blue flame indicates too much air. Make small incremental adjustments to the low-fire Adjusting Screw until the desired flame characteristic is achieved. The flame can be viewed from the inspection mirror mounted on the Volute.

7.12.3 AIR ADJUSTMENT FOR OIL-FIRED UNITS

(See Figure 7-13.)

7.12.3.1 High-fire Air Adjustment

The high-fire air supply is tuned by adjusting the Damper positioning using the high-fire Adjusting Screw. The Damper is in the horizontal position when the machine is in high-fire mode. A choice of two methods for adjusting the high-fire air supply are given in the following paragraphs. Smoke elimination is the primary method for adjusting the air supply. Adjusting the air supply using a Flue Gas Analyzer, when one is available, is an alternative method when it is not practical to observe smoke from the stack outlet.

The high-fire air adjustment is made while the Unit is operating in high-fire mode. To maintain hire-fire operation, set the operating pressure to 25 psi below maximum steam pressure.

Smoke elimination: Adjust the Air Damper with the high-fire Adjusting Screw to gradually restrict the air supply. Continue adjusting the Damper until smoke is observed at the stack outlet; then, reverse the Damper direction to start increasing the air supply until the smoke is *just* eliminated. Maximum Burner efficiency is achieved when the Burner air supply is just at the point of smoke elimination.

Flue Gas Analyzer: The Flue Gas Analyzer is used in cases where observing smoke from the stack outlet is not practical. The flue gas sampling is taken from the center and just above the stack connection of the Unit. A hole will have to be drilled in the stack to allow the flue gas sampling tube to be inserted into this position.

Adjust the Damper positioning to achieve an oxygen (O_2) reading in the range of 5–8 percent. Maintain carbon monoxide (CO) levels below 200 ppm, or below the local government emission limits. In addition, keep the O_2 level high enough to avoid Burner rumble.

7.12.3.2 Low-fire Air Adjustment

Place the Unit in low-fire mode by toggling the Burner Control Switch (at the Control Box) to LOW ONLY. The Air Damper Solenoid should have energized to pull the Damper into the low-fire position.

Smoke elimination: Adjust the low-fire Adjusting Screw until the smoke observed at the stack outlet has *just* been eliminated. Tighten the Wing Nut when finished.

Flue Gas Analyzer: Adjust the low-fire Adjusting Screw to an O_2 reading in the range of 6–10 percent and high enough to avoid Burner rumble. Maintain CO levels below 400 ppm, or below the local government emission limits, if applicable. Leave the Burner Control Switch in the LOW ONLY position after air supply adjustment has been accomplished.

7.13 FUEL PRESSURE SWITCH ADJUSTMENT

a. Start Unit in normal manner and slowly close Burner Control Valve. Observe the pressure reading on Fuel Gauge when Burner ignites. The Burner should ignite when pressure rises to about 150 psi.

b. If adjustment is necessary, turn Adjusting Screw clockwise to raise pressure adjustment; counterclockwise to lower pressure adjustment.

7.14 OVERLOAD RELAY

(See Figure 7-14.)

The Overload Relay is equipped with a Dial (5) to permit a plus or minus 10 percent field adjustment of tripping current This feature eliminates the necessity of changing Overload Heaters to prevent nuisance tripping of the Switch in hot weather. Normally, the Dial is set at the center position for normal ambient temperature. If nuisance shutdown occurs during hot weather, turn the Dial (5) (located on left-hand side of Relay) counterclockwise to a point which will maintain continuous operation. To maintain complete protection, the Dial should be returned to the original position when ambient temperature returns to normal.

a. To check for Welded Contacts in Overload Relay, depress the Weld Check Operator (6) (located on top left-hand side of Relay). When the Relay is in the reset condition, an audible "click" will be heard when Operator (6) is depressed, indicating that the Contacts are operating normally.

b. The Heater Units (2) are removable and may be interchanged or replaced by removing Heater Mounting Screws (1) and inserting new Heaters. Replace and securely tighten Heater Mounting Screws (1).

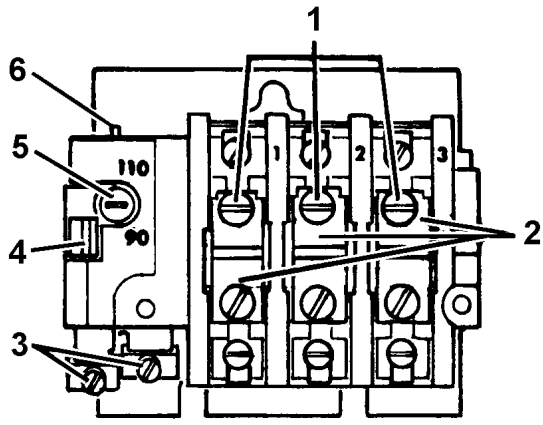
7.15 MAGNETIC CONTACTOR MAINTENANCE

(See Figure 7-14.)

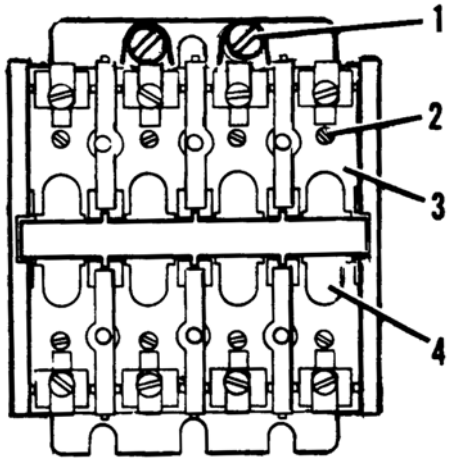
a. **Removal of Coil.** To replace a defective Coil (1), remove the four recessed Screws from back side of Stationary Mounting Plate. Remove Coil and replace with new one. Replace screws into Stationary Mounting Plate.

b. **Replacing Stationary Contact (3).** Remove Screw (2) and install new Contact. Replace Screw and tighten.

c. **Replacing Movable Contact (4).** Remove Spring from under breaker bar and slide Contact out. Install new Contact and replace Spring.



1. Heater Mounting Screws
2. Heater Units
3. Contact Terminals
4. Reset Arm
5. Adjustment Dial
6. Weld Check Operator



1. Magnetic Coil
2. Stationary Contact Screw
3. Stationary Contact
4. Movable Contact

Figure 7-14 Overload Relay, left; Magnetic Contactor, right

7.16 OPERATING PRESSURE SWITCH ADJUSTMENT

The Operating Pressure Switch (OPS) can be adjusted to open and stop the Burner at any desired maximum steam pressure between 65 psi and 25 psi below the Safety Valve set pressure. The Switch will close and restart the Burner when steam pressure drops about 8 psi below that point. To adjust, turn the large slotted Screw at the top of the Switch until the dial pointer on the Switch is opposite the maximum pressure desired. The Dial setting is approximate and final adjustment should be made (if necessary) by resetting the Switch to shut off the Burner when desired maximum pressure is reached on the Steam Pressure Gauge. If the Steam Pressure Switch setting is changed, the Modulating Pressure Switch should also be readjusted.

7.17 MODULATING PRESSURE SWITCH ADJUSTMENT

The Modulating Pressure Switch (MPS) is normally adjusted to modulate the Burner to "low-fire" operation when steam pressure reaches 10 psi below the SPS setpoint and return the Burner to high-fire operation when steam pressure drops about 8 psi below that point. This adjustment can be raised or lowered in relation to maximum steam pressure, but should never be set closer than 5 psi below the Steam Pressure Switch cut-out point. If it is set too close to the maximum steam pressure, operation will be unstable and there will be a tendency to override during abrupt drop in steam load. If set too low, steam pressure will not be maintained at high level during heavy loads. The recommended setting of 10 pounds below the maximum will, in most cases, provide both stable operation and relatively stable steam pressure during fluctuating demand. To adjust, turn the large slotted Screw at the top of the Switch until the Dial Pointer on the Switch is opposite the pressure desired. The Dial setting is approximate and final adjustment should be made (if necessary) by resetting the Switch in accordance with desired pressure as registered on the Steam Pressure Gauge.

7.18 AIR PRESSURE SWITCH ADJUSTMENT

The Air Pressure Switch (APS) should be set approximately 5 turns (2–3 inch w.c.) below the interrupting point (Blower air pressure). Use a 115-volt Test Light to indicate when the Switch is operated. Connect one lead to the "B" terminal (normally closed contact), the other to any white wire on the Terminal Block. Place the RUN-FILL Switch in the FILL position. The Burner will not operate during the adjustment. If it is desirable that the Pump not pump water, close the Feedwater Intake Valve. Start the Blower by pressing the Start Button. Using a screwdriver, increase the Air Pressure Switch Adjustment (clockwise rotation) until the Test Light comes on. Then decrease the adjustment (counterclockwise rotation) until the Test Light goes off. Continue to decrease the adjustment five more turns.

7.19 LIMIT PRESSURE SWITCH ADJUSTMENT

The Limit p1essure Switch (LPS) is mounted within the Electrical Controls Box. The Switch is connected in the Motor Circuit and in the event of excessive steam discharge pressure this Switch will actuate and stop Plant operation requiring a manual reset before the Plant can be restarted.

The Limit Pressure Switch (LPS) should be set to open (shutting Plant off) at a pressure which is about halfway between the SPS setpoint and the opening pressure of the Steam Safety Relief Valve(s). To set the Switch, operate the Plant and slowly throttle the Steam Discharge Valve to increase the steam pressure. Manually increase the SPS setpoint to some value above the desired LPS setting. Set the Limit Pressure Switch to open as described above.

7.19.1 GAS PRESSURE SWITCHES

Two Gas Pressure Switches (GPSL and GPSH) are installed on the unit (see Figure 2-4), one closing on rise in gas pressure and one opening on rise in gas pressure. If gas pressure is above or below the adjusted range of the two Switches, the circuit will not be complete and gas will not be admitted to the Burner. The Low Pressure Switch is located on inlet side of the Gas Train, and the High Pressure Switch is located on the Burner side of the Gas Train.

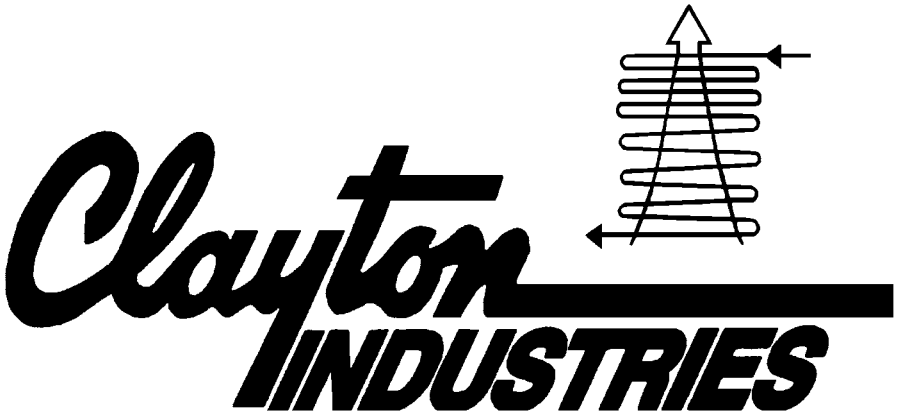
7.19.2 ADJUSTMENT

Adjust Low Gas Pressure Switch to close at 3 inches water column pressure and High Gas Pressure Switch to open at 9 inches water column pressure.

APPENDIX A

SUPPLEMENTAL INSTRUCTIONS

OPTIONAL EQUIPMENT



SUPPLEMENTAL INSTRUCTIONS

Auxiliary Pressure Control (APC)

Description

Auxiliary Pressure Control (APC) is designed for installations with two or more steam generators. Its operation requires at least one steam generator to always be on-line providing fluid pressure. APC allows the additional unit(s) to be in a standby mode and automatically come on-line should load demand exceed the capacity of the primary, or lead, unit. The standby steam generator(s) will stay on-line until the load demand requirement has been satisfied. When the load demand has been met, the standby steam generator will shut down its burner and go back into standby mode. Its feedwater pump(s) will continue running for the duration of the post-run period.

When using APC, it is important that the system be at normal operating pressure during the unattended start of the standby unit(s), allowing the water control system to function at near capacity within a few seconds after start. The Delayed Firing Rate Timing (DFRT) function of the standby unit(s) will keep the unit(s) at the low firing rate (50%) for a preset time (typically 5–10 minutes). Delaying the high-fire operation allows time for the unit(s) to rid the steam separator of excess fluid without carryover. The post run period (PRTD) function keeps the feedwater pump motor(s) energized for a preset time (typically 15–20 minutes) after burner operation has been interrupted (steam demand has been satisfied).

Actual delayed firing rate settings will be determined based on steam trap timing and separator flooding observations made at the time of initial firing. The post-run period is determined by the fluid temperature in the heating system, or by timer.

Initialization

Setup the auxiliary unit(s) for APC.

1. Set the Control Selector Switch (CSS), inside the electrical control box, to the AUXILIARY OPERATION position. This places the machine in auxiliary mode.
2. Pull out the STOP button.
3. Press the START pushbutton. The feedwater pump will activate and start pumping to fill the heating coil.

The unit enters standby mode and remains there until load demand requires it to come on-line. When load pressure falls below the cut-in setpoint, the auxiliary unit will start automatically, go through purge, and light-off. The unit will run until load demand is met. Once demand is met, the burner is shut off . The unit will go through the post run standby; then it will shut off.

NOTE

The unit(s) must be in *automatic* mode during auxiliary operation.

To return the unit(s) to standard operation, set the CSS to the STANDARD OPERATION position.

Settings

Figure 1, below, depicts the typical operating pressure setpoints for an APC installation consisting of two steam generators. OPS1 represents the standard pressure setpoint for the primary unit. OPS2 represents the pressure setpoint for the auxiliary unit. Both units are set to modulate at 80 psi.

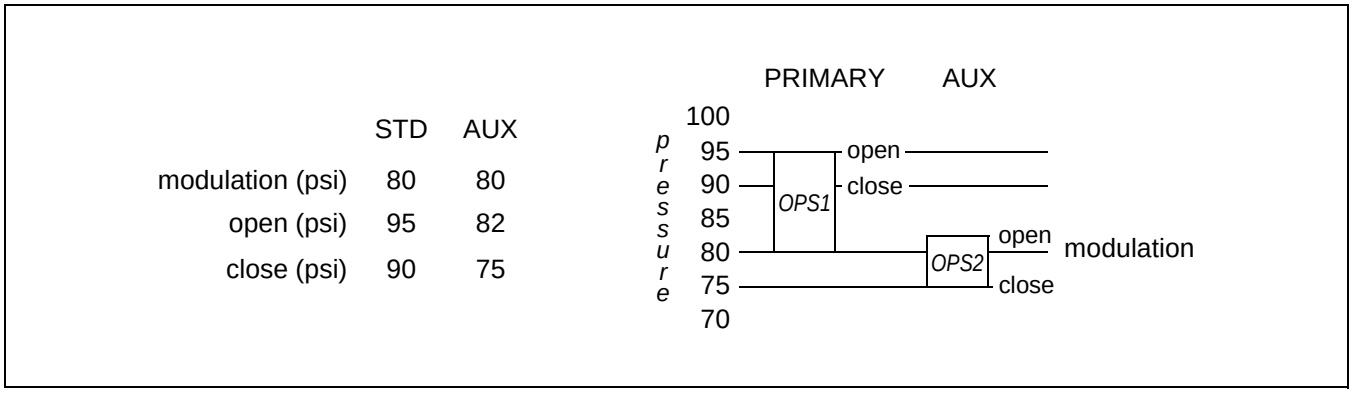


Figure 1. Typical pressure settings for a two-unit APC system

Operation

The auxiliary steam generator unit is automatically brought on-line when pressure in the main header reaches the OPS2 close setpoint (Figure 1).

The auxiliary unit will come on-line and will initially operate in a delayed firing rate mode. Once the DFRT period expires, the unit will begin operating normally, adjusting the firing rate to match load demands. The primary and auxiliary units will modulate together toward their minimum firing rate position as operating pressure rises. If the main header pressure continues to rise to the auxiliary unit's OPS2 open setpoint, the auxiliary unit will shut down (burner off) and go into the post-run period. The auxiliary unit will refill with chemically treated water and return to an idle standby condition once the post-run period has expired. The primary unit will once again carry the load until its capacity has been exceeded, then the auxiliary unit will be called back into service.

The auxiliary Operating Pressure Switch (OPS2) and the Modulating Pressure Switch (MPS) have an adjustable differential (proportional band) which allows for a wide range of pressure setting variations.

NOTE

Alternating the units on regular intervals will provide equal usage and running hours.

