



PATTERSON-KELLEY

THERMIFIC®

GAS-FIRED BOILER



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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Installation Date: _____



Patterson-Kelley

Harsco

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**WARNING!**

It is **essential** to read, understand, and follow the recommendations of this manual before installing, operating, or servicing this equipment. Failure to do so could result in fire or explosion and serious injury, death, and/or property damage.

The same features which permit this boiler to achieve high-efficiency performance make it unlike most other boilers of this general size, so it is important to understand how this boiler operates.

Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance.

WARNING!

Installation and service must be performed by a qualified installer, service agency, or gas supplier.

What to do if you smell gas:

- Do not try to light any appliance.
- Do not touch any electrical switch.
- Do not use any phone in your building. Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier call the fire department.



1.0 INTRODUCTION

The P-K Thermific® Gas-Fired Boiler combines a radial pre-mix fan-assisted burner with a compact, finned-tube heat exchanger to provide maximum efficiency in a minimum of space. The high-quality materials and thoroughly tested design of the boiler should provide years of trouble-free, hot-water service, if the instructions in this manual are followed carefully. This manual covers installation of P-K Thermific® Boiler Series 700, 1000, 1200, 1500, 1700, 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 may be built to operate with natural gas or liquefied petroleum gas (propane). Check the rating plate for correct fuel usage and gas pressures.

The boiler is only a part of the complete heating system. This boiler may be fully operational and yet because of poor circulation, control 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

2.1 GENERAL

The Thermific® gas-fired boiler **must** be:

- Installed by qualified personnel in accordance with designs prepared by qualified facility engineers including: structural, mechanical, electrical, and other applicable disciplines.
- Operated and serviced in accordance with a comprehensive safety program determined and established **by the customer**. Do not attempt to operate or service until such a program has been established.

- Operated and serviced by qualified, properly trained personnel in accordance with all applicable codes, laws, and regulations.

2.2 TRAINING



It is **essential** to read, understand, and follow the recommendations of this manual before installing, operating, or servicing this equipment. Failure to do so could result in serious injury, death, and/or property damage.

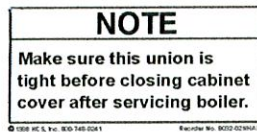
Proper training is the best protection against accidents. Operating and service personnel must be thoroughly familiar with the basic construction of the Thermific® boiler, the use and locations of the controls, the operation of the boiler, adjustment of its various mechanisms, and all applicable safety precautions. If any of the provisions of this manual are not fully and completely understood, contact the Patterson-Kelley Sales Department toll-free at (877) 728-5351 for assistance.

2.3 SAFETY FEATURES

It is the responsibility of the customer to maintain the safety features of this machine, such as: guards, safety labels, safety controls, interlocks, lockout devices, etc., in place and operable.



2.4 SAFETY LABELS



The safety labels shown above are affixed to your boiler. Although the labels are of high quality, they may become dislodged or unreadable over time. Contact Patterson-Kelley toll-free at (877) 728-5351 for replacement labels.

2.5 SAFETY PRECAUTIONS

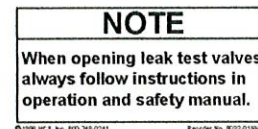
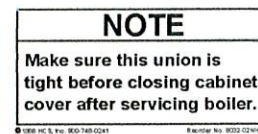
Provide a suitable location for the boiler, away from normal personnel traffic, with adequate working space, adequate clearances, proper ventilation and lighting, with a structure sufficiently strong and rigid to support the weight of the boiler, all piping, and accessories.

2.5.1 Electrical Hazards



- Shock hazard! Properly lockout/tagout the electrical service and all other energy sources before working on or near the machine.
- Shock hazard! Boiler is not rated for wash-down service.

2.5.2 Burn, Fire, and Explosion Hazards



- Burn, fire, and explosion hazards! Installation must be in strict conformance to all applicable codes and standards including NFPA 54, ANSI Z223.1 and CAN/CGA B.149. Install all required ventlines for gas devices. Refer to Section 3.7.2 below.
- Hazard from incorrect fuels! Possible fire, explosion, overheating, and damage. Do not use any fuels except the design fuel for the unit.
- Overfire hazards! High pressure in gas or propane supply could result in overfiring of other devices supplied from the same source.
- Fire and explosion hazards! Close the main gas shutoff before servicing boiler.



- Fire and explosion hazards! Do not store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other gas fired appliance.
- Burn hazard! Possible hot surfaces. Do not touch gas vent during firing operation. Use only factory recommended vent components.
- Burn hazard! Hot fluids. Use caution when servicing or draining boiler.
- Fire and explosion hazards! Use caution when servicing burner. Propane (LPG) is heavier than air and may linger in the combustion chamber, vent lines, or elsewhere.
- Gas leak hazard! Make sure all connections to main burner are tight when reassembling the burner. These connections cannot be tested after the burner is assembled.
- Gas leak hazard! All threaded gas connections must be made using a pipe compound that is resistant to liquefied petroleum. **Do not** use Teflon™ tape on threaded gas piping.
- Gas leak hazard! Check entire gas train for leaks after installation. If there is a smell of gas, shut down the boiler and obtain immediate assistance from trained service personnel and/or your local fire department.
- Overfire hazard! Possible fire and explosion from excess gas pressure. Make sure that gas inlet pressure does not exceed 14 inches W.C. to the regulator.
- Overfire hazard! Possible fire and explosion. Possible malfunction of regulators and/or motorized gas valves. Maintain all gas train components in good condition. Do not alter wiring connections. Annual inspection by factory-trained personnel for proper set-up and operation is recommended.
- Overfire and underfire hazards! Possible fire, explosion, overheating, and component failure. Do not attempt to adjust firing rate of the boiler. The firing rate must be adjusted **only** by factory trained personnel.

2.5.3 Crush Hazards



- Lifting hazards! Use properly rated lifting equipment to lift and position the boiler. The load is unbalanced. Test balance before lifting 3 ft. above the floor. Do not allow personnel beneath the lifted load. Refer to approximate weights in the table below:

Boiler Size	Weight in Pounds
700,000 Btu	595
1,000,000 Btu	595
1,200,000 Btu	685
1,500,000 Btu	985
1,700,000 Btu	990
2,000,000 Btu	1,025

- Bump hazard from overhead piping. Install piping with adequate vertical clearance.

2.5.4 Chemical Hazards



- Environmental hazard! The motorized gas valves may contain hydraulic oil. Use safe procedures for the disposal of all lubricants.
- Chemical hazards from cleaning products. Use caution when cleaning the system. The use of professional assistance is recommended. Use safe procedures for the disposal of all cleaning solutions.



2.5.5 Pressure Hazards



- Pressure hazard! Hot fluids. Install isolation valves on boiler water inlet and outlet. Make sure isolation valves are closed before servicing boiler.
- Pressure hazard! Hot fluids. Annually test safety relief valve for proper operation. Do not operate boiler with faulty relief valve.

2.5.6 Slip, Fall Hazards



- Tripping hazard! Do not install piping on floor surfaces. Maintain clear path around boiler.
- Slip and fall hazard! Use drip pan to catch water while draining the boiler. Maintain dry floor surfaces.
- Slip and fall hazard! **Do not** locate intake or exhaust terminations directly above a walkway; dripping of condensation can cause icing of the walking surface.



3.0 INSTALLATION

3.1 RECEIVING AND STORAGE

3.1.1 Initial Inspection

Upon receiving the boiler, inspect it for signs of shipping damage. Pay particular attention to the control panel on the top of the boiler and the components mounted on the back, which may show damage from mishandling.

The exterior cabinet must be reasonably air-tight for the burner to operate correctly. Leaks caused by dents in the sheet metal or panels out of position may cause the limit controls to show Low Air. Check to be sure that the mixer core in the top burner is centered and has not moved in shipment; (see Section 5.2, "Cleaning the Burner" for proper location). Verify that the total number of pieces shown on the packing slip agrees with those actually received.

Important: Note any damage or shortage on the freight bill and immediately notify the carrier. File all claims for shortage or damage with the carrier.

3.1.2 Storage Prior to Installation

If the boiler is not installed immediately, it must be stored in a location adequately protected from the weather, preferably indoors. If this is not possible, then it should remain in the shipping container and be covered by a tarpaulin or other waterproof covering.

Note: Controls and other equipment that are damaged or fail due to weather exposure are not covered by warranty.

3.2 COMPLIANCE WITH CODES

The P-K Thermific® Boiler with standard components and many options complies with American National Standard/CSA Standard ANSI Z21.13/CSA 4.9, latest edition, Gas-Fired Low Pressure Steam and Hot Water Boilers. The heat exchanger is constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code, Section IV for 160 psig maximum

operating pressure and/or 250° F maximum operating temperature.

Installation of the boiler must conform to all the requirements of all national, state and local codes established by the authorities having jurisdiction or, in the absence of such requirements, in the U.S. to the National Fuel Gas Code, ANSI Z223.1/NFPA 54, latest edition. In Canada, the equipment shall be installed in accordance with the current Installation Code for Gas Burning Appliances and Equipment, CAN/CGA-B.149, and applicable Provincial Regulations for the class, which should be carefully followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

Where required by local codes, the installation must conform to American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers (ASME CSD-1).

3.3 SETUP

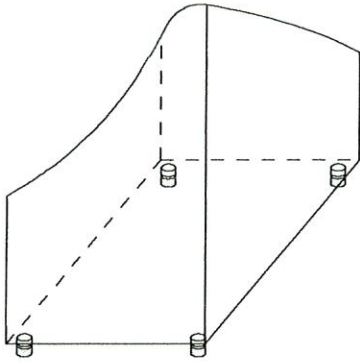
3.3.1 Foundation

Provide a firm, level foundation, preferably of concrete.

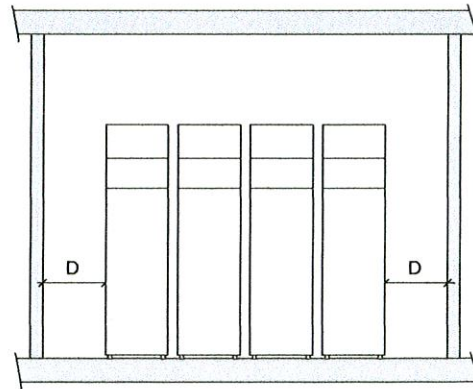
Note: The boiler may be installed on a combustible floor; however, the boiler must **never** be installed on carpeting.

3.3.2 Placement

The boiler must be level to function properly. To assist in leveling the boiler, the four (4) leg bolts (1/2"-NC) holding the boiler to the shipping skid must be reinstalled in the threaded legs on the bottom. The adjustable legs are also necessary to provide adequate floor clearance and prevent distortion on the cabinet, (twisting, etc.) in addition to leveling.



Adjustable Legs for Leveling and Floor Clearance



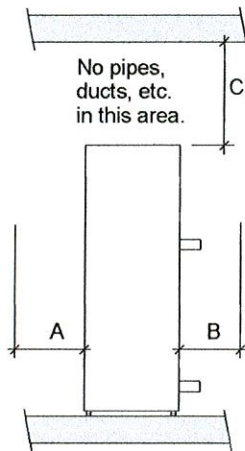
Minimum Clearances from Adjacent Walls, Ceiling, and Obstructions

3.3.3 Clearances

If the boiler is to be installed near combustible surfaces, the minimum clearances shown in the table below must be maintained.

Failure to provide for the service access clearances, even with non-combustible surfaces, may cause future problems servicing the boiler.

The boiler must be installed in a space large in comparison to the boiler as described in Section 6.3 of the National Fuel Gas Code, ANSI Z223.1, latest edition.



NOTE: "C" dimension includes clearance to remove the burner. Do not put pipes, ducts, etc. in this area above the boiler.

Type of Surface	Dimensions (inches)			
	A	B	C†	D
Combustible Surfaces	30	24	24	24
Non-combustible Surfaces	30	24*	24	24**

† "C" dimension includes clearance to remove the burner. Do not put pipes, ducts, etc. in this area above the boiler.

* CSA minimum. Actual clearance depends upon stacking requirements.

** Service access need be only on one side of a boiler or row of boilers. Boilers may be installed immediately adjacent to each other. However, P-K recommends this clearance between **each boiler** when there is insufficient access at the rear to allow for service and adjustment.

In Canada: The boilers are approved for installation with zero clearance to combustible surfaces, but 24 inch service clearances are recommended.

3.4 ELECTRICAL CONNECTIONS

The boiler is wired for 120 volts, single phase, 60 hertz. The total operating amperage is indicated on the rating nameplate. The 700 and 1000 series require less than 8 amps; the 1200 series less than 9 amps; the 1500, 1700, 2000 series less than 12 amps. Before



starting the boiler, check to ensure that the proper voltage and amperage is connected to the boiler.

An external electrical disconnect (not supplied with the boiler) with adequate overload protection is required. The boiler must be grounded in accordance with local codes or in the absence of such requirements, in the U.S. with National Electrical Codes, ANSI/NFPA No. 70 latest edition and in Canada, wire according to the current Canadian Electrical Code.

Note: A dedicated earth ground (green wire) is required to avoid nuisance shutdowns. Do not ground through the conduit. It is also important that proper polarity be maintained.

3.5 COMBUSTION AIR

Combustion air must be free from dust, lint, etc. The presence of such materials in the air supplied to the burner could cause nuisance "Low Air" shutdowns or premature burner failure. The boiler should not be operated during construction while the possibility of drywall dust, demolition dust, etc. exists.

Provisions for combustion and ventilation air must be in accordance with Section 5.3, Air for Combustion and Ventilation, of the National Fuel Gas Code, ANSI Z223.1, latest edition, or applicable provisions of the local building codes. In Canada, combustion air openings shall comply with CSA 4.9. The formula is "1 sq. in. per 1,000 Btu/hr of gas input but not less than 100 sq. in." The location shall be neither more than 18" nor less than 6" above the floor level.

The boiler room shall be provided with two openings to ensure adequate combustion air and proper ventilation. One opening should be 6 to 12 inches above the floor and the other 6 to 12 inches below the ceiling, preferably on opposite walls. The size of each opening is determined by whether air is taken from inside or outside the building. In Canada, ventilation air openings shall be at least 10% of the cross sectional area required for combustion air, but not less than 10 square inches. It is to be located at the highest practical point communicating with the outdoors.

If air is taken directly from outside the building, each opening should have a net free area of 1 square inch for each 4,000 Btu per hour of total boiler input. For

instance, 300 square inches (2-1/12 square feet) are required for 1,200,000 Btu per hour input.

