

## **Thermific™ Boiler**

# **GAS-FIRED BOILER INSTALLATION GUIDE**



A.G.A. Design Certified  
Complies with ANSI Z21.13  
Low-Press. Boiler



C.G.A. Approved  
Complies with CAN1-3.1  
Ind. & Comm. Boilers

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**PATTERSON-KELLEY CO.**

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## GUARANTEE

Patterson-Kelley Co. guarantees all materials, components and workmanship used in the construction of Thermific Hot Water Boilers to be of the highest quality. If any part should prove defective within one year from date of start-up, a new part will be supplied without charge F.O.B. East Stroudsburg, PA, provided that the boiler is started within six months from date of shipment. We further guarantee each boiler to perform at its rated capacity.

The Company makes no warranties covering deterioration or failure due to corrosion, erosion, scaling, sooting or to improper installation or operation. There are no other guarantees or any warranties, expressed or implied, of merchantability or otherwise.

### FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Don't touch electrical switches.
3. Extinguish any open flame.
4. Immediately call your gas supplier.

### FOR YOUR SAFETY

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

### WARNING:

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to this manual. For assistance or additional information consult a qualified installer, service agency or the gas supplier.

Authorized Representative:

┌

Installation Date: \_\_\_\_\_

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## INTRODUCTION

The P-K Thermific Gas-Fired Boiler combines a radial pre-mix 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.

Please read this entire manual before installing or operating the boiler. 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.

This manual covers installation of P-K Thermific Boiler Models N-700, N-900, N-1200, N-1500, N-1700, and N-1900. The model numbers may be followed by a suffix letter in some cases to indicate special features or different options. Not all boilers and not all options are A.G.A. Design Certified or CGA Approved, check the rating plate.

While details may differ slightly, basic operation is the same for all models; determine from the purchase order if any special features apply to the boiler. Boilers may be built to operate with natural gas or liquified petroleum gas, check 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, may 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.

## 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 to 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 of the burner is centered and has not moved in shipment (see section on **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 carrier.

## 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.

## CODES

The Thermific Boiler with standard components and many options is A.G.A. Design Certified and complies with ANSI Z21.13, latest edition, Low-Pressure Boilers. Units with a "C" suffix on the model number are CGA Approved and conform to CAN1-3.1, with latest revisions, Industrial and Commercial 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. Other codes or approvals which apply will be labeled on the boiler.

Installation of the boiler must conform to all the requirements of the 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-B149, 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, No. (CSD-1).

## INSTALLATION PROCEDURE

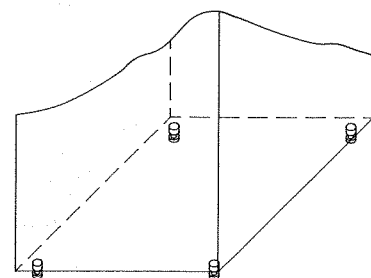
### FOUNDATION

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.

### PLACEMENT

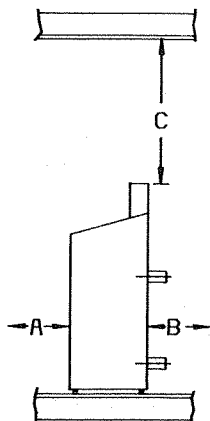
The boiler must be level to function properly. To assist in leveling the boiler, the four (4) leg bolts (1/2"-13NC) holding the boiler to the shipping skid must be reinstalled in the threaded legs on the bottom. The adjustable legs are also necessary to provide adequate floor clearance and prevent distortion of the cabinet, in addition to leveling.



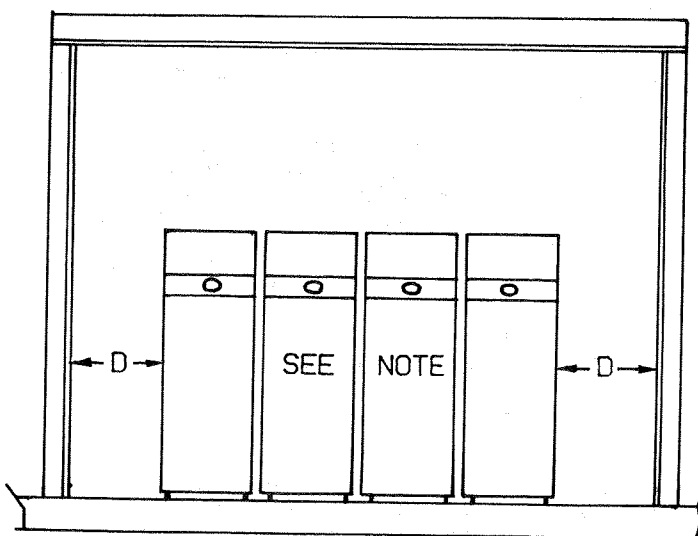
Adjustable Legs for  
Leveling and Floor Clearance

**NOTE:** If for any reason the boiler is not level, air pockets may be trapped in the top of the heat exchanger, which could cause premature failure.

## CLEARANCES



If the boiler is to be installed near combustible surfaces, the minimum clearances shown in the accompanying table must be maintained. Failure to provide for the service access clearances, even with non-combustible surfaces, will cause future problems servicing the boiler. The boiler must be installed in a space large in comparison to the boiler for adequate air circulation.



Minimum Clearances  
from Adjacent Walls and Ceiling

Type of Surface	Dimensions			
	A	B	C	D
Combustible Surfaces	30	24*	24	24
Non-Combustible Surfaces	30	24*	18	24**

\* A.G.A. minimum. Actual clearance depends upon stacking requirements.

\*\* Service access need be on only one side of a boiler or row of boilers. However, P-K strongly recommends service access space between each boiler.

In Canada: the boilers are approved for installation with zero clearance to combustible surfaces, but 48 inch service clearances are recommended.

## ELECTRICAL CONNECTIONS

The boiler is wired for 120 volts, single phase, 60 hertz. The total operating amperage is indicated on the rating nameplate. The N-700 and N-900 models require less than 8 amps; the N-1200 less than 9 amps; the N-1500, 1700 and 1900 less than 12 amps. Before starting the boiler, check to insure 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. In Canada, wire according to the current Canadian Electrical Code.

**NOTE:** A dedicated earth ground is recommended to avoid nuisance shutdowns. It is also important that proper polarity be maintained.

## COMBUSTION AIR OPENINGS

The boiler room should be provided with two openings to assure 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.

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 a 1,200,000 Btu per hour boiler.

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).

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.

**CAUTION:** Under no circumstances should 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.

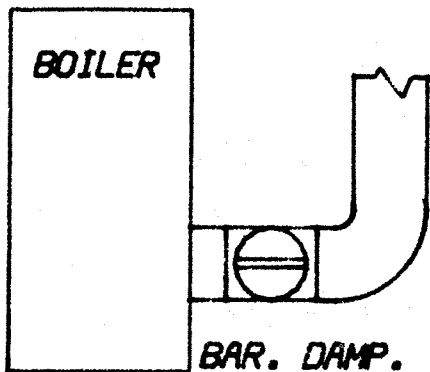
The combustion air supply must be completely free of chemical fumes, which may be corrosive when burned in the boiler. Common chemicals which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as freon, trichlorethylene, perchlorethylene,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

## FLUE VENTING

This boiler operates with a non-positive flue vent pressure and with a vent gas temperature at least 140°F above its dew point. These flue conditions correspond to Category I as defined in Part IV of ANSI Z21.13, latest edition. This boiler is suitable for use with Type B gas vent. As such it may also be used with Type L gas vent or an appropriately sized chimney. If local codes (CAN/CGA-B149) specifically prohibit the use of B-vent without a draft hood, the alternative is usually single wall meta' pipe.

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 provide a zero to slightly negative pressure (less than 0.1 inches of water column) at the boiler flue outlet with a stack temperature of 280°F.

To assist in providing suitable draft conditions, a barometric damper is supplied with each boiler, and should be installed according to the following guidelines:



**Barometric Damper Location**

1. locate the barometric damper immediately after the flue connector. A tee off the flue connector is recommended.
2. the damper may be located in either side of the horizontal section of stack.
3. in a multiple boiler installation, one barometric must be installed with **each** boiler.

Be sure that the damper hinge is mounted horizontally (**never vertically**). Be sure to remove all three (3) red stops from the damper **before start-up**. The damper door should swing freely. Carefully follow all the instructions provided with the barometric damper.

**Important:** 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.

The connection from the boiler to the vent should be as direct as possible and the upward slope of any horizontal breeching should be at least 1/4 inch per linear foot. This boiler shall 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.

The minimum vent height above the flue outlet should be five (5) 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 should be provided with a weather cap of approved design and adequate capacity.

