CleaverBrooks®

Profire E/LNE

Burner

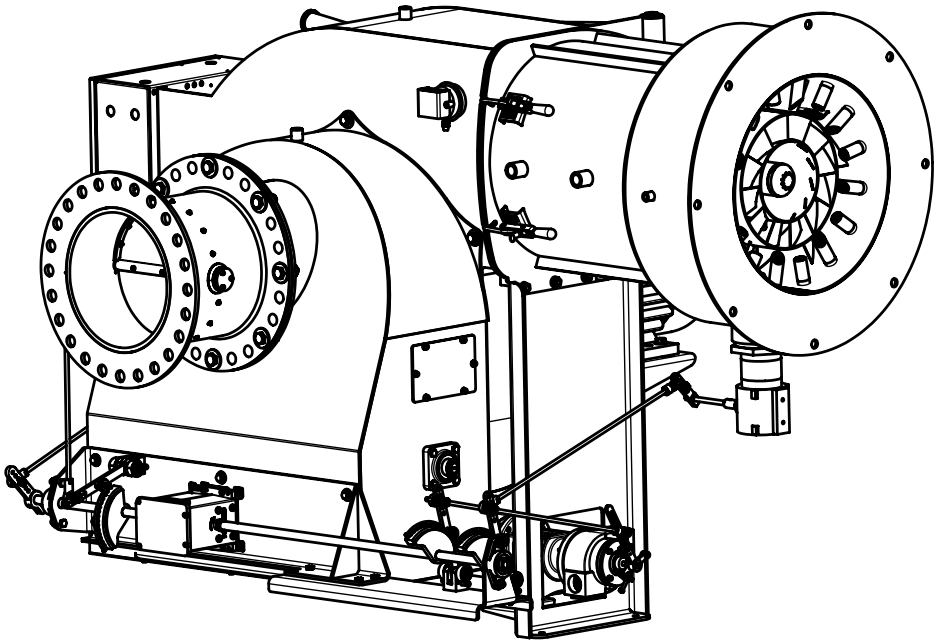
Light Oil, Gas, or Combination

Installation
Operation
Maintenance

Manual Part No. 750-297 09/2010

ProFire E/LNE SERIES

Installation, Operation, and Service Manual



Manual Number: 750-297

Release Date: September 2010

⚠WARNING

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

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PREFACE

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 to 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 Standards	Fuel-Air Atomization
EG	Gas
EL	#2 Oil
ELG	#2 Oil and Gas
LNEG	Gas
LNELG	#2 Oil and Gas

Example: The model number on the nameplate is ELG-252, No. 2 oil and gas burner with input rated at 25,200 MBtu per hour, against furnace pressures up to 5" W.C. at 60hz.

NOTE: Firing at higher furnace pressures de-rates the burner by approximately 5% per one half inch of additional pressure. Consult with the factory.

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. Where applicable, the Canadian Gas Association (CGA) B149 and Canadian Standard Association (CSA) B140 and B139 (for oil burners) codes shall prevail. 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 E Series burners are designed to burn either gas or light oil No. 1 or 2 as defined by ASTM D396-2010 specifications.

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

Standard Specifications for EG-EL-ELG Series: Gas, #2 Oil, Gas/Oil Configuration								
Burner Model & Frame Size	Standard Gas Train Pipe Size (in.)	Gas Input MBtu/hr	#2 Oil Input GPH	BHP @80 % Eff.	Furn. Press. ("W.C.)	Blower Motor HP	Separate Comp. Module Motor HP 3 PH	Metering System Motor HP 3 PH.
E-84-1	2 1/2	8,400	60	200	4	3	3	1/2
E-105-1	3	10,500	75	250	4	5	3	1/2
E-126-1	3	12,600	90	300	4	5	3	1/2
E-147-1	3	14,700	105	350	4	7 1/2	5	1/2
E-168-2	3	16,800	120	400	4	10	5	1/2
E-210-2	3	21,000	150	500	4	15	5	3/4
E-252-2	3	25,200	180	600	4	15	7 1/2	3/4
E-294-3	3	29,400	210	700	4	15	7 1/2	3/4
E-336-3	3	33,600	240	800	4	20	7 1/2	3/4
E-378-3	4	37,800	270	900	4	25	15	1
E-420-3	4	42,000	300	1,000	4	30	15	1

Standard Specifications for EG-EL-ELG Series: Gas, #2 Oil, Gas/Oil Configuration		
Burner Model & Frame Size	Blower Motor Volt/ PH 60 Hz.	Gas Pressure Required (PSI)
E-84-1	208/230/460/3	2.1
E-105-1	208/230/460/3	2.2
E-126-1	208/230/460/3	2.5
E-147-1	208/230/460/3	2.7
E-168-2	208/230/460/3	3.0
E-210-2	208/230/460/3	3.9
E-252-2	230/460/3	4.3
E-294-3	230/460/3	2.6
E-336-3	460/3	3.1
E-378-3	460/3	3.6
E-420-3	460/3	3.7

NOTES:

Input is based on fuel BTU content, listed furnace pressure and altitude of 2,000 feet or less. If altitude >2,000 feet and <8,000 feet, derate capacity 4% per 1,000 feet over 2,000. Consult factory for higher altitudes. If furnace pressure exceeds listed value, derate capacity 5% for every 0.5" w.c. of pressure in excess of stated. Consult factory if derate exceeds 20%. Gas input is based on natural gas with 1,000 BTU/cu. ft., 0.60 gravity, zero furnace pressure and the aforementioned conditions. For total pressure at manifold, add furnace pressure. Oil input based on 140,000 BTU/gal. and the aforementioned conditions. Consult factory for 50 Hz applications.

