FP SERIES

Installation, Operation, Service, and Parts Manual

INDUSTRIAL COMBUSTION

⚠ WARNING

ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD START UP, ADJUST, OR SERVICE THIS EQUIPMENT

IC-SA-1048
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INDUSTRIAL COMBUSTION

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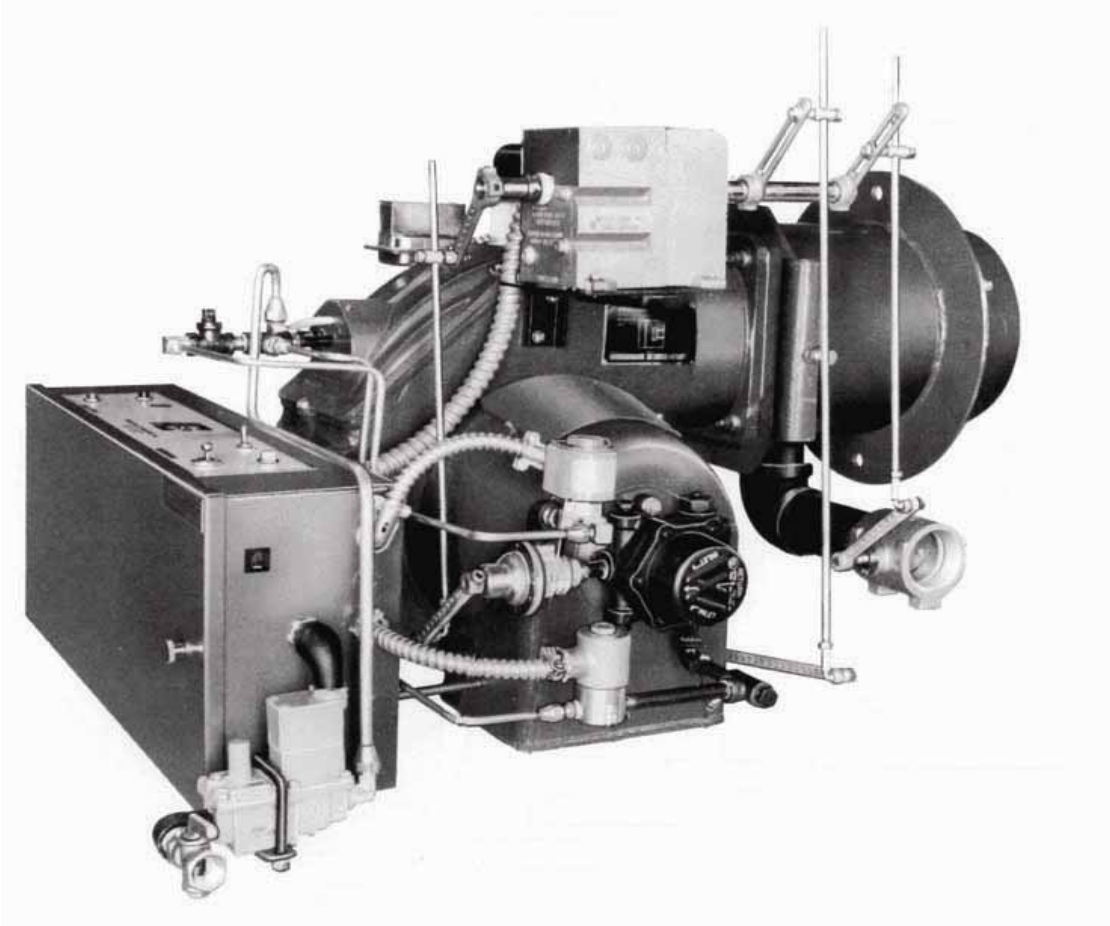

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PREFACE

OPERATING PRECAUTIONS

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Only trained and authorized personnel should be allowed to operate, adjust, or repair this equipment.

If you are operating a burner(s), it is your responsibility to ensure that such operation is in full accordance with all applicable safety requirements and codes.

Placed on all Industrial Combustion burners are warning or caution lab les designed to inform the operator of potential hazards and stress important information.

These symbols and their meanings are as follows:

⚠ Warning

Failure to install and operate this equipment in accordance with the manufacturer's recommended instructions and industry standards and practices can result in fire, explosion, property damage, and/or personal injury. Read this manual in its entirety prior to any attempt to commission this equipment. Installation, startup, operation, and maintenance of this equipment must be performed only by factory authorized experienced and qualified personnel.

⚠ Warning

Hazard of electric shock. More than one disconnect may be required to disconnect all power to this panel. serious personal injury or death may result.

⚠ Warning

To avoid personal injury from moving parts, shut off all electrical power before servicing this equipment.

⚠ Warning

Read product manual and fully understand its contents before attempting to operate this equipment. IF these instructions are not followed, serious personal injury or death may result.

⚠ Caution

Provide support for this panel to prevent damage to electrical components.

⚠ Caution

Only factory authorized berner service personnel should startup, adjust, or service this equipment.

⚠ Caution

After final fuel input adjustments are made, verify fuel input by meter, if possible.

Further warning and caution references have been made in this manual and should be adhered to for smooth operation of the burner.

⚠ Warning

This symbol precedes information which, if disregarded, may result in injury to the user of the burner or others.

⚠ Caution

This symbol precedes information which, if disregarded, may result in damage to the burner.

NOTE: This symbol precedes information which is vital to the operation or maintenance of the burner.

Model designations are based on the type of fuel(s) to be fired and the amount of furnace pressure to be overcome. Burner size is based on firing rate (rated input in Btu/hr).

Model	Fuel	Atomization
FPG	Gas	
FPL	#2 Oil	Pressure
FPLG	#2 Oil/Gas	Pressure

Example: The model number on the nameplate is FPLG-42, indicating it is a combination No. 2 oil and gas burner with input rated at 4,200 MBTU per hour, against furnace pressure up to 0.75” W.C.

Burner Size and Rated Furnace Pressure - FP Burner

Size 1 - FP5 to 12	0.75” W.C.
Size 2 - FP14 to 42	0.75” W.C.

RATED BURNER INPUT		
Size	**MBTU/Hr**	**US GPH**
5	550	3.9
7	700	5.0
8	800	5.7
9	900	6.4
11	1,100	7.9
12	1,200	8.6
14	1,400	10
17	1,700	12
20	2,100	14.5
25	2,500	18
28	2,940	21
36	3,600	25
42	4,200	30

** Gas input based on natural gas at 1,000 Btu/cu. ft. and 0.60 specific gravity.*

*** Oil input based on 140,000 Btu/gal.*

**** Refer to burner nameplate data for correct manifold pressures.*

The installation of a burner shall be in accordance with the regulations of authorities having jurisdiction. The equipment must be installed in accordance with applicable local, state, or provincial installation requirements including the National Electrical Code (NEC) and Associated Insurance Underwriters.

Oil and gas burning equipment shall be connected to flues having sufficient draft at all times, to assure safe and proper operation of the burner.

The V Series burners are designed to burn either gas or light oil No. 1 or No. 2 as defined by ASTM D396-1978 Specifications.

Do not use gasoline, crankcase oil, or any oil containing gasoline.

FP Series

Table of Contents

CHAPTER 1 Introduction

1.1 — General Information

Industrial Combustion FP Series burners are assembled, wired, and tested at the factory. They are listed by the Underwriters Laboratory, cUL, CSD-1, GAP, F.M., and other regulatory agency control options are available.

The operator of this equipment must be familiar with the individual functioning of all controls to understand the operations and procedures described in this manual, and supplementary instructions provided with optional controls.

⚠Caution

Only factory authorized burner service personnel should start-up, adjust, or service this equipment.

1.2 — Description

The Industrial Combustion FP Series burners are designed to operate with gas and light oil. The burners are designed for automatic, unattended operation except for periodic inspection and maintenance. The control panel components require little attention except for occasional cleaning.

The burners are available in the following configuration:

FP5-7	On-Off (Optional: Low-High-Off/Low, Full Modulation)
FP8-25	Low-High-Off (Optional: Low-High-Low, Full Modulation)
FP28-42	Full Modulation (Optional: Low-High-Off/Low)

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1.3 — Operating Controls: Panel

The control panel contains a flame safeguard programming control, motor relays (starters), and terminal strips mounted internally on a panel subbase. Lights, switches, and a control circuit breaker are mounted with external viewability as indicated below:

Component	Description
1. On-Off Burner Switch (FPG & FPL Only)	On-Off selector switch.
2. Fuel Selector Switch	• Gas Position: Selects gas as the firing fuel. • Off Position: Burner off. • Oil Position: Selects oil as the firing fuel.
3. Control Circuit Breaker	Supplementary low overcurrent protection only. No larger than 15 amps.
4. Auto-Manual Modulation Selector Switch (Full Mod Only)	• Auto Position: Selects boiler modulation control. In this position, the burner will operate automatically in response to load demand. • Manual Position: Selects 135 ohm potentiometer for manual modulating control.
5. Manual Modulating Control	135 ohm (for full modulation burners only) increases or decreases the burner firing rate manually.
6. Signal Lamps	• Power On (white): Illuminates when the control circuit is energized (powered). • Ignition (amber): Illuminates when the ignition transformer is powered, and pilot valve is energized (opened). • Main Fuel (green): Illuminates when the main fuel valve or valves are energized (open). • Flame Failure (red): Illuminates when the flame safeguard system fails to detect pilot or main flame.
7. Modulating Motor (Full Mod Only)	Operates the air damper and fuel rate valves through a linkage system to adjust air-fuel ratios under all load conditions.
8. Ignition Transformer	Provides high voltage spark for ignition of gas pilot or main flame direct spark models.

1.4 — Flame Safeguard Controls

The flame safeguard controls the operational sequence of the combustion system (pre-purge, pilot, firing, and shutdown). The flame safeguard programmer incorporates a flame sensing cell (scanner) to shut down the burner in the event of pilot flame or main flame failure. Other safety controls shut down the burner based on sequence of operation as shown in the manufacturer's flame safeguard manual.

Component	Description
1.Flame Scanner	Monitors gas pilot flame and energizes the programmer's flame relay in response to a flame. It monitors main flame (oil or gas) after termination of pilot proving period.
2. Motor	Drives blower fan and fuel unit at 3450 rpm.

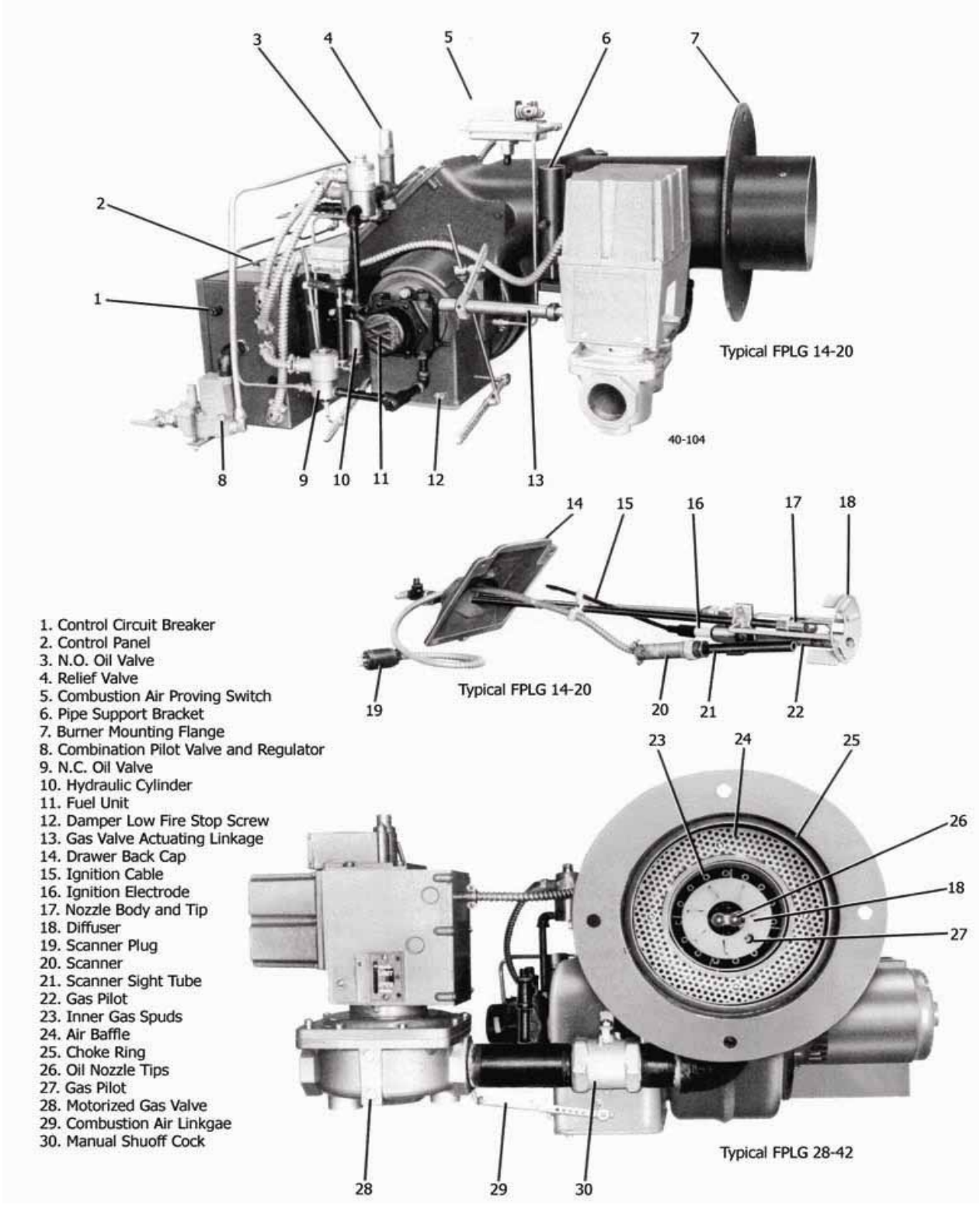

FIGURE 1-1. Typical FP Series Burners

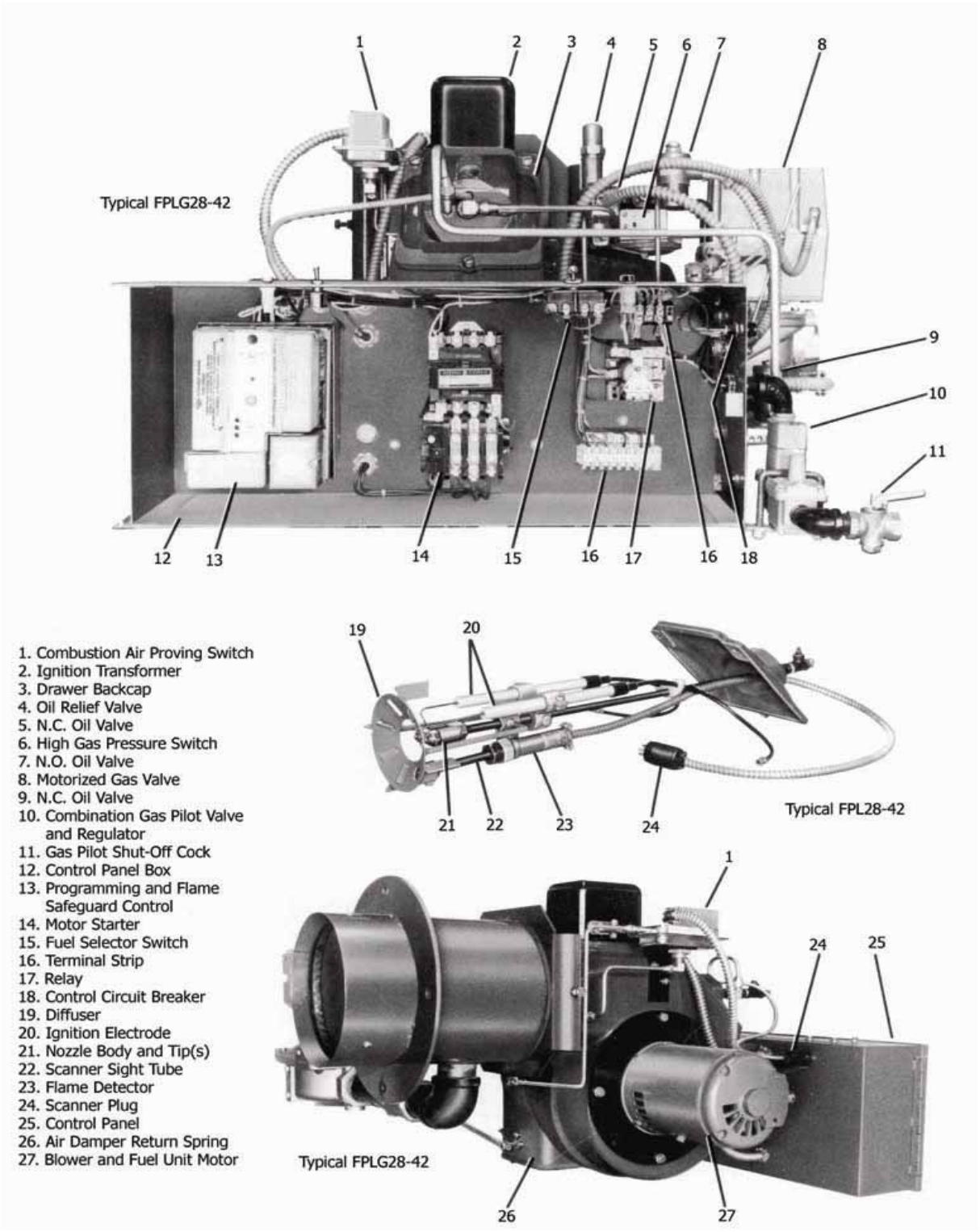

FIGURE 1-2. Typical FP Series Burners

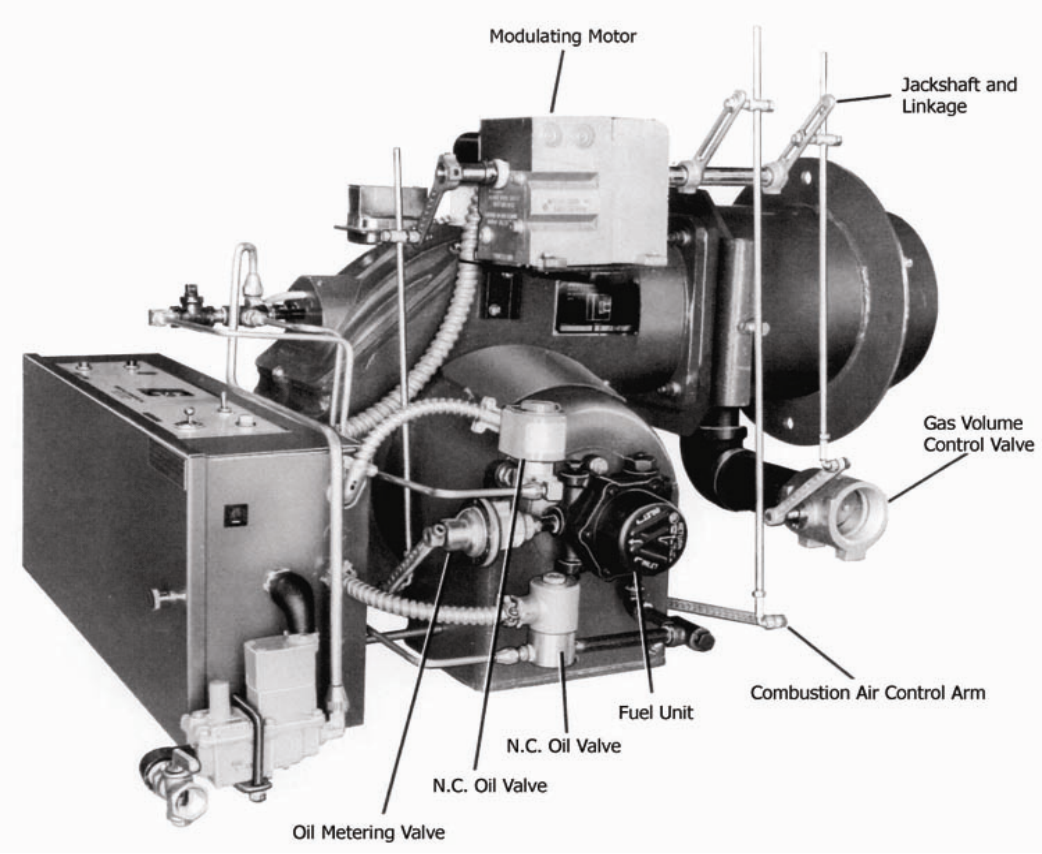

FIGURE 1-3. Full Modulation on FPLG28

1.5 — Combustion Air Handling System

Component	Description
1.Motor and Blower	Motor driven squirrel cage type blower fan for forced draft combustion air supply.
2. Air Volume Regulator	Air damper plate is located in the air inlet housing. The damper is mechanically linked and actuated by the main gas valve or the hydraulic cylinder for low-high-off or low-high-low operation. The modulating motor actuates the damper on full modulation models.
3. Combustion Air Proving Switch	A pressure sensitive switch actuated be air pressure created by the blower fan. Contacts close to prove combustion air flow.

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1.6 — Oil System

Component	Description
1. Fuel Unit	Direct driven from the blower motor with a flexible coupling at 3450 rpm, and set for 300 psi operation, the fuel unit is two-stage (two sets of gears) and must be installed for a two pipe installation, one suction and one return line.
2. Nozzle	The nozzle meters oil flow delivering a specified amount at a specific pressure. Fuel pressure (mechanical) atomizes oil in a fine conical spray pattern from the nozzle orifice. The burner is supplied with nozzles) to fire to its maximum rate unless a different firing rate was specified.
3. Nozzle Adaptor	The nozzle adaptor provides the the means for connecting fuel lines with the nozzle.
4. Oil Solenoid Valves	Two normally closed (N.C.) valves provide positive shutoff of fuel oil. On low-high-off and low-high-low burners, a single N.O. oil valve is used to close off the oil return to the pump and cycle the burner to high fire. On full modulation burners, this valve is replaced with an oil metering valve.
5. Oil Metering Valve	(Optional - Full Modulation) The firing rate is controlled by an adjustable metering valve in the return line. At low fire, the metering valve is open, and is closed at high fire (no return flow).
6. Regulating Valve	Regulates low fire oil pressure on low/high modulating burners.
7. Hydraulic Cylinder (Low/High only)	Regulates the combustion air damper from low to high fire. When the N.O. solenoid valve on the fuel return line is actuated (closes), the increased oil pressure in the hydraulic cylinder forces the piston lever against the resistance of the external return spring. As the piston lever moves down, the air inlet damper moves to its high fire position.