Installation

The sensing line for the auxiliary Operating Pressure Switch (OPS2) must be located in the main header downstream of the separator discharge valve and any stop-check or back pressure regulating valves.

The DFRT and PRTD are mounted inside the electrical control box, above the OPS1 and LPS.

The auxiliary Operating Pressure Switch (OPS2) is mounted on the side exterior of the electrical control box. Field installations will require electrical wiring modifications, specific to each machine. Modified electrical drawings can be provided by the Clayton Engineering Department.

Due to a greater amount of fluid during automatic start, an Automatic Dump Valve (ADV) is used to remove excess fluid from the separator (Figure 2). The ADV is a normally closed, electrically actuated solenoid valve, that is energized to open during the delay firing rate period, by the DFRT. The ADV returns to a closed position when the DFRT "times out."

The APC circuit, as described above, will result in a delay firing rate period each and every time the standby unit is called back into service. This may be a nuisance in some instances. To avoid this occurrence, a Secondary Transfer Pressure Switch (STPS) is installed. This additional pressure switch circuit will bypass the DFRT and allow the unit to go directly into the normal auxiliary operating mode if the system operating pressure is above the pressure setting (allowable system minimum) of the STPS.

The Modulating Pressure Switch (MPS) setting, shown on Figure 1, is the same for both Operating Pressure Switch (OPS1 and OPS2) settings. This deviates from the common practice of resetting the MPS when the OPS setting is changed. That procedure is intended to provide an adequate stabilization period between modulation (50%) and burner off period, at 10 psi on single unit installations. With two or more units operating in tandem, the added capacity will prevent rapid load swings that, ordinarily, would infringe on the stabilization period.

IMPORTANT

APC is not practical for every applications. Consult a Clayton representative to determine if APC is recommended for your application.

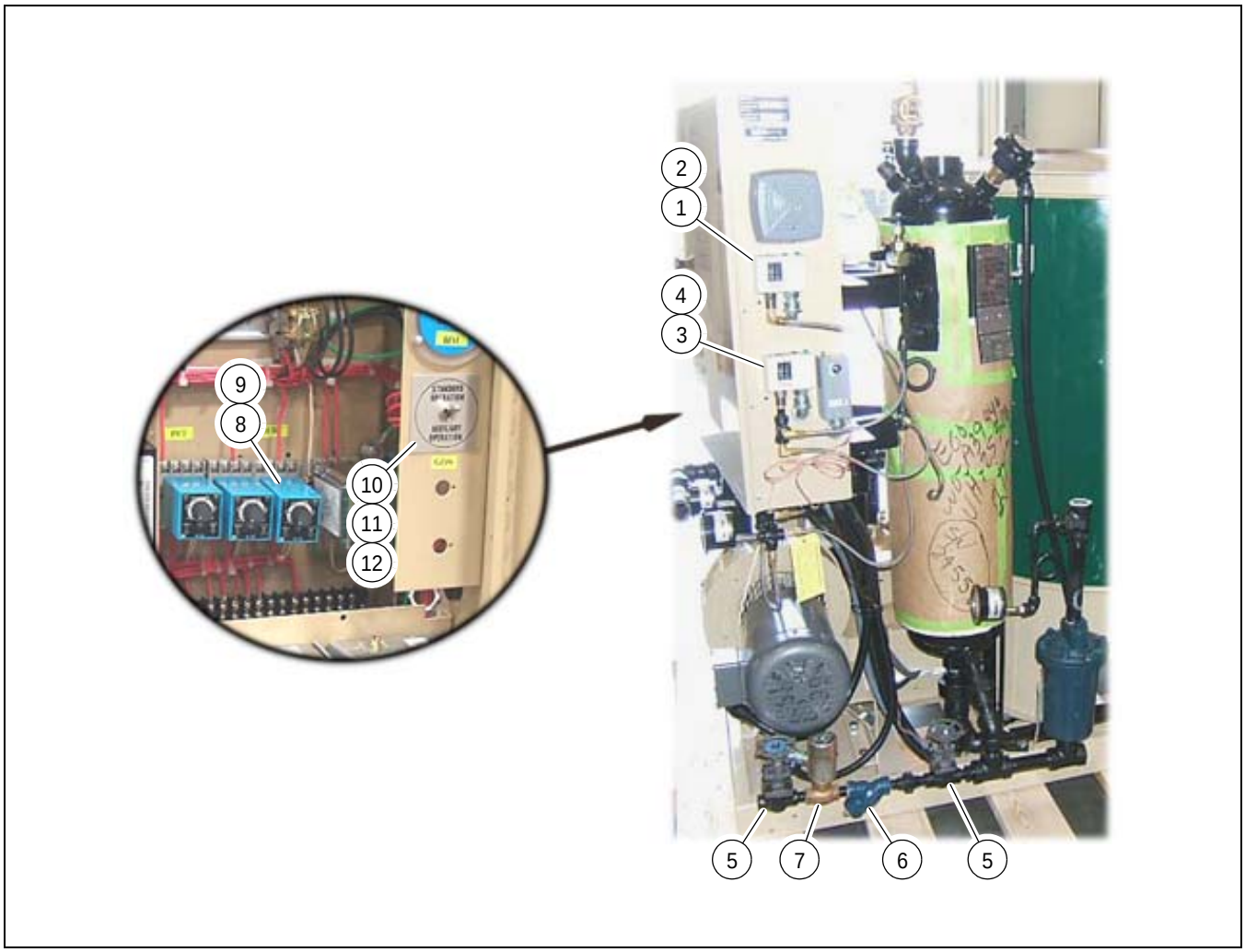


Figure 2. APC Kit, mechanical hookup

APC Parts List

Item	Part Number	Description	Total Qty.
1	39278	SWITCH, Pressure, 58–300 psi, manual reset (STPS)	1
2	UH-29443-057	LABEL, Generator, STPS	1
3	39277	SWITCH, Pressure, 15–150 psi, manual reset (OPS2)	1
4	UH-29443-055	LABEL, Generator, OPS2	1
5	20001	VALVE, Globe, 1/2 in., 800 psi, FPT	2
6	17094	STRAINER, Y, 1/2 in., 250 psi	1
7	38297	VALVE, Solenoid, two way, 1/2 in., 120 vac/60 Hz	1
8	37107	TIMER, Relay, IDEC, DPDT, 120 vac/50-60 Hz, .1 sec.–600 hr (DFRT)	1
9	27785	SOCKET, Octal, IDEC, 8 pin	1
10	24754	RING, Locking, toggle switch	1
11	UH-15822	PLATE, Name, selector switch	1
12	22111	SWITCH, Toggle, 3PDT (CSS)	1

SUPPLEMENTAL INSTRUCTIONS

HEATING COIL WATER WASHING

DESCRIPTION

Periodic water washing of the heating coil is required on oil-fired machines; it removes soot and dirt accumulation not removed by soot blower operation (refer to Periodic Maintenance in the Instruction Manual for soot blowing instructions). Regular soot blowing should maintain stack temperature within 20^{o} F of normal (compared to stack temperatures documented at time of initial firing), however not all soot will be completely removed from the heating coil. Over a period of weeks or months, soot will accumulate on the external tube surfaces of the heating coil. Excessive soot accumulation will be evident with a gradual rise in stack temperature. Frequency of water washing should be determined by daily monitoring of the stack temperature. Water washing should be performed when the stack temperature cannot be maintained within approximately 50^{o} F of normal by soot blowing alone.

NOTE

A 12 x 12 inch inspection door is required to facilitate coil water washing and should be installed in the lower portion of the exhaust stack, immediately above the outer heater cover during.

PREPARATION

(See Figure 1.)

Preparation for water washing of the Clayton Heating Coil should be performed as follows:

a. The facility water source must be capable of supplying water at a minimum of five gallons per minute.

b. If a floor drain is not available beneath the burner opening, obtain a ten to twenty gallon container equipped with a large drain hose. The container may be made from a cut down 55-gallon drum. Water may be drained or pumped from the pan or a water ejector could be used.

c. Close all fuel system valves.

d. Remove the burner manifold.

WATER WASHING

Water wash the heating coil in accordance with the following instructions:

a. If the machine has been in operation prior to washing, operate the blower (burner off) for approximately 15 minutes to cool the machine before washing.

b. Insert a garden hose (largest size possible) into the 12 x 12 inch inspection door. Turn on the water and manually distribute the water over the entire top of the heating coil. Continue this action until the drain water runs clear. It is important to have a high water-flow rate to ensure proper coil cleansing.

c. Before placing online, perform the following:

   1. Allow the water to drain from the heating coil.
   2. Operate the blower for a few minutes to remove any water from the air duct.
   3. Replace the inspection door in the exhaust stack.
   4. Re-install the burner manifold.

d. Open the fuel system valves and start the machine. Operate the machine at low fire for 15 minutes.

e. Resume normal operation of the machine

NOTE

A substantial quantity of contaminated fluid will be produced during the water washing procedure. Proper environmentally accepted drainage and disposal practices must be followed.

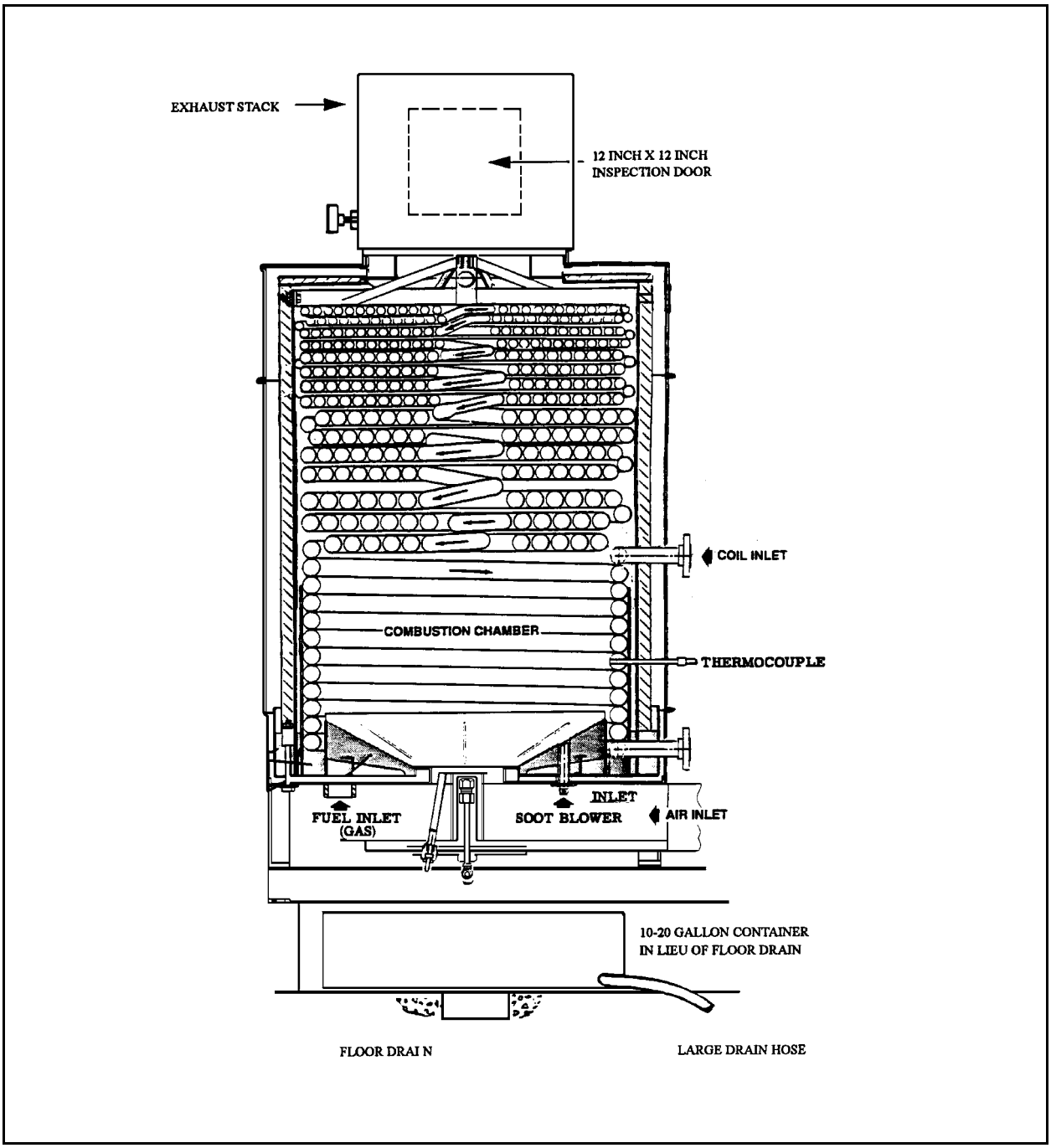


Figure 1 Set up heating coil unit for water washing

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SUPPLEMENTAL INSTRUCTIONS

for

SEPARATOR HIGH LEVEL ALARM
WITH PLC
(Canadian Units)

Introduction

The Separator High Level Alarm (SHLA) Kit is an option which satisfies certain safety code requirements for Canadian steam generators. This kit is designed to initiate a safety shutdown of a Clayton steam generating unit when the fluid in the steam separator reaches an unsafe level.

Description

The SHLA Kit consists of a remote fluid level sensor, sensor probe, plumbing, and a controller module. The fluid level sensor is installed near the top of the separator vessel, adjacent the safety relief valve (see Figure 1). It is wired to a controller module mounted inside the electrical control box.

The fluid level sensor is a conductance-type device. When the separator fluid makes contact with the sensor probe, it causes the normally-closed contacts in the controller module to open. This sends a signal to the PLC to execute a safety shutdown of the machine. The OIU, mounted on the electrical control box door, displays the message, “SEPARATOR WATER LEVEL --OUT OF LIMIT--” on its screen.

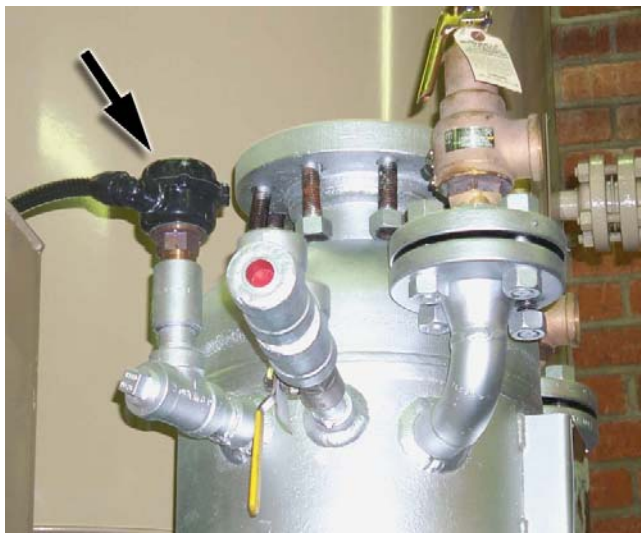

Figure 1. Remote separator fluid level sensor is installed near the top of the separator vessel.

Troubleshooting

If the control fails to operate as required, perform the following diagnostic checks:

1. Verify that the separator fluid is reaching the sensor probe.

2. Re-check all wiring to ensure proper connections, according to wiring diagrams.

3. Re-check the electircal ground connection for the remote sensor and control module.

4. Check the quality of the fluid to ensure adequate conductance.

Maintenance

Inspect the sensor probe annually, or more frequently depending on the fluid quality, for scale build-up. Clean and replace if needed. Make certain there is not scale or build-up on the probe or its white teflon insulator.

Clean the probe by wiping with a non-abrasive cloth and rinsing with clean water. DO NOT use sharp instruments to remove any accumulations of rust or scale.

CAUTION

Replace the sensor probe if the teflon insulator is cracked or worn, or if the probe is loose. Failure to follow this caution can cause damage to equipment or result in personal injuries.