**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.

All vent installations in the U.S. shall be in accordance with Part 7, Venting of Equipment, of the National Fuel Gas Code, ANSI Z223.1, latest edition, or applicable provisions of the local building codes. In Canada, refer to the current Installation Code for Gas Burning Appliances and Equipment, CAN/CGA-B149.

### 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 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 intermediate gas pressure regulator of the "lock-up" type must be provided to reduce the pressure to less than 14 inch W.C. All boilers are designed to operate at rate with a minimum inlet pressure of 4 inches W.C. with natural gas, 7 inches W.C. with LP gas.

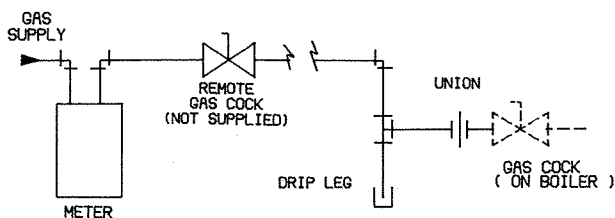
**CAUTION:** All threaded connections must be made using a pipe joint compound that is resistant to the action of liquified petroleum gases. Do not use teflon tape on gas line threads.

**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-B149.

**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 table 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						
		90 deg Ell		Equivalent Length of Pipe in Feet						
		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	1460	990	810	-	-	-	-
2	2.067	5.2	10.3	2750	1900	1520	1300	1150	950	800
2-1/2	2.469	6.2	12.3	4350	3000	2400	2050	1850	1500	1280
3	3.068	7.7	15.3	7700	5300	4300	3700	3250	2650	2280
4	4.026	10.1	20.2	15800	10900	8800	7500	6700	5500	4600



### 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.

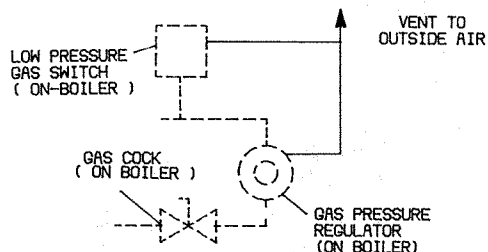
The boiler must be disconnected at the boiler shut-off valve from the gas supply piping system during any pressure testing of the system at pressures in excess of 1/2 psig (14 inch W.C.).

The boiler should be isolated from the gas supply piping system by closing the manual shutoff valve during any pressure testing of the gas supply piping system at pressures equal to or less than 1/2 psig (14 inch W.C.).

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

### 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 pressure regulator and gas pressure switches.



### Gas Vents by Installer

**NOTE:** The vent line connection on the gas pressure regulator and the low gas pressure switch (and high gas pressure switch, if so equipped) 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 & 2.9.7. If an N.O. vent valve is provided, it must be vented separately.

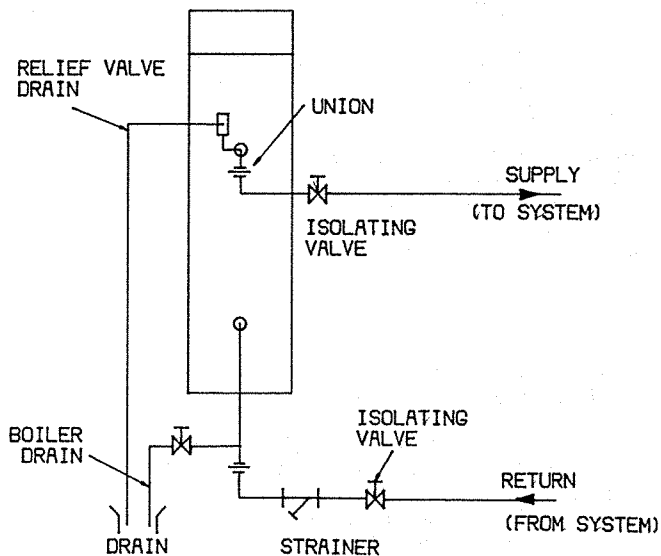
### BOILER INLET AND OUTLET CONNECTIONS

Make water connections as the application warrants, or at a minimum, as illustrated in BOILER WATER PIPING BY INSTALLER, but always in compliance with local requirements.

**Note:** Pipe unions and isolation 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 on the boiler is the "OUTLET" and should be connected as the **supply to** the system.



### Boiler Water Piping by Installer

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. (See Water Flow and Head Loss table.)

### RELIEF VALVE

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 CUTOFF

The boiler is furnished with a flow-switch-type low water cutoff, 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.

**WARNING:** Never install a valve that can isolate the low water cutoff from the 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 factory for details.

### DRAIN 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.

### FILLING THE BOILER

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

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. Close the valve and finish filling the system.

### WATER FLOW IN SYSTEM

Ideal operation of the Thermific Boiler would call for a 20 F degree temperature differential across the heat exchanger. The operating thermostat has an adjustable temperature differential. Water flow rates to achieve these conditions are shown in the Water Flow and Head Loss Table. 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 MACHINE

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.

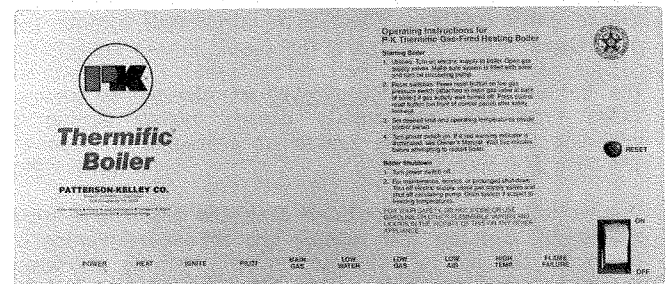
### BURNER AND IGNITION SYSTEM INSPECTION

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".) Inspect the pilot line, main gas train and ignition electrodes to be sure that 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.

### 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 and the line purged of air.
3. Water connections are complete, and the boiler and system have been filled and purged of air.
4. The boiler is connected to a 120 volt power source with 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, in accordance with the "CLEARANCES" section of this instruction manual.
7. Relief valves have been piped to floor drains.



### 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 (operating) and red (problem) indicators. The illuminated letters indicate the condition of the boiler.

### SAFETY CHECKS

#### IGNITION SAFETY SYSTEM

Before placing boiler in operation, test ignition system safety shutoff as follows:

**Disconnect** at least one wire leading to a main gas valve. With the main gas cock (manual gas valve) open and the pilot gas cock open, the burner should be cycled on.

After all of the safety limits on gas pressure, water flow and temperature are satisfied, the blower will run and pre-purge the boiler. When the air flow is established the ignition transformer and pilot will operate. Both of these functions will be indicated by separate green lights on the control panel. If a satisfactory pilot is obtained, the main gas valve indicator will be illuminated, even though a main gas valve will not open with a wire disconnected and gas will not flow to the main burner. Check for a good pilot flame, then immediately close the pilot gas cock. This will extinguish the pilot flame, and close the main gas valves, indicator lamp off. The pilot will try to re-light, but with the pilot cock closed the pilot cannot re-light and the flame safeguard programmer will go to a "lockout" mode, illuminating the red "FLAME FAILURE" indicator. This condition requires a manual reset of the flame safeguard.

**Reconnect** the wire(s) to the main gas valves.

#### LOW WATER CUTOFF

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



## WATER FLOW AND HEAD LOSS

### Design Temperature Rise Across Boiler

Model	15 deg.F		20 deg.F		25 deg.F		30 deg.F		35 deg.F		40 deg.F	
	Flow gpm	Loss ft.hd.	Flow gpm	Loss ft.hd.	Flow gpm	Loss ft.hd.	Flow gpm	Loss ft.hd.	Flow gpm	Loss ft.hd.	Flow gpm	Loss ft.hd.
N- 700	79	6	59	4	*		*		*		*	
N- 900	102	8	76	6	61	4	51	4	*		*	
N-1200	**		102	8	81	6	67	5	58	4	50	4
N-1500	170	11	127	7	102	5	85	4	73	4	64	3
N-1700	***		144	8	116	6	96	5	83	4	72	4
N-1900	***		161	10	129	7	108	5	92	5	81	4

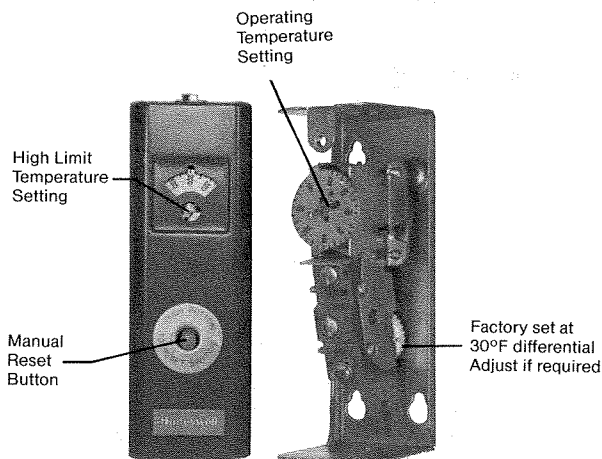
\* 50 gpm minimum. \*\* 120 gpm maximum. \*\*\* 180 gpm maximum.

system. After turning off the pump, turn the boiler back on. It should not operate, and a red indicator for "LOW WATER" 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.