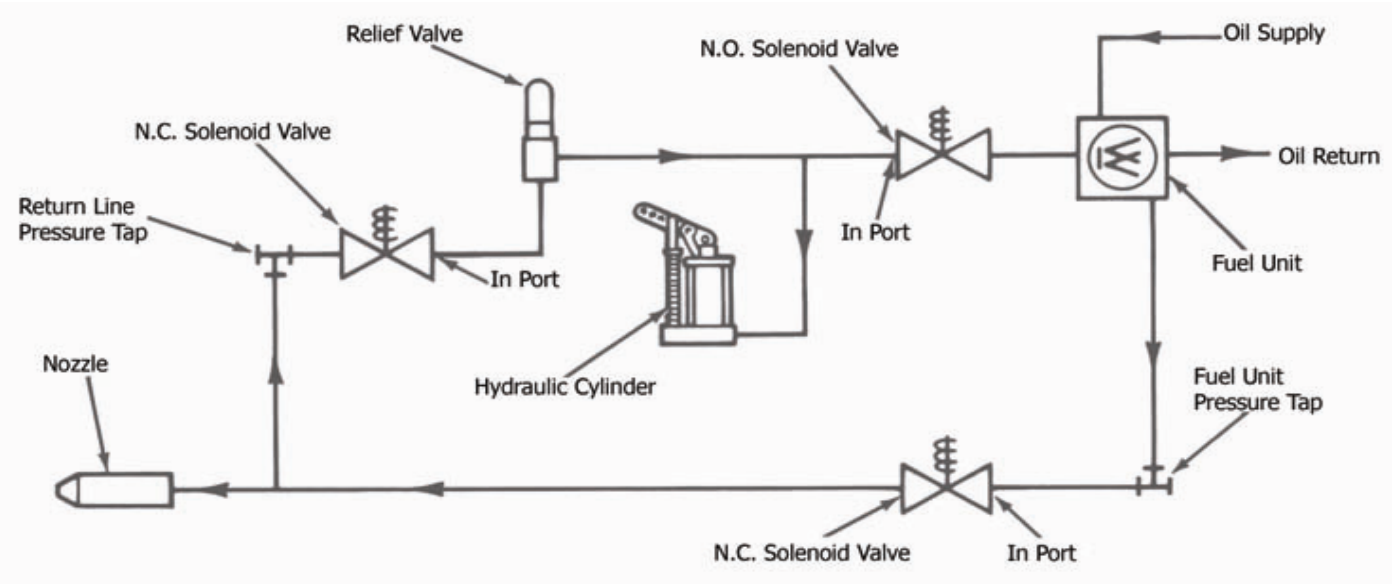

FIGURE 1-4. Low-High-Off and Low-High-Low Oil System

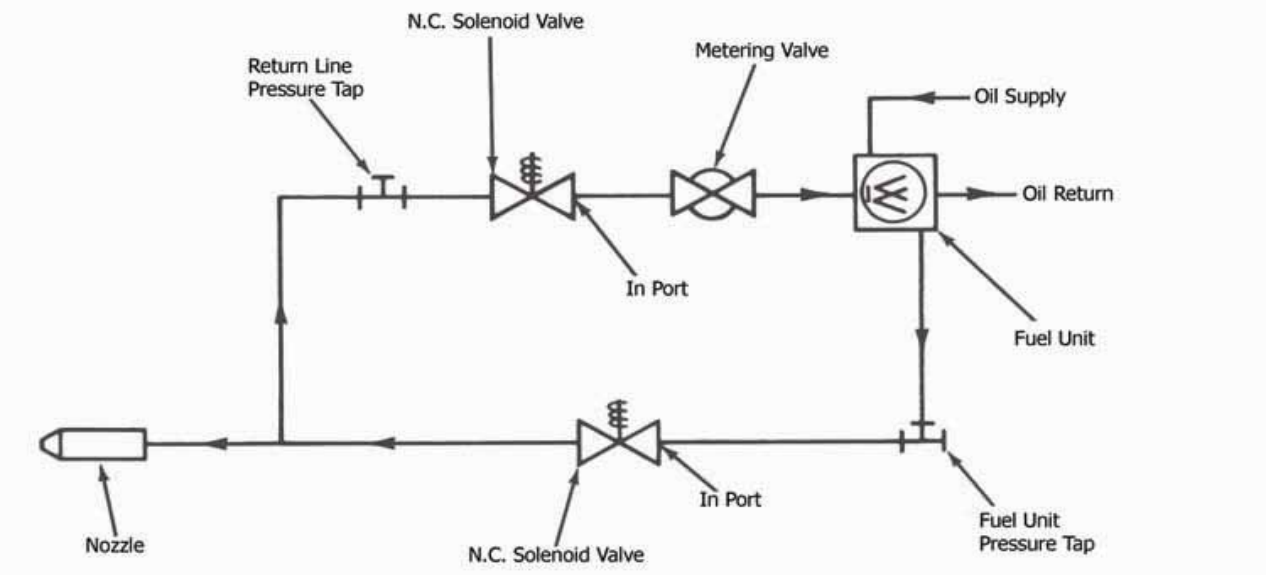

FIGURE 1-5. Full Modulation Oil System

1.7 — Gas System

Depending upon the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items:

Main Gas Train Component	Description
1. Main Gas Valves	Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard U.L. burners include: • Models 5-7: one diaphragm valve and one solenoid valve • Models 8-42: one motorized gas valve and one solenoid valve
2. Main Gas Regulator	Regulates gas train pressure to specified pressure required at inlet to gas train. Input is set by main gas pressure regulator adjustment.
3. Main Gas Cocks	Used for manual shutoff of the gas supply upstream of the pressure regulator. A second shutoff cock downstream of the main gas valve(s) provides a means of testing for leakage through the gas valve(s).
4. High Gas Pressure Switch (Models 28-42)	A pressure actuated switch that remains closed when gas pressure is below a selected setting. Should the pressure rise above the setting, the switch contacts will open causing main gas valve(s) to close. This switch requires manual reset after being tripped.
5. Low Gas Pressure Switch (Models 28-42)	A pressure actuated switch that remains closed when gas pressure is above a selected setting. Should the pressure drop below this setting, the switch contacts will open, causing main gas valve(s) to close. This switch requires manual reset after being tripped.
6. Gas Volume Valve (Full Mod Only)	When full modulation is provided the butterfly type valve is positioned by linkage from the modulating motor.

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1.8 — Pilot Gas Train

Component	Description
1.Gas Pilot Valve	A solenoid valve that opens during the ignition period to admit fuel to the pilot. It closes after the main flame is established.
2. Gas Pressure Regulator	Regulates gas pressure to that required by the pilot.
3. Gas Pilot Shutoff Cock	For manually closing the pilot gas supply.

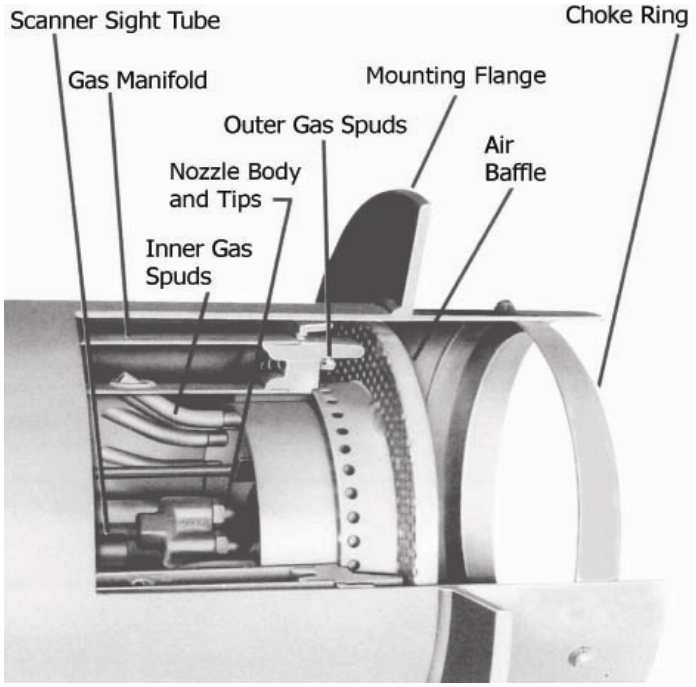


FIGURE 1-6. Cutaway View of Blast Tube

CHAPTER 2 Installation

2.1 — Draft Conditions

A boiler or other heating vessel fired with an FP Series burner does not depend on chimney draft for proper combustion air. Combustion air is supplied by the burner forced draft blower providing adequate air for any normal combustion condition.

Since draft control is essential to maximum efficiency, a draft regulator may be required when the vessel is connected to a tall stack or where wind conditions may cause erratic draft. excessive furnace draft contributes to inefficient burner operation.

Sealed boilers may be operated under positive firebox pressure within the capability of the burner.

2.2 — Combustion Air Supply

The space in which a burner operates must be supplied with adequate fresh air for combustion and ventilation purposes. Fresh air supply must meet or exceed all code requirements. Consult with the insurance carrier and/or local authorities for specific regulations.

⚠ Warning

The boiler room pressure must be at least equal to the outdoor atmospheric pressure. Where fan ventilation is used, air must be forced into the boiler room. Never exhaust air from the boiler room. Adjoining areas having exhaust fans must be positively isolated from the boiler room.

2.3 — Combustion Chamber Design

It is not possible to include a complete design and construction combustion chamber manual in this section, but the following may be helpful in arranging burner applications in typical boilers. Combustion chambers are of three basic types:

1. Completely water enclosed as in Scotch type boilers.
2. Conventional “dry bottom” firebox boilers having a refractory floor and full water walls.

3. Full refractory combustion chambers in “ash pit” type installations where a complete firebox is required below the level of the boiler water walls.

The FP Series burners are of the forced draft flame retention type. Refractory is required only to protect surfaces not adequately protected by free circulating water. Four objectives are:

1. Provide adequate combustion space.
2. Avoid flame impingement.
3. Protect surfaces not adequately water cooled.
4. Seal openings.

Suggested minimum combustion chamber dimensions in the following table are based on the rated capacity of the burner:

Burner Model	Combustion Chamber		
	Length	Width	CL Height
5	21	12	6
7	23	12	6
8	26	12	6
9	29	14	7
11	31	14	7
12	34	15	8
14	36	15	8
17	42	15	8
20	48	16	8
25	54	18	9
28	56	22	10
36	58	26	11
42	60	28	12

While these dimensions are typical for good practice, satisfactory results may be achieved with modifications to suit some conditions. Factors such as fuel properties, total combustion volume, and length of flame travel often make fixed requirements impractical. When in doubt, consult the factory.

Figure 2-1 shows a typical installation for firebox sectional type boilers. Refer to the above table for dimensions.

Figure 2-2 shows a typical installation for cast iron sectional type boilers. Refer to the above table for dimensions.

Insulation should be provided between the refractory and the boiler base. Mineral wool, or other material not likely to settle is preferred. The chamber front wall may be constructed of firebrick or insulating firebrick. Insulation should be used between refractory and front plate. Firebrick, or insulating firebrick should be set in high temperature bonding mortar with provision for expansion.

Figure 2-3 shows a typical installation for Scotch type boilers.

Figure 2-4 shows a typical fire door type installation in a sealed base firebox boiler. Where combustion volume is adequate and boiler design permits, fire door installations are acceptable. A suitable hearth can be made by filling the base with rubble and covering with insulation and loose or cast refractory.

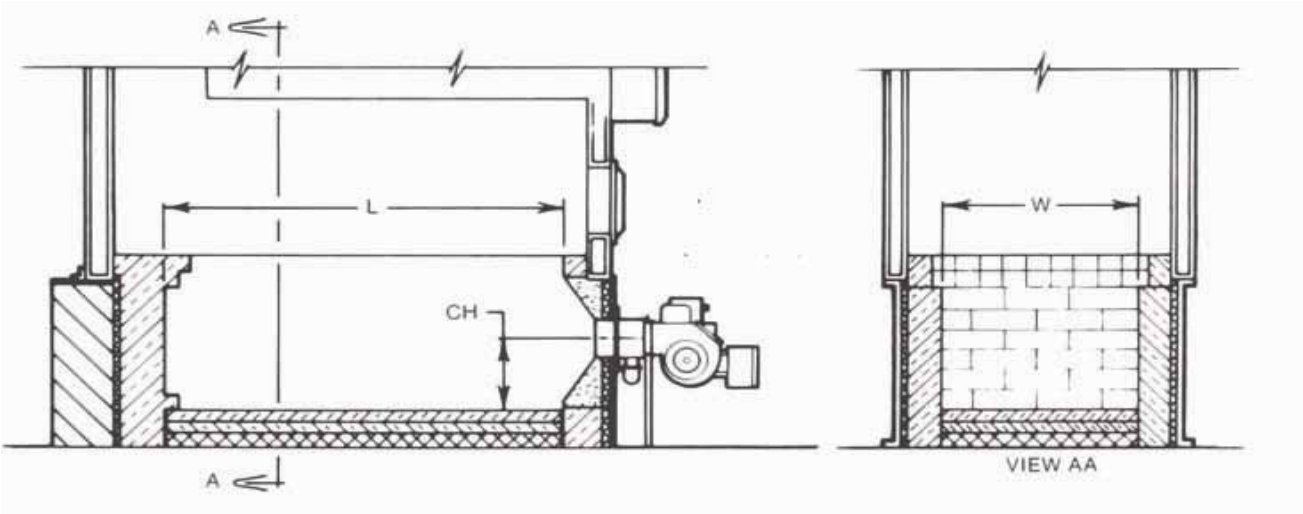


FIGURE 2-1. Typical Application to Firebox Boiler

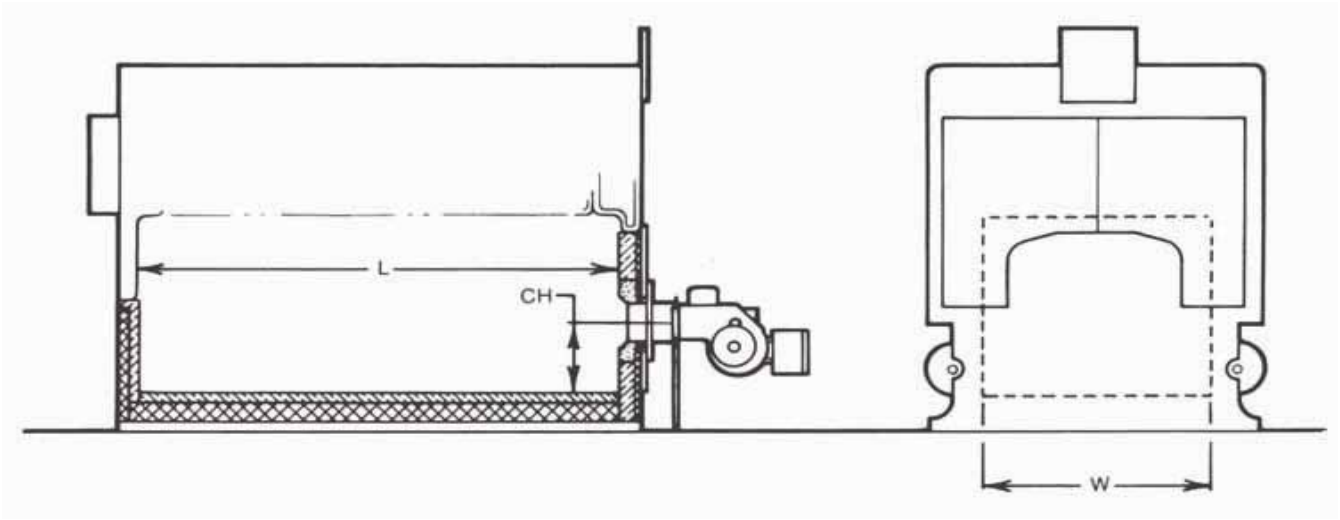


FIGURE 2-2. Typical Application to Cast Iron Sectional Boiler

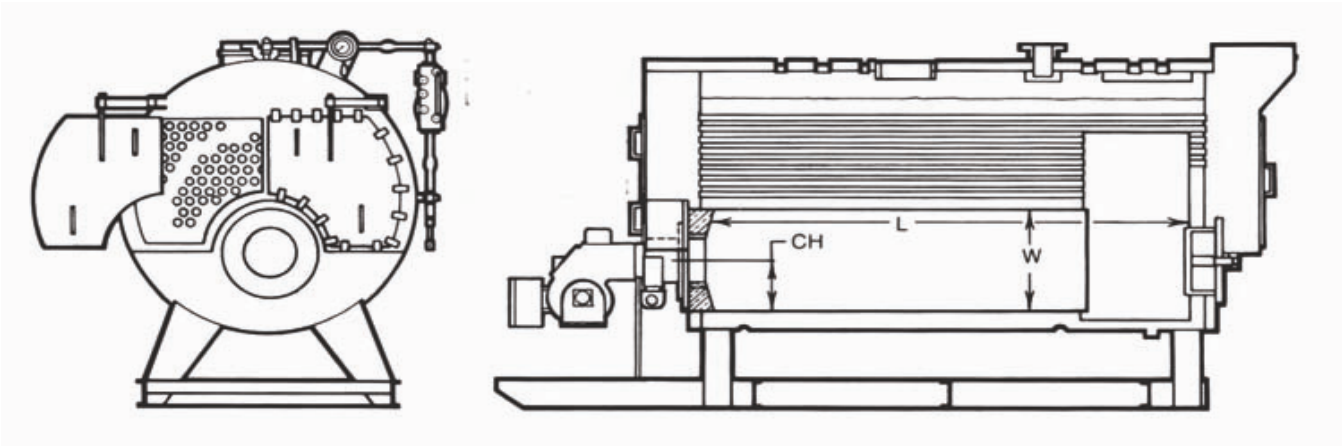


FIGURE 2-3. Typical Application to Scotch Type Boiler

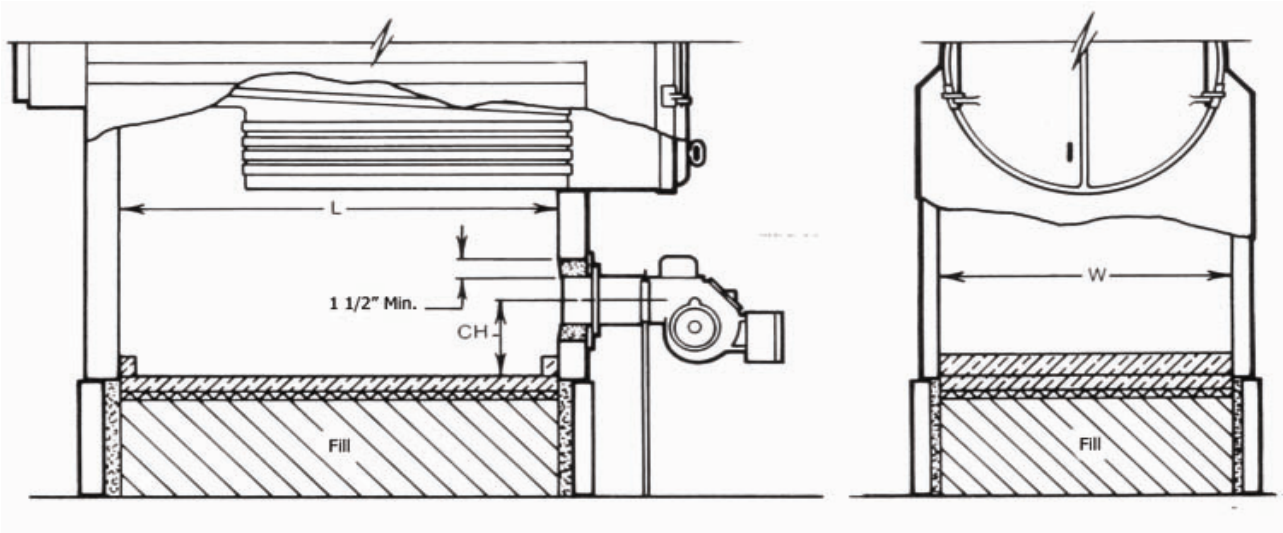


FIGURE 2-4. Typical Fire Door Application

2.4 — Burner Installation

1. Determine burner mounting height. Locate and scribe a level horizontal centerline across the mounting face.
2. Locate and scribe vertical centerline. Be sure stud locations line up where studs will have full support. If they don't or if opening is too large, a steel adapter plate, 3/8" minimum, may be welded or bolted in place. Suitable anchors should be provided to hold refractory in place. The adapter plate must be properly sealed (use insulating rope gasket to prevent leakage of combustion gases).
3. Refer to Figures 2-5, 2-6, and 2-7 for bolt circle and cutout dimensions.
4. Using insulating rope gasket, wrap rope on the inside of the bolt circle, looping rope around the four mounting studs.
5. Set the burner into position for mounting and tighten into place.

6. Permanently support the burner using the pipe support connections.
7. The space between the boiler refractory, water leg, or fire tube and outside diameter of the blast tube must be packed with plastic refractory, Kaiser Refractory Mono T-Air Set or equal. Ram plastic refractory from front to rear, parallel to outside surface of the blast tube. In Scotch type boilers, the refractory should extend past the tube sheet a minimum of 2-1/2". In firebox boilers, the refractory should be flush or set back from the fire-brick.

⚠ Caution

The gasket must be resilient to seal any uneven areas between the burner flange and the boiler front plate to prevent leakage of combustion gases.

