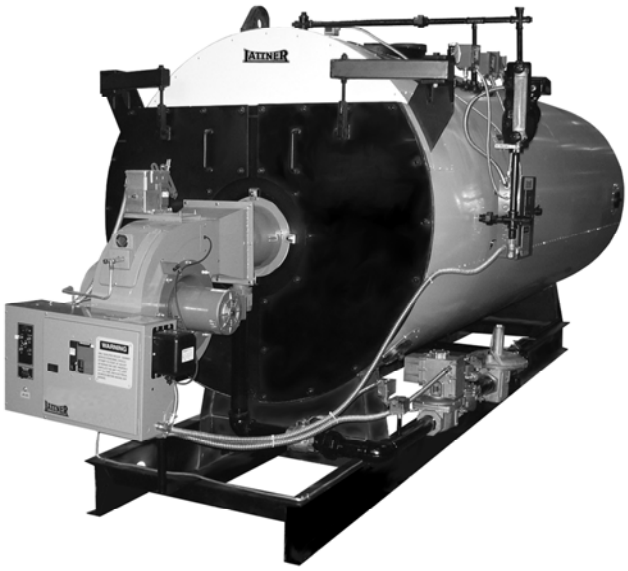
Lattner Boiler Company

Scotch Marine Steam & Hot Water Boilers



INSTRUCTION MANUAL

December 2005

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Section I: General Description

WARNING: All installation procedures must be followed completely by a competent installer familiar with boilers and boiler accessories.

CAUTION: Read and follow all instructions before installing any boiler equipment. All cover plates, enclosures and guards must be maintained and in place at all times, except during maintenance and servicing.

1. Boiler Design

Lattner horizontal firetube boilers are designed as three pass scotch marine dry back boilers with integral furnaces and convective heat transfer firetubes. The furnace and heat transfer tubes are completely submerged beneath the normal operating water level. The total heating surface is based on 5 square feet per boiler horsepower (output). All Lattner firetube boilers are built in accordance to the appropriate ASME Code for low pressure steam, high pressure steam, low pressure hot water, or high pressure hot water.

1.1. Gas Flow

The tube design of Lattner firetube boilers provides three pass longitudinal heated gas flow direction, ensuring maximum linear heated gas travel and heat transfer. Low maintenance, durable refractory lined steel baffles are incorporated for heated gas flow direction between the second and third passes. Symmetrical tube design and layout provides equalized flow of heat into each tube from the furnace and successive gas passes, ensuring high efficiency.

1.2. Water Circulation

All feedwater and water return connections enter the side of the vessel below the water line. By directing the make-up water below the water line of the boiler, the possibility of collapsing steam bubbles is eliminated allowing the boiler water to circulate naturally.

1.3. Tubes

Boiler tubes are a minimum of 2-1/2" OD, with a wall thickness of 0.105". Each tube is attached to the front and rear tube sheets through a rolling and beading process. High pressure boiler tubes are additionally seal welded at the entrance to the second pass.

1.4. Furnace

The furnace or combustion chamber is centrally located within the pressure vessel. It consists of a single cylindrical tube strength welded to the front and rear tube sheets. It is symmetrical in layout, assuring a balance flow-circulating pattern under all load conditions.

1.5. Outer Casing (Jacket)

The removable outer casing or jacket is fabricated of 22 gauge galvanealed steel panels supported by 2" thick fiberglass blanket insulation. This arrangement provides a skin temperature near ambient conditions.

1.6. Fireside Inspection

Front and read doors (davited or hinged on 60 horsepower and larger) are furnished for tube inspection and cleaning of the second and third passes. An inner rear furnace access door is available for furnace inspection, eliminating the need to remove the burner.

1.7. Water Side Inspection

For visual inspection of the water side internals and tube surfaces six 3" x 4" handhole inspection plates are provided. A 12" x 16" man hole is furnished for upper vessel inspection on boilers 80 horsepower and larger.

1.8. Flame Observation Port

For visual inspection of the pilot and main flame ignition, there are two flame observation ports. One flame observation port is provided integral to the burner and one is located in the rear furnace access door.

1.9. Boiler Lifting Lugs

Two lugs are provided to facilitate lifting and rigging the boiler into place. These lugs are located on the top centerline of the pressure vessel.

1.10. Boiler Base

A structural steel welded base is provided upon which the pressure vessel is placed. The minimum height of the structural base is 4" and the boiler is attached to the base at four points (legs). A short base extension may be incorporated to provide mounting for a separate oil pump or oversize control panel.

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2. Boiler Connections

2.1. The following items are factory installed in accordance with the ASME Code:

2.1.1. Steam Connection
The supply connection is located on the top centerline of the boiler and is either threaded or an ANSI flange design. The operating and design pressure of the boiler, in accordance with the ASME Code, determines the pressure rating of the flange.

2.1.2. Boiler Blowdown or Connection Drain
Boilers under 80 horsepower have one threaded fitting on the bottom centerline at the rear of the pressure vessel. Boilers 80 horsepower and larger have two threaded fittings on the bottom centerline at the rear of the pressure vessel.

2.1.3. Surface Blow-Off
A tapping is provided in the vessel near the normal water level line for connection to a manual or automatic surface contaminant removal system or metering valve.

2.1.4. Feedwater Make-Up
A tapping is provided on each side of the pressure vessel for connection to the make-up and/or condensate return.

2.1.5. Exhaust Gas Vent (Stack)
The connection for the stack or breaching is located at the rear on the top centerline of the boiler. This is a flanged connection, with the opening in accordance with the nominal dimension and rating sheets. A tapping is provided for a stack temperature probe or thermometer.

3. Boiler Trim

The following are factory installed standard trim and control items. Trim items are supplied in accordance with the ASME Code. Controls are UL listed and comply with ASME CSD-1 requirements.

3.1. Safety Relief Valve(s)
In compliance with the ASME Code, steam boiler pressure relief valves are provided. Size and quantity determined by the valve setting, valve capacity, and the ASME Code. These are shipped loose to prevent possible damage during shipment.

3.2. Water Column
Furnished complete with gauge glass, gauge glass drain valve, gauge glass isolation valves, column try-cock tappings, column drain valve, minimum of 1" equalized piping and crosses for inspection and clean-out.

3.3. Low Water Cut-Off
To prevent burner operation whenever a low water condition occurs, a single pole double throw float operated level switch is furnished in the water column. Cut-off is wired in series to the burner combustion safeguard control.

3.4. Pump Control
A single pole single throw float level switch is provided in the water column for ON/OFF operation of a feedwater make-up pump, starter, or valve.

3.5. Auxiliary Low Water Cut-Off
An additional control, separate from the primary low water cut-off control is provided to prevent burner operation if a low-low water condition exists. This device is an internal probe control located on the top centerline of the pressure vessel.

3.6. Steam Pressure Gauge or Temperature/Pressure Gauge
3-1/2" dial pressure gauge is furnished as standard. The range of the gauge will be in accordance with the safety valve setting, based on 1.5 times the valve setting for high-pressure units, and 2 times the design pressure of low-pressure units.

3.7. Pressure or Temperature Controls

3.7.1. On/Off Operation
On/Off operation is available on boilers 10 through 20 horsepower. On/Off operation requires two pressure or temperature controls, a "Limit" and a "Controller". The "Limit" determines the pressure at which the burner will cycle OFF. The "Controller" (with differential) determines the pressure at which the burner will cycle ON. See Section II for control setting directions.

3.7.2. Low/High/Off Operation
Low/High/Off operation is available on boilers 10 through 100 horsepower. Low/High/Off operation requires two pressure or temperature controls, a "Limit" and a "Controller". The "Limit" determines the pressure at which the burner will cycle OFF. The "Controller" (with differential) determines the pressure at which the burner will cycle ON. See Section II for control setting directions.

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3.7.3. Low/High/Low Operation
Low/High/Low operation is available on boilers 10 through 100 horsepower. Low/High/Low operation requires three pressure or temperature controls, a “Limit”, a “Controller”, and a “High Fire” device. The “Limit” determines the pressure at which the burner will cycle OFF. The “Controller” (with differential) determines the pressure at which the burner will cycle ON at low fire. The “High Fire” device determines the pressure at which the burner cycles ON at high fire. See Section II for control setting directions.

3.7.4. Modulating Operation
Modulating operation is available on boilers 10 through 200 horsepower. Modulating operation requires three pressure or temperature controls, “Limit”, “Controller”, and “Modulating” devices. The “Limit” determines the pressure at which the burner will cycle OFF. The “Controller” (with differential) determines the pressure at which the burner will cycle ON. The “Modulating” device regulates the rate at which the burner will fire (any rate between low and high fire). See Section II: Installation for control setting directions.

4. Fuel Burning System

The factory-assembled boiler is furnished with an UL approved and labeled fuel burning forced draft system. The system is mounted and wired integral with the front head of the boiler.

4.1. Burner Type
The burner is a forced draft (power burner) design, high radiant multi-port type for LP or Natural gas and mechanical pressure atomizing type for No. 2 fuel oil. The burner can be equipped to burn natural gas, oil, or a combination can be provided to manually switch between gas and oil fuels. The burner is not designed to burn both fuels simultaneously.

4.2. Burner Operation
The burner is designed to operate one of four modes:

4.2.1. On/Off
With the On/Off method of operation, the burner shuts off when the pressure reaches the set point of the “Controller” device. The burner turns on again when the differential set point on the “Controller” is exceeded.

4.2.2. Low/High/Off
With the Low/High/Off method of operation, the burner turns ON at low fire and shuts off when the pressure reaches the set point of the “Controller” device. The burner turns on again when the differential set point on the “Controller” is exceeded.

4.2.3. Low/High/Low
With the Low/High/Low method of operation, the burner fires on high fire until it reaches a predetermined pressure range. Once it reaches this range, the burner continues to fire on low fire as necessary until the boiler’s pressure drops below this range (in the case of a large steam demand) when the burner fires again at high fire.

4.2.4. Modulating
With the modulating method of operation, the burner fire rate is determined by the current demand. The burner modulates or throttles the input gas relative to constantly changing pressure requirements as determined by the “Modulate” pressure control.

4.3. Ignition and/or Pilot
For oil-fired units, a 10,000 volt ignition transformer is furnished for direct spark ignition. Gas-fired units are equipped with a spark-ignited gas pilot assembly. The gas pilot assembly includes a pilot gas cock, gas pressure regulator, ignition transformer, pilot safety shutoff valve, and gas pilot pressure gauge.

4.4. Forced Draft Fan
An integral fan assembly direct connected to a NEMA-1 foot mounted fan motor supplies the required combustion air. As standard, the fan motor is an open drip-proof (ODP) high efficiency type operating at 3600 RPM.

4.5. Air Proving Switch
An air pressure-sensing switch is mounted on the burner to prevent burner operation if sufficient air is not available for proper combustion or pilot ignition.

5. Fuel/Air Control

The control of combustion air is managed with an integral inlet air damper operating as follows:

5.1. On/Off
With the On/Off method of operation, the burner air damper is mechanically fixed for the correct combustion air to fuel ratio for on/off firing.

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5.2. Low/High/Off
With the Low/High/Off method of operation, the burner air damper is mechanically coupled to the damper motor and fuel input control valve(s). A Low/High/Off position control regulates the position of the damper and fuel input control valve(s) for either low fire input or high fire input.

5.3. Low/High/Low
With the Low/High/Off method of operation, the burner air damper is mechanically coupled to the damper motor and fuel input control valve(s). A Low/High/Low position control regulates the position of the damper and fuel input control valve(s) for either low fire input or high fire input.

5.4. Modulating
With the modulating method of operation, the burner air damper is controlled with potentiometer type positioning controls regulate the position of the damper and fuel input control valve(s) which are mechanically linked together. Integral switches of the damper motor provide proof of maximum airflow purge prior to ignition, and the safe start position at low fire, for pilot ignition.

6. Gas/Fuel Train
The burner is equipped with factory mounted fuel safety control and safety shut-off valves for either gas fuel or oil fuel. Each fuel piping assembly is equipped with the following:

6.1. Gas Assembly
Boiler base rail mounted, piped and wired gas piping assembly, consisting of main gas pressure regulator, safety shutoff valves, manual shutoff cocks, fuel input control valve, and gas pressure interlocks in accordance with the latest UL and CSD-1 requirements.

6.2. No. 2 Fuel Oil Assembly
For burners equipped to burn fuel oil, the boiler is equipped with dual safety shutoff valves, manual shutoff valve, oil discharge filter, and an oil pump. The oil pump is direct driven from the fan motor assembly and is used for mechanical pressure atomization of the fuel oil for proper combustion. This pump requires twice the burner firing delivery for suction line sizing.

A separate oil pump assembly with an integral oil pump motor can be furnished as an option and will be mounted on the boiler base extension or shipped loose for field installation by others. For units with this option, a Low Oil Pressure Safety Switch is provided.

7. Control Panel
A NEMA enclosed control panel is mounted integral to the burner or as an independent bracket mounted unit on the boiler base rail. This panel contains as a minimum the following components:

7.1. Combustion Flame Safeguard Control
This solid-state control provides for safe start sequencing of the burner from start-up, run, to safety shutdown. A flame-sensing device of the lead-sulphide scanning principle is furnished.

7.2. Burner On/Off Switch
A burner On/Off switch is provided to interrupt control power to the 120 volt control circuit. This switch does not disconnect the main power source.

7.3. Control Circuit Transformer
For burners above 2.5 million BTUs/Hr input (60 horsepower), a step-down transformer from the 3-phase power supply is furnished to provide the 120 volt single phase supply to the control circuit.

7.4. Indicating Lights
Indicating lights are mounted in the control panel door or switch ledge for “Load Demand”, “Power On”, “Fuel Valve On”, “Low Water”, and “Flame Failure”.

7.5. Manual/Auto Switch
For service checking and start up, a damper positioning switch is provided to allow the burner to be controlled via a manual positioning control in lieu of the automatic positioning device. This switch is furnished on Low/High/Off, Low/High/Low, and Modulating boiler/burner packages.

7.6. Main Flame Potentiometer
The main flame potentiometer is provided as a means to check the burner combustion process or base load the burner in a multiple boiler installation. This control is furnished on units with modulating burners only.

7.7. Wiring & Controls
All devices and wiring are provided in accordance with the latest UL/NFPA 70 requirements. Each device is UL listed or recognized and bears the UL label and/or stamp.

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8. Factory Tests

8.1. Pressure Vessel
The boiler is subjected to an ASME certified hydrostatic pressure test. This test, in accordance with the requirements of the ASME Code for Section IV Heating Boilers or Section I Power Boilers, is supervised by an independent inspection agency, to ensure the pressure vessel meets the standards of the ASME. Upon acceptance of the test by the independent inspector, the unit is stamped with the “H” symbol for 15 psig design units and with the "S" symbol for 150 psig and greater designs. One copy of the ASME data sheets is provided to the purchaser.

8.2. Boiler Piping Hydro (Optional)
As an option, Section I high pressure boiler (“S” stamped), built in accordance with the ASME Code, can be subjected to an additional hydrostatic pressure test. This test includes the integral steam and water trim piping and when included, the trim valves.

8.3. Burner & Controls
To ensure proper operation of the combustion safeguard control, ignition, and main fuel light off the burner manufacturer subjects the packaged burner to a preliminary factory fire test. All burner and boiler controls are checked for circuit continuity after mounting and wiring the burner onto the boiler.

9. Nameplates & Stamping

9.1. The National Board of Pressure Vessel Inspectors registration number is stamped on the pressure vessel with the boiler serial number, year built, maximum boiler output, and minimum safety valve capacity. This information is located on the pressure vessel beneath an inspection plate, near the upper rear of the boiler. A facsimile nameplate of this data stamping is mounted near or on the front door of the boiler.

9.2. A “red-line” mark is located on each front door, indicative of the lowest permissible water level within the boiler.

9.3. Boiler Feedwater care and maintenance information is provided on a nameplate located on the boiler near the water column.

10. Guarantees

10.1. Efficiency
The boiler package is guaranteed to operate at a minimum of 80% or greater, fuel input to steam pounds per hour output efficiency.

10.2. Warranty
The complete package is warranted for a period of one (1) year from the date of initial start-up or 18 months from the date of shipment or notice to ship, whichever occurs first. This guarantee does not include items that are damaged due to circumstances beyond the control of Lattner Manufacturing Company Inc., carelessness, or neglect. Refer to the Lattner’s standard warranty and terms and conditions documents for more detailed information.

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Section II: Installation

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1. Unloading

The boiler was loaded by Lattner (including any accessories) and accepted by the transport company as undamaged. Before unloading the equipment, determine whether any shipping damage is apparent. Once the equipment is lifted from the trailer, any damage sustained during transit and not filed with the transport company will be the responsibility of the rigger or purchaser.

1.1. Lifting

The boiler will arrive secured to a wooden skid/pallet and will include a lifting lug(s). When moving or lifting the unit, **DO NOT** attach sling around the boiler or to the burner in an attempt to pull the boiler.

1.2. Forklift

If lifting with a forklift, extended forks should be used beneath the skid. Care must be taken to ensure that the boiler sits correctly on the forks such that the unit does not topple. Always note the weight of the boiler relative to the lifting capacity of the forklift.

1.3. Crane or Boom

When lifting with a crane or boom, attach the hook to the lifting lug on top of the boiler. **DO NOT** attach slings or chains to any part of the boiler, boiler piping, or burner.

2. Rigging

Always use a competent rigger that has experience moving and setting boilers. If the unit will be moved into the permanent location with a forklift, crane, or boom, follow the directions in Section I. However, if moving the unit through a tight space or into an area that will not permit a forklift, place the boiler on rollers or on 2" pipes and roll the boiler into place. If the unit is dragged, attach chains to the base frame only.

If the entry way is too narrow for the boiler and controls to pass through, removal of the trim and controls can be executed. One should properly denote all wiring and piping connections and match mark accordingly for attachment after the boiler is placed. It may be helpful to use a digital camera to record the location of trim items for reference.

3. Placement of Boiler

3.1. Floor

Boiler must be placed on a level, non-combustible surface. **NEVER** install boiler on a wood floor or any other combustible surface (i.e., carpet, linoleum).

3.2. Combustible Surfaces

UL specifies the following minimum clearance to combustible surfaces:

- Top 48 inches
- Sides 36 inches
- Flue pipe 36 inches

3.3. Non-Combustible Surfaces

When placing boiler near non-combustible surfaces (i.e., cement or cinder block walls), maintain 18" around the boiler for servicing. NOTE: Any state or local fire and/or building codes requiring additional clearances take precedence over the above requirements.

4. Combustion Air

4.1. Ventilation

The boiler room must be adequately ventilated to supply combustion air to the boiler. The vent must be opened to the outside to allow air to flow into the room. Proper sizing of the vent is important to ensure that sufficient free air is available for complete combustion and proper venting of the flue gases.

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4.2. Vent Size
Use the following chart to determine vent size for Lattner boilers. Chart based on 1 square inch per 2,000 BTUs input.

Horsepower	Required Vent Size	Sq. In. Required
10	15" x 15"	209 in^2
15	18" x 18"	313 in^2
20	21" x 21"	418 in^2
25	23" x 23"	523 in^2
30	25" x 25"	627 in^2
40	29" x 29"	837 in^2
50	33" x 33"	1046 in^2
60	36" x 36"	1260 in^2
80	41" x 41"	1680 in^2
100	46" x 46"	2100 in^2
125	52" x 52"	2625 in^2
150	56" x 56"	3150 in^2
200	65" x 65"	4200 in^2

4.3. Additional Ventilation
The chart above shows vent sizes for one gas fired boiler. If there is other equipment in the room that uses air (large water heaters, air compressors, other boilers, exhaust fans, etc.), additional venting capacity is required.

5. Stack

5.1. Specifications
Install all stacks in compliance with state and local codes. Lattner recommends double wall stack per ANSI Z2231.1, appliance category III for positive vent pressure systems for boilers operating with a maximum continuous temperature not exceeding 1000°F.

5.2. Stack Diameter

5.2.1. The entire stack must be the same size as the stack outlet on the boiler or one size larger.
5.2.2. If the boiler stack is connected to other equipment, the stack size must be increased.

5.3. Stack Connections/Sections
Limit connections to one of the following combinations:

- Two 90 degree elbows
- One 90 degree elbow and one tee
- One 90 degree elbow and two 45 degree elbows
- Four 45 degree elbows

5.4. Overall Length
Avoid long runs of stack. A general rule is not to exceed 15 feet for every inch of stack diameter. For example, if the stack is 6" diameter, then the overall stack should not exceed 90 feet (6' x 15') in length and height combined.

5.5. Horizontal Stack
Avoid any horizontal runs of stack. If unavoidable, horizontal runs should have a minimum incline of 3" per foot. If a long horizontal run (4' or more) cannot be avoided, a draft inducer may be required to properly vent combustion gases.

5.6. Walls & Ceilings
When passing through combustible walls or ceilings, a stack thimble is required. The thimble must be double wall stack, 6 inches larger in diameter than the vent stack. The material used to close the opening between the stack and the stack thimble must be non-combustible.

6. Steam Outlet

6.1. Pipe Size
Size pipe according to system requirements.

6.2. Outlet Size
Refer to product literature sheet for steam outlet size on a particular boiler model.

6.3. Steam Stop Valve
Install a steam stop valve in the steam line as close to the boiler as is practical. Allows boiler to be isolated from the system during service work and may be helpful in throttling steam flow. Required by ASME Code if the boiler is operated over 15 psi.

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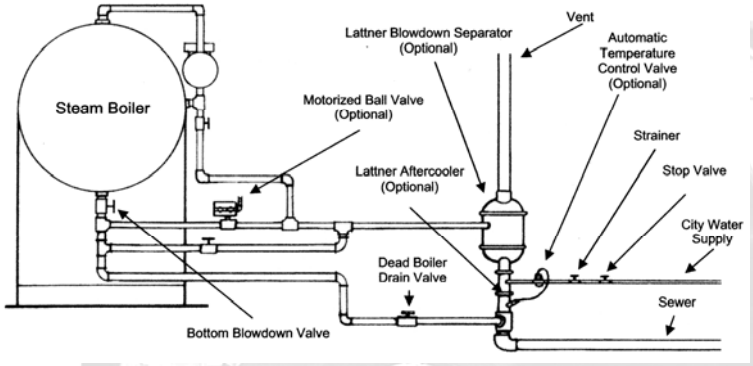
6.4. Steam Piping
Steam line should be pitched downward slightly away from the boiler and toward a steam trap. If using a steam solenoid valve, the steam line should slope upward slightly to the solenoid valve, and after the solenoid valve, the steam line should slope downward.

6.5. Codes & Standards
Piping must comply with all industry standards (especially ANSI B31.1) and all state and local codes.

7. Blowdown Piping

7.1. Boiler Bottom Blowdown (See Diagram Below)



7.1.1. **DO NOT REDUCE.** Blowdown piping and all fittings must be the same size as the boiler blowdown connection.

7.1.2. Low pressure boilers, operating at 15 psi or less, require one blowdown or drain valve. The pressure rating of the valve must be equal to or greater than the pressure of the boiler safety valve but not lower than 30 psi.

7.1.3. Boilers operating 16 psi to 100 psi inclusive require a single blowdown form a pocket inside the valve are not acceptable blowdown valves. A Y-type or a ball valve is acceptable blowdown valves.

7.1.4. Boilers operating 101 psi to 150 psi require piping designed for a pressure of 125% of the boiler safety valve set pressure (schedule 80 blowdown piping) and two slow opening blowdown valves. If cast iron, these valves must be class 250, or if steel, these valves must be class 150, or if bronze, a WSP rating of at least 200.

7.1.5. Standard globe and gate valves that form a pocket inside the valve are not acceptable blowdown valves. Y-type and ball valves are acceptable blowdown valves.

7.1.6. All blowdown piping must meet ANSI B31.1 code and all city and state codes.

7.1.7. Galvanized piping is not acceptable for boiler blowdown piping.

7.2. Automatic Bottom Blowdown
A Lattner automatic bottom blowdown valve may be used in place of one of the manual blowdown valves.

7.3. Water Level Control Drain Valve
A water column type level control is supplied with one drain valve. Connect the control drain line into the bottom blowdown line after the second bottom blowdown valve.

7.4. Blowdown Discharge
All boiler blowdown water must be discharged to a safe location, specifically to a blowdown separator.

7.5. Blowdown Separator
Select a Lattner Blowdown Separator according to the size of the boiler blowdown connection:

1”	**Model 810**
1-1/2”	**Model 1450 or 1455**
2”	**Model 1600**
2-1/2”	**Model 1800**

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7.6. Blowdown Separator Inspection Opening
The extra coupling in the separator vessel is an inspection opening. The inspection opening will be plugged.