### HIGH-LIMIT CONTROL

With the main burner operating, turn down the temperature setting on the "high-limit" thermostat until the main burner shuts off and the red "HIGH TEMP." indicator is illuminated. 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). Re-adjust thermostats to desired operating temperature and set high-limit temperature, typically 20°F above operating temperature.

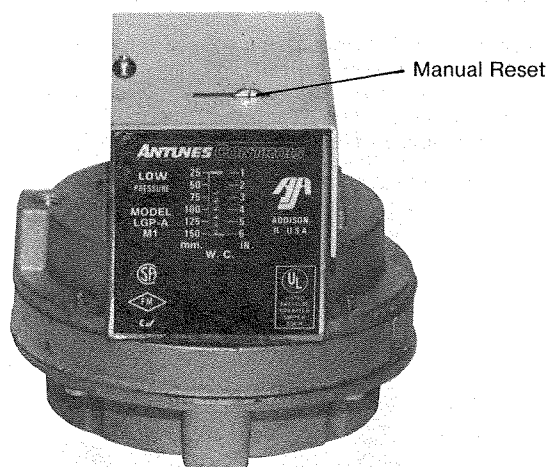


High-Limit and Operating Thermostats

### GAS PRESSURE SWITCH

The boiler is furnished with a low gas pressure switch. The operation of this switch should be checked by slowly closing the main gas cock while the burner is operating. The low gas-pressure switch should shut-down the main burner before combustion problems are encountered. When the gas-pressure switch opens, the "LOW GAS" indicator will illuminate. Upon re-opening the main gas cock, the

"LOW GAS" indicator should remain on until the low gas-pressure switch is reset.



Low Gas Pressure Switch

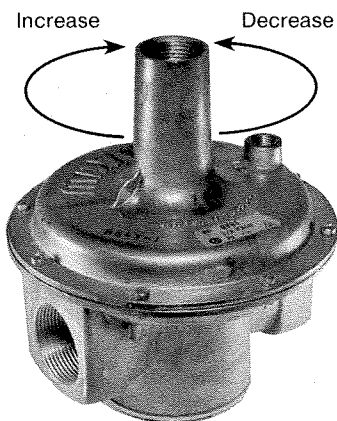
**WARNING:** After checking controls by manual re-adjustment, make sure they are always reset to their proper settings.

**NEVER** attempt to operate a boiler that has failed to pass all the safety checks outlined above. This work should be done by qualified service personnel.

### GAS PRESSURE ADJUSTMENT

See rating plate for the minimum and maximum gas pressure of the boiler. Each boiler is furnished with two 1/8" I.P.S. plugged taps in the gas manifold for test gauge connections. One tap is located in the main gas cock for measuring the gas supply pressure. 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, 7 in. W.C. for propane). The second tap is located downstream from the last main gas control in the pipe joint where the gas line enters the back of the cabinet and is for measuring the manifold gas pressure.

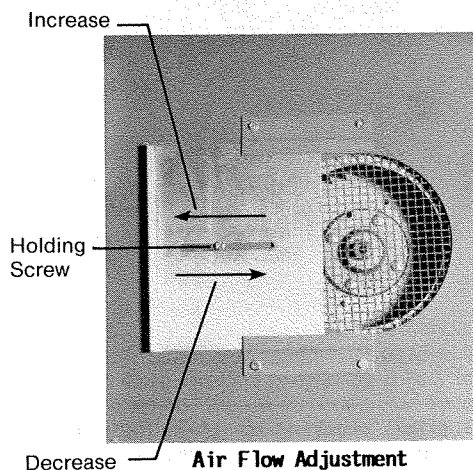
To adjust gas pressure, first connect appropriate pressure-sensing device at the manifold tap, then remove seal cap from regulator. Turn adjusting screw



clock-wise to increase pressure, counterclock-wise to decrease pressure. The manifold gas pressure on the "Rating Plate", inside the control panel cover, is provided only as a guide to the proper setting. The manifold gas pressure indicated on the "Factory Firetest" label affixed inside the control panel cover should be used to achieve the proper firing rate of the individual boiler. Replace seal cap after adjustment.

#### AIR FLOW ADJUSTMENT

Loosen the holding screw on the air shutter and open or close the shutter as required to adjust cabinet pressure, measured at the fitting on the back of the cabinet, to that shown on the "Factory Firetest" label. Re-tighten holding screw after adjustment.



If combustion measurement instrumentation is available, adjust air flow for carbon dioxide ( $\text{CO}_2$ ) or oxygen ( $\text{O}_2$ ) reading corresponding to approximately 50% excess air. Excess air level for proper combustion with this burner is higher than with some other types of gas burners.

#### LIGHTING AND SHUT-DOWN PROCEDURES

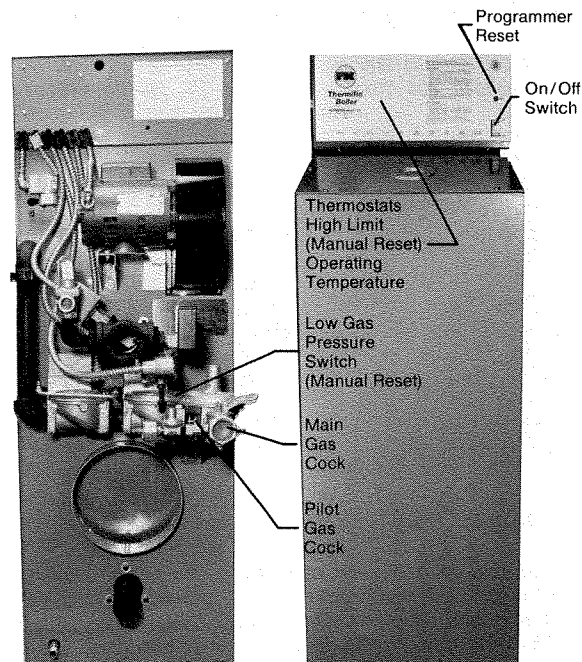
##### TESTS

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, latest edition, or CAN1-3.1 in Canada (see "Factory Firetest" label inside the control panel).

##### STARTING SYSTEM

1. Close main and pilot gas cocks.
2. Turn electric switch to "OFF" position.
3. Wait 5 minutes.
4. Open main and pilot gas cocks.
5. Turn electric switch to "ON" position.

6. Push reset button on flame safeguard programmer control.
7. Push reset on low gas pressure switch.
8. Check to be sure that pilot has been established.



Location of Manual Controls

##### SHUT DOWN

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

##### EMERGENCY SHUT OFF

Main and pilot gas cocks should be closed immediately if an emergency situation occurs, see Location of Manual Controls.

#### MAINTENANCE AND INSPECTION SCHEDULE

##### 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 red indicators which are illuminated or unusual noises or operating conditions and make necessary corrections. **CAUTION:** Check daily to be sure boiler area is free and clear of any combustible materials, including flammable vapors and liquids.

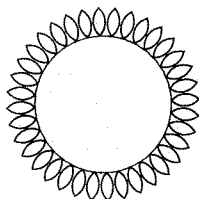
##### WEEKLY

Observe 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.

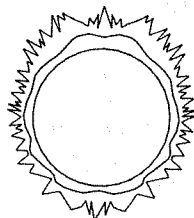
If flame pattern is pulsing or if flame is yellow and lifting off the burner, adjust air shutter opening until

correct flame pattern is achieved. A general glow within the combustion chamber is normal.

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<sub>2</sub>) or oxygen (O<sub>2</sub>) analyzer to set conditions for about 50% excess air.



Normal Burner Flame



Abnormal Burner Flame

#### MONTHLY (During Operation)

1. Safety relief valve. With boiler off, lift test lever. (Be sure valve closes completely after test.)
2. Test flame detection by voltage reading at the control programmer.
3. Test high-limit control by reducing setting below the operating temperature. Burner should shut off, after readjusting thermostat, press button to reset switch.
4. Test operating temperature controls by reducing or increasing temperature setting as necessary to check burner operation.
5. Check flue gas temperature at outlet. If there is a temperature increase over previous readings, this probably indicates sooting or water scale build-up.
6. Test low water cutoff by trying to restart boiler with the system pump off. The boiler should not operate.
7. Test low gas pressure switch by closing main gas cock and attempting to restart boiler.

This work should be performed by qualified maintenance personnel.

#### SEMI-ANNUALLY

In addition to the recommended **Monthly** service.