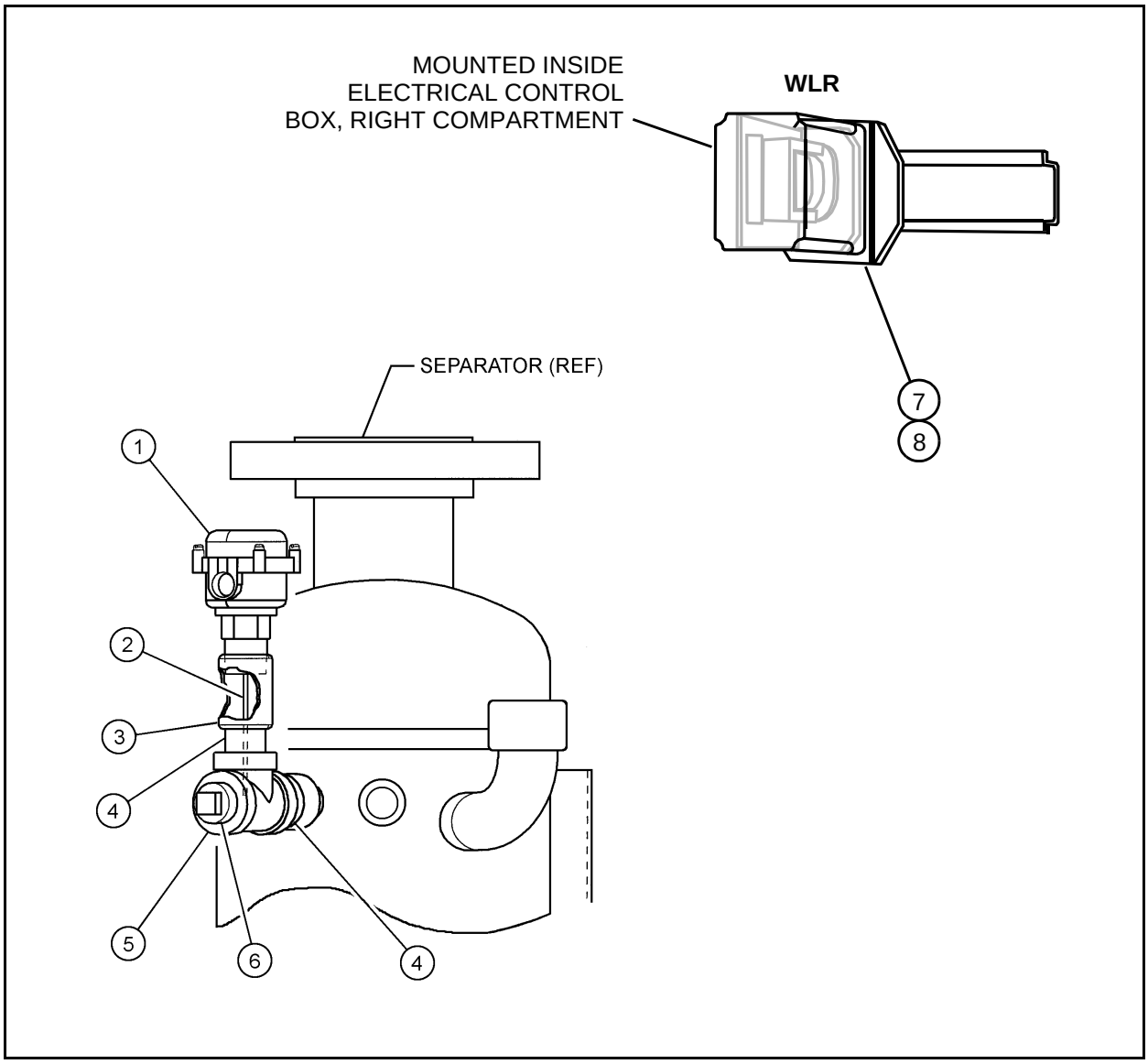

Figure 2. Separator High Level Alarm Kit Hookup

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			2 - SEPARATOR HIGH LEVEL ALARM KIT HOOKUP	
2 -1	38294		SENSOR, Water Level, conductance, 250# steam, NEMA housing	1
-2	38263		PROBE, Conductance, 4-1/4 in.	1
-3	13235		COUPLING, Pipe, 1 in., 3000#, forged steel	1
-4	11680		NIPPLE, Pipe, 1 x 2 in., seamless, ASME SA-106, grade B, black	2
-5	9771		TEE, Pipe, 1 in., 300#, black	1
-6	2095		PLUG, Pipe, 1 in., black	1
-7	38295		CONTROL, Level, 0–3 sec. time delay, 120 vac, 7.2 amp, 11 pin (WLR)	1
-8	29438		SOCKET, Relay, 11-pin, octal (WLR)	1

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APPENDIX B

REFERENCE TABLES
&
CHARTS

Clayton INDUSTRIES

MODEL E-100
OPEN SYSTEM
TABLE 1
SPECIFICATIONS

OUTPUT:		***ENGLISH UNITS***	***METRIC UNITS***
BOILER HORSEPOWER		100 bhp	
NET HEAT OUTPUT at 33,475 btu/hr-bhp		3,347,500 btu/hr	981 kw
OUTPUT, net at 100 psig from 60 deg F (15.6 deg C) and 100% make-up		2,882 lb/hr	1,307 kg/hr
EQUIVALENT OUTPUT, from and at 212 deg F (100 deg C) feedwater		3,450 lb/hr	1,565 kg/hr
OPERATION:			
DESIGN PRESSURE (safety valve setting) -see note 1		15 - 500 psig	1.1 - 35.2 kg/sq cm
OPERATING PRESSURE (depending upon design pressure) - see note 2		13 - 450 psig	0.9 - 31.6 kg/sq cm
CONDENSATE RECEIVER TEMPERATURE RECOMMENDED		180 - 200 deg F.	82 - 93 deg C
THERMAL EFFICIENCY @ maximum firing rate:			
GAS FIRED		80 %	
OIL FIRED		82 %	
FUEL INPUT REQUIREMENTS @ maximum firing rate:			
GAS FIRED HEAT INPUT		4,184,375 btu/hr	1,226 kw
NATURAL GAS CONSUMPTION (based on 1000 btu/cu ft gas)		4,184 scfh	118.5 cu meters/hr
PROPANE GAS CONSUMPTION (based on 2500 btu/cu ft gas)		1,674 scfh	47.4 cu meters/hr
OIL FIRED HEAT INPUT		4,082,317 btu/hr	1,196 kw
OIL CONSUMPTION (based on 140,600 btu/gal #2 fuel oil)		29.0 gph	110 liters/hr
SERVICE REQUIREMENTS @ maximum firing rate:			
GAS SUPPLY PRESSURE (standard gas train)	w/ Clayton regulator	.5 - 5 psig	.04 - .35 kg/sq cm
	w/o Clayton regulator	8 wci	20 wcmcm
OIL SUPPLY PRESSURE		0 - 5 psig	.04 - .35 kg/sq cm
PILOT GAS PRESSURE (regulated at 6" W.C.)		.5 - 5 psig	.04 - .35 kg/sq cm
WATER SUPPLY		530 gph	2,007 liters/hr
NET POSITIVE SUCTION HEAD REQUIREMENT FOR FEEDWATER PUMP		10 feet	3.0 meters
ELECTRIC SERVICE: 460V, 60HZ, 3 PH	(standard product up to 300 psi design pressure)		
(other voltages available - see note 4)	Recommended Disconnect Fuse size(s)	11 amps	
GENERAL:			
HEATING SURFACE		198 sq ft	18.4 sq meters
COIL WATER CONTENT (under normal operation)		16.5 gal	62 liters
COMBUSTION VOLUME - see note 5		9 cu ft	0.3 cu meters
ELECTRIC MOTOR	up to 300 psi design pressure	7.5 hp	5.6 kw
CUSTOMER CONNECTIONS:			
SEPARATOR OUTLET (300# R.F. flange)		2-1/2 in	
FLUE GAS STACK DIAMETER		18 in	457 mm
GAS SUPPLY INLET (f.p.t.)	w/ Clayton regulator	2 in	
	w/o Clayton regulator	2-1/2 in	
FEEDWATER INLET (f.p.t.)		2 in	
COIL GRAVITY DRAIN (f.p.t.)		1/2 in	
COIL DRAIN (BACKFLOW) (f.p.t..)		1 in	
SEPARATOR DRAIN (f.p.t.)		1 in	
SAFETY RELIEF VALVE - vary with design pressure, see installation drawing			
STEAM TRAP OUTLET (f.p.t.) - see note 3		1 in	

APPROXIMATE OVERALL DIMENSIONS:
Refer to Plan-Installation, Dimensional Diagram for details

APPROXIMATE WEIGHT (shipping)	3,850 lbs	1,746 kg

NOTES:

1. Standard design pressures (safety valve settings): 15, 150, 200, 300, 350 & 500 psig.
2. Operating pressures between 10 and 65 psi are typically obtained through use of a steam pressure reducing valve. Units designed to operate within 10 to 65 psig are available upon special request.
3. Line sizes downstream of this connection must be a full pipe size larger.
4. For 575V multiply by 0.8; for 380V multiply by 1.1; for 230V multiply by 2.0; for 208V multiply by 2.2
5. Volume based on UL795 & CSA-CAN 1-3.1 Standards which define this as combustion chamber and flue gas passage volume up to the stack collar.

NOTES

Motor Control Devices

Table 1: GROUP MOTOR PROTECTORS (GMP)

CLAYTON PART NUMBER			MAX. 3-PHASE HORSEPOWER					AMPERES RANGE
SERIES B*		SERIES C	200V	230V	380V	480V	575V	(A)
31327	32377	37272	-	-	-	.5	.5	.63 - 1.0
31333	32378	37271	-	-	.5	.75	1	1.0 - 1.6
31116	32379	37270	.5	.5	.75	1	1.5	1.6 - 2.5
31268	32380	37269	.75	1	1.5	2	3	2.5 - 4.0
31077	32381	37268	1	1.5	2	3	5	4.0 - 6.3
31154	32382	37267	2	3	5	5	7.5	6.3 - 10.0
31350	32383	37263	3	5	7.5	10	10	10.0 - 16.0
31351	32384	37464	5	5	10	10	15	14.5 - 20.0
31352	32385	37264	5	7.5	10	15	20	18.0 - 25.0
		37265	10	10	20	25	30	23.0 - 32.0
		37266	15	15	25	30	40	32.0 - 45.0
31078	32375	37261	AUXILIARY CONTACT BLOCKS FOR ABOVE GMPs					
		37517	10	15	25	30	40	25.5 - 40.0
31810		35956	20	20	40	40	60	40.0 -63.0
		36386	30	30	50	60	75	63.0 - 90.0
31809		35957	AUXILIARY CONTACT BLOCKS FOR THE ABOVE 3 GMPs (2 N.O./1 N.C.)					

Table 2: IEC-Type Contactors - Full Size

CLAYTON PART NUMBER		MAX. 3-PHASE HORSEPOWER					AMPERES RANGE
SERIES B*	SERIES C	200V	230V	380V	480V	575V	(A)
	31076	2	2	3	5	7.5	9 amps max.
	30808	3	3	5	7.5	10	12 amps max.
	30809	5	5	7.5	10	15	18 amps max.
	30810	5	7.5	10	15	20	24 amps max.
	30811	7.5	10	15	20	25	30 amps max.
	30812	10	10	20	25	30	38 amps max.
	31474	10	15	25	30	40	45 amps max.
	31447	15	20	30	40	50	60 amps max.
	31391	20	25	40	50	60	75 amps max.
	36385	25	30	50	60	60	85 amps max.
	32504	30	40	60	75	100	110 amps max.
32207	35081	AUXILIARY ADDER DECK CONTACTS (3 N.O./1 N.C.)					
32616	35104	AUXILIARY ADDER DECK CONTACTS (2 N.O./2 N.C.)					

IEC-Type Contactors - Mini

	33603	1	1.5	2	3	3	6.5 amps max.
	33431	3	3	5	5	5	12 amps max.
	33432	AUXILIARY ADDER DECK CONTACTS (2 N.O./2 N.C.)					

IEC Overload Relays

34947	.5	.75	1	1.5	2	1.0 - 2.9
34948	1	1	1.5	2	3	1.6 - 5.0
33922	3	3	5	7.5	10	3.7 - 12.0
34467	7.5	10	15	20	25	12.0 - 32.0
34949	10	15	25	30	40	14.0 - 45.0
34950	20	25	40	50	60	26.0 - 85.0
34466	PANEL MOUNT ADAPTER FOR OVERLOAD RELAY					

Main Temperature Limit Controllers (MTLC)

Instructions:

1. Determine the design pressure of the Unit. (-1=100 psig, -2=200 psig, -3=300 psig, -3.5=350 psig, -5=500 psig, -7=700 psig, -8=800 psig, -11=1,100 psig, -12=1,200 psig)
2. Select the corresponding Kit number from the Table below.
3. Select the MTLC part number from the first column as indicated by the "x" in the corresponding "Design pressure & Kit no." column.

Design pressures & Kit no. / MTLC part no.	-1 UH-31573	-2 UH-31574	-3 UH-31575	-3.5 UH-31576	-5 UH-31577	-7 - - -	-8 - - -	-11 UH-32475	-12 UH-32475
38277 (475 ^{o}F)	X								
38278 (500 ^{o}F)	X	X							
38279 (525 ^{o}F)		X	X						
38280 (550 ^{o}F)			X	X					
38281 (575 ^{o}F)				X	X				
38282 (600 ^{o}F)					X				
36854 (625 ^{o}F)						X	X		
38664 (650 ^{o}F)						X	X	X	X
38665 (675 ^{o}F)						X	X	X	X

APPENDIX C

PARTS CATALOG

Clayton INDUSTRIES

CONTENTS

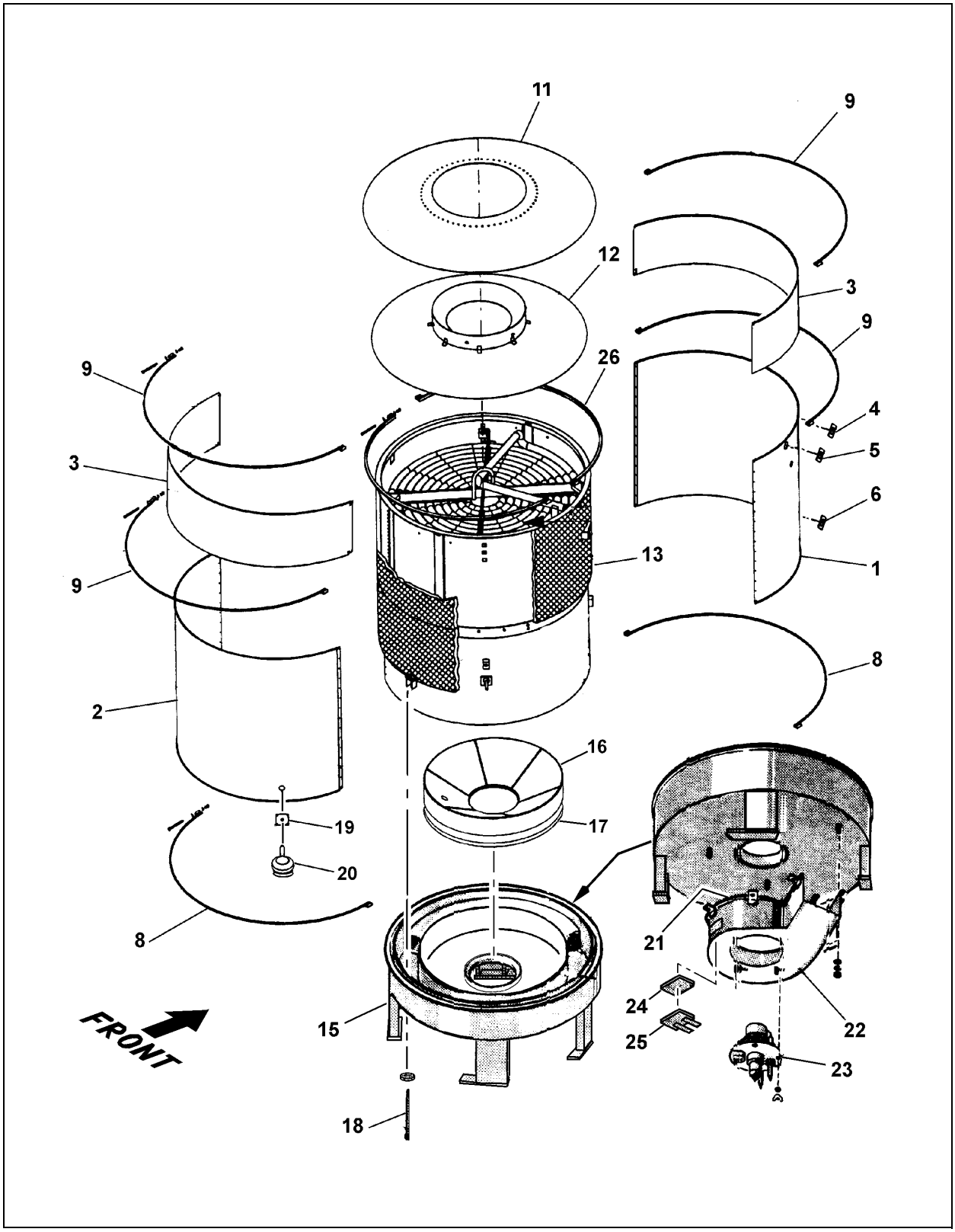

Figure 1. Heating Unit

Figure & Index No.		Part Number	1 2 3 4 5 6 7 Description	Units Per Assy
			1 - HEATING UNIT	
1	-1	UH-13492	SHELL, Outer, rear half	1
	-2	UH-13491	SHELL, Outer, front half	1
	-3	UH-65466	SHELL, Outer, extension	2
	-4	UH-14824	PLATE, Patch (gas-fired units)	1
	-5	UH-14497	PLATE, Sealing, 3/4 in. (gas-oil combination units)	1
	-6	UH-61441	PLATE, Patch (side and back mounts)	4
	-8	UH-22133	BAND, Clamp, half, bottom	2
	-9	UH-22132	BAND, Clamp, half, top	4
	-10	5551	ROPE, Fiberglass, 3/8 in. (specify length)	15 ft
	-11	UH-65455	COVER, Heater, outer	1
	-12	UH-30153	COVER AND INSULATION ASSY, Heater, inner	1
	-13	UH-25344	KIT, Coil Replacement (includes coil, insulation, and refractory)	1
		UH-32767	KIT, Coil Replacement, ABS (includes coil, insulation, and refractory)	1
	-15	UH-25887	BASE ASSY, Burner	1
	-16	11297	INSULATION, Refractory	150 lb
	-17	18506	INSULATION, Castable	150 lb
	-18	29583	SCREW, Cap, 1/2-13 x 9 1/2 in.	6
	-19	UH-63870	PLATE, Sealing, thermocouple	1
	-20	31355	THERMOCOUPLE, Dual J, 6 in.	1
	-21	B191664	MOLDING, Rubber (specify length)	6.7 ft
	-22	UH-22521	VOLUTE ASSY, Burner	1
	-23		MANIFOLD ASSY, Burner (See Figure 11a and 11b for details.)	1
	-24	11454	MIRROR, Inspection, 2 1/2 x 3 1/2 in.	1
	-25	UH-3116	BRACKET, Inspection Mirror	1
	-26	UH-28056	BAND, Clamp, inner	2