<30 PPM Low NOx Standard Specifications for LNEG-LNELG Series: Gas, Gas/Oil Configuration								
Burner Model & Frame Size	Standard Gas Train Pipe Size	Gas Input MBH	#2 Oil Input US GPH	BHP @80 % Eff.	Furn. Press. ("W.C.)	Blower Motor HP	Separate Comp. Module Motor HP 3 PH	Oil Metering System Motor HP 3 PH.
LNE-84-1	2 1/2	8,400	60	200	4	5	3	1/2
LNE-105-1	3	10,500	75	250	4	5	3	1/2
LNE-126-1	3	12,600	90	300	4	7 1/2	3	1/2
LNE-147-1	3	14,700	105	350	4	10	5	1/2
LNE-168-2	3	16,800	120	400	4	15	5	1/2
LNE-210-2	3	21,000	150	500	4	20	5	3/4
LNE-252-2	3	25,200	180	600	4	25	7 1/2	3/4
LNE-294-3	3	29,400	210	700	4	25	7 1/2	3/4
LNE-336-3	3	33,600	240	800	4	30	7 1/2	3/4
LNE-378-3	3	37,800	270	900	4	40	15	1
LNE-420-3	4	42,000	300	1,000	4	50	15	1

<30 PPM Low NOx Standard Specifications for LNEG-LNELG Series: Gas, Gas/Oil Configuration			
Burner Model & Frame Size	Blower Motor Volt/ PH 60 Hz.	Gas Pressure Required (PSI)	FGR Line Piping Size
LNE-84-1	208/230/460/3	2.1	6
LNE-105-1	208/230/460/3	2.2	6
LNE-126-1	208/230/460/3	2.5	6
LNE-147-1	208/230/460/3	2.7	6
LNE-168-2	208/230/460/3	3.0	8
LNE-210-2	208/230/460/3	3.9	8
LNE-252-2	230/460/3	4.3	8
LNE-294-3	230/460/3	2.6	10
LNE-336-3	460/3	3.1	10
LNE-378-3	460/3	3.6	10
LNE-420-3	460/3	3.7	10

NOTES:

Input is based on fuel BTU content, listed furnace pressure and altitude of 2,000 feet or less. If altitude >2,000 feet and <8,000 feet, derate capacity 4% per 1,000 feet over 2,000. Consult factory for higher altitudes. If furnace pressure exceeds listed value, derate capacity 5% for every 0.5" w.c. of pressure in excess of stated. Consult factory if derate exceeds 20%. Gas input is based on natural gas with 1,000 BTU/cu. ft., 0.60 gravity, zero furnace pressure and the aforementioned conditions. For total pressure at manifold, add furnace pressure. Oil input based on 140,000 BTU/gal. and the aforementioned conditions. Consult factory for 50 Hz applications.

Profire E/LNE Series

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CHAPTER 1 Introduction

1.1 — Overview

Profire E Series burners are assembled, wired, and tested at the factory. They are listed by the Underwriters Laboratory, CSD-1, NFPA-85, F.M., including the national Electrical Code (NEC), and associated insurance underwriters. Where applicable, the Canadian Gas Association (CGA) B149 and the Canadian Standards Association (CSA) B140 codes shall prevail. Other regulatory agency control options are available.

⚠ Caution

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

The operator must be familiar with the individual functioning of all controls to understand the operations and procedures described in this manual.

1.2 — Description

The Profire E Series oil burners are of the low pressure, air atomizing (nozzle) type. Gas burners are of the peripheral mix type. All burners feature ignition by spark-ignited gas pilot flame. With either fuel, the burner operates with full modulation. A switch permits changeover from automatic fully modulated firing to manually set firing at any desired rate between minimum and maximum. Additional safeguards assure that the burner always returns to the minimum firing position for ignition.

Profire E Series burners are designed for automatic, unattended operation except for periodic inspection and maintenance. After selecting the proper overload settings for the starter, the rest of the control panel components require little attention except for occasional cleaning.

1.3 — Operating Controls

1.3.1 — Control Panel

The control panel contains a flame safeguard programming control, motor starters, relays, time delays, and terminal strips mounted internally on a panel sub-base. Lights, switches, potentiometers, a control circuit breaker, and flame safeguard displays are mounted externally on the panel.

Component	Details
On-Off Burner Switch	For gas or oil only.
Fuel Selector Switch	Gas-Off-Oil For combination gas-oil burners only. a) Gas Position: Selects gas as the firing fuel. b) Off Position: Burner off. c) Oil Position: Selects oil as the firing fuel. **NOTE:** When changing from oil to gas fuel, allow the programmer to complete post-purge and shutdown before moving the selector switch to the gas position. This will allow the interlock circuit to de-energize at either the oil-air pump or the compressor.
Control Circuit Breaker	Supplementary low overcurrent protection only. No larger than 15 amps.
Auto-Manual Modulation Selector Switch	a) Auto Position: Selects boiler modulation control. b) Manual Position: Selects 135 ohm potentiometer for manual modulating control.
Manual Modulating Control 135 ohm	Increases or decreases the burner firing rate manually.
Signal Lamps	a) Power On (white): Illuminates when the control circuit is energized (powered). b) Ignition (amber): Illuminates when the ignition transformer is powered, and gas pilot valve is energized (open). c) Main Fuel (green): Illuminates when the main fuel valve or valves (gas or oil) are energized (open). d) Flame Failure (red): Illuminates when the flame safeguard system fails to detect pilot or main flame.

1.3.2 — Flame Safeguard Controls

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.

⚠ Warning

Read the flame safeguard manual and fully understand its contents before attempting to operate this equipment. Failure to do so may result in serious personal injury or death.

1.3.3 — Firing Rate Controls

Regardless of the fuel used, burner input is fully modulated between low fire and high fire on boiler demand. The firing rate is controlled by the potentiometer-regulated modulating motor. The combustion air control damper, oil metering pump, and/or gas volume butterfly valve are controlled through variable rate rod and lever linkages. The modulating motor rotates 90º from low to high position. Flow rate through each component is adjusted by positioning the control rods on the levers and the angular position of levers on shafts. The lever on the modulating motor shafts actuate the high fire position proving switch.

1.4 — Combustion Air Handling System

The combustion air handling system consists of two major components:

Component	Details
Damper Assembly	A rotary damper regulates the combustion air volume and is positioned by a modulating motor. The damper is normally almost closed in the low fire position and opens as the burner drives toward a high fire position.
Motor Driven Impeller	The diameter of the impeller determines available air pressure and the width determines air capacity in cubic feet per minute. Alternate motor-impeller combinations are available for 50 cycle or 60 cycle power and for firing against either moderate or high furnace pressure. All standard impellers are sized for up to 2,000 ft. altitudes and up to 4" W.C. furnace pressures. Alternate impeller wheels are available. For higher altitudes and higher furnace pressures, motor and impeller combinations are determined at the factory.