1. Inspect and clean blower fan and inlet screen of any accumulated dust or lint.
2. Clean burner of any accumulated dust or lint. See section on "CLEANING THE BURNER".
3. Inspect burner for any signs of deterioration or corrosion. Replace immediately.

The blower motor is permanently lubricated and does not require periodic lubrication.

#### ANNUALLY

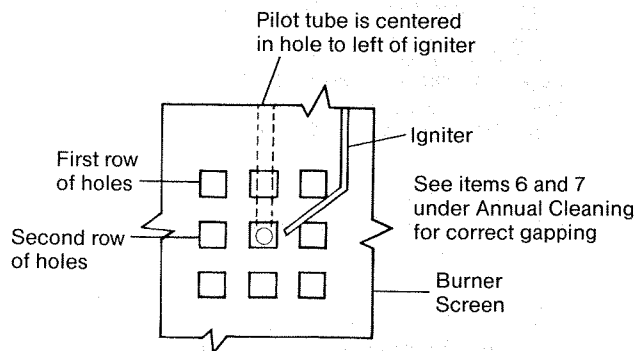
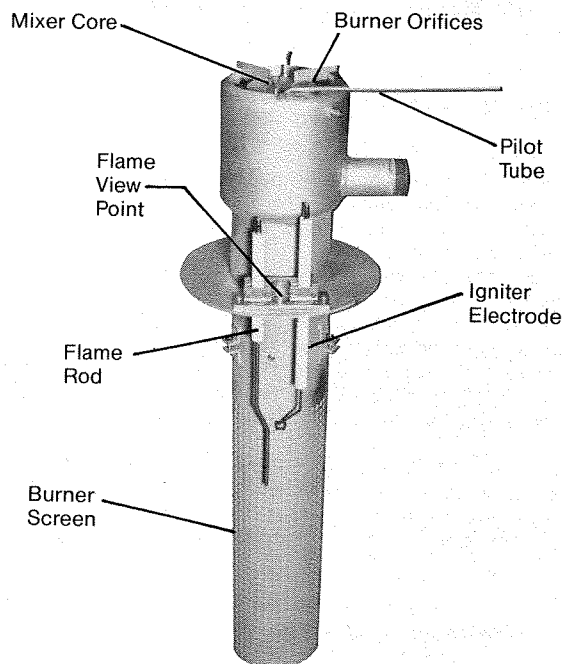
In addition to the recommended **Monthly** service.

1. Check burner and clean off any soot or foreign material that may have accumulated. See section on "CLEANING THE BURNER". Check for corrosion of the burner and its parts. If there is evidence of deterioration or corrosion, replace immediately.
2. Inspect combustion chamber through access door on front side of boiler. To remove doors, pull forward slightly, then pull upward. Note any signs of deterioration. Make repairs as necessary.

3. Inspect and clean heat exchanger. Clean exterior of finned tubes and flush inside of heat exchanger as required.
4. Examine the venting system at least once a year.
  - a. Check all joints and pipe connections for tightness.
  - b. Check pipe for corrosion or deterioration. If any piping needs replacing, do so immediately.
5. Inspect heating system for other problems.

This work should be performed by qualified maintenance personnel.

#### Burner Assembly



#### 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 wires.

#### SEMI-ANNUAL CLEANING

1. Remove mixer core.
2. Brush and vacuum inside of burner to remove any accumulated dust or lint build-up.

## ANNUAL CLEANING

1. Disconnect the union in the line at the burner.
2. Disconnect pilot and vent line, being careful not to disturb position of pilot.
3. Loosen and remove the four burner hold-down bolts.
4. Carefully remove the burner.
5. Brush the inside and outside of screen to remove all dust.
6. Check the position of the ignition electrode:  $1/8"$   $\pm 1/32"$  spark gap. Check the tightness of the electrode clamp.
7. Check the position of the flame rod which should be  $5/8"$   $\pm 1/16"$  from the burner screen, for N-700, N-900 and N-1200 or  $13/16"$   $\pm 1/16"$ , for N-1500, N-1700 and N-1900.
8. Before re-installing the burner, check the cleanliness of the exchanger and the condition of the firebox floor.

## REMOVING THE EXCHANGER

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 pipe cross containing the temperature-pressure indicator and relief valve along with the tee containing the water flow switch.
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 re-assembly is easier if they are separated slightly as the heat exchanger is re-installed. When re-assembling, reseal the top of inner cabinet with aluminum tape as needed.

## AFTER ALL REPAIRS OR MAINTENANCE

1. Follow "PRE-START CHECK LIST" in the "INSTALLATION GUIDE".
2. Check gas pressure and adjust gas flow if necessary (see "GAS PRESSURE ADJUSTMENT").
3. Check air pressure and adjust air flow if necessary (see "AIR FLOW ADJUSTMENT").

## SEQUENCE OF OPERATION

Status (red and green) indicators located on the front of the control panel 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 normally closed limit switches, including water flow, gas pressure and high temperature, and through the operating temperature control to the flame-safeguard programmer.
2. The water flow limit switch is closed when there is adequate 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. 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. Water flow, low gas and high temperature complete the limit series, unless an external control is placed ahead of the water flow limit, by replacing the red jumper wire.
5. When heat is required, as indicated by outlet water temperature, power is applied to Terminal 7 of the programmer, which initiates the burner ignition and operation sequence, and to an indicator marked "HEAT".
6. The programmer first energizes Terminal 8 which supplies power to the definite purpose 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.
7. A total time delay of about 10 seconds (30 seconds for I.R.I design) occurs between the time the blower starts and the programmer signals a continuation of the start sequence. During this time period the combustion chamber is purged to eliminate any residual combustible gas or combustion products.
8. A 10-second "trial-for-ignition" period is initiated with both Terminals 4 and 3 being energized.

Terminal 4 of the programmer powers the ignition transformer and the "IGNITE" indicator. The transformer output creates a spark at the igniter.

Terminal 3 powers the pilot gas valve through the normally closed contacts of a time delay relay and the indicator for "PILOT".

9. When a pilot flame is detected by the flame rod, a signal is sent to Terminal S2 in the programmer.
10. With flame recognition, Terminal 5 of the programmer is energized, which opens both main gas valves and illuminates the indicator for "MAIN GAS".

At the same time Terminal 5 is energized, Terminal 4 is de-energized to shut off the spark ignition.

Terminal 5 also initiates the time delay for the pilot interrupt relay. After a 10-second delay, the relay switches and de-energizes both the pilot valve and the "PILOT" indicator.

11. When the desired water temperature is reached, the operating control switch opens and the programmer is de-energized at Terminal 7 and the indicator for "HEAT" is turned off. This action also de-energizes Terminal 5, thus closing both main gas valves and turning off the indicator for "MAIN GAS".
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 the limits on water flow, gas pressure and high temperature are all met.

## PROBLEMS

### LOSS OF POWER

In the event of a power failure (or when the On/Off switch in the Off position), 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 all of the limits are satisfied.

### LOSS OF WATER FLOW

When the "LOW WATER" indicator is illuminated, there is insufficient water flow to close the switch and power to the programmer is interrupted. When water flow is re-established, the sequence returns to Step 5, provided other limits are satisfied.

### LOW GAS PRESSURE

When the "LOW GAS" 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 "LOW GAS" 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 "LOW GAS" indicator also may be illuminated to indicate high gas pressure.

## HIGH WATER TEMPERATURE

When the "HIGH TEMP." indicator is illuminated, the boiler water has exceeded both the operating and high-limit temperature; power to the programmer is interrupted. When the water temperature returns 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 other limits are satisfied.

### IGNITION FAILURE

In the event the pilot flame is not detected by the flame rod 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 a "FLAME FAILURE" indicator. A manual reset (located on the front of 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 returns to Step 8 to try to relight the main flame (lock-out occurs with I.R.I. design, no trial for re-start). After the spark ignition is re-energized and the pilot valve reopened, the 10 second trial-for-ignition begins again. 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.

Because of special requirements for IRI (Industrial Risk Insurers) and some local codes, the boiler may be supplied with a Fireye, Model TFM-3, programmer which will not recycle after either pilot or main flame failure during a firing period. If flame failure occurs and the indicator is illuminated, the controller must be manually reset.