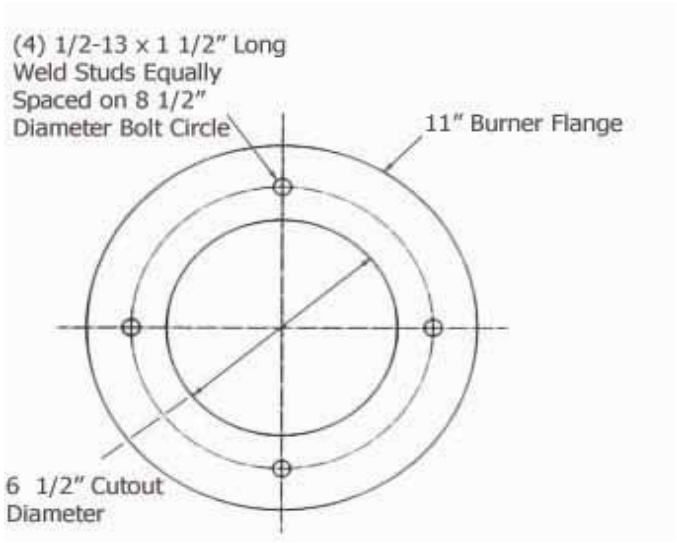


FIGURE 2-5. Mounting Dimensions 5-12

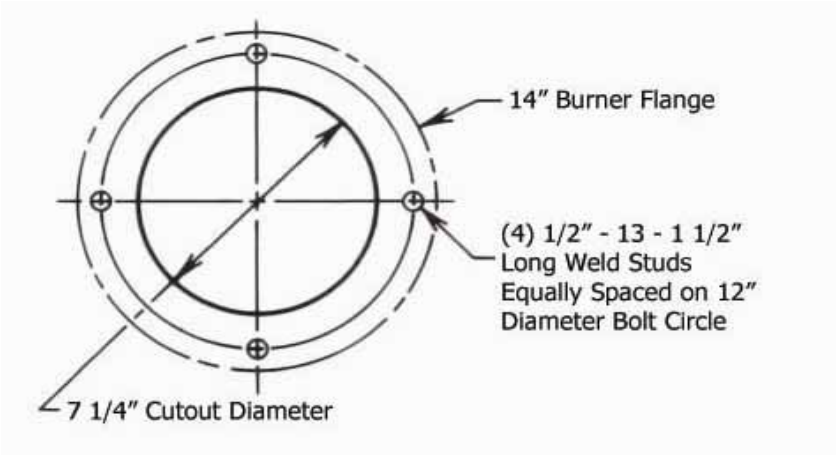


FIGURE 2-6. Mounting Dimensions 14-20

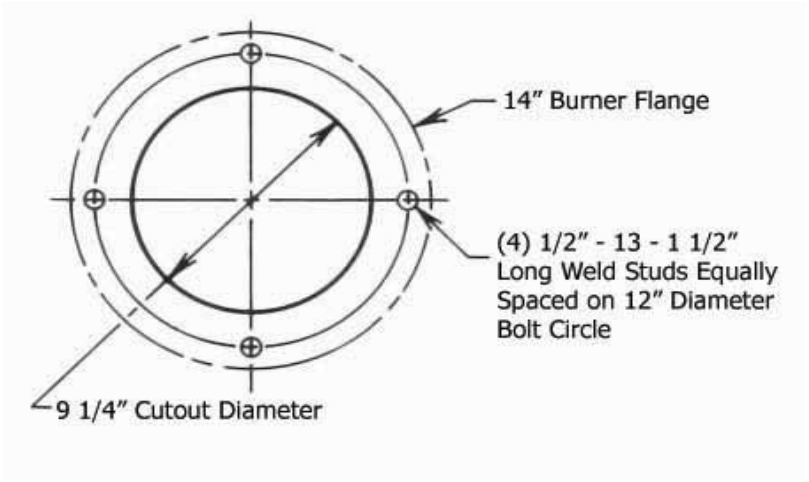


FIGURE 2-7. Mounting Dimensions 25-42

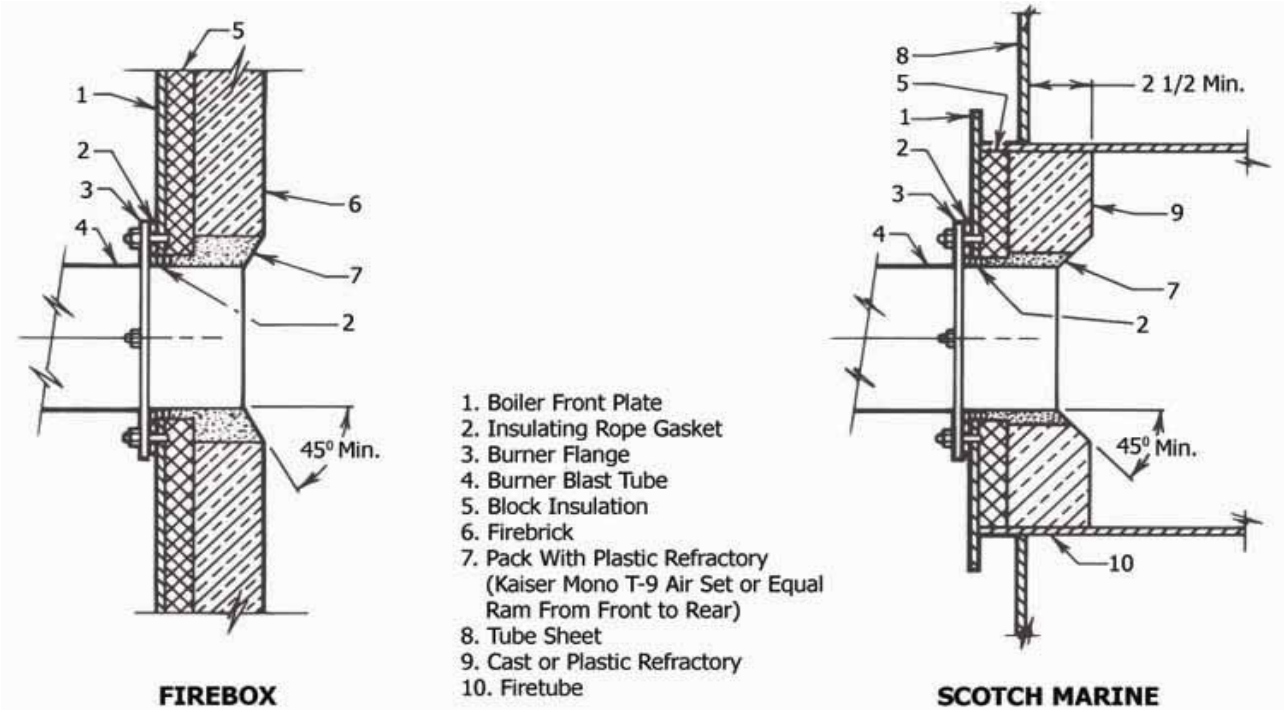


FIGURE 2-8. Mounting Detail

2.5 — Gas Piping

Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet.

All piping must be in strict accordance with applicable codes, ordinances, and regulations of the supplying utility. In the absence of other codes, piping should be in accordance with the following standards: “National Fuel Gas Code” NFPA No. 54, ANSI No. Z223-1.

Gas train components that are shipped loose should be mounted as close to the burner as practical. See Figures 2-9, 2-10, and 2-11 for component arrangement.

Arrange gas piping at the burner so that the burner is accessible for servicing without disassembly.

The gas pilot supply line must be connected upstream of the main gas regulator. If a reducing bushing is required between the house piping and the burner piping, it should be close to the burner shutoff valve.

The gas piping must be internally clean and free of foreign material. Before using in service, a leak test must be performed.

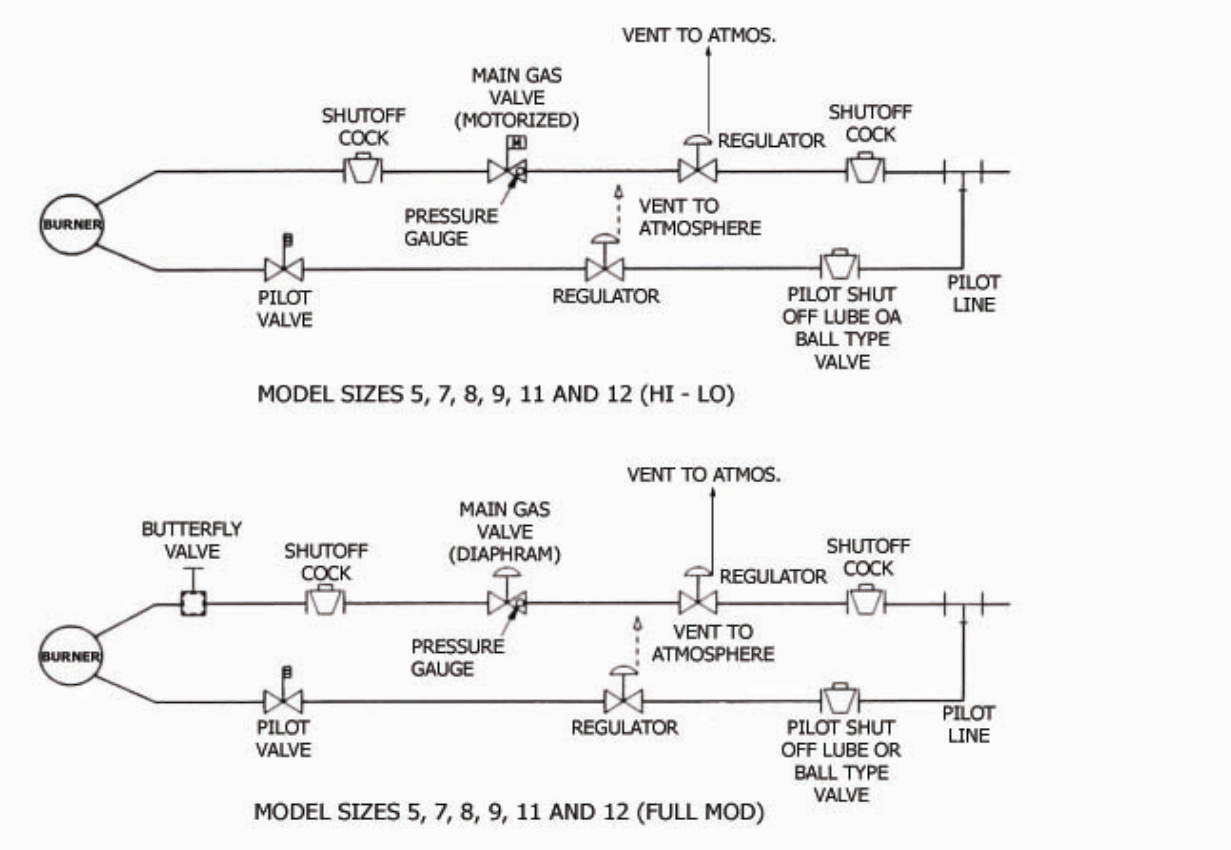


FIGURE 2-9. Gas Piping, Typical U.L. Arrangement FP5-12

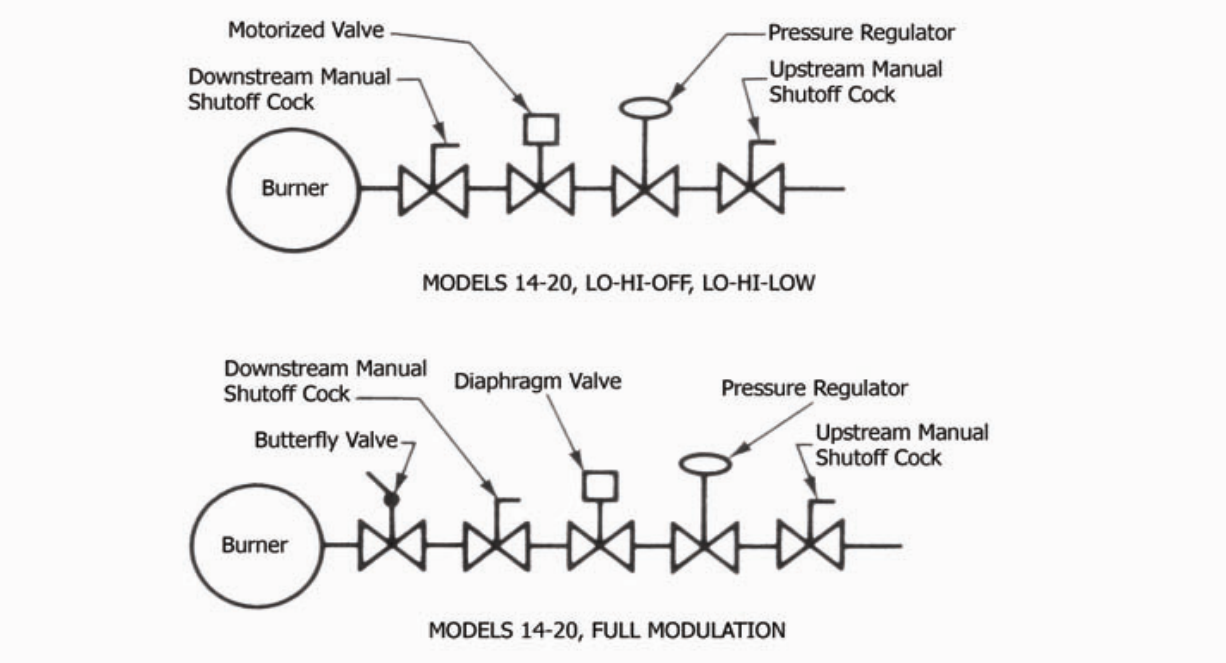


FIGURE 2-10. Gas Piping, Typical U.L. Arrangement FP14-20

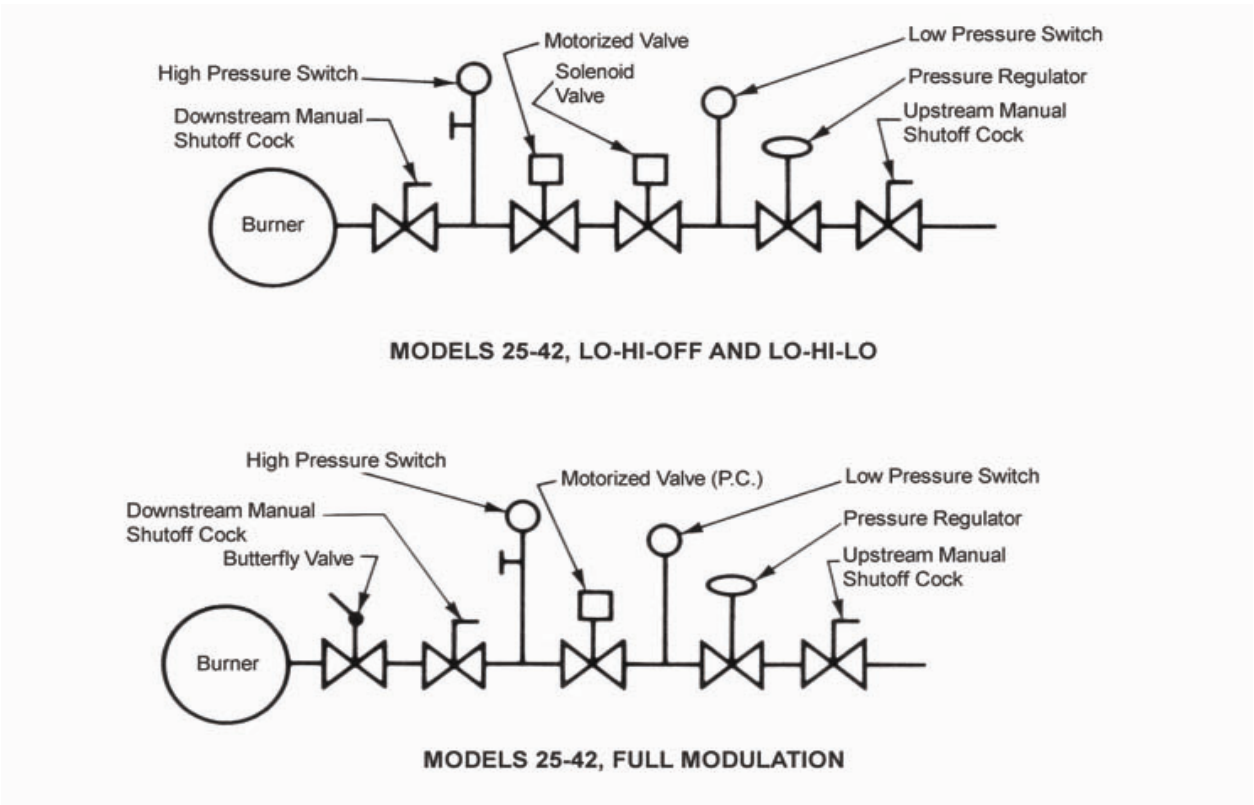


FIGURE 2-11. Typical U.L. Arrangement FP25-42

2.6 — Fuel Oil Piping

2.6.1 — Pressure Atomization Oil Piping

The FPL and FPLG model burners use pressure atomization. Fuel oil is provided by a burner mounted fuel unit. The suction and return line sizes (two-pipe system) are based on the suction rate of the fuel unit and not the burner.

2.6.2 — Two Pipe - Single Burner Operation

A two-pipe system is essential. The suction and return between the storage tank or supply source and the burner must be sized to supply the required quantity of oil circulated, including excess oil returned to the storage tank.

2.6.3 — Suction Line Sizing

The suction load is determined by:

1. The vertical lift from the oil level in tank to the pump.
2. Pressure drop through valves, fittings, strainers, etc.
3. The friction loss due to oil flow. This loss varies with:
   a. quantity of oil pumped (gph)
   b. length of suction line (feet)
   c. diameter of the suction line
   d. number of fittings

Although the gear type pumps used on the FP Series burners are capable of developing higher suction, it is not desirable to operate above 15” of mercury vacuum. If the vacuum is greater, flow may be erratic.

2.6.4 — Return Line Sizing

Generally, the return line should be sized the same as the suction line.

2.6.5 — Two Pipe - Multiple Burner System

Several options exist for a multiple burner installation. Figure 2-12 shows a typical installation showing separate suction lines for each burner with a common return line.

⚠ Caution

Do not use Teflon tape on connections. Use of Teflon tape will void fuel unit warranty.

Figure 2-13 shows multiple burners with oil supplied by a transfer pump. The circulating pump is sized, in this case for the total suction capacity of all burners. Note that a special pressure regulating valve is required if the fuel unit inlet pressure is above 3 psi.

Figure 2-14 shows an installation using a day tank. A pump supplies oil to the day tank.

Figure 2-15 shows a flooded loop system. The circulating pump is sized according to the maximum burner firing rate for all burners plus a 30% service factor. The burner return lines feed into the common supply line.

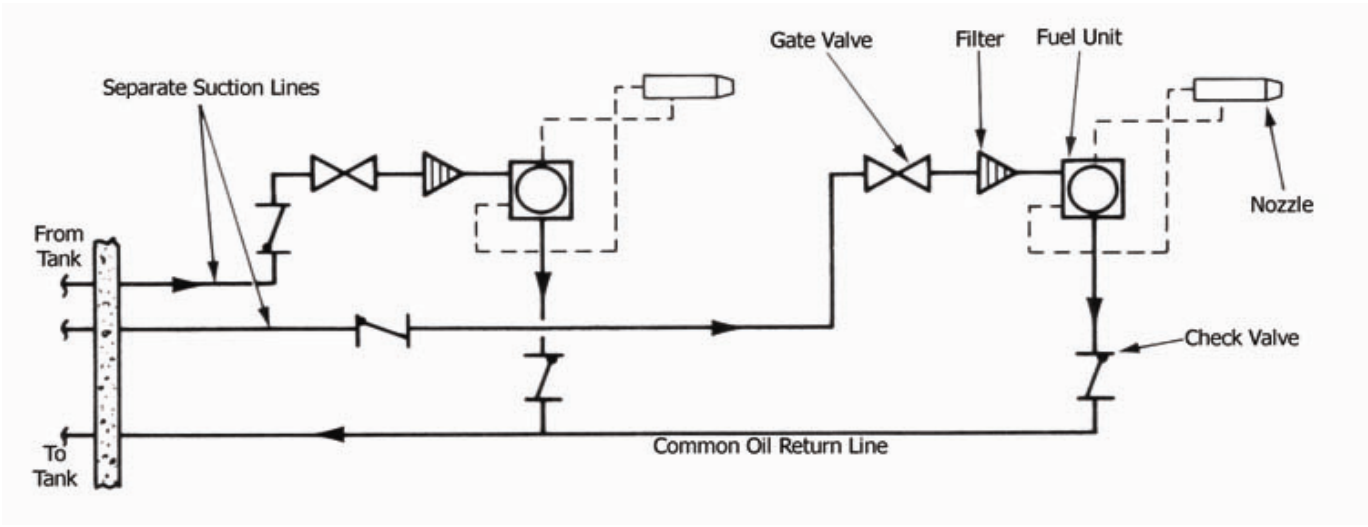


FIGURE 2-12. **Multiple Burners with Separate Suction Lines**

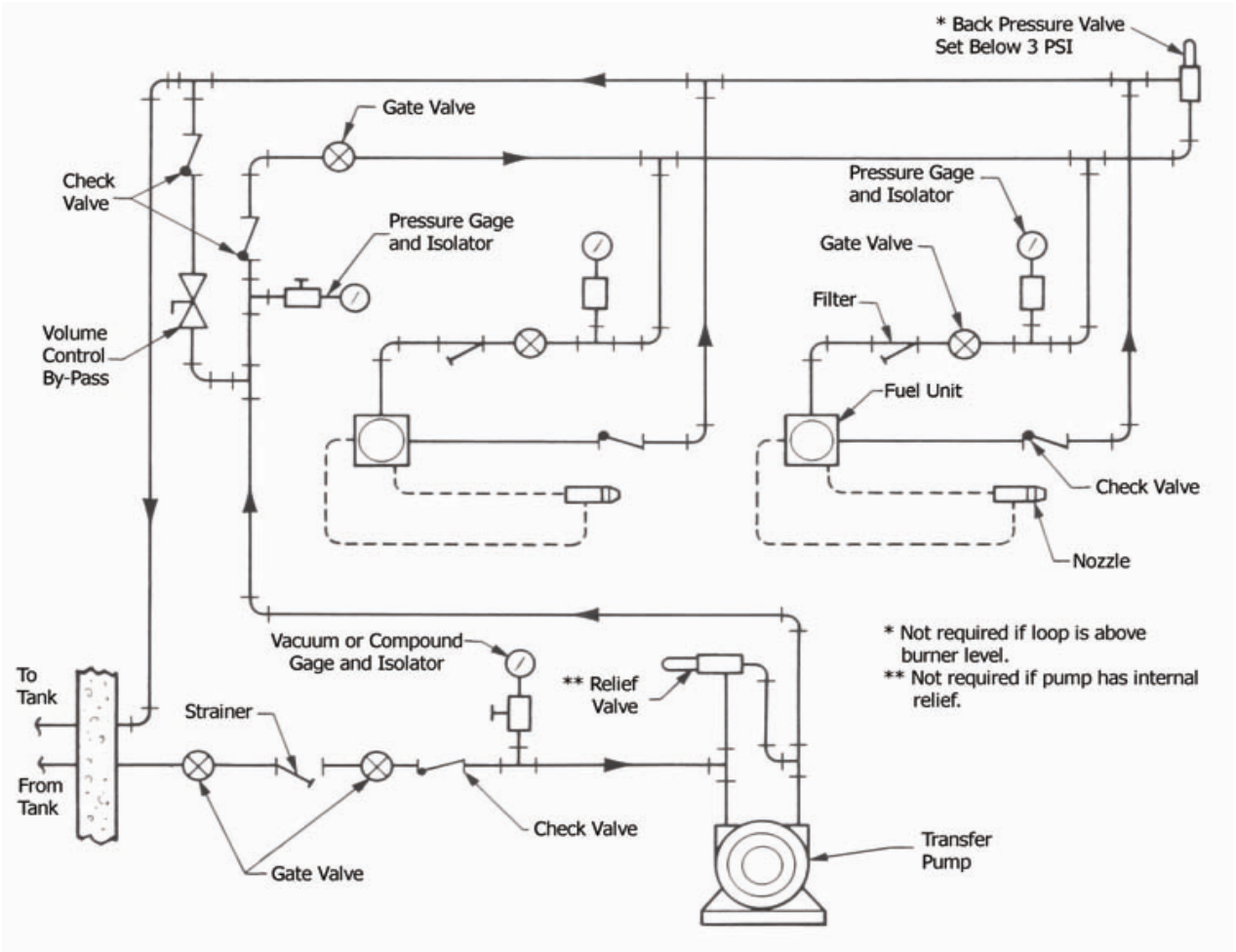


FIGURE 2-13. **Typical Oil Supply Loop for Multiple Burner Installation with Transfer Pump**