1.5 — Firing Head

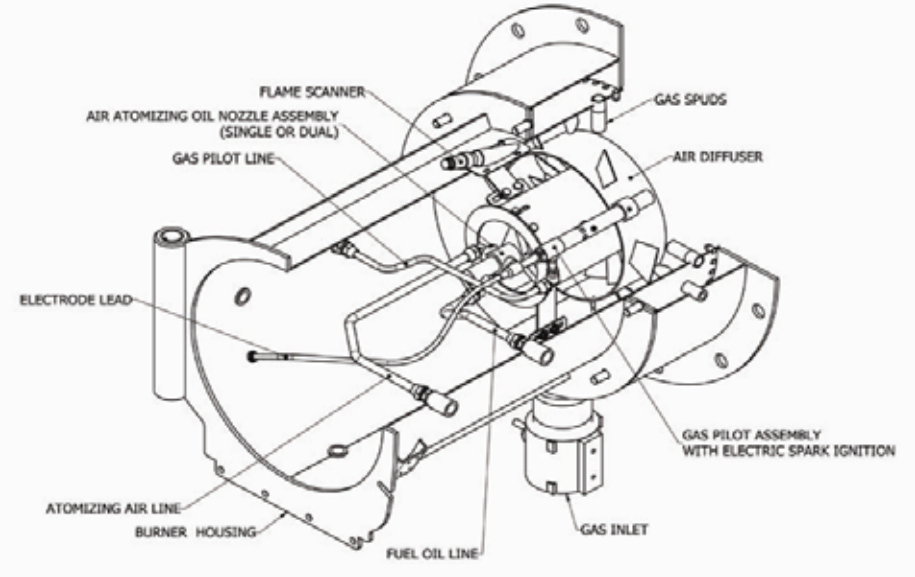


FIGURE 1-1. Burner Housing

Access to the firing head is provided by swinging open the impeller housing. First, disconnect the damper linkage, release the housing latch, and swing the housing to the open position. An internal gas pilot is standard on all burners. Pilot gas pressure is adjusted at the pilot pressure regulator.

1.6 — Oil System Air Atomizing

Profire E Series burners use compressed air for atomization. Atomizing air is independent of combustion air. The system is supplied with a separate compressor module for mounting near the burner.

1.6.1 — 3-Way Solenoid Valve

Metered oil enters the common port of the 3-way solenoid valve. During shutdown, pre- and post-purge, the valve is de-energized (N.C. port closed) and all metered fuel oil returns to the storage tank. When the valve is energized, metered oil is directed to the nozzle through the N.C. port.

1.6.2 — Nozzle Assembly

The nozzle assembly consists of four main parts: body, compression spring, swirler, and tip. The swirler is held against the nozzle tip by the compression spring. The nozzle body has inlet ports for air and oil lines. Metered fuel oil enters the nozzle body and flows through a tube to the swirler. Oil is forced from the core of the swirler to the side ports where it meets with the atomizing air. Atomizing air enters and passes through the nozzle body to grooves in the swirler, where it mixes with fuel oil. Air/oil passes through grooves and out of the nozzle orifice in a cone of atomized oil. Proper velocity and angle of the fine spray ensures good mixing with the combustion air, providing quiet starts and excellent combustion efficiency. During pre- and post-purge, the nozzle tip is purged with air. This prevents afterdrip or baked-on residue.

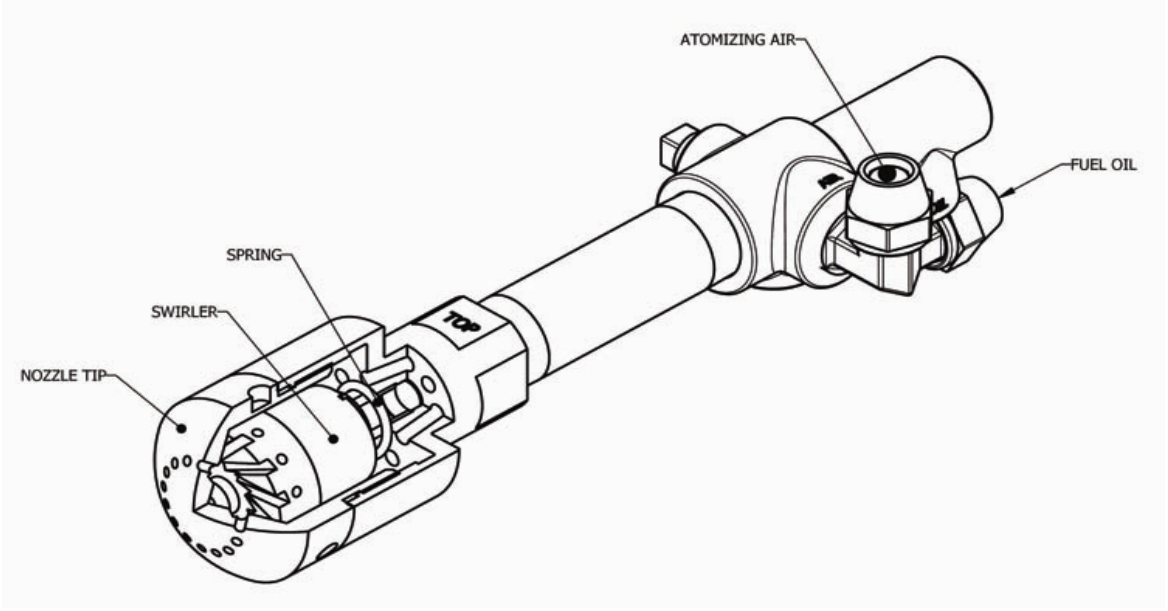


FIGURE 1-2. Nozzle Assembly

1.6.3 — Oil Strainer

Prevents foreign matter from entering the burner oil system.

1.6.4 — Atomizing Air Proving Switch

Pressure actuated switch contacts close when sufficient atomizing air pressure is present. The oil valve will not open unless switch contacts are closed.

1.6.5 — Oil Metering

Fuel oil under nominal pressure in the circulating loop flows to the adjustable positive displacement (volumetric metering unit). Oil metering is accomplished by changing the piston stroke by means of an eccentric shaft and pin assembly. The pistons reciprocate in a rotor assembly, turning in a hardened steel sleeve having oil inlet and discharge slots. During each revolution the pistons go through the following cycle:

1. **Inlet Cycle**. The piston is at the bottom dead center position. At this position, the cavity between the top of the piston and the outside diameter of the rotor fills with oil.
2. **Discharge Cycle**. (180º from inlet cycle) The piston is at the top dead center position. At this position, the oil is forced out of the discharge port to the nozzle. The piston stroke length is determined by the position of the eccentric shaft and plate. The piston adjustment plate is positioned by an adjustable eccentric shaft. The eccentric shaft is positioned by the modulator through adjustable linkage. Counterclockwise rotation of the eccentric shaft increases the piston stroke (more oil delivered to nozzle); clockwise rotation decreases the amount of oil delivered. When the eccentric shaft is stationary, at any position, the stroke of the pistons remains constant delivering a constant volume of oil regardless of viscosity.