7.7. Blowdown Separator Vent
The blowdown separator must be vented to atmosphere. Vent pipe must discharge outside through the roof. **DO NOT** reduce the vent pipe size. **NEVER** connect the vent pipe from the condensate tank to the separator vent.

7.8. Blowdown Separator Drain
The water leaving the separator through the drain should be piped to the sewer. Some codes require the water to pass through an air gap before entering the sewer.

7.9. Aftercooler
If the water must be cooled before entering the sewer (required by some codes), then an aftercooler must be used. The aftercooler attaches to the separator drain connection and mixes cold water with the hot drain water. Units may be either manual or automatic. Select the aftercooler according to blowdown separator drain size.

205A (auto) or 205M (manual)	**Model 810**
301A (auto) or 301M (manual)	**Model 1450 or 1455**
525A (auto) or 525M (manual)	**Model 1600**
625A (auto) or 625M (manual)	**Model 1800**

7.10. Cooling Water Supply
Connect cold water supply pipe to aftercooler:

205A (auto) or 205M (manual)	**1/2" NPT**
301A (auto) or 301M (manual)	**1" NPT**
525A (auto) or 525M (manual)	**1-1/4" NPT**
625A (auto) or 625M (manual)	**1-1/4" NPT**

7.11. Dead Boiler Drain Valve
For draining the boiler when it is cool and not under pressure, the entire drain line must be lower than the bottom of the boiler. Pipe to sewer or floor drain. Valve must be rated up to the MAWP of the boiler.

7.12. Codes & Standards
All blowdown piping, drain and sewer connections, water piping and separator connections must be done in strict compliance with all applicable codes.

8. Safety Valve

8.1. Installation
Be sure safety valve is threaded securely into the boiler or into the elbow supplied with boiler. The safety valve will always be installed in the upright position.

8.2. Discharge
Pipe the safety valve outlet to a safe point of discharge. **DO NOT** reduce the safety valve discharge piping. **NEVER** plug the safety valve outlet.

8.3. Supports
Safety valve piping should be secured by clamps or braces to a wall or structural member. Do not allow the discharge piping to hang on the safety valve.

8.4. Codes & Standards
All safety valve piping and supports must conform to all applicable codes.

9. Gas/Fuel Train Piping

9.1. Components
Generally, a gas train should include the following:

- Manual gas cock
- Main gas pressure regulator
- Main gas valve
- Pilot gas pressure regulator
- Pilot gas valve
- Flame failure control

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9.2. Motorized Gas Valve

The main gas valve and pressure regulator are two separate components. The motorized gas valve is a two-piece valve. The lower section is the valve body, which is a plunger valve. The upper section is the actuator. The actuator has a small built-in hydraulic system. The hydraulic system opens and closes the valve. The motorized gas valve is a gas valve only, and has no other functions. This gas train requires a separate main gas pressure regulator, pilot gas pressure regulator and pilot valve.

As an option, the combination gas valve can be supplied with an intermittent pilot. This system has a spark-ignited pilot and will shut off the gas within four seconds of a flame failure.

9.3. Gas Supply Pipe

The gas pipe to the boiler must be at least the same size as the gas train supplied with the boiler. **DO NOT** reduce.

9.4. Drip Leg

Gas supply piping must be installed with a proper drip leg ahead of any gas train components.

9.5. Gas Supply Pressure

Natural Gas: Supply pressure should be between 6" and 11" water column ahead of the gas pressure regulator when the boiler is running. Manifold pressure when the boiler is operating should be 4-1/4" to 4-1/2" water column.

Liquid Propane (LP): Gas supply pressure should be 11" water column. A pressure regulator will not be supplied with a propane fired boiler.

WARNING: NEVER use Teflon tape on any part of the gas train piping. This will void any warranty on the gas train assembly.

9.6. Codes & Standards

All gas piping must be done in accordance with all applicable codes (National Fuel Gas Code, utility company requirements, local building codes etc.).

10. Boiler Feed Systems

10.1. Condensate Return Systems

10.1.1. Make-Up Water Supply

Connect city water line to the float valve with the boiler feed system. Install a manual shut-off valve in the water line.

10 HP through 50 HP	**1/2" NPT**
60 HP through 200 HP	**3/4" NPT**

10.1.2. Pump Suction Line

This is pre-piped from the factory with an isolation valve and strainer.

10.1.3. Pump Discharge Line

DO NOT reduce. Use 1" NPT pipe and fittings between pump and boiler. Install two spring-loaded check valves. Install a hand shut-off valve between the last check valve and the boiler. Keep the number of elbows and fittings to a minimum.

10.1.4. Condensate Return Line

Condensate from all steam traps should be tied into a common return line. The condensate return line should be pitched downward toward the condensate return tank.

10.1.5. Condensate Return System Vent

Condensate return tank must be properly vented to atmosphere. Vent should discharge through the roof or through a wall to the outside. Do not reduce the vent pipe size.

10 HP through 50 HP	**1" NPT**
60 HP through 200 HP	**1-1/2" NPT**

10.1.6. Condensate Return System Overflow

Pipe to floor drain. Overflow connection should be at least as large as the condensate return.

10.1.7. Condensate Return System Drain Connection

Pipe to floor drain. Install a valve in the line. 1" NPT line is sufficient.

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10.2. Solenoid Water Valve

10.2.1. Water Pressure
This system will work only if the water supply pressure is at least 10 psi higher than the boiler pressure.

10.2.2. Water Inlet
Refer to the boiler assembly print for correct connection and location of the feedwater inlet.

10.2.3. Piping
The solenoid water valve assembly will be piped in the following order: Y-type strainer, solenoid valve, spring-loaded check valve, globe valve, and boiler. All pipe is 1/2" NPT.

10.2.4. Water Supply
Connect water supply to the strainer.

11. Electrical Connections

11.1. Reconnecting Controls
If the boiler was shipped with controls removed, re-connect the wires according to the wiring diagram. All wires that need to be reconnected will have a tag indicating the control or terminals to which they must be connected.

11.2. Electrical Supply
Supply 120 volt single phase from a separate fused disconnect. Use a 30 amp circuit breaker or fused disconnect if the boiler has a 3/4 hp pump motor or larger. Refer to wiring diagram for specific instructions.

11.3. Wiring Water Feed System
Wire the solenoid water valve, boiler feed pump or pump motor starter as indicated on the wiring diagram.

11.4. Power Supply
Connect the power supply to the terminals in the panel box as shown on the wiring diagram. "Hot" side will be marked L1. Neutral will be marked L2.

11.5. Secure Connections
After all wiring is complete and before any power is supplied to the boiler, be sure all wiring connections are tight.

11.6. Turn Pump Switch "ON"
Turn on the pump switch. Pump or solenoid valve should start immediately. If not, see troubleshooting section.

11.7. Check for Leaks
While the boiler is filling, check for leaks in the piping and around boiler. If there are leaks, turn off the pump switch and fix all leaks before continuing.

12. Before Firing the Boiler

12.1. Spare Fittings
Check that all unused pipe nipples are plugged or capped.

12.2. Float Block
Remove the float block screwed into the body of the McDonnell Miller level control. Replace with a malleable iron plug.

12.3. Condensate Return System
Make sure there is make-up water supply to the tank. Make sure there is water in the tank.

12.4. Turn Pump Switch "ON"
Turn on the pump switch. Pump should start immediately. If not, see the troubleshooting section of this manual.

12.5. Check for Leaks
While the boiler is filling, check for leaks in the piping and around the boiler. If there are leaks, turn off the pump switch and fix all leaks before continuing.

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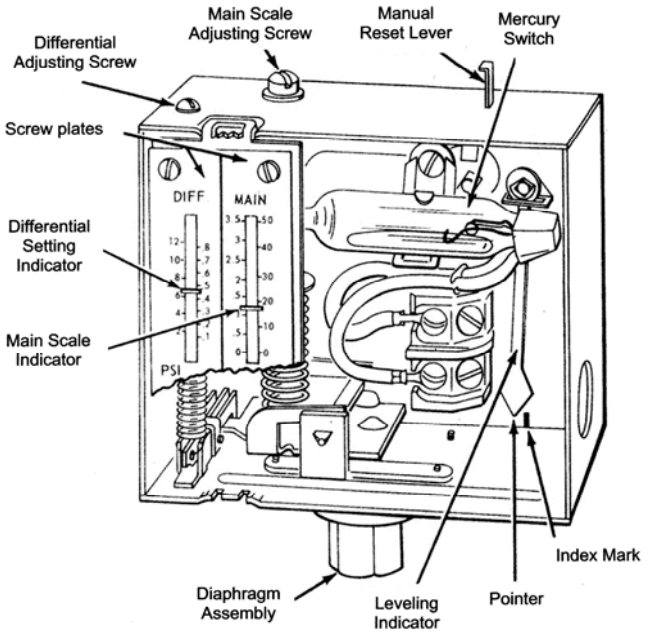
13. Pressuretrols: Controller and Limit



13.1. Standard
All Lattner boilers will have at least two pressure switches, a “controller” and a “limit”.

13.2. Controller
Before the boiler is started, the steam pressure is 0 psi. At this point, the controller is in the "on" condition and is calling for heat. When the boiler switch is turned on, the boiler will fire and start generating steam. As the boiler fires, the steam pressure will rise. When the steam pressure reaches the controller's set point, the controller will shut off the burner. As steam is used, the pressure will begin to drop. When steam pressure drops enough, the controller will start the burner again. The controller will continue to operate in this manner to maintain boiler pressure.

13.3. Setting Controller
On the left side of the pressuretrol is the set point indicating scale labeled "MAIN". Turn the main scale adjustment screw until the set point indicator aligns with the desired operating pressure. Turn screw clockwise to increase pressure, counterclockwise to decrease pressure.

13.4. Differential
When the boiler pressure reaches the set point the controller shuts off the burner. The pressure must drop by a set amount before the controller will turn on the burner again. That amount is called the differential. The differential is adjustable.

13.5. Setting the Differential
On the far left side of the pressuretrols is the differential indicating scale labeled "DIFF". Turn the differential adjusting screw until the indicator aligns with the desired differential. A minimum differential will maintain the boiler pressure closer to the set point. A larger differential will help prevent rapid on and off cycling of the boiler.

13.6. Limit
The limit switch is similar in operation to the controller but has a slightly higher set point. If the controller fails to shut off the boiler and the steam pressure continues to rise, the limit switch will shut down the boiler. The controller is an operating switch; the limit serves as an auxiliary safety cut-off. The limit switch is supplied with a manual reset function. If the steam pressure trips the high limit switch, the limit locks in the off position. The limit switch will not reset until the manual reset lever is pressed.

13.7. Setting the Limit
This is done using the same procedure as for the controller. The limit setting will be slightly higher than the controller's set point. For low pressure boilers (15 psi or less), set the limit switch 4 psi higher than the controller and 3 psi lower than the safety valve setting. For high pressure boilers, set the limit switch at least 10 psi higher than the controller and 5 psi lower than the safety valve setting.

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13.8. Night Operating Pressure Switch
A third pressure switch may be supplied as an option. This switch allows the boiler to operate at low pressure at night for heating the building. Set the night operating pressure switch at approximately 10 psi. The boiler panel box will also be wired with a High/Low selector switch. Setting the selector switch at "Low", the boiler will operate at 10 psi. When the switch is turned to "High", the night operating switch is by-passed and the boiler operates at the normal operating pressure.

13.9. Example
Boiler with a 100 psi safety valve. Set the controller at 80 psi with an 8-10 psi differential. Set the limit switch at 90 psi. Turn on the boiler, burner will fire. When the steam pressure reaches 80 psi, the controller shuts down the burner. When the pressure drops to 70-72 psi the burner restarts. The boiler continues to cycle to maintain 80 psi. If the steam pressure rises to 90 psi, the limit switch shuts off the boiler. The manual reset on the limit switch must then be reset before the boiler will operate again.

For any additional information on the Honeywell Pressuretrols, refer to the Honeywell product sheet in the back of this manual.

14. Firing the Boiler

14.1. Leave the Boiler Switch "OFF"
14.2. Purge the Gas Line
14.3. Gas Supply
14.4. Turn the Boiler Switch "ON"
14.5. The Burner should Fire

If burner fails to fire, refer to troubleshooting section of this manual (Section IV).

14.6. Burner Head Pressure
Check gas pressure at burner head. Burner head pressure should be as specified in the burner manual.

14.7. Adjust Pressure
If the burner head pressure is not within the range specified, adjust gas pressure regulator. Motorized gas trains have separate gas pressure regulators. Removed large slotted cover screw and turn adjusting screw underneath. Refer to Maxitrol manual.

14.8. Check for Gas Leaks
Brush a soapy water solution on each connection in the main gas and pilot gas lines. Look for bubbles. If there are any gas leaks, shut off the main gas supply and fix any leaks before continuing. Repeat steps 1 through 6.

14.9. Adjust the Burners
Forced draft burners can only be properly set up by using combustion test equipment. These burners cannot be set up solely on the appearance of the flame. Refer to the burner manual in the product literature section for proper carbon monoxide, carbon dioxide, and excess oxygen levels.

14.10. Burner Tuning Objectives
The following measures are approximations only. Data may vary by location, environment, fuel, gas pressure, BTU content and more. Refer to burner manual for more specific instructions, including low-NOx burner instructions for California and Texas.

Constituent	Value
Gas Supply Pressure	6" w.c. (minimum)
Manifold Pressure	4-1/4" w.c. (minimum)
O_2	4.5% to 7.5%
CO_2	8% to 10%
CO	Less than 100 ppm
NO_x	Less than 60 ppm
Stack Temperature	425°F to 500°F
Efficiency	80% to 83%

14.11. Pressuretrols
Allow the boiler to reach its operating pressure. Check the pressuretrols to be certain they're are set as described and functioning properly.

14.12. Level Controls
Make certain the level control feeds water into the boiler and maintains a proper water level.

14.13. Odors
It is normal for a new boiler to give an odor when it first fires. This odor will generally subside within two days.

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15. Boil Out recommendations for New Boilers

With proper operation and maintenance you can expect years of trouble free service from your new Lattner boiler. The procedure for correct operation and care of your unit is not complicated, nor is it time consuming. It is necessary to clean the inside of the new boiler of oil and grease used as tube rolling lubricants, threading, and/or other various reasons beyond the manufacturer's control. Since these coatings may lower the heat transfer rate of the heating surfaces, failure to remove these coatings will result in your unit foaming, priming, carry-over or other damage. The boil out operation is easily accomplished by following the procedure as outlined below:

15.1. Fill the boiler to the normal water line. Close boiler steam stop valve in the steam line.

15.2. Remove safety valves at the top of the boiler. The safety valves must be removed to prevent any contaminants or boil out solution from entering them.

15.3. Tri-sodium phosphate and caustic soda each in the amount of one pound per 50 gallons of water are the suggested chemicals for cleaning boilers. Dissolve these compounds in water and add dissolved chemicals through an opening at the top of the boiler. **NOTE:** When dissolving and mixing the boil-out chemicals, the use of a suitable face mask, goggles, rubber gloves, and protective clothing is mandatory. **DO NOT** permit the dry chemicals or the concentrated solution to come in contact with skin or clothing.

15.4. It is necessary to connect an overflow pipe from the safety valve opening in the boiler to a safe point of discharge. After adding the boil out solution, add water to the boiler until it is completely filled.

15.5. Fire the boiler intermittently at low fire for 4 to 5 hours. Maintain just enough heat to hold the solution at the boiling point. **IT IS CRITICAL THAT YOU DO NOT OVER FIRE BOILER DURING THIS PORTION OF THE START UP**. Do not allow boiler to produce any steam pressure. During this procedure, allow just a small amount of water to enter the boiler to carry off any surface impurities through the overflow pipe. Continue the process until the overflow water appears clear.

15.6. Stop the burner and allow the water to cool to about 120°F. Drain the boiler while the water is still warm. NOTE: Prior to draining the boiler, check with local water treatment facilities to determine whether special instructions or permits are required to dispose of the water.

15.7. Remove the handhole (and manhole) plates from the boiler and wash the interior with tap water at full pressure through a nozzle. Wash until all evidence of dirt, mud, and impurities are removed through the bottom handhole openings. Inspect the internal surfaces. If not clean, repeat the boil out procedure.

15.8. After closing the openings and reinstalling the safety valves, fill the boiler to its normal water level and fire it until the water temperature is at least 180°F to drive off any dissolves gasses and oxygen which might otherwise corrode the metal.

On a steam system, the condensate should be wasted until test show the elimination of undesirable impurities. During the period the condensate is wasted, attention must be given to the treatment of the raw water used as make up so that an accumulation of unwanted materials or corrosion does not occur. Follow the advice of you water treating company.

On a hot water system, chemical cleaning of the entire system is generally necessary and the entire system should be drained after treatment. Consult a water treatment company for recommendations, cleaning compounds, and applicable procedures.

16. Standard Maintenance Items

16.1. General

There are three standard maintenance items which should be kept in stock at all times to unnecessary shut down, handhole gaskets, McDonnell Miller head gaskets, and sight glasses.

16.1.1. Gaskets

The handhole gaskets and the McDonnell Miller head gasket must be replaced after each internal inspection. If any leaks are present around the gasket surfaces, replace the gasket immediately. High pressure water and steam leaks will erode the metal surfaces and cause expensive repairs. Keep a full set of handhole and McDonnell Miller head gaskets in stock at all times.

16.1.2. Sight Glasses

A sight glass with gaskets and washers should be in stock. Replace the sight glass with new gaskets and washers.

16.2. Routine Service

These standard maintenance items are considered routine repair parts and are not covered under warranty.

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17. Water Quality Limits for Lattner Steam Boilers

Constituent	Recommended Value or Limit
Oxygen	0 parts per million
Carbon Dioxide	0 parts per million
pH	9.0 to 10.0
Total Hardness	1 parts per million as $CaCO_3$
Total Alkalinity	600 parts per million as $CaCO_3$
Total Dissolved Solids	2200 to 2500 parts per million
Total Iron	<0.1 parts per million
Specific Conductance	3500 umho/cm non-neutralized
Silica	<150 parts per million
Oily Matter	<0.1 parts per million

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WARRANTY VALIDATION & BOILER START UP REPORT

The following information must be recorded during each boiler start up. This information must be returned to Lattner Boiler Manufacturing Company for warranty validation. If this information is not returned, warranty consideration may not be extended.

Lattner Boiler Model: _____
National Board Number ("NB"): _____
Lattner Dealer Name: _____
Start Up Company: _____
Start Up Date: _____
Start Up Technician: _____

Owner Name: _____
Company Name: _____
Street Address (start up location): _____
State: _____
Zip Code: _____
Telephone Number: _____

☐ Natural Gas or ☐ LP (Propane) Gas
Gas Pressure at Train Inlet: _____" w.c. (boiler OFF)
Gas Pressure at Train Inlet: _____" w.c. (boiler ON)
Manifold Pressure: _____" w.c. (boiler OFF)
Manifold Pressure: _____" w.c. (boiler ON)
Gas Pressure at Pilot Tee: _____" w.c. (boiler OFF)
Gas Pressure at Pilot Tee: _____" w.c. (boiler ON)
Input: _____ btu/hr (clocked at meter)

Voltage: _____ v / _____ ph / _____ hz
Pilot Signal Reading: _____ VDC
O_2: _____%
CO_2: _____%
CO: _____ parts per million (ppm)
NO_x: _____ parts per million (ppm)
Stack Temperature: _____ degrees Fahrenheit
Combustion Efficiency: _____%

Limit Control Setting (cut out): _____ psi or °F
Operating Control Setting: _____ psi or °F
Operating Control Differential Setting: _____ psi or °F

Modulating Control Setting: _____ psi or °F
Modulating Control Differential Setting: ____ psi or °F

Checked for proper operation of:

Low Water Cut Off	☐ yes ☐ no	Barometric Damper	☐ yes ☐ no
High Water Cut Off	☐ yes ☐ no	Boiler Combustion Air	☐ yes ☐ no
Flame Safeguard Control Ignition	☐ yes ☐ no	Boiler Flue/Stack Compliance	☐ yes ☐ no
Flame Safeguard Main Flame	☐ yes ☐ no	Gas Line Leakage	☐ yes ☐ no
Air Flow Switch	☐ yes ☐ no	Gas Equipment Ventilation	☐ yes ☐ no

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Notes:

_____
_____
_____

IMPORTANT: For warranty validation, return this document to (mail, fax, or email):

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Cedar Rapids, IA 52406
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F: (319) 366-0770
E: info@lattner.com

Section III: Boiler Care & Maintenance

WARNING: All maintenance procedures must be performed by competent personnel familiar with boilers and boiler accessories.

CAUTION: Read and follow all instructions before working on any boiler equipment.

NOTE: Certain maintenance items concerning specific components may be found in the product literature specifications of this manual.

1. Daily Procedures

1.1. Blowdown primary low water cut-off while burner is firing.
1.2. Verify that feedwater pump cycles normally and that burner shut off.
1.3. Observe the burner starting sequence and flame characteristics to verify normal behavior.
1.4. Conduct visual check of all pressure and temperature gauge readings.
1.5. Check safety valve, handholes, and manway for signs of leakage.

2. Weekly Procedures

2.1. Check function of auxiliary low water cut-off while burner is firing. Verify proper response of alarms.
2.2. Check flame safety control's response to lack of flame with main gas OFF. Start burner with pilot OFF, verify lock-out.
2.3. During and after flame failure test, observe ignition spark and pilot flame for abnormalities.
2.4. Record pilot and main flame signals if digital display module is available.
2.5. If boiler is equipped with modulating burner, verify that adequate differential exists between operating and modulating controls to prevent short cycling.
2.6. Verify that main fuel valves are closing within specified times. Check valve position indicators.

3. Monthly Procedures

3.1. Check air flow switches mechanically and electrically. Snap switches can stick in closed position if shaft is dirty. Disconnect wire, start burner, verify that pilot does not light.

3.2. Check low fire start proving switch circuit with voltmeter. Terminal must not be powered until motor returns to low fire position. If wire is disconnected, verify that pilot does not light.

3.3. Check open damper proving switch circuit with voltmeter. Terminal must not be powered until motor reaches high fire position. If wire is disconnected, verify that motor remains at high fire position.

3.4. Test main gas valves for leakage. Close checking cock, connect hoses to open lead test valves, submerge hose ends in water, and watch for bubbling.

3.5. Test fuel pressure interlock switches. With burner in normal operation (preferably at high fire), raise low gas or oil pressure switch setpoint above available fuel pressure. Burner must shut off when visual indicator trips. Test high gas pressure switch by reducing setpoint below existing manifold pressure. Again, burner must shut off when indicator trips.

3.6. After returning to normal setpoints, burner must no restart until switches have been manually rest.

3.7. Test oil atomizing medium interlock by interrupting flow of compressed air or steam to burner. Oil valves must close, with subsequent flame safeguard lock-out.

3.8. Manually lift safety valve set with test level while boiler is at normal operation pressure.

3.9. Check flame safety control's response to lack of flame with main gas OFF. Start burner with pilot OFF, verify lock-out.

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4. Annual Procedures

4.1. Since the low water cut-off wiring terminal strips tend to be at the highest operating temperatures found in the boiler control circuit, check wire insulation for brittleness, cracking, or missing patches.

4.2. Clean all safety control related piping, including low water cut-off equalizers, pressure control manifolds, and air flow switch tubes.

4.3. Check boiler pressure gauge against calibrated master gauge or with dead weight tester. New gauges are built to 1% accuracy.

4.4. Jumper operation control and run boiler under manual control at reduced load to determine proper operation of limit.

4.5. Bypass both operating and high limit controls under manually controlled low load condition. Gradually bring boiler pressure up to safety valve setpoint. 15 psi valves must open at 15 psi. Valves rated 15 psi to 69 psi are permitted 2 psi tolerance, and 70 psi to 300 psi valve vary 3%.

4.6. Remove gas line strainer basket and clean.

5. Care of Idle Boilers

Boilers used on a seasonal basis that will be idle for a long period of time (in excess of 30 days) should be laid up either under a dry or wet method during periods of inactivity.

5.1. Boilers Laid Up Dry

In the event that the boiler could be subject to freezing temperatures or if the boiler is to be idle for an excessive period of time, the following preparation should be made and carried out so that the boiler is not damaged over its period of inactivity:

5.1.1. Drain and clean the boiler thoroughly (both fire and water sides) and dry the boiler out.

5.1.2. Place lime or another water absorbing substance in open trays inside the boiler and close the unit tight to exclude all moisture and air.

5.1.3. All allied equipment such as condensate tanks, pumps, etc., should be thoroughly drained.

5.2. Boilers Laid Up Wet

In order to protect the boiler during the short periods of idleness, the boiler be laid up wet in the following manner:

5.2.1. Fill the boiler to overflowing with hot water. The water should be approximately 120°F to help drive out the free oxygen. Add enough caustic soda to the hot eater to maintain approximately 350 parts per million of alkalinity and also add enough sodium sulphide to produce a residue of 50 to 60 parts per million of this chemical.