TYPICAL\* BOILER OPERATING CONDITIONS

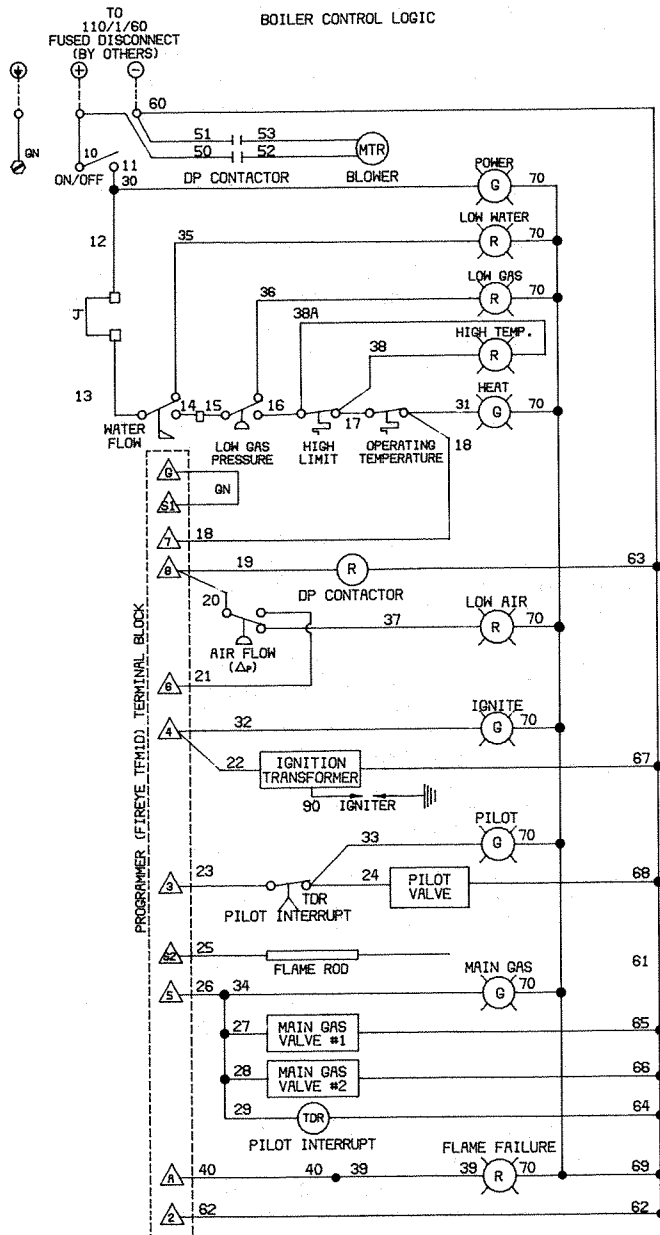
Model Number	Input Rating [Btu/hr]	Natural Gas			LP Gas			Total Amperage [amps]
		Gas Rate (1030 Btu/ft <sup>3</sup> ) [ft <sup>3</sup> /hr]	Manifold Pressure* [inches W.C.]	Output Capacity [Btu/hr]	Gas Rate (2500 Btu/ft <sup>3</sup> ) [ft <sup>3</sup> /hr]	Manifold Pressure* [inches W.C.]	Output Capacity [Btu/hr]	
N- 700	700,000	680	1.7	595,000	280	4.2	609,000	8
N- 900	900,000	874	1.7	765,000	360	4.5	783,000	8
N-1200	1,200,000	1165	2.6	1,020,000	480	5.0	1,044,000	9
N-1500	1,500,000	1456	2.8	1,275,000	600	4.2	1,305,000	12
N-1700	1,700,000	1650	2.8	1,445,000	680	4.2	1,479,000	12
N-1900	1,900,000	1845	2.7	1,615,000	760	4.0	1,653,000	12

Refer to Rating Plate on Boiler for Specific Information and Certification or Approval Agencies

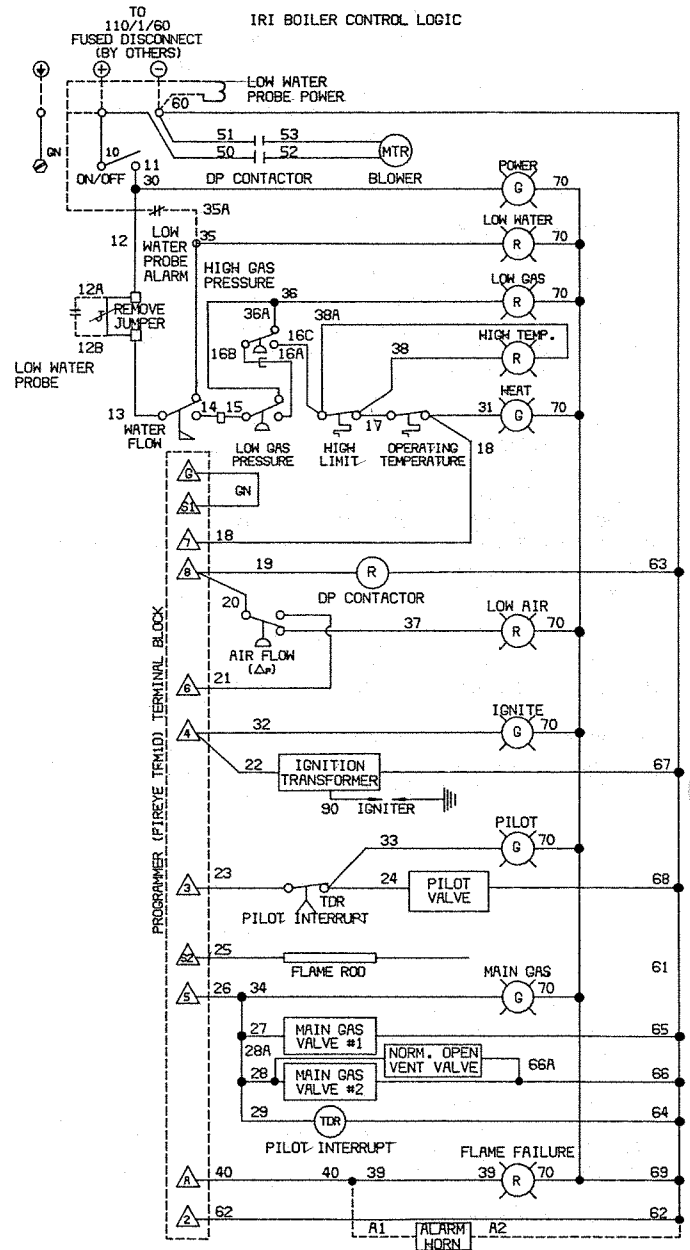
\* Manifold Pressure is measured at the test opening in the elbow where the main gas pipe enters the back of the boiler. See "Factory Firetest" label for exact pressures recommended for the firing rate.