1.6.6 — Separate Compressor Module

EL and ELG burners have a burner mounted oil metering unit and a separate compressor module. The system functions as follows:

Air is supplied by a positive displacement rotary vane compressor. This provides a constant volume of atomizing air regardless of pressure. The compressor module includes motor, air-oil reservoir tank, air filter, and lube oil cooling coil. Air enters the compressor through the filter. The air flows from the compressor into the air-oil separating and reservoir tank. Filtering material and baffles separate the lube oil from the compressed air. The tank air pressure forces lubricating oil from the tank to the compressor to lubricate bearings and vanes. A sight glass indicates the level of lubricating oil in the air/oil reservoir. Lubricating oil must be visible in the gauge glass at all times. Air compression heat is absorbed in part by the flow of lube oil, creating a hot oil mist. The air/oil mist is cooled by a coil assembly. Lube oil is also cooled before entering the compressor.

Fuel is delivered to the positive displacement metering pump at 10 to 15 psi. Metered oil is delivered to the common port of a 3-way solenoid valve for transfer to the burner nozzle through the normally closed port or back to the storage tank through the normally open port. During pre- and post-purge, metered oil is returned to the tank. During normal firing, all metered oil is delivered to the nozzle. For the description of typical fuel oil piping installations, see Chapter 2. Air enters a rotary vane compressor through an air cleaner where it is compressed to atomizing pressure. Air flows from the compressor to an air/oil tank which serves the multiple purpose of dampening air pulsation, lube oil mist recovery, lube oil and atomizing air storage. The compressor rotor is cooled and lubricated continuously by oil under pressure from the air/oil tank. Oil vapor is extracted by a mist eliminator in the upper section of the tank. Atomizing air from the upper tank section is delivered to the nozzle at a constant volume. Air pressure increases as the burner firing rate increases. Atomizing pressure may be adjusted by the needle valve located on the air-oil pump. The valve allows air to be bled from the tank to the compressor inlet. Delivery rate of the fuel oil metering pump is controlled by the modulating motor through adjustable linkage.

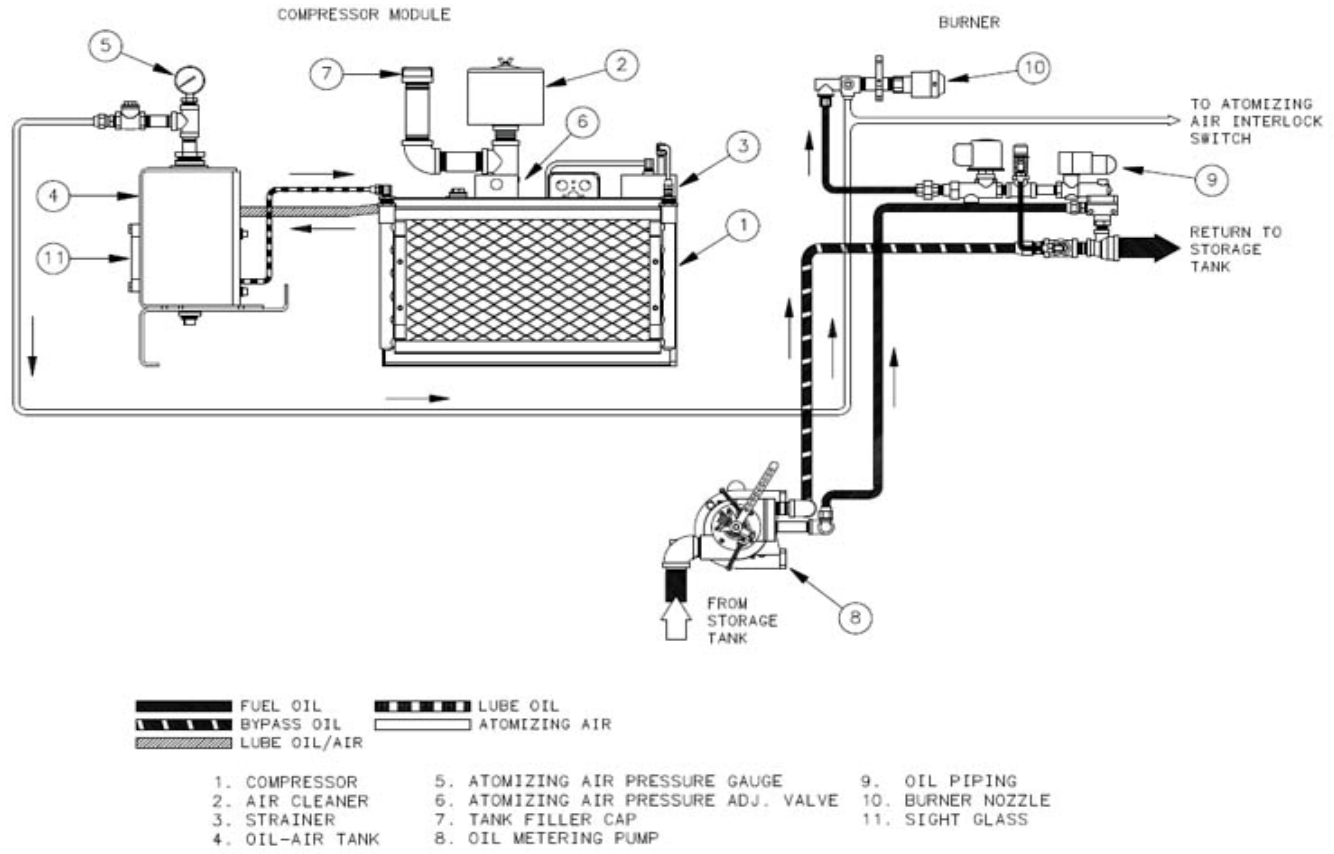


FIGURE 1-3. Compressor Module and Burner

1.7 — Gas System

Gas is introduced into the combustion zone from a circular manifold through multiple ports in the manifold. Firing rate is determined by the size and number of ports, by manifold pressure, and by combustion zone pressure. The firing rate is regulated by a rotary, butterfly-type throttling valve at the manifold inlet. The valve is actuated by an adjustable linkage from the modulating motor. Depending upon specific requirements, one or two safety shutoff motorized main gas valves are provided for installation in the gas train upstream of the butterfly valve. Safety shutoff gas valves are wired into the programming control to automatically open and close at the proper time in the operating sequence.