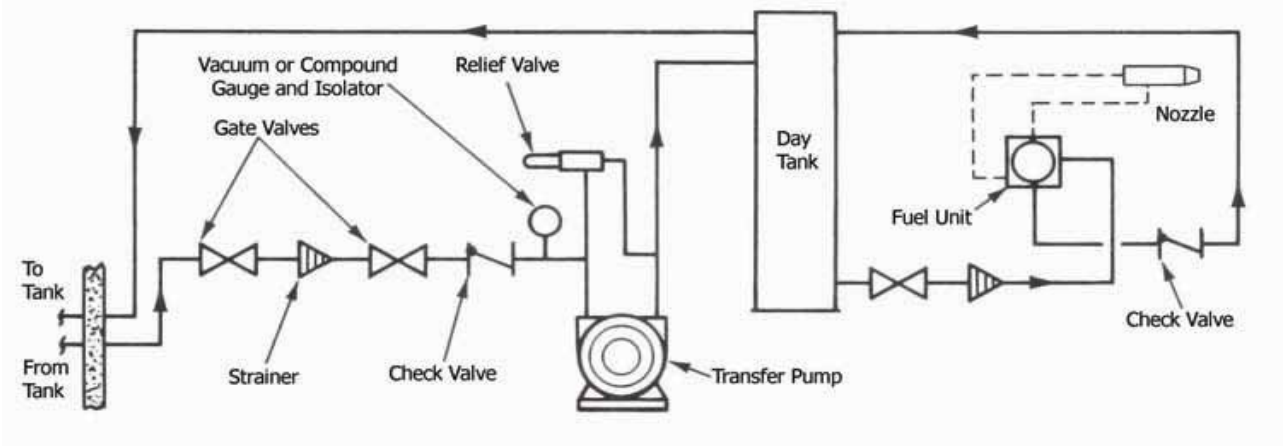


FIGURE 2-14. Typical Installation Using Day Tank

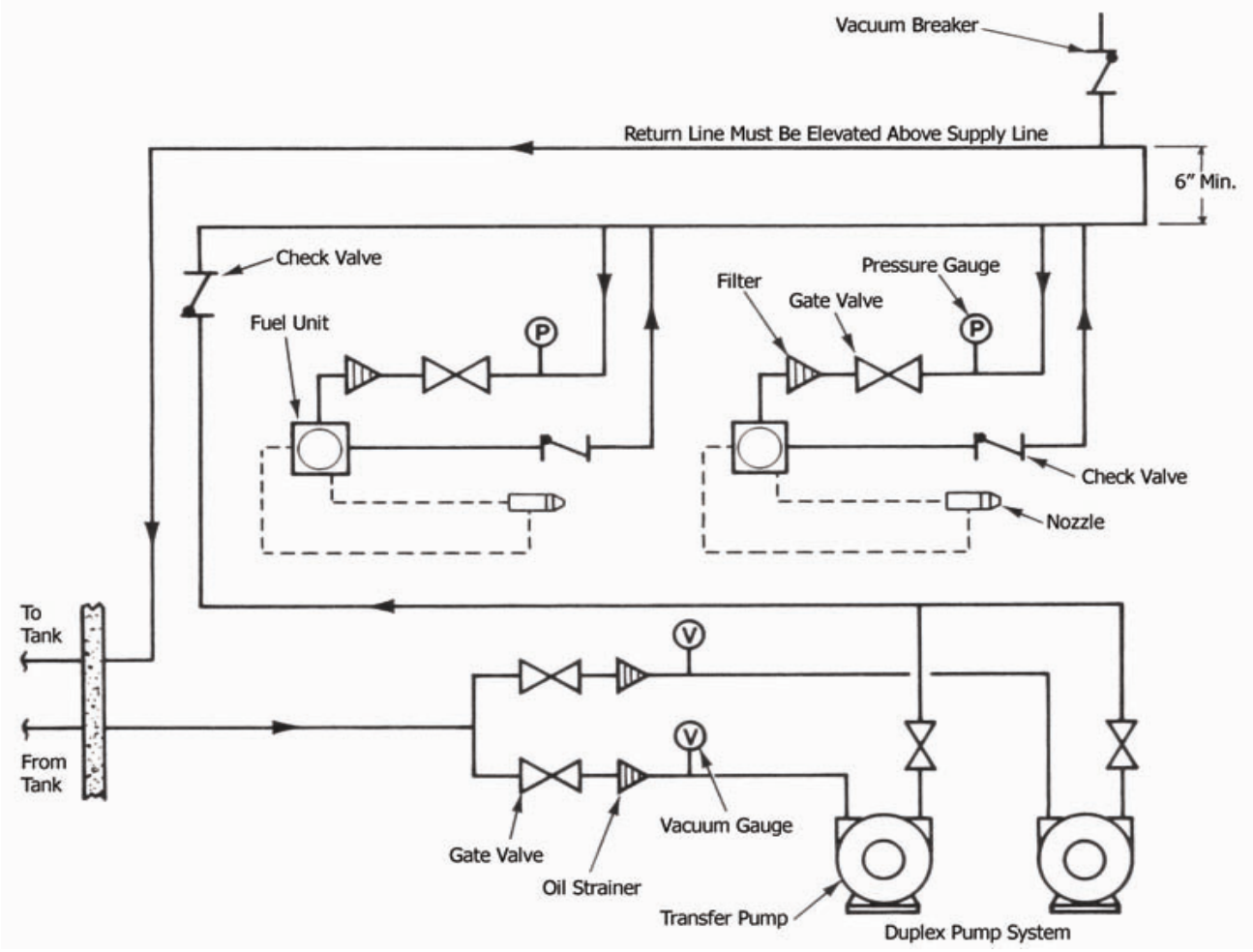


FIGURE 2-15. Typical Flooded Loop System

INDUSTRIAL COMBUSTION

2.7 — Installation Checklist

1. All burners are carefully assembled and tested at the factory, but before being placed in service all connectors should again be checked for looseness caused during shipment. Check:
   a. electrical terminals in the control panel and on all electrical components
   b. pipe fittings and unions
   c. tubing connections
   d. nuts, bolts, screws
2. Open all necessary oil shutoff valves. Do not run pumps or fuel unit without oil.
3. Before connecting electrical current to any component, be sure the supply voltage is the same as that specified on the component nameplate.
4. Before burner operation, be sure all motors are rotating in the proper direction.
5. Before firing, make sure the burner firing head and dry areas of the boiler are protected with refractory. The burner mounting flange must be properly sealed against the vessel front plate.
6. Make certain that the operator in charge is properly instructed in operation and maintenance procedures.

CHAPTER 3 Starting Up and Operation

3.1 — Preparation for Initial Startup

When the installation is complete and all electrical, fuel, water, and vent stack connections are made, make certain these connections are tight. The operator should become familiar with the burner, boiler controls, and components. Adjustment procedures given in Chapter 4 should be reviewed prior to firing. The wiring diagram should also be studied along with the operating sequence of the burner programmer. Check the electrical power supply for accordance with the nameplate specifications for all motors and controls.

Read and understand starting instructions before attempting to operate the burner. The following checks must be made:

Component	Check
Boiler	Check the boiler water level. Be sure all boiler values are installed correctly and positioned properly. Set the high limit control slightly above the operating control. Set the operating control at the desired temperature or pressure.
Burner	For protection in shipment, the flame safeguard control chassis is shipped unmounted. Check all screw connections before attaching the flame safeguard chassis to the base. The screw must be secure to assure low resistance connections. The relay chassis is mounted on the subbase with a screw which, when tightened, completes the connection between the subbase and chassis contacts. Press the manual reset button to be sure the safety switch contacts are closed.
	Check fuses in the main panel and in the burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. The control cabinet components are 120 volt. If a control transformer is supplied, ensure that the supply voltage matches its primary voltage.
	Check motor rotation by momentarily closing the starter or relay. Blower rotation is clockwise when viewed from the drive end.
	Check the pilot electrode setting. Refer to Chapter 4.
	Check the control linkage for proper movement of the air volume damper and fuel metering components. This can be done by loosening the linkage at the actuator lever and manipulating by hand.
	Check the air shutter and adjust low fire setting. Refer to Chapter 4.

INDUSTRIAL COMBUSTION

3.2 — Firing Preparations

Check to make certain that all plugs, connections, linkages, etc. are tight. Prior to initial firing, oil flow and pressure should be verified.

3.2.1 — Gas Burners

A representative of the gas utility should turn on the gas. Determine by a test gauge upstream of the burner regulator that sufficient pressure exists at the entrance to the gas train. The gas pressure regulator must be adjusted to the pressure required and the pressure setting recorded.

On combination fuel models, set the selector switch to gas. On initial startup it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequences to determine that the main gas valve opens. Turn the burner switch “OFF” and allow the programmer to finish its cycle. Check to see that the gas valve closes tightly.

On burners equipped with high and low pressure switches, set switch pressure actuating levels and record the settings for future reference.

See the burner specification nameplate inside the control panel door for minimum and maximum input rate and required manifold pressure.

When the conditions covered above and in Chapter 2 are assured, the burner is ready for firing. Refer to Section 3.5 for starting and operating information.

3.2.2 — Oil Burners

Prior to initial firing, oil flow and pressure should be verified. If the burner is a dual fuel model, make certain that the main gas shutoff cock is closed and the fuel selector switch is set to “OIL.”

3.2.3 — Oil Flow

If the oil supply tank is below the level of the oil fuel unit, it is recommended that the suction line be primed with oil prior to starting the pump to avoid the possibility of damage to the pump through operation without lubrication.

To check for proper pump rotation, momentarily energize the starter. With rotation verified, operate the pump to determine that oil circulation is present. Observe the oil burner pressure gauge. If no pressure shows after a few moments, stop the oil pump and re-prime. If the supply tank is lower than the pump, it is possible that the initial priming of the suction line, followed by operation of the pump, will not establish oil flow. This might be caused by obstruction in the suction line, excessive lift, inadequate priming, suction line leaks, etc. Until oil flow is established, avoid prolonged operation of the pump. If oil flow is not established after a second priming, investigation is required.

A vacuum (or compound pressure-vacuum) gauge should be installed at the suction port of the pump. It is advisable that the reading be less than 15” Hg vacuum. Vacuum in excess of this may because unstable firing.

3.2.4 — Oil Pressure and Vacuum

If the vacuum gauge reads higher than calculated, look for restriction in the suction line, a closed valve, kinked copper tubing, plugged filter, sticking check valve, frozen oil line, undersized oil line, or excessive lift.

When there is a positive head of oil at the fuel unit, either from a gravity or by pump circulation, the pressure must not exceed 3 psi at the fuel unit suction inlet. Special pressure regulating valves are available for suction pressure above 3 psi. The fuel unit discharge pressure should be set at 300 psi.

3.2.5 — Burner Settings

To ensure reliable and safe burner performance, the location and gap setting of the electrode for direct spark igniters, and the relative positions of the burner nozzle. diffuser, and air baffle components must be correctly set. The air damper blades must be adjusted, relative to the established flow rates, to provide the correct amount of air for complete efficient combustion.

These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position.

Refer to Chapter 4 for instructions.

3.2.6 — Combustion Settings

Fuel and air flow rates are individually adjusted at low fire and at high fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, the ability to cope with environmental changes (including air temperature, humidity, barometric pressure), and fuel property changes. Refer to the nameplate inside the control panel for minimum and maximum fuel input ratings.

Refer to Chapter 4 for instructions.

3.2.7 — Test Equipment

The following test equipment should be on site:

1. Combustion analyzer with O_2 or CO_2 indication.
2. U-Tube manometer, or pressure gauge, to measure gas pressures (main and pilot), pressure and vacuum gauge for the oil burners.
3. Inclined manometer to measure draft pressures.
4. Smoke spot tester for oil burners and CO analyzer for gas fired units.
5. Voltmeter/Ammeter.
6. Stack thermometer and thermocouples.

⚠ Warning

Read the flame safeguard manual and fully understand its content before attempting to operate this equipment. If this instruction is not followed, serious injury or death may result.

⚠ Warning

Should a starting failure occur for any reason, combustible fumes may fill the combustion chamber. Never attempt to re-light the burner under these conditions without first purging the chamber.

3.3 — Sequence of Operation

The programming control sequences the operation of all controls and components through the starting, ignition, firing, and shutdown cycle. The burner and control system are in starting condition when:

a. The operating and high limit control (temperature pressure) are below their cutoff setting.

b. All power supply switches are closed.

c. Power is resent at the control panel.

Refer to the manufacturer's literature on programming controls and burner wiring diagrams for detailed information.

3.4 — Electrical Interference Test

Prior to putting the burner into service, conduct the following test to ascertain that ignition spark will not cause the flame relay to pull in.

3.4.1 — Gas Fired

Close the pilot and main line manual gas valves. Start the burner and at time of the pilot trial with just the electrical ignition system energized. The flame relay should not pull in (should not be energized).

Upon completion of a successful test, proceed with startup procedures.

3.4.2 — Oil Fired

Disconnect the electrical power to the burner. Disconnect the electric oil safety shutoff valve. Reconnect the electric power. Close the pilot line manual gas valve, if used.

Start the burner and at the time of pilot trial, with just the electrical ignition system energized. The flame relay should not pull in.

Upon completion of a successful test, disconnect the poser supply. Reconnect the oil safety shutoff valve and turn on the manual pilot gas valve. Reconnect the power supply and proceed with startup procedures.

3.5 — Startup and Operating

3.5.1 — Gas Burners

Performing a Gas Valve Leak Test (Bubble Test)

A gas valve leak test must also be performed on the automatic safety shutoff valves located in the main gas train prior to any initial commissioning or subsequent maintenance of the burner and gas train systems — where automatic valve proving systems interlocked with the main burner safety control are not provided. This test should be performed periodically to ensure no leakage of valves in their closed or de-energized position.

Refer to Figure 3-1 when following this procedure. The unit should be taken out of service if the unit fails any of the following tests. Any defective part must be replaced prior to putting the equipment back into service.

⚠ Warning

Failure to follow this procedure may result in explosion, fire, property damage, and personal injury. This procedure must be performed only by authorized and qualified personnel.

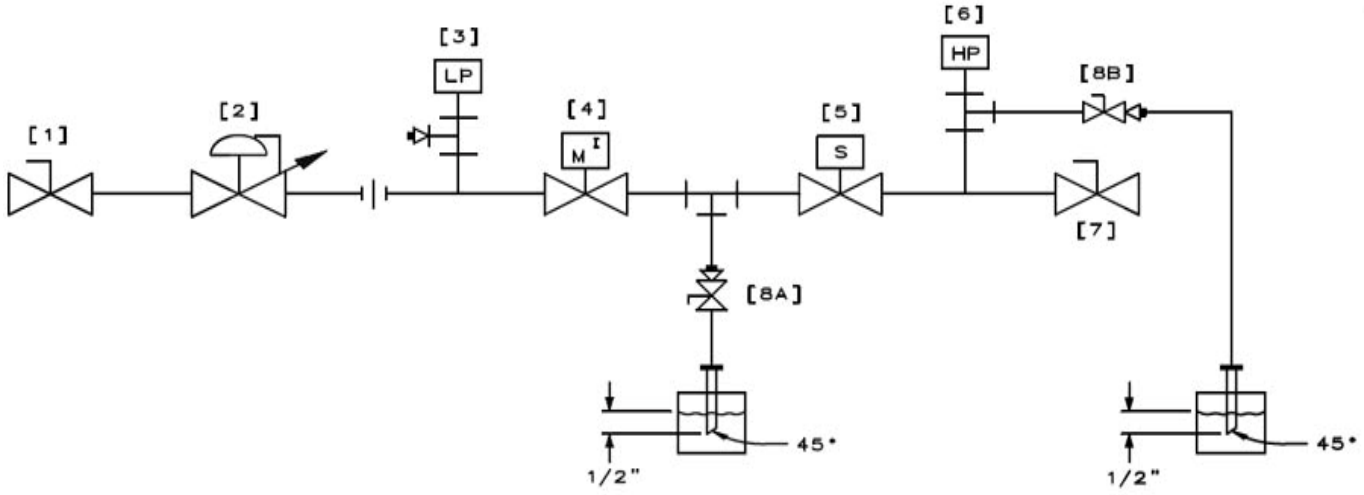


FIGURE 3-1. Gas Valve Leak Test Diagram

1. Close (or shut off) manual valve [7] downstream of the automatic safety shutoff valves, trapping gas pressure between the safety shutoff valves and manual valve and causing a flame failure. This should close the auxiliary safety shutoff valve [4] and main gas safety shutoff valve [5]. If both or either valve fails to close, do not proceed further until you correct the problem.
2. Release gas pressure at the leak test cock [8B] between the manual valve [7] and the main gas safety shutoff valve [5], then conduct a bubble test for a leak through the blocking valve [5]. If no leak, close the test cock.
3. Release gas pressure at the test cock [8A] and bubble test for a leak through the auxiliary safety shutoff valve [4]. If there is no leak, close the test cock and go to the next step. If either valve leaks, correct the problem and retest 10 times before proceeding.
4. When there are no valve leaks, open the manual valve [7] and relight the burners. Then close the manual valve [1]. The safety shutoff valve and blocking valve should close due to low gas pressure.
5. Relight the burners. Reduce the high gas pressure switch [6] setpoint setting until it reaches the operating gas pressure, which should cause the auxiliary and main gas safety shutoff valves to close from high gas pressure. Return the setpoint to its original position before proceeding.
6. Shut off the combustion air blower. This should cause a failure due to low air pressure and cause the safety valves to close.
7. Reset all manual valves to their normal setting for operation. Make sure all electric valves are operating normally. Make sure all test cocks are closed before resuming normal operation.

8. Close the downstream main and pilot gas cocks. Make sure the “ON-OFF” switch is in the “OFF” position. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
9. for “Low-High-Low” models, set the MOD switch to “Low.” For “Full Modulation” models set the “Manual-Auto” switch to “Manual.”
10. Set the manual potentiometer to low fire position.
11. Open the gas pilot cock.
12. Set the “ON-OFF” switch to “ON.” The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot solenoid are energized.
13. On initial startup it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequence. Then determine that the main gas valve opens. When this is confirmed, turn the burner switch “OFF” and allow the programmer to finish its cycle. Check to see that the gas valve has closed tightly.
14. If ignition does not occur, turn the burner switch “OFF” and allow the programmer to recycle for a new ignition trial.
15. Turn the burner “ON” and after pilot ignition, when the flame relay pulls in, the slow opening, motorized, main gas valve is energized. Slowly open the downstream manual shutoff gas cock. Main flame should ignite at this time. The gas valve and air damper continue advancing until high fire is reached.
16. Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting the butterfly valve and air linkage. Refer to Chapter 4. Using a combustion analysis instrument, adjust the low fire. Typical combustion analysis for low fire is 4% to 5% O_2 on standard turndown systems. Verify the minimum input rate by measuring the gas meter.
17. When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
18. After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 2% to 3.5% O_2. Verify maximum input rate by measuring the gas meter.

Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings. CO levels should be less than 400 ppm on an air-free basis at all firing rates with $<$50 ppm as the target value.

When conditions covered above are assured, refer to Sections 3.6 and 3.7.

3.5.2 — Oil Burners

1. Set the fuel selector switch to “OIL” and the “ON-OFF” switch to the “OFF” position. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
2. Set the “ON-OFF” switch to “ON.” The burner will start and pre-purge. After pre-purge, the ignition transformer will direct spark. If the flame detector proves the presence of a satisfactory pilot, the programmer will proceed to main flame ignition.
3. Make initial air shutter setting for smooth ignition. Return line oil pressure should be set according to Chapter 4. do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the oil low fire rate by

adjusting the oil return pressure and air linkage. Refer to Chapter 4. Using a combustion analysis instrument, adjust the low fire. Typical combustion analysis for low fire is 4% to 5% O_2.

4. When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open the main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
5. After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle. In high fire the oil metering valve should be in the fully closed position and the fuel oil pressure should be about 300 psi. Check high fire at this point using combustion analysis instruments. High fire combustion analysis typically is 3% to 4% O_2. Verify maximum input rate by measuring the oil meter if available or by weighing the oil.
6. The burner should be set up and maintained to yield smoke spot levels less than a #1 spot (ASTM D2156 Shell-Bacharach Scale) to minimize soot buildup in the boiler.

Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings.

When conditions covered above are assured, refer to Sections 3.6 and 3.7.

3.5.3 — Combination Gas-Oil Burners

In general, the combination fueled system is to be started first using oil, because, as a fuel, oil has a greater combustion air requirement than natural gas.

Refer to the Gas Burner or Oil Burner adjustment procedures in Chapter 4.

Once the adjustments are set for oil, shut down the burner and restart and adjust the natural gas fuel. DO NOT READJUST THE AIR SHUTTERS. The adjustment is made by balancing the fuel input rate against the existing flow of combustion air.

When conditions covered above are assured, refer to Sections 3.6 and 3.7.

3.6 — Normal Operation

Normal operation must be with the “Manual-Auto” switch selector on “Auto.”

In automatic operation, the operating cycle always proceeds sequentially through pre-purge, pilot ignition, main flame ignition, run, and post-purge. The length of the purge and ignition trials vary according to the type of programmer used.

During the run cycle, burner input is regulated to the load demand by the modulating pressure or temperature control on the boiler. The burner will continue to modulate until the operating pressure or temperature is reached.

Programmer control operation should be tested when the burner is initially placed into service, when a control is replaced, and at scheduled intervals in the maintenance program.

Refer to adjustment procedures and maintenance instructions given in Chapters 4 and 5.

3.7 — Shutdown

When the operating limit control setting is reached or the burner switch is turned “OFF,” the following sequence occurs:

- The fuel valve(s) de-energizes and the flame extinguishes. The blower motor continues running during post-purge (if so equipped with post-purge feature).
- At the end of the post-purge the blower motor is de-energized. The programmer returns to its starting position and stops. The unit is ready to restart.

Abnormal shutdown might result from motor overload, flame outage, low water, current or fuel supply interruption. combustion or atomizing air pressure below minimum level, tripped circuit breakers, blown fuses, or other interlock devices. check for the cause and correct it before restarting the burner.

Safety shutdown caused by ignition or flame failure will actuate a red indicator light and energize an audible alarm (if so equipped). If the programmer has a non-recycling interlock circuit, any interruption in this circuit during the pre-purge or firing cycle will cause a safety shutdown. This type of shutdown requires manual reset of the programming control and must be corrected before operation can be resumed.

CHAPTER 4 Adjustments

4.1 — Overview

While each burner is tested at the factory for correct operation before shipment, variable conditions such as burning characteristics of the fuel used and operating load conditions may require further adjustment after installation to assure maximum operating efficiency.

Prior to placing the boiler into initial service, a complete inspection should be made of all controls, connecting piping, wiring, and all fastenings such as nuts, bolts, and setscrews to be sure that no damage or misadjustments occurred during shipment and installation.

A combustion efficiency analysis made during the initial startup will help to determine what additional adjustments are required in a particular installation.

4.2 — Combustion Adjustment

Efficient combustion cannot be properly judged by flame appearance, although it may help in making preliminary settings.

The proper settings of air-fuel ratios must be determined by flue gas analysis. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. Instruments are available to measure carbon dioxide (CO_2), oxygen (O_2), and carbon monoxide (CO). At no time should CO_2 measurements alone be used to indicate proper excess air levels. Only O_2 measurement can definitively show whether sufficient air has been provided for combustion.

4.2.1 — Stack Temperature

Net stack temperature is obtained by subtracting the ambient temperature from the flue gas temperature. A high net stack temperature indicates wasted heat. Decreasing either the temperature or the volume of the flue gas, or both can reduce stack heat loss. Flue gas temperature is reduced by improving heat transfer or by reducing excess combustion air. A certain amount of excess air is necessary to complete combustion. More efficient burners require minimum excess air.

INDUSTRIAL COMBUSTION

4.2.2 — Smoke Measurement

Smoke measurements can be made using a variety of different methods. The standards will vary somewhat according to the equipment used, and instructions accompanying the instrument should be followed.

Smoky combustion can result from:

- improper air delivery
- insufficient draft
- improper fuel viscosity
- improper air-fuel ratio
- excessive air leaks in the combustion chamber
- improper fuel oil temperature

4.2.3 — Test Equipment

The following test equipment should be used to set up and adjust the burner correctly:

1. Combustion Analyzer for O_2 or CO_2 indicator
2. U-Tube Manometer, or pressure gauge, to measure gas pressures (main and pilot), vacuum and pressure gauges for oil
3. Inclined Manometer to measure draft pressures
4. Smoke Spot Tester for oil burners and CO analyzer for gas fired units
5. Voltmeter/Ammeter
6. Stack Thermometer and Thermocouples

4.2.4 — Gas Adjustments

Low fire combustion analysis typically is 7% to 9% CO_2 and less than .04% CO (400 ppm). A high fire reading typically is 9% to 10.5% O_2 and less than .04 percent CO.

NOTE: Check for CO through the entire firing range.

