PATTERSON-KELLEY

THERMIFIC®

MODU-FIRE® GAS-FIRED BOILER

Supplement to the standard Installation and Owner's Manual (TBIG - Latest Edition)

C.S.A Design-Certified
Complies with ANSI Z21.13/CSA 4.9
Gas-Fired Low Pressure Steam and Hot Water Boilers

ASME Code, Section IV
Certified by Patterson-Kelley

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Gas-Fired Low Pressure Steam and Hot Water Boilers

Installation Date: _____

Patterson-Kelley
Harsco

100 Burson Street, P.O. Box 458,
East Stroudsburg, PA 18301
Telephone: (877) 728-5351, Facsimile: (570) 476-7247
www.pkboilers.com

1.0 INTRODUCTION

The P-K MODU-FIRE® Gas Fired Boiler is a revolutionary advance; Patterson-Kelley now combines full-modulation burner control with our time-tested modular hot water boiler design. The result is "modular full-modulation"- Modu-Fire! This new hybrid boiler combines the best of our earlier designs with a generation of burner and control technology. You will achieve even higher part load efficiencies – but without the complexity you might expect in this type of high performance boiler. High performance made simple and dependable for years of trouble-free operation.

This manual covers installation of the P-K MODU-FIRE® Boiler Series 1000, 1500, and 2000. The model numbers may be followed by a prefix or suffix letter in some cases to indicate special features or different options. While details may differ slightly, basic operation is the same for all models. Boilers are built to operate with natural gas. Check the rating plate for the correct gas flow rate.

The boiler is only a part of the complete heating system. This boiler may be fully operational and yet because of poor circulation, controls, or other operating characteristics, not deliver heat to the desired location. Additional equipment such as temperature sensors, pumps, flow switches, balancing valves and check valves will be required for satisfactory operation of any system. Patterson-Kelley cannot be responsible for the design or operation of such systems and a qualified engineer or contractor must be consulted.

2.0 SAFETY

(Refer To TBIG Latest Edition)

2.1 GENERAL

(Refer To TBIG Latest Edition)

2.2 TRAINING

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2.3 SAFETY FEATURES

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2.5.1 Electrical Hazards

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2.5.2 Burn, Fire, and Explosion Hazards

(Refer To TBIG Latest Edition)

2.5.3 Crush Hazards

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2.5.4 Chemical Hazards

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2.5.5 Pressure Hazards

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2.5.6 Slip, Fall Hazards

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3.0 INSTALLATION

(Refer To TBIG Latest Edition)

3.1 RECEIVING AND STORAGE

(Refer To TBIG Latest Edition)

3.1.1 Initial Inspection

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3.2 COMPLIANCE WITH CODES

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3.3.1 Foundation

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(Refer To TBIG Latest Edition)

3.4 ELECTRICAL CONNECTIONS

(Refer To TBIG Latest Edition)

3.5 COMBUSTION AIR

(Refer To TBIG Latest Edition)

3.6 FLUE VENTING

For boilers connected to gas vents or chimneys, vent installations shall be in accordance with Part 7, Venting of Equipment, of the National Fuel Gas Code, ANSI Z223.1, or applicable provisions of the local building codes.

This boiler is Category II as it is defined in ANSI Z21.13/CSA 4.9 latest edition.

In Canada, the boiler is certified for installation with a “Power Venter” by the Canadian Gas Association when installed with the “listed accessories.” Consult your local distributor for information on proper selection. The venting system and the horizontal portions of the venting system shall be supported to prevent sagging.

Consult your local vent supplier for correct vent sizing and structural support requirements. Vent diameter is dictated by the length and height of horizontal and vertical portions of the vent installation and the materials of construction. Correct sizing should be based on High fire input at a nominal -.04" W.C. draft pressure at the boiler outlet with a gross stack temp of 325º F and CO_2 ratings at 7.5%.

3.6.1 Vent Elbows

(Refer To TBIG Latest Edition)

3.6.2 Barometric Damper

This boiler is certified for operation without a barometric damper. However, some venting installations may require a barometric damper for excessive draft conditions. (Not supplied by factory.)

3.6.3 Barometric Damper Location

(Refer To TBIG Latest Edition)

3.6.4 Flue Connection

(Refer To TBIG Latest Edition)

3.6.5 Vent Termination

(Refer To TBIG Latest Edition)

3.6.6 Removing an Existing Boiler

(Refer To TBIG Latest Edition)

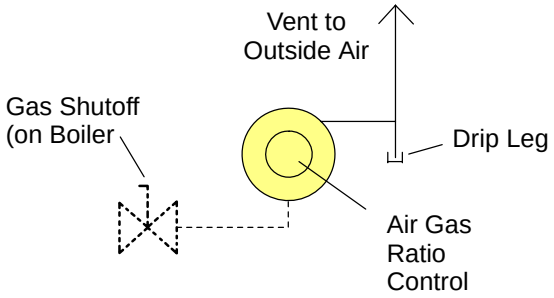
3.7 GAS PIPING

(Refer To TBIG Latest Edition)

3.7.1 Gas Supply Piping by Installer

(Refer To TBIG Latest Edition)

3.7.2 Gas Bleeds and Vents



Gas Bleeds and Vents

If your unit is equipped with a diaphragm gas valve, the bleed line must be vented to the outdoors.

Maintain size of vent line consistent with vent connection size.

Gas vents to outdoor air must be provided for the Air Gas Ratio Control (AGRC). This connection is labeled COMBUSTION/ATMOSPHERE. The pilot regulator is equipped with a vent limiting device and does not require external venting!

Gas Vents by Installer

Note: Provide a drip leg, as shown, in the vent line. All vent lines should be pitched up at all times to prevent building a trap into the vent line.

Note: The vent line connection on the Air Gas Ratio Control must be piped to outdoor air by the installer in accordance with the National Fuel Gas Code ANSI Z223.1, latest edition, Sections 2.8.4 and 2.9.7.

If a N.O. (normally open) vent valve is provided, it must be vented independently of any other bleeds and vents. Discharge of vent lines should be protected by an insect screen.

3.8 Boiler Water Piping

(Refer To TBIG Latest Edition)

3.8.1 Piping Design

(Refer To TBIG Latest Edition)

3.8.2 Boiler Inlet and Outlet Connections

(Refer To TBIG Latest Edition)

3.8.3 Boiler Water Piping by Installer

(Refer To TBIG Latest Edition)

3.8.4 Flushing and Filling

(Refer To TBIG Latest Edition)

3.9 Burner and Ignition System

(Refer To TBIG Latest Edition)

3.9.1 Inspection

(Refer To TBIG Latest Edition)

3.10 Pre-Start Check List

(Refer To TBIG Latest Edition)

3.11 Safety Checks

The following checks of safety systems must be made before putting the boiler into normal operation.

Before firing the boiler refer to Sections 4.1 and 4.2 for information on the use of the controls, lighting, and shut-down procedures.

WARNING!

Never attempt to operate a boiler that has failed to pass all the safety checks described below.

WARNING!

After checking controls by manual adjustment, make sure they are always reset to their proper settings.

3.11.1 Test of Ignition Safety System

Test the ignition system safety shutoff as follows:

1. Close downstream gas cock.

2. With the main gas cock (inlet manual gas valve) open and the pilot gas cock open, the burner should be cycled on. After all the safety limits on gas pressure, water flow and temperature are satisfied, the blower will run and pre-purge the boiler.
3. When air flow is established, the ignition transformer and pilot will operate. Both functions will be indicated by separate green lights on the flame safeguard.
4. If a satisfactory pilot is established, the spark will terminate and the pilot will remain on, alone, for 10 seconds.
5. After 10 seconds, the green "Main" light on the flame safeguard will go on; gas will not flow since the downstream cock is closed. The "Pilot" will remain on, along with the "Main Gas", for another 10 seconds and then go out. Since the gas cock is closed, at this point there will be no main flame signal and the flame safeguard programmer will assume a "Flame Failure" and go to a "lockout" mode. Lockout will require manual reset of the flame safeguard. After completing this test, turn off the boiler and reopen the downstream gas cock.

3.11.2 Test of Low Water Cut-off

(Refer To TBIG Latest Edition)

3.11.3 Test of High-Limit Control

Fire the boiler and test the high limit control as follows:

With the main burner operating, turn down the temperature setting on the "high-limit" thermostat until the main burner shuts off. The high-limit switch must be manually reset after testing. This check should also be made for the "Operating Temperature" control (the green "Heat" indicator will go out) (see next section for Modulating Units). Readjust thermostats to desired operating temperature and set high-limit temperature, typically 20º F above operating temperature.

3.11.4 Test of Gas Pressure Switch

(Refer To TBIG Latest Edition)

3.12 INITIAL ADJUSTMENTS

3.12.1A – Configuring the Controller

Operating Modes:

- Internal Setpoint
- Night Setback
- Outdoor Air Reset
- Analog Input Setpoint (See Section 3.12.1B.)
- Analog Input Direct Drive (Multiple boiler Controls)

Definitions:

SP1- Setpoint 1: ..... This is the primary setpoint of the boiler.