When air is taken from the outdoors through a vertical duct, 1 square inch per 4,000 Btu per hour is required. If a horizontal duct is used, 1 square inch per 2,000 Btu per hour is required, i.e., 600 square inches for 1,200,000 Btu per hour input.

If air is taken from another interior space, each opening should have a net free area of 1 square inch for each 1,000 Btu per hour of boiler input (1,200 square inches for a 1,200,000 Btu per hour.)

WARNING!

Under no circumstances shall the boiler room ever be under a negative pressure. Particular care should be taken when exhaust fans, compressors, air-handling units or other equipment may rob air from the boiler.

The combustion air supply must be completely free of chemical fumes which may be corrosive when burned in the boiler. Common chemicals which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as freon, trichlorethylene, perchlorethylene, chlorine, etc. These chemicals, when burned, form acids which quickly attack the critical boiler components. The result is improper combustion and premature boiler failure.

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 certified as Category I as it is defined in ANSI Z21.13/CSA 4.9, latest edition. This boiler is suitable for use with Type "B" vent.

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 adequately supported to prevent sagging. Consult your local vent supplier for correct vent sizing and structural support requirements.

Vent diameter, for a given input, is dictated by the length and height of horizontal and vertical portions of the vent installation and the materials of construction. For vent design calculations assume a high fire input, a nominal $-.04''$ W.C. draft pressure at the boiler outlet with a gross stack temp of 325°F and CO_2 content of 7.5%.

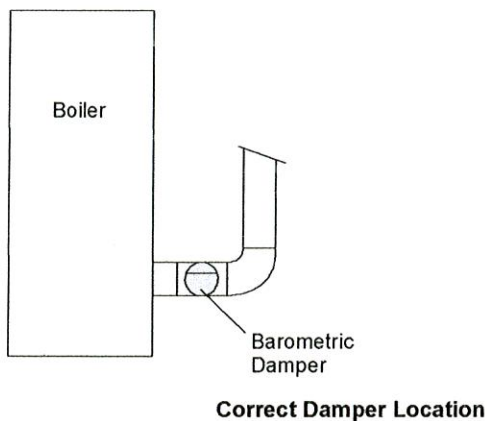
3.6.1 Vent Elbows

The turn from horizontal to vertical should be made with two 45° ell's or with one long radius 90° ell for best operation. Do not use "short radius" ell's.

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 smooth operation. A barometric damper is supplied with each boiler, and when used, should be installed according to the following guidelines.

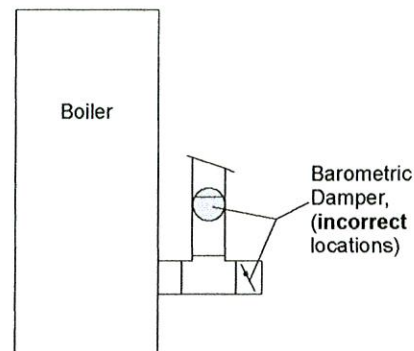
3.6.3 Barometric Damper Location



1. We recommend that the barometric damper be located immediately after the flue connector for best operation.

2. The damper may be located in either the left or right side of the horizontal section of stack.
3. In a multiple boiler installation, one barometric damper must be installed with each boiler.

Be sure that the damper is mounted horizontally (never vertically). Be sure to remove all three red stops from the damper before start-up. The damper door should swing freely. Carefully follow all the instructions provided with the barometric damper.



Incorrect Damper Locations

WARNING!

To avoid spillage into the boiler room of dangerous flue gas containing carbon monoxide, the opening in the damper (draft control gate) must never face against the flow of flue gas.

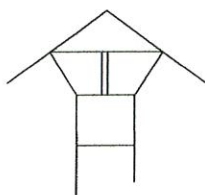
3.6.4 Flue Connection

The connection from the boiler to the vent should be as direct as possible and the upward slope of any horizontal breaching should be at least $1/4$ inch per linear foot. This boiler should not be connected into any portion of a mechanical draft system operating under positive pressure. Provisions must be made for supports to prevent contact of the vent with combustible surfaces.

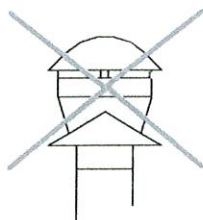
Note: If the vent is erected directly behind the boiler, make sure that the weight of the vent is **not supported** by the boiler vent collar. The collar is not designed to support the weight of the vent. Structural support and spacing from combustible surfaces must be in accordance with the vent manufacturer's requirements.



3.6.5 Vent Termination



Correct Listed
Termination



Incorrect
Termination
(too restrictive)

Vent Termination

The minimum vent height above the flue outlet must be six (6) feet and the vent should extend at least three (3) feet above the roof, or at least two (2) feet above the highest part of any structure within ten (10) feet of the vent.

The vent must be provided with a weather cap of approved design and adequate capacity.

3.6.6 Removing an Existing Boiler

(from a common venting system)

When an existing boiler is removed from a common venting system, the common venting system is likely to be too large for proper venting of the appliances remaining connected to it.

At the time of removal of an existing boiler, while the other appliances remaining connected to the common venting system are not in operation, the following steps should be followed with each appliance remaining connected to the common venting system placed in operation:

1. Seal any unused openings in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch and determine that there is no blockage or restriction, leakage, corrosion or other deficiency which could cause an unsafe condition.
3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any

appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers.

4. Place the appliance being inspected in operation. Follow the lighting instructions. Adjust the thermostat so that the appliance will operate continuously.
5. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle or smoke from a cigarette, cigar or pipe.
6. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas-burning appliance to their previous conditions of use.

Any improper operation of the common venting system should be corrected so the installation conforms with the National Fuel Gas Code, ANSI Z223.1.

When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate tables in Part II in the National Fuel Gas Code, ANSI Z223.1.

3.7 GAS PIPING

Before making the gas hook-up, make sure the boiler is being supplied with the type of fuel shown on the boiler nameplate.

The boiler shall be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control replacement, etc.)

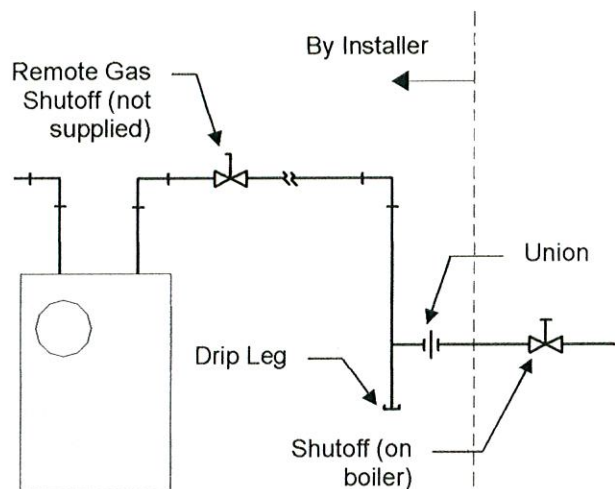
The gas pressure regulator supplied with the boiler is set during a factory fire-test to provide the proper pressure to the main burner, which for natural gas is based on 7 inches W.C. inlet pressure to the regulator (11 inches W.C. for propane). The gas train components are designed to handle a maximum inlet pressure of 14 inches water column (1/2 psig.). If the available gas pressure exceeds 14 inch W.C., a suitable additional



intermediate gas pressure regulator of the "lock up" type must be provided to reduce the pressure to less than 14 inch W.C.

WARNING!

All threaded connections must be made using a pipe compound that is resistant to the action of liquefied petroleum gases. Do not use Teflon tape on gas line threads.

**Gas Piping**

Note: Install a sediment trap (drip leg) and a union connection ahead of the primary manual shutoff valve on the boiler. Gas piping should be installed in accordance with National Fuel Gas Code, ANSI Z223.1, latest edition, and any other local codes which may apply; in Canada see CAN/CGA-B 149.

Note: See chart below for required pipe size, based on overall length of pipe from meter plus equivalent length of all fittings. Approximate sizing may be based on 1 cubic foot of natural gas per 1,000 Btu per hour input, i.e., 900,000 Btu per hour requires about 900 cubic feet per hour. (See Typical Boiler Operating Conditions, Section 4.3, for more information.)

Pipe Capacity for Natural Gas

Nominal Iron Pipe Size (Inches)	Internal Diameter (Inches)	Equivalent Pipe Length		Maximum Capacity in Cubic Feet of Natural Gas per Hour Pressure Drop of 0.5 inch Water Column/Equivalent Length of Pipe (in feet)						
		90° Ell (Feet)	Tee (Feet)	20	40	60	80	100	150	200
1-1/4	1.380	3.5	6.9	950						
1-1/2	1.610	4.0	8.0	1,460	990	810				
2	2.067	5.2	10.3	2,750	1,900	1,520	1,300	1,150	950	950
2-1/2	2.469	6.2	12.3	4,350	3,000	2,400	2,050	1,850	1,500	1,280
3	3.068	7.7	15.3	7,700	5,300	4,300	3,700	3,250	2,650	2,280
4	4.026	10.1	20.2	15,800	10,900	8,800	7,500	6,700	5,500	4,800



3.7.1 Gas Supply Piping by Installer

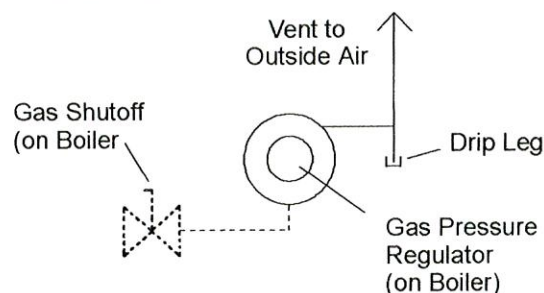
The boiler and all gas piping connections should be pressure-tested and must be checked for leaks before being placed into service. Test with compressed air or inert gas if possible.

The boiler must be **disconnected** at the boiler manual shut-off valve (located at the end of the supplied gas train) from the gas supply piping system during any pressure testing of the system at pressures in excess of 1/2 psig (14 inch W.C.). Excessive pressure could cause component damage.

During any pressure testing of the gas supply piping system at pressures equal to or less than 1/2 psig (14 inch W.C.), the boiler should be isolated from the gas supply piping system by closing the manual shut-off.

Some leak test solutions, including soap and water, may cause corrosion. These solutions should be rinsed-off with water after testing.

3.7.2 Gas Bleeds and Vents



Gas Bleeds and Vents

The bleed vents* on the diaphragm gas valves have been factory-piped to terminate at the burner, as required by ANSI Z21.13. This feature provides combustion of any gas which leaks past a ruptured diaphragm during operation. Gas vents to outdoor air must be provided for the main pressure regulator. The pilot regulator is equipped with a vent limiting device and does not require external venting!

- When installing per ASME CSD-1, disconnect factory piped bleed vents and vent the diaphragm gas valves to outdoor air (field piping.)

Gas Vents by Installer

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

“Vent limiters” are NOT to be installed on this boiler.

Note: The vent line connection on the gas pressure regulator 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. vent valve is provided, it must be vented independently.

IMPORTANT:

The vent/bleed line must be piped by the installer in accordance with the National Fuel Gas Code (NFPA 54), ANSI Z223.1, 2002 edition, which states:

“In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter.”

The National Fuel Gas Code Handbook goes on to say that *“Insects, insect nests, ice, or freezing rain can block outdoor vents....”*

3.8 BOILER WATER PIPING

3.8.1 Piping Design

Water Flow in System

Ideal operation of the P-K Thermific® Boiler would consist of a 20° F temperature differential across the heat exchanger. The operating thermostat has an adjustable temperature differential. Insufficient flow may result in excessive short cycling of the boiler and eventual damage or premature failure of the equipment.

In any case, Minimum Return Water Temperature should be greater than 130° F to avoid problems of



condensation on the outside of the heat exchanger or in the flue passages.

Proper flow rates and return water temperature may be achieved through a combination of primary and secondary flow loops. Multiple zones and pumps may result in different flow rates at different times. Consideration must be given to all possible conditions and their consequences.

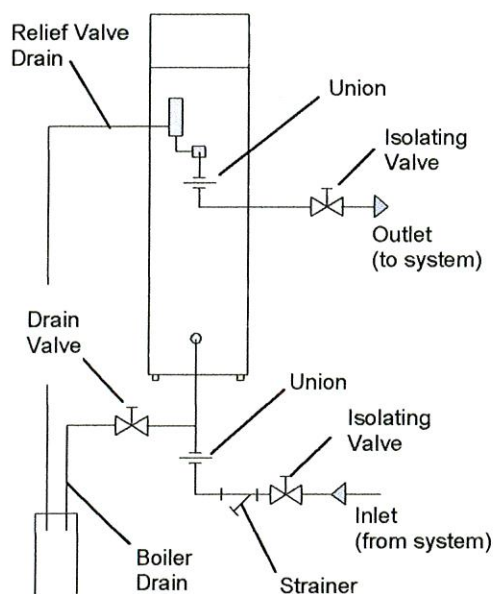
Piping With Refrigeration Machines

When used with a refrigeration system, the boiler shall be installed so that chilled medium is piped in parallel with the boiler. Valves should be installed to prevent chilled water from entering the boiler when the system is operated in the cooling mode.

Piping With Air Handling Units

The boiler piping system of a hot water heating boiler connected to heating coils located in air handling units, where they may be exposed to refrigerated air circulation, must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

3.8.2 Boiler Inlet and Outlet Connections



**All parts provided by contractor
Boiler Inlet and Outlet Connections**

Make water connections as the application warrants, or at a minimum, as shown, but always in compliance with the local requirements.

Note: Pipe unions and isolating valves must be installed in both water connections for ease of service.

The bottom connection to the boiler is the INLET and must be used for the return from the system.

The top connection to the boiler is the OUTLET and must be connected as the supply to the system.

3.8.3 Boiler Water Piping by Installer

Strainer

To avoid possible contamination of the boiler with dirt, rust or sediment from the system, a strainer near the boiler inlet is strongly recommended. Even new systems may contain sufficient foreign material to eventually reduce the performance of the heat exchanger. Adequate circulation of good clean water is essential to maximum efficiency and long life of the boiler.

Relief Valve and Piping

Each boiler is supplied with a pressure-relief valve sized in accordance with ASME requirements. The relief valve should be piped to a suitable floor drain. Reducing couplings or other restrictions are not permitted in the discharge line.