1.7.1 — Main Gas Train Components

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:

Component	Description
Gas Volume Valve	The butterfly-type valve is positioned by linkage from the modulating motor and controls the rate of flow of the gas.
Main Gas Valves	Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard U.L. burners include: • Models E84-105: One motorized gas valve w/closure interlock and one solenoid valve. • Models E126-630: Two motorized gas valves, one w/closure interlock.
Main Gas Regulator	Regulates gas train pressure to specified pressure required at inlet to the gas train. Input is set my the main gas pressure regulator adjustment.
Main Gas Cocks	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).
High Gas Pressure Switch	A pressure actuated switch that remains closed when gas pressure is below a pre-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.
Low Gas Pressure Switch	A pressure actuated switch that remains closed when gas pressure is above a pre-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.

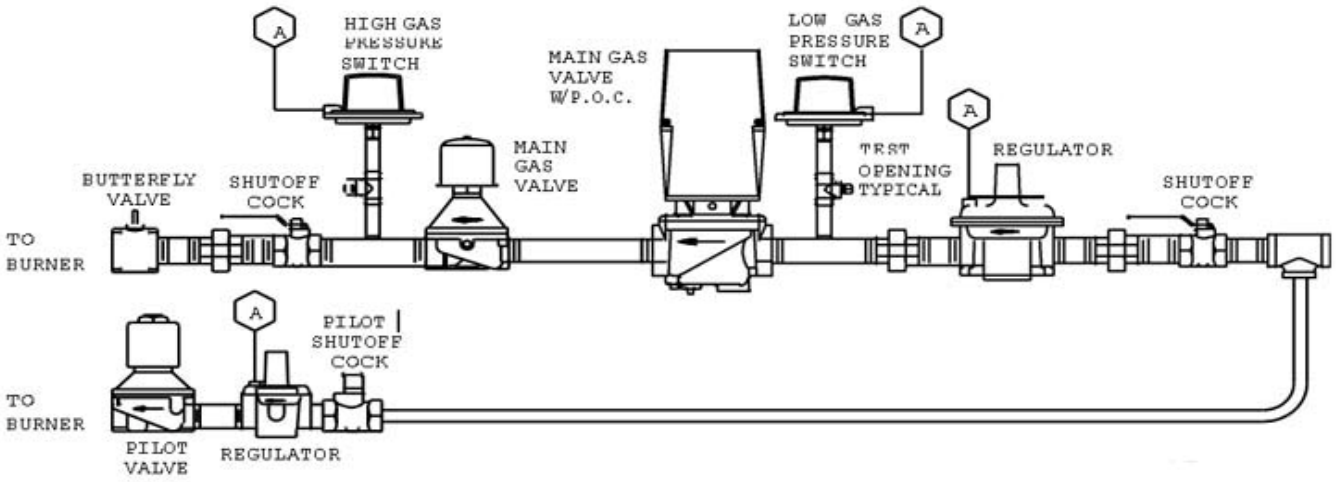


FIGURE 1-4. Main Gas Train

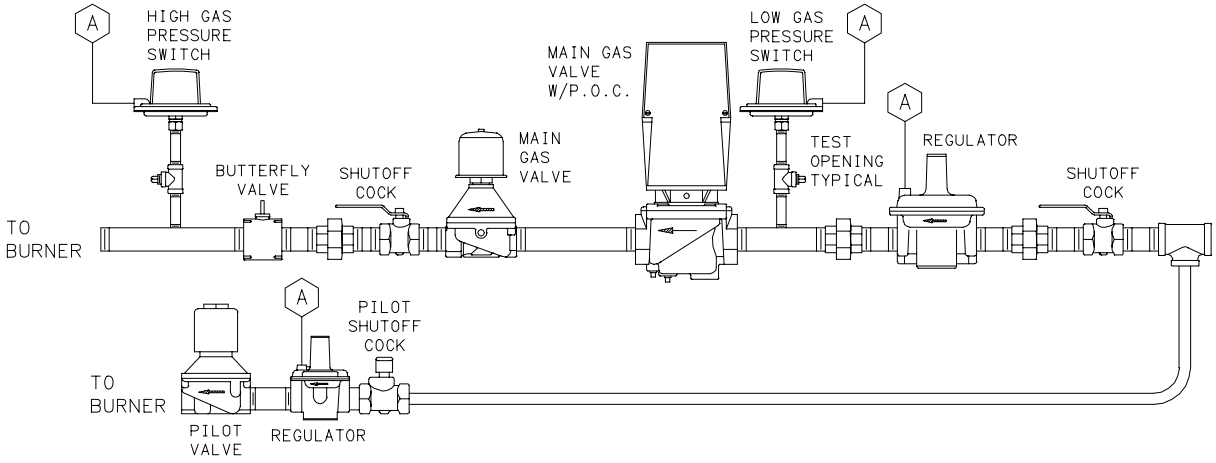


FIGURE 1-5. Main Gas Train (BTU Specific)

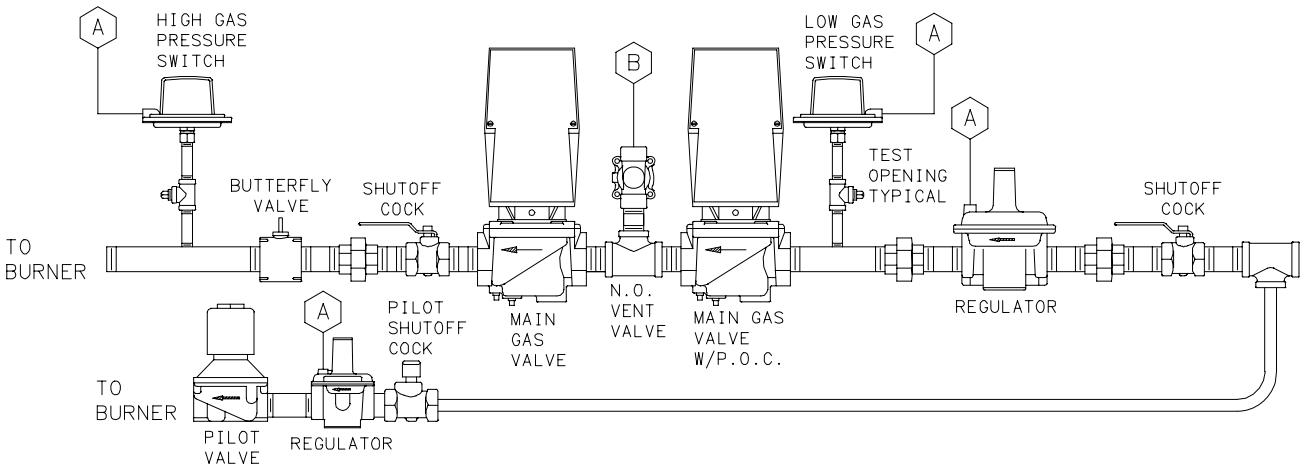


FIGURE 1-6. Main Gas Train (BTU Specific)

NOTE: These piping layouts are for reference only and are subject to change without notice. Optional equipment may change a layout.