4.2.5 — Fuel Oil Adjustments

Adjust for a “clean fire.” Typically for No. 2 oil, CO2 is 8% to 11% at low fire, and 10% to 13% at high fire.

The burner should be set up and maintained to yield smoke spot levels less than a #1 spot (ASTM D2156 Shell-Bacharach Scale) to minimize soot buildup in the boiler.

NOTE: Some conditions may make it impossible to attain accurate combustion analysis. Air infiltration through the boiler at any point will dilute flue gas.

4.3 — Gas System

4.3.1 — Gas Pressure

Gas must be supplied at a pressure high enough to overcome the pressure loss in the burner gas train and furnace pressure while running at full input.

4.3.2 — Gas Flow

The volume of gas is measured in cubic feet as determined by a meter reading. The gas flow rate required depends on the heating value (Btu/cu. ft.). The supplying utility can provide this information as well as pressure correction factors. To determine the required number of cubic feet per hour of gas, divide burner input (Btu/hr.) by the heating value (Btu/cu. ft.).

NOTE: When checking the input rate, make sure no other equipment is operating on the same meter.

4.3.3 — Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. A normal setting is 3" to 6" W.C. when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame.

Although it is possible to visibly adjust the size of the pilot flame, obtain a proper DC volt or microamp reading of the flame signal.

The flame safeguard amplifier has a meter jack for this purpose. At initial startup and during planned maintenance, test the pilot flame signal, pilot turndown, and safety switch lockout.

⚠ Warning

An ultra-violet flame sensor electrical spark interference test must be performed after final adjustment. See Chapter 3 for additional information.

An ultra-violet flame sensor electrical spark interference test is conducted to determine if the sensor is picking up ignition spark. To test:

1. Close the manual valves in the main and pilot gas lines.
2. Turn the burner on.
3. With the electric ignition energized there should not be any signal on the test meter. If spark interference is encountered, the position of the UV sight tube may be out of place, in which case adjustment is necessary.

The various flame safeguard system manufacturer's literature describes detailed checkout and measurement procedures.

4.3.4 — Motorized Gas Valve

Upon being energized, the motorized gas valve has a damper positioning arm which controls the air damper. See Figure 4-1.

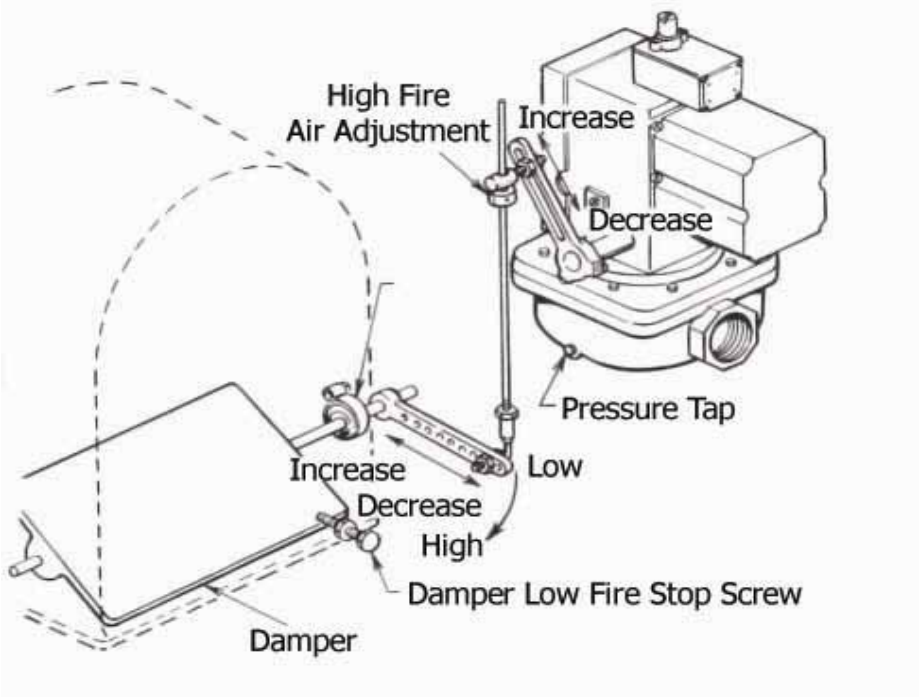


FIGURE 4-1. Air Adjustments - Gas Burners

4.3.5 — Optional Motorized Gas Valve (Low-High-Low Firing)

This two position gas valve opens to low fire position when power is supplied to the actuator. Low fire position is adjustable on the actuator (refer to the manufacturer's literature for adjustment procedure). The actuator opens the valve to high fire when firing rate controller contacts are made. When the firing rate controller is satisfied, the actuator will drive the valve to the low fire position. The valve will close when the limit control is satisfied, shutting down the burner.

4.3.6 — Main Gas Pressure Regulator

The gas pressure required at the burner manifold is the pressure that is required to fire the burner at its rated capacity. The gas pressure regulator must be adjusted to achieve this pressure to assure full input (refer to manufacturer's literature for regulator adjustment).

4.3.7 — Low Gas Pressure Switch (Models 28-42)

Turn the adjusting screw until the indicator moves to a pressure setting slightly below the operating gas pressure. The control will break a circuit if pressure is below this setpoint. The control should be finally adjusted to prevent operation with low gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur.

4.3.8 — High Gas Pressure Switch (Models 28-42)

Turn the adjusting screw until the indicator moves to a pressure setting slightly above the maximum operating gas pressure. The control will break a circuit if pressure exceeds this value. The control should be adjusted to prevent operation with excessive gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur.

This switch must be manually reset after tripping. To reset, allow gas pressure to drop and press the manual reset button.

4.3.9 — Gas Combination Adjustment

After operating for a sufficient period of time to assure a warm boiler, make adjustments for most efficient combustion.

Basically, gas adjustments are made with the gas pressure regulator which controls the pressure and indirectly the rate of flow. On full modulation models the butterfly gas valve directly controls the rate of flow. The low fire light off setting should be regarded as preliminary until proper gas pressure for high fire operation is established.

Determine the actual gas flow from a meter reading at high fire. With the gas valve or butterfly valve open and with regulated gas pressure set, the actual flow rate should be quite close to the required input. If corrections are necessary, increase or decrease the gas pressure by adjusting the gas pressure regulator, following manufacturer's directions for regulator adjustment.

When proper gas flow is obtained, take a gas analysis reading. With the high fire air-fuel ratio established, the gas pressure regulator needs no further adjusting.

Recheck low fire and adjust if necessary.

NOTE: Proper settings of the air-fuel ratios at all rates must be determined by combustion analysis. See Section 4.2 for additional information.

If a burner is to be fired on gas for an extended period, disconnect oil fuel unit flexible coupling to eliminate unnecessary wear on the fuel unit. See Figure 4-2 (this does not apply to a separately driven fuel unit or remote pump sets).

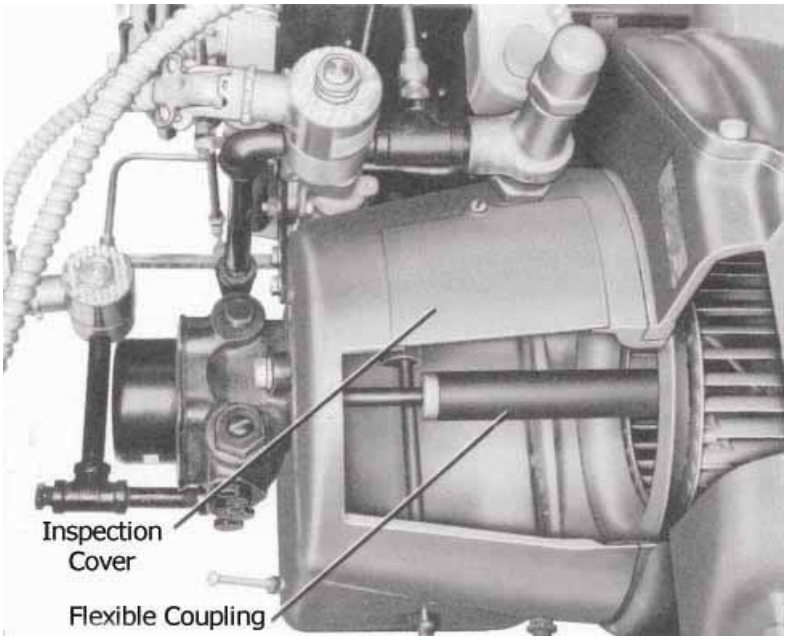


FIGURE 4-2. **Flexible Coupling - Cutaway View**

4.4 — Oil System

Models FPL and FPLG are designed for low fire start and high fire operation at 300 psi fuel oil pressure.

Oil flow to the nozzle is controlled by three solenoid valves. The high pressure safety shutoff valves (N.C.) prevent flow to the nozzle except upon command of the flame safeguard system. The other valve (N.O.) controls the low fire rate. The N.O. solenoid bypasses oil from the fuel unit through the low pressure regulating valve. When the high fire switch is actuated, the N.O. valve closes and full fuel unit pressure is delivered to the nozzle. Oil pressure actuates the hydraulic cylinder to open the air damper, which is spring-loaded to return to the low fire position (see Figure 4-3).

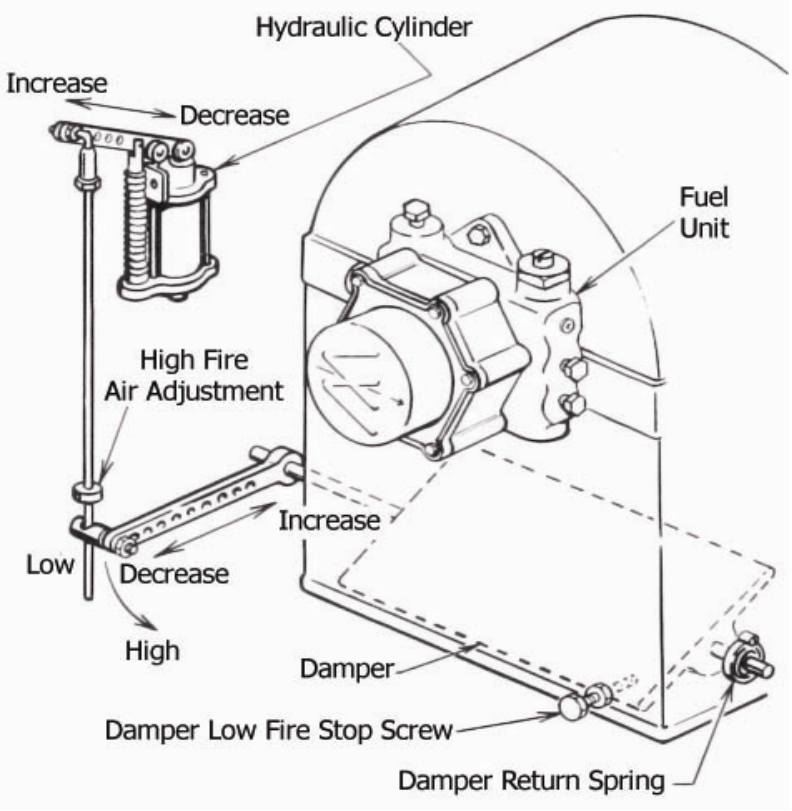


FIGURE 4-3. Air Adjustments: Oil Burners

4.4.1 — Fuel Unit

Vacuum readings at the fuel unit inlet must not exceed 15” Hg. A 30” Hg vacuum gauge in the oil supply will affirm this reading.

If the fuel unit is gravity or supply pump fed, inlet pressure must be limited to 3 psi maximum to ensure compliance with N.F.P.A. standards. A pressure reducing valve must be installed if supply pressure is over 3 psi.

The pressure gauge between the fuel unit and the solenoid valve should read 300 psi with the valve closed. discharge pressure should be adjusted at startup and checked during planned maintenance.

Operating pressure is adjusted by removing the screw cover and inserting an allen wrench into the adjusting screw. Turn clockwise to increase pressure. The spring saddle and adjusting spring are designed to produce max-

imum pressure of about 15% above pump rated to ensure an adequate reserve to compensate for normal wear over the life of the pump.

4.4.2 — Hydraulic Cylinder

FPL and FPLG burners on oil operation use a hydraulic cylinder actuated by fuel oil to regulate the damper from low to high fire. When the burner is in low fire position, the hydraulic cylinder is at rest with the damper in a nearly closed position. The damper must be set as low as possible for trouble-free ignition operation while still allowing for clean combustion. When the N.O. solenoid valve on the fuel return line is actuated (closes) the increased oil pressure in the hydraulic cylinder forces the piston lever against the resistance of the external return spring. As the piston lever moves, the air inlet damper moves to its high fire position. Adjustments should be made as follows:

1. With the firing rate switch in low fire, adjust the air volume at the damper to give a “clean fire,” normally resulting in less than No. 2 smoke and 8% to 11% CO_2. Adjust the damper by positioning the low fire stop and tightening the lock nut. The damper returns to this position after high fire by spring tension.
2. Switch the controls to high fire position. The hydraulic cylinder will extend and open the damper to increase air flow. Without disturbing the low fire setting, adjust air volume for required high fire setting. This is usually less than No. 2 smoke and 10% to 13% CO_2. Adjust by positioning the damper linkage (refer to Figure 4-3). The linkage should be adjusted so that the air/oil ratio is correct when the cylinder reaches the end of its travel.
3. Cycle the burner from low to high several times and make certain that all linkage connections are secure. Remove the oil pressure gauge after completing adjustments.

4.4.3 — Relief Valve

The adjustment screw under the castle nut regulates the low fire oil pressure. Adjust by reading the pressure gauge in the nozzle line at the drawer back cap.

4.4.4 — Oil Meter Valve (Optional: Full Modulation)

The firing rate is regulated by a metering valve in the nozzle return line. At low fire, the arrow on the valve points to approximately number 7 on the valve dial and is in the closed position at high fire (no return flow). See Figure 4-4.

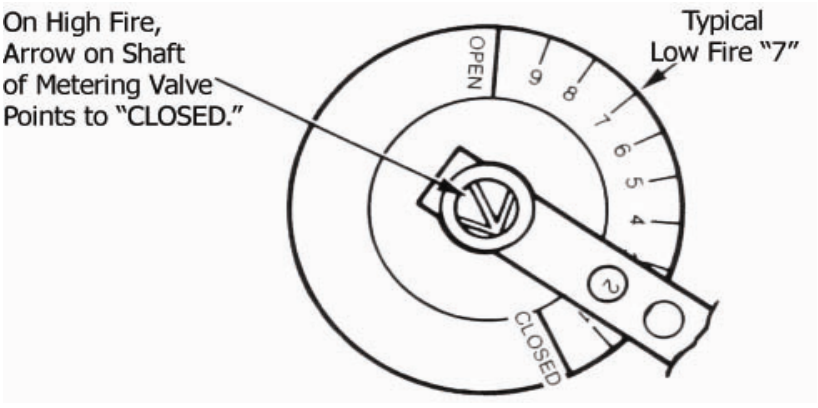


FIGURE 4-4. Air Adjustments: Oil Burners

The moveable pointer in front of the dial is an indicator only and has no effect on the valve operation. Make adjustments by the arrow on the valve shaft.

The firing rate is also affected by pump pressure setting and nozzle selection.

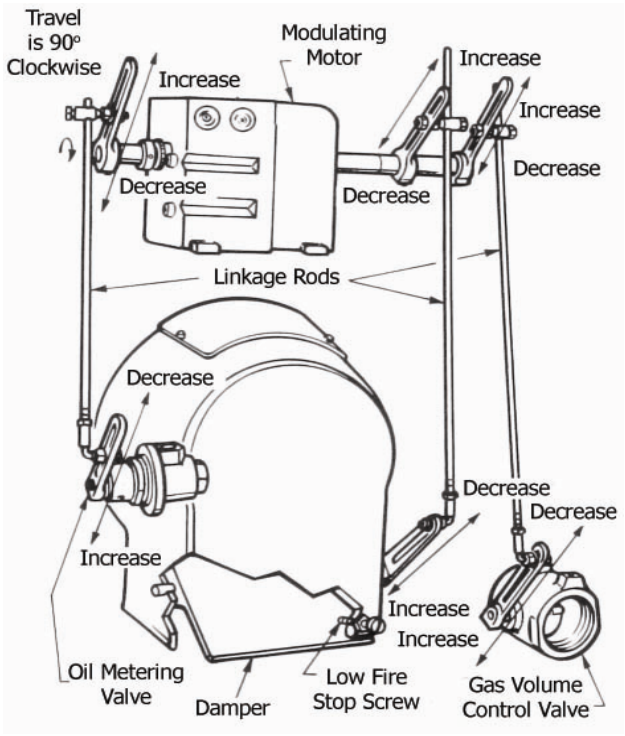
Return line pressure is determined by gauge measurement. The pressure varies in response to the oil metering valve position between open and closed. Where a lower than normal high fire rate is required, use a lower capacity nozzle rather than reduce the return line pressure or fuel unit pressure.

4.5 — Linkage Adjustments

The linkage consists of levers, rod(s), and ball joints that transmit motion from the gas valve actuator damper crank or the hydraulic cylinder arm to the air damper on Low-High-Off or Low-High-Low firing models or from the optional modulating motor to the air damper and gas rate butterfly valve and/or metering valve on full modulation models.

When properly adjusted, coordinated movement of the air damper and fuel provides proper air/fuel ratios for reliable ignition, low and high fire, or through the firing range on full modulation burners.

Settings are adjusted by the length of the linkage rods, length of lever arms, and the angular positions of the levers on the shafts (see Figures 4-1, 4-3, and 4-5). The most rapid rod travel occurs when the lever is perpendicular to the rod. The closer the rod comes to parallel with the lever, the slower the rod moves.



The angles of the driven levers on the jackshaft can be adjusted to vary the rate of change. The closer the rod to the hub of the lever, the less distance it will travel.

Increasing the lever length on the damper, metering unit, and valve(s) decreases the flow rate.

FIGURE 4-5. Air and Fuel Adjustments: Full Modulation

4.6 — Modulating Motor (Optional)

The modulating motor, through a linkage arrangement, positions the air damper and the fuel metering valve to maintain proper air/fuel ratio throughout the firing range (see Figures 1-4 and 4-5).

The motor is controlled by either a temperature or pressure actuated modulating control. During normal operation, the motor moves in either direction or stops at any position within a 90º stroke before installing.

The flame safeguard programmer holds the modulating motor in low fire during ignition and until the main flame is established. A low fire switch, integral to the motor or damper mounted, is actuated by the rotation of the motor. This switch must be closed to prove that the damper and fuel metering units are in low fire position before ignition. During this time, neither the manual potentiometer nor modulating control have any effect on the damper motor.

Some burners have a second integral switch to prove the motor has driven the damper to an open position during pre-purge. This switch closes at the high fire position to allow continuation of the programming cycle.

Refer to the manufacturer's literature for adjusting the modulating motor switch.

4.7 — Combustion Air Damper

The damper regulates the combustion air volume. The air damper is positioned by the gas valve actuator damper crank, hydraulic cylinder arm, or the modulating motor. At low fire the damper must be set as low as possible for trouble free ignition operation while still allowing for efficient combustion.

All adjustments for low and high fire must be made in the low fire position.

CHAPTER 5 Maintenance

5.1 — Overview

A maintenance program avoids unnecessary downtime, costly repairs, and promotes safety. It is recommended that a record be maintained of daily, weekly, monthly, and yearly maintenance activities.

Electrical and mechanical devices require systematic and periodic inspection and maintenance. Any “automatic” features do not relieve the operator from responsibility, but rather free him from certain repetitive chores, providing time for upkeep and maintenance.

Unusual noise, improper gauge reading, leak, sign of overheating, etc. can indicate a developing malfunction, requiring corrective action.

⚠ Warning

Only factory authorized burner service personnel should start-up, adjust, or service this equipment.

⚠ Caution

Any cover plates, enclosures, or guards anchored to the burner, or any burner related equipment, must remain in position at all times. Only during maintenance and service shutdown can these cover plates, enclosures, or guards be allowed to be removed. They must be replaced, and securely anchored before testing, adjusting, or running the burner or burner related equipment.

5.2 — Control System

Most operating controls require very little maintenance beyond regular inspection. Examine electrical connections. Keep the controls clean. Remove any dust from the interior of the control. Covers should be left on controls at all times. Keep the control cabinet doors closed. Dust and dirt can damage motor starters and relay contacts. Starter contacts are plated with silver and are not harmed by discoloration. Never use files or abrasive materials such as sandpaper on contact points.

⚠ Warning

When replacing a control or cleaning contacts, be sure to disconnect the main power supply since the control is energized even though the burner switch is off. More than one disconnect switch may be required to disconnect all power.

5.2.1 — Programming Control

This control requires no adjustment, nor should any attempt be made to alter contact settings or timing logic. Those programmers with contacts may require occasional cleaning. If so, follow the instructions given in the manufacturer's bulletin. Never use abrasive materials. The manufacturer's bulletin also contains troubleshooting information.

The flame detector lens should be cleaned as often as conditions demand.

A periodic safety check procedure should be established to test the complete safeguard system. Tests should verify safety shutdown with a safety lockout upon failure to ignite the pilot or the main flame, and upon loss of flame. Each of these conditions should be checked on a scheduled basis. The safety check procedures are contained in the manufacturer's bulletin.

5.2.2 — Motors

Supply voltage to the motor must not vary more than 10% from the nameplate ratings. At initial startup and regularly thereafter, check the motor current with an ammeter while the burner is in high fire position. If the reading exceeds the nameplate rating plus service factor, determine the cause and correct it. In dusty locations, clean the motor regularly to assure adequate cooling. Lubricate in accordance with the manufacturer's instructions.

5.3 — Gas System

Check the gas train for leaks. Check the gas valves and verify the low and high gas pressure settings.

5.3.1 — Solenoid Valves

A faint hum from the solenoid is normal when the coil is energized. Should the valve fail to operate, check that there is voltage at the valve coil. If there is no voltage at the coil, check for loose wiring connections. If there is proper voltage at the valve coil and the valve still fails to open, replace the coil. Refer to the manufacturer's bulletin for the correct coil replacement procedure.

Should it become necessary to replace the complete valve, be sure that the flow is in the direction of the arrow on the valve body.

Test for gas leaks and check the valve action several times to ensure proper operation before attempting to relight the burner.

⚠ Caution

All power must be disconnected before servicing the valves.

5.4 — Oil System

Little maintenance is required on the oil systems other than cleaning the oil filter. This procedure should be done at regular intervals. An increased inlet vacuum reading may indicate a clogged filter. Follow the strainer manufacturer's maintenance schedule.

Maintenance checks on the flexible coupling between the fuel unit and motor for alignment, tightness and wear and oil piping connection tightness should also be made at regular intervals. Access the coupling by removing the airbox cover and loosening the two setscrews on the flex coupling.

The oil nozzle should be checked. Inside the nozzle lies a small screen that keeps out any particle not caught by the strainer. These particles will interfere with the normal oil flow pattern exiting the nozzle. A distorted flame can indicate a clogged nozzle. Inspect and clean the nozzle and screen. To clean the screen, swirler, and tip, unscrew the tip from the nozzle body. Clean the nozzle parts in solvent. Never use wire or sharp metal tools to clean the nozzle orifice. A metal tool will distort the orifice and ruin the nozzle. Reassembly the nozzle. The tailpiece must be screwed in with the swirler seated tight against the tip to ensure proper atomization. Reassemble the nozzle into the nozzle body. If a nozzle is replaced, it must be an identical nozzle (make, size, and spray angle).