SP2- Setpoint 2 : ..... An alternate setpoint. Available through the night setback contact.

dSP- Differential Setpoint : .. An alternate setpoint differential from SP1. Available through the night setback contact.

tA- Air temperature: ..... Measurement of outside air temperature.

SP.E- External Setpoint: ..... Measurement of the external setpoint.

HyS1: ..... Low temperature differential.

HyS3: ..... High temperature differential.

Internal Setpoint

The boiler water outlet temperature is controlled to SP1 (setpoint 1) and the boiler modulates to maintain SP1 subject to the upper and lower temperature differentials and the upper and lower setpoint limit.

For example, assume the following settings:

ITEM	DISPLAY	VALUE
SETPOINT 1	SP1	160
LOW TEMP DIFFERENTIAL	HyS1	-5
HIGH TEMP DIFFERENTIAL	HyS3	12
LOW TEMP SETPOINT	SPL	150
HIGH TEMP SETPOINT	SPH	195

The boiler will modulate to try to maintain 160 °F. If the temperature increases to 172 °F which is Setpoint 1 (SP1) **160** + High Temp Differential (HyS3) **12**, it will shut off. Once it shuts off, it will not restart until the temperature drops to 155 °F which is Setpoint 1 (SP1) **160** + Low Temp Differential (Hys1) **-5**. The Low Temp Setpoint (SPL) prevents the operator from setting Setpoint 1 (SP1) lower than Low Temp Setpoint (SPL) **150**. The High Temp Setpoint (SPH) prevents the operator from setting Setpoint 1 (SP1) higher than the High Temp Setpoint (SPH) **195**.

Alternate Setpoint

The control must be configured for night setback. (See the configuration menu.) When the Alternate Setpoint contact is closed the boiler switches to its alternate setpoint.

The alternate setpoint can be determined by several different values. It can be a fixed alternate setpoint SP2. It can be a fixed differential from SP1 called dsP. dsP will "offset" the main setpoint SP1 by the value of dsP. dsP can be positive or negative.

The Alternate Setpoint can also be determined by an external analog source such as a 4-20 mA signal.

Outdoor Air Reset

The control must be configured for outdoor air reset. (See the configuration menu.)

The setpoint of the boiler is controlled by an outdoor temperature sensor. As the outdoor temperature falls the setpoint of the boiler is increased.

The boiler modulates to maintain this setpoint. The boiler functions as indicated in internal setpoint; however SP1 is determined by the outdoor air temperature.

The setpoint SP1 is reset using a linear relationship with outdoor air temperature. As the outdoor air temperature drops the setpoint SP1 is increased a proportional amount. This increase is determined by the Heating Slope H. (See Table 1 at the end of this section.) For example if H is set at 1 then for every degree the outdoor air temp drops, the setpoint SP1 will increase 1 degree.

This heating curve has a reference temperature of 68°. This reference can be offset using the Parallel shift parameter P. (See Table 1 at the end of this section.) If P is set to 0 the setpoint SP1 will be 68° when the outdoor temp is 68°. If P is set to 10, the setpoint SP1 will be 78° when the outdoor temp is 68°. The minimum setpoint of the boiler is limited by the control. In the above example the actual setpoint SP1 of the boiler will not go below 150°.

Analog Input Setpoint

The control must be configured for external setpoint. (See the configuration menu.)

The setpoint of the boiler is controlled by an external signal. The boiler functions as described with the internal setpoint, using the value determined by the external analog signal.

Analog Input Direct Drive

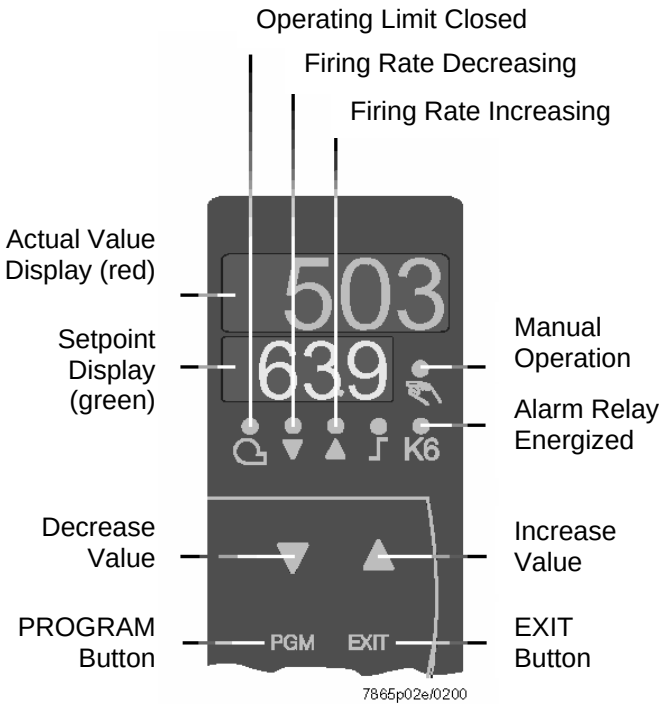
The firing rate of the boiler is controlled by an external analog signal, usually from a multiple

boiler control. The boiler turns on and off as directed by the external control.

An operating limit control ensures that the boiler temperature does not exceed the set value.

Refer also to Section 3.12.1B.

Use of the Controller



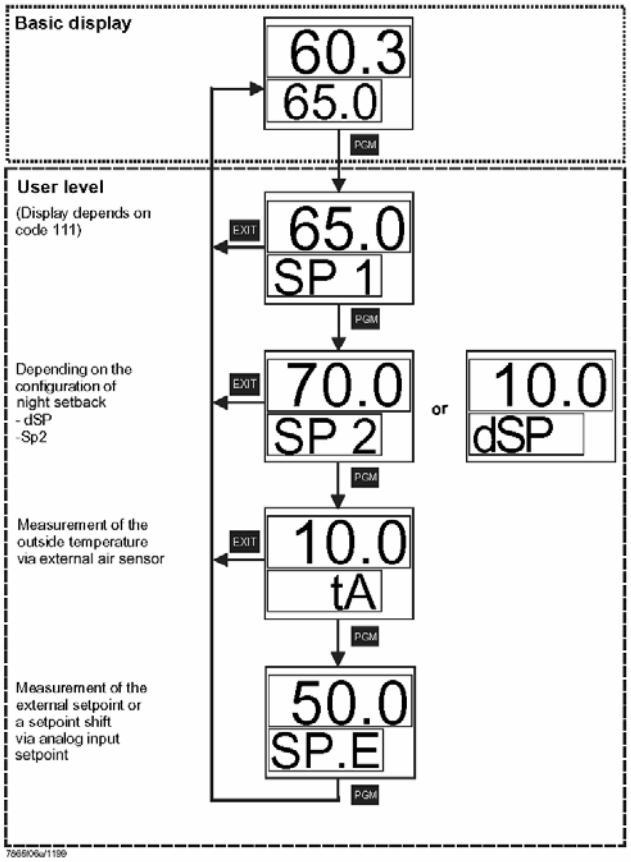
The diagram shows the RWF40 after switching on power. This condition is called the basic display. The actual value and the currently active setpoint are shown here. Manual operation, self-setting, and the user, parameter, and configuration levels can be activated from here.

Operation of the Control:

The temperature control has three levels of cascading menus. They are:

- **USER** level,
- **PARAMETER** level, and the
- **CONFIGURATION** level.

The following table indicates the menu options available from each level. The options available depend on the operating mode of the boiler.



User Level:

- To access the **User** level from the basic display press **PGM**.
- Change the setpoint **SP1** with ↑ or ↓.
- Change to setpoint **SP2** or **dSP** with **PGM.**
- Change the setpoint **SP2** or **dSP** with ↑ or ↓.
- Return to the basic display with **EXIT.**

Manual Operation of the Boiler

The boiler firing rate can be controlled manually.

- To change to manual operation press **EXIT** for 5 seconds.
- The LED above the hand symbol lights up.

- Change the firing rate of the boiler with ↑ or ↓.
- The firing rate increases as long as ↑ is pressed.
- The firing rate decreases as long as ↓ is pressed.

  LED's on the control indicate if the firing rate is increasing or decreasing.
- To change back to automatic operation press **EXIT** for 5 seconds.

Manual operation can only be activated if the burner relay is on. If the control sets the burner relay to off during manual operation, then the control is changed to automatic operation.

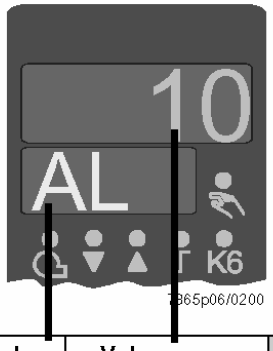
Parameter Level:

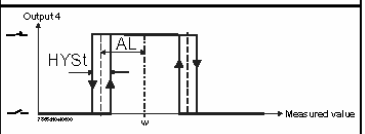
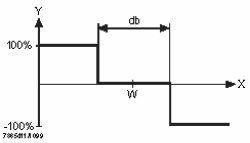
The parameters available in this level are used for proper functioning of the boiler with the system.

Within the parameter level you can go to the next parameter by pressing **PGM.** (Must be held for 2 seconds.)