# BOILER CONTROL LOGIC

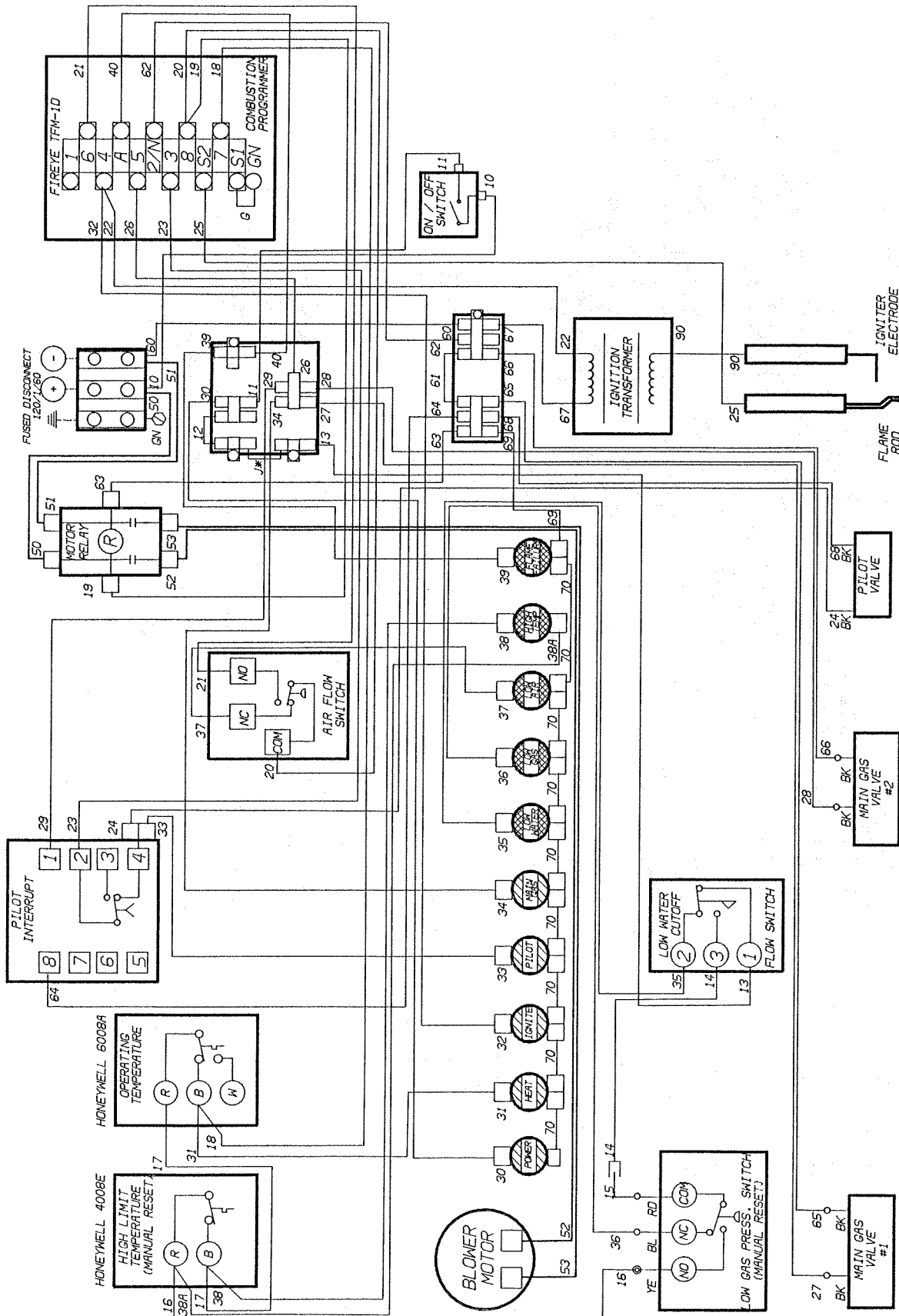
Standard Schematic



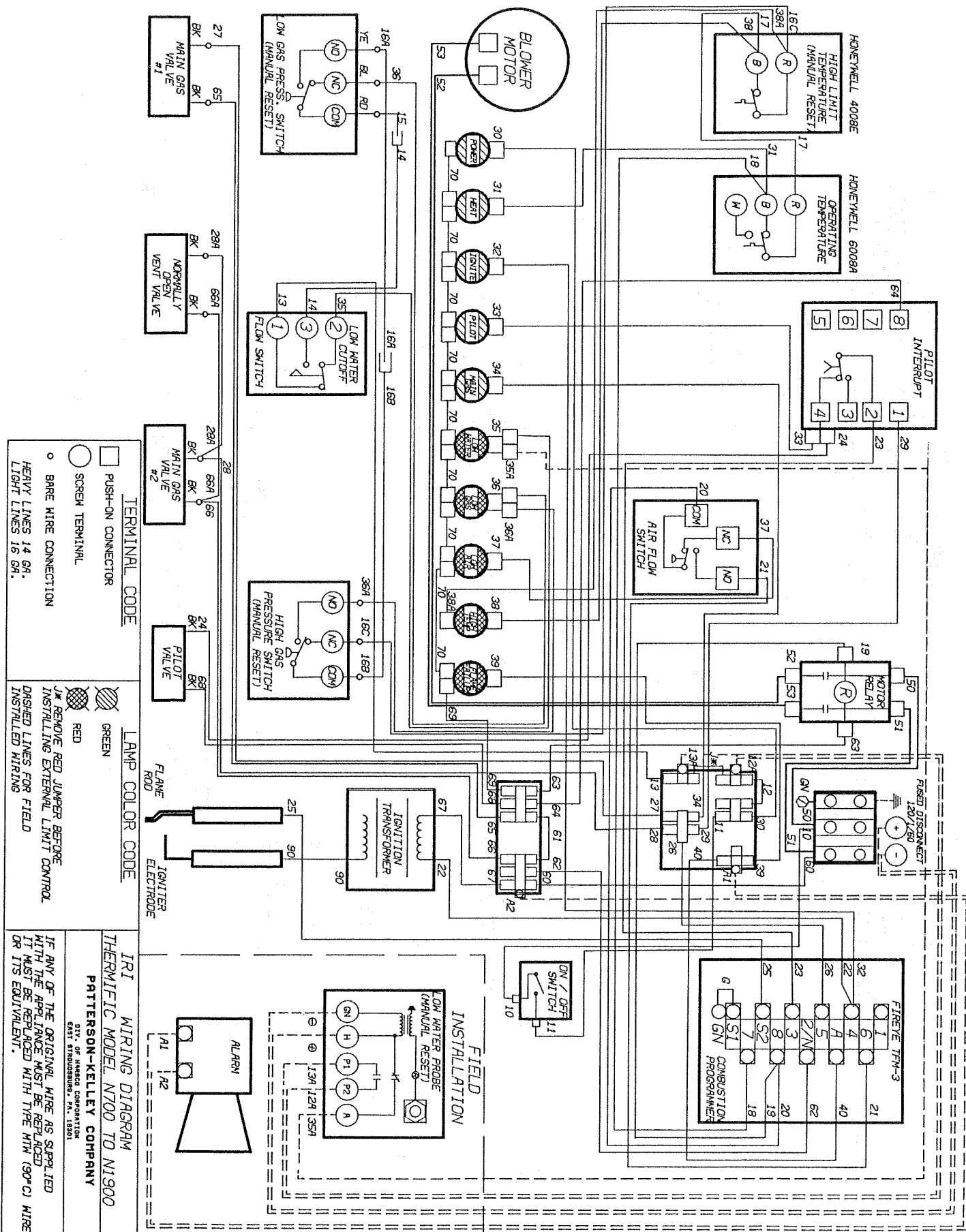
IRI Schematic



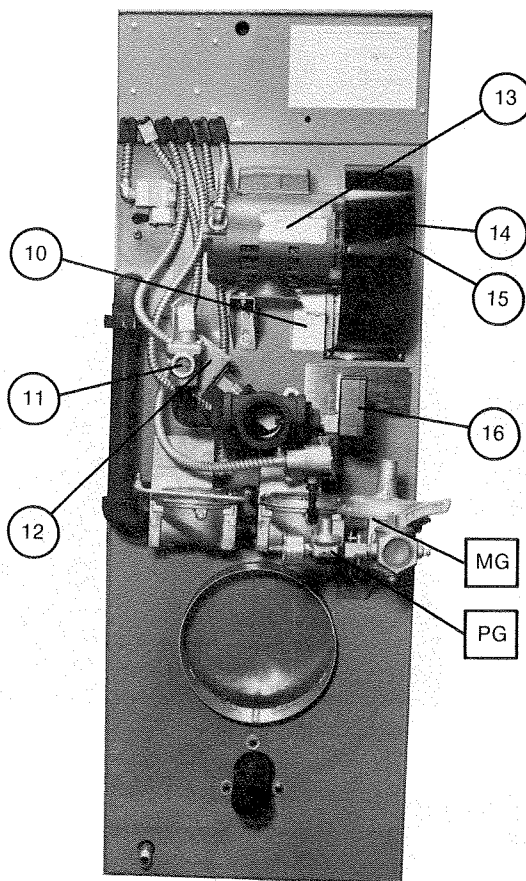
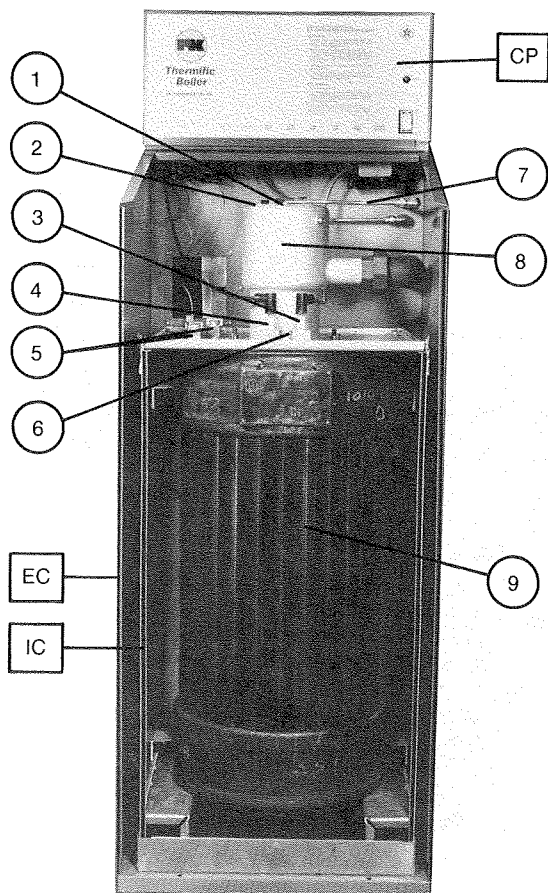
Note: If any of the original wire as supplied with the appliance must be replaced. It must be replaced with type MTW (90°C) wire or its equivalent.