Low Water Cut-off

The boiler is furnished with a flow-switch-type low water cut-off as required by Section IV ASME Code; no field piping is required. If the flow switch does not sense water flow, the boiler will shut down and a red indicator will be illuminated on the control panel. This flow switch only proves that flow is present. It does not prove adequate flow as required by this boiler.

Installation of an external low water cutoff or manual reset low-water switch may be required by certain codes or in certain installations. Consult your local code for details.

**WARNING!**

Never install a valve that can isolate the low water cut-off from the boiler.

Drain Valve and Piping

The boiler is not provided with external drain connections. A drain valve should be installed near the inlet (system return) connection to the boiler and piped to a suitable floor drain. The boiler can be completely drained through the bottom header by removing the flush plug in the bottom end plate.

This plug may also be used to flush accumulated sediment from the bottom of the boiler.

WARNING: Burn hazard! Hot fluids. Use caution when servicing or draining boiler.

3.8.4 Flushing and Filling**Flushing the System**

Before filling the boiler, flush the system to remove the debris. Clean and flush old piping thoroughly before installing the boiler.

Under no circumstances should the hydronic system be flushed while the boiler is attached to the system since the debris or corrosion products could accumulate in the boiler and plug the boiler heat exchanger.

If the piping system attached to this unit will be chemically cleaned, the boiler must be disconnected from the system and a bypass installed so that the chemical cleaning solution does not circulate through the boiler.

Filling

To be sure that the boiler is not air-bound, open the pressure-relief valve located at the rear of the boiler. Leave the relief valve open until a steady flow of water is observed at the floor drain. Close the valve and finish filling the system.

3.8.5 Water Quality

The boiler is designed to operate in a closed-loop system. As such, the system should be tight and not require make-up water. A high percentage of untreated make-up water can cause premature failure due to buildup of scale; such failure is not covered by warranty.

Scale can also reduce efficiency. For example, a scale thickness of 1/16" will result in a 12.5% loss of efficiency.

The water quality should be within the guidelines established by the American Boiler Manufacturers Association, as follows:

Total solids:..... 2,500 ppm
Total alkalinity:..... 500 ppm
Total hardness:..... 150 ppm

The amount of oils, fats, grease, and other organic matter should be limited to 10 ppm.

Consult your water conditioning or chemical treatment supplier for analysis and recommendations.

3.9 BURNER AND IGNITION SYSTEM**3.9.1 Inspection**

Inspect the burners to be sure nothing was damaged or knocked loose during shipment. Make sure that the mixer core in the top of the burner is centered in the burner head; (see burner photo in section on "Cleaning the Burner" Section 5.2). Inspect the pilot line, main gas train and ignition electrode to be sure they were not damaged during shipment or installation. Check to see that the pilot is securely attached and that it is properly positioned to ignite the main burner.



3.10 PRE-START CHECK LIST

Before attempting to start the boiler, make sure the following items have been completed.

1. Flue gas from the boiler is properly vented.
2. Gas connection has been made, pressure tested for leakage, and the line purged of air. Make sure all required bleeds and vents have been installed.
3. Water connections are complete, and the boiler and system have been filled and purged of air.
4. The boiler must be connected to a 120 volt / 60 Hz power source with proper polarity and dedicated machinery ground. Provide a disconnect having adequate overload protection.
5. Combustion air openings are not obstructed in any way and have adequate capacity.
6. The boiler is placed the proper distance from any combustible walls or substances, in accordance with Section 3.3.3.
7. Relief valves have been piped to floor drains.

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 the gas cock which is downstream from the two safety shut off valves (in the vertical line).
2. With the main gas cock (manual gas valve) open and the pilot gas cock open, the burner should be cycled on. When air flow is established and all the safety limits on gas pressure, water flow and temperature are satisfied, the blower will run and pre-purge the boiler.
3. When the pre-purge is complete, the ignition transformer and pilot will operate.
4. If a satisfactory pilot is established the pilot will remain on, alone, for 10 seconds.
5. After 10 seconds, the "Main" light (on flame safeguard) will go on. However, gas cannot flow to the burner with the gas cock closed (Step 1). The "Pilot" (on flame safeguard) will remain on, along with the "Main", for another 10 seconds and then go out. Since the main flame cannot be burning at this point, there will be no flame signal and the flame safeguard programmer will "lockout". Lockout will require manual reset of the flame safeguard.

After completing this test, turn off the boiler and open the gas cock that was closed in Step 1.

3.11.2 Test of Low Water Cut-off

The boiler is furnished with a flow-switch-type low water cutoff in the outlet nozzle. Test as follows:

Operation of the switch can be checked by first turning the boiler off and then turning the system pump off, stopping water flow in the boiler. After turning off the pump, turn the boiler back on. It should not operate, and a red indicator for "Water Flow" should be illuminated. Do not shut the pump off while the boiler is operating.

Perform appropriate tests on any external probe-type low water cutoff.

3.11.3 Test of Temperature Controls

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



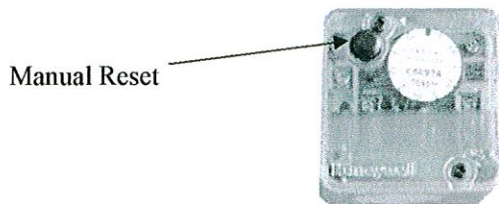
main burner shuts off. The high-limit switch will trip and must be manually reset by pushing the red button after testing.

A similar check should also be made for the "Operating Temperature" control. (See next section for Adjustment Procedures for Lo-Hi-Lo units).

The green "Heat" indicator will go out during either test.

Readjust thermostats to desired operating temperature and set high-limit temperature, typically 20° F above operating temperature.

3.11.4 Test of Low Gas Pressure Switch



Gas Pressure Switch

The boiler is furnished with a low gas pressure switch. The operation of this switch must be checked by slowly closing the main gas cock while the burner is operating. The switch should shut down the main burner. When the gas pressure switch opens, the "Gas Press." indicator will light. Upon reopening the main gas cock, the "Gas Press." indicator should remain on until the low gas pressure switch is manually reset.

3.11.5 Test of High Gas Pressure Switch (if supplied)

The correct setting of the high gas pressure switch is essential for proper operation of the boiler. This switch is set by the factory at 4.0" w.c. and must not be changed.

This switch must be checked by factory-trained personnel.

3.12 INITIAL ADJUSTMENTS

3.12.1 Operating Temperature Controller for Lo-Hi-Lo Thermiflic®

The two stages of this boiler are operated by programming each set point and differential into the controller. The boiler will be turned on at set point 1 minus its differential and turned off at set point 1. The Hi fire operation of the boiler will be energized at set point 2 minus its differential and de-energized at set point 2.

Example:

Set point 1 at 180° F with a 20° F differential, and

Stage 1 energized (Boiler/Low fire turned on at 160° F.

Stage 1 de-energized (Boiler turned off) at 180° F.

Set point 2 at 170° F with a 15° F differential.

Stage 2 energized (Hi fire on) at 155° F.

Stage 2 de-energized (Hi fire off/Low fire on) at 170° F.

Note: the set points should be adjusted for system requirements.

Contact your local P-K service representative for assistance adjusting your Lo-Hi-Lo operating temperature control to meet system requirements.

Record setting in the following Programming worksheet for future reference.

Programming Worksheet

Stage 1:

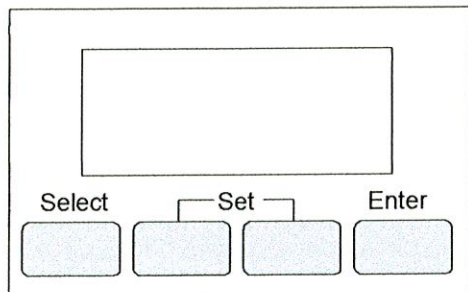
SetPt 1: ____ (Ta) On at ____ (Tb)

Diff 1: ____ (Tdl) Off at ____ (Ta)

Stage 2:

SetPt 2: ____ (Tb) On at ____ (Tc)

Diff 2: ____ (Td2) Off at ____ (Tb)

**Lo-Hi-Lo Operating Temperature Controller**

To adjust operating temperature controller:

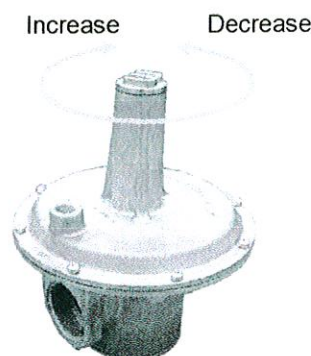
1. Turn the boiler ON. The controller will begin a 210 second countdown.
2. To override this time delay, press Select.
3. Press Select to display the current stage setpoint.
4. Press Up Arrow to increase or Down Arrow to decrease to the desired setpoint.
5. Press Enter to enter the displayed value into memory; **(you must press ENTER to save each value into the controller).**
6. Press Select to display the current stage switching differential.
7. Press Up Arrow to increase or Down Arrow to decrease to the desired switching differential.
8. Press Enter to enter the displayed value into memory **(you must press ENTER to save each value into the controller).**
9. Repeat steps 3 through 8 to program stage 2.
10. Press Select Select (2 times) to return to stage 1 parameters. Scroll through the programming loop a second time to confirm that the appropriate values have been entered into memory by pressing Select.

Note: The control values programmed into memory will not be lost because of a power failure.

Important: After initial programming, altering the set point for stage 1 up or down will result in a change in set point 2 by the same number of degrees and in the same direction. If increasing or decreasing the set point for stage 1 results in exceeding the control limits

(-40° to +220° F) for stage 2, the control will not allow the user to enter a value for stage 1 higher or lower than this limit.

3.12.2 Gas Pressure Adjustment

**Gas Pressure Regulator**

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" I.P.S.). The supply pressure during main burner operation must be greater than the minimum indicated on the rating plate: 5 in. W.C. for natural gas, (4 in W.C. for low pressure option), 7 in. W.C. for propane. 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.).

If a replacement Lo-Hi-Lo actuator is required, follow manufacturers instructions and pre-set the Lo fire setting of the actuator the same as the original actuator. This must be performed by qualified service personnel.

Important: Never underfire low fire (Lo-Hi-Lo only).

To adjust gas pressure, first connect appropriate pressure-sensing device at the manifold tap, then remove seal cap from regulator. Turn adjusting screw clockwise to increase pressure, counter-clockwise to decrease pressure. The manifold gas pressure indicated on the "Factory Firetest" label (affixed on the back of



the cabinet) should be used to achieve the proper firing rate of the individual boiler. Replace seal cap after adjustment.

Important: Never underfire low fire (Lo-Hi-Lo only).

NOTE: Gas flow adjustment must be completed first. Then the following air flow adjustment set must be made utilizing a combustion analyzer to achieve the correct O₂/CO₂ readings.

3.12.3 Air Flow Adjustment

All air flow adjustments must be performed by qualified service personnel.

The air flow is pre-set at the factory prior to shipment.

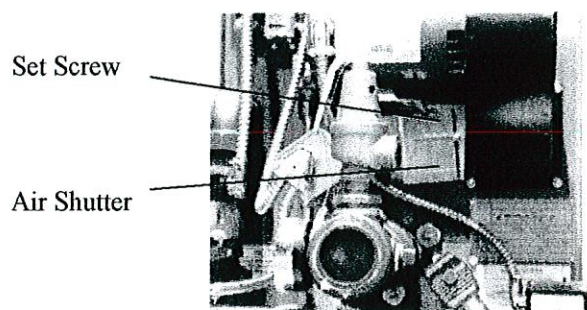
For initial light off, lock the flame safeguard in test position during the purge cycle. Then adjust the air flow until the cabinet pressure is the same as shown on the "Factory Firetest" label. After this adjustment is complete, return the flame safeguard to the run position and allow the boiler to start normally.

The air **MUST** then be adjusted for local conditions.

Combustion measurement instrumentation must be used to adjust the boiler for local conditions (See instructions below). Adjust the carbon dioxide (CO₂) or oxygen (O₂) reading corresponding to approximately 50% excess air.

On/Off

(700, 1000, 1200 Series only)



Increase

Decrease

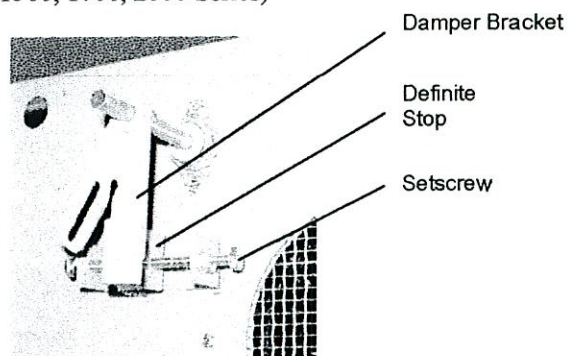


Air Flow Adjustment - On/Off

Loosen the setscrew on the air shutter and open or close the shutter as required to adjust the air flow. Retighten the holding screw after adjustment.

Alternate On/Off

(1500, 1700, 2000 Series)



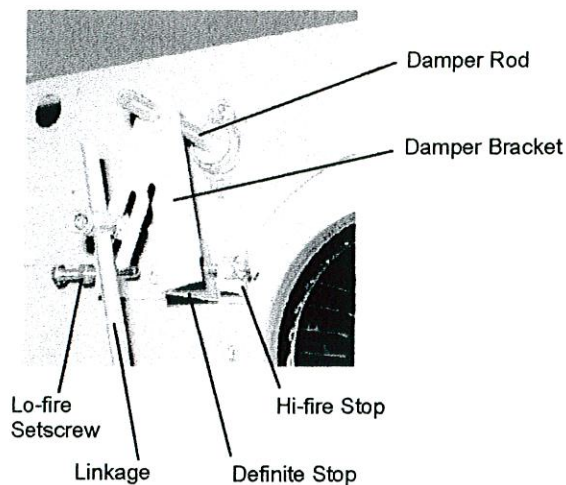
Alternate Air Flow Adjustment - On/Off

The setscrews on the definite stop bracket hold the air damper in place. Loosen the nuts and rotate the screws as required for proper air flow. When the definite stop is in the desired position, tighten the nut on each screw. Both setscrews must be touching the definite stop before they are locked in place. Do not adjust any other part of this mechanism.

Lo-Hi-Lo

This is a two stage firing arrangement with the mechanical action provided by the two stage gas valve actuator. The boiler is factory fire-tested and adjusted for two firing rates: Hi fire (100% of rated input) and Lo fire (60% of rated input).