The parameters and their functions are listed in Table 1 on the following page. The actual parameters available depend on the configuration of the control.

Table 1 - Table of Parameters



Parameter	Display	Value range	Factory setting	Remarks
Setpoint range alarm value [1]	**AL**	-1999...+9999 digit	0	 ⇨ «**C112** – limit comparator, controller type, setpoint «SP1», locking»
Alarm hysterisis [1]	**HYSt**	0.1..999.9 digit	1	Switching differential at the edges for the limit comparators ⇨ «**C112** – limit comparator, controller type, setpoint «SP1», locking»
Proportional band [1]	**Pb.1**	0.1...999.9 digit	10	Affects the P-response of the controller
Derivative time	**dt**	0...9999 sec	80	Affects the D-response of the controller. Within dt = 0, the controller has no D-response.
Integral action time	**rt**	0...9999 sec	350	Affects the I-response of the controller. With rt = 0, the controller has no I-response
Contact spacing (dead band) [1]	**db**	0...999.9 digit	1	For floating output 
Actuator running time	**tt**	10...3000 sec	15 sec	Stroke time of the actuator
Switch-on burner [1]	**H Y S 1**	0...-199.9 digit	-5	⇨ Boiler turns on when the temperature of HYS 1 is below the setpoint.
Unused	**H Y S 2**	0...HYS3 digit	3	Unused
Switch-off [1]	**H Y S 3**	0...999.9 digit	5	⇨ Section 5.2 «High-fire operation»
Response threshold	**q**	0...999.9	0	⇨ Section 5.6 «Response threshold Q»
Slope for outdoor air reset	**H**	0...4	1	⇨ Section 5.5.1 «Heating curve slope»
Offset for outdoor air reset [1]	**P**	-90...+90	0	⇨ Section 5.5 «Weather-dependent setpoint shift»

[1] This parameter is affected by the setting of the decimal place.

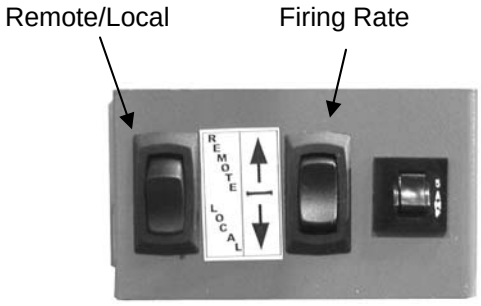
Configuration Level:

The configuration level is used to set up the control for the sensors used, and the functioning of the alarm relay. The configuration level must be adjusted by a qualified factory authorized personnel only.

3.12.1B Remote/Local Switch

The firing rate of the boiler is controlled by an external analog signal, usually from a multiple boiler control. The boiler turns on and off as directed by the external control.

An operating limit control ensures that the boiler temperature does not exceed the set value.



Remote/Local and Firing Rate Switches

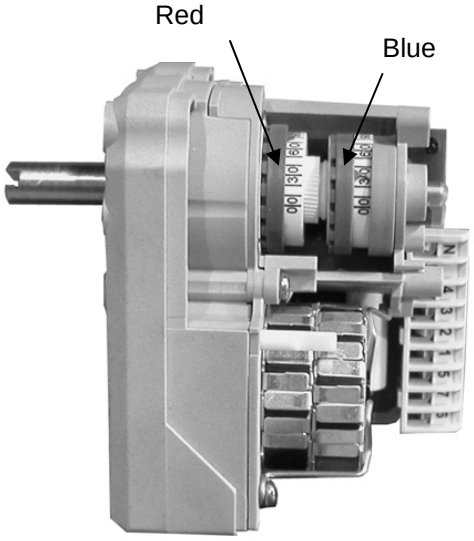
Local control of the boiler can be obtained by placing the Remote/Local switch in the local position. With the boiler in local mode, the up/down switch can be used to control the firing rate of the boiler. Pressing this switch in the up direction increases the firing rate. Placing this switch in the down position decreases the firing rate. Local control is used for setting up and testing the boiler.

3.12.2 Air Flow Adjustments

The air flow is pre-set at the factory prior to shipment. The air (and gas) may have to be adjusted for local conditions. All air flow adjustments must be performed by qualified service personnel.

The air and gas are adjusted at two firing rates: High fire and Low fire. The boiler modulates between these two rates to maintain a steady outlet temperature.

Fuel adjustments for proper fuel input are made first at High fire; then Low fire fuel adjustments are made at Low fire.



The air flow rates are adjusted by setting the end switches in the damper actuator. The red end switch sets the High fire position. The blue end switch sets the Low fire position. To set the position of the switch, rotate the colored wheel corresponding to either High fire or Low fire until it indicates the desired setting. Once the desired setting is set, move the damper to a mid position and then back to either low or High fire as desired.

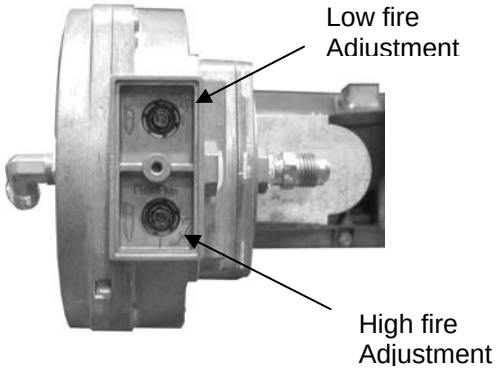
The red air flow cam should be set so that the plenum pressure at High fire is at or below that indicated on the rating plate for High fire. The blue cam should be set so that the plenum pressure at Low fire is at or above that indicated on the rating plate for Low fire.

The air plenum pressure at Low fire must be at least 0.3” W.C.

3.12.3 Gas Pressure Adjustment

See rating plate for the minimum and maximum gas pressure of the boiler. Each boiler is furnished with two plugged taps in the gas manifold for test gauge connections. One tap is located at the main gas

cock for measuring the gas supply pressure (1/4" IPS). The supply pressure during main burner operation must be greater than the minimum indicated on the rating plate (4 in. W.C. for natural gas.) The second tap is located downstream from the last main gas control at the elbow where the gas line enters the back of the cabinet and is for measuring the manifold gas pressure (1/8" I.P.S.)



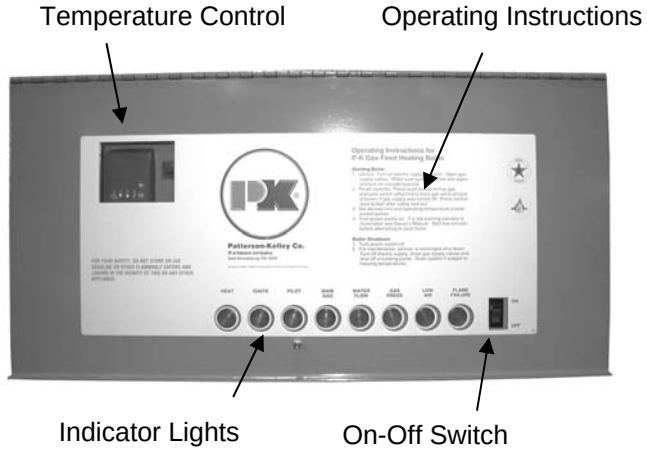
To adjust the gas pressure, remove the cover plate from the air / gas ratio control valve. Set the boiler at High fire as described in the boiler operation section of the manual. The High fire gas pressure is adjusted with the lower screw of the air / gas ratio control vale. Using combustion measurement equipment adjust the oxygen reading between 6.5% and 7.5%Set the boiler at Low fire as described in the boiler operation section of the manual. For initial adjustment the cabinet pressure should be the same as shown on the "Factory Firetest" label. The Low fire gas pressure is adjusted with the upper screw of the air / gas ratio control valve. Using combustion measurement equipment adjust the oxygen reading between 6.5% and 7.5%.

Run the firing rate up and down through the complete firing range and verify that the oxygen readings are within the proper range.

4.0 OPERATION

4.1 GENERAL

4.1.1 Control Panel Front

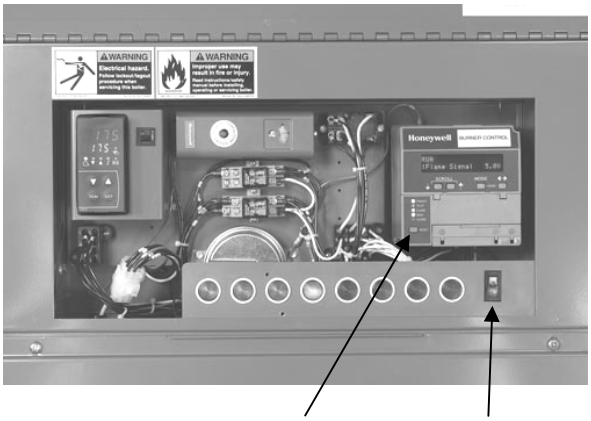


Become familiar with the basic operation of the boiler. The front of the control panel shows Operating Instructions and a series of illuminated green and amber (operating) and red (problem) indicator lights which show the condition of the boiler.