5.2.2. Check all boiler connections for leaks and take a weekly water sample to make sure that the alkalinity and sulphide are stable.

When cleaning a boiler in preparation to laying up the boiler, the water side of the unit should be cleaned and then the unit fired to drive off gases. The fire side should then be cleaned. An oil coating of fire side metal surfaces is beneficial when the boiler is not used for extended periods of time. This will prevent oxidization of the metal. Fuel oil lines should be drained and flushed of residual oil and refilled with distillate fuel. If oil boilers are to be laid up, care of oil tanks, lines, pumps and heaters is similarly required.

6. Care & Service of Boiler Tubes

6.1. Hard water causes short tube life in scotch marine boilers. Chemical action from hard water plus oxygen in the water will attack the boiler tubes. This action can be so drastic that tubes may be pitted through in a few months.

6.2. Water that is too soft (zero soft) causes pitting of tubes and boiler plates below the water line. Ideal feedwater is 3 to 6 grains in hardness. Water that is too soft is usually apparent because it causes a bouncing water level in the gauge glass and usually causes foaming and priming, throwing water into the main steam piping.

6.3. When first installed, new boiler may develop leaks around the tube ends. While the boiler was tight and showed no leaks during final hydrostatic testing by the ASME inspector (third party), leaks often develop after the boiler has been shipped some distance. If leaks do not take up and stop after the boiler has been operated for 24 hours, tubes that are leaking must be slight re-rolled.

6.4. Re-rolling of the tubes to sop leaks, when the boiler is new or if it has been in service for some time, is a very delicate procedure. There is danger of over-rolling. When the tubes are installed in a new boiler, they are rolled just enough to prevent leakage. Re-rolling must be done on the same basis. The boiler should be subjected to a small amount of water pressure when tubes are being re-rolled. The tube roller can then be used sparingly and just enough to stop the leaks. Even one turn of the tube roller may be too much. Over-rolling makes the tubes so thin that during expansion and contraction boiler pressure will bend the thin part of the tube inward. The tube will then leak constantly, making it necessary to replace the tube.

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6.5. If tubes leak at rolled joints after boiler had been in service for some time, the cause of such leaks is usually one of the following:

6.5.1. Firing the boiler when it is low water.

6.5.2. Lime and scale deposits around the tubes near the rolled joints. This insulates the joint from the water and permits overheating of the tube ends, causing leakage.

6.5.3. Feeding water to the boiler at any point near tube sheets may cause the boiler leak. Instruction sheets show the proper feedwater inlet. Scotch marine boilers have water inlets halfway up the side of the boiler shell.

6.5.4. Boiler can be chilled causing leaks by blowing the boiler completely down when it is too hot. Boiler pressure should not exceed 15 psi for complete blowdown.

6.5.5. Boiler can be chilled causing leaks by filling with cold water too soon after blowdown. After complete blowdown and before filling with water, the boiler should be allowed to cool for two hours if there is no internal firebrick and three hours if there is an internal firebrick-lined combustion chamber.

7. Boiler Tube Replacement

7.1. Prior to tube replacement, it is necessary to have these tools available:

7.1.1. Tube driving mandrel and sledge hammer, or cutting torch
7.1.2. Chisel
7.1.3. Tube roller, properly sized for boiler tube diameter and thickness
7.1.4. Flaring tool
7.1.5. Beading tool
7.1.6. Socket wrench
7.1.7. Oil

7.2. In addition to these basic tubes, tube replacement is simplified with the following equipment:

7.2.1. Air compressor or air source
7.2.2. Small air hammer
7.2.3. Impact wrench or tube rolling motor

7.3. Boiler Tube Removal, Method A

7.3.1. In most cases the boiler tube will be covered with scale, therefore it is extremely difficult to pull the tube out of the tube sheet. Equipment is available that can easily remove scale encrusted tubes through their respective tube holes; however these tools are very costly.

7.3.2. Using a chisel, carefully remove the bead from one end of the tube to be replaced. **IMPORTANT:** Extreme care must be exercised when using the chisel so the tube sheet and the tube hole are not damaged.

7.3.3. A special driving mandrel must be placed into the tube end from which the bead has been removed. The mandrel must fit inside the end of the tube and its shoulder must be able to pass through the tube hole in the tube sheet. Preferably the mandrel should be attached to the end of a steel rod about 2' or 3’ in length. After inserting the mandrel with its rod into the tube, a sledge hammer can be used to drive the tube out of the tube sheet. After the tube extends about 2’ from the opposite tube sheet, it can generally be manipulated to crush the adhering scale as it is physically removed. As mentioned above, tube removal by this method is very difficult.

7.4. Boiler Tube Removal, Method B

7.4.1. **IMPORTANT:** This method of tube removal with a cutting torch can be used ONLY if the tube to be removed can be withdrawn from a handhole opening. It is not possible to remove a tube severed with a cutting torch from a tube hole.

7.4.2. In this method the tube is severed with a cutting torch and is removed through a handhole opening.

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8. Handhole Plate Removal & Installation

Figure 1

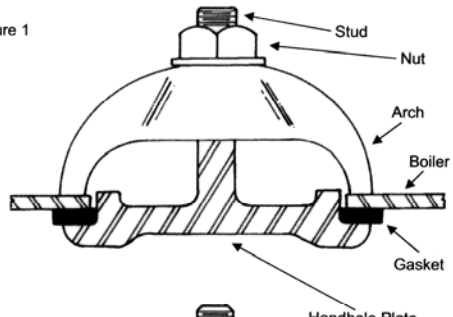
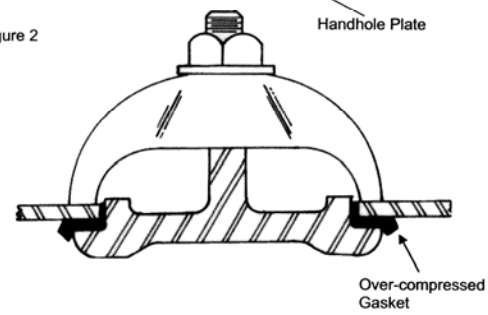


Figure 2



8.1. Disconnect all power to the boiler. The boiler must be cool and drained of all water.

8.2. Remove the handhole plate nut. Remove arch over handhole plate. Remove handhole plate. Sometimes it is necessary to tap on the handhole plate to loosen it. Make sure the handhole plate does not fall inside the boiler.

8.3. Scrape the inside of the boiler around the handhole area to remove any scale or old gasket material. Scrape the old gasket material off the handhole plate. Make sure there are no burrs around the handhole opening. Remove any burrs with a file.

8.4. Place the handhole plate back into the boiler handhole plate opening without the gasket. If the plate rocks back and forth, remove the high spots on the handhole plate with a file. **DO NOT LEAVE THE HANDHOLE PLATE INSTALLED IN THE BOILER WITHOUT THE GASKET.**

8.5. Install the gasket on the handhole plate. Make sure the gasket is pressed firmly down on to the handhole plate. **DO NOT USE ANY GREASE. LUBRICANTS OR ADHESIVES WHEN INSTALLING HANDHOLE GASKETS.**

8.6. Reinstall the handhole plate into the boiler. Replace the arch over the stud of the handhole plate. The arch should extend across the width (short way) of the handhole opening.

8.7. Replace the nut on the handhole plate stud. Tighten the nut hand tight, then turn the nut ¼ turn with a socket. **DO NOT COMPRESS THE GASKET EXCESSIVELY.** This will only shorten the life of the gasket.

8.8. Reconnect the power to the boiler.

8.9. Check the handhole plate for leakage with pressure on the boiler. If leaks are noted, remove the pressure from the boiler, let the boiler cool and drain to reposition the handhole plate. Repeat steps 12 through 16.

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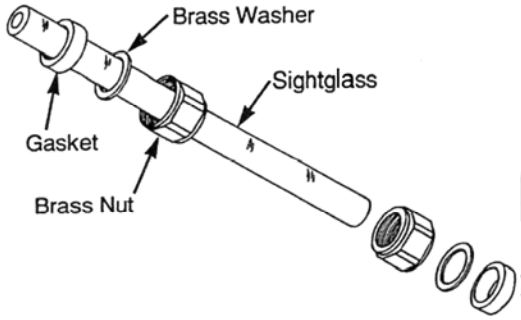
9. Sight Glass Removal & Installation



9.1. Boiler and pump should be switched off. Boiler should be cool and the water level should be below the lower water gauge fixture. Close the upper and lower water gauge valves.

9.2. Loosen both sight glass packing nuts (top and bottom) with a wrench. Slide glass carefully upward into the upper fixture. Glass should lift out of the lower fixture.

9.3. Pull glass down, out of the upper fixture tilting the glass slightly to clear the lower fixture. Be careful not to break the sight glass when removing. Assemble the new sight glass as shown. **ALWAYS** replace the gaskets and brass washers when installing a new sight glass.

9.4. Slide the new glass into the upper fixture. Glass should clear the lower fixture and tilt into position. Slide the sight glass down into the lower fixture. Equalize the gap between the upper and lower fixtures.

9.5. Tighten the sight glass packing nuts hand tight. Use a wrench to tighten 1/4 turn past hand tight. **NEVER** over tighten the sight glass. This will crack the glass and cause it to shatter under pressure.

9.6. Open the upper and lower gauge valves. Switch on boiler and pump.

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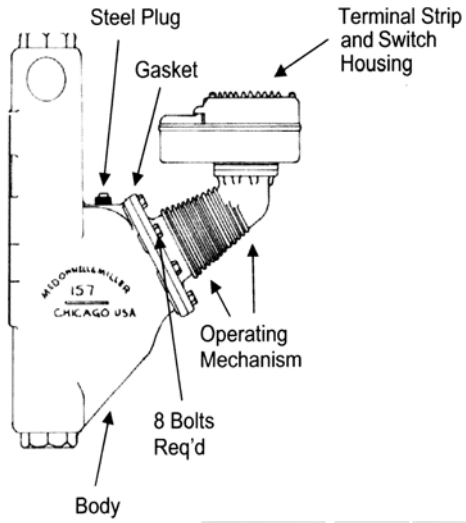
10. McDonnell Miller Servicing



10.1. Disconnect all power to the boiler. The boiler should be cool and drained of all water just below the McDonnell Miller control. Make sure all water is drained from the McDonnell Miller control by opening the control blowdown valve.

10.2. Disconnect the wiring and conduit connection to the McDonnell Miller. Tag all wires to ensure they are reconnected properly.

10.3. Remove the eight bolts holding the operating mechanism to the McDonnell Miller body. Use a 9/16" wrench or a crescent wrench. It may be necessary to tap near the base of the operating mechanism to free it from the body.

10.4. Lift the McDonnell Miller operating mechanism out of the body. Be careful to avoid damaging the float and float arm which extend into the body of the McDonnell Miller.

10.5. Carefully scrape the old gasket from the body and the operating mechanism of the McDonnell Miller. Remove any scale in the McDonnell Miller body. Always check the operating mechanism for any scale that might be blocking the float or float arm.

10.6. Check the float for any holes. Hold the float submerged in a bucket of water and look for any air bubbles coming from the float. Always reassemble the McDonnell Miller operating mechanism to the body with a new gasket.

10.7. Reinstall the eight bolts to the operating mechanism. Draw up the bolts evenly to prevent damage to the gasket, body or operating mechanism. Do not over tighten the bolts.

10.8. Reconnect the McDonnell Miller per wiring diagram. Reconnect all power to the boiler.

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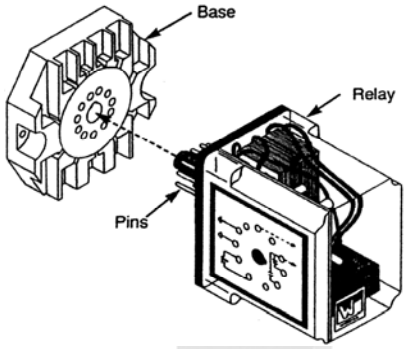
11. Warrick Relay Replacement

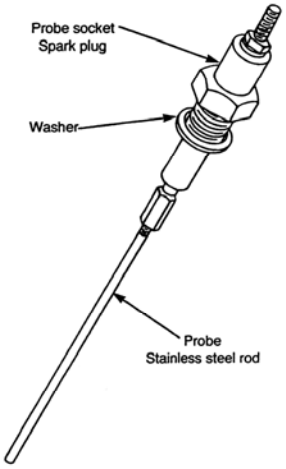


11.1. Disconnect all power to the boiler.

11.2. Pull relay out by hand. This may take a little force but be careful. Replace the Warrick with a new 26M series Warrick. The relay has a small tab so that it can be installed only one way.

11.3. Reconnect the power to the boiler.

12. Auxiliary Low Water Cut-Off Probe Cleaning



12.1.1. Disconnect all power to the boiler.

12.1.2. Remove the four screws on top of the probe enclosure with a Phillips screwdriver. Remove the wire from the probe using a 5/16" wrench or a crescent wrench. Only the wire on the probe is to be removed.

12.1.3. Use a 13/16" spark plug socket and remove the probe. Clean the stainless steel probe and probe fitting. Reinsert the probe using a 13/16" spark plug socket. Only tighten the probe enough to stop any steam leaks. Over-tightening will destroy the threads of the enclosure.

12.1.4. Reinstall the probe wire to the probe. Reassemble the cover to the enclosure with the four Phillips screws. Reconnect power to the boiler.

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Section IV: Troubleshooting

WARNING: All troubleshooting procedures must be followed completely by competent personnel familiar with scotch marine boilers and accessories.

CAUTION: Read and follow all instructions before troubleshooting any boiler equipment.

1. Normal Operation

All Lattner forced draft gas-fired boilers follow the same operating sequence:

1.1. Turn the pump switch on.
1.2. McDonnell Miller pump control turns on the pump or solenoid water valve.
1.3. Pump or solenoid valve fills boiler.
1.4. McDonnell Miller shuts off the pump or solenoid water valve when water is at normal operating level.
1.5. Turn boiler switch to the on position.
1.6. Gas valve opens and main burners light.
1.7. Boiler pressure will rise to the pressure controller's set point. The then controller will shut off the gas valve.
1.8. When the boiler calls for water, the McDonnell Miller level control will turn on the pump or solenoid water valve.
1.9. If the pump cannot fill the boiler, the McDonnell Miller low water cut-off will shut down the boiler.
1.10. If the McDonnell Miller does not shut down the boiler, the auxiliary low water cut-off will shut down the boiler.
1.11. If the boiler has optional controls, refer to the wiring diagram.

2. Basic Service Tools

The following basic equipment will aid in troubleshooting Lattner boilers:

2.1. Schematic diagram of the boiler
2.2. Volt/ohm meter
2.3. Gas pressure gauge(s)
2.4. Combustion Analyzer

3. Before You Begin

Before you begin any troubleshooting procedures, check the following:

3.1. Make sure the pilot is lit.
3.2. Be certain boiler switch is on and that there are 115 volts supplied to the boiler control circuit.
3.3. Be certain pump switch is on and check for proper pump voltage and phase if different from boiler circuit.
3.4. Check if breaker is tripped or if fuse is blown.
3.5. Make sure there is water in the boiler.
3.6. Be certain manual gas cock is open and that gas is supplied to the boiler.
3.7. Be certain that all manual resets, if supplied with the boiler, are reset.

Note: Generally, all Lattner boiler controls are wired in series. The boiler operating controls and limits form a series circuit. When all switches close, the boiler should fire.

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4. Troubleshooting

The chart below is a general chart that shows common problems that may occur in boiler operation. This chart is only to be used by competent service personnel familiar with Lattner boiler equipment and controls. To us this chart, read down the side of the chart from the problem, then read the right side for possible causes. The causes are arranged with the most common first. If the problem is not on the chart below, consult a trained boiler service company.

Problem	Cause
Boiler and pump switches are ON, pump does not run, low water level in boiler.	**1. Circuit breaker tripped or fuse blown. 2. McDonnell Miller piping is plugged. 3. McDonnell Miller float is stuck. 4. McDonnell Miller is wired incorrectly. 5. Pump or solenoid water valve is wired incorrectly.**
Pump runs but does not maintain water level in boiler.	**1. Hand valve between pump and boiler is closed. 2. Bad check valve. Always replace with a spring-loaded check valve. 3. Bad steam traps. 4. Water temperature is too hot. 5. Strainer is plugged. 6. Pump isolation valve is closed. 7. No water is supplied to the pump. 8. Pump out of adjustment.**
Pump or solenoid overfills the boiler.	**1. Solenoid water valve is not seating properly. 2. McDonnell Miller float is operating incorrectly. 3. McDonnell Miller mercury tube is malfunctioning. 4. McDonnell Miller is wired incorrectly. 5. Pump is wired incorrectly.**
Boiler takes excessive time to reach pressure.	**1. Burners out of adjustment. 2. Improper gas pressure. 3. Insufficient quantity of gas supplied to the boiler. 4. Boiler flue passages need to be cleaned. 5. Gas valves firing on low fire only. 6. Scale build-up inside boiler.**
Limit switch always shuts down boiler.	**1. Scale build-up inside of the boiler. 2. Operating pressure switch is set higher than limit switch. 3. Operating pressure switch is not operating properly.**
Boiler shuts down with auxiliary low water cut-off.	**1. Pump switch is turned off. 2. Probe wired incorrectly. 3. Auxiliary level control relay wired incorrectly. 4. Probe has scale, dirt, or debris on it. 5. Foaming problem in boiler. 6. Water in boiler is too soft. 7. McDonnell Miller is not operating correctly. 8. Pump is not functioning properly. 9. Bad check valve. Always replace with spring-loaded check valve. 10. No water supplied to the pump. 11. Probe is out of probe socket.**
Flashback or rough light-off of main burners.	**1. Air shutters/louvers on the burner are open too wide. 2. Pressure switch differential set to close. 3. Drafty conditions around the boiler. 4. Lack of free air in the boiler room. 5. Pilot burner not functioning properly. 6. Incoming gas line to gas valve is too small. 7. Pressure regulator not functioning properly.**

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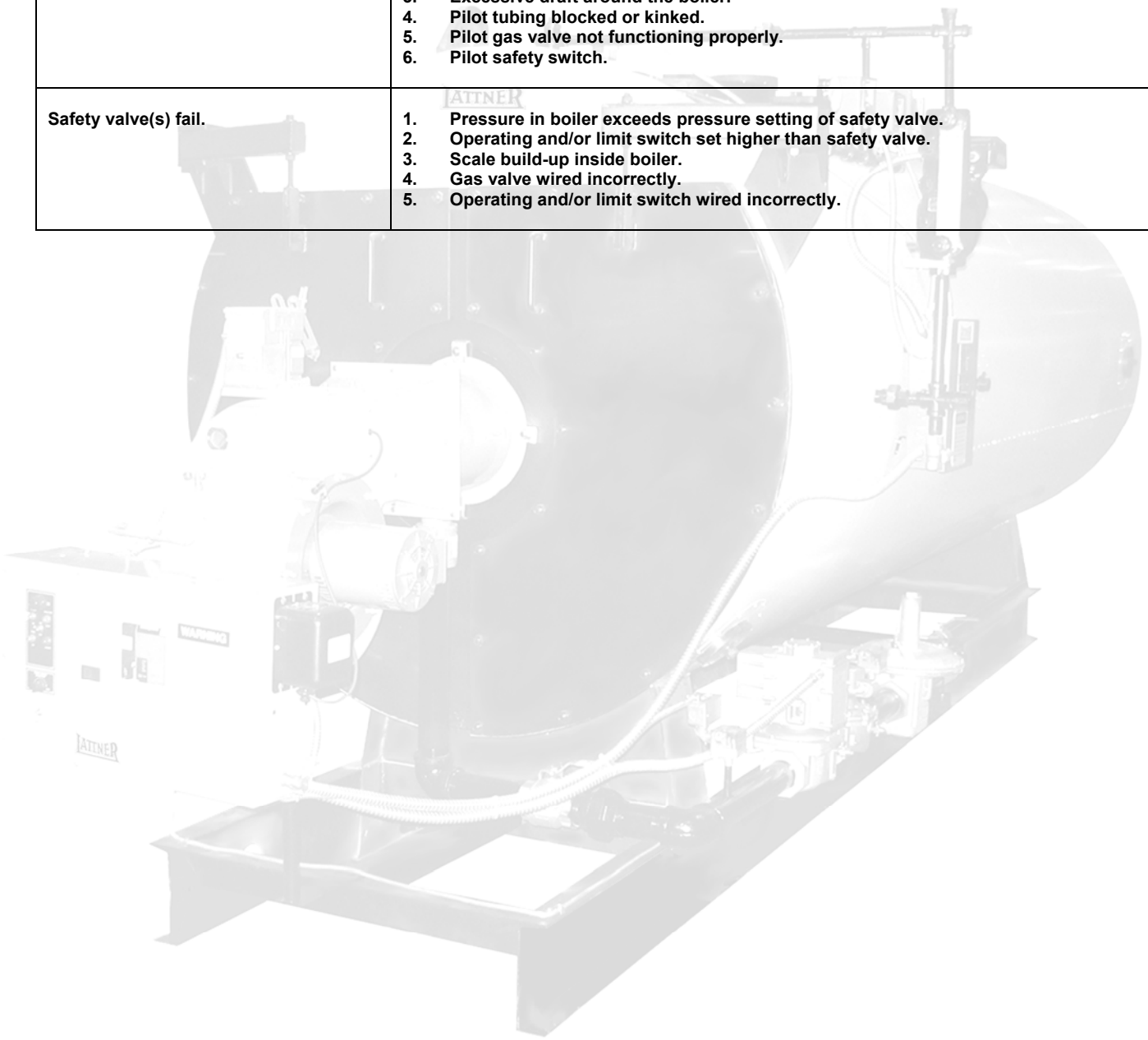
	8. Gas valve not functioning properly. **9. Pilot burner is not in correct location.** **10. Pilot tubing is blocked or kinked.** **11. Blocked orifices on main or pilot burner.**
Pilot fails to light or stay lit.	**1. Pilot gas pressure too high or too low.** **2. Main or pilot gas line not purged.** **3. Excessive draft around the boiler.** **4. Pilot tubing blocked or kinked.** **5. Pilot gas valve not functioning properly.** **6. Pilot safety switch.**
Safety valve(s) fail.	**1. Pressure in boiler exceeds pressure setting of safety valve.** **2. Operating and/or limit switch set higher than safety valve.** **3. Scale build-up inside boiler.** **4. Gas valve wired incorrectly.** **5. Operating and/or limit switch wired incorrectly.**



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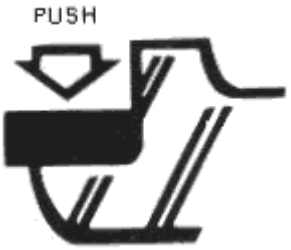
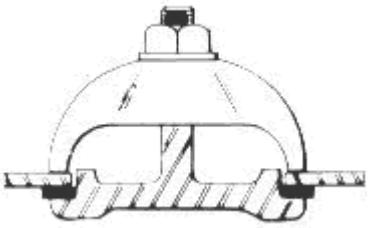
Easy Topog-E® Boiler Installation Instructions

1. **Remove old gasket and thoroughly clean the surface on boiler and on cover plate. Sometimes it is necessary to buff each surface.**
2. **Place Topog-E® Gasket on handhole cover plate. Be sure the gasket is pushed down tight on the plate. Do not use any grease, lubricant, or adhesive.**



3. **After cover plate is in boiler and gasket is in place, make one last cleaning swipe of the mating surface in the boiler. Use a rag wrapped around your finger.**

4. **Set crab, then center plate in opening and tighten nut enough to give a snug fit. Then, snug up with 1/4 turn of wrench.**



SPECIAL NOTES:

- **If gasket leaks while pressure is being built up, tighten only enough to stop leakage. Never over-compress a gasket.**
- **Gaskets on the bottom of a boiler shell are usually hard to install without leaking because particles of scale or sand tend to run down onto the mating surface between the time the surface is cleaned and the handhole cover plate is put into place ready**

to be tightened. When this happens, drain the boiler again and start over, or expect to replace the gasket in a very short time.

- **As pressure builds up in the boiler the bolt and crab will loosen. It takes some time for the gasket to reach its ultimate compression, so the operator should watch this for several days and keep the bolt tight until it no longer loosens. This is especially true if the boiler is operated intermittently; i.e., shut off at night to allow pressure to drop. In this case, vacuum pressure in the boiler would suck the cover plate in and allow the water to leak out of the boiler.**
- **Re-using gaskets after they have been in service is not recommended!**

Topog-E® Bolt Gaskets (when required) should be used with Topog-E® Handhole Gaskets.