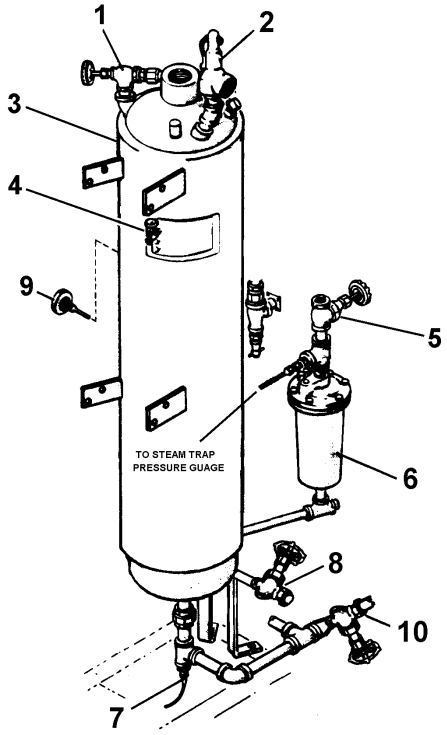

Figure 2. Separator Installation

Figure & Index No.		Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
				2 - SEPARATOR INSTALLATION	
2	-1	19929		* VALVE, Angle, 3/4 in., 800 lb (soot-blow for EO/EOG models)	3
	-2			VALVE, Safety, Relief [1]	1
	-3	UH-25202		SEPARATOR ASSY, 10 in. (standard pressure)	1
		UH-25703		SEPARATOR ASSY, 10 in. (low pressure)	1
		UH-25882		SEPARATOR ASSY, 10 in. (ABS/BV/DNV)	1
	-4	30079		VALVE, Globe, 1/4 in., 10,000 lb	1
	-5	19348		** VALVE, 1 in., 800 lb	1
	-6			TRAP, Steam [1]	1
	-7			BULB TUBE CONNECTION, ATS	Ref
	-8	19348		** VALVE, 1 in., 800 lb	1
	-9	30199		** THERMOMETER, Dial, 3 in., 50°–150° F	1
	-10	20001		** VALVE, Globe, 1/2 in., 800 lb	1
	-11	16976		INSULATION, Pipe, 10 in.	3.2 ft

[1] Call Clayton Service for replacement part number. Have the model number and the serial number of the machine available before calling.

* Optional equipment

** Optionally available, or customer furnished.

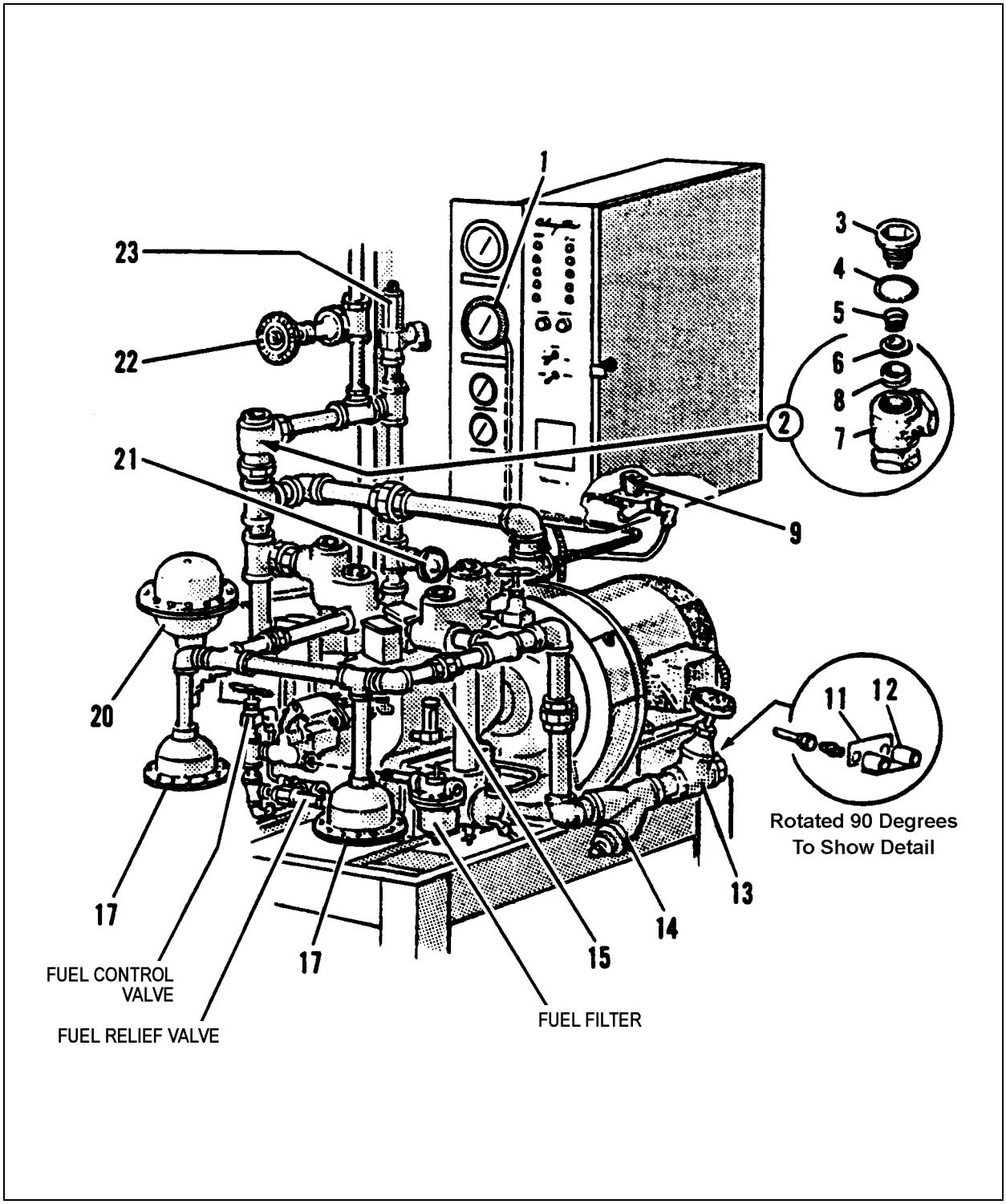

Figure 3. Pump Installation

Figure & Index No.		Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
				3 - PUMP INSTALLATION	
3	-1	38206		GAUGE, Pressure, 3 1/2 in. dia, 0–600 psi (standard pressure)	1
		38210		GAUGE, Pressure, 2 1/2 in. dia, 0–30 psi (low pressure)	1
	-2	UH-23304		VALVE, Check, 1 1/4 in., 300 lb	1
	-3	UH-12797		. CAP	1
	-4	16547		. GASKET	1
	-5	UH-18285		. SPRING	1
	-6	UH-25196		. DISC	1
	-7	UH-15479		. HOUSING	1
	-8	UH-25189		. SEAT	1
	-9	UH-24921		VALVE AND PLATE ASSY, Control, flow (semi-closed only)	1
	-11	UH-15287		PLATE, Name, Cooling Water (semi-closed only)	1
	-12	UH-23126		COUPLING AND PLATE ASSY, Control, flow (semi-closed only)	1
	-13	30484		* VALVE, Ball, 1 1/2 in. (feedwater intake)	1
	-14	26793		* STRAINER, Y, 1 1/2 in.	1
	-15			PUMP ASSY, Water (See Figure 4 for details.)	1
	-17			CHAMBER ASSY, Surge, Intake (See Figure 5a for details.)	2
	-20			SNUBBER ASSY, Discharge (See Figure 5b for details.)	1
	-21	19348		* VALVE, Globe, 1 in., 800 lb (coil drain)	1
	-22	7785		VALVE, Globe, 1 in., 300 lb (coil feed) (standard pressure)	1
		7784		VALVE, Globe, 3/4 in., 300 lb (coil feed) (low pressure)	1
	-23			VALVE ASSY, Relief (See Figure 17 for details.)	1

*** Optional or Customer Furnished**

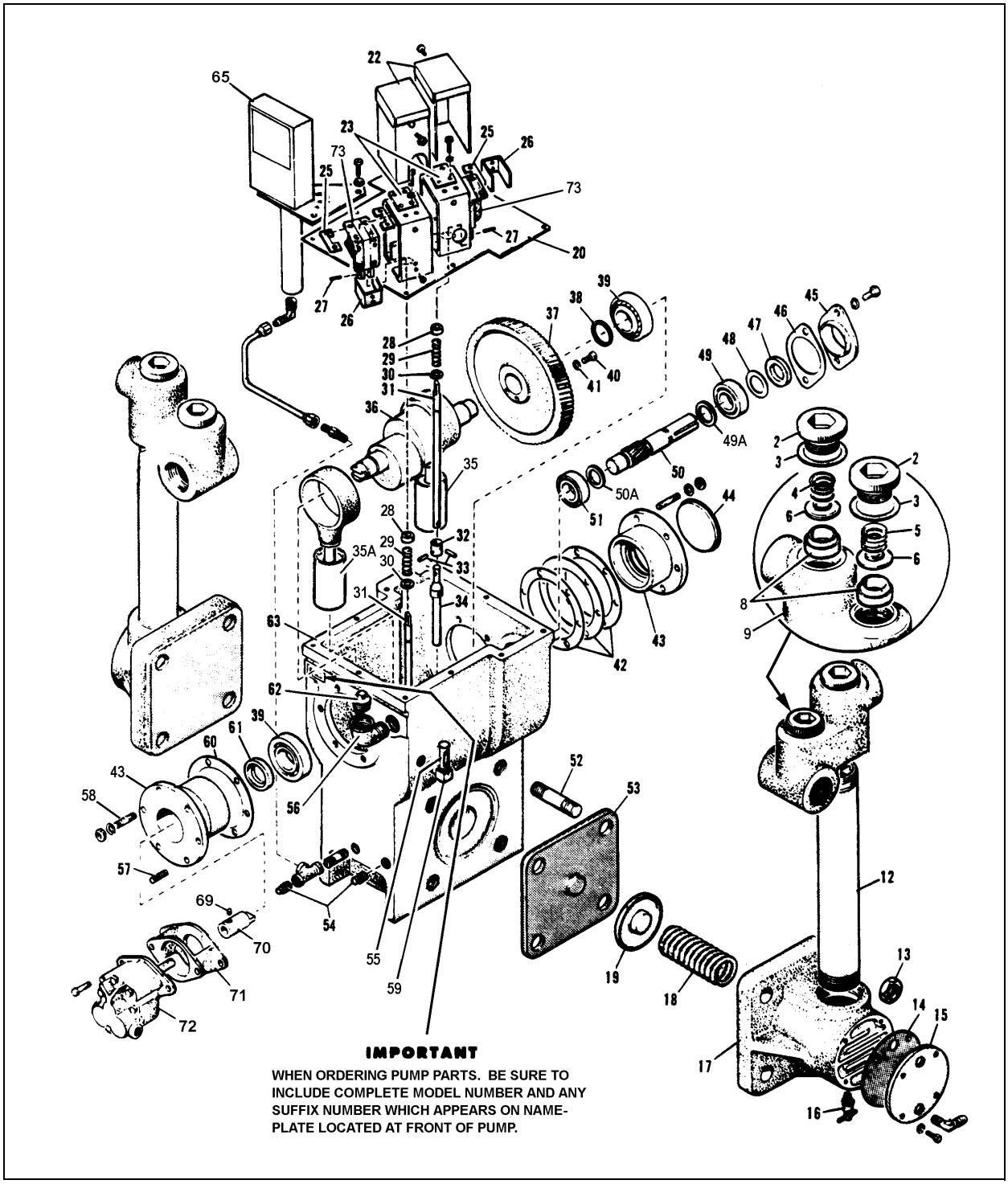

Figure 4. Water Pump Assembly with Fuel Pump

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			4 - WATER PUMP ASSEMBLY WITH FUEL PUMP	
4	UH-26714		PUMP ASSY, Water (60 Hz)	Ref
	UH-26715		PUMP ASSY, Water (50 Hz)	Ref
-2	UH-12797		. CAP, Check-valve	4
-3	16547		. GASKET, 2 in. o.d. x 1 3/4 in. i.d.	4
-4	UH-18285		. SPRING, Discharge valve (free length 31/32 in.)	2
-5	UH-18286		. SPRING, Intake valve (free length 25/32 in.)	2
-6	UH-25196		. DISC, Check-valve	4
-8	UH-25189		. SEAT, Check-valve	4
-9	UH-18277		. HOUSING, Check-valve	2
-12	UH-23054		. STANDPIPE ASSY, Pump	2
-13	4515		. NUT, Hex, 1-14 CRS	8
-14	UH-15062		. GASKET, Plate, cooling water (semi-closed only)	2
-15	UH-15061		. PLATE, Cover, cooling water (semi-closed only)	2
-16	12588		. COCK, Drain, 1/4 in.	2
-17	UH-15057		. HEAD, Pump, F2, w/ cooling	2
-18	UH-12803		. SPRING, Diaphragm	2
-19	UH-12801		. WASHER, Diaphragm	2
-20	UH-26624		. PLATE ASSY, Cover	1
-22	UH-21132		. COVER ASSY, Solenoid box	2
-23	UH-62545		. PLATE, Patch, solenoid box	2
-25	UH-14279		. PLATE, Mounting, solenoid	4
-26	UH-21991		. BRACKET ASSY, Retainer	2
-27	UH-13082		. PIN, Rod, Solenoid	2
-28	15431		. RING, Packing, u-cup, 3/8 in. i.d. x 7/8 in. o.d.	2
-29	30138		. SPRING, Compression, .609 in. o.d., 2 in. free length	2
-30	15284		. RING, Retaining	2
-31	UH-61246		. ROD, By-pass, upper	2
-32	UH-12375		. COUPLING, Rod, by-pass	2
-33	UH-15758		. PIN, By-pass, rod	4
-34	UH-61236		. ROD, By-pass, lower	2
-35	UH-32155		. PISTON AND LINK ASSY, One-piece Connector Link	1
-35A	UH-32176		. PISTON AND LINK ASSY, Two-piece Connector Link	1
-36	UH-60510		. CRANKSHAFT, 1.094, 180 phase pump	1
-37	UH-14103		. GEAR, Main, 115 tooth (used on 60 Hz units)	1
	UH-14105		. GEAR, Main, 112 tooth (used on 50 Hz units)	1
-38	UH-15863		. SPACER, Bearing	1
-39	19253		. BEARING, Roller, 1.125 in. bore x 2.75 in. o.d. x .998 long	2
-40	11724		. SCREW, Cap, hex socket, 5/16-24 x 1 1/4 in.	2
-41	14373		. WASHER, Lock, 5/16 in.	2
-42	UH-14281		. GASKET, Aluminum, 0.015 in. thick (Qty. may vary to obtain proper clearance)	2
	UH-14282		. GASKET, Aluminum, 0.010 in. thick (Qty. may vary to obtain proper clearance)	2
	UH-I4283		. GASKET, Aluminum, 0.005 in. thick (Qty. may vary to obtain proper clearance)	2
-43	UH-28287		. CAP, Bearing Set	1
-44	UH-63434		. PLATE, Retainer, pump	1
-45	UH-63096		. RETAINER, Bearing, pinion	1
-46	UH-12611R		. GASKET, Retainer	1
-47	29211		. SEAL, Oil	1
-48	UH-13877		. SHIM, Shaft (Quantity may vary to obtain proper clearance)	AR
-49	16227		. BEARING, Ball (ND No. 7605X1A)	1
-49A	UH-12609		. SPACER, Bearing (60 Hz only)	1
-50	UH-14104		. PINION, Drive, 15 tooth (60 Hz only)	1
	UH-13093		. SHAFT AND GEAR, Pinion, 18 tooth (50 Hz only)	1
-50A	UH-14101		. SPACER, Bearing, pinion (60 Hz only)	1
-51	17408		. BEARING, Ball (ND No. 7505X1A)	1
-52	UH-12603		. STUD, Head, pump	8