1.7.2 — Pilot Gas Train Components

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

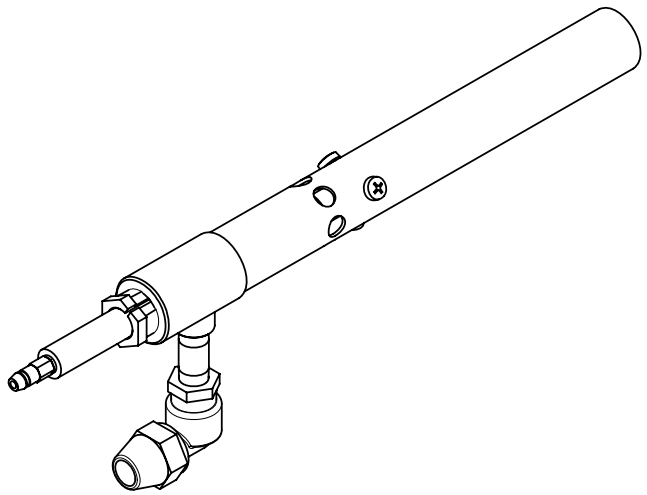


FIGURE 1-7. **Gas Pilot**

1.7.3 — Operation

Metered gas flows through the main gas shutoff cock, through the pressure regulator to the automatic gas valves and butterfly valve to the gas manifold.

The butterfly gas valve modulates flow to burner input demand. The butterfly valve is positioned through mechanical linkage by the modulating motor. The air control damper is positioned simultaneously by the modulating motor.

The automatic gas valve(s) cannot be energized unless the combustion air proving switch is closed. The low and high gas pressure switches must be closed to prove proper gas pressure.

A normally open vent valve, if required, is located between the two automatic gas valves. This valve is shut when the automatic gas valves are open. When the automatic valves are closed, the vent valve is open for venting gas to the outside, should any be present.

CHAPTER 2 Installation

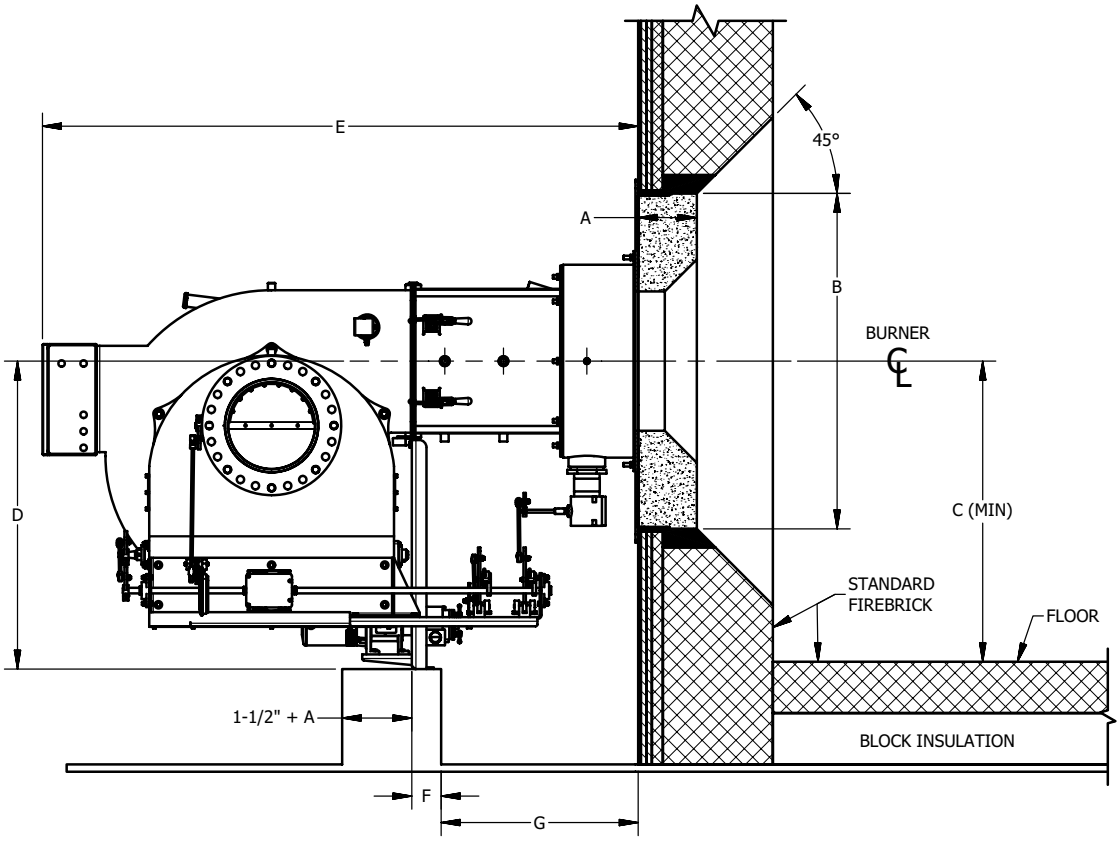
2.1 — Application

Electrical power available is usually 208 volt, 3-phase, 60 cycle, 230/460 volt, 3-phase, 60 cycle or 380 volt, 3-phase, 50 cycle. Control circuit is 115 volt, single phase, 60 cycle or 115 volt, single phase, 50 cycle. Refer to the electrical schematic diagram shipped with the burner. Power connections are made at the control panel. Wiring from the panel to burner mounted components is installed at the factory. Wiring from the burner panel to boiler controls, low water controls, remote compressor motor, and remotely located fuel valves is furnished by the installer.

Automatic over-fire draft control or barometric draft regulators are not usually required except where the system has a tall chimney. The exact height of a chimney requiring draft control is indeterminate, but draft regulation is seldom needed for chimneys less than fifty feet high, especially with Scotch Marine or sealed firebox boilers. Fuel oil piping and gas piping instructions are described in this Chapter.