Topog-E® Gaskets are sold for use in steam, water, air, and other selected applications only. Recommendations for use of Topog-E Gaskets are based on tests believed to be reliable and on actual customer experience. Since their installation and use is beyond our control we cannot guarantee the results, whether or not such use is in accordance with directions. We disclaim any responsibility.

TOPOG-E ®
(PRONOUNCED Tōe — pŏg — ē)
Gaskets
MOLDED FROM A SPECIAL COMPOSITION

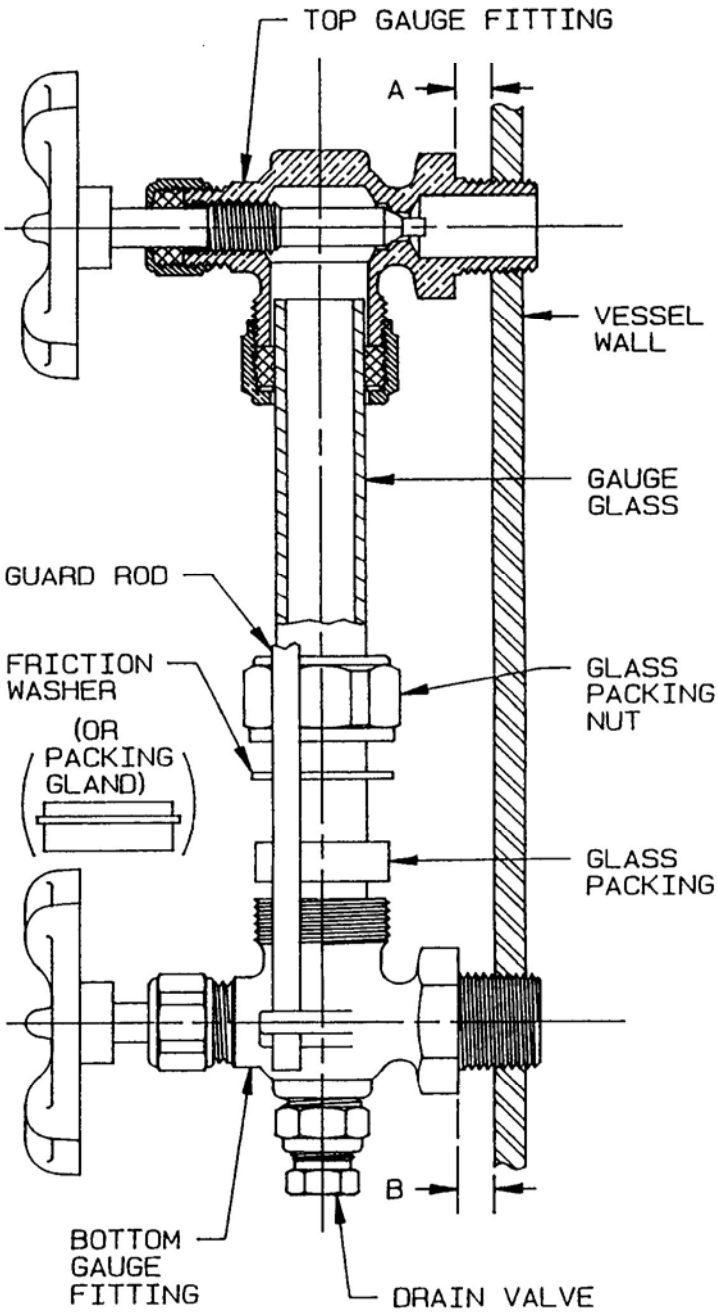
1224 North Utica
Tulsa, OK 74110-4682
1-800-587-7123
918-587-6649
Fax: 918-587-6961
topogesales@topog-e.com

CONBRACO WATER GAUGE & GAUGE GLASS INSTALLATION INSTRUCTIONS

INSTALLATION

Only properly trained personnel should install and maintain water gauge glass and connections. Remember to wear safety gloves and glasses during installation. Before installing, make sure all parts are free of chips and debris.

1. Apply Teflon tape or pipe dope to pipe threads. Install top gauge fitting (fitting without a drain valve) into the uppermost tapping. Wrench tighten the fitting until it is snug and the glass outlet is pointing at five o'clock (about 1/8 turn from its final downward vertical position).
2. Install the bottom gauge fitting (the fitting with a drain valve) until it is snug and the glass outlet is pointing directly upward. Verify top and bottom fittings are threaded into the tappings the same number of turns (distance A=distance B).
3. Remove glass packing nut, friction washer (or packing gland, depending upon the model), and glass packing from the fittings, and place them, in the same order, on to both ends of the gauge glass. Push both packings about an inch up the gauge glass.
4. Gently insert one end of the glass into the top gauge fitting. Keeping the glass inside the top fitting, gently rotate the top gauge fitting clockwise until vertically aligned with the bottom gauge fitting, then insert glass into bottom fitting until glass bottoms out on the shoulder inside the bottom fitting.
5. Carefully raise glass bout 1/16" and slide lower glass packing down until the glass packing contacts the lower gauge fitting. **DO NOT** allow the metal to remain in contact with any metal!
6. Carefully slide upper glass packing up as far as possible.
7. Hand tighten both glass packing nuts, then tighten 1/2 turn more by wrench. Tighten only enough to prevent leakage. **DO NOT OVER TIGHTEN!** If any leakage should occur, tighten slightly, a quarter turn at a time, checking for leakage after each turn.



CONBRACO

WATER GAUGE GLASS

NOTICE: READ ALL WARNINGS AND INSTRUCTIONS BEFORE PERFORMING INSTALLATION OR MAINTENANCE.

WARNING!

SAFETY GLASSES AND GLOVES SHOULD BE WORN AT ALL TIMES WHEN WORKING WITH OR EXAMINING WATER GAUGE GLASS AND CONNECTIONS.

IMPROPER INSTALLATION OR MAINTENANCE OF GAUGE GLASS AND CONNECTIONS CAN CAUSE IMMEDIATE OR DELAYED BREAKAGE RESULTING IN BODILY INJURY AND/OR PROPERTY DAMAGE.

USE AND CARE

DO NOT'S

DO NOT use glass if it contains any scratches, chips, or any other visible signs of damage.
DO NOT reuse any tubular glass or glass packings.
DO NOT subject gauge glass to bending or torsional stresses.
DO NOT over tighten glass packing nuts.
DO NOT allow glass to touch any metal parts.
DO NOT exceed the recommended pressure of the gauge or gauge glass.
DO NOT clean the gauge or gauge glass while pressurized or in operation.

CONBRACO

CONBRACO INDUSTRIES, INC.
P.O. BOX 247
MATTHEWS, NORTH CAROLINA 28106
MADE IN U.S.A.

WATER GAUGE GLASS

DO'S

DO verify proper gauge has been supplied.
DO examine gauge glass and packings carefully for damage before installation.
DO install protective guards and utilize automatic ball checks where necessary to help prevent injury in case of glass breakage.
DO inspect the gauge glass daily, keep maintenance records, and conduct routine replacements.
DO protect glass from sudden changes in temperatures such as drafts, water spray, etc.

MAINTENANCE

Examine the gauge glass regularly for any signs of clouding, scratching, erosion, or corrosion. The glass should be inspected daily until the need for replacement becomes apparent. This will help establish the routine inspection and routine replacement schedules.

CLEANING

Use commercial non-abrasive glass cleaners to keep glass clean. Use diluted acids such as Hydrochloric (muriatic) acid when regular cleaners do not seem to work. Do not use wire brushes or any other abrasive materials which could scratch the glass.

INSPECTION

Examine the surface of the glass for scratches, corrosion, chips, cracks, surface flaws, or nicks. To do this, shine a very bright concentrated light at an angle of about 45 degrees. A defective glass will glisten as the light strikes imperfections. Glass which appears cloudy or roughened, and will not respond to cleaning, should be replaced.

STORING

Keep gauge glass in original packaging until ready to install.

I-5334-00 Rev. C

Honeywell

L404A-D,F; L604A,L,M Pressuretrol® Controllers

L404 and L604 Pressuretrol® Controllers are line voltage pressure controllers that provide operating control, automatic limit protection, or manual reset limit protection for pressure systems of up to 300 psi (21.1 kg/cm^2 or 2068 kpa).

- Can be used with steam, air, non-combustible gases, or fluids non-corrosive to the pressure sensing element.
- Stainless steel diaphragm (except 300 psi [21.1 kg/cm^2 (2068 kPa)] models) also allows use with ammonia, oxygen, distilled water, and similar media.
- L404B is recommended for supervision of atomizing medium pressure in oil burner systems.
- Models are available with spst, spdt, or dpst switching and in variety of operating ranges.
- Dustproof, trouble-free mercury switches (all models except L404F, which has snap-acting switch).
- Automatic reset models have adjustable, subtractive differential (except L604M).
- Trip-free mechanism on manual reset models assures that limit function of controller cannot be defeated by jamming reset lever.
- Screw adjustments made on top of case.
- Scaleplates marked in English (psi) and Metric (kg/cm^2) units.
- L404F models available with European enclosure, British Standard Pipe Threads, ground screw, and scaleplates marked in kg/cm^2 and either psi or kPa.
- Clear plastic cover on case to observe pressure settings and switch action.
- Leveling indicator visible through cover.
- Hexagonal fitting with 1/4-18 NPT internal threads for direct mounting to 14026 Steam Trap (siphon loop).
- Surface mount is available using screws through holes (knockouts) in case backing.

CONTENTS

L. Z. • Rev. 3-95 •

60-2150-10

Specifications

TRADELINE® MODELS

TRADELINE® models are selected and packaged to provide ease of stocking, ease of handling, and maximum replacement value. Specifications of TRADELINE® controls are the same as those of standard models except as noted below.

TRADELINE® MODELS AVAILABLE:

L604A Pressuretrol® Controllers—Available in 2 to 15, 5 to 50, 10 to 150, and 20 to 300 psi (.14 to 1.1 kg/cm^2 [14 to 103 kPa], .4 to 3.5 kg/cm^2 [34 to 345 kPa], .7 to 10.6 kg/cm^2 [69 to 1034 kPa], and 1.4 to 21.0 kg/cm^2 [138 to 2068 kPa]) .

ADDITIONAL FEATURES: TRADELINE® pack with cross-reference label.

STANDARD MODELS

MODELS: L404A-D,F and L604A,L,M Pressuretrol® Controllers. See Table 1. A 14026 Steam Trap (siphon loop) is available, except where noted in Table 1. The steam trap is necessary for boiler installations.

SWITCH(ES): Mercury switch(es) in all models except the L404F, which has a Micro Switch snap-acting switch.

PRESSURE SENSING ELEMENT: Stainless steel diaphragm (brass bellows in 300 psi [21.1 kg/cm^2, (2068 kPa)] models).

MAXIMUM AMBIENT TEMPERATURE: 150°F (66°C).

MINIMUM AMBIENT TEMPERATURE: Minus 35°F (minus 37°C); also refer to the note in the Location and Mounting section.

ADJUSTMENT MEANS: Screws on top of controller case. Scales are marked in psi and kPa.

ELECTRICAL CONNECTIONS: Internal screw terminals; hole in side of case for 1/2 in. conduit.

MOUNTING MEANS: Hexagonal fitting on diaphragm has 1/4-18 NPT internal threads for mounting on a pipe or steam trap (siphon loop). Also can be surface-mounted using screws through two holes (knockouts) in back of case.

Ordering Information

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the Tradeline Catalog or price sheets for complete ordering number, or specify—

1. Order number (TRADELINE® model, if desired).
2. Operating range (see Table 1).
3. Model without steam trap, if desired and available (see Table 1, Note b).
4. Optional specifications, if desired (see Table 1).
5. Replacement parts, if desired.
6. Accessories, if desired.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Home and Building Control Sales Office (please check the white pages of your phone directory).
2. Home and Building Control Customer Logistics
   Honeywell Inc., 1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386 (612) 951-1000

   In Canada—Honeywell Limited/Honeywell Limitée, 740 Ellesmere Road, Scarborough, Ontario M1P2V9. International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

TABLE 1—MODELS AVAILABLE.

Model	Switching Action on Pressure Rise to Setpoint	Operating Ranges[a]			Midscale Subtractive Differential[a] (Adjustable)			Maximum Surge Pressure		
		psi	kg/cm²	kPa	psi	kg/cm²	kPa	psi	kg/cm²	kPa
L404A	spst, breaks circuit	2 to 15[b,c] 5 to 50 10 to 150[b] 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10.6 1.4 to 21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	2 to 6 4 to 12 8 to 16 15 to 40	.14 to .41 .28 to.82 .56 to 1.10 1.04 to 2.76	14 to 4 127 to 83 55 to 110 103 to 276	50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L404B[i]	spst, makes circuit	2 to 15d,[c,e,f] 5 to 50 10 to 150[e,b] 20 to 300[d]	.14 to 1.1 .35 to 3.5 .66 to 10.6 1.4 to 21.0	14 to 103 24 to 345 69 to 1034 138 to 2068	2 to 6 4 to 12 8 to 16 15 to 40	.14 to .41 .28 to .82 .56 to 1.10 1.04 to 2.76	14 to 41 27 to 83 55 to 110 103 to 276	50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L404C	spst, breaks circuit	2 to 15 5 to 50 10 to 150 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10.6 1.4 to 21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	manual reset (fixed, subtractive differential)			50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L404D	spst, makes circuit	2 to 15 10 to 150	.14 to 1.0 .66 to 10	14 to 103 69 to 1068	manual reset[g] (fixed, subtractive differential)			50 225	3 5 15.8	345 1550
L404F	spdt snap-acting switch,[h] makes R-W, breaks R-B	2 to 15 5 to 50[i] 10 to 150 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10 1.4 to21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	2 to 6 6 to 14 10 to 22 20 to 50	.14 to .41 .41 to .97 .69 to 15.2 1.4 to 3.5	14 to 41 41 to 97 60 to 152 138 to 345	50 85 225 500	3.5 6.0 15.8 35.2	345 586 1550 3445
L604A	2 isolated spst circuits, or 1 spdt,[j] makes R1-W, breaks R2-B	2 to 15[c] 5 to 50 10 to 150 20 to 300[d]	.14 to 1.0 .35 to 3.5 .66 to 10 1.4 to21.0	14 to 103 34 to 345 69 to 1034 138 to 2068	2 to 6 4 to 12 8 to 16 15 to 40	.14 to .41 .28 to .82 .56 to 1.10 1.04 to 2.76	14 to 41 27 to 83 55 to 110 103 to 276	25 85 225 500	1.8 6.0 15.8 35.2	172 586 1550 3445
L604L	spdt circuit makes R-W, breaks R-B	2 to 15	.14 to 1.0	14 to 103	manual reset[g] (fixed, subtractive differential)			25	1.8	172
L604M	spdt circuit makes R-W, breaks R-B	10 to 150	.66 to 10.1	69 to 1034	fixed: 3.5 psi (24.1 kPa)			225	15.8	1550

[a] Scaleplates are marked in both psi and kg/cm²
[b] Model available with special fixed low differential. Switch rated for 0.5A at 120 Vac.
[c] L404A,B and L604A models are available with 1 to 6 psi midscale subtractive differential in 2 to 15 psi models.
[d] Brass bellows replaces stainless steel diaphragm. Not suitable for use with ammonia, oxygen, or other corrosive materials.
[e] Model available with minimum operating pressure of 1.25 psi (0.09 kg/cm² or 8.62 kPa) and minimum subtractive differential of 0.5 psi (0.035 kg/cm² or 3.45 kPa).
[f] Model available with special fixed low differential. Switch rated for 0.5A at 120 Vac.
[g] L404C,D and L604L models are designated as Manual Reset 2 controllers; the trip-free reset mechanism does not permit the controller to function as an automatic-reset device when the manual reset lever is held in the reset position. The subtractive differential is fixed at the minimum value of the adjustable differential of the L404A for each corresponding operating range.
[h] L404F only; all other models have mercury switches.
[i] Model available with sealed bell crank adjustment.
[j] Spst switches operate in unison; spdt action when jumper is installed between R1 and R2.
[k] Also recommended for supervision of atomizing medium pressure (air or steam) in an oil burner system.

SWITCH CONTACT RATING (in amperes at 50/60 Hz):

Model	Load	120 Vac	240 Vac	120 Vdc	240 Vdc
L404A	Full Load Locked Rotor Noninductive[a]	8.0 48.0 10.0	5.1 30.6 5.0	2.4 24.0 5.0	1.2 12.0 2.0
L604A,L[b]	Full Load Locked Rotor Noninductive	8.0 48.0 10.0	5.1 30.6 5.0	2.0 20.0 8.0	1.0 10.0 4.0
L604M	Full Load	1.0	0.5	1.0	0.5

[a] L404F (snap-acting) does not have non-inductive or dc ratings.
[b] L604A and L have also been tested (and listed by Underwriters Laboratories Inc.) and breaking (not making) a load with a total rating of 9.8 A full load, plus 360 VA ignition, plus 250 VA pilot duty at 120 Vac.

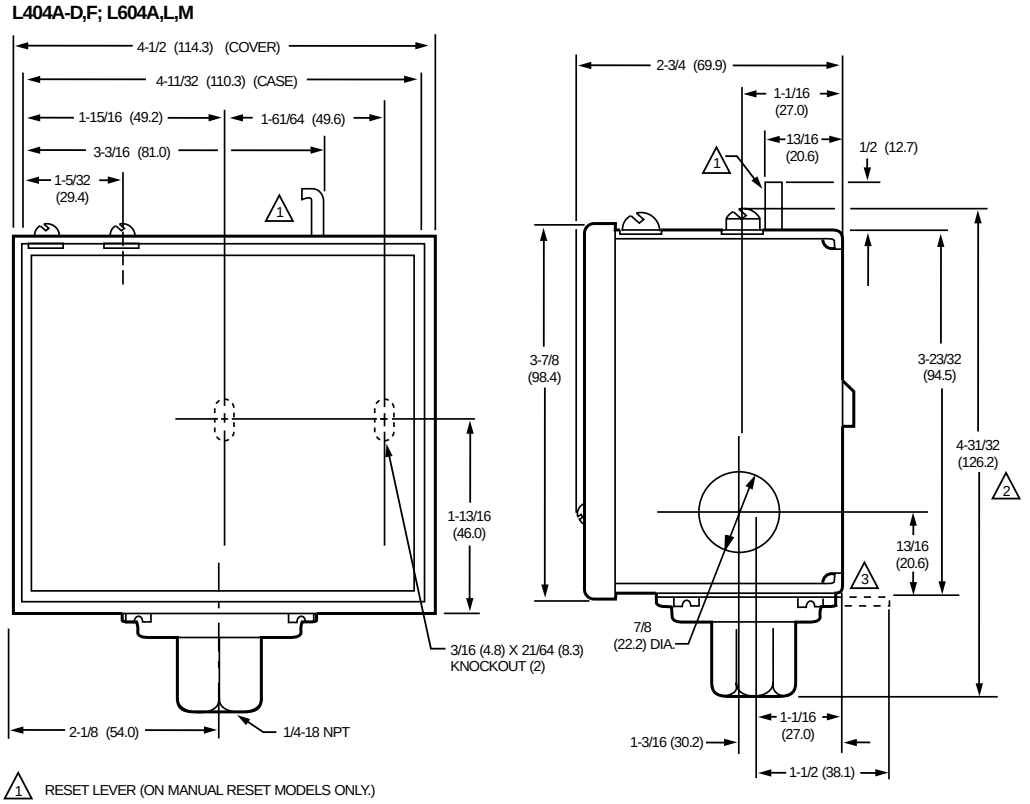
DIMENSIONS: See Fig. 1. See Fig. 2 for mounting steam trap (siphon loop).
WEIGHT: 2 IBC. (0.91 kg).
FINISH: Gray.
APPROVALS:
Underwriters Laboratories Inc. listed (L404A,B,C,D,F; L604A,L,M only): file no. MP466, vol.10; guide no. MBPR.
Canadian Standards Association certified (L404A,B,C,D,F; L604A,L only): file no. LR1620; guide no.400-E-0.

REPLACEMENT PARTS:
129178 Thermoplastic Cover.
14026 Steam Trap (siphon loop)—1/4 in. black iron pipe. Necessary for boiler installations.
ACCESSORIES:
33312B Knurled Adjustment Knob—with setscrew; fits on main scale pressure adjusting screw.
4074BWJ Limit Stop Assembly—to limit set point ranges; includes 129564 Range Stop, 107194 Range Stop Screw, and 23466 Wrench.

TABLE 2—CONVERSION TABLE (psi to kPa).

Operating Range			Subtractive Differential		
Scale-Plate (psi)	Equivalent		Scale-Plate (psi)	Equivalent	
	(kg/cm^2)	(kPa)		(kg/cm^2)	(kPa)
0 to 15	0 to 10	0 to 103	—	—	—
2 to 15	.14 to1.0	14 to 103	1 to 6 2 to 6	07 to 4 .14 to .4	7 to 41 14 to 41
5 to 50	.3 to 3.5	34 to 345	4 to 12 5 to 14	.3 to .8 .4 to 1.0	28 to 83 41 to 97
5 to 150	.3 to 10.3	34 to 1034	—	—	—
10 to 150	.7 to 10.3	69 to 1034	8 to 16 10 to 22	.6 to 1.1 .7 to 1.5	55 to 110 69 to 152
20 to 300	1.4 to 20.7	138 to 2068	15 to 40 20 to 50	1.0 to 2.8 1.4 to 3.5	103 to 276 138 to 345

Fig. 1—Mounting dimensions of the L404A,B,C,D,F and L604A,L,M Pressuretrol® Controllers, in in. (mm).



1 RESET LEVER (ON MANUAL RESET MODELS ONLY.)

2 THIS DIMENSION IS 4-27/32 IN. (123.0 MM) ON L604 MODELS WITH A 2 TO 15 PSI (.14 TO 1.0 kg/cm^2 (14 TO 103 kPa)) OPERATING RANGE, AND 5-3/4 IN. (146.A MM) ON L604 MODELS WITH A 20 TO 300 PSI (1.4 TO 20.7 kg/cm^2 (138 TO 2068 kPa) OPERATING RANGE.

3 ONLY ON L604 MODELS WITH A 2 TO 15 PSI (.14 TO 1.0 kg/cm^2 (14 TO 103 kPa)) OPERATING RANGE.

M8933

Installation

WHEN INSTALLING THIS PRODUCT. . .

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.

2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.

3. Installer must be a trained, experienced, flame safeguard control technician.

4. After installation is complete, check out product operation as provided in these instructions.

CAUTION

1. Disconnect power supply before beginning installation to prevent possible equipment damage or electrical shock.
2. When using the controller with a compressor, install a dampening device (such as a needle valve, header, or surge tank) to dampen pulsations that can damage the controller or reduce its life.

IMPORTANT:

1. *Locate the controller where the ambient temperature will not exceed 150°F (66°C).*
2. *Use pipe compound sparingly to avoid clogging the hole in the pipe or diaphragm fitting.*
3. *Do not tighten the controller by hand by holding the case.*
4. *Accurately level the controller for proper operation.*

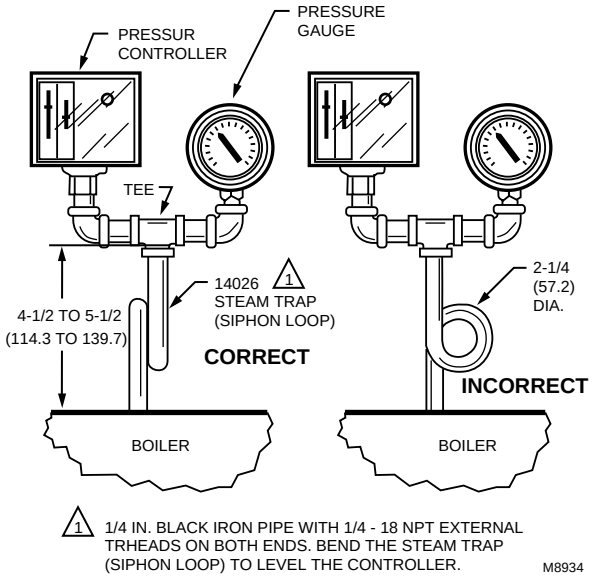
LOCATION AND MOUNTING

NOTE: For most accurate operation; add supplemental heat to installations where the temperature falls below minus 20°F (minus 29°C). Never locate the controller where the temperature falls below minus 35°F (minus 37°C), because mercury in the switch freezes at this temperature.

When used with steam boilers, always mount the controller *above the water line* in the boiler. A steam trap (siphon loop) must always be connected between the controller and the boiler (Fig. 2) to prevent boiler scale and corrosive vapors from attacking the diaphragm. The loop on the steam trap must always be perpendicular to the face of the controller. If the loop is parallel to the controller, expansion or contraction of the loop tips the controller and causes the switch to operate inaccurately.