4.2 LIGHTING AND SHUT-DOWN PROCEDURES

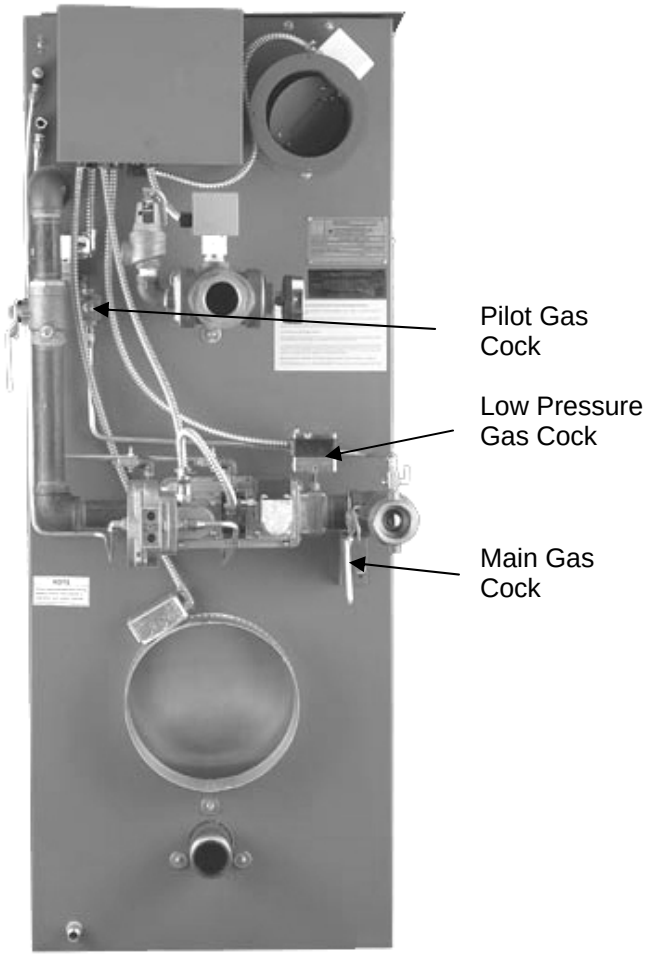
(Refer To TBIG Latest Edition)

4.2.1 Lighting Procedures



1. Close main and pilot gas cocks.
2. Turn On-Off switch to "OFF" position.
3. Wait 5 minutes.
4. Open main and pilot gas cocks.
5. Turn On-Off switch to "ON" position.
6. Push Reset button on flame safeguard programmer control.
7. Push Reset on low gas pressure switch (and high pressure gas switch if applicable.)
8. Check to be sure the pilot has been established.

The controller will now complete the automatic firing sequence.



4.2.2 Normal Shut Down Procedures

(Refer To TBIG Latest Edition)

4.2.3 Emergency Shut Off

(Refer To TBIG Latest Edition)

4.3 TYPICAL BOILER OPERATING CONDITIONS

Model No.	Input Rating (Btu/hr)	Natural Gas (1030 Btu/cu. Ft.)		
		Gas Rate (CFH)	Manifold Pressure (in. W.C.)	Output Capacity (Btu/Hr.)
1000	1,000,000	971	3.3 Max. 0.3 Min	850,000
1500	1,500,000	1,456	2.7 Max. 0.3 Min	1,275,000
2000	2,000,000	1,942	2.5 Max. 0.3 Min.	1,700,000

5.0 MAINTENANCE

5.1 MAINTENANCE AND INSPECTION SCHEDULE

CAUTION!

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.

Verify proper operation after servicing.

5.1.1 Daily

(Refer To TBIG Latest Edition)

5.1.2 Weekly

Observe the conditions of the pilot and main flame. A normal High fire flame is blue. If the flame is yellow, then corrective action must be taken. In Low fire the burner will glow a yellowish orange.

Correct air adjustment is essential to the efficient operation of this boiler. If an adjustment in the combustion is necessary, the flue gas composition should be checked with a carbon dioxide (CO_2) or oxygen (O_2) analyzer to set conditions. Refer to Section 3.12.2 and 3.12.3.

5.1.3 Monthly (During Operation)

(Refer To TBIG Latest Edition)

5.1.4 Semi-Annually

(Refer To TBIG Latest Edition)

5.1.5 Annually

(Refer To TBIG Latest Edition)

5.2 CLEANING THE BURNER

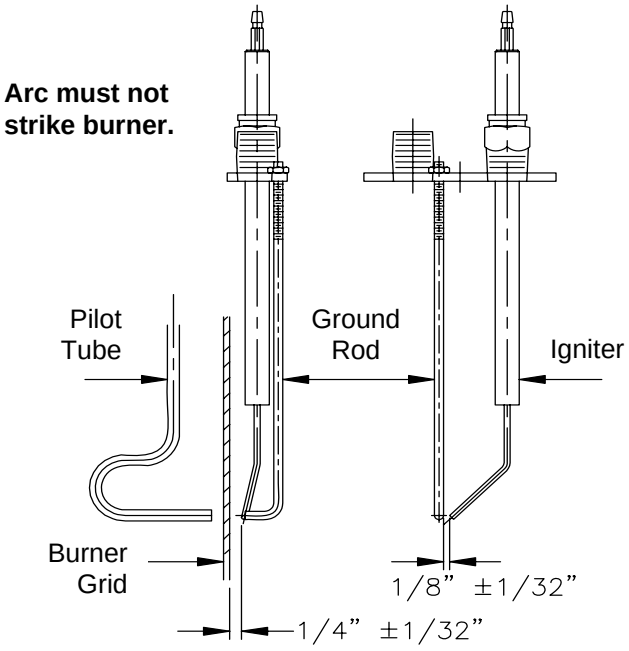
(Refer To TBIG Latest Edition)

5.2.1 Semi-Annual Cleaning

1. Remove mixer core.
2. Use low pressure air, Max. 20 psig inside the burner to remove any accumulated dust or lint build-up.

5.2.2 Annual Cleaning

1. Disconnect the union in the line at the burner.
2. Disconnect pilot and vent line, being careful not to disturb the position of the pilot.
3. Loosen and remove the four (4) hold down bolts and washers.
4. Carefully remove the burner.
5. Use low pressure air, max. 20 psig inside the burner to remove any accumulated dust or lint build-up.
6. Check that the ceramic portion of the ignition electrode is not cracked.



7. Check the position of the ignition electrode: 3/32" – 1/8" spark gap. Check the tightness of the electrode clamp.
8. Use a soft, clean cloth to remove accumulated contaminants from the UV radiation tube (UV scanner) glass envelope.

9. Before re-installing the burner, check the cleanliness of the heat exchanger and the condition of the combustion chamber.

5.3 REMOVING THE EXCHANGER

(Refer To TBIG Latest Edition)

5.4 AFTER ALL REPAIRS OR MAINTENANCE

(Refer To TBIG Latest Edition)

5.5 SEQUENCE OF OPERATION

5.5.1 STANDARD MODULATING

1. When the On/Off (Main power) switch is turned on, the switch illuminates. Power is provided to the flame safeguard control, the temperature control, and through normally closed contact of relay-1 to the damper close terminal. Power is also applied through the "start logic string" a series of normally closed switches, including water flow, gas pressure, high stack temp, high limit temperature, and operating temperature to the flame safeguard programmer.
2. The water flow limit switch is closed when there is adequate water flow through the boiler.

   Note: The closing of this switch does not prove that flow is adequate. Refer to Technical Data Sheet # TD110 for proper flow requirements.

3. When adequate gas pressure is available, the low gas pressure limit switch is closed. Manual reset is required following conditions resulting in low gas pressure.
4. When the temperature sensed by the high limit temperature control is below the set limit, the switch is closed. Manual reset is required following conditions exceeding high limit temperature.
5. When heat is required as indicated by the outlet water temperature, power is applied to Terminal 6 of the programmer, which initiates the burner ignition and operation sequence.
6. The programmer first energizes Terminal 4 which supplies power to the motor contactor, the damper motor limit switch, and normally open contact on relay-2. If the damper motor is open far enough for purge, the limit switch is made and relay 2 is energized. This supplies power to the air flow switch, which initially shows low air flow with the "LOW AIR" indicator. This indicator will remain on until sufficient air flow is sensed. If the damper motor is not open enough for purge, the limit switch is not made, relay 2 is not energized and the combustion sequence does not continue.
7. Once sufficient airflow is indicated by the air flow switch, Terminal 7 of the combustion control is energized. This starts the Prepurge period. The combustion chamber is Prepurged for 30 seconds.
8. A 10-second "trial for ignition" period is initiated with both Terminal 8 and 10 being energized. Terminal 10 of the combustion control powers the ignition transformer. The transformer output creates a spark at the igniter. Terminal 8 powers the pilot gas valve.
9. When a pilot flame is detected by the UV scanner a signal is sent to the combustion control. When this signal is detected, Terminal 10 of the combustion control is de-energized, terminating the spark.
10. After the 10 second "trial for ignition" period, if pilot flame has been established, Terminal 9 of the Combustion Control is energized. This opens the main gas valve and energizes the air gas ratio control. The 10 second Main trial for ignition" period begins. If pilot flame has not been established, the unit will lock out on pilot flame failure.
11. After the 10 second "main trial for ignition period" if flame has been established, Terminal 8 of the combustion control is de-energized, closing the pilot valve. Terminal 21 is energized, energizing Relay-1. If main flame has not been established, the unit will lock out on main flame failure.