Fuel adjustments for proper fuel input are made first at the gas pressure regulator with the valve actuator in the Hi fire position. Lo fire fuel adjustments are made second, with the valve actuator in the Lo fire position. The low fire cam (internal to the valve actuator) is increased or decreased to obtain proper fuel input.



Note: Do not utilize the Hi fire definite stop screw to adjust Hi fire air on Lo-Hi-Lo models.

Lo fire adjustments are made with the valve actuator in the Lo fire position. Use the left hand screw on the definite stop bracket to obtain desired Lo fire air and lock it with the nut.

Air Flow Adjustment - Lo-Hi-Lo

Air adjustments corresponding to **both** Hi fire and Lo fire are required. Adjust Hi fire air first, and Lo fire air second. The valve actuator utilizes a damper output shaft that is connected to the assembly shown in the photo via the damper rod.

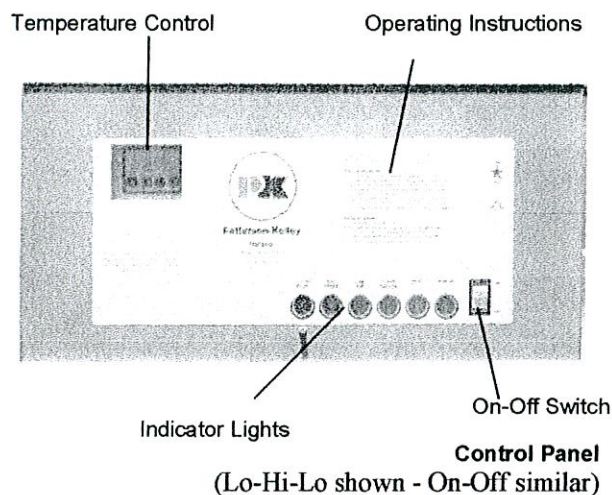
Adjust Hi fire as follows:

- Grasp the damper rod with pliers, loosen the two allen screws (1/16") on damper rod, and make very small adjustment to shaft. Retighten the allen screws. A slot in the end of the damper rod indicates the damper position.
- After adjustments are complete, adjust the Hi fire definite stop screw until it touches the definite stop and lock it with the nut.

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 indicator lights which show the condition of the boiler.

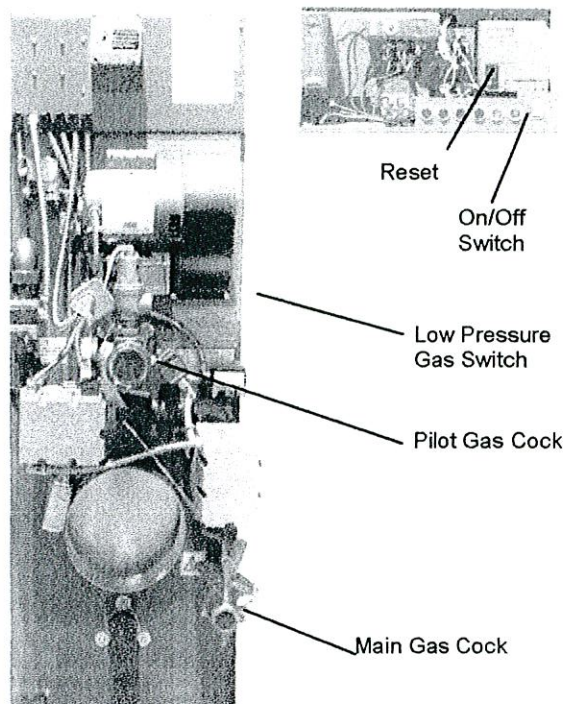
4.1.2 Tests

Safe lighting and other performance criteria were met with the gas manifold and control assembly provided on this boiler when the boiler underwent tests specified in ANSI Z21.13/CSA 4.9, latest edition. (See "Factory Firetest" label.)

4.2 LIGHTING AND SHUT-DOWN PROCEDURES

Do not use this boiler if any part has been under water. Immediately call a qualified service technician to inspect the boiler and to replace any part of the control system and any gas control which has been under water.

4.2.1 Lighting Procedures



Lighting the Burner

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 that pilot has been established.

The controller will now complete the automatic firing sequence.

**4.2.2 Normal Shut Down Procedures**

1. Close all manual gas valves.
2. Turn off electric power.

4.2.3 Emergency Shut Off

Main and pilot gas cocks should be closed immediately if an emergency situation occurs; see Section 4.2.1 for the location of the gas cocks.

CAUTION: If overheating occurs or the gas supply fails to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the boiler.

4.3 TYPICAL BOILER OPERATING CONDITIONS

Model Number		Input Rating (Btu/hr)	Natural Gas (1030 Btu/cu. ft.)			LP Gas (2500 Btu/cu. ft.)			Total Amperage (amps)
			Gas Rate (CFH)	Manifold Pressure* (in W.C.)	Output Capacity (Btu/hr)	Gas Rate (CFH)	Manifold Pressure* (in W.C.)	Output Capacity (Btu/hr)	
700		700,000	680	1.1	595,000	278	2.2	609,000	8
1000		1,000,000	971	2.1	850,000	397	4.5	870,000	8
1200		1,200,000	1,165	3.0	1,020,000	476	6.6	1,044,000	9
1500	max	1,500,000	1,456	2.4	1,275,000	595	3.0	1,305,000	12
	min	900,000	874	0.8	765,000	357	1.1	783,000	12
1700	max	1,700,000	1,650	1.9	1,445,000	674	2.1	1,479,000	12
	min	1,020,000	990	0.7	867,000	404		887,400	12
2000	max	2,000,000	1,942	2.1	1,700,000	793	2.6	1,740,000	12
	min	1,200,000	1,165	0.8	1,020,000	476		1,044,000	12



5.0 MAINTENANCE

5.1 MAINTENANCE AND INSPECTION SCHEDULE

This work should be performed by qualified service personnel. The Daily and Weekly observations can be done by operating personnel. Any required adjustments, servicing, etc. should be performed by qualified service personnel.

The following is a suggested service schedule. Local codes or jobsite conditions may require more frequent servicing.

CAUTION!

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

CAUTION: Follow proper lockout/tagout procedures when performing any type of service on this unit.

Verify proper operation after servicing.

5.1.1 Daily

Observe operating temperature and general conditions. Make sure that the flow of combustion and ventilating air to the boiler is not obstructed. Determine the cause of any illuminated red indicators, unusual noises or operating conditions and make the necessary corrections.

CAUTION!

Check daily to be sure that the boiler area is free and clear of any combustible materials, including flammable vapors and liquids.

5.1.2 Weekly

Observe the conditions of the pilot and main flame. A normal flame is blue with a well-defined inner core.

If the flame is yellow or if it pulsates, or if the burner starts with a rumble or puff, corrective action must be taken by qualified personnel.

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 (CO₂) or oxygen (O₂) analyzer to set conditions for about 50% excess air.

5.1.5 Annually

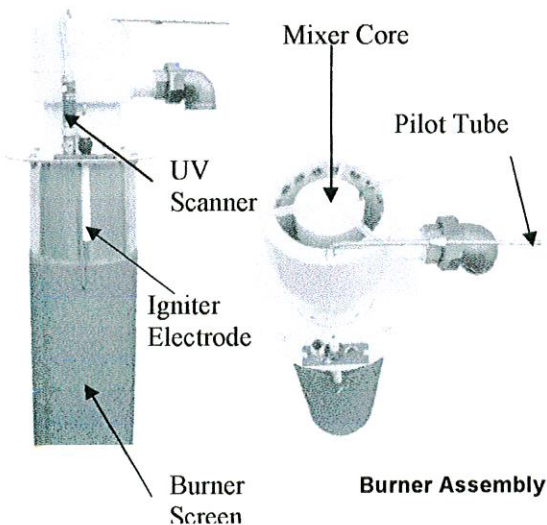
1. Test flame detection by voltage reading at the control programmer.
2. Test high-limit control by reducing setting below the operating temperature. Burner should shut off. After readjusting the thermostat, press the button to reset the switch.
3. Test operating temperature controls by reducing or increasing temperature setting as necessary to check burner operation.
4. Check flue gas temperature at outlet. If there is a temperature increase over previous readings, this probably indicates sooting or water scale build-up.
5. Test the water cutoff by trying to restart boiler with the system pump off. The boiler should not operate. Water flow indicator should light.
6. Test low gas pressure switch by closing main gas cock and attempting to restart boiler.
7. Inspect and clean blower fan and inlet screen of any accumulated dust or lint.
8. Check burner and clean off any soot or foreign material that may have accumulated. See Section 5.2 on "Cleaning the Burner." Check for corrosion of the burner and its parts. If there is evidence of deterioration or corrosion, replace immediately.
9. Inspect combustion chamber through access doors on front side of boiler. To remove doors, remove the screws at the top, then pull forward slightly, then pull upward. Note any signs of deterioration. Make repairs as necessary.
10. Inspect and clean heat exchanger. Clean exterior of finned tubes and flush inside of heat exchanger as required (separate from system flush).



11. Examine the venting system.
 - a. Check all joints and pipe connections for tightness.
 - b. Check pipe for corrosion or deterioration. If any piping needs replacing, do so immediately.
12. Perform combustion analysis.

5.2 CLEANING THE BURNER

1. Close pilot and main gas cocks.
2. Turn off the electric current to the boiler.
3. Remove the top cover of the boiler.
4. Disconnect the electrode wire.
5. Disconnect the UV scanner.
6. Remove mixer core.
7. Brush inside of burner to remove any accumulated dust or lint build-up.



8. Disconnect the union in the line at the burner.
9. Disconnect pilot and vent line, being careful not to disturb position of pilot.
10. Loosen and remove the four burner hold-down bolts.
11. Carefully remove the burner.

12. Brush the inside and outside of screen to remove all dust.

Note: The most effective method of cleaning the burner is to blow out the screen with compressed air.

13. Check that the ceramic portion of the ignition electrode is not cracked.
14. Check the position of the ignition electrode: 3/32"-1/8" spark gap. Check the tightness of the electrode clamp.
15. Use a soft, clean cloth to remove accumulated contaminants from the UV radiation tube (UV scanner) glass envelope.
16. Before re-installing the burner, check the cleanliness of the exchanger and the condition of the firebox floor.

5.3 REMOVING THE EXCHANGER

This work should be performed by qualified service personnel.

1. Remove the burner as above.
2. Remove the front doors by pulling forward and upward.
3. Remove the top panel of the inner cabinet.
4. Close the isolation valves to the system.
5. Drain the boiler.
6. Disconnect the supply and return lines.
7. Remove the manifold cross containing the temperature-pressure indicator, relief valve, and the water flow switch (on the D series units disconnect at the grooved pipe coupling [Victaulic]).
8. Remove the nuts and bolts from the flanges of the inlet and outlet nozzles at the rear of the outer casing.
9. Remove the exchanger and clean the fins.



Note: The inner and outer cabinets are separate parts and reassembly is easier if the inner cabinet and exchanger are removed together as one unit. When re-assembling, reseal the top of inner cabinet with aluminum tape as needed.

WARNING!

The heat exchanger is heavy; use proper lifting equipment and techniques.

5.4 AFTER ALL REPAIRS OR MAINTENANCE

1. Follow "Pre-Start Check List" (Section 3.10) and all "Safety Checks" (Section 3.11).
2. Check gas pressure and adjust gas flow if necessary. (See "Gas Pressure Adjustment", Section 3.12.2.)
3. Check air pressure and adjust air flow if necessary. (See "Air Flow Adjustment", Section 3.12.3.)
4. Perform combustion check.

5.5 SEQUENCE OF OPERATION

Status indicator lights located on the front of the control panel or on the flame safeguard of this boiler are specifically designed to indicate the sequence of operations and the cause of common problems. Careful observation of indicators should provide a guide to most operational conditions and problems.

1. When the On/Off (main power) switch is turned on, a green indicator marked "Power" is illuminated. Power is applied through a series of switches, including water flow, gas pressure and high temperature, and through the operating temperature control to the flame safeguard programmer.

Note: When the On/Off switch is in the Off position, there is still power to the DP Contactor (motor relay).
2. The water flow limit switch is closed when there is water flow through the boiler.

Note: The closing of this switch does not prove that flow is adequate. Refer to your local representative for proper flow requirements.

3. When gas pressure is available, the low gas-pressure limit switch is closed. Manual reset is required following conditions resulting in low gas pressure.
4. If the temperature sensed by the high-limit temperature control is below the set limit, the normally closed position of the switch sends power to the operating temperature control. Manual reset is required following conditions exceeding high-temperature limit. The limit series is complete unless the red jumper wire is removed and another external control (Building Management System, sequencer, etc.) is put in its place.
5. When heat is required, as indicated by outlet water temperature, power is applied to Terminal 6 of the programmer, which initiates the burner operating sequence, and to an indicator marked "Heat".
6. The programmer first energizes Terminal 4 which supplies power to the 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 (approximately 5-8 seconds).
7. A pre-purge period of 30 seconds occurs after the air proving switch closes and the programmer signals a continuation of the start sequence. During this time period the combustion chamber is pre-purged to eliminate any residual combustible gas or combustion products.
8. A 10-second "trial-for-ignition" period is initiated with both Terminals 10 and 8 being energized. Terminal 10 of the programmer powers the ignition transformer. The transformer output creates a spark at the igniter. Terminal 8 powers the pilot gas valve and the indicator for "Pilot" on the flame safeguard.
9. When a pilot flame is detected by the UV scanner, a signal is sent to Terminal F in the programmer and a "Flame" indicator is illuminated. Terminal 10 is de-energized shutting off the spark ignition and the pilot remains on for 10 seconds during the pilot flame establishing period.
10. After the pilot flame establishing period, Terminal 9 is energized, which opens both main gas valves and lights the "Main" indicator. After 10 seconds,



Terminal 8 is de-energized and the pilot valve and indicator light are extinguished.

Lo-Hi-Lo: When Terminal 9 is energized, the Lo-Hi-Lo valve will be maintained in the low fire position for "low fire start" for ten seconds. If the operating temperature control calls for high fire, the programmer will initiate high fire after this 10 second period.

11. When the desired water temperature is reached, the operating control switch opens and the programmer is de-energized at Terminal 6 and the indicator for "Heat" is turned off. This action also de-energizes Terminal 9, thus closing both main gas valves and turning off the indicator for "Main".
12. 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 that the limits on water flow, gas pressure, and high temperature are all met.