The controller can be mounted (1) alongside the pressure gauge, (2) in a fitting on the boiler provided by the manufacturer, (3) at a remote location in case of excessive vibration, or (4) in a special mounting on a low water cutoff.

Fig. 2—Right and wrong mounting of a steam trap (siphon loop), with approximate dimensions in in. (mm).



Make all pipe connections in accordance with approved standards. Use only a small amount of pipe compound to seal the connection joints. Excess pipe compound can clog the small hole in the fitting and prevent the controller from operating properly.

To avoid leaks and damage to the case, use a parallel jaw wrench on the controller's hexagonal fitting. *Do not tighten the controller by hand by holding the case.*

Leveling

A controller with a mercury switch must be accurately leveled for proper operation. It is level when the leveling indicator (Fig. 11) hangs freely with its pointer directly over the index mark inside the back of the case. Level the controller by carefully bending the steam trap (siphon loop).

Mounting Alongside a Pressure Gauge

To mount the controller *alongside a pressure gauge* (Fig. 2), remove the gauge. In its place, install a steam trap (siphon loop) with a tee on top. Using elbows and pipe nipples, mount the controller and pressure gauge on the ends of the tee. Level the controller after installation.

Mounting on a Boiler

If it is not convenient to mount the controller alongside the pressure gauge, install a steam trap (siphon loop) *in the fitting provided* by the boiler manufacturer. If there is no fitting, mount the steam trap at a location recommended by the boiler manufacturer. Screw the controller directly to the steam trap, and level the controller.

Mounting at a Remote Location

If there is *excessive vibration* at the boiler that can adversely affect the operation of the controller, mount the controller at a remote location. All piping from the boiler must be suitable and solidly mounted. The piping must be properly pitched to drain all condensation back to the boiler. A steam trap (siphon loop) must be mounted between the remote piping and the controller. Level the controller after installation.

Supervision of Atomizing Medium Pressure (Air or Steam)—L404B

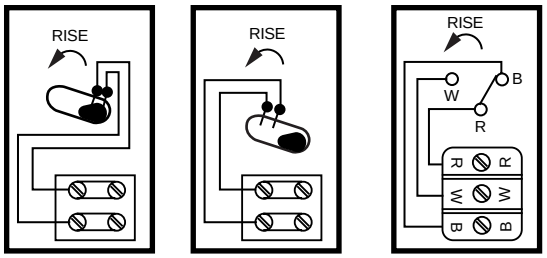
When air or steam is used as an atomizing medium in an oil burner system, authorities having jurisdiction (approval bodies and codes) often require a low limit to prevent opening the main oil valve until sufficient atomizing pressure is present, and to shut down the system when the atomizing pressure falls too low.

The L404B is recommended for this application. It makes a circuit when the pressure rises to the set point, and breaks when the pressure falls to the set point minus the differential (Fig. 10).

WIRING

1. Disconnect the power supply before beginning wiring to prevent electrical shock or equipment damage.
2. Assume all wiring complies with applicable electrical codes, ordinances, and regulations. Use NEC Class 1 (line voltage) wiring.
3. For normal installations, use moisture-resistant No. 14 wire suitable for at least 167°F (75°C) when you are using the controller with a flame safeguard primary control, or at least 194°F (90°C) when using it with a programming control.
4. For high temperature installations, use moisture-resistant No. 14 wire, selected for a temperature rating above the maximum operating temperature.
5. All models have a terminal block inside the cover (Fig. 3 and 4) and a 7/8 in. (22.2 mm) hole in one side for 1/2 in. conduit, cable, or wires. Remove the front cover by loosening the screw at the bottom of the main scale.
6. Refer to Fig. 5 through 9 for typical hookups. Follow the burner or boiler manufacturer's wiring diagram if provided .
7. Make sure the loads do not exceed the Switch Contact Ratings in the Specifications section.
8. Replace the front cover when wiring is completed.

Fig. 3—L404 terminal blocks and internal schematics.



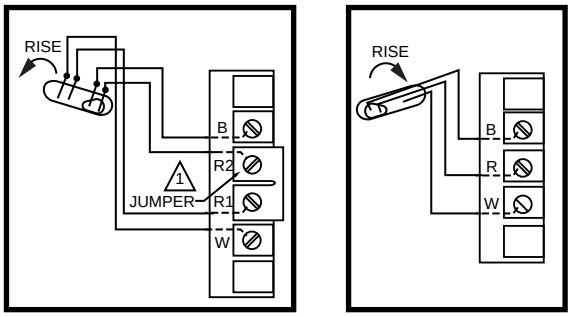
L404A,C
BREAKS ON PRESSURE RISE TO SETPOINT

L404B,D
MAKES ON PRESSURE RISE TO SETPOINT

L404F (SNAP-ACTING)
BREAKS R-B, MAKES R-W ON PRESSURE RISE TO SETPOINT

M8941

Fig. 4—L404 terminal block and internal schematic.



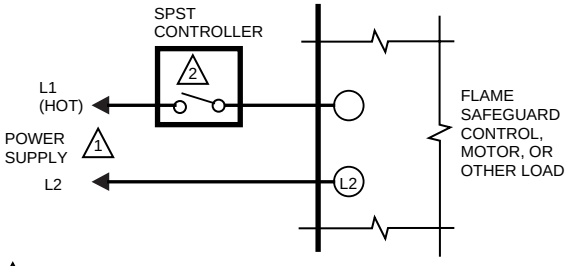
L604A
MAKES R1-W
BREAKS R2-B
ON PRESSURE RISE TO SETPOINT.

L604L,M

1 SPDT SWITCH ACTION WITH JUMPER INSTALLED; OTHERWISE, TWO ISOLATED SPST SWITCHES.

M8935

Fig. 5—L404 used as a limit or as an operating controller.

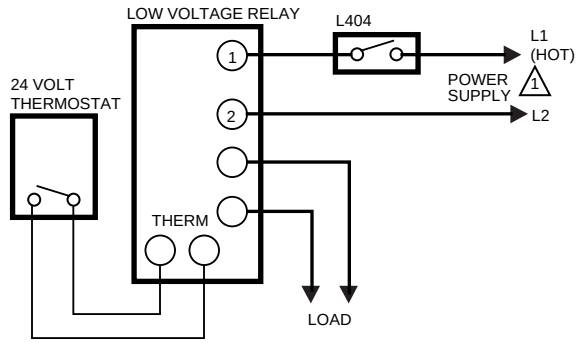


1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 HIGH LIMIT—L404A OR C BREAKS WHEN PRESSURE RISES TO SETPOINT.
LOW LIMIT—L404B BREAKS WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.
OPERATING CONTROLLER—L404A BREAKS WHEN PRESSURE RISES TO SETPOINT, AND MAKES AGAIN WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

M8936

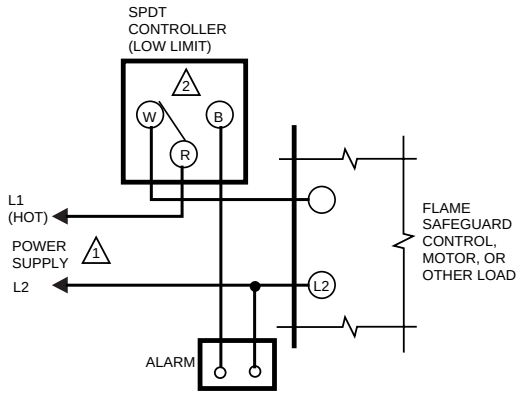
Fig. 6—L404 with a low voltage relay.



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

M8940

Fig. 7—L404F, L604A (jumper installed) used as a high limit, with an alarm circuit.

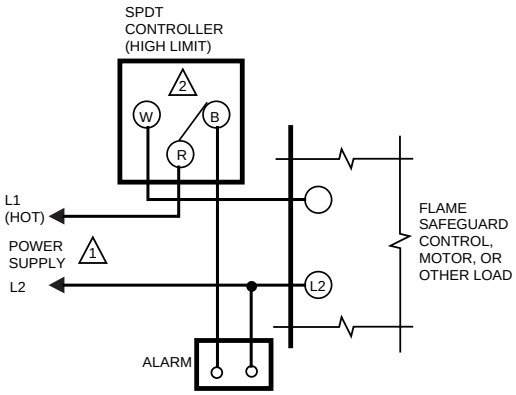


1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO W AND MAKES R TO B WHEN PRESSURE FALLS TO SETPOINT MINUS DIFFERENTIAL.

M8937

Fig. 8—L404F, L604A (with jumper installed) or L604M, used as a low limit, with an alarm circuit.

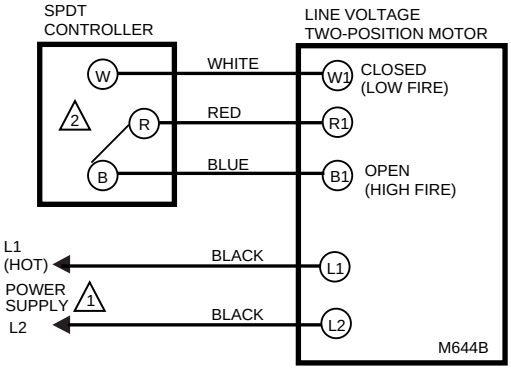


1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO B AND MAKES R TO W WHEN PRESSURE RISES TO SETPOINT.

M8938

Fig. 9—L404F, or L604 with jumper installed, controlling an M644B motor.



1 PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.

2 BREAKS R TO B AND MAKES R TO W WHEN PRESSURE RISES TO SETPOINT.

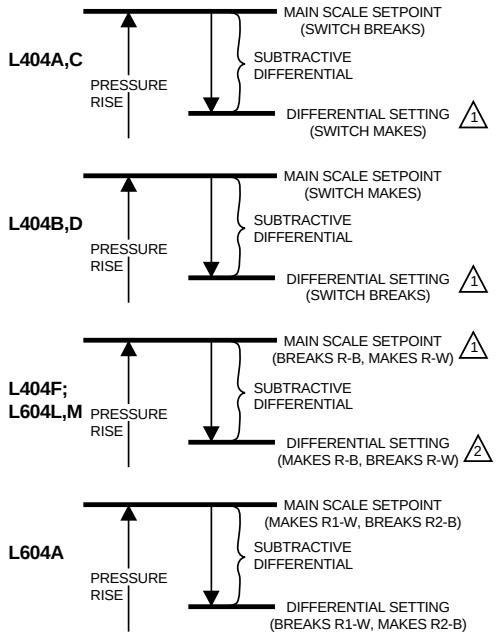
M8939

Setting and Checkout

SETTING

In all models, the differential is subtractive from the main scale set point. The upper operating point is determined by the main scale set point, while the lower operating point is determined by the main scale setting less the differential setting. The L404F and L604A (with jumper installed), L,M have spdt switching action. Operating points are shown in Fig. 10.

Fig. 10—L404 and L604 operating points.



1 L404C,D AND L604L MANUAL RESET MODELS HAVE A SMALL, FIXED DIFFERENTIAL. THEY CAN BE MANUALLY RESET WHEN THE PRESSURE FALLS TO THE MAIN SCALE SETPOINT MINUS THE DIFFERENTIAL.

2 L604M HAS A SMALL, FIXED DIFFERENTIAL OF 3.5 PSI (0.25 kg/cm2) OR 24.1 kPa.)

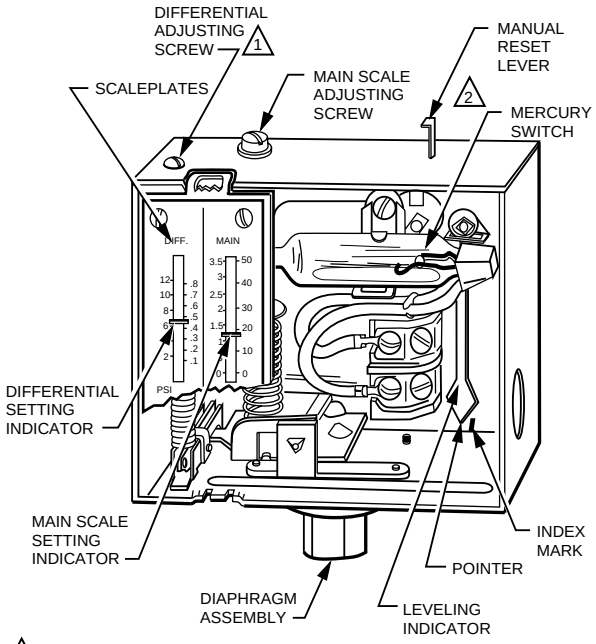
M8942

Adjust the main scale set point for the desired operating pressure by turning the main scale adjusting screw (Fig. 11) on the top of the case until the main scale setting indicator is at the desired value. On an L404A,B,F with a 5 to 150 psi (.3 to 10.3 kg/cm^2 [34 to 1034 kPa]) operating range, or an L604A, adjust the differential setting by turning the differential adjusting screw (Fig. 11) until the differential setting indicator is at the desired value. L404C,D and L604L are manual reset models: see the next paragraph. The L604M has a fixed differential. The scaleplates are marked psi and kg/cm^2.

Trip-Free Manual Reset Feature (L404C,D and L604L only)

The L404C breaks, the L404D makes, and the L604L makes R-W and breaks R-B when the pressure rises to the main scale setpoint. They will not automatically return to their former positions. To reset one of these controllers, wait until the pressure falls to the set point minus the differential (Fig. 10). Then depress the manual reset lever (Fig. 11) and release it. The controller will not be reset until you release the manual reset lever. This prevents the controller from becoming an automatic-reset device if the reset lever is stuck, held in, or tied down.

Fig. 11—Setting a Pressuretrol® Controller.



1 ADJUSTABLE DIFFERENTIAL ON THE L404A,B,F; L404L WITH A 5 TO 150 PSI (0.34 TO 10.3 kg/cm^2 [34 TO 134 kPa] OPERATING RANGE; AND L604A MODELS ONLY.

2 TRIP-FREE MANUAL RESET LEVER ON THE L404C,D AND L604L MODELS ONLY.

M8943

CHECKOUT

After the controller has is installed, wired, and set, test it with the system in operation. First allow the system to stabilize. Then observe the operation of the controller while raising and lowering its setpoint. Pressure should increase when the setpoint is raised and decrease when the set point is lowered.

Also check the make and break points of the controller. If they do not agree with a separate, accurately calibrated pressure gauge, a slight adjustment of the scaleplate(s) may be necessary.

Use accurate pressure testing equipment when checking out the controller. Do not rely on inexpensive gauges. The controllers are carefully calibrated at the factory.

Boiler Installation

If the controller is being used on a boiler installation, test it as follows:

1. Note the boiler pressure by checking the boiler pressure gauge. (To perform this test properly, the boiler should have a pressure reading near the middle of the controller's main scale range.)
2. Turn the main scale adjusting screw (Fig. 11) until the main scale setting indicator on the controller corresponds to the boiler pressure gauge reading.
3. The L404A or C should break the control circuit(s) automatically when the boiler pressure gauge reading equals or slightly exceeds the controller setting.

The L404B or D should make the circuit under the same circumstances.

The L404F; L604L,M should make the R-W circuit and break the R-B circuit under the same circumstances.

The L604A should make the R1-W circuit and break the R2-B circuit under the same circumstances.

4. If the controller is operating properly, turn the main scale adjusting screw (Fig. 11) until the main scale setting indicator is at the desired set point.

If a Controller Seems to Operate Improperly

If the controller is suspected of operating improperly, it may be further checked as follows (Fig. 12):

1. Disconnect all power to the controller, loosen the cover screw, and remove the cover.
2. Disconnect the wires from the controller.
3. Connect an ohmmeter between the switch terminals.
4. Lower the set point of the controller (simulating a pressure increase) through a range greater than the differential. The switch should either make or break, depending on the model of the controller. (An L404A or C should break, an L404B or D should make, an L404F; L604L,M should break R-B and make R-W, and an L604A should break R2-B and make R1-W.) If it makes, the ohmmeter reads zero; if it breaks, the ohmmeter reads infinity.
5. Raise the set point of the controller (simulating a pressure decrease) through a range greater than the differential. The switch should break or make, just the opposite of its action in step 4 (except for the L404C,D and L604L manual reset models).

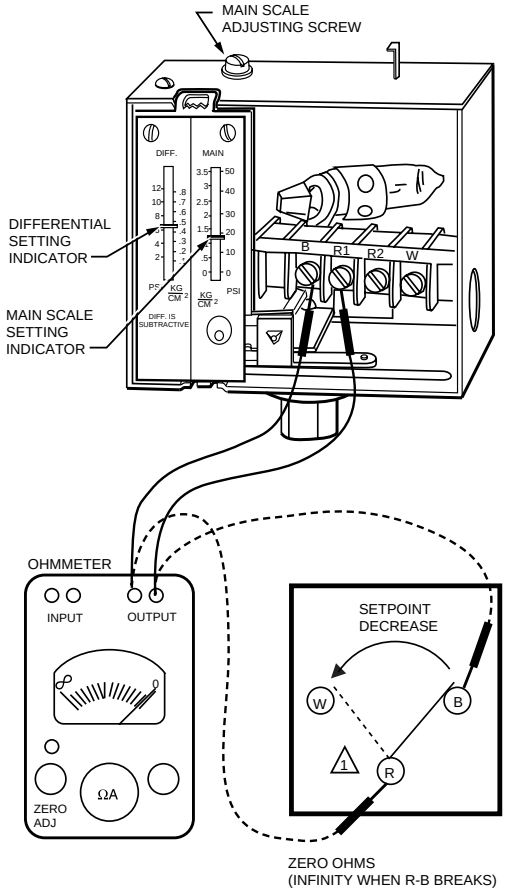
NOTE: An approximation of the differential can be made by observing the change in set point required for a resistance change from zero to infinity.

6. If the controller operates improperly, replace it.
7. When the controller is operating properly, reconnect the wires to the terminal block, replace the cover and tighten the cover screw, and reconnect the power.

! CAUTION

Do not put the system into service until you have satisfactorily completed all applicable tests described in this Checkout section, in the Checkout section of the applicable instructions for the flame safeguard control, and any others required by the burner and boiler manufacturers.

Fig. 12—Checking controller operation using an ohmmeter.



1 AN L604, WITH JUMPER INSTALLED BETWEEN R1 AND R2, IS SHOWN; AN L404F OPERATES SIMILARLY (SPDT SWITCHING). AN L404A, B, C OR D HAS ONLY TWO TERMINALS (SPST SWITCHING); AN L404A OR C BREAKS AND L404B OR D MAKES WHEN THE SETPOINT IS DECREASED FAR ENOUGH.

M8944

Service Information

CALIBRATION

The controller was carefully calibrated during manufacturing and should not require recalibration. Most calibration errors are caused by improper leveling. The controller should be level when the pointer on the leveling indicator is directly over the index mark (Fig. 11). In some cases, the leveling indicator may not be accurate enough. The pointer may be over the index mark, but the controller still may not be operating within the tolerance of its scale setting. In this case, carefully bend the steam trap (siphon loop) until the controller switches properly.

MAINTENANCE

The cover of the controller should be in place at all times to protect the internal components from dirt, dust, and physical damage. Routine maintenance should consist of occasional inspection and blowing or brushing away any accumulated dirt and dust. To ensure proper functioning of the controller at all times, perform an operational check of the entire system during routine maintenance checks.

KUNKLE PRESSURE RELIEF VALVES

Installation and Operating Instructions

Pre-Installation Handling

This pressure relief valve is designed to protect equipment from overpressure. The valve should be handled with care, not subjected to heavy shock loads, and protected to prevent contamination from getting inside. It should be installed correctly per A.S.M.E. Boiler & Pressure Vessel Code requirements. Failure to do so could result in property damage or serious injury to personnel. When hoisting the valve into position for installation, care should be exercised so that lifting straps do not contact the valve lift lever.

Installation

Always wear proper safety equipment, including safety glasses and ear protection.

1. Mount the valve in a vertical position so that the valve body is self-draining. If a body drain port is provided, make sure it is open when required by the ASME code. Do not plug any bonnet vent openings. The inlet piping should be as short as possible, with no elbows, and equal to or greater than the size of the pressure relief valve inlet connection. This will help to limit the inlet pressure drop to 3% or less when the valve is relieving.

2. When discharge piping is connected to valve outlet, make sure it is self draining if a body drain port is not used. The valve should not be connected to any discharge pipe that contains pressure before the valve opens or to any pipe where the pressure build-up is greater than 10% of the set pressure when the valve is open and relieving.

   Discharge piping, other than a short tailpipe, must be supported. For steam service, a drip pan elbow or flexible connection between the valve and the pipe should be used to prevent excessive pipe stress, due to thermal expansion, from being imposed on the valve body.

3. For threaded valves, to prevent sealing compound from entering and damaging the valve, apply a small amount of pipe thread sealing compound to external threads only. Do not put any sealing compound on the first thread or on any internal threads. To do so may cause the sealing compound to enter the valve and cause seat leakage.

   Do not use the valve body or bonnet for installing the valve in threaded connections. Use the wrench flats provided to tighten the valve to the connecting pipe, and do not overtighten. To do so may cause valve leakage.

4. For flanged valves, use new gaskets and tighten the mounting studs evenly.

Operation

1. Maintain a system operating pressure at least 5 psig or 10% below the set pressure of the valve, whichever is greater. Operating too close to the valve set pressure will cause seat leakage and will shorten the time between valve maintenance.

2. Do not use the safety valve as a control valve to regulate system operating pressure. Excessive operation will cause the seat to leak and will require more frequent valve maintenance.

3. ASME Section I and VIII valves equipped with lift levers are designed to be operated only when the system pressure is 75% of set pressure or greater. ASME Section IV valves may be operated at any set pressure. When hand operating the valve, hold it open long enough to purge any foreign matter from the seat area. If a cable or wire is attached to the lift lever for remote actuation, make sure the direction of pull is the same as it would be if the lever were pulled directly by hand.

Maintenance

Maintenance should be performed on a regular basis. An initial inspection interval of 12 months is recommended. Depending on the service conditions and the condition of the valve, the inspection interval may be decreased or increased. Use only Kunkle parts for repair. Depending on the local jurisdictional requirements where the valve is installed, repairs may have to be made by a repair facility holding a VR stamp.

WARNING!

Removal of the seal wires or any attempt to adjust, repair or modify this product by non-qualified or non-authorized persons voids the product guarantee and may cause serious damage to equipment, personal injury, and death. Kunkle Valve is not liable for any damage resulting from misuse or misapplication of its products.

Kunkle Valve Division

Rev B 01/14/2002

Phone: 828-669-5515 953 Old US 70, Black Mountain, NC 28711 Fax: 828-669-4017

Gas Appliance Pressure Regulators

Straight-Thru-Flow Design

RV52, RV53, RV61, RV81, RV91, RV111, and RV131

1/2", 3/4", 1", 1¼", 1½", 2", 2½", 3" & 4"

design certified

S-T-F Series

Maximum Pressure
CSA Rated (except RV131) ..... 1/2 psi (35 mbar)
Maxitrol Tested*
RV52 & RV53 ..... 1/2 psi (35 mbar)
RV61, RV81, RV91, & RV111 ..... 1 psi (70 mbar)
RV131 ..... 2 psi (140 mbar)
* Do not use if inlet pressure is more than 10 times desired outlet pressure

EMERGENCY EXPOSURE LIMITS (Maxitrol Tested)
RV52 & RV53 ..... 3 psi (210 mbar)
RV61, RV81, RV91 & RV111 ..... 5 psi (350 mbar)
RV131 ..... 15 psi (1050 mbar)

GAS CONTAINMENT EXPOSURE LIMITS*
RV 52 & RV53 ..... 15 psi (1050 mbar)
RV61, RV81, RV91, RV111,
& RV131 ..... 25 psi (1750 mbar)
* Please note that internal damage may occur when exposed to these pressures.

AMBIENT TEMPERATURE LIMITS
RV52, RV53, RV61, RV81,
RV91 & RV111 ..... -40° to 205° F (-40° to 96° C)
RV131 ..... -40 to 125° F (-40 to 52° C)

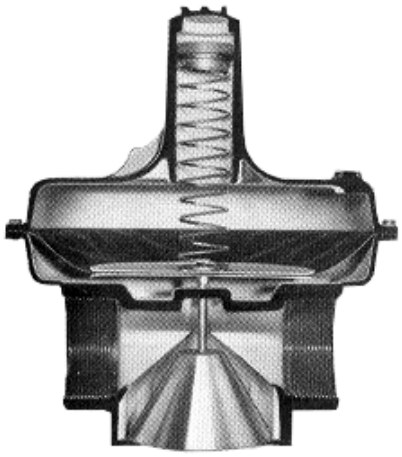
GASES: Natural, manufactured, mixed, liquefied petroleum, or LP gas-air mixture.