5.5 — Drawer Assembly

The drawer assembly may be removed for inspection and service:

1. Shut off the burner by turning the burner switch to the "OFF" position.
2. Shut off all electric power to the burner.
3. Disconnect the fuel lines from the drawer assembly access cover.
4. After making note of where the bolts are located in relationship to the access cover slots, remove the drawer assembly access cover bolts. Pull the drawer partially out of the housing. Reach inside to disconnect the ignition cables from the electrodes for direct spark applications. Pull the drawer assembly completely out of the housing.
5. To reinstall the drawer assembly, insert it part way into the housing, connect the ignition cables, if applicable, and seat the assembly fully. Install the access cover bolts loosely. Slide the cover into the original location, and tighten the bolts. Reconnect the fuel lines.

5.6 — Ignition Electrode, Cable, and Pilot

Failure to keep electrodes clean and set in the proper position accounts for much faulty burner operation. Not only must the gap be correct, but the electrode points must be carefully located with respect to the nozzle. Sometimes difficulty in securing the electrodes in their clamps can be corrected by using light metal shims around the porcelain. Defective or cracked porcelains require replacement to prevent short circuiting of the spark. A gradual wearing away of the electrode tips may require re-spacing of the points or replacement of the electrode.

The pilot should be checked monthly for loosening of components and carbon buildup. Before removing the pilot, ensure that the fuel supply is shut off.

On direct spark oil units, once you have removed the drawer assembly, check the electrode to nozzle gap and adjust if necessary.

For burners equipped with a gas pilot, the pilot is located on the side opposite to the main gas entrance.

1. Close the gas pilot cock.
2. Disconnect the pilot gas supply line.
3. Remove the screws on the pilot access plate.
4. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly.
5. The pilot gun assembly will slide back away from the flame side of the burner. Once the pilot assembly is clear of the burner head bracket, turn the pilot assembly and retract it through the access hole.
6. Inspect the electrode and adjust the gap if necessary.
7. Thoroughly clean and adjust the porcelain insulated electrodes. Correct all variations from the clearance dimensions.
8. If the insulation on the high voltage cables becomes cracked or charred, install new cables.

The ignition cable should not be exposed to moisture, abrasion, or rough handling. See that the connectors are in perfect contact with the cable ends. Unscrewing the snap portion of the connector will show whether this is true.

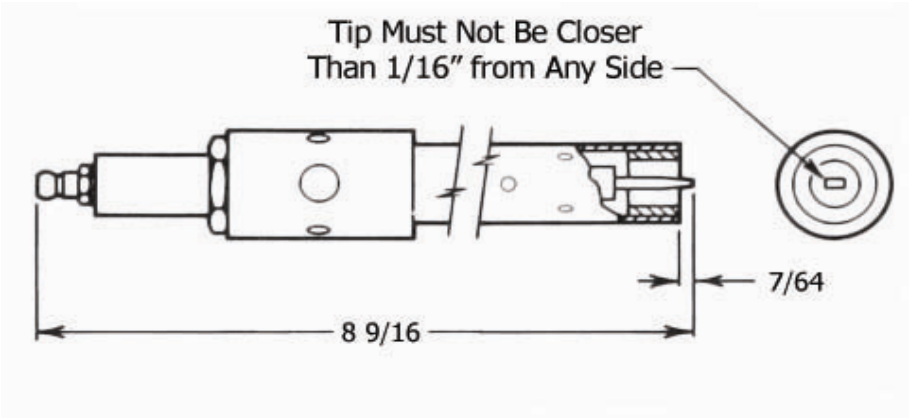


FIGURE 5-1. Electrode Adjustment

5.7 — Flame Scanner

The scanner must be clean. Even a small amount of contamination will reduce the flame signal. Wipe the scanner lens with a clean soft cloth. Check pilot and flame signal strength.

5.8 — Burner Mounting Inspection

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. If leaking occurs, refer to Chapter 2 for proper sealing procedure.

5.9 — Extended Shutdown

When shutting down the burner for an extended period, the operator should use the following general guidelines to protect the burner from its surrounding elements. This will add to the life of the burner.

1. Turn the main electrical disconnect switch to the burner to “OFF.”
2. Close all main fuel valves.
3. If the burner operates in a damp environment, cover it with plastic to protect all electrical components from moisture.
4. Remove the flame safeguard and store in a dry atmosphere.