-53	UH-15055	. DIAPHRAGM, Pump	2
-54	2091	. PLUG, Pipe, 1/4 in. (Not part of this Assembly - Order separately)	4
-56	2035	. ELBOW, Pipe, 1 in.	1
-57	2540	. STUD, 3/8-16 x 1 1/2 in.	10
-58	6533	. STUD, Bracket, 3/8-16 x 2 in.	2
-60	UH-14281	. GASKET, Aluminum, 0.015-in. thick	2
-61	17399	. SEAL, Oil	1
-62	UH-66477	. PLUG, Pipe, vented, 1 in.	1
-63	UH-61245	. CRANKCASE, Pump	1
-65	UH-29557	KIT, Oil Level Float Switch (See Figure 7 for details.)	1
-69	17266	SCREW, Set, coupling, 5/16-18 x 3/8 in.	2
-70	UH-24740	COUPLING, Pump, fuel	1
-71	UH-61945	BRACKET, Fuel, pump	1
-72		PUMP, Fuel (See Figure 9 for details.)	Ref
-73	18157	SOLENOID, 115 V/50-60 Hz (Not part of this Assy - Order Separately)	2
	18159	. COIL, Solenoid, 115 V/50-60 Hz (Replacement for above solenoid)	2
	18158	SOLENOID, 230 V/50-60 Hz (Not part of this Assy - Order Separately)	2
	18160	. COIL, Solenoid, 230 V/50-60 Hz (Replacement for above solenoid)	2

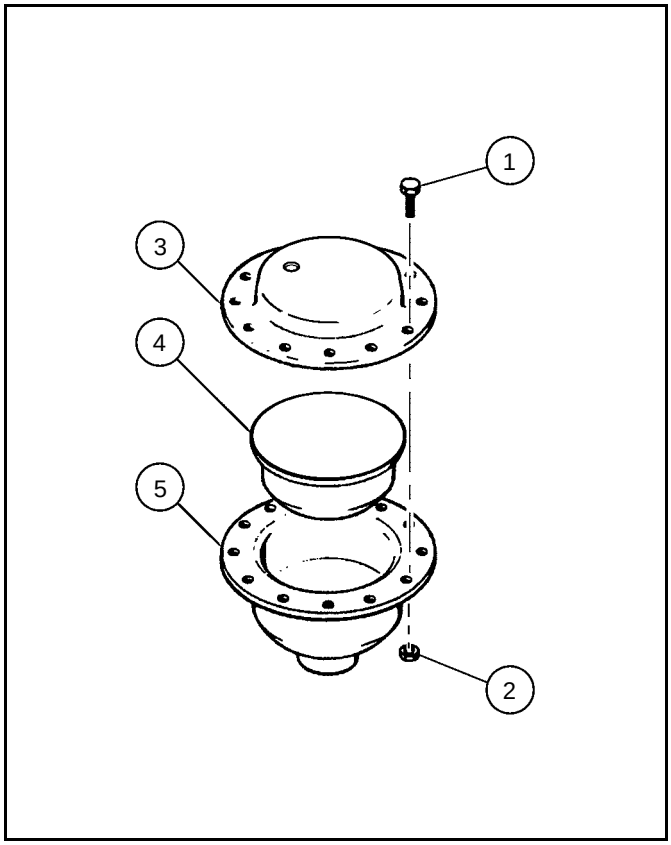

Figure 5a. Intake Surge Chamber Assy

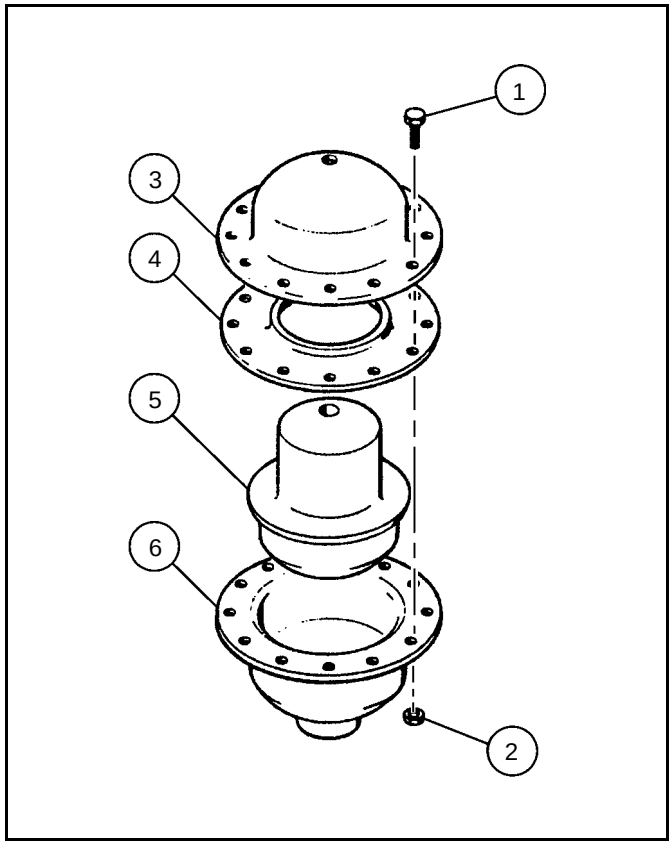

Figure 5b. Discharge Snubber Assy

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			5a - INTAKE SURGE CHAMBER	
5a	UH-27007		CHAMBER ASSY, Surge, intake, med. press./DA/HD (for inlet pressures up to 25 psi)	Ref
1	2643		. SCREW-Cap, 3/8-16 x 1 in.	12
2	2761		. NUT-Hex, 3/8-16 in., CRS	12
3	UH-24013		. HOUSING	1
4	UH-60077		. INSERT, Rubber	1
5	UH-61769		. PLATE, Cover	1
			5b - INTAKE/DISCHARGE SNUBBER CHAMBER	
5b	UH-24580		SNUBBER ASSY, Intake, SCR (over 550 psi)	Ref
	UH-25466		SNUBBER ASSY, Discharge, med. press./DA	Ref
	UH-30595		SNUBBER ASSY, Discharge, HD/SCR (over 550 psi)	Ref
1	10582		. SCREW, Cap, 3/8-16 x 1 1/4 in., Soc. Hd.	12
2	2761		. NUT, Hex, 3/8-16 x 1 1/4 in., Soc. Hd.	12
3	UH-16373		. HOUSING, Top.	1
4	UH-16371		. RETAINER, Insert	1
5	UH-17616		. INSERT, Rubber, 45/55, ylw (used on UH-24580)	1
	UH-62868		. INSERT, Rubber (used on UH-25466)	1
	UH-65987		. INSERT, Rubber, low compression (used on UH-30595)	1
6	UH-24013		. HOUSING, Bottom	1

(Figure 6: Reserved)

Figure 6. Reserved

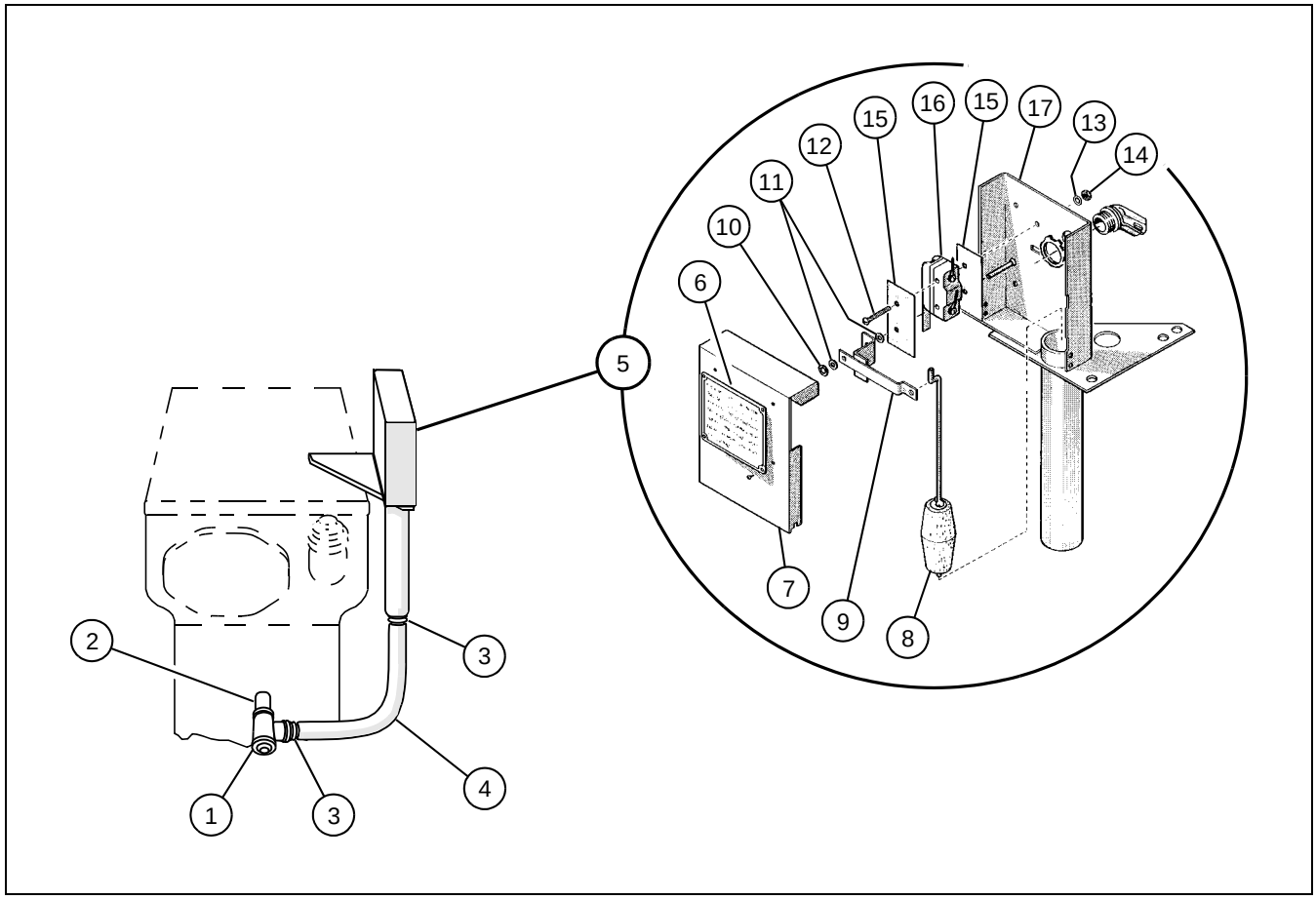

Figure 7 Oil Level Switch Kit

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			7 - OIL LEVEL SWITCH KIT	
	UH-29557		KIT - Oil Level Switch	Ref
1	2071		. TEE - Pipe, 1/4 in., 150#	1
2	5324		. NIPPLE - Pipe, black, 1/4 x 1 in.	1
3	23451		. CONNECTOR - Tube, p-flo, 3/8T x 1/4P	2
4	23452		. TUBE - Nylo-Seal, 3/8 in.	2 ft
5	UH-26877		. SWITCH - Float, level oil	1
6	UH-15255		. . PLATE - Instruction	1
7	UH-60061		. . COVER	1
8	UH-23173		. . FLOAT ASSY	1
9	UH-23103		. . ARM - Lever	1
10	18382		. . RING - Retaining	1
11	2762		. . WASHER - Plain, #6	2
12	8051		. . SCREW - Machine, #6-32 x 1 1/8, RHB	2
13	15894		. . WASHER - Lock, shockproof, #6	2
14	2754		. . NUT - Hex, #6-32, CRS	2
15	UH-15174		. . INSULATOR - Switch	2
16	18381		. . SWITCH - SPDT, Leveract	1
17	UH-26621		. . HOUSING ASSY	1

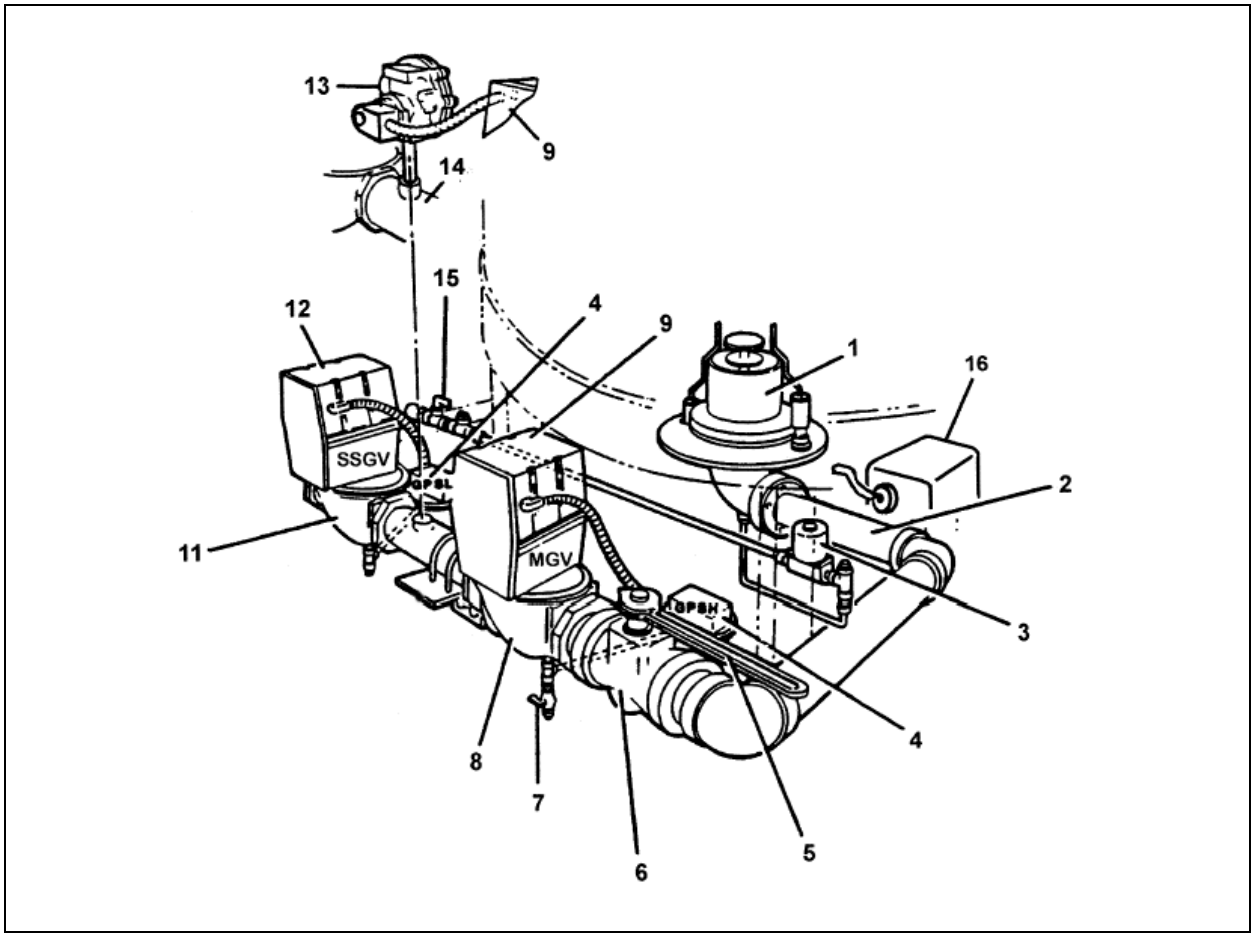

Figure 8. Fuel System (Gas-fired Units)