<b>STANDARD WIRING DIAGRAM</b> <b>THERMIFAC MODEL N700 TO N1900</b> <b>PATTERSON-KELLEY COMPANY</b> <small>DIV. OF HARGREAVE CORPORATION</small> <small>EAST STROUDSBURG, PA. 18043</small>		
<b>TERMINAL CODE</b> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div>	<b>LAMP COLOR CODE</b> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> </div>	<b>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 ITS EQUIVALENT.</b>







## BOILER PARTS LIST

### Main Assembly

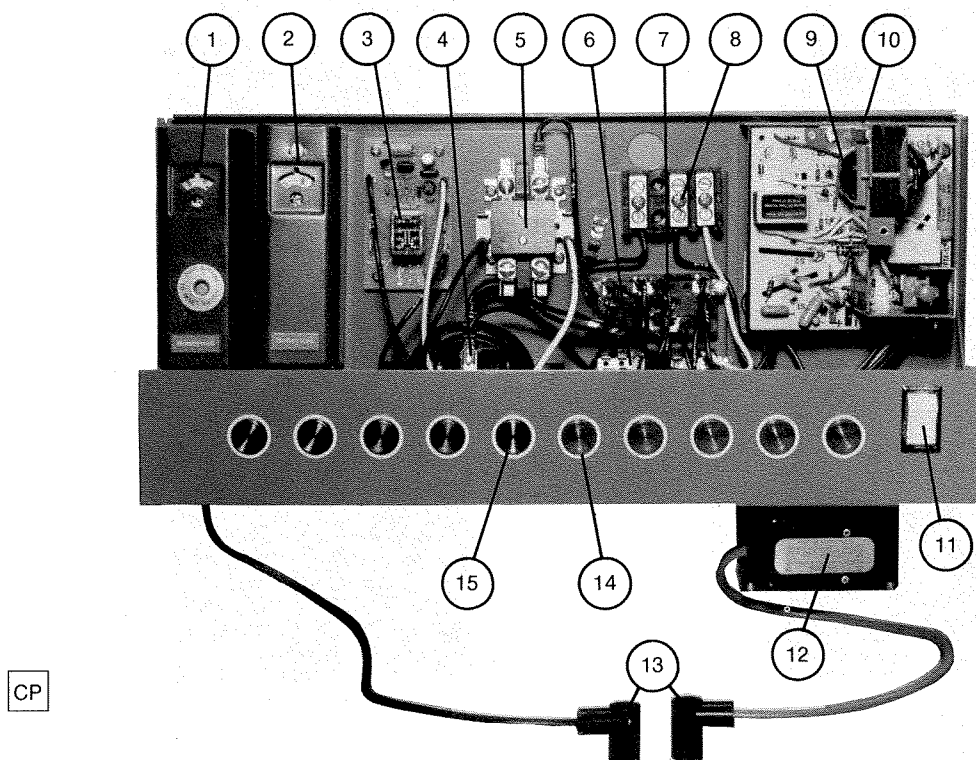
No.	Part	Prefix No.	N-700	N-900	N-1200	N-1500	N-1700	N-1900
1	Mixer Core, Burner	86-5170-	0070	0090	0120	0150	0170	0190
2	Burner Orifice	86-5360-	0060	0060	0055	0060	0060	0060
3	Spark Igniter Electrode	86-2450-	0810	0810	0810	0810	0810	0810
4	Flame Rod Electrode	86-7100-	0230	0230	0230	0230	0230	0230
5	Thermowell w/ Clip	86-8800-	0890	0890	0890	0890	0890	0890
6	Ignition Assembly	87-5540-	0776	0776	0776	0776	0776	0776
7	Pilot Tube	87-6440-	1076	1076	1076	1176	1176	1176
8	Burner Assembly	87-3410-	0776	0976	1276	1576	1776	1976
9	Heat Exchanger	87-5285-	0776	0776	1276	1576	1576	1576
10	Blower, Damper	86-7653-	0300	0300	0300	0400	0400	0400
11	Pressure Relief Valve	86-9420-	0090	0090	0090	0250	0250	0250
12	Water Flow Switch	86-8350-	0800	0800	0800	0800	0800	0800
13	Blower, Motor	80-6250-	5022	5022	5166			
		80-6300-				5166	5166	5166
14	Blower, Housing	86-4030-	0020	0020	0020	0015	0015	0015
15	Blower, Wheel	86-4140-	0001	0001	0002	0003	0003	0003
16	Press./Temp. Gauge	86-3560-	0200	0200	0200	0200	0200	0200
	Installation Manual	86-3757-	1010	1010	1010	1010	1010	1010
	Owner's Manual	86-5055-	0150	0150	0150	0150	0150	0150

CP Control Panel (see Page 18)  
 EC Exterior Cabinet (see Page 20)  
 IC Interior Cabinet (see Page 20)  
 PG Pilot Gas Train (see Page 19)  
 MG Main Gas Train (see Page 19)

Identify Part No. by Prefix plus Model No. Suffix  
 i.e., Burner Assembly for N-1500 Part No.:

XX-XXXX-XXXX  
 86-1187-0032

Replacement parts are available from your P-K Thermific representative or  
 Patterson-Kelley, East Stroudsburg, PA 18301 Phone No. (717) 421-7500 Fax No. (717) 421-8735



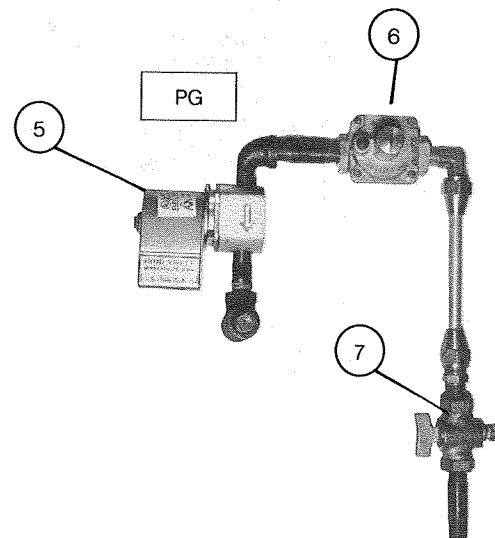
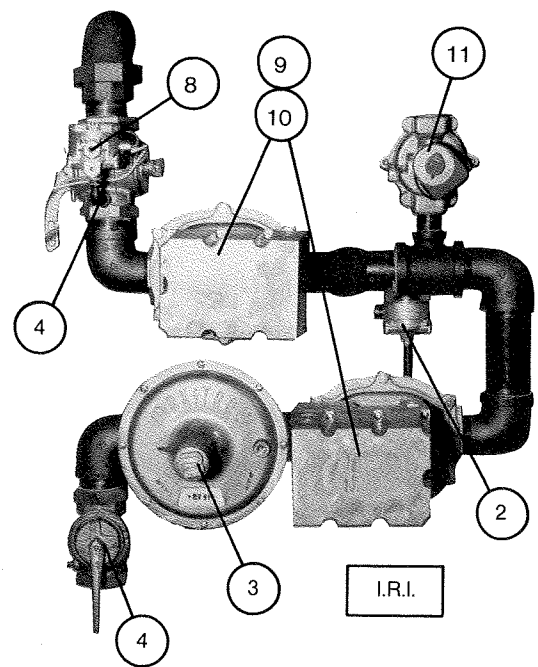
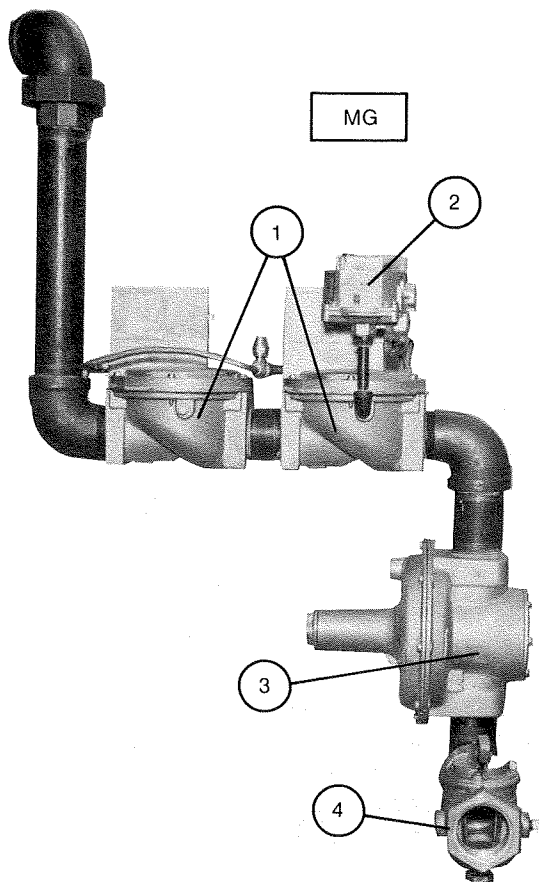
# **BOILER PARTS LIST (cont.)**