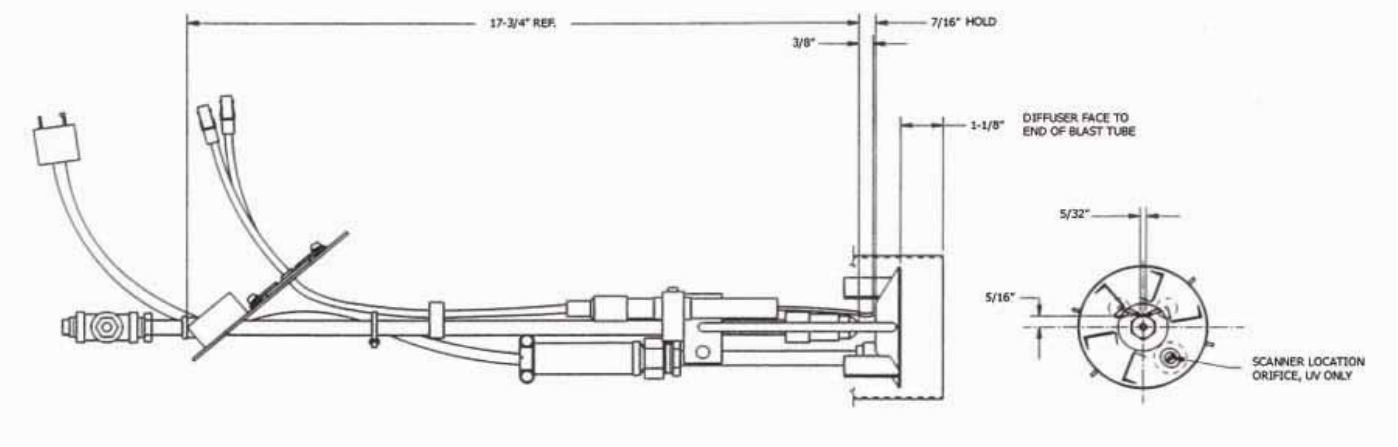


FIGURE 5-2. FPL 5 & 7 Drawer Assembly Direct Spark

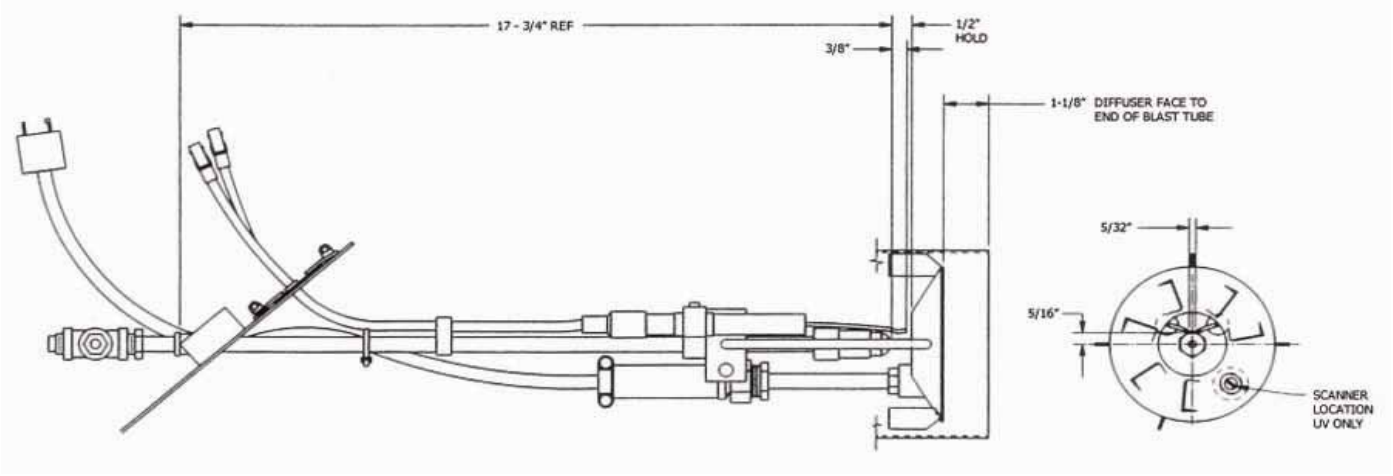


FIGURE 5-3. FPL 8, 9, 11, & 12 Drawer Assembly Direct Spark

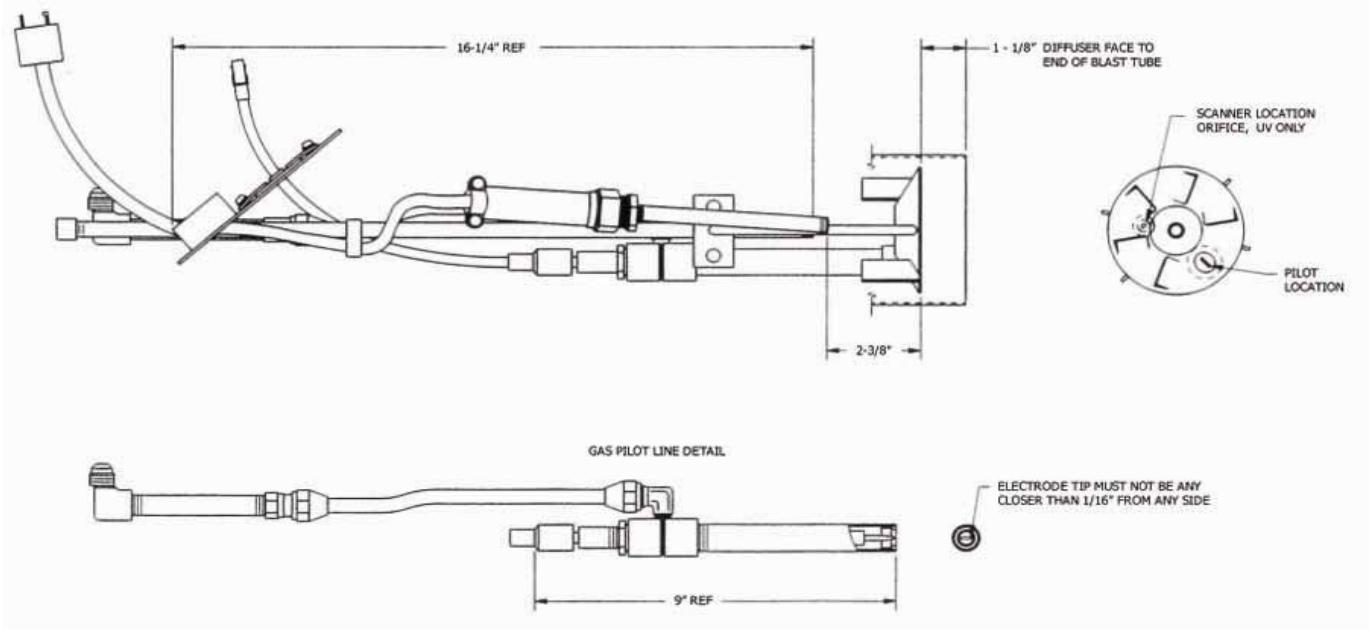


FIGURE 5-4. FPG 5 & 7 Drawer Assembly with Gas Pilot

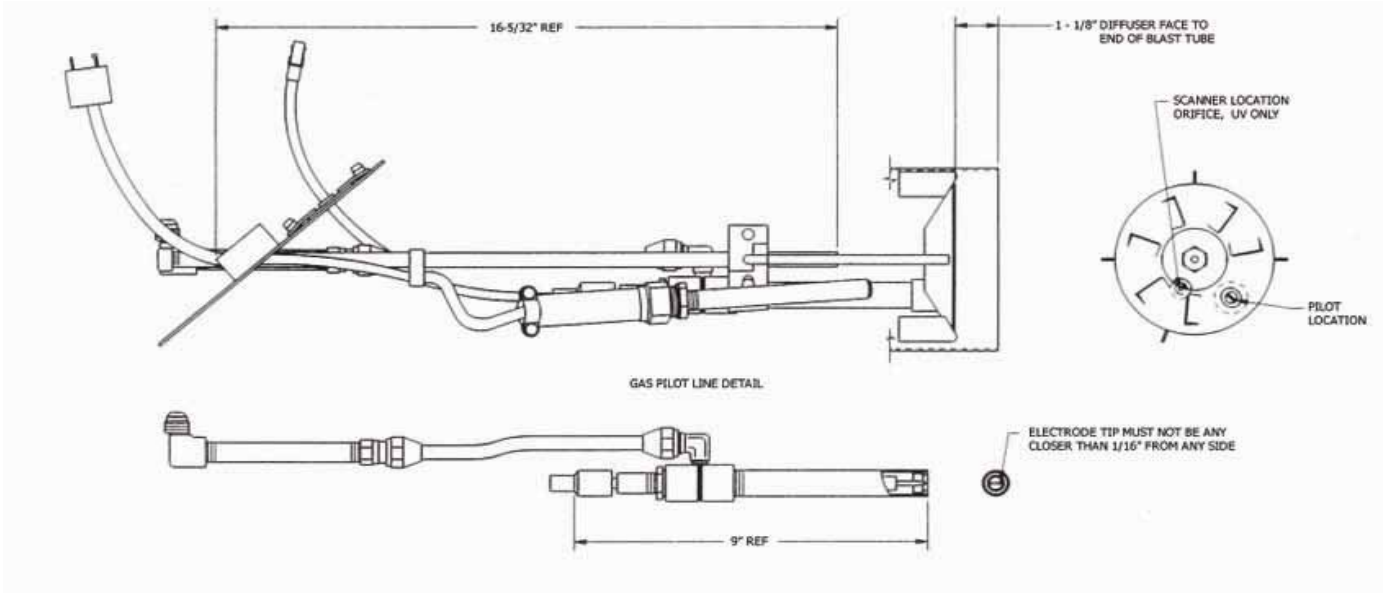


FIGURE 5-5. FPG 8, 9, 11, & 12 Drawer Assembly with Gas Pilot

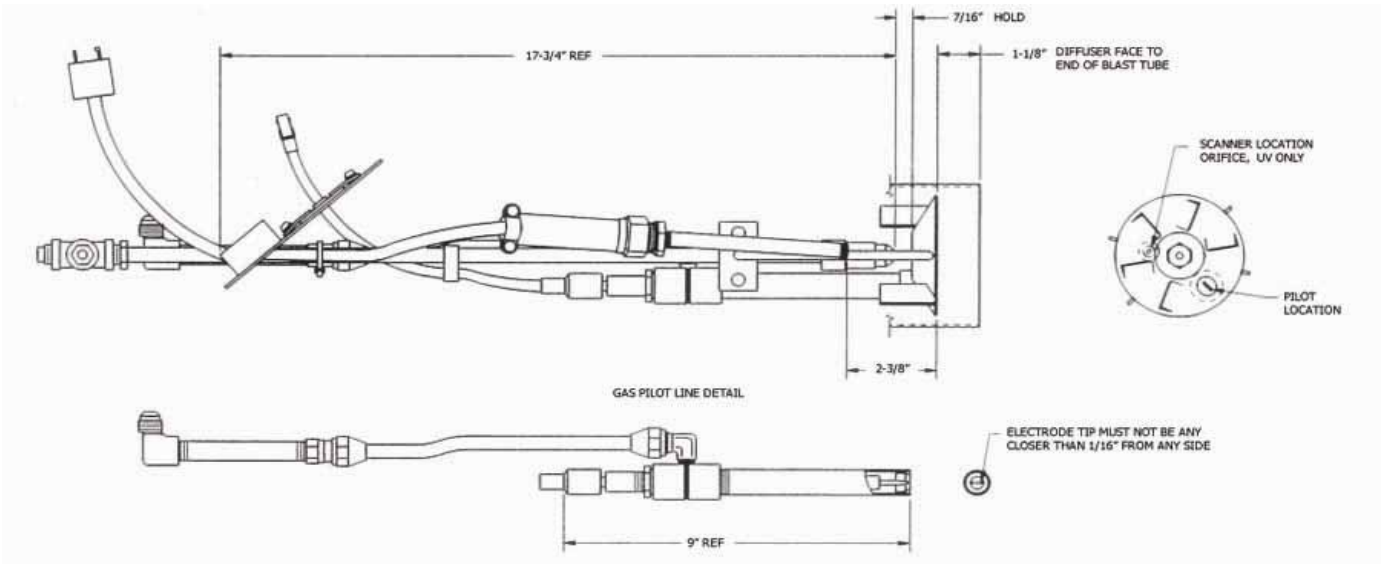


FIGURE 5-6. FPL, FPLG 5 & 7 Drawer Assembly with Gas Pilot

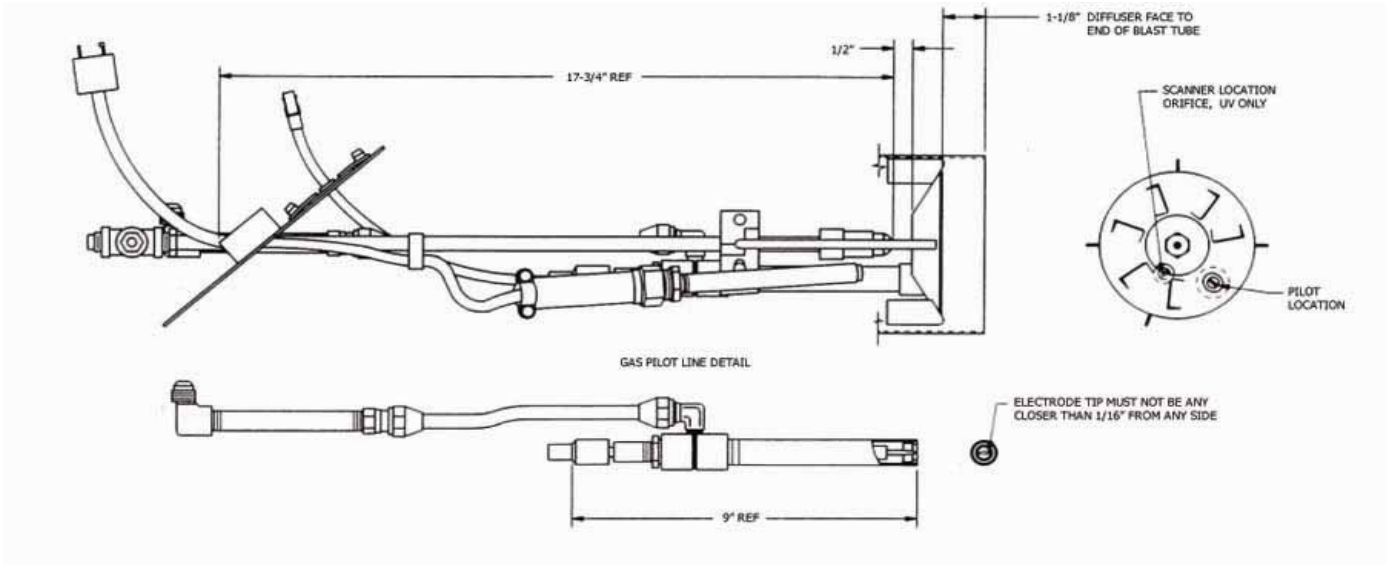


FIGURE 5-7. FPL, FPLG 8, 9, 11, & 12 Drawer Assembly with Gas Pilot

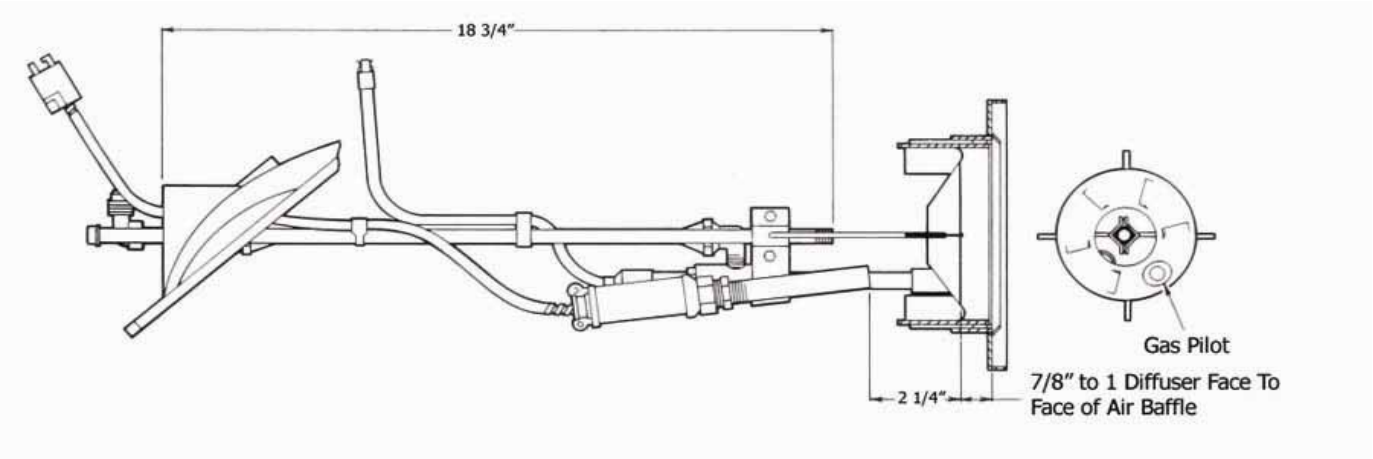


FIGURE 5-8. **FPG 14, 17, & 20 Drawer Dimensions**

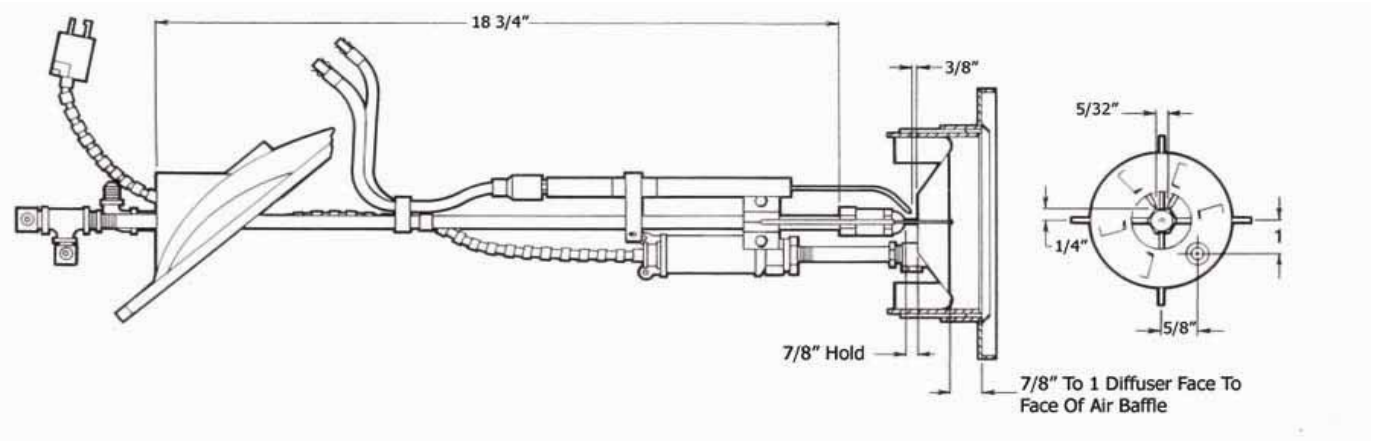


FIGURE 5-9. **FPL 14, 17, & 20 Drawer Dimensions**

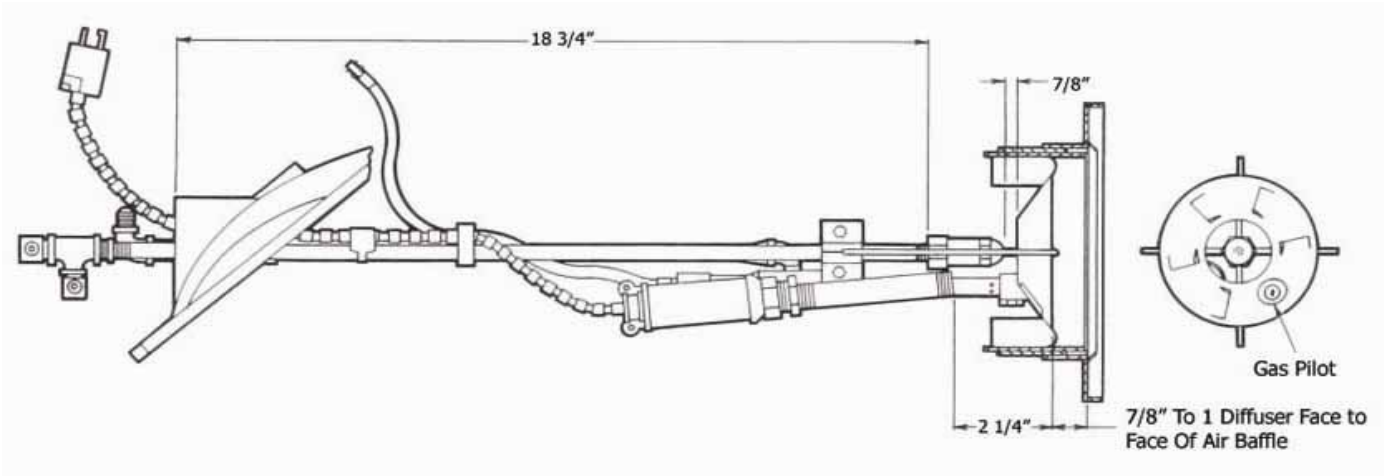


FIGURE 5-10. **FPLG 14, 17, & 20 Drawer Dimensions**

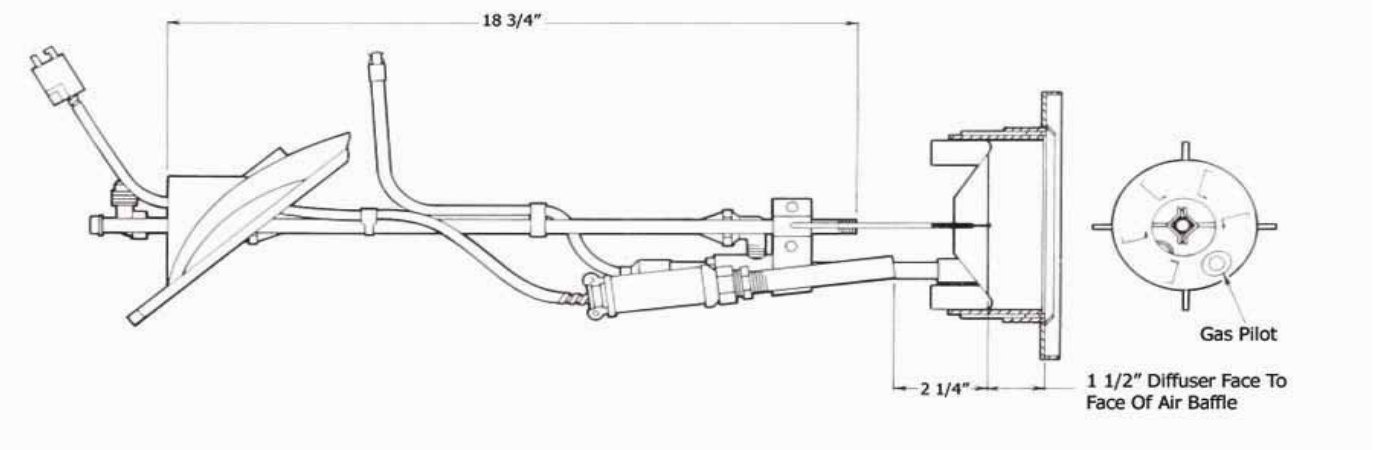


FIGURE 5-11. FPG 25, 28, 36, & 42 Drawer Dimensions

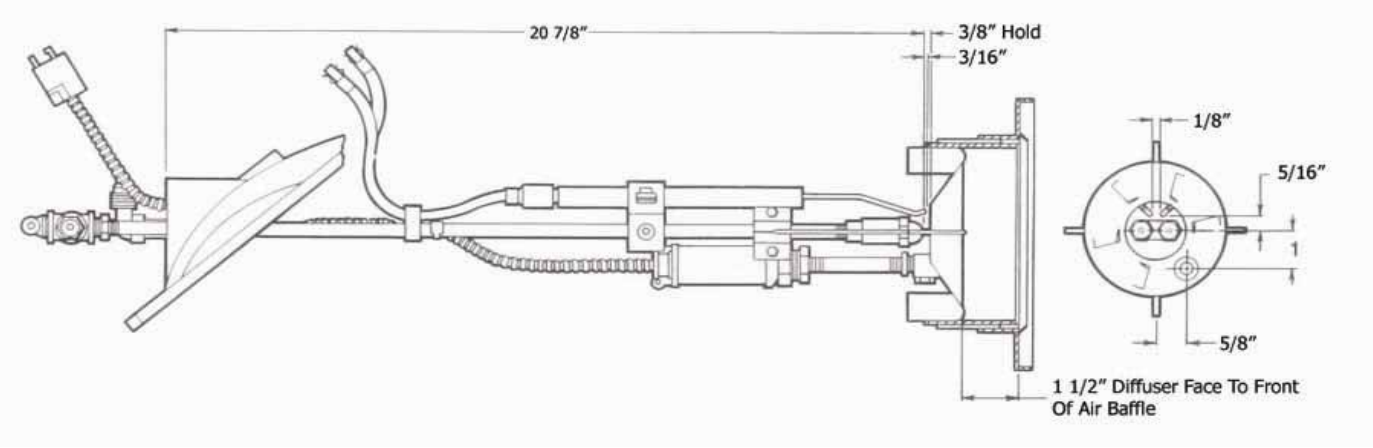


FIGURE 5-12. FPL 25, 28, 36, & 42 Drawer Dimensions

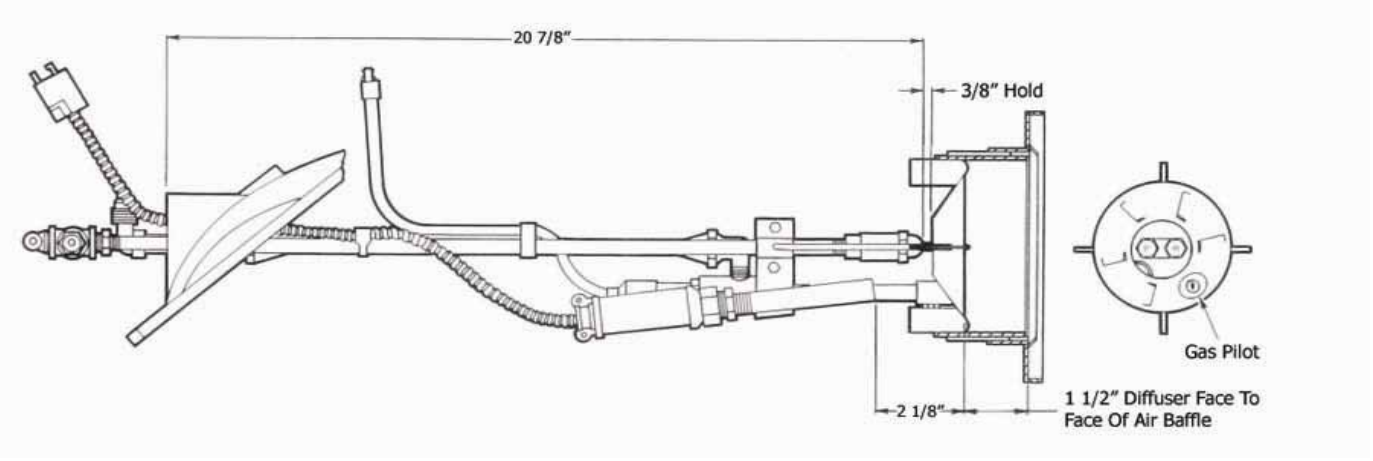


FIGURE 5-13. FPLG 25, 28, 36, & 42 Drawer Dimensions

INDUSTRIAL COMBUSTION

5.10 — Maintenance Flow Chart Recommended Test Schedule

ITEM	SERVICE BY	REMARKS
DAILY		
Gauges, Monitors, Indicators	Operator	Make visual inspection and record readings in log.
Instrument and Equipment Settings	Operator	Make visual check against recommended specifications.
Low Water, Fuel Cutoff, Alarms	Operator	Refer to instructions.
WEEKLY		
Firing Rate Control	Operator	Verify factory settings.
Igniter	Operator	Make visual inspection. Check flame signal strength.
Pilot and Main Fuel Valves	Operator	Open limit switch. Make audible and visual check. Check valve position indicators. Check fuel meters.
Flame Failure Controls	Operator	Close manual fuel supply for (1) pilot and (2) main fuel cock and/or valve(s). Check safety shutdown timing. Record results in log.
Flame Signal Strength Controls	Operator	Read and log the flame signal for both pilot and main flame. Notify Service if readings are very high, very low, or fluctuating.
Linkages	Operator	Check all burner linkages for tightness. Tighten if required.
MONTHLY		
Low Fan Pressure Interlock	Operator	Manually adjust until switch opens.
High and Low Gas Pressure Interlocks	Operator	Refer to instructions. Manually adjust until switch opens.
Scanner and Diffuser	Operator	Check, inspect, and clean for soot buildup.
Pilot Assembly	Operator	Check for loosening of components, erosion, or carbon buildup.
ANNUALLY		
Strainer (Oil Units)	Operator	Replace or clean the oil strainer element.
Impeller	Operator	Inspect and clean the combustion impeller.
Combustion Test	Service Tech	Perform a complete combustion test. Adjust burner if necessary. Read and log data.
Pilot Turndown Test	Service Tech	Required after any adjustment to flame, scanner, or pilot.
Operating Controls	Service Tech	Refer to instructions.

CHAPTER 6 Troubleshooting

⚠ Warning

Troubleshooting should be performed only by personnel who are familiar with the equipment and who have read and understood the contents of this manual. Failure to follow these instructions could result in serious personal injury or death.

⚠ Warning

Disconnect and lockout the main power supply in order to avoid the hazard of electrical shock. Failure to follow these instructions could result in serious personal injury or death.

6.1 — Awareness

Chapter 6 assumes that:

- The unit in question has been properly installed and that it has been running for some time.
- The operator has become thoroughly familiar with both the burner and the manual by this time.

The points set forth under each heading are brief, possible causes, suggestions, or clues to simplify locating the source of the trouble. Methods of correcting the trouble, once it has been identified, may be found elsewhere in this manual.

If the burner will not start or operate properly, the Troubleshooting section should be referred to for assistance in pinpointing problems that may not be readily apparent.

The program relay has the capability to self-diagnose and to display a code or message that indicates the failure condition. Refer to the control bulletin for specifics and suggested remedies.

Familiarity with the programmer and other controls in the system may be obtained by studying the contents of this manual. Knowledge of the system and its controls will make troubleshooting that much easier. Costly down-time or delays can be prevented by systematic checks of actual operation against the normal sequence to determine the stage at which performance deviates from normal. By following a set routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

If an obvious condition is not apparent, check each continuity of each circuit with a voltmeter or test lamp. Each circuit can be checked and the fault isolated and corrected. In most cases, circuit checking can be accomplished between appropriate terminals on the terminal boards in the control cabinet or entrance box. Refer to the wiring schematic supplied for terminal identification.

⚠ Caution

Never attempt to circumvent any of the safety features.

⚠ Warning

The cause for loss of flame or any other unusual condition should be investigated and corrected before attempting to restart. Failure to do so may result in serious personal injury or death.

⚠ Warning

Do not repeat unsuccessful lighting attempts without rechecking the burner and pilot adjustments. Failure to do so may result in serious personal injury or death.

⚠ Warning

Do not re-light the pilot or attempt to start the main burner, either oil or gas, if the combustion chamber is hot and/or if gas or oil vapor combustion gases are present in the furnace or flue passages or when excess oil has accumulated. Promptly correct any conditions causing leakage. Failure to do so may result in serious personal injury or death.

6.2 — Emergency Shutdown

In case of emergency, shut down the burner by turning the “ON-OFF” switch to the “OFF” position. Turn the fuel selector switch to the “OFF” position. Shut off the main manual fuel shutoff valves on the fuel supply line. The unit can also be shut down with the main electrical power disconnect. Inspect the burner carefully and trouble-shoot before restarting the unit. Follow the instructions in Chapter 3 for starting and operating.

6.3 — Troubleshooting

Problem	Possible Causes
Burner Does Not Start	1. No voltage at the program relay power input terminals. a. Main disconnect switch open. b. Blown control circuit fuse. c. Loose or broken electrical connection.
	2. Program relay safety switch requires resetting.
	3. Limit circuit not completed - no voltage at end of limit circuit program relay terminal. a. Pressure or temperature is above setting of operation control b. Water below required level. Low-water light (and alarm horn) should indicate this condition. Check manual reset button, if provided, on low-water control. c. Fuel pressure must be within settings of low pressure and high pressure switches. d. Check burner air proving switch and high-fire limit switch.
	4. High or low gas pressure. Investigate and repair.
No Ignition	1. Lack of spark. a. Electrode grounded or porcelain cracked. b. Improper electrode setting. c. Loose terminal on ignition cable, cable shorted. d. Inoperative ignition transformer. e. Insufficient or no voltage at pilot ignition circuit terminal.
	2. Spark but no flame. a. Lack of fuel - no gas pressure, closed valve, empty tank, broken line, etc. b. Too much air flow. c. No voltage to pilot solenoid. d. Defective pilot solenoid. e. Improperly positioned electrode (direct spark models).
	3. Low-fire switch open in low-fire proving circuit. a. Damper motor not closed, slipped cam, defective switch. b. Damper jammed or linkage binding.
	4. Running interlock circuit not completed. a. Combustion or atomizing air proving switches defective or not properly set. b. Motor starter interlock contact not closed.
	5. Flame detector defective, sight tube obstructed, or lens dirty.

Problem	Possible Causes
Pilot Flame, but No Main Flame	1. Insufficient pilot flame.
	2. Gas fired unit: a. Manual gas cock closed. b. Main gas valve inoperative. c. Gas pressure regulator inoperative.
	3. Oil fired unit: a. Oil supply cut off by obstruction, closed valve, or loss of suction. b. Supply pump inoperative. c. No fuel. Broken. loose, or missing oil pump coupling. d. Main oil valve inoperative. e. Check oil nozzle, gun, and lines.
	4. Flame detector defective, sight tube obstructed or lens dirty.
	5. Insufficient or no voltage at main fuel valve circuit terminal.
Burner Stays in Low-Fire	1. Pressure or temperature above modulating control setting.
	2. Manual-automatic switch in wrong position.
	3. Inoperative modulating motor.
	4. Defective modulating control.
	5. Binding or loose linkages, cams, setscrews, etc.

Problem	Possible Causes
Shutdown Occurs During Firing	1. Loss or stoppage of fuel supply.
	2. Defective fuel valve, loose electrical connection.
	3. Flame detector weak or defective.
	4. Scanner lens dirty or sight tube obstructed.
	5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
	6. If the programmer lockout switch has tripped: a. Check fuel lines and valves. b. Check flame detector. c. Check for open circuit in running interlock circuit. d. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.
	7. Improper air/fuel ratio (lean fire). a. Slipping linkage. b. Damper stuck open. c. Fluctuating fuel supply. Temporary obstruction in the fuel line. Temporary drop in gas pressure.
	8. Interlock device inoperative or defective.
	9. Air in the oil lines. Bleed lines.
Modulating Motor Does Not Operate	1. Manual/automatic switch in wrong position.
	2. Linkage loose or jammed.
	3. Motor does not drive to open or close during pre-purge or close on burner shutdown. a. Motor defective. b. Loose electrical connection. c. Damper motor transformer defective.
	4. Motor does not operate on demand. a. Manual/automatic switch in wrong position. b. Modulating control improperly set or inoperative. c. Motor defective. d. Loose electrical connection. e. Damper motor transformer defective.

CHAPTER 7

Ordering and Parts Lists

7.1 — Instructions

7.1.1 — Ordering

When ordering repair parts, please include the part number, the burner serial number, the burner model, burner size, and voltage. The burner model and size information can be obtained from the burner nameplate and the voltage information can be found on the data label on the panel door.

When ordering fan wheels, give the overall diameter, width, bore, manufacturer, and motor HP.

This parts section does not included such common hardware items as nuts, washers, electrical parts, copper tubing, flare fittings, and pipe. Items such as these can be readily purchased locally.

The following parts are sold on an exchange basis:

- Oil-Air Metering Pumps
- Oil and Air Pumps
- Bearing Assembly
- Air Modulators
- Relief Valves

7.1.2 — Parts Shipping Policy

All orders for stocked items will be processed and ready for shipment with twenty-four (24) hours of its receipt.

Air shipments (U.P.S. or otherwise) will be shipped the same day if the order is received before 2:30 p.m. (weather permitting).

Ground shipment to Wisconsin and bordering states will be shipped the same day upon request.

Industrial Combustion
351 21st Street
Monroe, WI 53566

Plant Phone: (608) 325-3141
Fax: (608) 325-4379

Parts Direct: (608) 325-5003
Fax: (608) 329-3190

INDUSTRIAL COMBUSTION

7.1.3 — Return Goods Procedures (Credit or Replacement Parts)

Defective Warranty parts or parts to be repaired are not to be returned to the Parts Department without calling for a Return Goods Authorization Number.

1. Before any item is returned, please call the Parts Department to obtain an RGA (Return Goods Authorization) number. Please have the following information available when calling:
   a. Item part number
   b. Item description
   c. Reason for the return with a full description of the defect(s)
   d. Parts Order or Sales Order on which the Item was purchased
   e. Name, address, and date of installation
   f. Identify if credit or replacement is to be issued
2. Once an RGA number has been issued, the item may be returned. You will have thirty (30) days to return the item from the date of the issued RGA or there will be a 10% handling charge.
3. Returned goods must have the RGA number appearing on the address label attached to the outside of the box being returned. If the RGA number is not on the label, your credit may be delayed and there will be a $50.00 service charge for paperwork. All new parts returned to the factory will be charged with a 25% restocking fee.

Please Note:

- Failure to provide complete and correct information may result in delayed or credit refusal.
- Return of Warranty parts — Warranty parts must be returned to the factory freight prepaid within thirty (30) days after a new part has been received or there will be a 10% handling charge.
- Shipping charges — On a Warranty part, we will assume standard shipping charges. This does not include special handling such as Air Freight, U.P.S. Next Day Air Service, or U.P.S. Second Day Air Service, etc.

7.1.4 — Motor Warranty Policy

The following procedure must be used for proper replacement and/or repair of electric motors that have failed under warranty:

1. Remove motor from unit and take motor to a manufacturer authorized service station.
2. The service station will determine the warranty status by installation date of the unit and the date of failure, along with the age of the motor, determined by the code date.
3. If the unit is within warranty, the unit will be inspected for cause of failure and repair requirements.
4. If the unit is within warranty limitations, the service station will repair on a “no-charge” basis.
5. If the repairs are extensive, the service station will contact the motor manufacturer warranty manager to decide if the motor is to be repaired or replaced.

Exception to the Above Procedure:

Emergency situations may dictate that because of the distance between user and authorized service stations, severe damage or interruptions may result.

The following procedure should be used:

1. Select a knowledgeable motor repair shop.

2. Repair shop to contact motor manufacturer warranty repair manager, detailing repairs necessary along with the complete nameplate data before any repairs are made.
3. If any problems occur, the Industrial Combustion Parts Dept. will provide assistance.

7.1.5 — Marathon Electric Motors Warranty Repair Procedure*

The following procedure must be used for proper replacement and/or repair of Marathon Electric motors that have failed under warranty.

NOTE: Failure to follow this procedure will result in repairs being made at the customer's expense.

1. End user will remove motor from unit and take failed motor to Marathon Electric authorized service station.
2. Service station will determine warranty status by installation date of unit and date of failure along with age of motor determined by date code.
3. If within warranty limitations, unit will be inspected for cause of failure and repair requirements determination will be made that failure was caused by defect in materials or workmanship and not by misuse, abuse, accident, or other exclusions listed in our warranty.
4. If minor repair is required, service station will repair motor and return to user on a "no charge" basis.
5. If major repair (rewind) is required, service station may:

   a. Rewind motor and return to user on a "no charge" basis if user requirement is not an emergency and repair can be made within Marathon Electric price guidelines.

   or

   b. Nameplate will be removed and along with a report of cause of failure will be given to the user.
6. User will present nameplate and report to distributor.
7. Distributor will furnish user with a new motor, no charge, either from distributor's inventory or secure replacement unit directly from parent organization.