MAXITROL® company

Straight-Thru-Flow Design

RV series

RV52, RV53, RV61, RV81, RV91, RV111, and RV131



FEATURES

- Greater accuracy—higher pressure drop capacity
- Outlet pressures available to 42" w.c.
- Available in full range of pipe sizes from 1/2" to 4"
- All models tapped with NPT vent bosses
- CSA Design Certified (except RV131)

BENEFITS

- Unique conical valve design fills need of combining good regulation with high capacity in low to intermediate pressure range
- Allows more pressure drop to be assigned to piping and valves—permits reduction in manifold size
- Provides accurate, sensitive regulation at inlet pressures as low as 3" w.c.
- RV131 only, provides bonus benefits of high capacity and good performance at pressures of 1 psi or higher
- Ease of installation and replacement

All models except RV131 are CSA design certified for 1/2 psi rated pressure under the ANSI standard for gas pressure regulators; and CSA listed to certify compliance with nationally published safety, construction, and performance standards.

They are main burner only, non-lockup type. They should not be used as a line gas pressure regulator ahead of low pressure controls. Use only where downstream controls can operate at line pressure. Refer to other Maxitrol sales bulletins for proper types.

The RV52, RV53, & RV61 are suitable for multipoise mounting. The RV81, RV91, RV111, & RV131 are recommended for normal horizontal position only.

Maxitrol's original Straight-Thru-Flow design meets your needs for high capacities at low inlet pressures. The basic difference between S-T-F design and other type regulators lies in the conical valve. The cone principal permits gas to flow straight through the regulator without changing directions. Frictional flow resistance is reduced, resulting in greater capacity.

The improved flow pattern provides accurate sensitive regulation at extremely low pressure differentials. The ability of the regulator to handle large capacity appliances with limited supply pressure offers a definite advantage to designers of commercial and industrial gas-fired equipment. Models up to the three inch pipe size have high strength pressure cast aluminum housings. The RV131 four inch model is of cast iron and steel construction. RV61, RV81, RV91, RV111, & RV131 internal conical valves are coated with Teflon® for long life. Diaphragm material is cut from the finest synthetic coated fabrics available. All other parts are carefully specified corrosion-resistant or plated material.

Pipe sizes of 1/2", 3/4", 1", 1-1/4", 1-1/2", 2", 2-1/2", 3", and 4" are available. Models through the 3" size are threaded, the 4" RV131 is flanged.

At the emergency exposure limits, there may be no regulation, but all models will contain gas. They will suffer no internal damage and will resume regulation when normal pressure is restored.

Straight-Thru-Flow appliance regulators are intended for use with all fuel gases, and may also be used with air or other noncorrosive gases within their pressure limits.

Typical applications include all types of residential, commercial and industrial gas-fired appliances and equipment used on low pressure gas supply. See Maxitrol's "Spring Selection Chart" for part numbers, color and size of springs.

NOTE: All Maxitrol appliance regulators should be installed in accordance with Maxitrol's "Safety Warning" bulletin.

Capacities and Pressure Drop

CAPACITIES—expressed in CFH (m^3/h)—0.64 sp gr gas

Model Number and Pipe Size		CSA MAX	Pressure DropÑinches w.c. (mbar)												
			0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	2	3	4
RV52	1/2 x 1/2 3/4 x 3/4	450 (12.7)	151 (4.2)	214 (6.1)	262 (7.4)	302 (8.5)	338 (9.5)	370 (10.5)	400 (11.3)	427 (12.1)	453 (12.8)	478 (13.5)	676 (19.1)	828 (23.4)	956 (27.1)
RV53	3/4 x 3/4 1 x 1	710 (20.1)	217 (6.1)	306 (8.6)	375 (10.6)	433 (12.2)	484 (13.7)	530 (15)	573 (16.2)	612 (17.3)	650 (18.4)	684 (19.3)	968 (27.4)	1185 (33.5)	1369 (38.7)
RV61	1 x 1 1-1/4 x 1-1/4	1100 (31.1)	379 (10.7)	536 (15.1)	675 (19.1)	759 (21.5)	848 (24)	929 (26.3)	1004 (28.4)	1073 (30.4)	1138 (32.2)	1200 (34.0)	1742 (49.3)	2134 (60.4)	2464 (69.8)
RV81	1-1/4 x 1-1/4 1-1/2 x 1-1/2	2500 (70.8)	780 (22.1)	1102 (31.2)	1350 (38.2)	1559 (44.1)	1743 (49.5)	1909 (54)	2062 (58.4)	2204 (62.4)	2339 (66.2)	2465 (69.8)	3485 (98.7)	4269 (120)	4929 (139)
RV91	2 x 2 2-1/2 x 2-1/2	3275 (92.7)	1212 (34.3)	1714 (48.5)	2100 (59.4)	2424 (68.6)	2711 (76.7)	2969 (84.1)	3208 (90.8)	3429 (97.1)	3637 (103)	3834 (108)	5422 (153)	6640 (188)	7668 (217)
RV111	2-1/2 x 2-1/2 3 x 3	7500 (212)	2742 (78)	3878 (110)	4750 (134)	5485 (155)	6132 (175)	6718 (190)	7256 (205)	7757 (219)	8227 (233)	8572 (243)	12134 (343)	14862 (420)	17161 (486)
RV131	4 x 4	--	4734 (134)	6695 (190)	8200 (232)	9468 (268)	10586 (300)	11596 (328)	12525 (354)	13390 (380)	14202 (402)	14971 (424)	21172 (600)	25930 (734)	29942 (848)

Sizing Instructions

In order to select the proper size regulator, you must know the available inlet pressure, desired outlet pressure, and the required maximum flow rate.

Example No. 1—To select a regulator of ample capacity to handle flow.

KNOWN:
Pipe size 2-1/2", flow rate 8,000 CFH (0.64 sp gr), inlet pressure 9" w.c., desired outlet pressure 5" w.c.

SOLUTION:

1. Determine differential pressure available:
   Inlet pressure 9" w.c.
   Subtract outlet pressure - 5" w.c.
   Available differential pressure 4" w.c.
2. When determining capacity Maxitrol recommends that the pressure drop not exceed 1/2 of available differential pressure (1/2 of 4" w.c. = 2" w.c.).
3. Check Capacity Chart to determine which regulator has a pressure drop of 2" w.c. or less at a flow rate of 8,000 CFH.
4. The RV111 meets these standards with a flow rate of 12,134 CFH for the 2-1/2" pipe size at 2" w.c. pressure drop. The 2-1/2" RV91 flows 5422 CFH at 2" w.c. pressure drop. Therefore, the RV111—2-1/2" is the correct regulator to use.

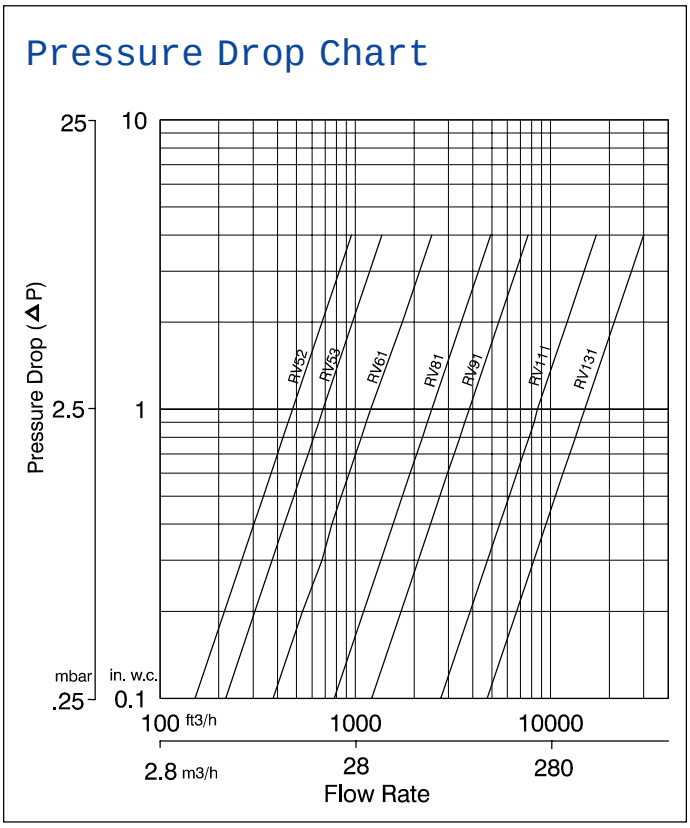
Example No. 2—To determine maximum recommended operating outlet pressure.

KNOWN:
Pipe size 4", flow rate 21,000 CFH, inlet pressure 10" w.c.

SOLUTION:

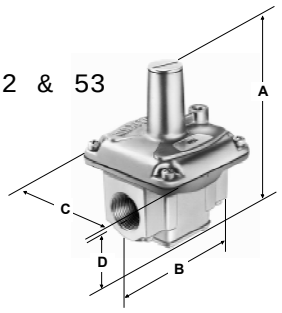
1. Check capacity Chart above for 4" regulator, RV131.
2. Note that at a flow rate of 21,172 CFH the pressure drop is 2" w.c.
3. Multiply this by two to obtain recommended differential pressure (4" w.c.).
4. Subtract 4" differential pressure from 10" w.c. inlet pressure to obtain maximum recommended outlet pressure setting of 6" w.c.

Pressure Drop Chart

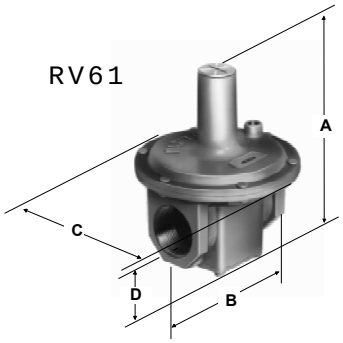


Dimensions and Spring Ranges

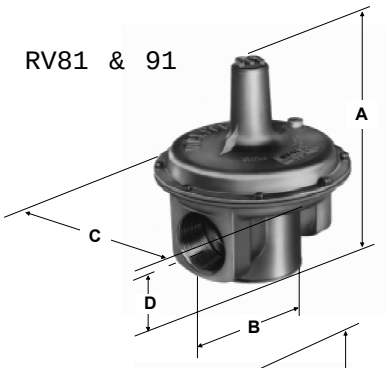
RV52 & 53



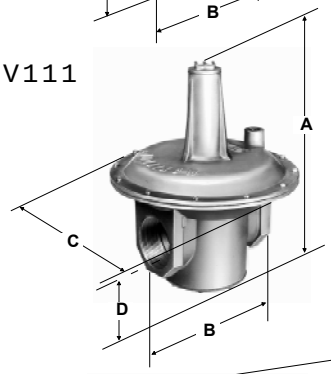
RV61



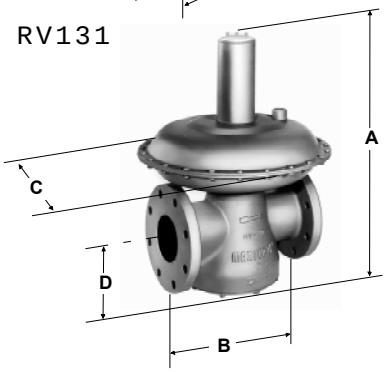
RV81 & 91



RV111



RV131



DIMENSIONS*—inches (millimeters)

Model & Illustration Number	Vent Tap	Swing Radius	Call-Outs			
			A	B	C	D
RV52	1/8" NPT	3.6 (91)	4.9 (124)	3.2 (81)	3.25 (83)	1.25 (32)
RV53	1/8" NPT	3.9 (99)	5.2 (132)	3.75 (95)	3.9 (99)	1.3 (33)
RV61	1/8" NPT	4.8 (122)	6.4 (164)	4.4 (111)	5.4 (138)	1.6 (41)
RV81	3/8" NPT	6.4 (162)	8.4 (213)	6 (153)	7 (178)	2 (51)
RV91 2" pipe	1/2" NPT	8.5 (216)	10.8 (275)	6.5 (165)	9.1 (232)	2.3 (60)
RV91 2.5" pipe	1/4" NPT	8.3 (212)	10.5 (267)	7.1 (181)	9.1 (232)	2.4 (62)
RV111	3/4" NPT	11.5 (284)	15.1 (373)	9 (229)	13.4 (324)	3.5 (89)
RV131	3/4" NPT	18.2 (462)	23.25 (590)	13.9 (353)	18 (458)	5.1 (129)

* *Dimensions are to be used only as an aid in designing clearance for the valve. Actual production dimensions may vary somewhat from those shown.*

SPRING SELECTION CHART—inches w.c. (mbar)

Model Number	CSA Certified Springs			Other Springs Available							
RV52	3 to 6 (7.5-15)	4-8 (10-20)	5-12 (12.5-30)	1-3.5 (2.5-9)	2-5 (5-12.5)	3-8 (7.5-20)	4-12 (10-30)	--	--	--	--
RV53	3 to 6 (7.5-15)	4-8 (10-20)	5-12 (12.5-30)	1-3.5 (2.5-9)	2-5 (5-12.5)	3-8 (7.5-20)	4-12 (10-30)	--	--	--	--
RV61	3 to 6 (7.5-15)	4-8 (10-20)	5-12 (12.5-30)	1-3.5 (2.5-9)	2-5 (5-12.5)	3-8 (7.5-20)	--	--	10-22 (25-55)	--	--
RV81	3 to 6 (7.5-15)	4-8 (10-20)	5-12 (12.5-30)	1-3.5 (2.5-9)	2-5 (5-12.5)	3-8 (7.5-20)	4-12 (10-30)	5-15 (12.5-38)	10-22 (25-55)	--	--
RV91	3 to 6 (7.5-15)	4-8 (10-20)	5-12 (12.5-30)	1-3.5 (2.5-9)	2-5 (5-12.5)	3-8 (7.5-20)	4-12 (10-30)	5-15 (12.5-38)	10-22 (25-55)	--	--
RV111	3 to 6 (7.5-15)	4-8 (10-20)	5-12 (12.5-30)	1-3.5 (2.5-9)	2-5 (5-12.5)	3-8 (7.5-20)	4-12 (10-30)	5-15 (12.5-38)	10-22 (25-55)	--	--
RV131	3 to 6 (7.5-15)	--	5-12 (12.5-30)	--	2-5 (5-12.5)	3-8 (7.5-20)	4-12 (10-30)	--	10-22 (25-55)	15-30 (38-75)	20-42 (50-105)

NOTE: The area within the heavy line indicates CSA certified springs.

MAXITROL® company

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SAFETY WARNING INSTRUCTIONS

FOR MAXITROL GAS PRESSURE REGULATORS

NOTE: GAS PRESSURE REGULATORS WILL ***NOT*** TURN OFF THE FLOW OF GAS.

SPECIAL WARNINGS

IF YOU DO NOT FOLLOW THESE INSTRUCTIONS EXACTLY, A FIRE OR EXPLOSION MAY RESULT CAUSING PROPERTY DAMAGE, PERSONAL INJURY OR LOSS OF LIFE.
NO UNTRAINED PERSON SHOULD ATTEMPT TO INSTALL, MAINTAIN OR SERVICE GAS PRESSURE REGULATORS.

To minimize the possibility of FIRE, EXPLOSION, and OTHER HAZARDS:

1. All products, including gas pressure regulators, used with combustible gas **must** be installed and used **strictly** in accordance with the instructions of the manufacturer, with government codes and regulations, and plumbing codes and practices.

2. Do **not** use a gas pressure regulator if it appears to have been subjected to high temperatures, damaged in any way, or to have been taken apart or tampered with. Any of these may be signs of possible leakage or other damage that may affect proper operation and cause potentially dangerous combustion problems

3.

a. Install the regulator properly with gas flowing as indicated by the arrow on the casting.
b. Use pipe compound or thread sealant, properly threaded pipes and careful assembly procedure so that there is no cross threading, etc., which might cause damage or leakage.
c. Apply wrench or vise pressure only to the flat areas around the pipe tappings at the end being threaded to the pipe to avoid possible fracture of the regulator body which could result in leakage
d. Make sure markings or wording on regulator are not painted over or obliterated.

4. Check carefully for gas leaks immediately after the regulator has been installed and the gas turned on. **Do this before attempting to operate the appliance or other gas burning device.** Use a rich soap solution (or other accepted leak tester) around the diaphragm flanges, bottom plate, vent opening, seal cap, pipe connections, and all other joints. Wipe clean with a damp rag. It is a good practice to periodically check for leakage during use of the appliance. **Absolutely no leakage should occur, otherwise there is a danger of fire or explosion depending upon conditions. Never use if leakage is detected.**

CAUTION

NEVER CONNECT REGULATOR DIRECTLY TO THE PROPANE SUPPLY SOURCE. MAXITROL REGULATORS REQUIRE AN EXTERNAL REGULATOR (NOT SUPPLIED). INSTALL THE EXTERNAL REGULATOR BETWEEN THE PROPANE SUPPLY SOURCE AND MAXITROL REGULATOR.

5. Very high pressure surges in the gas supply line (or as a result of exposing the system to high pressure) may result in serious internal damage and cause leakage or affect regulator operation. If you suspect that a Maxitrol regulator has been exposed to more than twice the maximum operating inlet pressure, as shown in the following chart, turn off the gas and have the system checked by an expert.

(over)

INSTRUCCIONES PARA PRECAUCIONES DE SEGURIDAD

PARA REGULADORES DE PRESION DE GAS MAXITROL

NOTA: LOS REGULADORES DE PRESION DE GAS **NO** CORTAN EL FLUJO DE GAS

¡PRECAUCIONES ESPECIALES!

SI USTED NO SIGUE ESTAS INSTRUCCIONES EXACTAMENTE, PUEDE OCURRIR UN INCENDIO O UNA EXPLOSION, CAUSANDO DAÑOS A LA PROPIEDAD, LESIONES PERSONALES O PERDIDA DE VIDAS. NADIE QUE NO HAYA SIDO ENTRENADO DEBERA DE TRATAR DE INSTALAR, DAR SERVICIO O DAR MANTENIMIENTO A LOS REGULADORES DE PRESION DE GAS

Para reducir la posibilidad de INCENDIO, EXPLOSION Y OTROS RIESGOS:

1. Todos los productos, incluyendo los reguladores de presión de gas, que se usan con gases combustibles **deberán** instalarse y usarse **estrictamente** de acuerdo con las instrucciones del fabricante, usando los códigos y reglamentos gubernamentales así como los códigos y prácticas de plomería.

2. **No** usar un regulador de presión de gas si parece haber estado expuesto a altas temperaturas, dañado en alguna forma o que se haya desmantelado o maltratado. Cualquiera de éstas pueden ser señales de posibles fugas u otros daños que pueden afectar el funcionamiento correcto y causar problemas de combustión potencialmente peligrosos.

3.

a. Instalar el regulador correctamente con el gas fluyendo como se indica en la flecha en la carcasa de fundición.
b. Usar un compuesto sellador de tubería o hilo sellador de rosca, tuberías correctamente roscadas y procedimientos de ensamble cuidadoso, asegurándose de que no haya trasroscados, lo cual podría causar daños o fugas.
c. Aplicar únicamente la presión de una llave o tornillo de banco en las áreas planas alrededor de las roscas de la tubería del extremo a enroscar para evitar la posible rotura del cuerpo del regulador que podría resultar en fugas.
d. Asegurarse de que no se pinten o tachen las marcas o escritura en el regulador.

4. Verificar inmediatamente que no haya fugas de gas después de que el regulador haya sido instalado y se haya abierto el paso del gas. **Esto deberá hacerse antes de tratar de operar el aparato electrodoméstico o cualquier otro dispositivo quemador de gas.** Usar una solución espesa de jabón (u otro probador de fugas aceptado) alrededor de las bridas del diafragma, el fondo del plato, la apertura de ventilación, la tapa selladora y las conexiones de la tubería y todas las demás juntas. Limpiar con un trapo húmedo. Es una buena práctica verificar periódicamente que no haya fugas durante el uso del aparato electrodoméstico. **Absolutamente no deberá haber ninguna fuga. De otra forma hay peligro de incendio o explosión dependiendo de las condiciones. Nunca deberá usarse si se detectan fugas.**

¡PRECAUCION!

NUNCA CONECTAR EL REGULADOR DIRECTAMENTE AL SUMINISTRO DE PROPANO. LOS REGULADORES MAXITROL REQUIEREN UN REGULADOR EXTERNO (NO PROVISTO). INSTALAR EL REGULADOR EXTERNO ENTRE EL SUMINISTRO DE PROPANO Y EL REGULADOR MAXITROL

5. Aumentos grandes de presión en la línea de suministro de gas (o como resultado de exponer el sistema a alta presión) pueden resultar en daños internos y causar fugas o afectar el funcionamiento del regulador. Si usted sospecha que un regulador Maxitrol ha sido expuesto a más del doble de la presión máxima de entrada, como se muestra en la tabla siguiente, cierre el paso del gas y haga que el sistema sea verificado por un experto.

(a la vuelta)

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6. Venting **must** be controlled in accordance with government and plumbing codes and regulations to avoid the danger of escaping gas should there be internal leakage. Vent pipes **must** be open and the open end protected against entry of foreign matter, including water.

7. The outlet pressure of the regulator **must** be measured to make sure it is in accordance with intended usage. If a spring change is required to develop the required outlet pressure, the spring **must be one specified by MAXITROL**

8. Caution should be used to guarantee that there is sufficient inlet pressure to achieve the desired outlet pressure and no readjustment of the outlet pressure setting should be made unless the inlet pressure is within the proper limits for the regulator. Failure to follow this may result in overfiring of the appliance or other gas burning device. **The MAXITROL bulletin for the regulator** should be consulted for specific inlet and outlet pressure relationships.

9. A MAXITROL regulator **must be used** within the temperature range and not in excess of the maximum inlet pressure shown in the following table and should be in the mounting position indicated. Maxitrol regulators can be used with all fuel gases.

10. In case of any doubt, please contact the Service Manager, Maxitrol Company, Southfield, MI USA. Phone: 248/356-1400.

6. La ventilación **deberá** estar controlada de acuerdo con los códigos y reglamentos gubernamentales de plomería para evitar el peligro de que se escape el gas en caso de una fuga interna. Los tubos de ventilación deberán estar abiertos y el extremo abierto deberá estar protegido contra cualquier materia extraña, incluyendo el agua.

7. La presión de salida del regulador **deberá** medirse para asegurarse que está de acuerdo para el uso que se pretende. Si se necesita cambiar un resorte para desarrollar la presión de salida requerida, el resorte **deberá ser especificado por MAXITROL** y la nueva presión de salida deberá anotarse en el regulador.

8. Deberá usarse precaución para garantizar que hay suficiente presión interna para alcanzar la presión de salida deseada y no deberá hacerse ningún reajuste en la presión de salida a menos que la presión interna esté dentro de los límites correctos para el regulador. Si esto no se lleva a cabo podría resultar en una llama excesiva del aparato electrodoméstico u otro dispositivo quemador de gas. **Deberá consultarse el boletín MAXITROL para el regulador** para ver la relación específica entre la presión de entrada y la de salida.

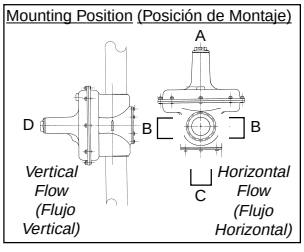
9. **Un regulador MAXITROL deberá usarse** dentro del rango de temperatura y no deberá excederse la presión máxima de entrada que se muestra en la tabla siguiente y deberá estar en la posición indicada de montaje. Los reguladores MAXITROL pueden usarse con todo tipo de gases combustibles.

10. En caso de dudas, favor de comunicarse con el Service Manager (Gerente de Servicio), Maxitrol Company, Southfield, MI USA. Teléfono: 248-356-1400.