12. Relay 1 bypasses the purge switch, removes power from the closed terminal of the damper motor, and releases the temperature control to modulate.
13. The unit modulates between the Low fire setting and the High fire setting to maintain the desired outlet water temp set point.
14. When the load is below the Low fire rating of the boiler, the boiler will continue firing and the outlet water temperature will rise until it reaches the operating limit setpoint. At this point the operating control switch opens and the combustion control is de-energized at Terminal 6 and the indicator for HEAT is turned off. This action also de-energizes Terminal 9 thus closing the main gas valve and the air gas ratio control valve. Relay-1 and 2 are de-energized which applies power to the close terminal of the air damper motor. The air damper closes.
15. When the water temperature is reduced by the load on the system, the operating control switch will close again. The operating sequence will recycle to step 5, provided the limits on water flow, gas pressure, and high temperature are all met.

5.5.2 IRI MODULATING

1. When the On/Off (Main power) switch is turned on, the switch illuminates. Power is provided to the flame safeguard control, the temperature control, and through the flame safeguard control to the damper close terminal. Power is also applied through the proof of closure switch on the air gas ratio control, and to the "start logic string" a series of normally closed switches, including water flow, gas pressure, high stack temp, high limit temperature, and operating temperature to the flame safeguard programmer.
2. The water flow limit switch is closed when there is water flow through the boiler.
3. When adequate gas pressure is available, the low gas pressure limit switch is closed. Manual reset is required following conditions resulting in low gas pressure.
4. When the temperature sensed by the high limit temperature control is below the set limit, the switch is closed. Manual reset is required following conditions exceeding high limit temperature.
5. When heat is required as indicated by the outlet water temperature, power is applied to Terminal 6 of the programmer, which initiates the burner ignition and operation sequence.
6. The flame safeguard control first energizes Terminal 5 which supplies power to the motor contactor for the blower motor and the air flow switch, which initially shows low air flow with the "Low Air "indicator. This indicator will remain on until sufficient air flow is sensed. Terminal 12 is also energized which drives the air damper to the open position. When the damper motor is at the full open position, the High fire limit switch is made which energizes the High fire switch input terminal 19 on the flame safeguard control.
7. Once sufficient airflow is indicated by the air flow switch, Terminal 7 of the flame safeguard control is energized. If the High fire switch and proof of closure switch are in the correct state, this starts the Prepurge period. The combustion chamber is Prepurged for 30 seconds.
8. When the Prepurge time period elapses the flame safeguard control energizes terminal 14, which drives the damper motor to the Low fire position.
9. When the damper motor is at the Low fire position, the Low fire limit switch is made, which energizes the Low fire switch input terminal 18 on the flame safeguard control. A 10-second "trial for ignition" period is initiated with both Terminal 8 and 10 being energized. Terminal 10 of the combustion control powers the ignition transformer. The transformer output creates a spark at the igniter. Terminal 8 powers the pilot gas valve.
10. When a pilot flame is detected by the UV scanner a signal is sent to the combustion control. When this signal is detected, Terminal 10 of the combustion control is de-energized terminating the spark.

11. After the 10 second "trial for ignition" period, if pilot flame has been established, Terminal 9 of the Combustion Control is energized. This opens the main gas valve and energizes the air gas ratio control. The 10 second Main trial for ignition" period begins. If pilot flame has not been established, the unit will lock out on pilot flame failure.
12. After the 10 second "main trial for ignition period" if flame has been established, Terminal 8 of the combustion control is de-energized, closing the pilot valve. Terminal 15 is energized, providing power to the modulating control of the boiler. If main flame has not been established, the unit will lock out on main flame failure.
13. The unit modulates between the Low fire setting and the High fire setting to maintain the desired outlet water temp set point.
14. When the load is below the Low fire rating of the boiler the boiler will continue firing and the outlet water temperature will rise until it reaches operating limit setpoint value. At this point the operating control switch opens and the combustion control is de-energized at Terminal 6 and the indicator for HEAT is turned off. This action also de-energizes Terminal 9 thus closing the main gas valve and the air gas ratio control valve. Terminal 14 is energized which applies power to the close terminal of the air damper motor. The air damper closes.
15. When the water temperature is reduced by the load on the system, the operating control switch will close again. The operating sequence will recycle to step 5, provided the limits on water flow, gas pressure and high temperature are all met.

5.6 TROUBLE SHOOTING

5.6.1 Loss of Power

Refer To TBIG Latest Edition)

5.6.2 Loss of Water Flow

(Refer To TBIG Latest Edition)

5.6.3 Low Gas Pressure

(Refer To TBIG Latest Edition)

5.6.4 High Water Temperature

(Refer To TBIG Latest Edition)

5.6.5 Low Air

If the "Low Air" indicator remains on for longer than 20 seconds, there is insufficient airflow through the burner. An extended low air indication does not necessarily mean that the low air switch is defective.

- Check the cabinet pressure for a minimum of 0.3" W.C.
- Check burner is clean (Refer to section 5.2)

5.6.6 Ignition Failure

(Refer To TBIG Latest Edition)

5.6.7 Flame Failure

In the event of a flame failure during a firing period, the main fuel valves are de-energized and the programmer immediately goes into a "lockout" mode. If flame failure occurs and the indicator is illuminated, the programmer must be manually reset.

IMPORTANT

If any "Manual Reset" limit device trips
DO NOT
reset without determining and correcting the cause.

(Flame safeguard, high or low gas pressure, high temperature limit, stack temperature.)

6.0 PARTS/TECHNICAL SUPPORT

Spare parts and replacement parts can be ordered from Patterson-Kelley by calling (570) 421-7500 or Toll Free (877) 728-5351. Ask for the Heat Transfer Department. The fax number is (570) 476-7247. Refer to the parts list shown on the assembly drawing provided with this manual.

Technical information is also available at the above number.

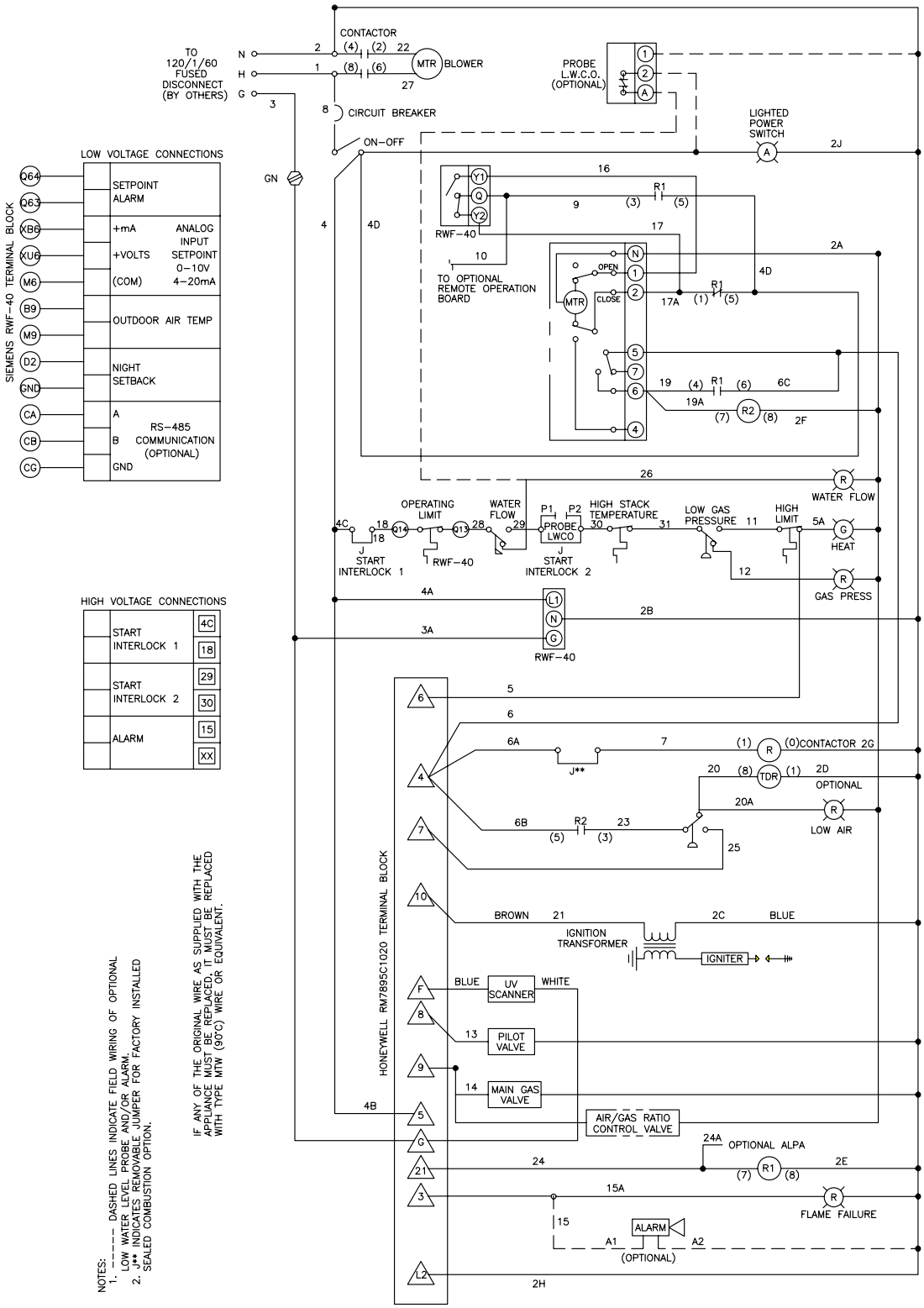
When ordering replacement parts please have the **model number** and **serial number** of your boiler available.