***Marathon Electric Warranty Repair Procedure, DPN-79-113, Electric Motors, 48-215 Frame

INDUSTRIAL COMBUSTION

7.2 — Parts Lists

7.2.1 — Blower & Housing Section

Blower & Housing		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
19-474	Cover, Air Inlet Housing	1	1	1	1	1	1	1	1	1	1	1	1	1
22-501	Plate, Pump TG Hole Cover, EPG	1	1	1	1	1	1	1	1	1	1	1	1	1
29-1035	Flange, Motor Mounting	1	1											
29-1006	Flange, Motor Mounting			1	1	1	1	1	1	1				
29-1004	Flange, Motor Mounting										1	1	1	1
40-342	Housing Ass'y, Inlet	1	1											
40-325	Housing Ass'y, Inlet			1	1	1	1	1	1	1				
40-323	Housing Ass'y, Inlet										1	1	1	1
40-341	Housing Ass'y, Fan	1	1											
40-374	Housing Ass'y, Fan			1	1	1	1	1	1	1				
40-373	Housing Ass'y, Fan										1	1	1	1
67-328	Rod, Air Damper	1	1	1	1									
67-327	Rod, Air Damper					1	1	1	1	1	1	1	1	1
74-104	Shaft, Jack FPL & FPLG	1	1	1				1	1					
74-103	Shaft, Jack FPL & FPLG				1	1	1			1	1	1	1	1
82-140	Spring, Return	1	1	1	1	1	1	1	1	1	1	1	1	1
97-97	Cone, Flame Choke 9-12 Optional			1										
108-57	Shutter, Air Damper	1	1											
108-56	Shutter, Air Damper			1	1	1	1	1	1	1				
108-55	Shutter, Air Damper										1	1	1	1
265-86	Cone, Blower Air Inlet	1	1											
265-87	Cone, Blower Air Inlet			1										
265-98	Cone, Blower Air Inlet				1									
265-99	Cone, Blower Air Inlet					1	1			1				
265-88	Cone, Blower Air Inlet							1	1					
265-89	Cone, Blower Air Inlet										1	1		
265-90	Cone, Blower Air Inlet												1	
265-91	Cone, Blower Air Inlet													1
807-326	Bearing, Nylon	2	2	2	2	2	2	2	2	2	2	2	2	2
817-581	Switch, Air Pressure FPG & FPLG	1	1	1	1	1	1							
836-366	Switch, Air Pressure FPG & FPLG							1	1	1	1	1	1	1
819-149	Coupling, Flex Drive FPL & FPLG	2	2	2	2	2	2	2	2	2				
819-141	Coupling, Flex Drive FPL & FPLG										2	2	2	2
894-1048	Motor, 3/4HP 115-230/1/60/ 3450	1	1	1	1	1	1	1	1	1				
894-1067	Motor, 3/4HP 208-460/3/60/ 3450	1	1	1	1	1	1	1	1	1				
894-1231	Motor, 1HP 115-230/1/60/3450										1	1		
894-928	Motor, 1HP 208-460/3/60/3450										1	1		
894-1293	Motor, 2HP 115-230/1/60/3450												1	
894-1290	Motor, 2HP 208-460/3/60/3450												1	
894-1296	Motor, 3HP 115-230/1/60/3450													1
894-1291	Motor, 3HP 208-460/3/60/3450													1

Blower & Housing		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
951-169	Wheel, Blower 6-1/4" Dia. X 2-1/2" X 5/8" Shaft CCW	1												
951-163	Wheel, Blower 6-1/4" Dia. X 3" X 5/8" Shaft CCW		1	1										
951-168	Wheel, Blower 6-1/4" Dia. X 4-1/16" X 5/8" Shaft CCW				1									
951-170	Wheel, Blower 7" Dia. X 4-1/16" X 5/8" Shaft CCW					1	1			1				
951-172	Wheel, Blower 7" Dia. X 2" X 5/8" Shaft CCW							1	1					
951-253	Wheel, Blower 7" Dia. X 4" X 5/8" Shaft CCW										1	1		
951-171	Wheel, Blower 7-11/16" Dia. X 3" X 5/8" Shaft CCW												1	
951-173	Wheel, Blower 9-3/16" Dia. X 3-1/2" X 5/8" Shaft CCW													1

7.2.2 — Blast Tube

Blast Tube Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
42-32	Spud, Gas Insert FPG & FPLG	10	10											
42-39	Spud, Gas Insert FPG & FPLG			18	18	18	18							
42-56	Spud, Gas Insert FPG & FPLG							18						
42-57	Spud, Gas Insert FPG & FPLG								18					
42-58	Spud, Gas Insert FPG & FPLG									18				
42-55	Spud, Gas Secondary FPG & FPLG										30	30	30	30
76-113	Sleeve Ass'y, Air Adjustment							1	1	1				
76-121	Sleeve Ass'y, Air Adjustment										1	1	1	1
257-81	Tube Ass'y, Blast	1	1											
257-82	Tube Ass'y, Blast			1	1	1	1							
90-445	Tube Ass'y, Blast							1	1	1				
90-464	Tube Ass'y, Blast										1	1	1	1
97-95	Downstream Choke		1											
97-97	Downstream Choke			1										
865-29	Knob, Air Proportioning Sleeve Adjustment							1	1	1	1	1	1	1

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7.2.3 — Drawer Assembly

Drawer Assembly Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
8-1203	Bracket, Sight Glass Retaining	2	2	2	2	2	2	2	2	2	2	2	2	2
8-1294	Bracket, Electrode FPL w/Direct Spark	1	1	1	1	1	1	1	1	1	1	1	1	1
10-1050	Bushing, Electrode Protection FPL w/Direct Spark	2	2	2	2	2	2	2	2	2	2	2	2	2
13-200	Cap Ass'y, Back	1	1											
13-197	Cap Ass'y, Back			1	1	1	1	1	1	1	1	1	1	1
31-38	Glass, Flame Sight	1	1	1	1	1	1	1	1	1	1	1	1	1
36-103	Guide, Ignition Cable	1	1	1	1	1	1	1	1	1	1	1	1	1
90-418	Tube, Sight FPL w/Direct Spark	1	1											
90-448	Tube Ass'y, Scanner Sight Models w/Gas Pilot			1	1	1	1	1	1	1	1	1	1	1
90-502	Tube Ass'y, Gas Pilot Models w/Gas Pilot	1	1	1	1	1	1	1	1	1	1	1	1	1
158-50	Plug, Sight Tube Orifice FPG & FPLG w/UV Scanner	1	1											
158-61	Plug, Sight Tube Orifice FPG & FPLG w/UV Scanner			1	1	1	1	1	1	1	1	1	1	1
158-63	Plug, Sight Tube Orifice FPL w/UV Scanner	1	1	1	1	1	1							
275-365	Diffuser Ass'y, Air FPL w/Direct Spark	1	1											
275-366	Diffuser Ass'y, Air Models w/Gas Pilot	1	1											
275-370	Diffuser Ass'y, Air			1	1	1	1	1	1	1				
275-384	Diffuser Ass'y, Air										1	1	1	1
848-157	Connector, Wire 7mm X STR FPL w/Direct Spark	2	2	2	2	2	2	2	2	2	2	2	2	2
848-157	Connector, Wire 7mm X STR Models w/Gas Pilot	1	1	1	1	1	1	1	1	1	1	1	1	1
848-166	Connector, Wire 7mm X STR FPL w/Direct Spark	2	2	2	2	2	2	2	2	2	2	2	2	2
848-166	Connector, Wire 7mm X STR Models w/Gas Pilot	1	1	1	1	1	1	1	1	1	1	1	1	1
848-446	Plug, Twist Lock 15 Amp	1	1	1	1	1	1	1	1	1	1	1	1	1
873-34	Electrode, Ignition FPL w/Direct Spark	2	2	2	2	2	2	2	2	2	2	2	2	2
873-92	Electrode, Ignition Models w/Gas Pilot	1	1	1	1	1	1	1	1	1	1	1	1	1
899-11	Nozzle Body, Oil Single Nozzle FPL & FPLG	1	1	1	1	1	1							
899-220	Nozzle Body, Oil Dual Nozzle FPL & FPLG							1	1	1	1	1	1	1
899-240	Nozzle, Simplex Oil 2.5 GPH FPL & FPLG	1												
899-226	Nozzle, Simplex Oil 3.0 GPH FPL & FPLG		1											
899-241	Nozzle, Simplex Oil 3.5 GPH FPL & FPLG			1										
899-227	Nozzle, Simplex Oil 4.0 GPH FPL & FPLG				1									
899-228	Nozzle, Simplex Oil 4.5 GPH FPL 7 FPLG					1								

Drawer Assembly Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
899-229	Nozzle, Simplex Oil 5.0 GPH FPL & FPLG						1							
899-253	Nozzle, Simplex Oil 2.5 GPH FPL & FPLG							2						
899-254	Nozzle, Simplex Oil 3.0 GPH FPL & FPLG								2					
899-252	Nozzle, Simplex Oil 4.5 GPH FPL & FPLG									2				
899-259	Nozzle, Simplex Oil 5.5 GPH FPL & FPLG										2			
899-255	Nozzle, Simplex Oil 6.0 GPH FPL & FPLG											2		
899-256	Nozzle, Simplex Oil 7.5 GPH FPL & FPLG												2	
899-257	Nozzle, Simplex Oil 8.5 GPH FPL & FPLG													2
900-396	Pipe, Std 1/8" X 19" LG Threaded Both Ends	1	1	1	1	1	1	1						
900-230	Pipe, Std 1/8" X 27-1/2" LG Threaded Both Ends								1	1	1	1	1	1

7.2.4 — Oil Pump

Oil Pump Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
ON-OFF MODULATION														
910-436	Pump, Oil 30 GPH	1	1											
940-654	Valve, 1/4" N.C. Solenoid	1	1											
LOW-HIGH-OFF & LOW-HIGH-LOW MODULATION														
901-436	Pump, Oil 30 GPH	1	1	1	1	1	1	1	1	1				
901-462	Pump, Oil 34 GPH										1	1	1	
901-437	Pump, Oil 55 GPH													1
940-654	Valve, 1/4" N.C. Solenoid	1	1	1	1	1	1	1	1	1	1	1	1	1
940-1214	Valve, 1/4" N.O. Oil			1	1	1	1	1	1	1	1	1	1	1
940-1364	Valve, Oil Pressure Regulator			1	1	1	1	1	1	1	1	1	1	1
FULL MODULATION														
901-436	Pump, Oil 30 GPH							1	1	1				
901-462	Pump, Oil 34 GPH										1	1	1	
901-437	Pump, Oil 55 GPH													1
940-654	Valve, 1/4" N.C. Solenoid							1	1	1	1	1	1	1
940-1350	Valve, Oil Metering							1	1	1	1	1	1	1

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7.2.5 — Gas Piping

Gas Piping Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
ON-OFF MODULATION														
817-582	Regulator, Gas 1" Std Specify Gas Pressure Avail.	1	1											
940-1103	Valve, Gas Diaphragm 1" On/Off Mod.	1	1											
940-1373	Valve, Air Bleed for "V48A" Diaphragm Valves	1	1											
941-594	Valve, Shutoff 1" NPT	2	2											
LOW-HIGH-OFF & LOW-HIGH-LOW MODULATION														
817-570	Switch, Low Gas Pressure											1	1	1
817-571	Switch, High Gas Pressure											1	1	1
817-582	Regulator, Gas 1" Std Specify Gas Pressure Avail.	1	1	1	1	1	1	1						
817-622	Regulator, Gas 1-1/2" Std Specify Gas Pressure Avail.								1	1	1			
817-617	Regulator, Gas 2" Std specify Gas Pressure Avail.											1	1	1
940-1263	Valve, Gas Motorized 1" Parabolic Seat			1	1	1	1	1						
940-1288	Valve, Gas Motorized 1-1/2" Parabolic Seat								1	1	1			
940-1289	Valve, Gas Motorized 2" Parabolic Seat											1	1	1
940-1096	Valve, Gas Solenoid											1	1	1
941-594	Valve, Shutoff 1" NPT	2	2	2	2	2	2	2						
941-127	Valve, Shutoff 1-1/2" NPT								2	2	2			
941-128	Valve, Shutoff 2" NPT											2	2	2
945-125	Actuator, Valve WO/POC (Low-High-Low Mod only)	1	1	1	1	1	1	1	1	1	1	1	1	1
945-136	Actuator, Valve WO/POC (Low-High-Low Mod only)	1	1	1	1	1	1	1	1	1	1	1	1	1
FULL MODULATION														
817-570	Switch, Low Gas Pressure											1	1	1
817-571	Switch, High Gas Pressure											1	1	1
817-582	Regulator, Gas 1" Std Specify Gas Pressure Avail.							1						
817-622	Regulator, Gas 1-1/2" Std Specify Gas Pressure Avail.							1	1	1				
817-617	Regulator, Gas 2" Std Specify Gas Pressure Avail.											1	1	1
940-1256	Valve, Gas Butterfly 1-1/2" Reduced Port							1						
940-1254	Valve, Gas Butterfly 1-1/2" Full Port								1	1	1			
940-1257	Valve, Gas Butterfly 2" Reduced Port											1	1	
940-1192	Valve, Gas Butterfly 2" Full Port													1
940-1103	Valve, Gas Diaphragm 1"							1						
940-1090	Valve, Gas Diaphragm 1-1/2"								1	1	1			
940-1373	Valve, Air Bleed for "V48A" Diaphragm Valves							1	1	1	1			
940-1221	Valve, Gas Motorized 2"											1	1	1
941-594	Valve, Shutoff 1" NPT							2						

Gas Piping Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
FULL MODULATION (continued)														
941-127	Valve, Shutoff 1-1/2" NPT								2	2	2			
941-128	Valve, Shutoff 2" NPT											2	2	2
945-122	Actuator, Valve On-Off w/POC											1	1	1

7.2.6 — Gas Pilot Piping

Gas Pilot Piping Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
817-695	Regulator, Gas Pilot 1/2" NPT	1	1	1	1	1	1	1	1	1	1	1	1	1
940-1127	Valve, Gas Pilot Solenoid 1/2" 120V	1	1	1	1	1	1	1	1	1	1	1	1	1
941-585	Valve, Shutoff 1/2" NPT	1	1	1	1	1	1	1	1	1	1	1	1	1

7.2.7 — Modulation Section

Modulation Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
ON-OFF MODULATION														
	No System Required													
LOW-HIGH-OFF & LOW-HIGH-LOW MODULATION														
8-1344	Bracket, Hydraulic Cylinder Mounting FPL & FPLG			1	1	1								
8-1180	Bracket, Hydraulic Cylinder Mounting FPL & FPLG						1	1	1	1	1	1	1	1
618-4	Cylinder Ass'y, Hydraulic Mod FPL & FPLG			1	1	1	1	1	1	1	1	1	1	1
836-301	Switch, Safety & High/Low Fire FPL & FPLG											1	1	1
FULL MODULATION														
8-1215	Bracket, Mod Motor Mounting							1	1	1	1	1	1	1
10-295	Bushing, Modulating Motor 1-1/2" FPLG							1	1	1	1	1	1	1
10-295	Bushing, Modulating Motor 1-1/2" FPL							2	2	2	2	2	2	2
10-309	Bushing, Modulating Motor 9-1/4" FPL & FPLG							1	1	1	1	1	1	1
894-1345	Motor, Modulation 120V 90 Deg. Stroke							1	1	1	1	1	1	1

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7.2.8 — Linkage

Linkage Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
ON-OFF MODULATION														
	No System Required													
LOW-HIGH-OFF & LOW-HIGH-LOW MODULATION														
2-13	Arm, Linkage for 5/16" Shaft 17 Hole FPLG	2	2	2	2	2	2	2	2	2	2	2	2	2
2-13	Arm, Linkage for 5/16" Shaft 17 Hole FPG & FPLg	1	1	1	1	1	1	1	1	1	1	1	1	1
2-184	Arm Ass'y, Linkage for 3/4" Shaft X 3" Slot FPG & FPLG	1	1	1	1	1	1	1	1	1	1	1	1	1
10-295	Bushing, Modulating Motor 1-1/2" FPG & FPLG	1	1	1	1	1	1	1	1	1	1	1	1	1
266-200	Collar, Stop 1/4" ID FPLG	2	2	2	2	2	2	2	2	2	2	2	2	2
883-31	Ball Joint, 1/4-20 Male X 9/16 Slide Joint FPG & FPLG	2	2	2	2	2	2	2	2	2	2	2	2	2
883-31	Ball Joint, 1/4-20 Male X 9/16 Slide Joint FPLG	4	4	4	4	4	4	4	4	4	4	4	4	4
977-6	Bar, Rnd Brass 1/4" Dia Specify Length													
FULL MODULATION														
2-13	Arm, Linkage for 5/16" Shaft 17 Hole							1	1	1	1	1	1	1
2-183	Arm Ass'y, Linkag for 3/8" Shaft X 3 Slot FPG & FPL							1	1	1	1	1	1	1
2-183	Arm Ass'y, Linkag for 3/8" Shaft X 3 Slot FPLG							2	2	2	2	2	2	2
2-184	Arm Ass'y, Linkage for 3/4" Shaft X 3" Slot FPG & FPL							2	2	2	2	2	2	2
2-184	Arm Ass'y, Linkage for 3/4" Shaft X 3" Slot FPLG							3	3	3	3	3	3	3
883-31	Ball Joint, 1/4-20 Male X 9/16 Slide Joint FPG & FPL							4	4	4	4	4	4	4
883-31	Ball Joint, 1/4-20 Male X 9/16 Slide Joint FPLG							6	6	6	6	6	6	6
977-6	Bar, Rnd Brass 1/4" Dia Specify Length													

7.2.9 — Control Panel

Drawer Assembly Section		Quantity												
Part No.	Description	5	7	8	9	11	12	14	17	20	25	28	36	42
119-471	Panel Ass'y, Control 10 X 16 X 6.5	1	1	1	1	1	1							
119-523	Panel Ass'y, Control 13 X 20 X 6.5							1	1	1	1	1	1	1
832-118	Transformer, Ignition 120/1/60-10,000 V FPL	1	1	1	1	1	1	1	1	1	1	1	1	1
832-763	Transformer, Ignition 120/1/60-8,500 V FPG & FPLG	1	1	1	1	1	1	1	1	1	1	1	1	1
832-879	Circuit Breaker, Control 15 Amp	1	1	1	1	1	1	1	1	1	1	1	1	1
832-1040	Terminal Block, Interconnect	SPECIFY QUANTITY												
832-1041	Terminal Block, End Cap use with 832-1040	SPECIFY QUANTITY												
833-589	Relay, D.P.S.T. 120V Coil	1	1	1	1	1	1	1	1	1	1	1		
*See Note	Contactor Blower Motor	1	1	1	1	1	1	1	1	1	1	1	1	1
*See Note	Overload Blower Motor	1	1	1	1	1	1	1	1	1	1	1	1	1
836-209	Potentiometer, 135 OHM (full Mod only)							1	1	1	1	1	1	1
836-212	Switch, Toggle 3 P.D.T. WO/CTR Off (full Mod only)							1	1	1	1	1	1	1
836-255	Switch, Toggle 4 P.D.T. W/CTR Off FPLG	1	1	1	1	1	1	1	1	1	1	1	1	1
836-264	Switch, Toggle S.P.D.T. WO/CTR Off FPL & FPG	1	1	1	1	1	1	1	1	1	1	1	1	1
836-264	Switch, Toggle S.P.D.T. WO/CTR Off	1	1	1	1	1	1	1	1	1	1	1	1	1
Add for LOW-HIGH-LOW MOD only														
848-445	Receptacle, Flanged 15 Amp	1	1	1	1	1	1	1	1	1	1	1	1	1
881-136	Light, Neon "White"	1	1	1	1	1	1	1	1	1	1	1	1	1
881-137	Light, Neon "Red"	1	1	1	1	1	1	1	1	1	1	1	1	1
881-138	Light, Neon "Green"	1	1	1	1	1	1	1	1	1	1	1	1	1
881-139	Light, Neon "Amber"	1	1	1	1	1	1	1	1	1	1	1	1	1
*CONTACT FACTORY WITH SPECIFIC MODEL & SERIAL # TO INSURE CORRECT COMPONENT														

Warranty Policy

Limited Warranty: The Company warrants that at the time of shipment, the equipment manufactured by it shall be merchantable, free from defects in material and workmanship and shall possess the characteristics represented in writing by the Company. The Company's warranty is conditioned upon the equipment being properly installed and maintained and operated within the equipment's capacity under normal load conditions with competent supervised operators.

Equipment, accessories, and other parts and components not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty to the Company. In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer than the Company's warranty covering equipment manufactured by the Company.

Exclusions From Warranty: (I) THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, ORAL OR EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES THAT EXTEND BEYOND THE DESCRIPTION OF THE EQUIPMENT. THERE ARE NO EXPRESS WARRANTIES OTHER THAN THOSE CONTAINED HEREIN TO THE EXTENT PERMITTED BY THE LAW. THERE ARE NO IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE. THE PROVISIONS AS TO DURATION, WARRANTY ADJUSTMENT AND LIMITATION OF LIABILITY SHALL BE THE SAME FOR BOTH IMPLIED WARRANTIES (IF ANY) AND EXPRESSED WARRANTIES.

(II) The Company's warranty is solely as stated in (a) above and does not apply or extend, for example, to: expendable item; ordinary wear and tear; altered units; units repaired by persons not expressly approved by the Company; materials not of the Company's manufacture; or damage caused by accident, the elements, abuse, misuse, temporary heat, overloading, or by erosive or corrosive substances or by the alien presence of oil, grease, scale, deposits or other contaminants in the equipment.

Warranty Adjustment: Buyer must make claim of any breach of any warranty by written notice to the Company's home office within thirty (30) days of the discovery of any defect. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts of the equipment which within twelve (12) months from the date of initial operation but no more than eighteen (18) months from date of shipment shall prove the Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within the above warranty. Any warranty adjustments made by the Company shall not extend the initial warranty period set forth above. Expenses incurred by Buyer in replacing or repairing or returning the equipment or any part or parts will not be reimbursed by the Company.

Spare and Replacement Parts Warranty Adjustment: The Company sells spare and replacement parts. This subparagraph (10.4) is the warranty adjustment for such parts. Buyer must make claim of any breach of any spare or replacement parts by written notice to the Company's home office within thirty (30) days of the discovery of any alleged defect for all such parts manufactured by the company. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts or material it manufacture which, within one (1) year from the date of shipment shall prove to Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within this part warranty. The warranty and warranty period for spare and replacement parts not manufactured by the company (purchased by the Company, from third party suppliers) shall be limited to the warranty and warranty adjustment extended to the Company by the original manufacturer of such parts; In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer for such parts than the

Company's warranty adjustment covering part manufactured by the Company as set forth in this subparagraph (10.4). Expenses incurred by Buyer in replacing or repairing or returning the spare or replacement parts will not be reimbursed by the Company.

Limitation of Liability: The above warranty adjustment set forth Buyer's exclusive remedy and the extent of the Company's liability for breach of implied (if any) and express warranties, representations, instructions or defects from any cause in connection with the sale or use of the equipment. THE COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES OR FOR LOSS, DAMAGE OR EXPENSE, DIRECTLY OR INDIRECTLY ARISING FROM THE USE OF THE EQUIPMENT OR FROM ANY OTHER CAUSE WHETHER BASED ON WARRANTY (EXPRESS OR IMPLIED) OR TORT OR CONTRACT, and regardless of any advice or recommendations that may have been rendered concerning the purchase, installation, or use of the equipment.

Startup/Service Report

The following information should be filled in by the service technician at startup or after any adjustment to the burner.

A copy of the startup report MUST be forwarded to IC in order to validate the warranty of the burner.

Burner Model _____ Serial Number_____ Startup Date_____

Electric Motors	Voltage			Amperage		
	L1	L2	L3	L1	L2	L3
Control Voltage						
Blower Motor						
Air Compressor						
Air-Oil or Metering						

Test Conducted	Gas			Oil		
	Low	50 %	High	Low	50 %	High
Firing Rate MMBtu/gph						
Stack Temp (gross) º F						
Room Temp º F						
O2%						
CO%						
CO (PPM)						
NOx (PPM)						
Smoke (Bacharach)						
Combustion Eff. %						
Stack Draft " W.C.						
Furnace Pressure " W.C.						
Blast Tube Pressure " W.C.						
Steam Pressure PSIG						
Water Temp º F						
Supply Oil Pressure PSIG						
Return Oil Pressure PSIG						
Vacuum Oil Pump " HG						
Oil Temp						
Atom. Air Pressure						
Gas Pressure @ Burner Manifold " W.C.	Inner Manifold					
	Outer Manifold					
Center Gas Pressure " W.C.						
Gas Pressure @ Regulator Inlet PSIG						
Gas Pressure @ Regulator Outlet PSIG						
Pilot Gas Pressure @ Regulator Outlet " W.C.						
Flame Signal Main	Low		50%		High	

Control Check	Test	Set Point
Low Water Cutoff		
Aux. LWCO		
High Water Cutoff		
Operating Limit		
High Limit		
Operating Control		
Stack Temp Interlock		
Flame Failure		
Combustion Air Switch		
High Purge Switch		
Low Fire Interlock		
Oil Pressure Switch		
Oil Valve w/P.O.C. Interlock		
High Gas Pressure Switch		
Low Gas Pressure Switch		
Gas Valve P.O.C. Interlock		
Pilot Turndown Test		
Flame Signal Pilot		
(For Low NOx Burners)		
Blast Tube Temp Interlock		
FGR Line Purge Switch		
FGR Valve P.O.C.		

Adjusted by:

Date:

Accepted by:

(Signature Required)