5.6 TROUBLESHOOTING

Loss of Power

In the event of a power failure the "Power" indicator is not illuminated and the entire system is de-energized, closing all automatic valves and halting all boiler operations. When power is restored the sequence of operation will resume at Step 5, provided that all the limits are satisfied.

Loss of Water Flow

When the "Water Flow" indicator is illuminated, there is insufficient water flow to close the switch, and burner operation is interrupted. When water flow is re-established, the sequence returns to Step 5, provided that the other limits are satisfied.

Low Gas Pressure

When the "Gas Press" indicator is illuminated, there is (or has been) insufficient gas pressure available for safe and proper operation of the boiler, and power to the programmer is interrupted. If a gas-supply shut-off

valve is closed for any reason, a low gas condition will result.

When gas pressure is restored, the "Gas Press" indicator will remain on and the boiler will remain locked out until the low gas pressure switch is manually reset.

On certain boilers equipped with a High Gas pressure switch, the "Gas Press" indicator may also be illuminated to indicate high gas pressure. This is also a manual reset condition.

Once the switch is reset, the sequence returns to Step 5, provided that the other limits are satisfied.

High Water Temperature

When the boiler water has exceeded both the operating and high-limit temperature; power to the programmer is interrupted. When the water temperature falls below the high-limit temperature, the boiler will remain locked out until the switch is manually reset. Once the switch is reset, the sequence returns to Step 5 to await heat demand below the operating temperature, provided that the other limits are satisfied.

**Low Air**

If the "Low Air" indicator remains on for longer than 10 seconds, there is insufficient airflow through the burner. Check that the burner is clean ("Cleaning the Burner", Section 5.2) before adjusting the air inlet damper (see "Air Flow Adjustment," Section 3.12.3). A low air indication does not necessarily mean that the low air switch is defective.

Ignition Failure

In the event the pilot flame is not detected by the UV scanner during the 10 second trial-for-ignition period (Step 8), the pilot gas valve and spark ignition are de-energized. At this time a safety lockout occurs which de-energizes all outputs from the programmer except Terminal A, which is connected to the "Flame Failure" indicator. A manual reset of the programmer (located inside the control panel) is required when a safety lockout occurs.

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 during a trial-for-ignition, a safety lock-out occurs (see Ignition Failure). If flame failure occurs and the indicator is illuminated, the programmer must be manually reset.

WARNING

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) 476-7261 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 WIRING DIAGRAMS

Wiring and control schematic drawings are shown on the following pages.

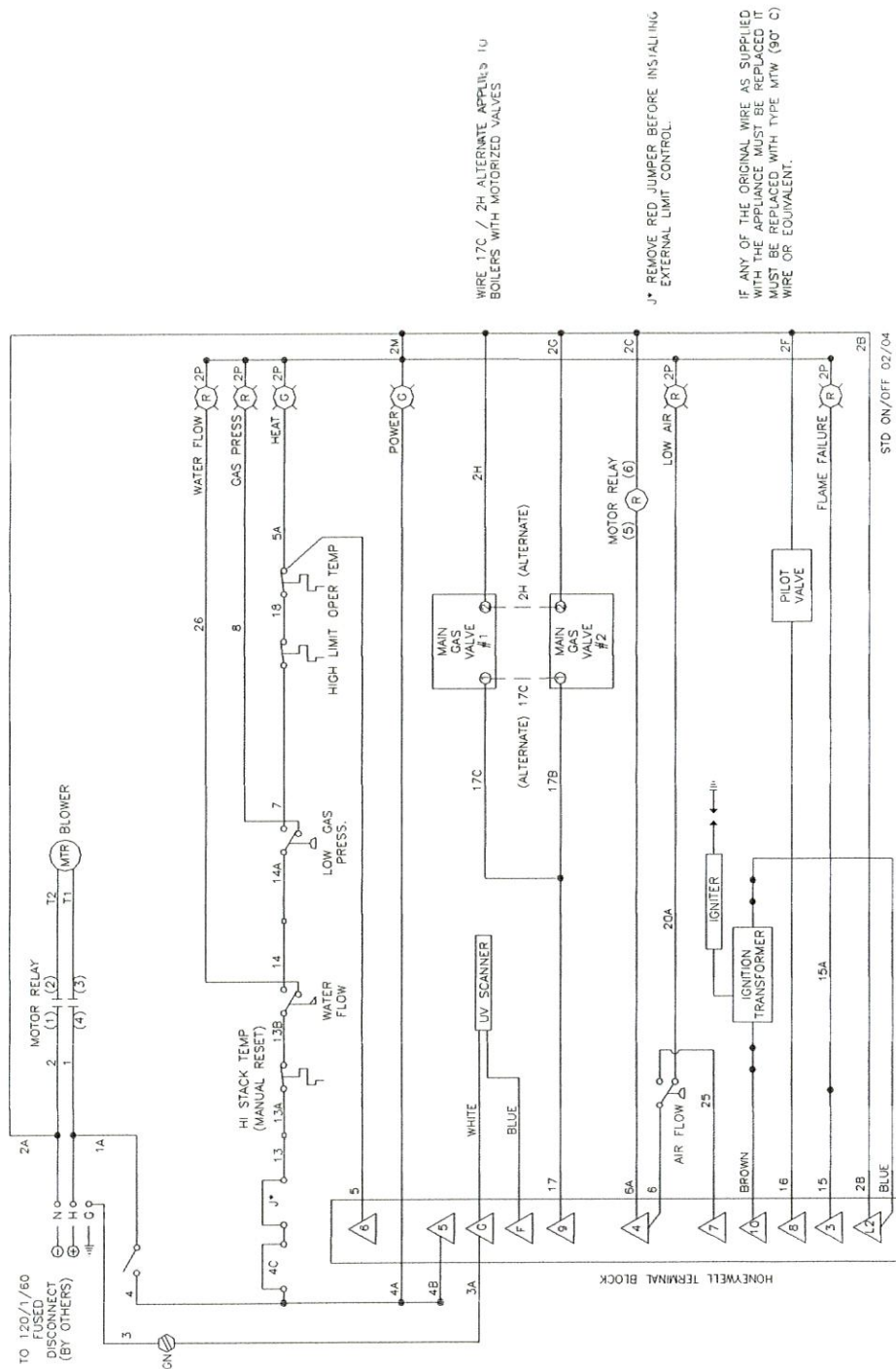
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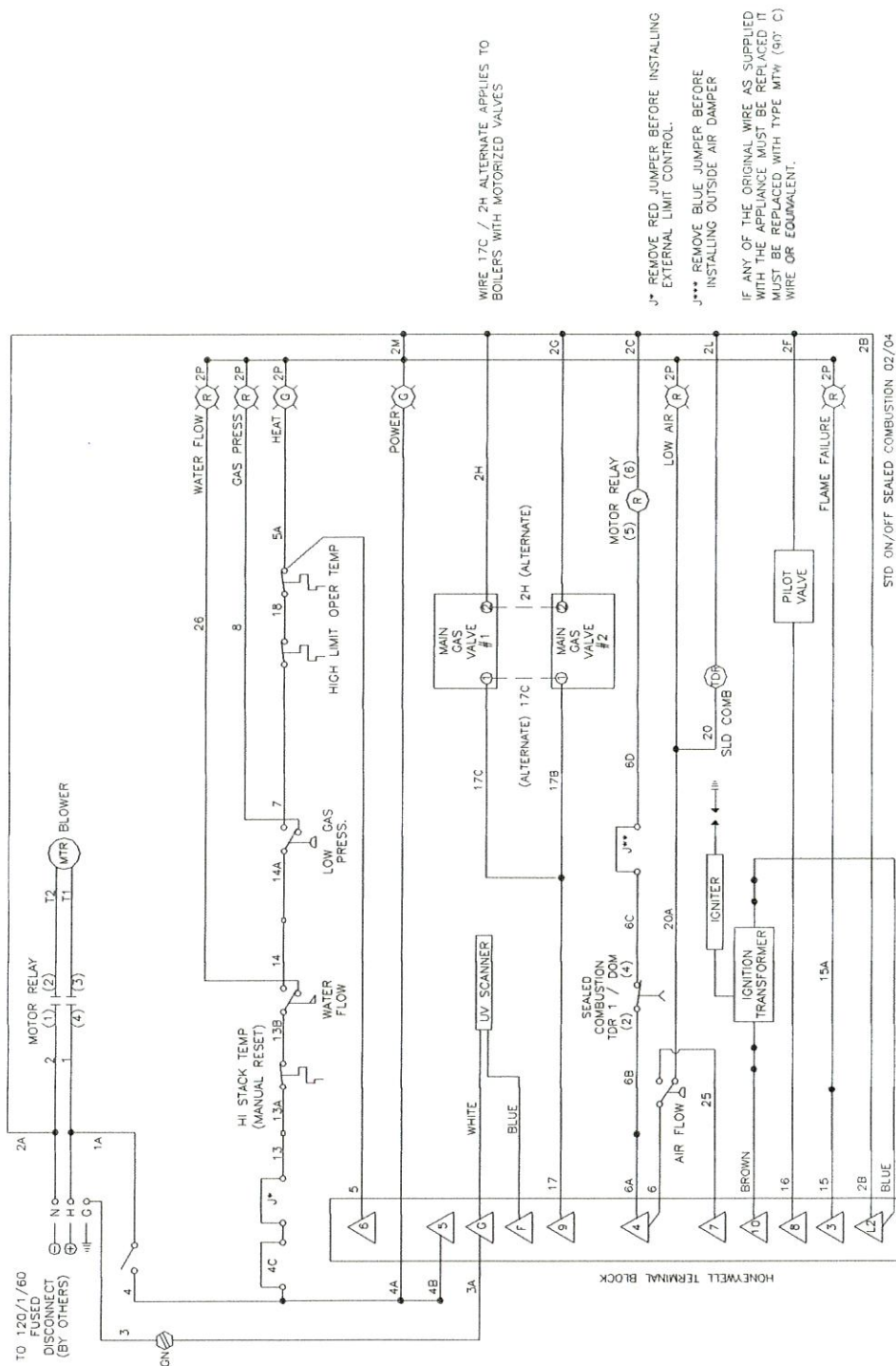
SC – Sealed Combustion



On-Off Wiring Diagram



On-Off Sealed Combustion Diagram



WIRE 17C / 2H ALTERNATE APPLIES TO
BOILERS WITH MOTORIZED VALVES

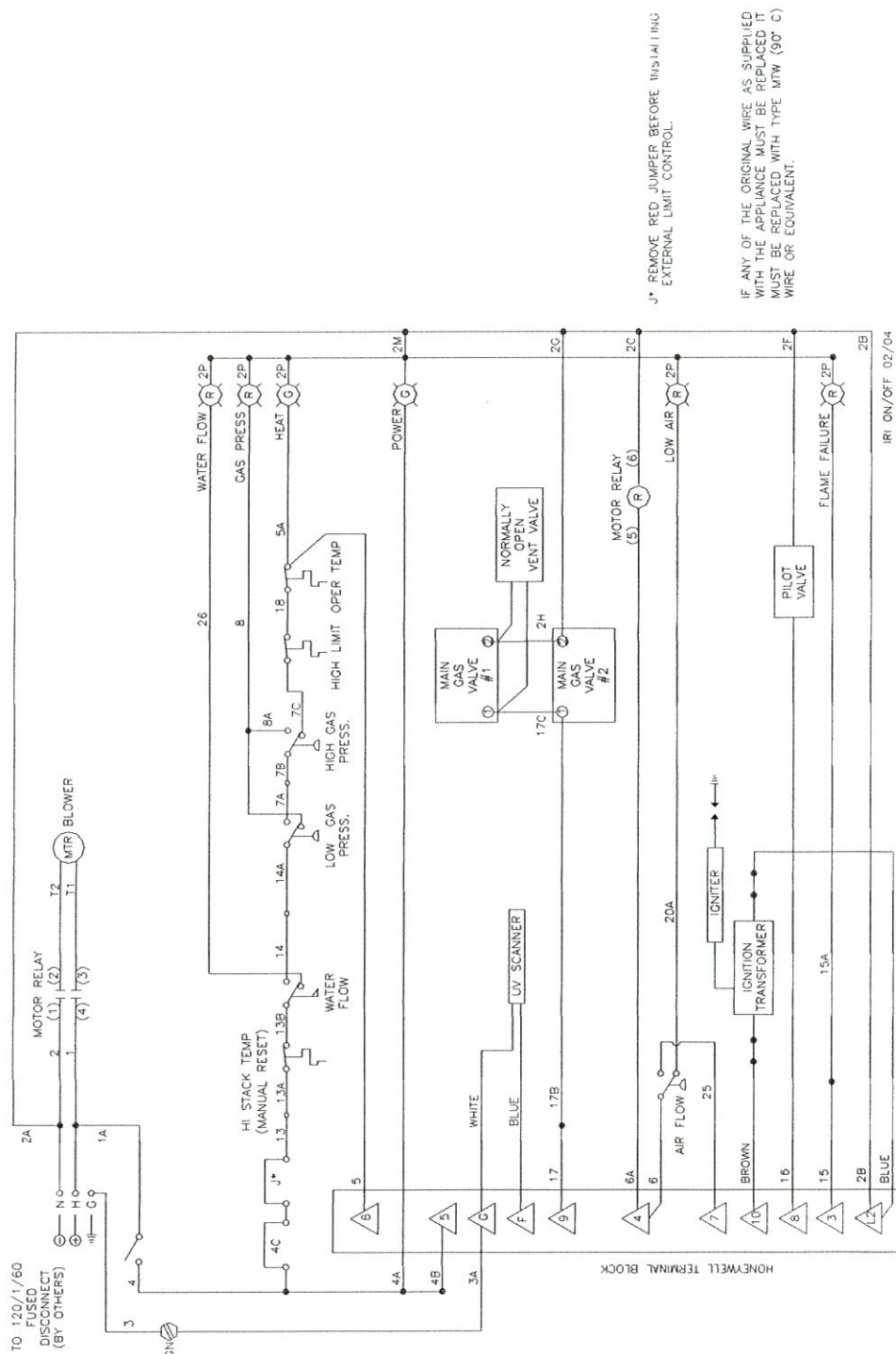
J* REMOVE RED JUMPER BEFORE INSTALLING EXTERNAL LIMIT CONTROL.

J*** REMOVE BLUE JUMPER BEFORE
INSTALLING OUTSIDE AIR DAMPER

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.