6.1 SCHEMATIC DIAGRAMS

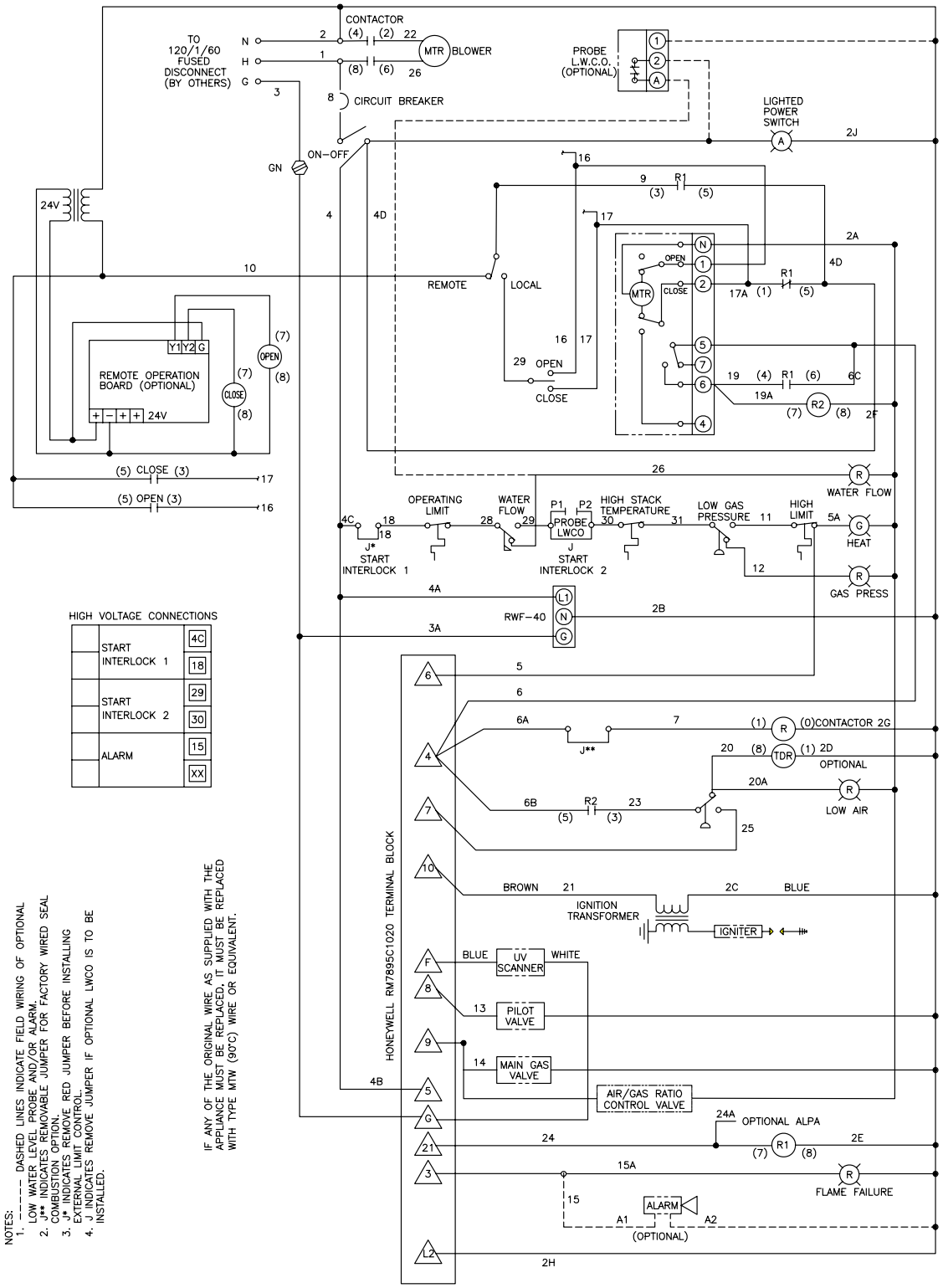
Schematic drawings are shown on the following pages.

Table of Contents for this Section:

Standard Unit w/ Siemens Control



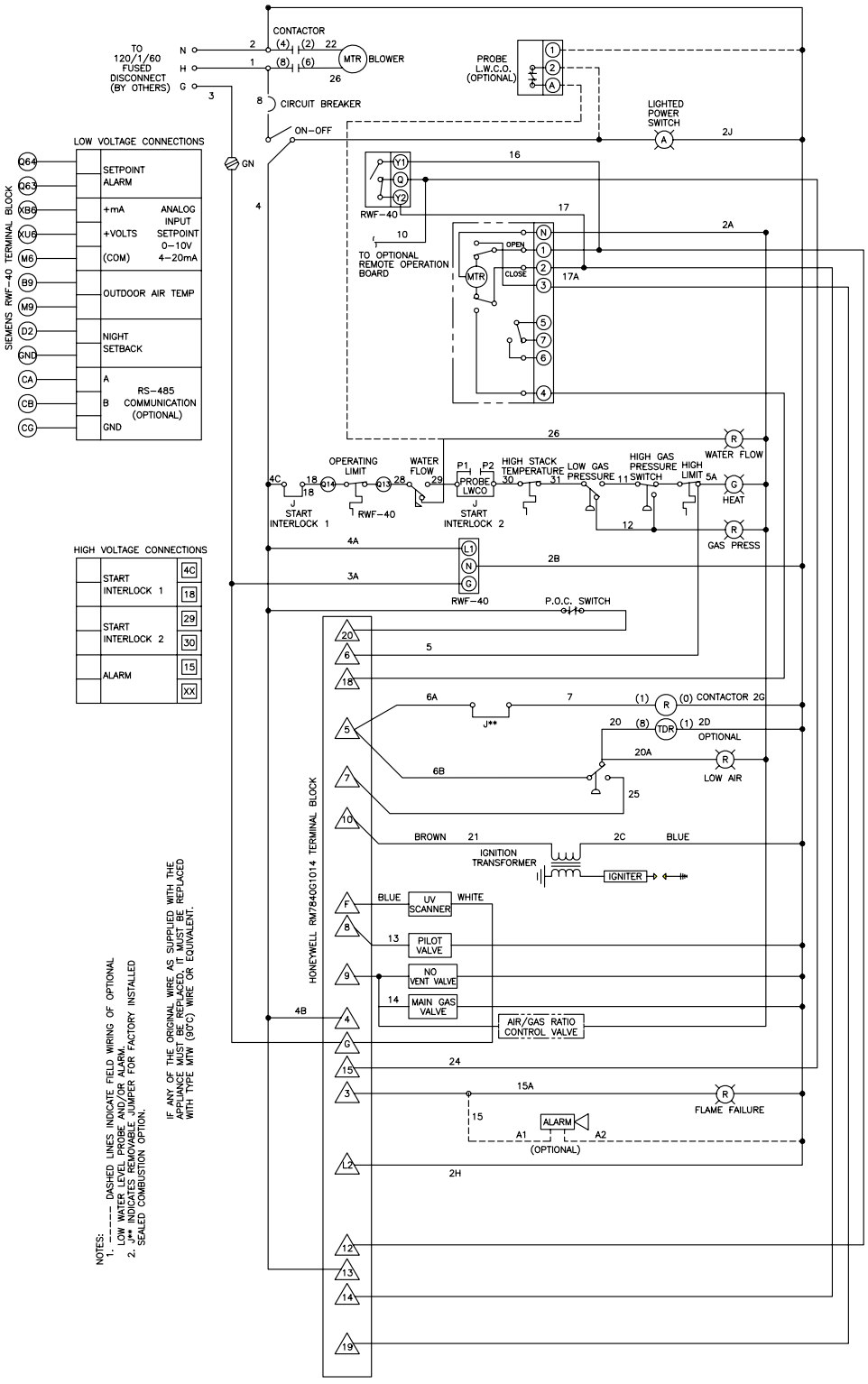
Standard Unit w/ Remote Control



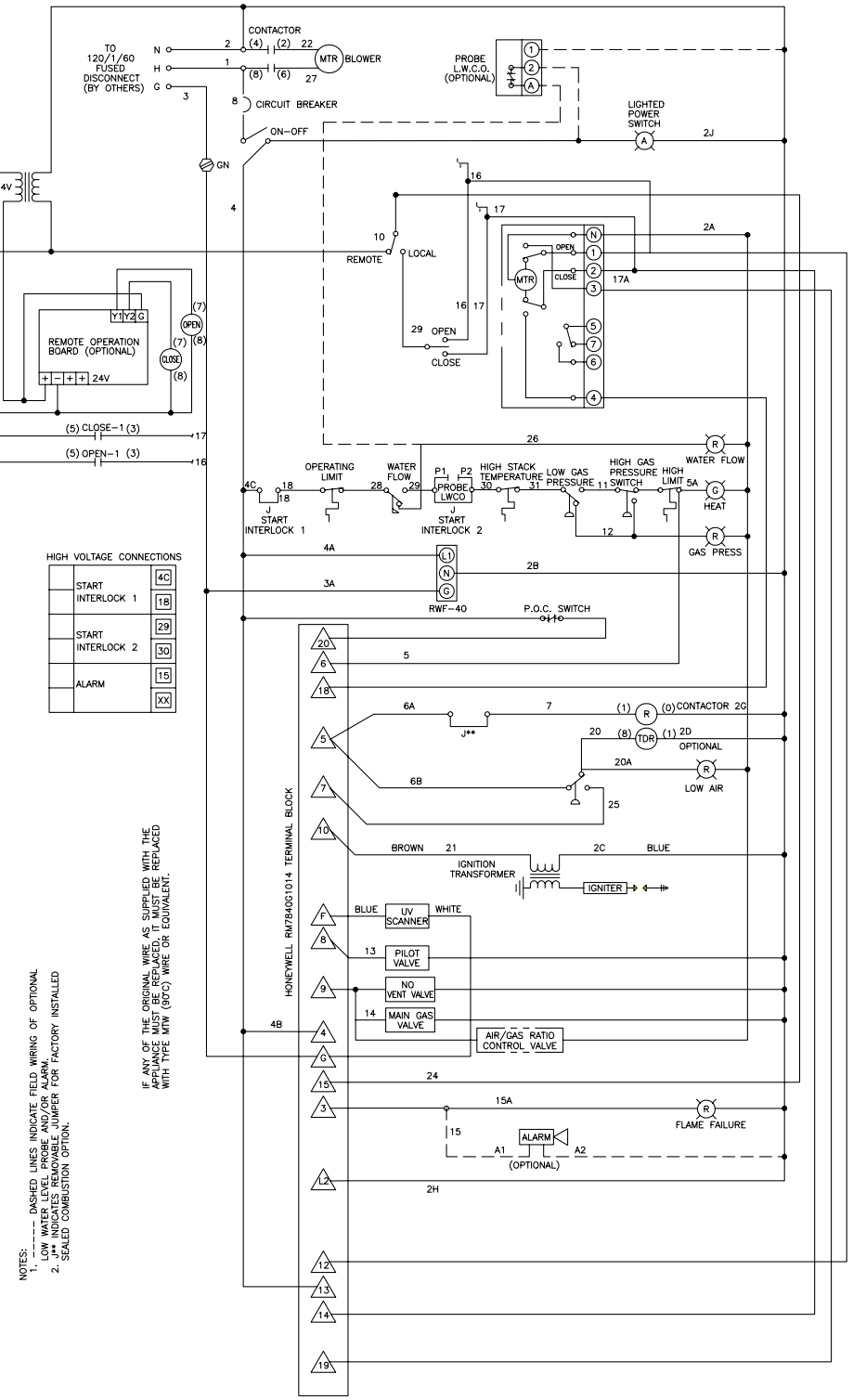
NOTES:
1. ---- DASHED LINES INDICATE FIELD WIRING OF OPTIONAL LOW WATER LEVEL PROBE AND/OR ALARM.
2. J** INDICATES REMOVABLE JUMPER FOR FACTORY WIRED SEAL COMBUSTION OPTION.
3. J* INDICATES REMOVE RED JUMPER BEFORE INSTALLING EXTERNAL LIMIT CONTROL.
4. J INDICATES REMOVE JUMPER IF OPTIONAL LWCO IS TO BE INSTALLED.

IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH TYPE MTW (90°C) WIRE OR EQUIVALENT.

IRI with Siemens Control

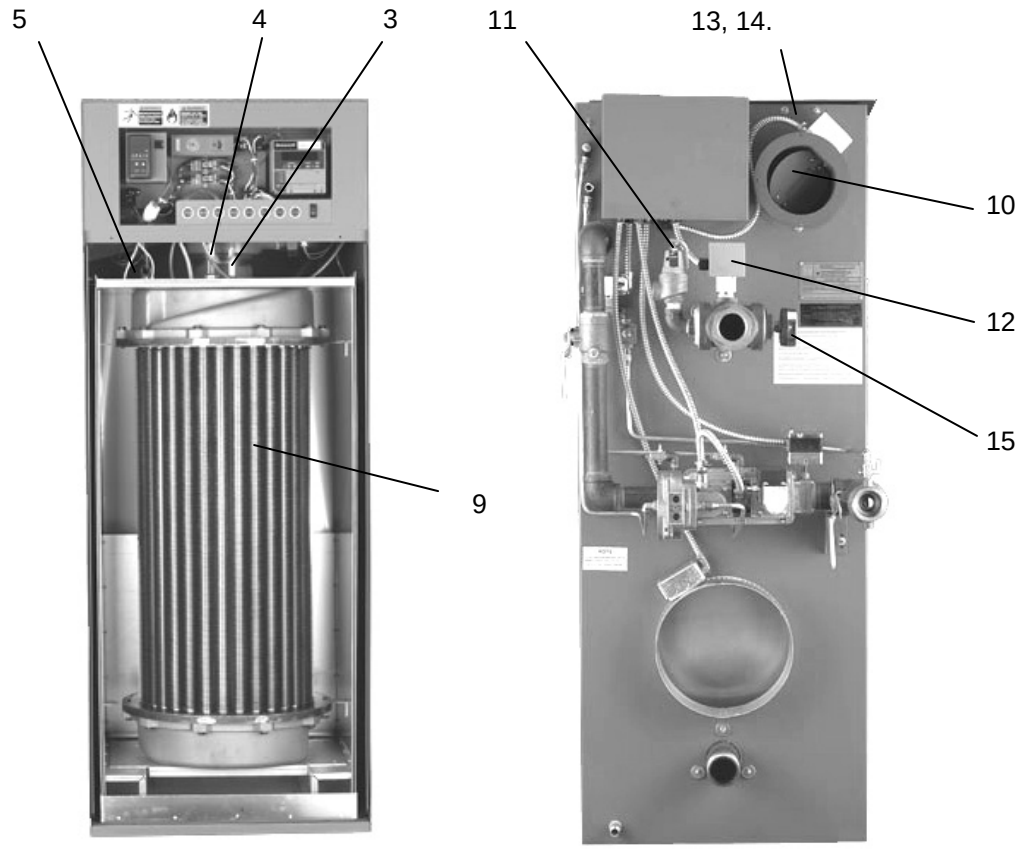


IRI with Remote Control



6.2 BOILER PARTS LIST

6.2.1 Main Assembly



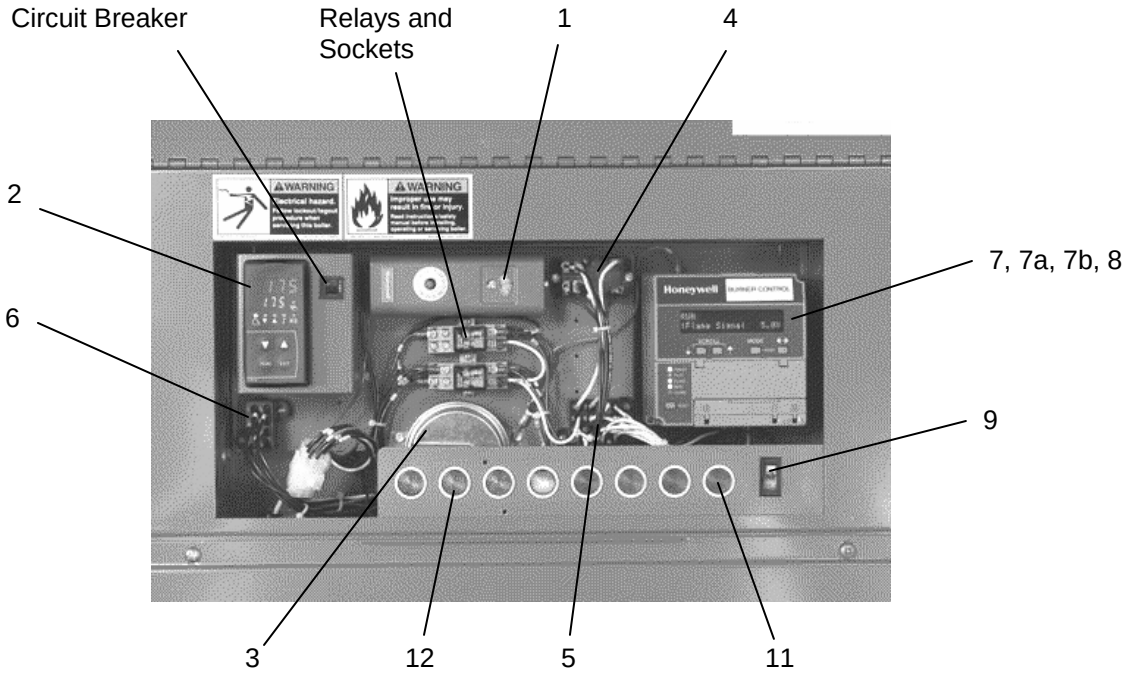
No.	Part
1.	Mixer Core, Burner (Inside Cabinet)
2.	Burner Orifice (Inside Cabinet)
3.	Spark Igniter Electrode
4.	UV Scanner
5.	Thermowell w/Clamp
6.	Electrode Assembly w/Mica (Inside Cabinet)
7.	Pilot Tube (Inside Cabinet)
8.	Burner (Inside Cabinet)
9.	Heat Exchanger
10.	Blower Damper
11.	Pressure Relief Valve (100 PSI)