2.2 — Combustion Chamber Construction

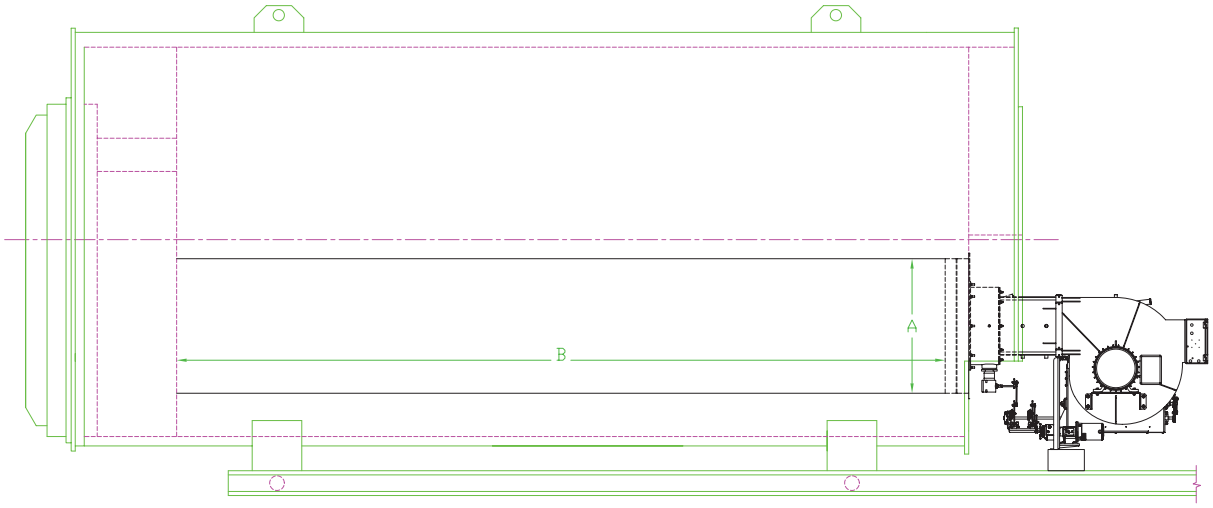
The combustion chamber dimensions should be proportioned to the heating load of the boiler.



Burner Size	A	B	C	D	E	F	G	Combustion Chamber Min. Width	Combustion Chamber Min. Length
84	10	19	19	31.5*	64	3.5	23	38	74
105	10	19	23	31.5*	64	3.5	23	46	84
126	10	19	24	31.5*	64	3.5	23	50	90
147	12	22	25	31.5*	64	3.5	23	55	100
168	12	27.5	27	37*	78	3.5	31	60	108
210	12	27.5	30	37*	78	3.5	31	70	120
252	15	31.5	30	37*	78	3.5	31	84	132
294	15	31.5	32	42*	87	3.5	33	84	144
336	18	34.6	34	42*	87	3.5	33	86	152
378	18	34.6	36	42*	87	3.5	33	92	160
420	18	34.6	38	42*	87	3.5	33	96	170

** Dimension is for oil applications. Dimension will be less for gas only applications.*

FIGURE 2-1. Combustion Chamber Dimensions



Burner Model	Boiler HP	A	B
84	200	34	115
105	250	34	144
126	300	38	158
147	350	38	185
168	400	42	155
210	500	42	195
252	600	46	194
294	700	48	204
336	800	50	230
378	900	60	230
420	1000	60	230

FIGURE 2-2. Burner Model/Boiler HP

2.3 — Installation

Locate the burner properly. The burner is designed for operation with the blast tube level. Do not tilt the burner up or excessively downward. Installation of the refractory oven or combustion cone, shipped with the burner. Securely support the burner pedestal on the floor or foundation. Allow enough clearance at the rear of the burner to allow the housing to swing open for service and maintenance. Many boilers, including some Scotch Marine types, do not have sufficiently rigid front plates and require additional support under the burner base. Bases under the support leg must be long enough to support the burner when being inserted or withdrawn from the

boiler. Boilers operating with the combustion pressure above atmospheric pressure must be sealed to prevent escape of combustion products into the boiler room. The burner mounting flange is designed to provide for a seal. The face of the boiler and burner flange must be sealed with a rope gasket (not supplied with the burner). Make sure the dry oven and burner blast tube are concentric. For maximum safety, it is recommended that boilers not operating under pressure should also be sealed.