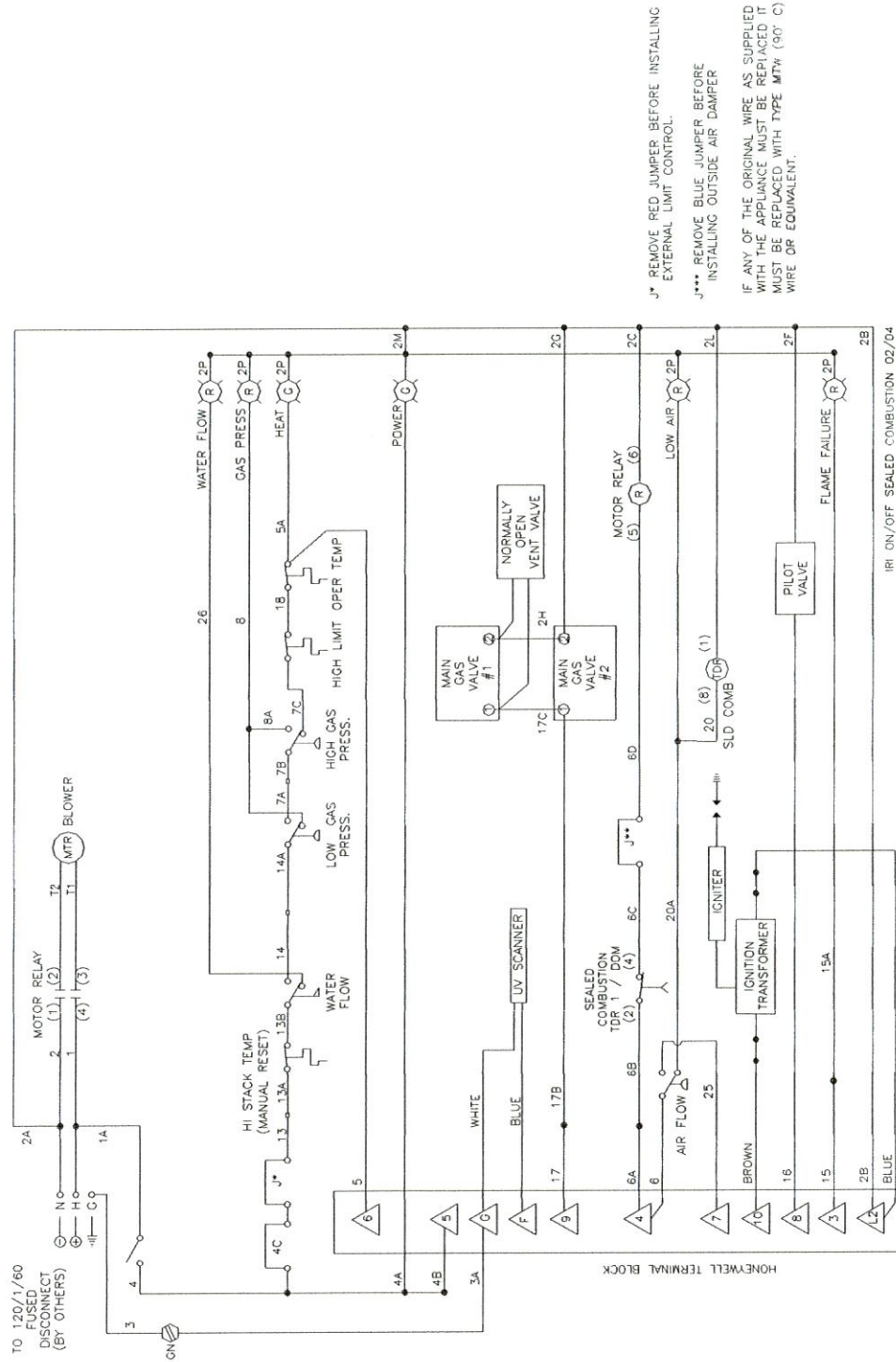
6.1.1a On-Off IRI

On-Off/IRI Wiring Diagram





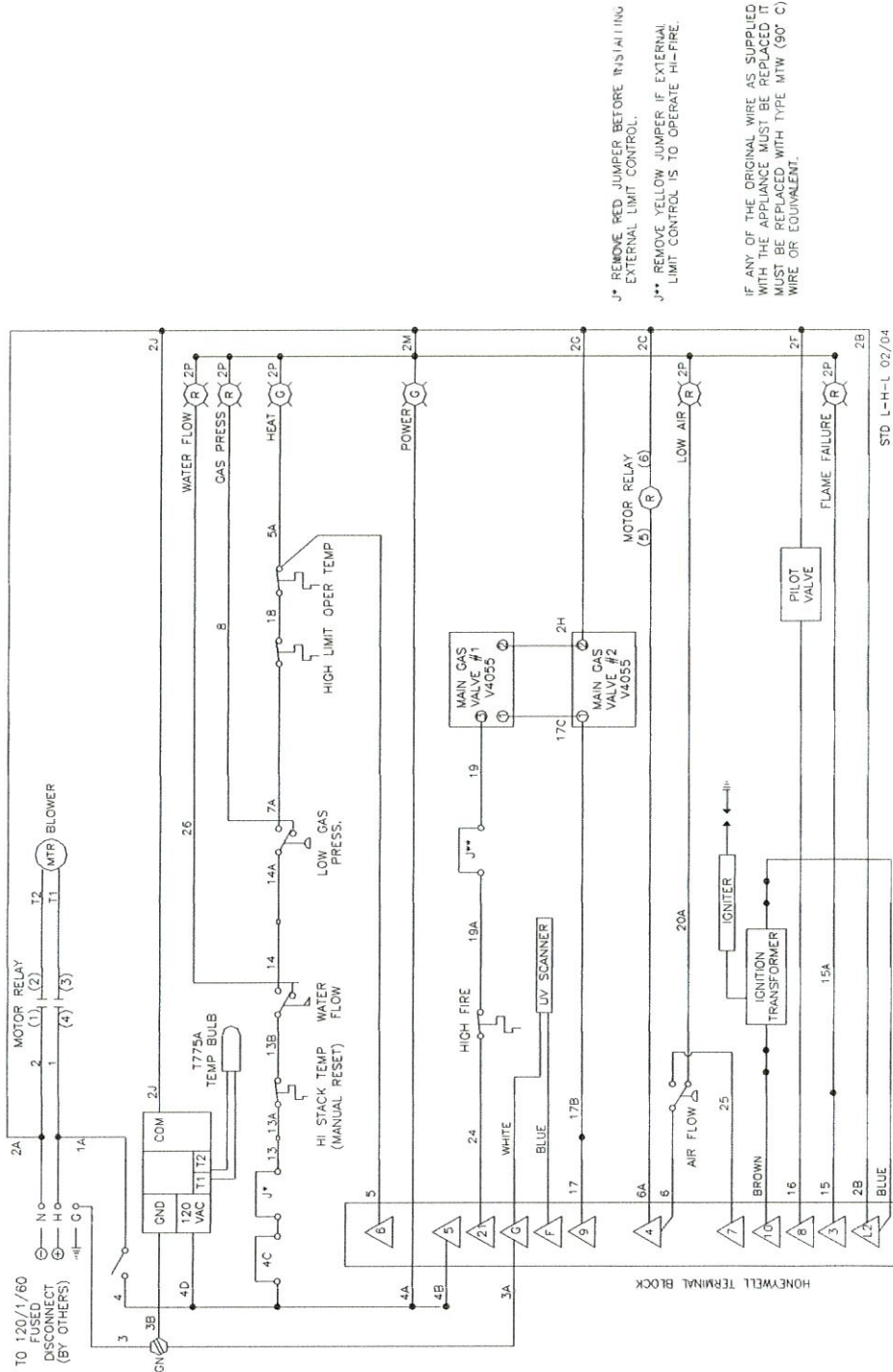
On-Off/IRI Sealed Combustion Diagram



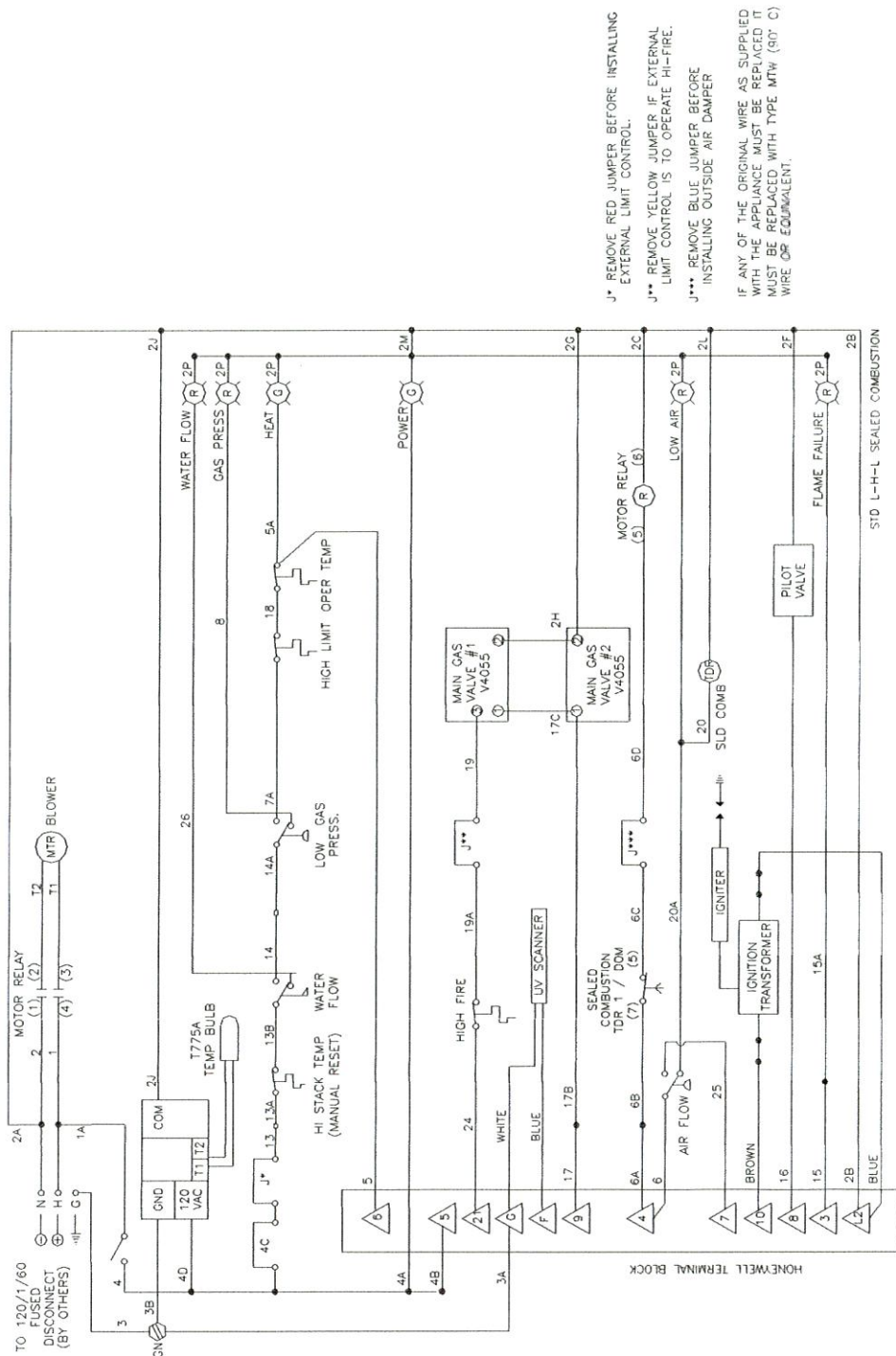


6.1.2 Lo-Hi-Lo

Lo-Hi-Lo Wiring Diagram

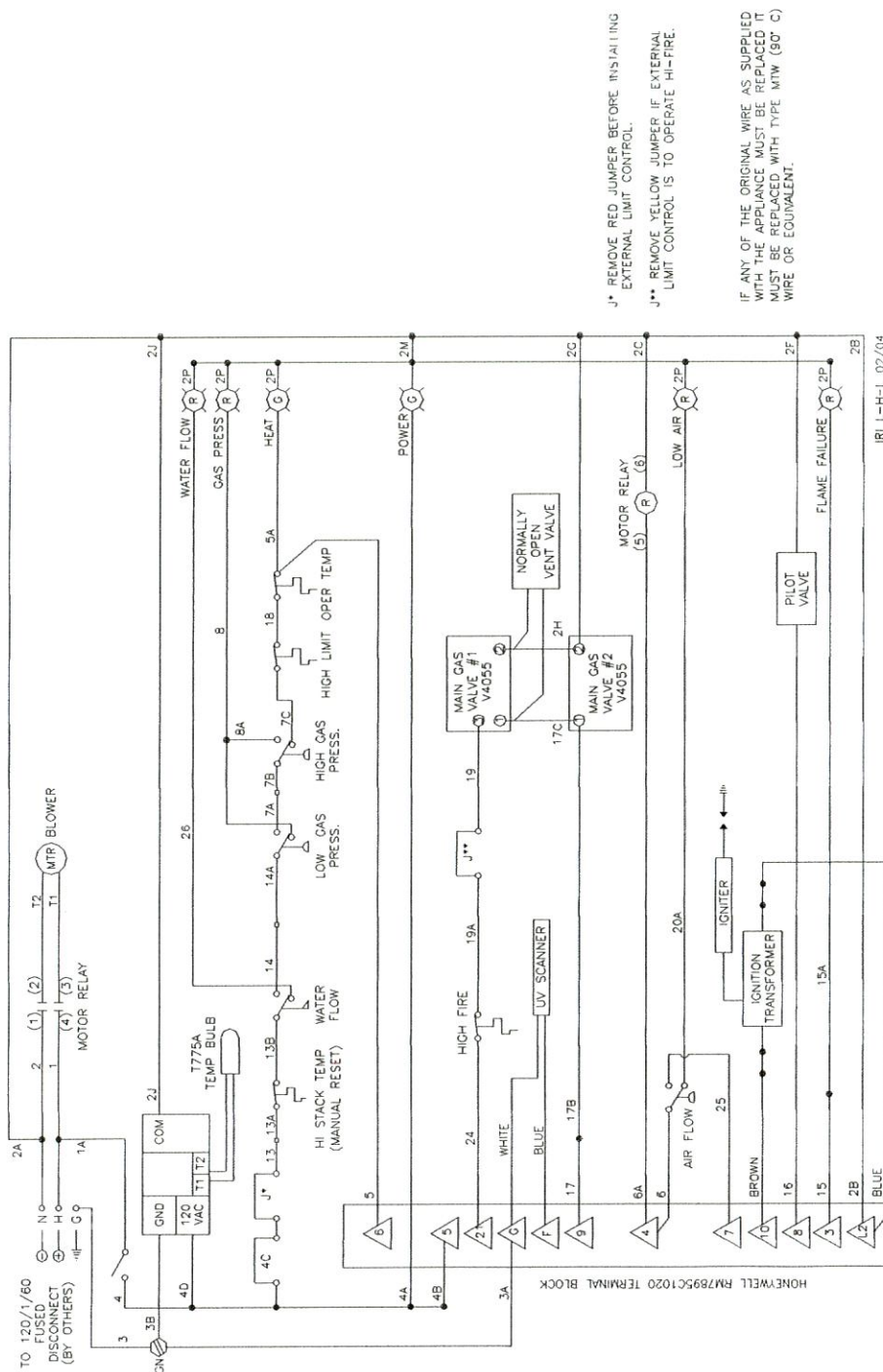


Lo-Hi-Lo Sealed Combustion Diagram



6.1.2a Lo-Hi-Lo IRI

Lo-Hi-Lo/IRI Wiring Diagram



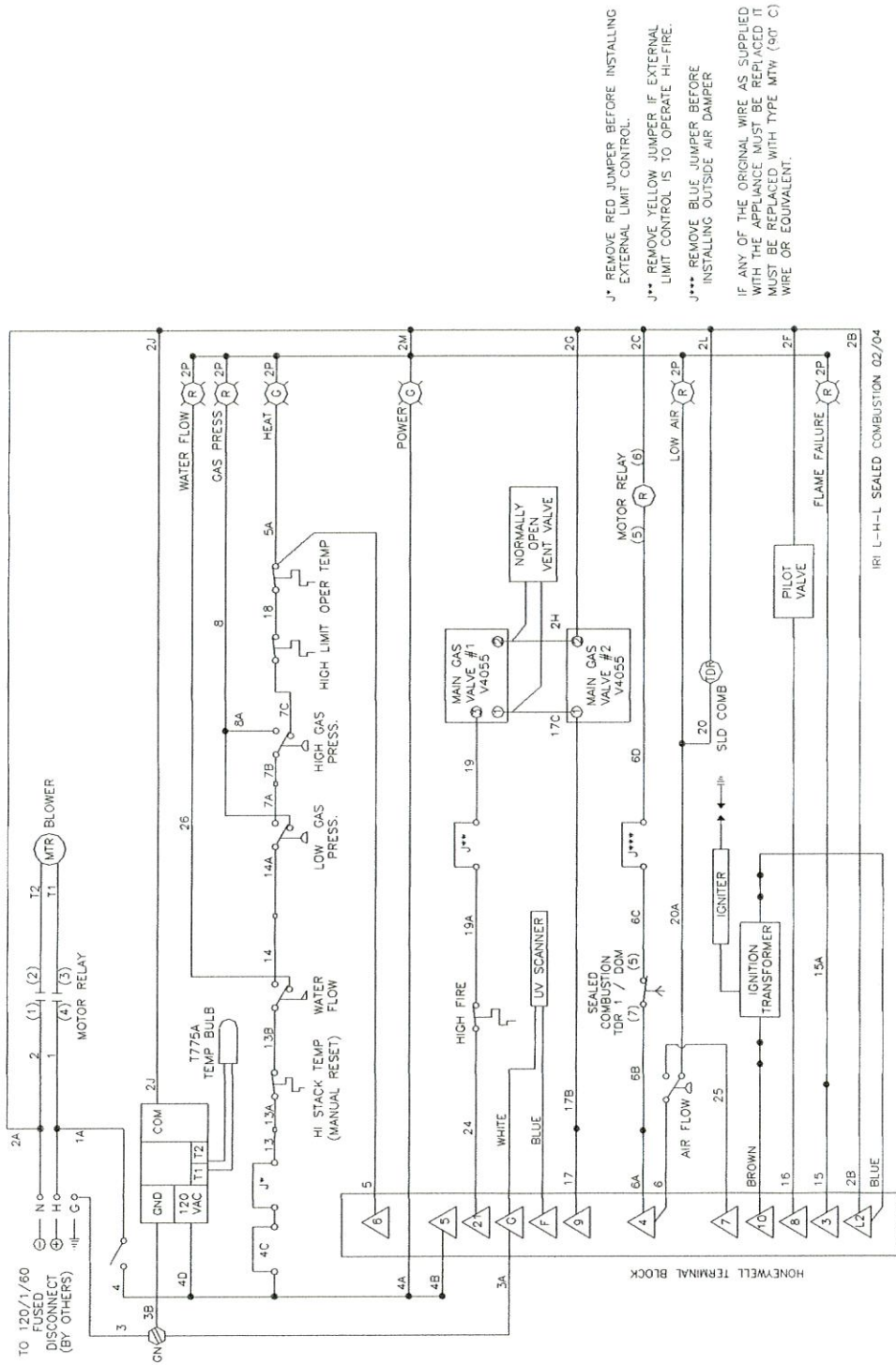
• REMOVE RED JUMPER BEFORE INSTALING EXTERNAL LIMIT CONTROL.

J** REMOVE YELLOW JUMPER IF EXTERNAL