Figure & Index No.	Part Number	1 2 3 4 5 6 7 Description	Units Per Assy
		8 - FUEL SYSTEM (GAS-FIRED UNITS)	
8 -1		MANIFOLD ASSY, Burner, gas (See Figure 11a for details.)	Ref
-2	UH-18328	NIPPLE, Burner, 2 in.	1
-3	27618	VALVE, Solenoid, gas, 1/4 in., 115 v, 60 Hz	1
-4	16832	SWITCH, Pressure (GPSH/GPSL)	2
-5	14616	WRENCH, Valve	1
-6	22652	VALVE, Gas, 2 1/2 in.	1
-7	14177	COCK, Gas 1/8 in. (FM only)	1
-8	29201	BODY, Valve (MGV)	1
-9	29207	ACTUATOR Valve. (MGV)	1
	29204	SWITCH KIT, Auxiliary (MGV)	1
-10	UH-28747	BRACKET, Mounting	1
-11	29202	BODY, Valve (SSGV)	1
-12	29206	ACTUATOR, Valve (SSGV)	1
-13	21187	VALVE, Solenoid, 1 1/4 in.	1
-14	UH-27978	NIPPLE & COUPLING ASSY	1
-15	3440	COCK, Gas, pilot, 1/4 FPT x 1/4 MPT	1
-16	7717	TRANSFORMER, Ignition (IT) (Gas and Gas/ Oil Units Only)	1
not illustrated	29204	KIT, Switch, Auxiliary (installed inside valve actuator housing)	1

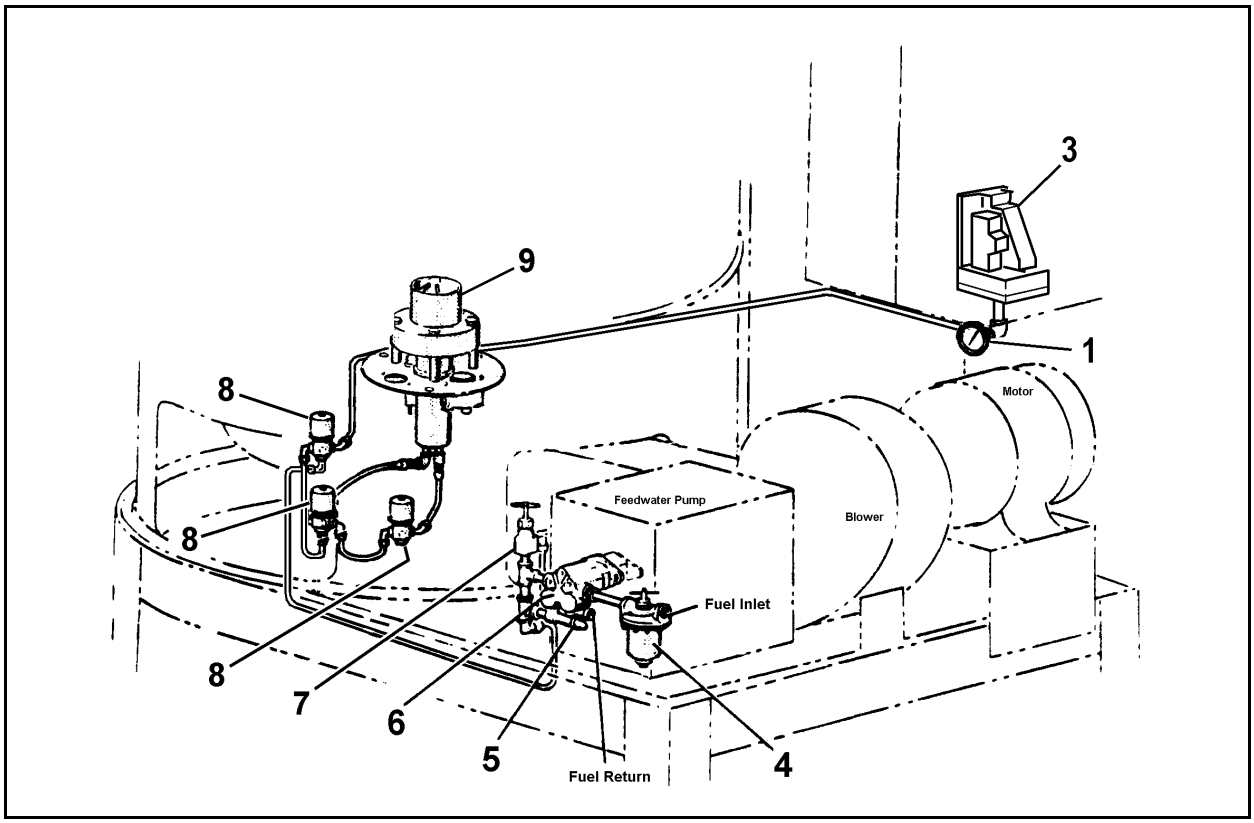

Figure 9. Fuel System (Oil-fired Units)

Figure & Index No.	Part Number	1 2 3 4 5 6 7 Description	Units Per Assy
		9 - FUEL SYSTEM (OIL-FIRED)	
9 -1	27789	GAUGE, Pressure, 600 lb, 2 1/2 in. dia	1
-3	31258	SWITCH, Fuel pressure, 30–300 psi, SPDT (FPS)	1
-4	16255	FILTER, Fuel, 1/2 in.	1
-5	17775	VALVE, Relief, 3/8 in. (Fuel Regulator Valve)	1
-6	36126	PUMP, Fuel	1
	UH-24740	COUPLING ASSY, Fuel Pump	1
	36141	ADAPTER, SAE, 1 1/16 x 3/4 in. NPT (fuel pump)	1
	36142	ADAPTER, SAE, 1 1/16 x 3/4 in. NPT (fuel pump)	1
-7	17894	VALVE, Angle, fuel control, 1/4 in.	1
-8	37774	VALVE, Solenoid, 1/8 in., 115 V/50-60 Hz	2
-9		MANIFOLD ASSY, Burner, oil (See Figure 11b for details.)	1
Not Shown	* 37097	PUMP, Fuel	1
Not Shown	* 25321	MOTOR, Pump, Fuel, 3/4 hp	1
Not Shown	* 32009	COUPLING, Flex, 1/2 x 7/16	1
Not Shown	* 37097	COUPLING, Flex, 5/8 x 7/16	1
Not Shown	7717	TRANSFORMER, Ignition, 1-pole, 120 V/60 Hz	1

*** Parts maybe substituted for item -6 by Clayton Industries.**

(Figure 10: Reserved)

Figure 10. Reserved

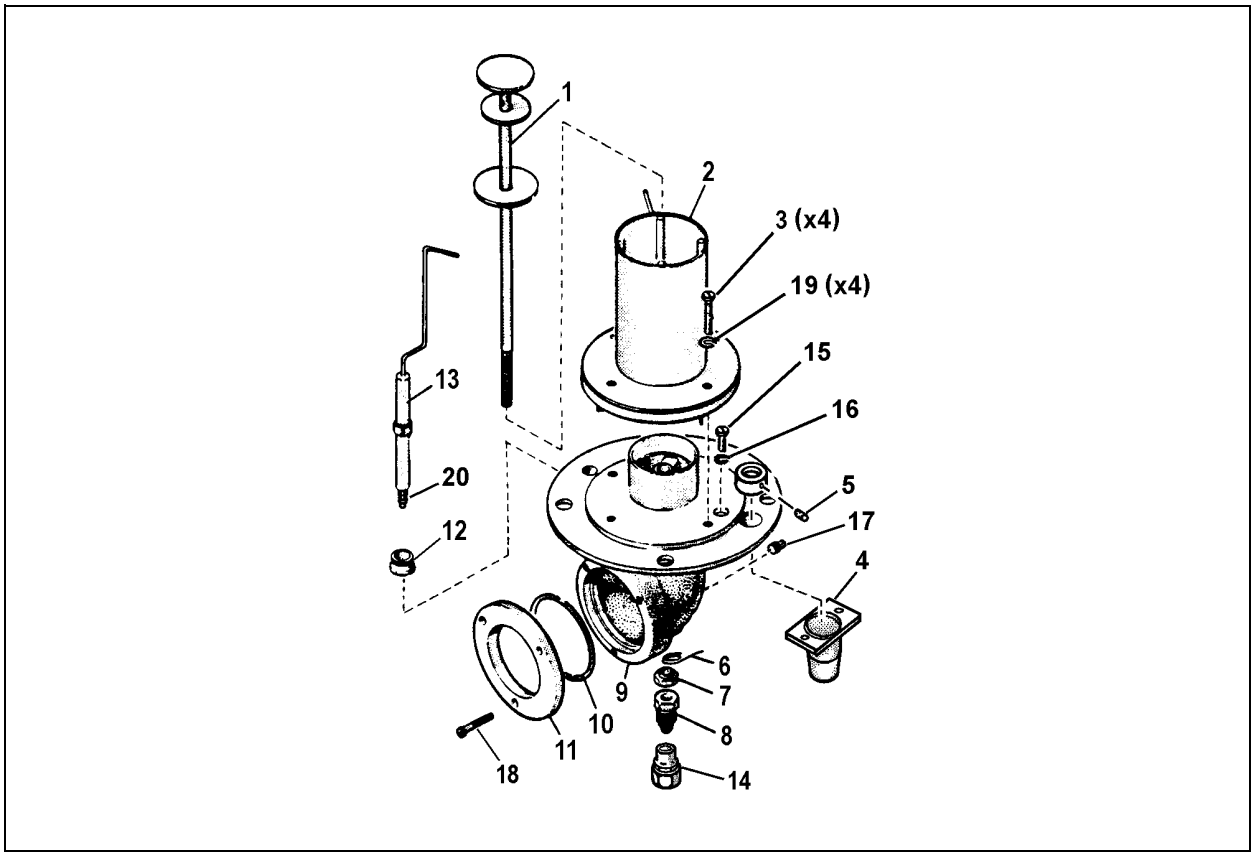

Figure 11a. Gas Burner Manifold

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			11A - GAS BURNER MANIFOLD	
11a	UH-31799		MANIFOLD ASSY, Burner, gas	Ref
1	UH-22950		. STEM ASSY, Pilot	1
2	UH-25222		. CONE ASSY	1
3	3194		. SCREW, Machine, 1/4-20 x 1 1/4 in.	4
4	UH-66844		. NIPPLE, Adapter, UV	1
5	3222		. SCREW, Set, 1/4-20 x 1/4 in.	1
6	18991		. CORD, Fiberglass, 1/8 in.	0.30 ft
7	UH-9717		. NUT, Lock	1
8	2130		. BUSHING, Pipe, 1/4 x 1/8 in.	1
9	UH-60094		. ELBOW, Manifold, burner	1
10	7735		. PACKING, O-ring, 2 5/8 o.d. x 2 1/4 i.d.	1
11	UH-18326		. RING, Packing	1
12	JL-539		. NUT, Lock	1
13	UH-16079		. ELECTRODE, Ignition	1
14	28212		. CONNECTOR, Tube, 3/8T x 1/4FP in.	1
15	4488		. SCREW, Machine, #6-32 x 1/2	1
16	15894		. WASHER, Lock, #6, shakeproof	2
17	2092		. PLUG, Pipe, 3/8 in.	1
18	2689		. SCREW, Machine, 1/4-20 x 1/2 in.	3
19	2608		. WASHER, Lock, 1/4 in.	4
20	13191		. STUD, Hex, base	1
Not Shown	UH-22535		CABLE, Scanner	1

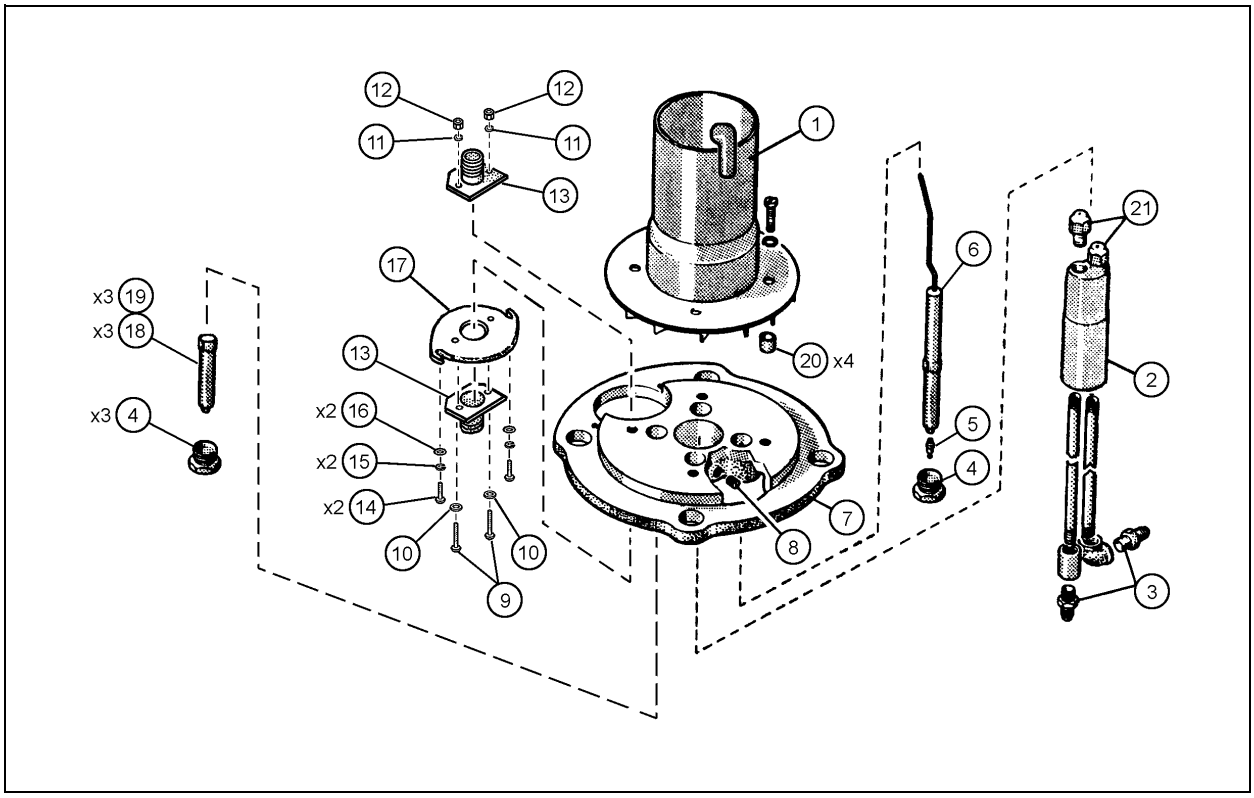

Figure 11b. Oil Burner Manifold

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			11B - OIL BURNER MANIFOLD	
11b	**UH-31796**		**MANIFOLD ASSY, Burner, oil**	**Ref**
1	**UH-31795**		**. CONE ASSY**	**1**
2	**UH-62215**		**. STEM**	**1**
3	**18901**		**. CONNECTOR, Tube, 1/4T x 1/8P**	**2**
4	**JL-539**		**. NUT, Lock, electrode**	**4**
5	**13191**		**. STUD, Hex**	**1**
6	**UH-66850**		**. ELECTRODE, Ignition**	**1**
7	**UH-14213**		**. PLATE, Mounting**	**1**
8	**16701**		**. SCREW, Set, 5/16-18 x 1/4 in.**	**2**
9	**2743**		**. SCREW, Machine, 8-32 x 3/8 in.**	**2**
10	**12863**		**. WASHER, Lock, #8**	**2**
11	**2607**		**. WASHER, Lock, #8**	**2**
12	**2755**		**. NUT, Hex, #8-32**	**2**
13	**UH-30924**		**. NIPPLE ASSY, Flame Scanner**	**1**
14	**5428**		**. SCREW, Machine, #10-32 x 5/8 in.**	**2**
15	**4280**		**. WASHER, Lock, #10**	**2**
16	**33469**		**. WASHER, Flat, #10**	**2**
17	**UH-66626**		**. PLATE, Adapter**	**1**
18	**JL-1567**		**. ELECTRODE, Ignition**	**3**
19	**UH-66849**		**. PLUG, Electrode, .56 x 1 in.**	**3**
20	**UH-6364**		**. SPACER, Manifold**	**4**
21	**33524**		**. NOZZLE, Burner, 90^{o} spray, 9.5 gph**	**2**