Model Number (Número de Modelo)	Maximum Operating Inlet Pressure (Presión Máxima de Entrada para Operación)	Ambient Temperature Range (Rango de Temperatura Ambiente)	Mounting Position [see below] (Posicióndе Montaje) [ver abajo]
RV12LT, RV20LT	1/2 psi (34 mbar)	-40° to 275° F (-40° to 135° C)	A, B, C, D
RV20L	2 psi (138 mbar)	-40° to 225° F (-40° to 107° C)	A, B, C, D
RV47, RV48 (*1)	1/2 psi (34 mbar)	32° to 225° F (0° to 107° C)	A, B, C, D, (*1)
RV48T (*1)	1/2 psi (34 mbar)	32° to 275° F (0° to 135° C)	A, B, C, D, (*1)
RV52, RV53, (*1)	1/2 psi (34 mbar)	-40° to 205° F (-40° to 96° C)	A, B, C, D, (*1)
RV61, (*1)	1 psi (69 mbar)	-40° to 205° F (-40° to 96° C)	A, B, C, D, (*1)
RV81, RV91	1 psi (69 mbar)	-40° to 205° F (-40° to 96° C)	A only (únicamente)
RV111	1 psi (69 mbar)	-40° to 205° F (-40° to 96° C)	A only (únicamente)
RV131	2 psi (138 mbar)	-40° to 125° F (-40° to 52° C)	A only (únicamente)
R400, R500, R600, (*1)	1 psi (69 mbar)	-40° to 205° F (-40° to 96° C)	A, B, C, D, (*1)
R400S, R500S, R600S, (*1)	5 psi (345 mbar)	-40° to 205° F (-40° to 96° C)	A, B, C, D, (*1)
R400Z, R500Z, R600Z	1psi (69 mbar)	-40° to 205° F (-40° to 96° C)	A, B, C, D, (*1)
210D, E, G, J	10 psi (690 mbar)	-40° to 205° F (-40° to 96° C)	A only (únicamente)
210DZ, EZ, GZ, JZ	5 psi (345 mbar)	-40° to 205° F (-40° to 96° C)	A only (únicamente)
220D, E, G, J	10 psi (690 mbar)	-40° to 205° F (-40° to 96° C)	A only (únicamente)
325-3 (*1), 325-5A (*1), 325-7	10 psi (690 mbar) (*1)	-40° to 205° F (-40° to 96° C)	A, B, C, D, (*1)

(*1) When equipped with a ball-check type automatic vent limiting device (12A04, 12A09, 12A39), regulators **must** be in upright position (A) with non-integral vent limiter installed directly into vent threads. **Any other mounting position may interfere with lockup or cause pilot outage, where applicable.** Maximum inlet pressure for regulators with 12A09 or 12A39 is 2 psi (LP) or 5 psi (natural). Inlet pressures exceeding 2 psi (LP) or 5 psi (natural) require a vent line.

(*1) Para estar seguro que el regulador responde con rapidez cuando está equipado con un dispositivo limitador de ventilación automático tipo bola (12A04, 12A09,12A39), los reguladores deberán estar en posición vertical (A) con el limitador de ventilación instalado directamente a las roscas del tubo de ventilación. **Si se usa cualquier otra posición durante su instalación, esto podrá interferir con el cierre o causar que el piloto se apague.** La presión máxima de admisión para reguladores con los dispositivos 12A09 o 12A39 es de 2 psi (gas licuado) o 5 psi (gas natural). Las presiones de admisión que excedan 2 psi (gas licuado) o 5 psi (gas natural) requerirán una línea de ventilación.



LITHO IN U.S.A. 110MMP

Installation & Maintenance
Instructions MM-217(F)

McDonnell & Miller

ITT Industries

Series 150 and 157

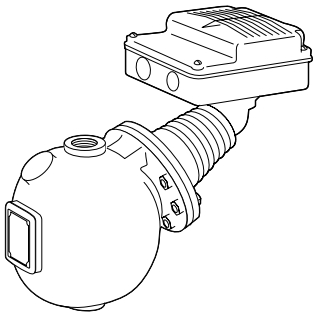
(Mercury Switch)

Series 150S and 157S

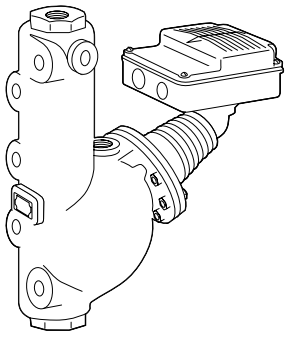
(Snap Switch, All Models except 157S-RB-P)

Low Water Cut-Off/Pump Controllers

For Steam Boilers and Other Level Control Applications



Series 150 and 150S

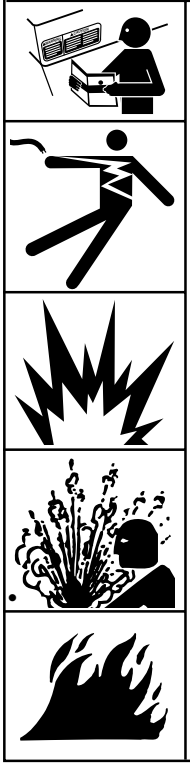


Series 157 and 157S

Typical Applications:

- **Primary or secondary pump controller/ low water fuel cut-off for steam boilers**
- **Motorized valve controller**
- **Low water cut-off**
- **High water cut-off**
- **Alarm actuator**

⚠ WARNING



- **Before using this product read and understand instructions.**
- **Save these instructions for future reference.**
- **All work must be performed by qualified personnel trained in the proper application, installation, and maintenance of plumbing, steam, and electrical equipment and/or systems in accordance with all applicable codes and ordinances.**
- **To prevent serious burns, the boiler must be cooled to 80˚F (27˚C) and the pressure must be 0 psi (0 bar) before servicing.**
- **To prevent electrical shock, turn off the electrical power before making electrical connections.**
- **This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.**
- **We recommend that secondary (redundant) Low Water Cut-Off controls be installed on all steam boilers with heat input greater than 400,000 BTU/hour or operating above 15 psi of steam pressure. At least two controls should be connected in series with the burner control circuit to provide safety redundancy protection should the boiler experience a low water condition. Moreover, at each annual outage, the low water cut-offs should be dismantled, inspected, cleaned, and checked for proper calibration and performance.**
- **To prevent serious personal injury from steam blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.**
- **To prevent a fire, do not use this low water cut-off to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.**

Failure to follow this warning could cause property damage, personal injury or death.

OPERATION

Maximum Pressure: 150 psi (10.5 kg/cm^2)

Electrical Ratings

Voltage	PumpCircuit Rating (Amperes)		Pilot Duty
	Full Load	Locked Rotor	
120 VAC	7.4	44.4	345 VA at 120 or 240 VAC
240 VAC	3.7	22.2	

Alarm Circuit Rating	
Voltage	Amps
120 VAC	1
240 VAC	1/2

Motor Horsepower	
Voltage	Hp
120 VAC	1/3
240 VAC	1/3

Enclosure rating: NEMA 1 General Purpose

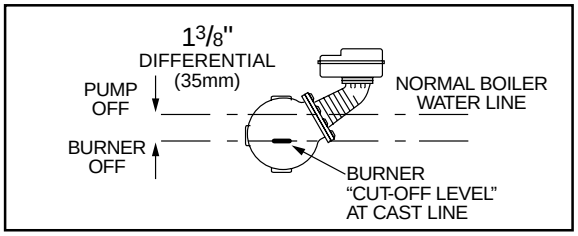
Settings and Differential Pressures

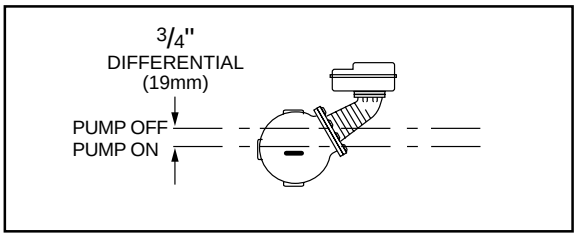
Values are ± ⅛" (3.2mm).

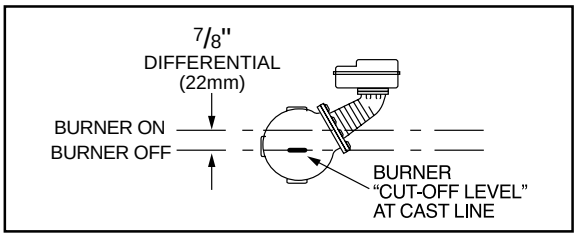
Series 150, 150S, 157 and 157S

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm^2)	Pump Off	15/16 (24)	5/16 (8)
	Pump On	5/8 (16)	
	Burner On	5/8 (16)	3/8 (16)
	Burner Off	1/4 (6.4)	
150 psi (10.5 kg/cm^2)	Pump Off	1 3/8 (41)	3/4 (19)
	Pump On	5/8 (16)	
	Burner On	7/8 (22)	7/8 (22)
	Burner Off	0 (0)	

150 psi (10.5 kg/cm^2) Levels



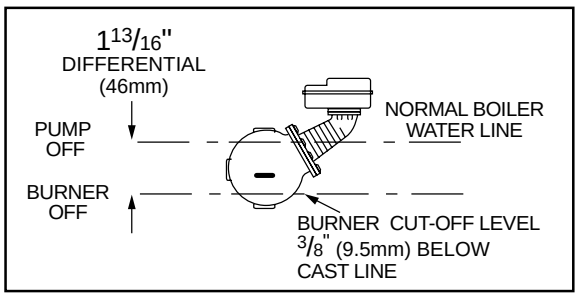


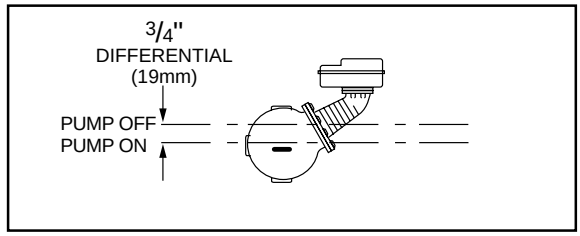


Model 150-MD, 150S-MD, 157-MD and 157S-MD

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm^2)	Pump Off	15/16 (24)	3/8 (16)
	Pump On	9/16 (14)	
	Burner Off	0 (0)	N/A
150 psi (10.5 kg/cm^2)	Pump Off	1 7/16 (37)	3/4 (19)
	Pump On	11/16 (17)	
	Burner Off	- 3/8 (-16)	N/A

150 psi (10.5 kg/cm^2) Levels





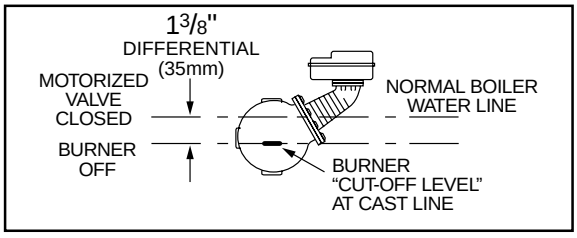
Settings and Differential Pressures (continued)

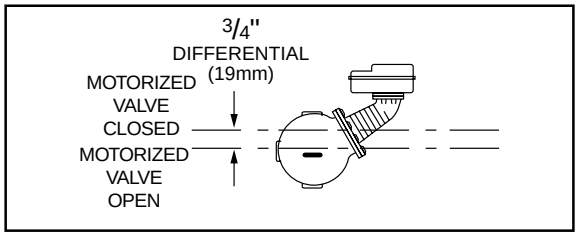
Values are ± ⅛" (3.2mm).

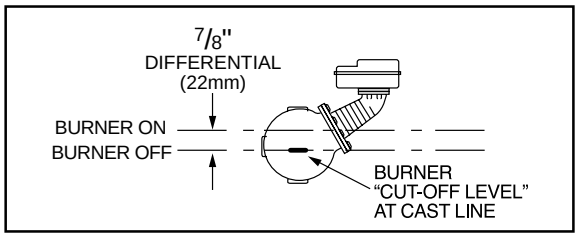
Model 158/158S

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Motorized Valve Closed	15/16 (24)	5/16 (8)
	Motorized Valve Open	5/8 (16)	
	Burner On	5/8 (16)	3/8 (16)
	Burner Off	1/4 (6.4)	
150 psi (10.5 kg/cm²)	Motorized Valve Closed	1 3/8 (41)	3/4 (19)
	Motorized Valve Open	5/8 (16)	
	Burner On	7/8 (22)	7/8 (22)
	Burner Off	0 (0)	

150 psi (10.5 kg/cm²) Levels





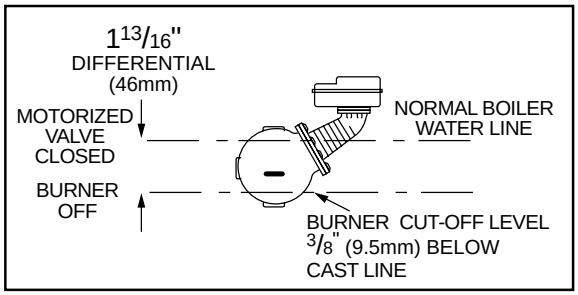


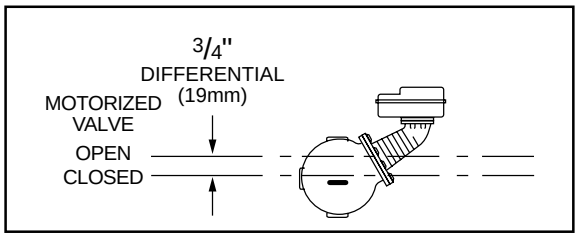
NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.

Model 158-MD/158S-MD

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Pump Off	15/16 (24)	3/8 (16)
	Pump On	9/16 (14)	
	Burner Off	0 (0)	N/A
150 psi (10.5 kg/cm²)	Pump Off	1 7/16 (37)	3/4 (19)
	Pump On	11/16 (17)	
	Burner Off	- 3/8 (-16)	N/A

150 psi (10.5 kg/cm²) Levels





NOTE: Due to the slower operation of some motorized valves, complete valve opening or closing will occur at slightly different levels than indicated above.

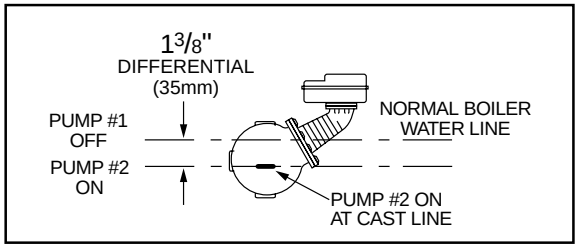
Settings and Differential Pressures (continued)

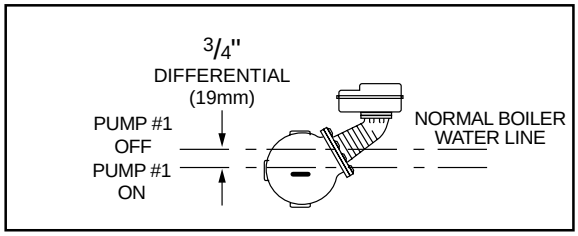
Values are ± ⅛" (3.2mm).

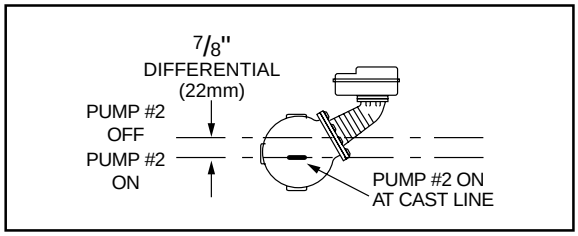
Model 159/159S

Pressure	Setting	Approximate Distance Above Cast Line In. (mm)	Differential In. (mm)
0 psi (0 kg/cm²)	Pump #1 Off	15/16 (24)	5/16 (8)
	Pump #1 On	5/8 (16)	
	Pump #2 Off	5/8 (16)	3/8 (16)
	Pump #2 On	1/4 (6.4)	
150 psi (10.5 kg/cm²)	Pump #1 Off	1 3/8 (41)	3/4 (19)
	Pump #1 On	5/8 (16)	
	Pump #2 Off	7/8 (22)	7/8 (22)
	Pump #2 On	0 (0)	

150 psi (10.5 kg/cm²) Levels







INSTALLATION

TOOLS NEEDED:
Two (2) pipe wrenches, one (1) flathead screw driver, and pipe sealing compound.

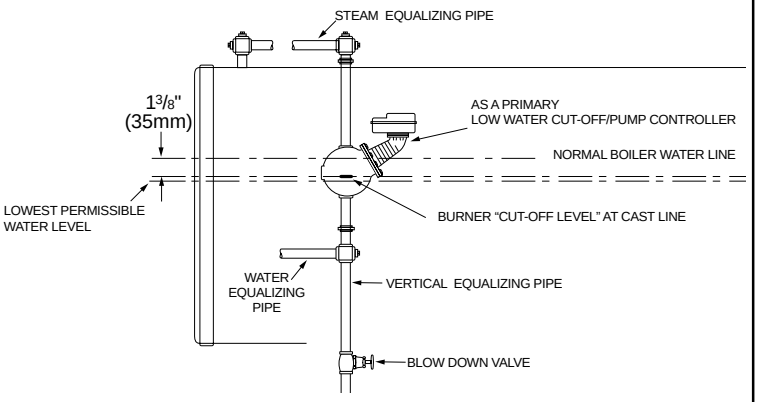
IMPORTANT: Follow the boiler manufacturer's instructions along with all applicable codes and ordinances for piping, blow down valve and water gauge glass requirements.

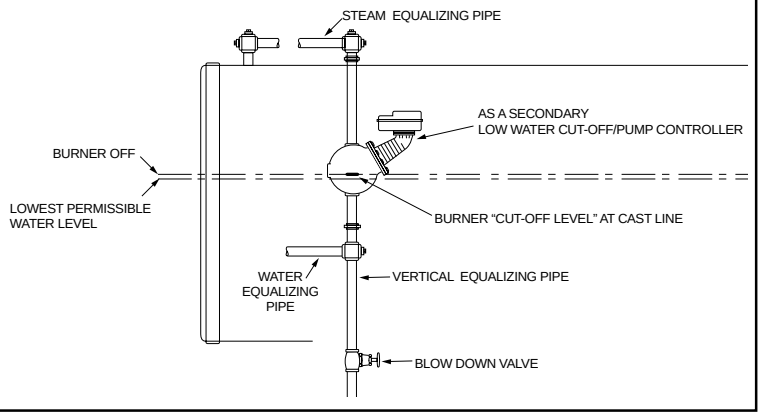
STEP 1 - Determine the Elevation at Which the Low Water Cut-Off/Pump Controller Must be Installed

If the control will be the primary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is **1⅜" (35mm) below** the boiler's **normal** water level, **but not lower than the lowest, safe permissible water level, as determined by the boiler manufacturer.**

OR

If the control will be the secondary low water fuel cut-off, size the steam (top) and water (bottom) equalizing pipe lengths so that the horizontal cast line on the body is **at or above, the lowest, safe permissible water level, as determined by the boiler manufacturer.**

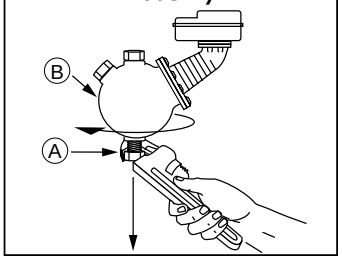




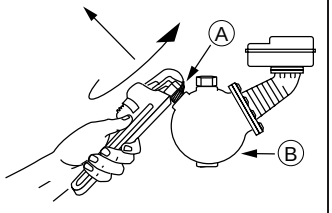
STEP 2 - Installing the Low Water Cut-Off

a. Using a pipe wrench, unscrew the plastic float blocking plug (A) from the low water cut-off body (B).

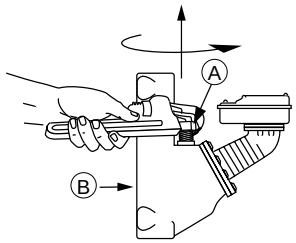
Series 150 and 150S (except Model 150-B and 150S-B)



Models 150-B and 150S-B



Series 157 and 157S



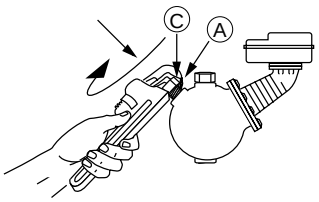
b. For Models 150-B and 150S-B and Series 157 and 157S (For all other models, proceed to Step 3).

Screw the ¾" NPT steel plug (C) (provided) in tapping (A).

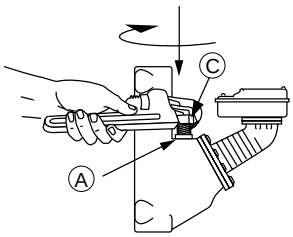
⚠ CAUTION

The plug must be reinstalled before control is shipped installed on the boiler, and removed when boiler is installed after shipment. Failure to follow this caution may damage float and operating mechanism.

Models 150-B and 150S-B



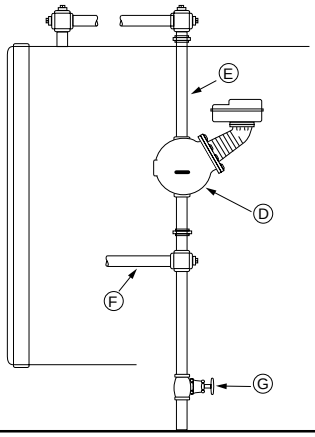
Series 157 and 157S



c. Mount and pipe the low water cut-off (D) on a vertical equalizing pipe (E) at the required elevation level, as determined in Step 1.

Install a full ported blow down valve (G) directly below the lower cross of the water equalizing pipe (F).

Note: 1" NPT tappings are provided, with the exception of some 157 and 157S models which are 1¼" NPT.

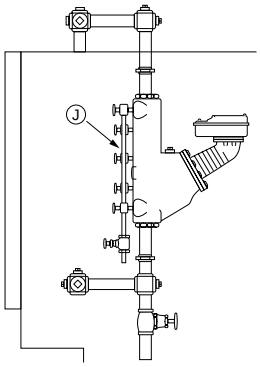


STEP 3 - Installing a Water Gauge Glass *(Required on all steam boilers)*

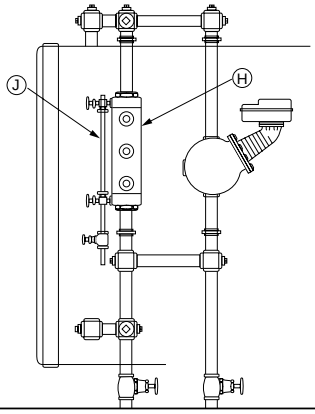
a. Install a water column (H) (not included with product) for all models except Series 157 and 157S (with integral water column).

b. Install a water gauge glass (J).
Note: Gauge glass and tri-cocks not included with product.

Series 157 and 157S



All Other Models



STEP 4 - Electrical Wiring

⚠ WARNING

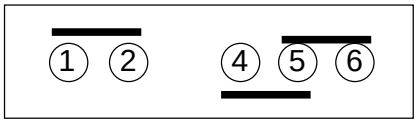
- **To prevent a fire, do not use this product to switch currents over 7.4A, 1/3 Hp at 120 VAC or 3.7A, 1/3 Hp at 240 VAC, unless a starter or relay is used in conjunction with it.**
- **To prevent electrical shock, turn off the electrical power before making electrical connections.**
- **This low water cut-off must be installed in series with all other limit and operating controls installed on the boiler. After installation, check for proper operation of all of the limit and operating controls, before leaving the site.**
- **Modification of the switch assembly before or after installation could cause damage to the boiler and/or boiler system.**

Failure to follow this warning could cause electrical shock, an explosion and/or a fire, which could result in property damage, personal injury or death.

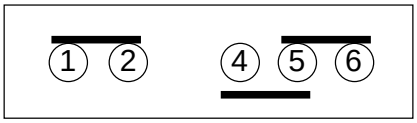
Switch Operation

For all Models except 158/158S and 159/159S

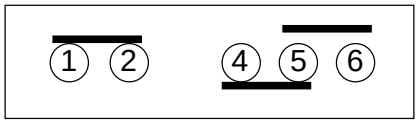
Boiler feed pump off, burner on, alarm off.



Boiler feed pump on, burner on, alarm off.

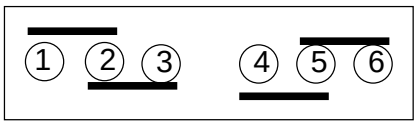


Boiler feed pump on, burner off, alarm on.

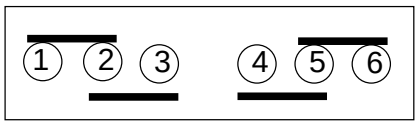


For Models 158 and 158S

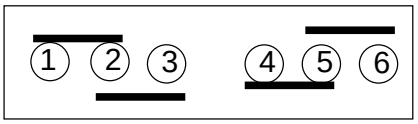
Motorized valve closed, burner on, alarm off.



Motorized valve open, burner on, alarm off.

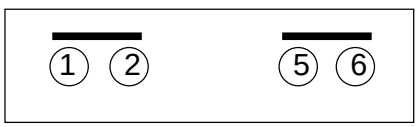


Motorized valve open, burner off, alarm on.

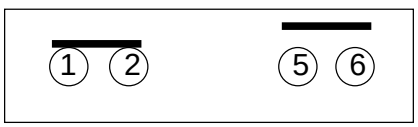


For Models 159 and 159S

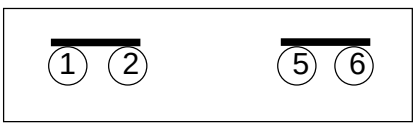
Pump #1 off, pump #2 off.



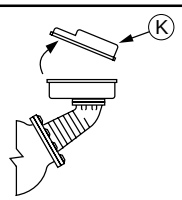
Pump #1 on, pump #2 off.