LIMIT CONTROL IS TO OPERATE HI-FIRE.

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.



Lo-Hi-Lo/IRI Sealed Combustion Diagram

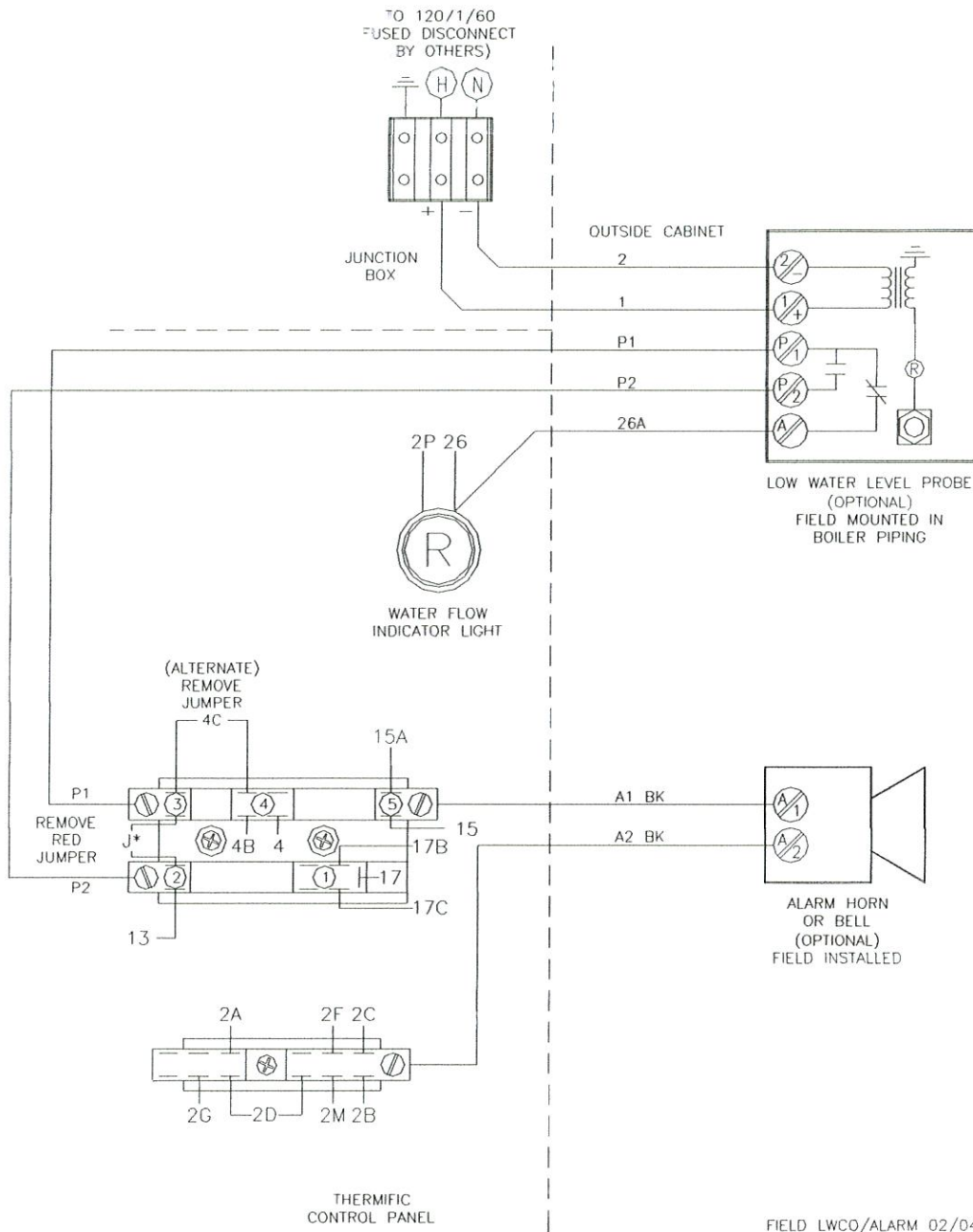


- J* REMOVE RED JUMPER BEFORE INSTALLING EXTERNAL LIMIT CONTROL.
 - J** REMOVE YELLOW JUMPER IF EXTERNAL LIMIT CONTROL IS TO OPERATE HI-FIRE.
 - J*** REMOVE BLUE JUMPER BEFORE INSTALLING OUTSIDE AIR DAMPER
- IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLANCE MUST BE REPLACED IT MUST BE REPLACED WITH TYPE MTW (90° C) WIRE OR EQUIVALENT.