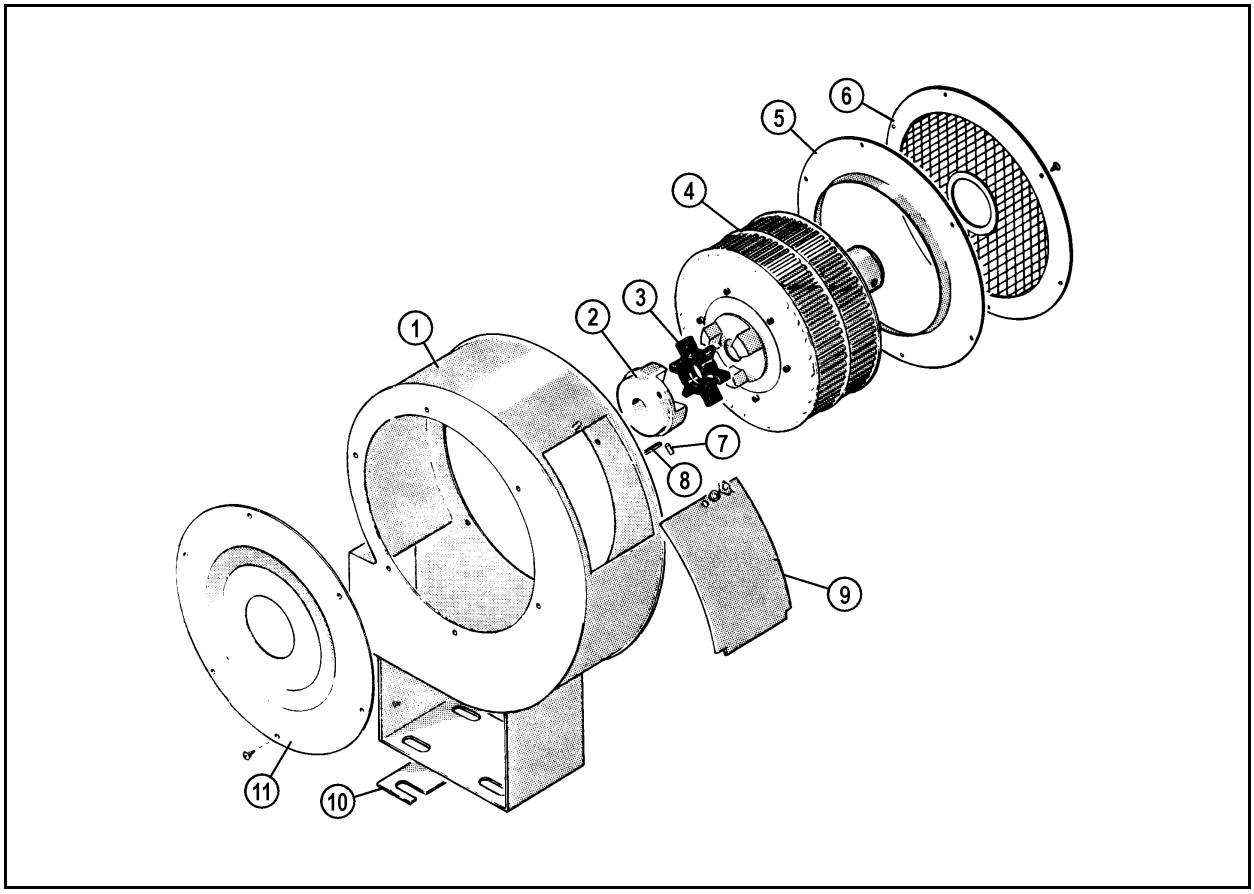

Figure 12a. Blower Installation

Figure & Index No.	Part Number	1 2 3 4 5 6 7 Description	Units Per Assy
		12A - BLOWER INSTALLATION	
12a -1	UH-26332	HOUSING ASSY, Blower	1
-2	22609	COUPLING, Flex, pump half	1
-3	UH-13170	COUPLING, Spider, flex	1
-4	UH-26406	ROTOR AND HUB ASSY, Blower	1
	UH-26405	ROTOR AND HUB ASSY, Blower, high altitude (above 5,000 ft)	1
-5	UH-60933	FLANGE, Intake, 230/460v, 60 Hz	1
	UH-60797	FLANGE, Intake, 380 v (also 60 Hz high altitude)	1
-6	UH-26372	GUARD, Blower	1
-7	12464	SCREW, Set, 3/8-16 x 1/2 in. self-locking	1
-8	JL-1573	KEY, Shaft, 3/16 x 3/16 x 1 3/4 in.	1
-9	UH-12829	PLATE, Cover, housing	1
-10		(not applicable)	
-11	UH-60796	PLATE, Cover, blower	1
Not Shown	UH-15252	TOOL, Cleaning, rotor	1
Not Shown		MOTOR, Electric [1]	1
Not Shown	UH-25125	BASE, Motor, mounting	1

[1] Call Clayton Service for replacement part number. Have the model number and serial number of the machine available before calling.

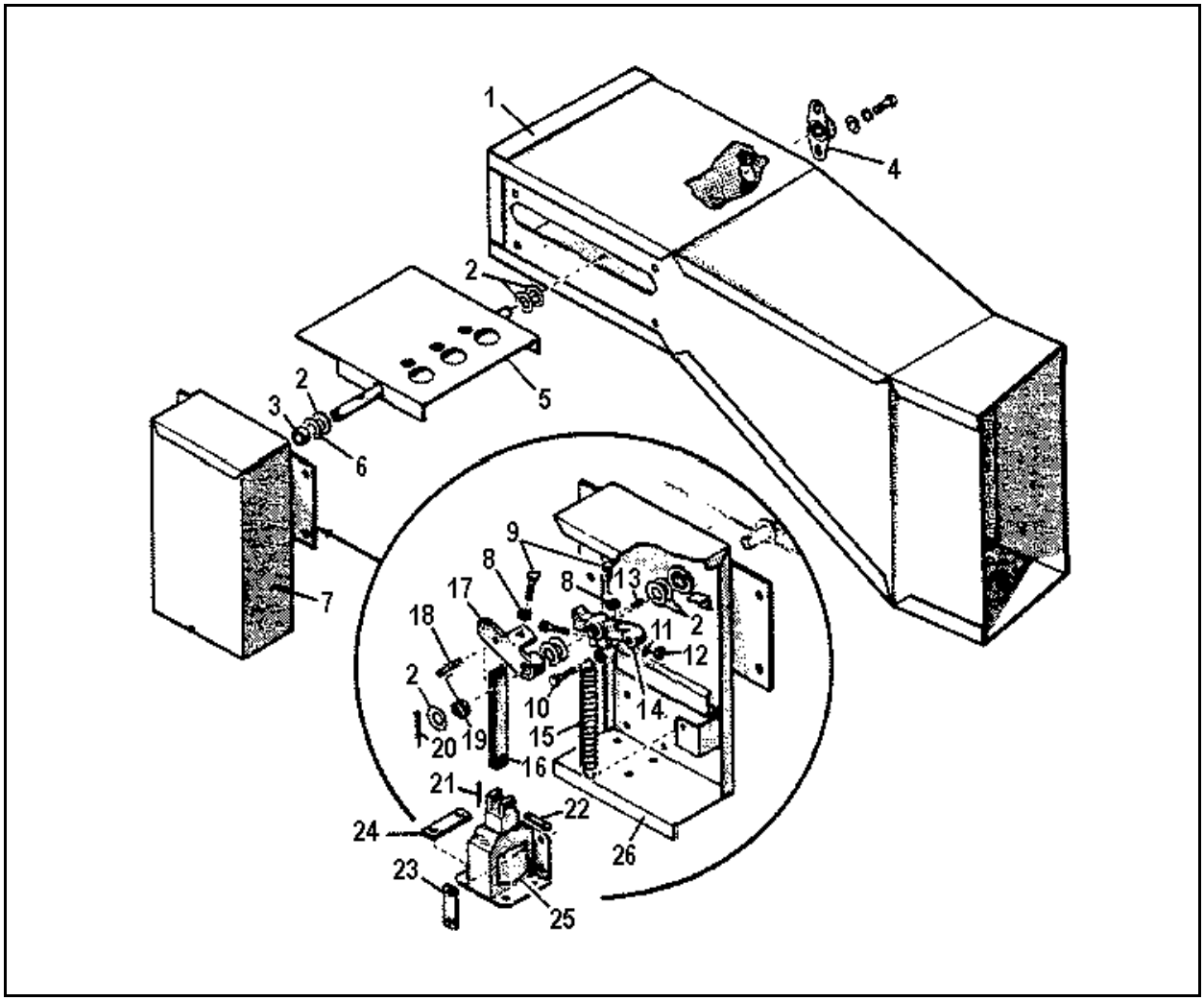

Figure 12b. Air Duct and Damper

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			12B - AIR DUCT AND DAMPER	
12b -	UH-23538		DUCT AND DAMPER ASSY, Air	Ref
-1	UH-23539		. DUCT ASSY, Air	1
-2	UH-14240		. WASHER, Spacer, 0.030 in. thick	8
-3	17562		. BEARING	1
-4	19118		. BEARING, Flanged	1
-5	UH-23541		. BLADE AND SHAFT ASSY	1
-6	UH-14239		. WASHER, Spacer, 0.015 in. thick	AR
-7	UH-15260		. COVER	1
-8	2722		. NUT, Hex, 1/4-20	2
-9	18476		. SCREW, Cap, 1/4-20 x 1 in.	2
-10	13248		. SCREW, Cap, socket hd., 10-32 x 1 in.	2
-11	4836		. WASHER, Lock, 3/16 in.	1
-12	2756		. NUT, Hex, 10-32 CRS	3

-13	**7293**	**. KEY, Woodruff**	**1**
-14	**UH-15217**	**. ARM, Lever**	**1**
-15	**UH-14717**	**. SPRING**	**1**
-16	**UH-14714**	**. LINK, Solenoid**	**1**
-17	**UH-14715**	**. LINK, Control**	**1**
-18	**15771**	**. PIN, Roll**	**1**
-19	**UH-14713**	**. SPRING, Retaining, solenoid**	**1**
-20	**7998**	**. PIN, Cotter, link**	**1**
-21	**16204**	**. PIN, Cotter, solenoid**	**1**
-22	**UH-13620**	**. PIN, Link, solenoid**	**1**
-23	**UH-13628**	**. PLATE, Mounting**	**2**
-24	**UH-14279**	**. PLATE, Mounting**	**2**
-25	**17519**	**. SOLENOID, Damper, 115 v, 50/60 Hz**	**1**
	17520	**. SOLENOID, Damper, 230 v, 50/60 Hz (Not part of this assy, order seperately)**	**1**
-26	**UH-23540**	**. PLATE AND HOUSING ASSY**	**1**
Not Shown	**UH-26940**	**. TUBE ASSY, Air Pressure**	**1**
Not Shown	**23449**	**. ELBOW, Tube, 1/4T x 1/4P**	**1**
Not Shown	**4934**	**. SCREW, Sheet Metal, No. 10 x 318 inch**	**2**

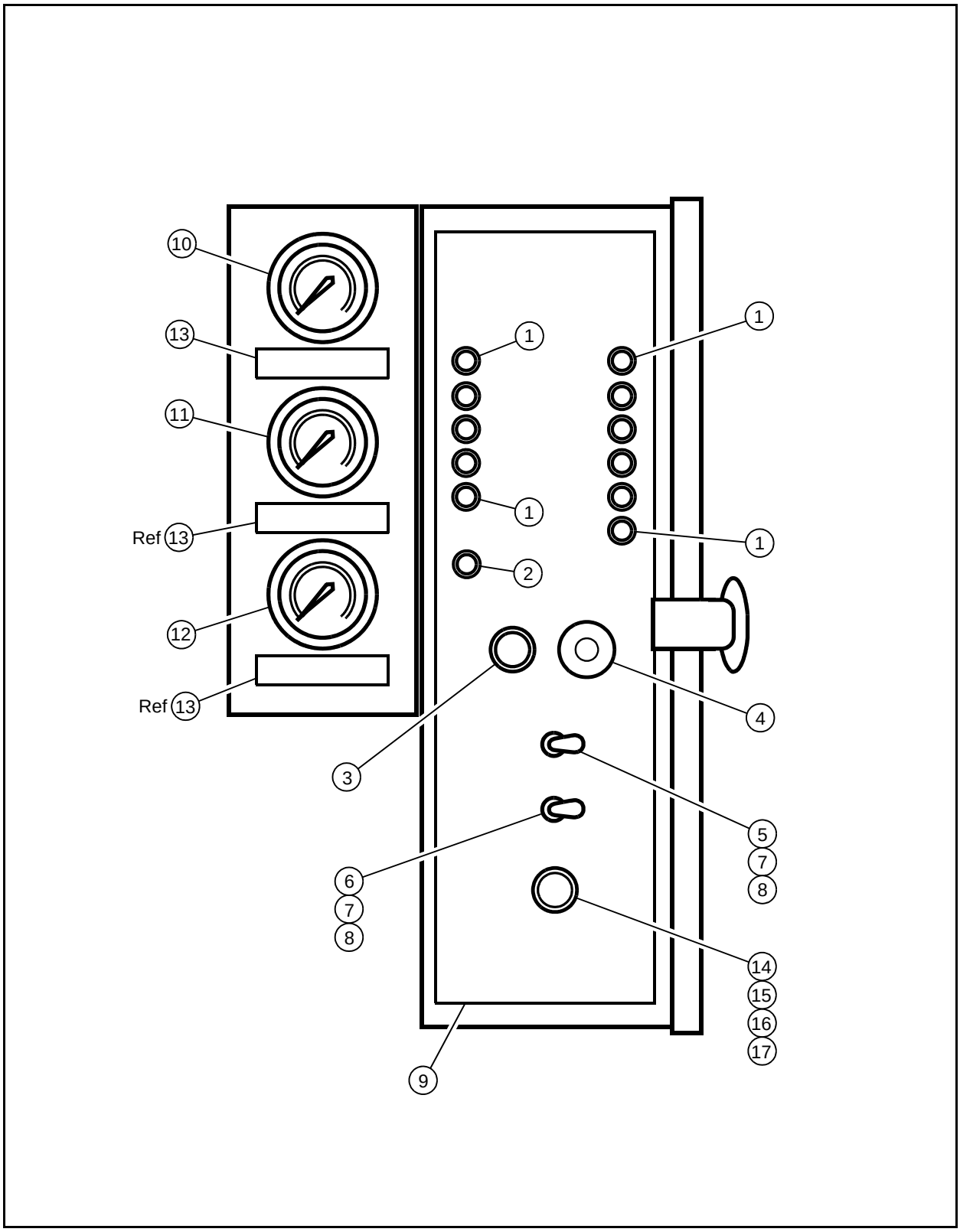

Figure 13a. Electrical Control Box - Front Panel

Figure & Index No.		Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			13A - ELECTRICAL CONTROL BOX - FRONT PANEL		
13a	-1	24761		LIGHT, Pilot, amber, 115 V (IL)	11
	-2	24761		LIGHT, Pilot, amber, 115 V (ILHLG) (UA option)	1
	-3	UH-30105		PUSHBUTTON ASSY, START (PB2)	1
	-4	UH-30104		PUSHBUTTON ASSY, STOP (PB1)	1
	-5	22978		SWITCH, Toggle, SPST (AMS)	1
	-6	27682		SWITCH, Toggle, 4PDT (RFS)	1
	-7	24754		RING, Lock, Toggle Switch	2
	-8	22457		BOOT, Seal, switch	2
	-9	UH-64406		LABEL, Silkscreen	1
	-10	38207		GAUGE, Pressure, 2 1/2 in., 500 psig (Discharge Pressure) (med. press.)	1
		38212		GAUGE, Pressure, 2 1/2 in., 600 psig (Discharge Pressure) (high press.)	1
		38210		GAUGE, Pressure, 2 1/2 in., 30 psi (Discharge Pressure) (low press.)	1
	-11	38212		GAUGE, Pressure, 2 1/2 in., 600 psig (Feed Pressure) (med. press.)	1
		38206		GAUGE, Pressure, 2 1/2 in., 1000 psig (Feed Pressure) (high press.)	1
	-12	38208		GAUGE, Pressure, 2 1/2 in., 300 psig (Trap Pressure)	1
		38210		GAUGE, Pressure, 2 1/2 in., 30 psi (Trap Pressure) (low press.)	1
	-13	UH-64089		LABEL, Set, Gauge Panel (optional Gauge Panel Kit)	1
	-14	38480		PUSHBUTTON, Momentary, 22.5 mm, NEMA type 4, flush head, black	1
	-15	38481		LATCH, Mounting	1
	-16	38482		CONTACT, Block, normally-closed	1
	-17	38483		CONTACT, Block, normally-open	1