## **Control Panel Components**

No.	Part	Prefix No.	N-700	N-900	N-1200	N-1500	N-1700	N-1900
1	Thermostat (Manual Reset)	86-1761-	0330	0330	0330	0330	0330	0330
2	Thermostat	86-8730-	0809	0809	0809	0809	0809	0809
3	Pilot Time Delay Relay	86-6520-	0420	0420	0420	0420	0420	0420
4	Air Flow Switch	86-8335-	0170	0170	0170	0170	0170	0170
5	Motor Starter Relay	86-1750-	0075	0075	0075	0075	0075	0075
6	Terminal Block, Neutral	86-8610-	0220	0220	0220	0220	0220	0220
7	Terminal Block, Junction	86-8610-	0230	0230	0230	0230	0230	0230
8	Terminal Block, Power	86-8610-	0240	0240	0240	0240	0240	0240
9	Flame Safeguard Programmer	86-2640-	0210	0210	0210	0210	0210	0210
	Flame Safeguard Prog. (IRI)	86-2640-	0200	0200	0200	0200	0200	0200
	Timing Card - Prog. (IRI)	86-2640-	0720	0720	0720	0720	0720	0720
10	Programmer, Sub-Base	86-2640-	0220	0220	0220	0220	0220	0220
11	Switch, On/Off	86-8510-	0170	0170	0170	0170	0170	0170
12	Ignition Transformer	86-8950-	0010	0010	0010	0010	0010	0010
13	Connector, Spark Plug	85-1900-	0585	0585	0585	0585	0585	0585
14	Indicator Light, Red	86-4720-	0250	0250	0250	0250	0250	0250
15	Indicator Light, Green	86-4720-	0260	0260	0260	0260	0260	0260
	Low Water Switch (IRI - MR)	86-2215-	0050	0050	0050	0050	0050	0050
	Alarm Bell (IRI)	86-0787-	5030	5030	5030	5030	5030	5030

Identify Part No. by Prefix plus Model No. Suffix      **XX-XXXX-XXXX**  
i.e., Pilot Time Delay Relay      Part No.:      **86-6520-0420**

Replacement parts are available from your P-K Thermific representative or  
Patterson-Kelley, East Stroudsburg, PA 18301 Phone No. (717) 421-7500 Fax No. (717) 421-8735



# **BOILER PARTS LIST (cont.)**

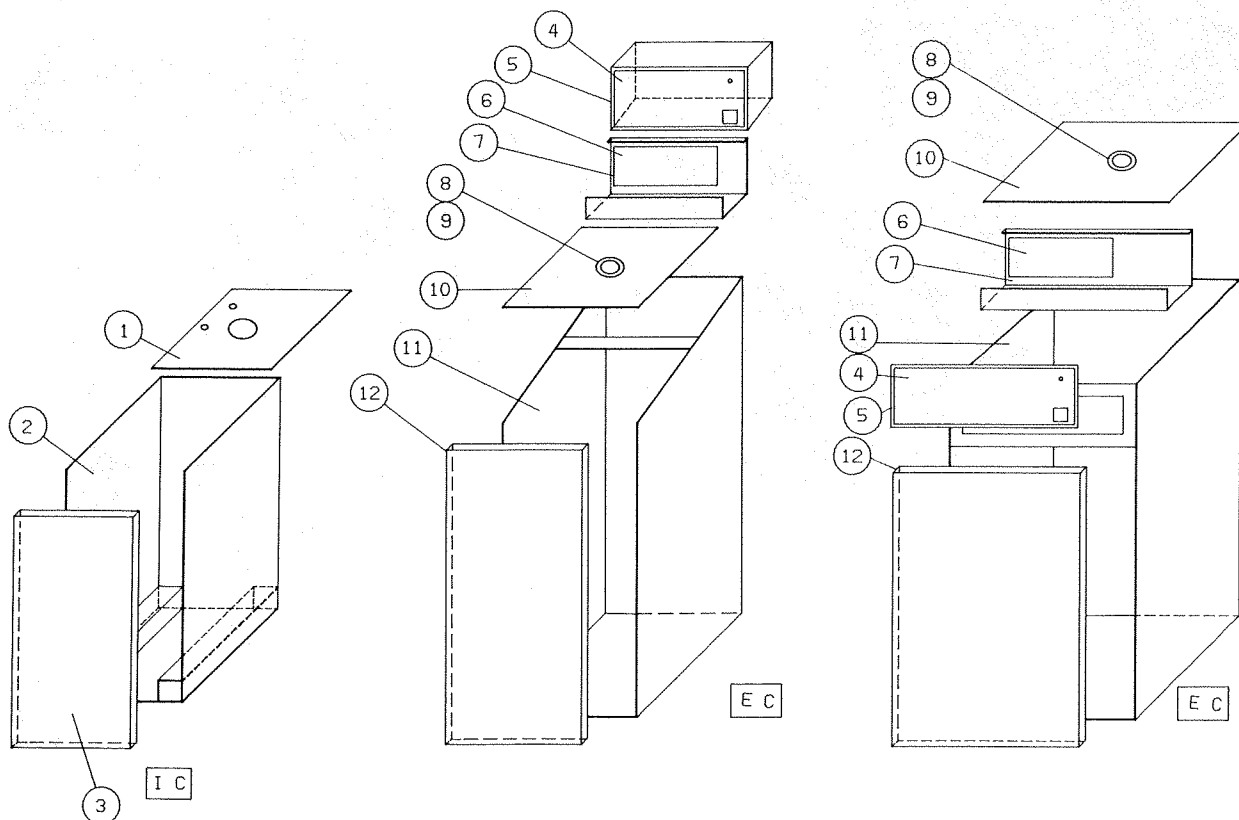
## **Gas Train Components**

No.	Part	Prefix No.	N-700	N-900	N-1200	N-1500	N-1700	N-1900
1	Main Gas, Valve	86-9306-	0100	0100	0120	--	--	--
1a	Main Gas, Valve Body	86-9309-	--	--	--	9020	9020	9020
1b	Main Gas, Valve Actuator	86-0039-	--	--	--	9070	9070	9070
2	Low Gas Pressure Switch	86-8470-	0045	0045	0045	0045	0045	0045
3	Main Gas, Regulator	86-6450-	0310	0310	0510	0630	0630	0630
4	Main Gas, Shut-off Cock	85-1540-	0075	0075	0083	0090	0090	0090
5	Pilot, Solenoid Valve	86-9460-	0041	0041	0041	0041	0041	0041
6	Pilot, Regulator	86-6450-	0020	0020	0020	0020	0020	0020
7	Pilot, Shut-off Cock	86-9451-	0002	0002	0002	0002	0002	0002
<b>IRI Options</b>								
8	High Gas Pressure Switch	86-8470-	0046	0046	0046	0046	0046	0046
9	Main Gas, Valve Body	86-9309-	9010	9010	9015	9020	9020	9020
10	Main Gas, Valve Actuator	86-0039-	9070	9070	9070	9070	9070	9070
11	Vent Valve, Gas	86-9490-	0130	0130	0130	0230	0230	0230

Identify Part No. by Prefix plus Model No. Suffix  
i.e., Main Gas Valve for N-1200 Part No.:

**XX-XXXX-XXXX**  
**86-9306-0120**

Replacement parts are available from your P-K Thermific representative or  
Patterson-Kelley, East Stroudsburg, PA 18301 Phone No. (717) 421-7500 Fax No. (717) 421-8735



# **BOILER PARTS LIST (cont.)**

No.	Part	Prefix No.	N-700	N-900	N-1200	N-1500	N-1700	N-1900
1	Combustion Chamber, Top	86-1602-	0070	0070	0120	0200	0200	0200
2	Combustion Chamber, Assy.	86-1600-	0070	0070	0120	0200	0200	0200
3	Combustion Chamber, Door	86-1601-	0070	0070	0120	0200	0200	0200
4	Control Panel, Label	86-5310-	0226	0226	0226	0226	0226	0226
5	Control Panel, Cover	86-5820-	0421	0421	0421	0430	0430	0430
6	Control Panel, Sub Panel	86-5829-	0100	0100	0100	0100	0100	0100
7	Control Panel, Base Assy.	86-5820-	0420	0420	0420	0420	0420	0420
8	Sight Glass	86-7660-	0310	0310	0310	0310	0310	0310
9	Sight Glass Bezel	86-7660-	0315	0315	0315	0315	0315	0315
10	Exterior Cabinet, Top	86-1292-	0070	0070	0120	0200	0200	0200
11	Exterior Cabinet, Assy.	86-1290-	0070	0070	0120	0200	0200	0200
12	Exterior Cabinet, Door	86-1291-	0070	0070	0120	0200	0200	0200

Identify Part No. by Prefix plus Model No. Suffix

i.e., Combustion Chamber, Assy. for N-1200 Part No.:

**XX-XXXX-XXXX**

**86-1600-0120**

Replacement parts are available from your P-K Thermific representative or  
Patterson-Kelley, East Stroudsburg, PA 18301 Phone No. (717) 421-7500 Fax No. (717) 421-8735