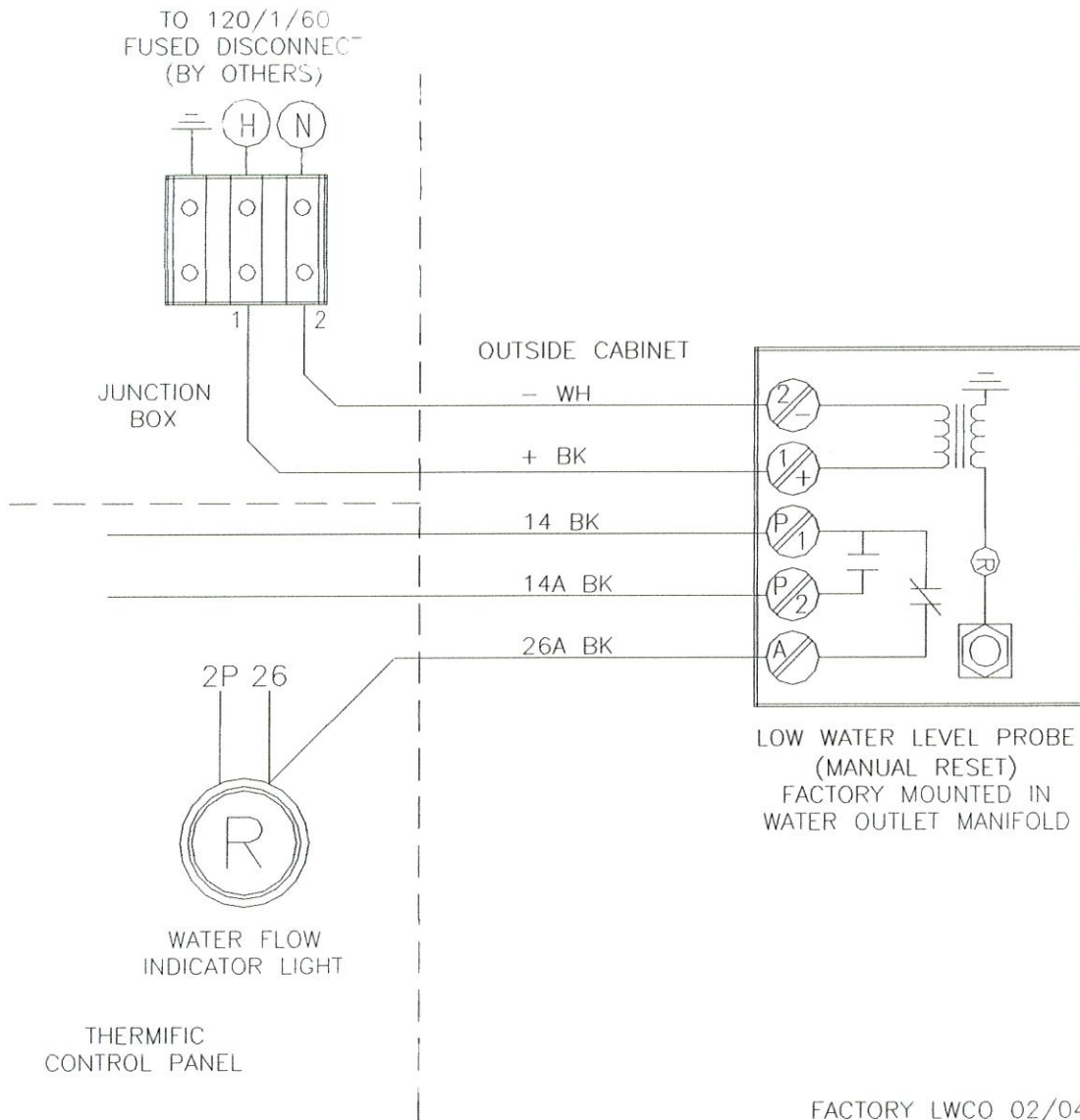
6.1.3 Water Cut-Off

Field Installed Low Water Cut-Off Diagram





Factory Installed Low Water Cut-Off Diagram

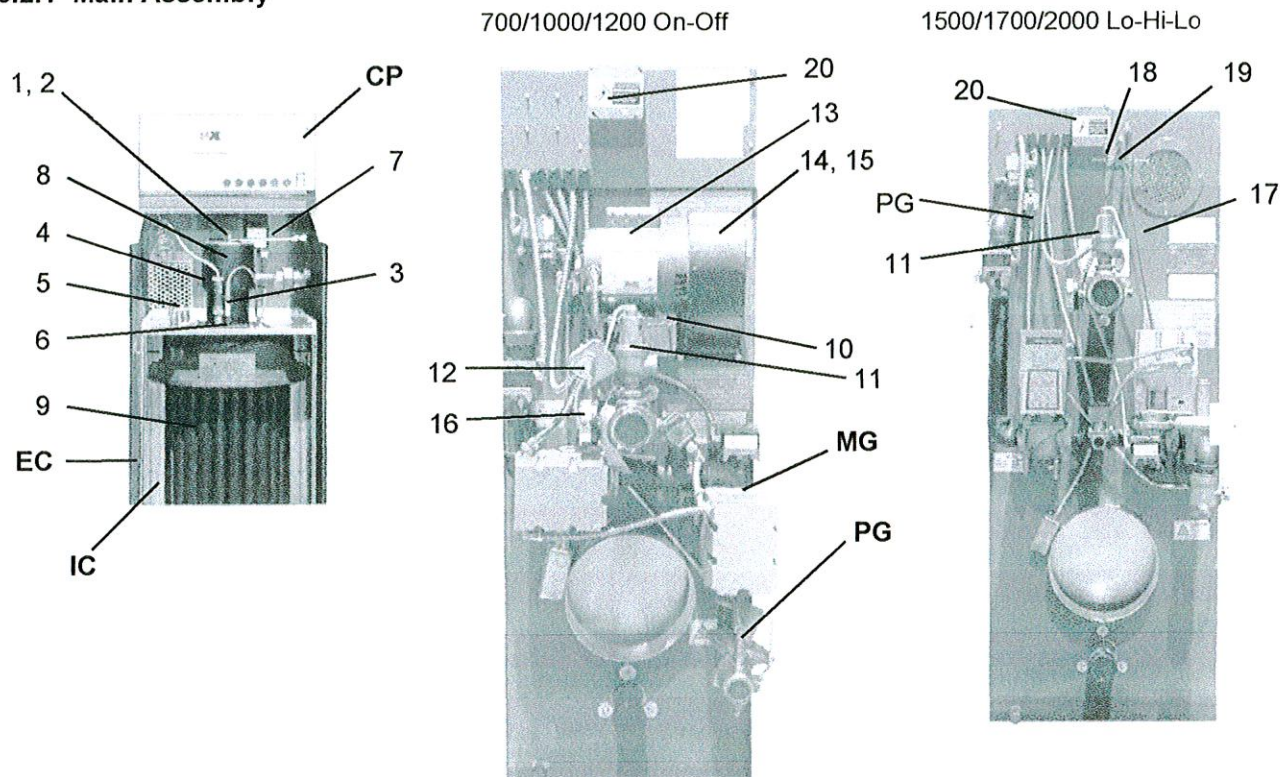


FACTORY LWCO 02/04



6.2 BOILER PARTS LIST

6.2.1 Main Assembly



No.	Part
1	Mixer Core, Burner
2	Burner Orifice
3	Spark Igniter Electrode
4	UV Scanner
5	Thermowell w/Clamp
6	Electrode Assembly w/Mica
7	Pilot Tube
8	Burner
9	Heat Exchanger
10	Blower, Damper (inside cabinet)
11	Pressure Relief Valve (100 PSI)
12	Water Flow Switch
13	Blower, Motor
14	Blower, Housing

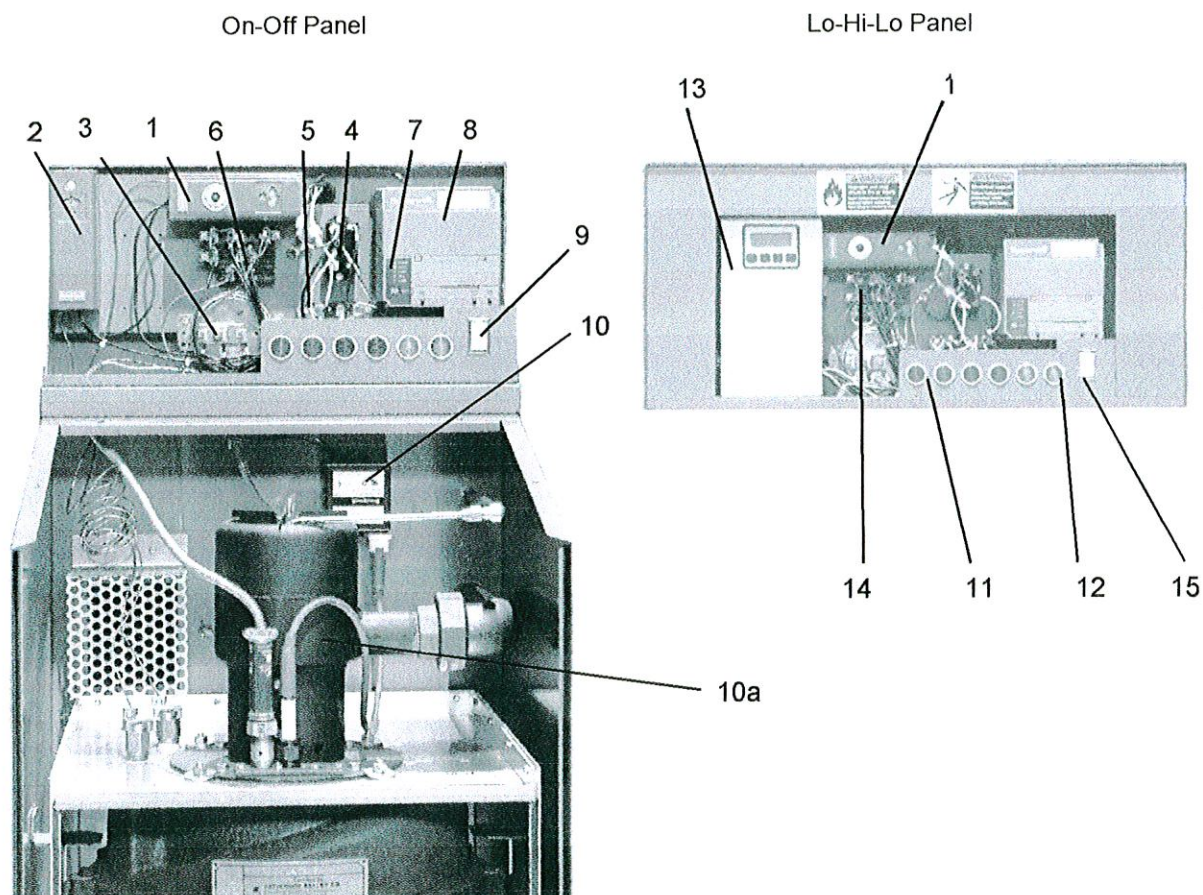
No.	Part
15	Blower, Wheel
16	Press./Temp. Gauge (w. 100 PSI relief valve)
17	Damper Rod, Lo-Hi-Lo
18	Definite Stop Bracket
19	Definite Stop
20	Junction Box, Power

Installation/Owner's Manual All Models -TBIG

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



6.2.2 Control Panel



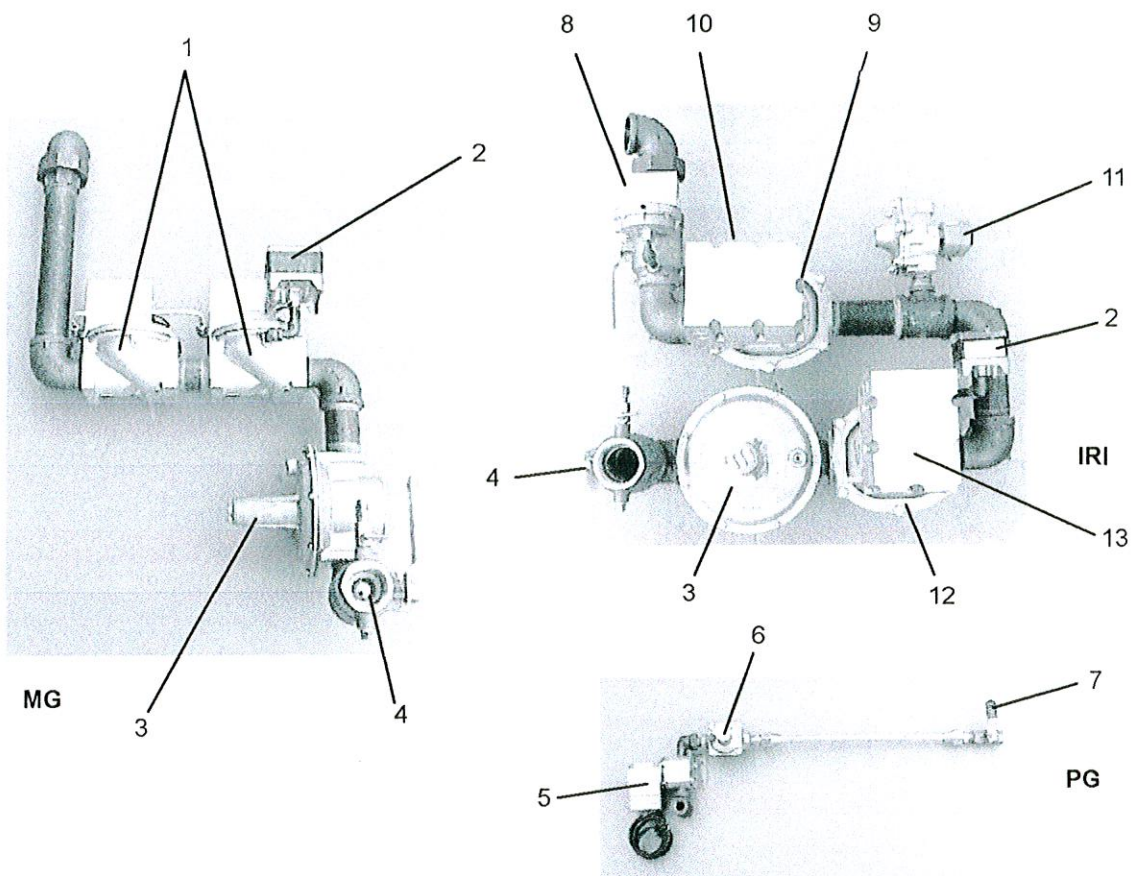
No.	Part
1	Thermostat (Manual Reset)
2	Thermostat (Oper. Temp)
3	Air Flow Switch
4	Motor Starter Relay
5	Terminal Block, Neutral
6	Terminal Block, Junction
7	Flame Safeguard Programmer
7a	Amplifier (UV Scanner)
7b	Timing Card, 30 sec.
8	Programmer, Sub-Base
9	Switch, On/Off

No.	Part
10	Ignition Transformer
10a	Ignition Cable
11	Indicator Light, Red
12	Indicator Light, Green
13	Lo-Hi-Lo, Oper. Thermostat
14	Lo-Hi-Lo, Jumper Terminal Block
15	Switch, Lighted On/Off

Low Water Switch (Optional)
Alarm Bell (Optional)



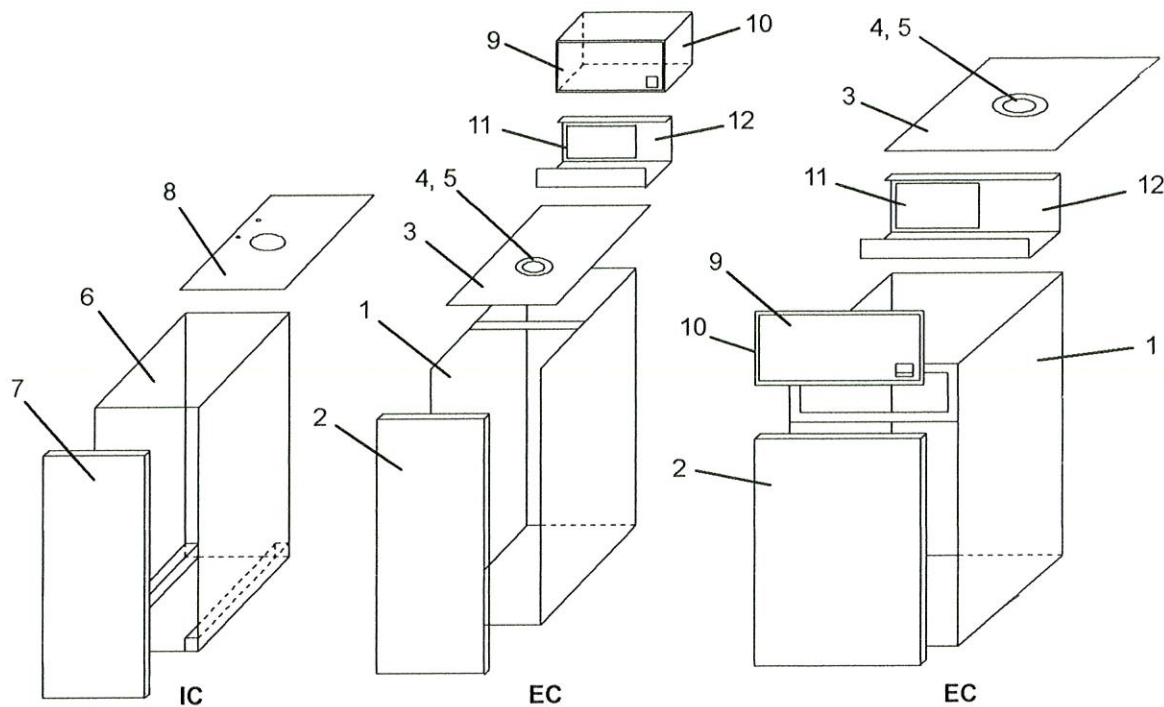
6.2.3 Gas Train



No.	Part
1	Main Gas, Valve (Diaphragm)
2	Low Gas Pressure Switch
3	Main Gas, Regulator
4	Main Gas, Shut-off Cock
5	Pilot, Solenoid Valve
6	Pilot, Regulator
7	Pilot, Shut-off Cock
8	High Gas Pressure Switch
9	Main Gas, Valve Body
10	Main Gas, Valve Actuator
11	Vent Valve, Gas
12	Lo-Hi-Lo, Valve Body
13	Lo-Hi-Lo, Valve Actuator



6.2.4 Cabinet



No.	Part
1	Exterior Cabinet, Assy.
2	Exterior Cabinet, Door
3	Exterior Cabinet, Top
4	Sight Glass
5	Sight Glass Bezel
6	Combustion Chamber, Assy.
7	Combustion Chamber, Door
8	Combustion Chamber, Top
9	Control Panel, Label
10	Control Panel, Cover
11	Control Panel, Sub Panel
12	Control Panel, Base Assy.



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") 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 (1) 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., P.O. 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 the 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 (1) 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.