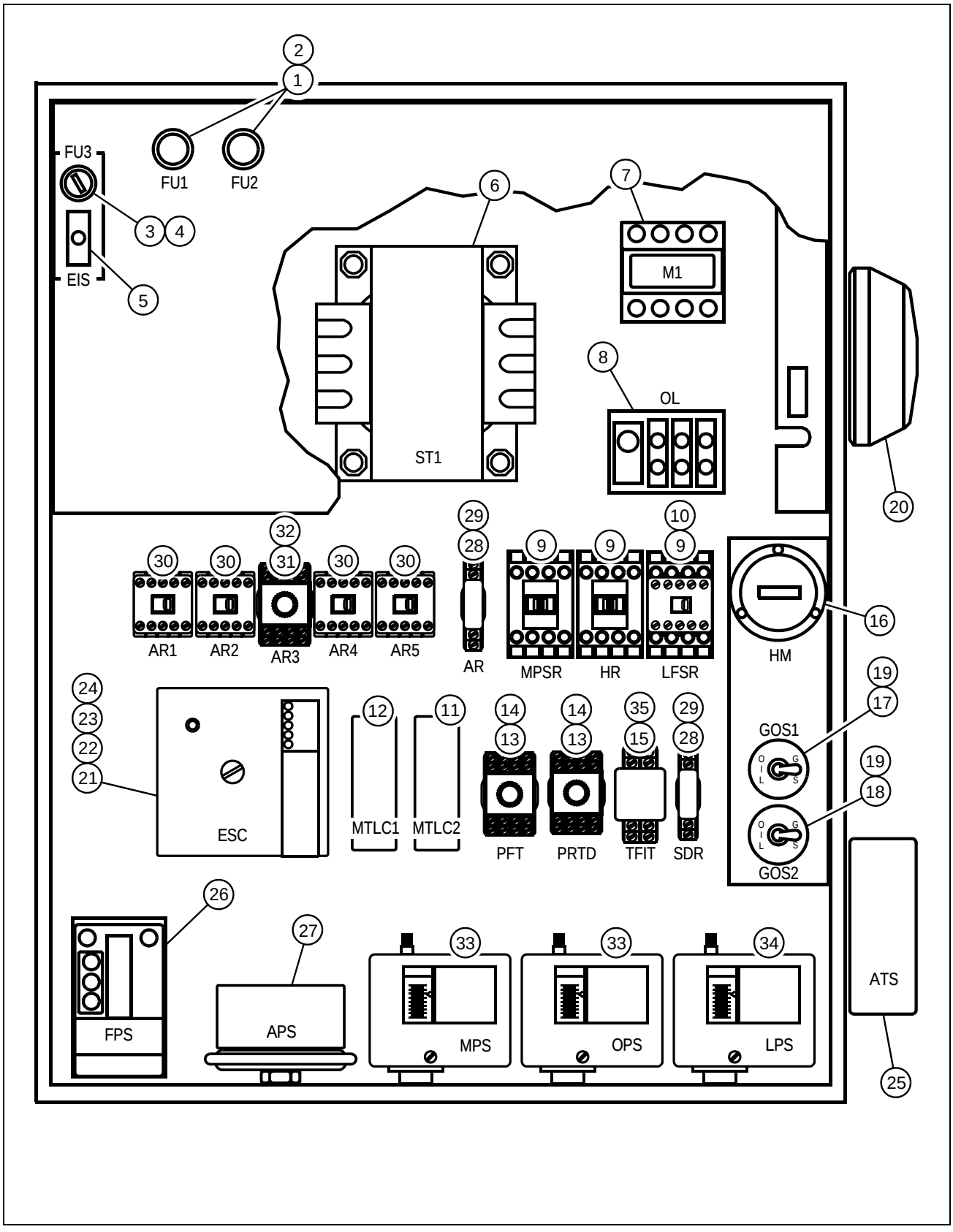

Figure 13b. Electrical Control Box - Internal components

Figure & Index No.	Part Number	1 2 3 4 5 6 7 Description	Units Per Assy
		13B - ELECTRICAL CONTROL BOX - INTERNAL COMPONENTS	
13b -1	29853	FUSE, Dual Element, 2.5 A, 500 vac (FU1, FU2)	2
	36463	FUSE, Slow Blow, class CC, 2.5 A, 600 vac (FU1, FU2)	2
-2	27469	HOLDER, Fuse	2
-3	35047	FUSE, 10 A, 250 vac, 3AG (FU3)	1
-4	8793	POST, Fuse Extractor	1
-5	23769	SWITCH, Pushbutton, 2-pole (EIS)	1
-6	33333	TRANSFORMER, Stepdown, .750 kVa, 380/400/575-115 VAC, 50/60 Hz (ST1)	1
	31025	TRANSFORMER, Stepdown, .750 kVa, 230/460-115 VAC, 50/60 Hz (ST1)	1
-7	24743	CONTACTOR, Magnetic, 110 V/50-60 Hz/30 A (M1)	1
-8	24751	RELAY, Overload, w/ manual reset, 1 n.o./1 n.c., 27 A (OL)	1
-9	30968	RELAY, Control, IEC 120 V/50-60 Hz, 2 n.o./2 n.c. (HR, LFSR, MPSR)	3
-10	35104	CONTACT, Auxiliary Adder, 2 n.o./2 n.c. (use with LFSR)	1
-11	- - -	CONTROLLER, Main Temperature Limit, primary (MTLC2)[1]	1
-12	- - -	CONTROLLER, Main Temperature Limit, secondary (MTLC1)[1]	1
-13	37107	TIMER, Relay, DPDT, .1 min–10 h, 120 VAC/50-60 Hz (PFT, PRTD)	2
-14	27785	SOCKET, Octal, IDEC, 8-pin	2
-15	36012	RELAY, Control, IDEC, DPDT, 10 amp (ASR)	1
-16	29745	METER, Hour, 115 vac/60 Hz (HM)	1
	29746	METER, Hour, 115 vac/50 Hz (HM)	1
-17	22111	SWITCH, Toggle, 3PDT (GOS1)	1
-18	27682	SWITCH, Toggle, 4PDT (GOS2)	1
-19	24754	RING, Lock, toggle switch	2
-20	16305	HORN, Alarm, 120 V/60 Hz	1
-21	30991	MODULE, Programmer (ESC)	1
	36423	MODULE, Programmer, no pilot stabilization (ESC)	1
-22	30992	MODULE, Amplifier, UV, EO/EOG (ESC)	1
	30993	MODULE, Amplifier, Flamerod, EG models (ESC)	1
	36181	MODULE, Amplifier, IR, EO/EOG models (ESC)	1
-23	30994	CHASSIS, Combustion Control (ESC)	1
-24	22083	BASE, Relay, mounting (ESC)	1
-25	18014	SWITCH, Auxiliary Thermostat (ATS)	1
-26	31258	SWITCH, Pressure, oil, SPST switch contact, 30–300 psi (FPS)	1
-27	32669	SWITCH, Pressure, 2–20 in. w.c., 230 V (APS)	1
-28	33169	RELAY, SPST, 120 VAC (AR, SDR) (control box option)	2
-29	33170	SOCKET, Blade, 5-pin (control box option)	2
-30	33429	RELAY, Control, IEC, 4-pole, 2 n.o./2 n.c., 110 VAC/50-60 Hz (UA option)	4
-31	37107	TIMER, Relay, DPDT, .1 s–600 h, 120 vac, 50/60 Hz (UA option)	1
-32	29734	SOCKET, Relay (UA option)	1
-33	29231	SWITCH, Pressure, 2–80 psi range (MPS, OPS) (30–100 psig design press.)	2
	13829	SWITCH, Pressure, 0–150 psi range (MPS, OPS) (100–250 psig design press.)	2
	15723	SWITCH, Pressure, 50–240 psi (MPS, OPS) (100–250 psig design press.)	2
	23788	SWITCH, Pressure, 50–500 psi range (MPS, OPS) (300–350 psig design press.)	2
-34	13829	SWITCH, Pressure, 0–150 psi range (LPS) (30–100 psig design press.)	1
	24842	SWITCH, Pressure, 50–240 psi range (LPS) (100–250 psig design press.)	1
	32531	SWITCH, Pressure, 20–300 psi range (LPS) (250–300 psig design press.)	1
	36390	SWITCH, Pressure, 160–1650 psi (LPS) (350 psig design press.)	1
-35	34103	SOCKET, Blade, IDEC, 8 pin	1

[1] See Appendix B for part numbers.

Figure 14. Gravity Fill Option - Elevated Receiver

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			14 - GRAVITY FILL OPTION - ELEVATED RECEIVER	
1	38163		VALVE, Check, swing, 1/2 in., 800#	2
2	38194		VALVE, Ball, 1/2 in., 250#, stainless steel	1

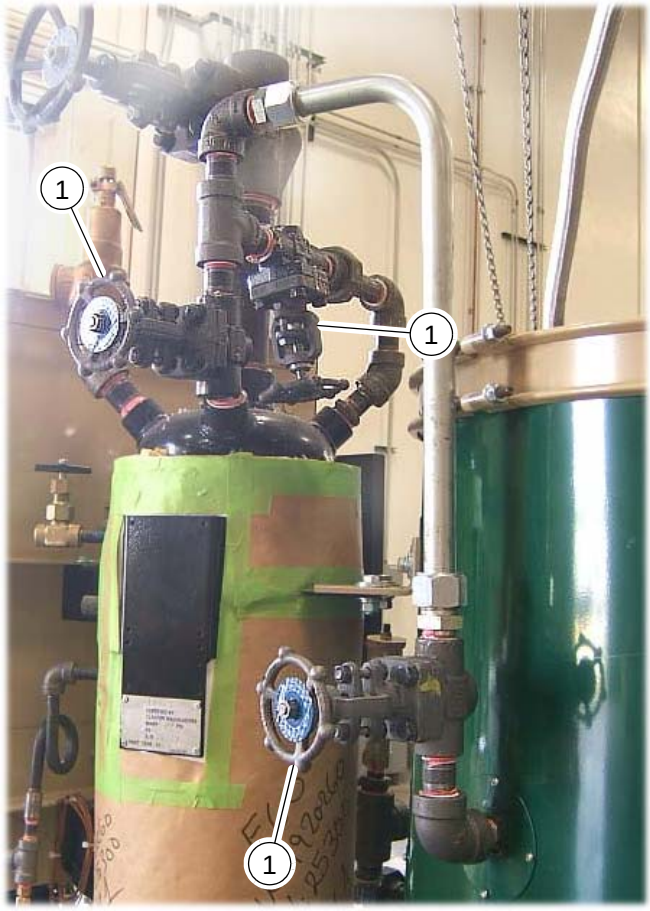

Figure 15. Sootblow Valves

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			15 - SOOTBLOW VALVES	
1	**19929**		**VALVE, Globe, 3/4 in., 800# . . . . . .**	**3**

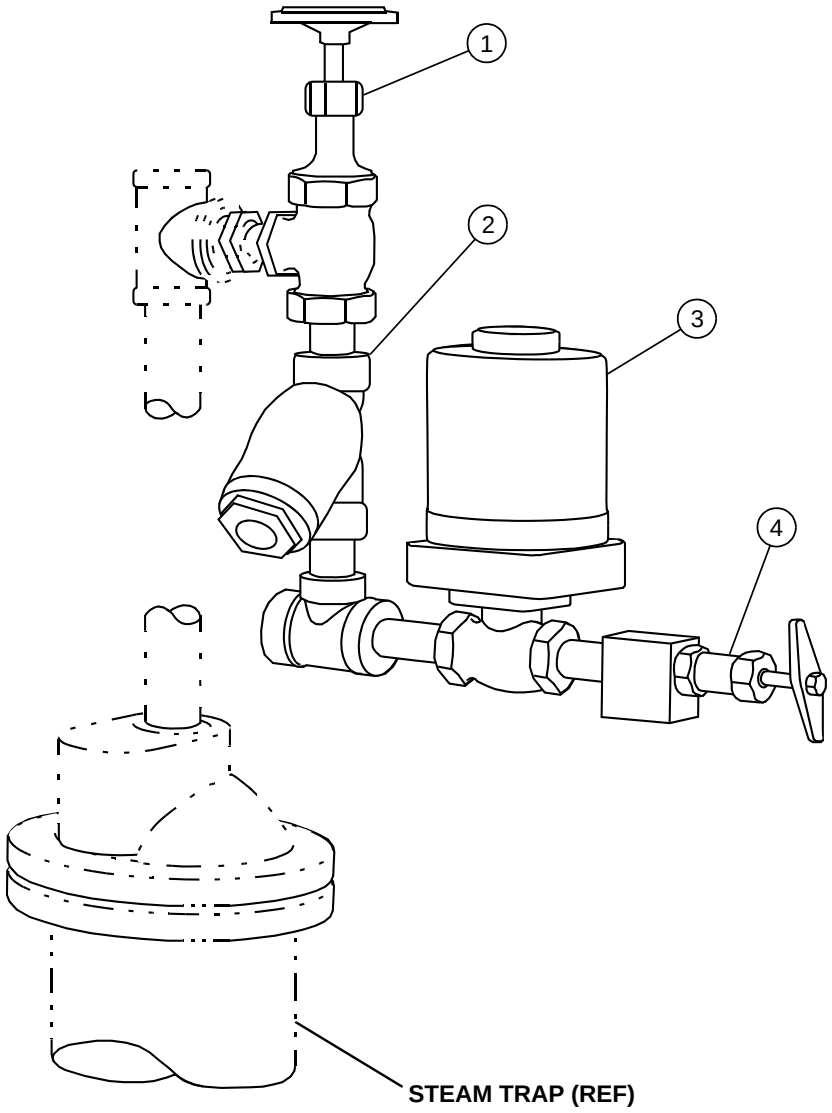

Figure 16. Continuous Bleed Blowdown Option

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			16 - CONTINUOUS BLEED BLOWDOWN OPTION	
-1	17371		VALVE, Angle, 1 1/2 in., 300#	1
-2	17094		STRAINER, Y, 1/2 in., 250#	1
-3	34804		VALVE, Solenoid, 110 V/60 Hz, normally-closed, 1/2 in., 150 psi	1
-4	16601		VALVE, Angle, 3/8 in., 6000#	1

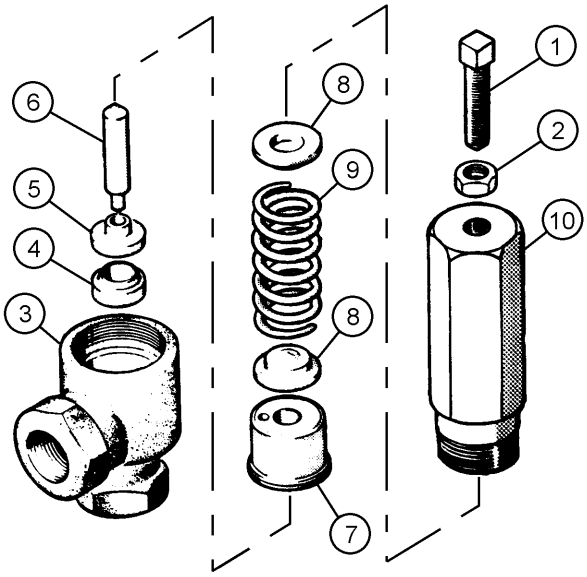

Figure 17. Relief Valve - Feedwater Pump

Figure & Index No.	Part Number	1 2 3 4 5 6 7	Description	Units Per Assy
			17 - RELIEF VALVE - FEEDWATER PUMP	
	UH-22198		VALVE ASSY, Relief, 1/2 in., 600 psi (See Figure 3 for installation)	Ref
1	12100		. NUT, Hex, 3/8-16	1
2	27740		. SCREW, Set, sq. hd. cone pt., 3/8-16 x 1 1/2 in.	1
3	UH-25419		. BODY AND SEAT ASSY	1
			. . BODY (not available separately - order item 3)	1
4	UH-13660		. . SEAT	1
5	UH-13661		. DISC	1
6	UH-13662		. STEM	1
7	UH-13663		. GUIDE	1
8	K-6153		. WASHER, Spring	2
9	K-6201		. SPRING	1
10	UH-14290		. HOUSING	1

NOTES

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