No.	Part
12.	Water Flow Switch
13.	Blower, Motor (Inside Cabinet)
14.	Blower, Wheel (Inside Cabinet)
15.	Press./Temp. Gauge (w.100 PSI relief valve)

Installation/Owner's Manual All Models-TBIG

CP Control Panel (see Section 6.2.2)
EC Exterior Cabinet (see Section 6.2.4 in TBIG)
IC Interior Cabinet (see Section 6.2.4 in TBIG)
PG Pilot Gas Train (see Section 6.2.3 in TBIG)
MG Main Gas Train (see Section 6.2.3)

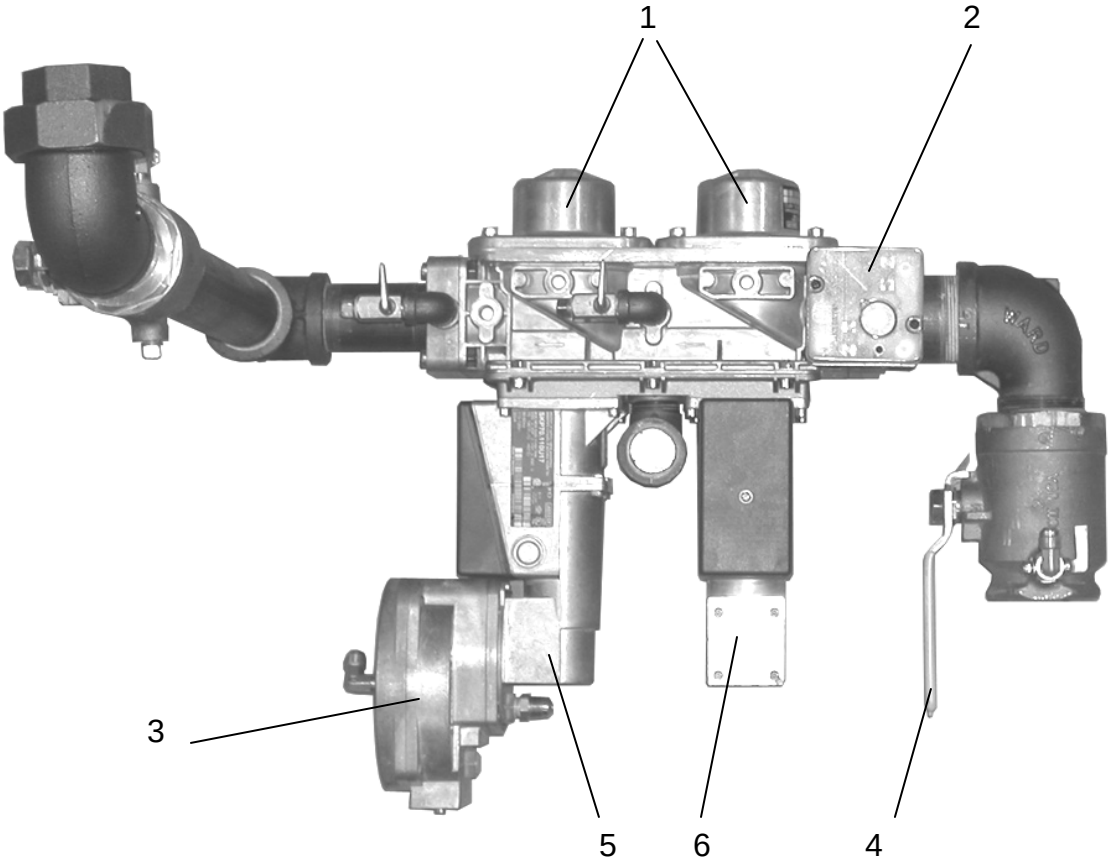
6.2.2 Control Panel



No.	Part
1.	Thermostat (Manual Reset)
2.	Thermostat (Oper. Temp)
3.	Air Flow Switch
4.	Motor Start Relay
5.	Terminal Block, Neutral
6.	Terminal Block, Power
7.	Flame Safeguard Programmer
7a.	Amplifier (UV Scanner)
7b.	Timing Card, 30 sec.
8.	Programmer, Sub-Base
9.	Switch, On/Off, Lighted

No.	Part
10.	Ignition Transformer
10a.	Ignition Cable
11.	Indicator Light, Red
12.	Indicator Light, Green
	Low Water Switch (IRI-MR)
	Alarm Bell (IRI)

6.2.3 Gas Train



No.	Part
1.	Main Gas, Valve
2.	Low Gas Pressure Switch
3.	Main Gas, Regulator
4.	Main Gas, Shut-off Cock
5.	Main Gas Actuator
6.	Safety Shut-off Valve

7.0 LIMITED WARRANTY

Subject to the terms and conditions herein and except as provided below with respect to products or parts not manufactured by Patterson - Kelley Co., Seller warrants to the original owner at the original installation site that products manufactured by Seller ("Products") comply, at the time of manufacture, with recognized hydronics industry regulatory agency standards and requirements then in effect and will be free from defects in materials and workmanship for a period of five (5) years from date of shipment (the "Warranty Period"). For products or parts not manufactured by Patterson - Kelley, the warranty obligations shall, in all respects, be limited to one year.

REMEDY

The sole remedy of this warranty is expressly limited to the repair or replacement of any part found to be defective under conditions of normal use within the Warranty Period.

Installation is not included.

Warranty - The owner must notify the original installer of the Product and Seller (Attention: Patterson-Kelley Co, Box 458, East Stroudsburg, PA 18301), in writing, within the Warranty Period, providing a detailed description of all claimed defects. Transportation to the factory or other designated facility for repairs of any products or items alleged defective shall, in all events, be the responsibility and at the cost of the owner.

EXCLUSIONS

Seller shall have no liability for and this warranty does not cover:

A. Incidental, special or consequential damages, such as loss of the use of products, facilities or production, inconvenience, loss of time or labor expense involved in repairing or replacing the alleged defective Product.

B. The performance of any Product under conditions varying materially from those under which such Product is usually tested under industry standards as of the time of shipment.

C. Any damage to the Product due to abrasion, erosion, corrosion, deterioration, abnormal temperatures or the influence of foreign matter or energy.

D. The design or operation of owner's plant or equipment or of any facility or system of which any Product may be made a part.

E. The suitability of any Product for any particular application.

F. Any failure resulting from misuse, modification not authorized by Seller in writing, improper installation or lack of or improper maintenance.

G. Equipment furnished by the owner, either mounted or unmounted, or when contracted for by the owner to be installed or handled.

H. Leakage or other malfunction caused by:

1. Defective installations in general and specifically, any installation which is made:
   a. in violation of applicable state or local plumbing housing or building codes,
   b. contrary to the written instructions furnished with this unit
2. Adverse local conditions in general and, specifically, sediment or lime precipitation in the tubes and/or headers or corrosive elements in the atmosphere.
3. Misuse in general and, specifically, operation and maintenance contrary to the written instructions furnished with the unit, disconnection, alteration or addition of components or apparatus, not approved by seller, operation with fuels or settings other than those set forth on the rating plate or accidental or exterior damage.

I. Production of noise, odors, discoloration or rusty water.

J. Damage to surrounding area or property caused by leakage or malfunction.

K. Costs associated with the replacement and/or repair of the unit including: any freight, shipping or delivery charges, any removal, installation or reinstallation charges, any material and/or permits required for installation, reinstallation or repair, charges to return the boiler and or components. Seller's liability under this warranty shall not in any case exceed the amount paid for the Product found to be defective.

THIRD-PARTY WARRANTIES

For goods or components not manufactured by Seller, the warranty obligations of Seller shall, in all respects, conform and be limited to one year from the date of shipment.

SEVERABILITY

To the extent that any provision of this warranty would be void or prohibited under applicable law, such provisions shall be limited in effect to the minimum extent necessary to render the remaining provisions hereof enforceable.

NO OTHER WARRANTIES

Seller makes no implied warranty of merchantability or fitness for a particular purpose or other warranties with respect to any products or services except as expressly set forth in this limited warranty.