Pump #1 on, pump #2 on.



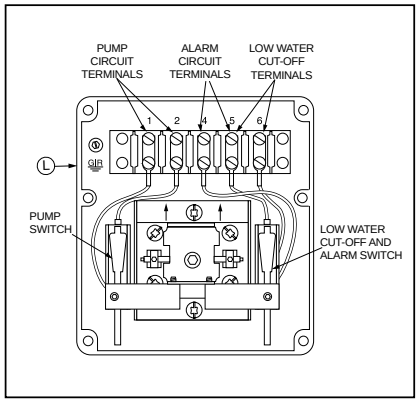
a. Using a flathead screwdriver, remove the junction box cover (K).



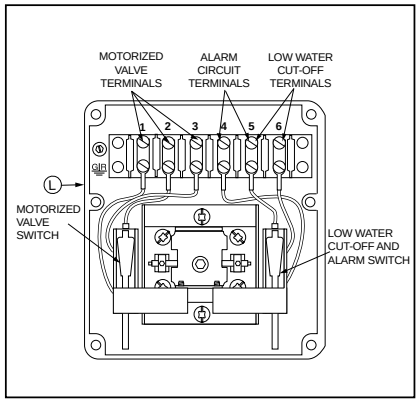
b. Following the appropriate wiring diagram, (refer to page 9) based on your application requirements, and using BX armored cable or Thinwall electrical metal tubing connector fittings, make electrical connections to the junction box (L).

IMPORTANT: There must be a minimum space of 1/2" (13mm) between connector fittings and electrical live metal parts.

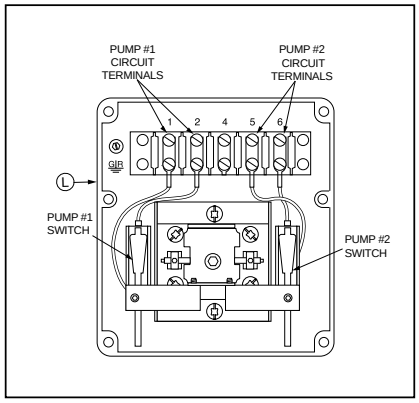
Snap Switches (Series 150S and 157S)



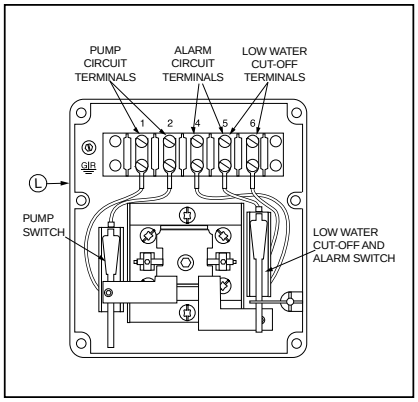
Automatic Reset (All models except 158S and 159S)



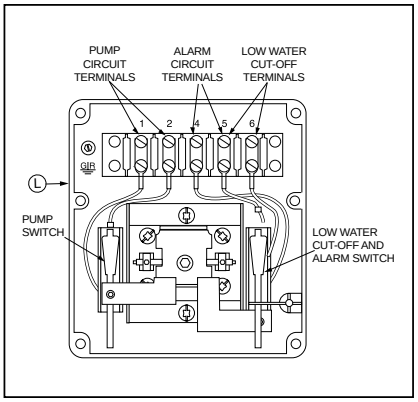
Automatic Reset Model 158S



Automatic Reset Model 159S

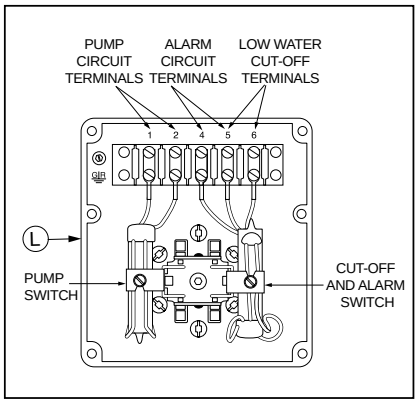


Manual Reset (All models except 158S)

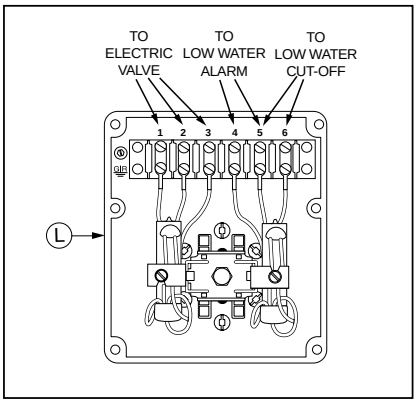


Manual Reset Model 158S-M

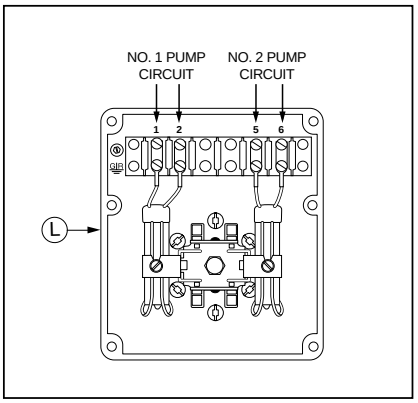
Mercury Switches (Series 150 and 157)



(All models except 158 and 159)



Model 158



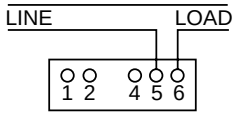
Model 159

WIRING DIAGRAMS

For Motorized Valves, refer to the valve manufacturer's wiring instructions.

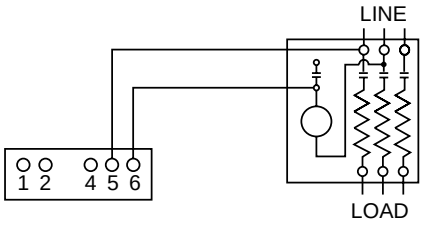
Low Water Cut-Off Only

1. Main Line Switch - For burner circuits within the switch's electrical rating.



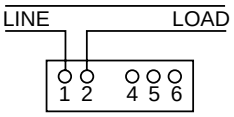
OR

2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch's electrical rating.



Pump Control Only

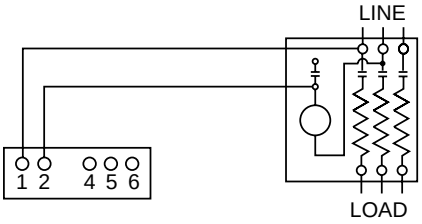
1. Main Line Switch - For pump motors within the switch's electrical rating.



Note: For Models 159 and 159S, use terminals 5 and 6 for pump #2.

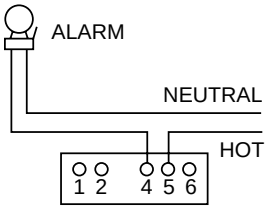
OR

2. Pilot Switch - To holding coil of a starter when the pump circuit exceeds the switch's electrical rating.



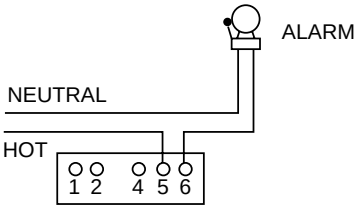
Alarm Circuit Only

1. Low Water Alarm



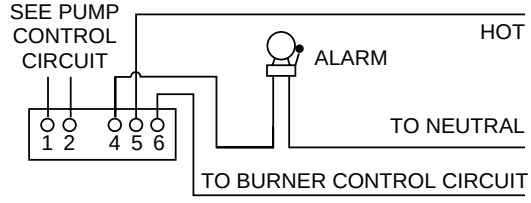
OR

2. High Water Alarm



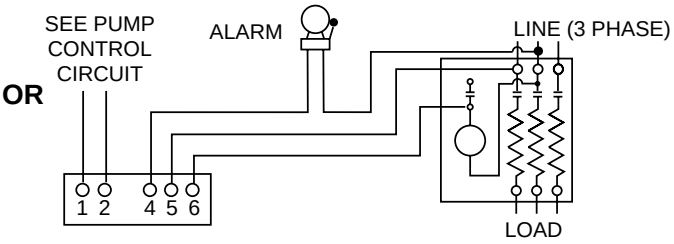
Combination Pump Control, Low Water Cut-Off and Alarm

1. Main Line Switch - For burner circuits within the switch's electrical rating.



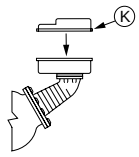
OR

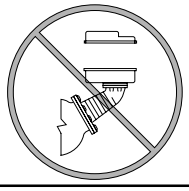
2. Pilot Switch - To holding coil of a starter when the burner circuit exceeds the switch's electrical rating.



6. Re-attach the junction box cover (K).

Note:
Cover must be installed correctly as shown



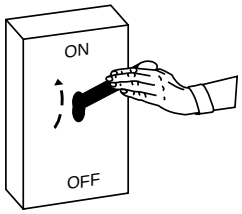


STEP 5 - Testing

This control is factory calibrated for specific applications. The following testing procedure is only meant to serve as a verification of proper operating sequence.
Dimensions provided are typical for a boiler not being fired and/or not at pressure. Actual operating ranges are shown on page 2 in the "Operation" section.

IMPORTANT: Follow the boiler manufacturer's start-up and operating instructions along with all applicable codes and ordinances. **Note:** Water levels stated below are only for 150 psi (10.5 kg/cm^2) operation.

a. Turn on the electric power to the boiler. With the boiler empty the pump should go on and the burner must remain off.



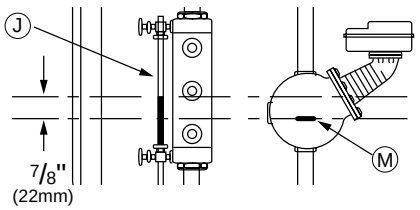
⚠ WARNING

If the burner comes on, immediately turn the boiler off and make the necessary corrections.

Failure to follow this warning could cause an explosion or fire and result in property damage, personal injury or death.

b. The boiler should begin to fill with water. Watch the gauge glass (J) until the water level reaches approximately ⅞" (22mm) above the horizontal cast line (M) on the low water cut-off.

IMPORTANT: If water does not start filling the boiler, immediately turn off the the boiler and make the necessary corrections.

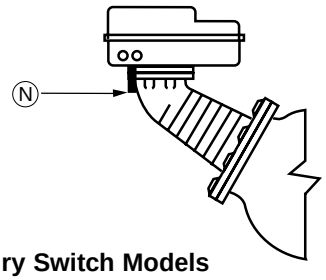


c. For automatic reset models only. When the water level reaches approximately 7/8" (22mm) above the horizontal cast line (lower for MD models) the burner should come on (pump #2 should shut off with Models 159 and 159S).

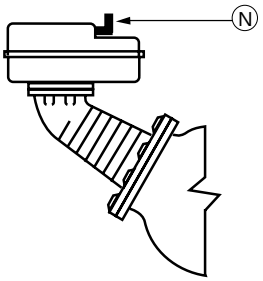
OR

For manual reset models only. When the water level reaches approximately 7/8" (22mm) above the horizontal cast line press the reset button (N). The burner should then come on.

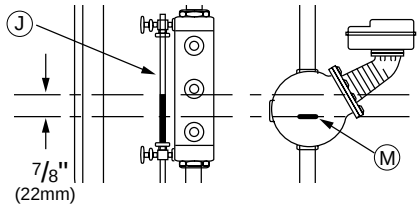
Snap Switch Models



Mercury Switch Models



d. Continue watching the gauge glass (J) to see that the water continues to rise to approximately 1 3/8" (35mm) (1 7/16" (37mm) for MD models) above the horizontal cast line (M). The pump should shut off (the motorized valve should close with Models 158 and 158S, or with Models 159 and 159S, pump #1 should shut off).



⚠ CAUTION

To prevent serious personal injury from steam pipe blow down, connect a pipe to avoid exposure to steam discharge.

Failure to follow this caution could cause personal injury.

e. Blow down the control when the water in the boiler is at its normal level and the burner is on. Follow Blow Down Procedure found in Maintenance Section on the last page of these instructions.

INSTALLATION COMPLETE

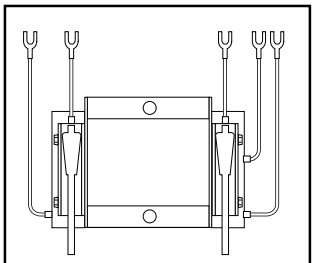
MAINTENANCE

SCHEDULE:

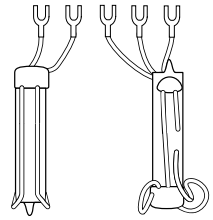
- **Blow down control as follows when boiler is in operation.**
  - **– Daily if operating pressure is above 15 psi.**
  - **– Weekly if operating pressure is below 15 psi.**

NOTE
More frequent blow-down may be necessary due to dirty boiler water and/or local codes.

- **Disassemble and inspect annually. Replace the low water cut-off/pump controller if it is worn, corroded, or if components no longer operate properly.**
- **Inspect the float chamber and equalizing piping annually. Remove all sediment and debris.**
- **Replace head mechanism every 5 years.** More frequent replacement may be required when severe conditions exist such as rapid switch cycling, surging water levels, and use of water treatment chemicals.
- **We recommend head mechanism replacement when the switch(es) no longer operate properly.** If you choose to replace the switch(es), order the proper McDonnell & Miller replacement switch or switch assembly and follow the Repair Procedure provided.



Replacement Switch Assembly



2-Wire Pump **3-Wire Burner**

Replacement Mercury Tubes

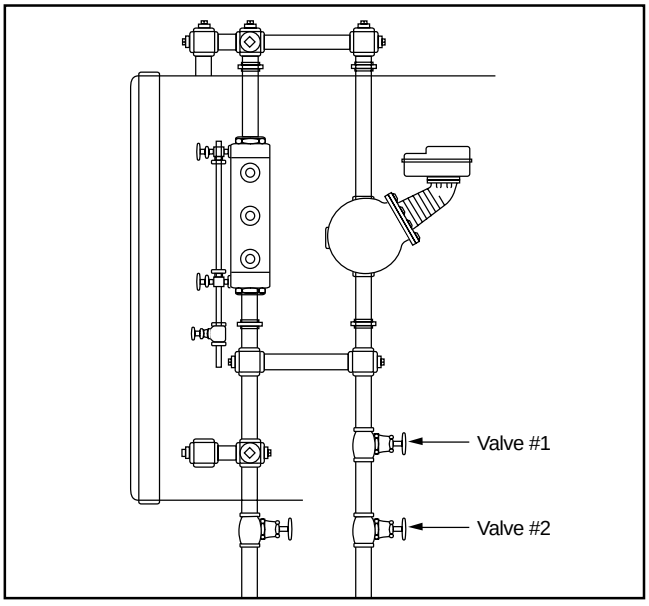
⚠ CAUTION
Snap switches must be replaced as an assembly.

BLOW DOWN PROCEDURE:

⚠ CAUTION	
	**To prevent serious personal injury from steam pipe blow down, connect a drain pipe to the control opening to avoid exposure to steam discharge.** **Failure to follow this caution could cause personal injury.**

Blow down the control when the water in the boiler is at its normal level and the burner is on. **Slowly** open the upper then the lower blow-down valves and observe the water level fall in the sight glass. Close the valves (lower first then upper) after verifying that the pump contacts have closed and the burner shuts off. If this does not happen, immediately shut off the boiler, correct the problem and retest.

For Models 158 and 158S, close the blow down valve after the motorized valve opens and the burner shuts off. For Models 159 and 159S, close the blow down valve after both pumps come on. If this does not happen, immediately shut off the boiler and correct the problem.



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Form 261
Sheet P/N 100204-1
Rev. H

Warrick® Series 26M Controls

Installation and Operation Bulletin

This bulletin should be used by experienced personnel as a guide to the installation of series 26M controls. Selection or installation of equipment should always be accompanied by competent technical assistance. We encourage you to contact Gems Sensors or its local representative if further information is required.

Specifications

Control Design: Solid State components enclosed in clear lexan plug-in style housing. Housing carries no NEMA ratings.

Contact Design: SPDT (1 form C): One normally open (N.O.) and one normally closed (N.C.) powered contacts.

Contact Ratings: 10 A @ 120,240 VAC resistive (120°F), 1A @ 120, 240 VAC resistive (150°F), 1/3 H.P. @ 120, 240 VAC (120°F)

Contact Life: Mechanical- 5 million operations Electrical- 100,000 operations minimum at rated load.

Supply Voltage: 120, 240 or 24 VAC models: +10% -15% 50/60 Hz. 208/240 model: 187 Vmin to 255 Vmax. VAC 50/60Hz

Supply Current: Relay energized at 4.4 VA

Secondary Circuit: 12 VAC RMS Voltage on probes. 1.5 milli-amp Current.

Sensitivity: Models operate from 4.7K to 100K maximum specific resistance.

Temperature: -40 TO 150°F ambient

Terminals: All connections #6-32 screw type terminals with pressure clamps.

Time Delays: Standard – LLCO probe, 3 seconds standard for lowering level.

Listings: U.L. limit control recognition (353). 240 and 208 volt units are not U.L. limit control recognized.

Installation

1. Install octal socket in appropriate enclosure using two #6 or #8 metal screws.

1A. Install rail mount socket on appropriate rail (DIN mount) in appropriate enclosure if applicable.

2. Wire control per wiring diagram, following N.E.C. and local codes

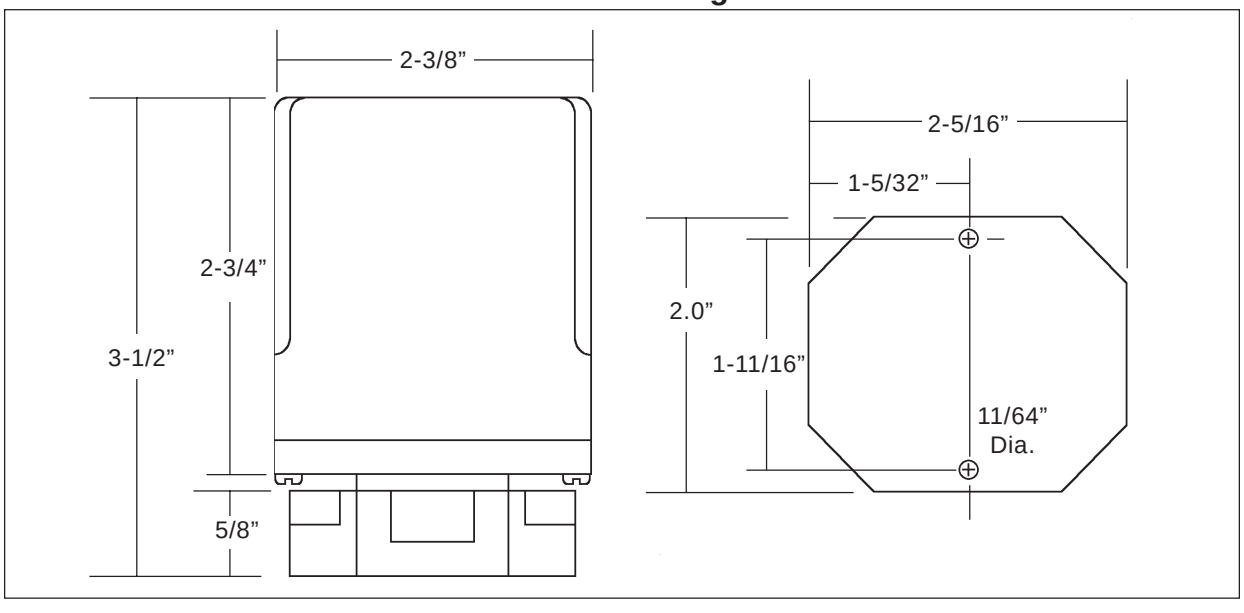
3. Install control module in socket.

Sensitivities vs Maximum Probe Wire Distance*

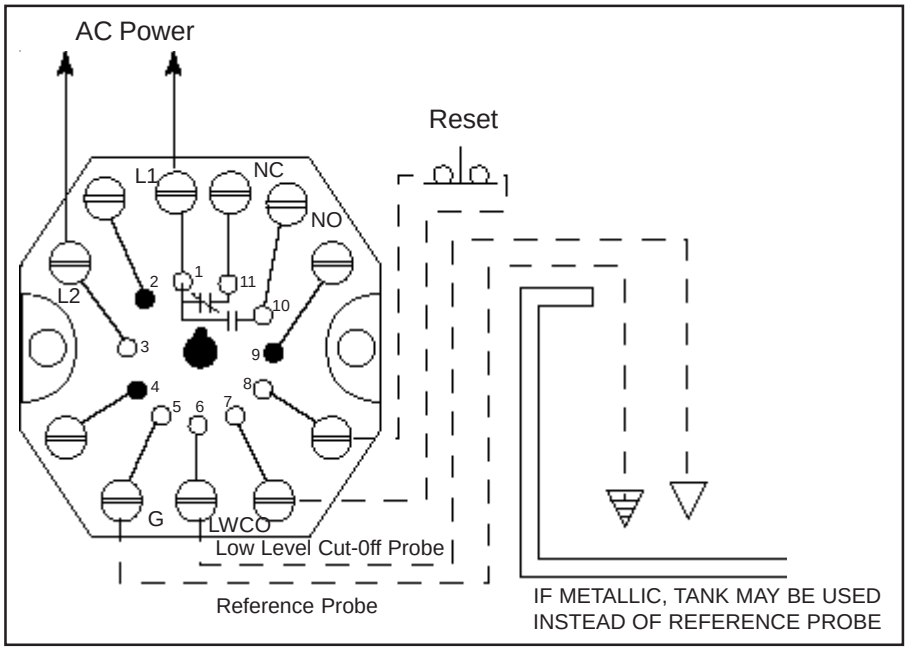
SENSITIVITY CHARACTER	SENSITIVITY (KOHMS)	DISTANCE (FT)
A	4.7	900
B	10	600
C	26	250
D	50	100
E	100	50

* Based on type MTW or THHN wire, #14 or #16 Awg

Dimensional Diagram



Wiring Diagram



Options:

Automatic Reset: (Reset terminals not used): When the liquid rises to the electrode on terminal 6, the control energizes, changing state of the load contacts. (LED will be lit) The control remains energized until the liquid level recedes below electrode on terminal 6. The control then de-energizes, (LED will not be lit) returning load contacts to original state. Unless otherwise specified, there is a three second time delay on decreasing level. Liquid must be below probe on terminal 6 for a full three seconds before control de-energizes.

Manual Reset : (Normally closed pushbutton installed across terminals #7 and #8): When the liquid rises to the electrode on terminal 6, the control will remain de-energized until the pushbutton is depressed. The control will then energize, (LED will be lit) changing the state of the contacts. The control remains energized until the liquid level recedes below electrode on terminal 6. The control then de-energizes, (LED will not be lit) returning load contacts to their original state. Unless otherwise specified, there is a three second time delay on decreasing level. Liquid must be below probe on terminal 6 for full three seconds before control de-energizes.

Manual Reset with Optional Power Outage Feature: (Normally closed pushbutton across reset terminals) Control will ignore power loss to control. With liquid above electrode on terminal 6, a power outage will cause the control to de-energize, but will automatically energize upon return of power. However, loss of liquid will cause control to de-energize and remain so until liquid again rises to electrode and pushbutton is depressed.

Dirty Electrode Detection: The LED will flash every half-second once the probe resistance reaches a value greater than the nominal control sensitivity rating. The relay state will not change until it exceeds the nominal sensitivity by more than 25% (typically) at nominal input voltage. At which time the LED and relay contact return to the dry state. Such a condition may suggest electrode maintance is required.

Test Feature Allows LLCO circuit to be tested. Holding down the reset button for 3 seconds will allow the LLCO circuit to trip which simulates the loss of water, without the need of draining the water level in the boiler. The control will return to normal operation once the reset button is pressed a second time.

26M X X X X X XX XX X

- **Dirty Probe:** Blank = No Dirty Probe, A = With Dirty Probe
- **Time Delay Increasing Level:** 00-90 seconds. Blank = 0 seconds
- **Time Delay Decreasing Level:** 03-90 seconds. Blank = 3 seconds
- **Optional Character:** Optional character chart
- **Enclosure:** 0=None, 1=NEMA 1, 4=NEMA 4
- **Socket Style:** A=11 Pin Octal, B=DIN mount, M=None,module only
- **Supply Voltage:** 1=120VAC, 2=240VAC, 3=24VAC, 8=208/240VAC
- **Sensitivity :** A=4.7K, B=10K, C=26K, D=50K, E=100K

Optional Character Chart

	N.C. Pushbutton	Power Outage	Test Feature
A	X	X	X
B			X
C	X		
E		X	
F	X	X	
Y	X		X
Z		X	X
X	No Option		

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