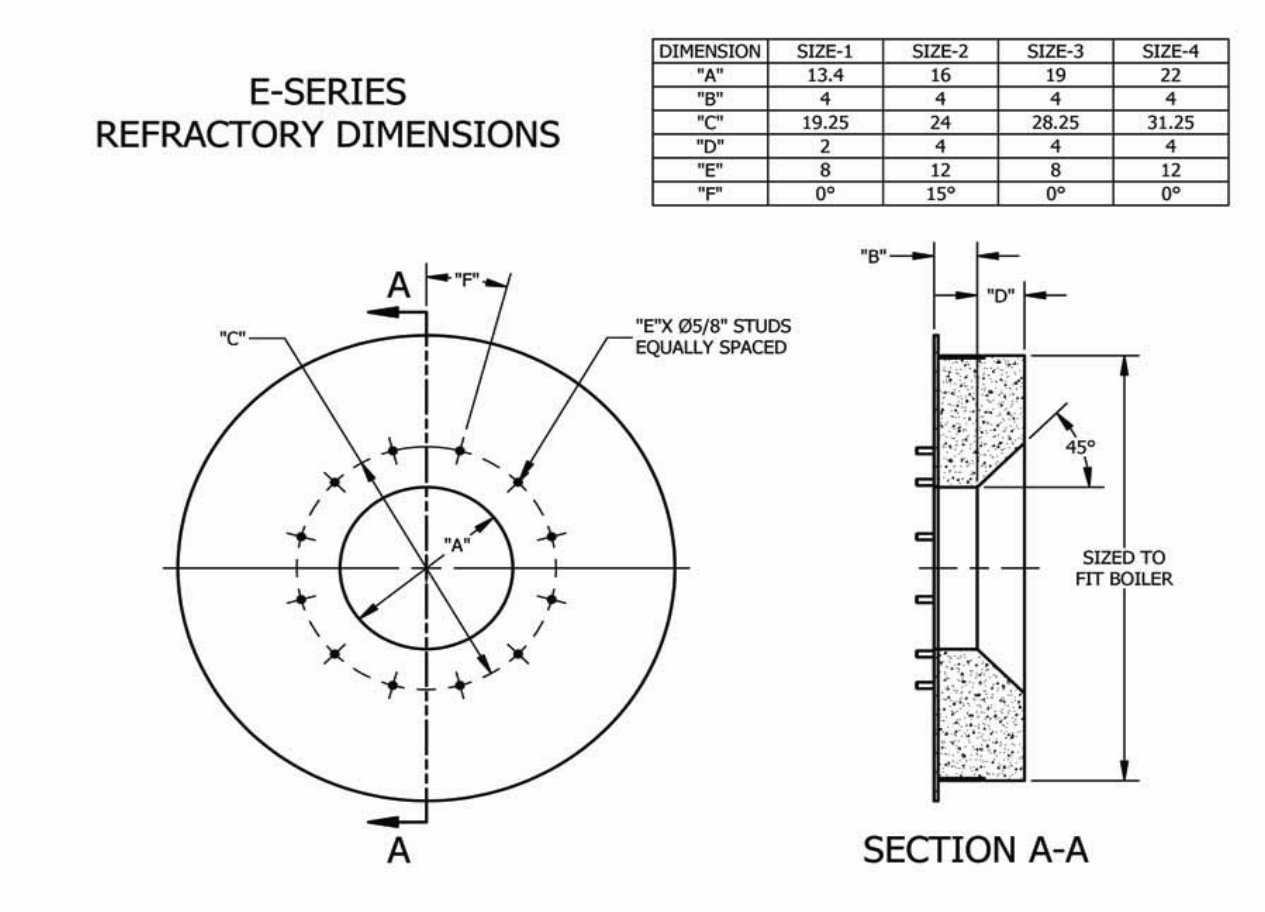


FIGURE 2-3. E-Series Refractory Dimensions

2.4 — Packing Plastic Refractory Around Oven (If Dry Oven is Supplied)

⚠ Caution

It is important that you provide support for the housing when in the open position to prevent damage to the hinges and subsequent components.

The area between the outside circumference of the dry oven and existing refractory should be packed with Kaiser Refractory Mono T-9 Airset or equal within two hours after coating the dry oven with Trowleze. From inside the furnace, ram the plastic refractory from the front to the rear, parallel to the outside surface of the dry oven.

2.5 — Separate Compressor Module

For oil burners supplied with the separate compressor module, piping to the burner is installed. Earlier models have the oil cooler finned coil located below the damper. The earliest units used a coil in the blast tube, but piping to the compressor and tank is essentially similar. Copper tubing for the installation is not supplied with the burner.

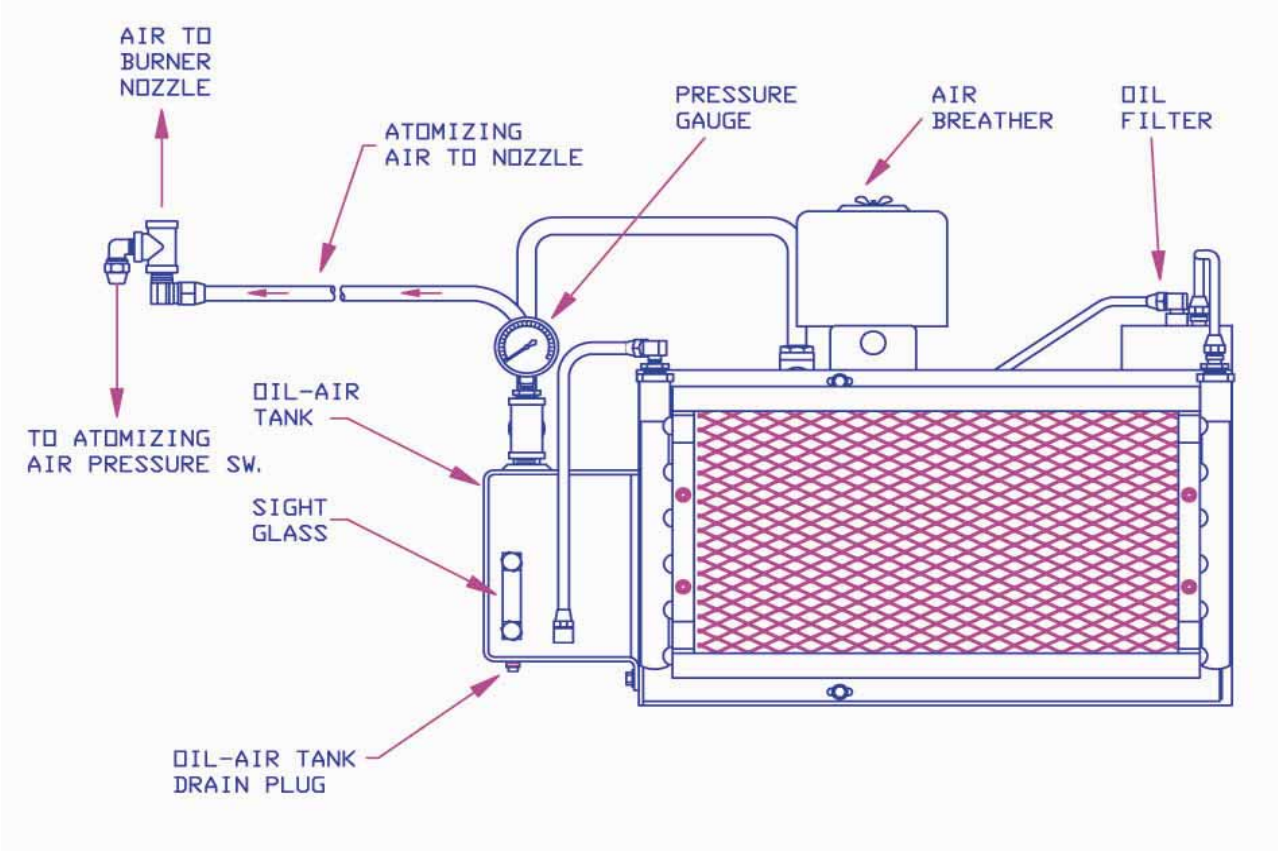


FIGURE 2-4. Separate Compressor Module

2.6 — Typical Oil Supply Loop

Continuous oil circulation must be supplied to the burner at a rate of 50 percent greater than the high fire burning rate. The oil circulating pump should be located as close as possible to the storage tank to keep suction lines short and minimize suction loss. Pipe line sizes indicated on the following oil piping schematics are of ample size to reduce pressure losses. If heating of the fuel oil is required, the lines must be large enough to prevent restriction of flow through any cold spots in the system. Note that the supply line is approximately 20 inches or higher above the burner metering pump inlet to help eliminate air problems. Above that is an adjustable, spring-loaded back pressure valve that sets approximately 10 to 15 PSI on the circulating loop. The return line to the tank is connected at the discharge port of the back pressure valve. Since air rises to the highest point, it will rise from the supply entrance and pass through the back pressure valve to the return line and on to the tank. Metered oil is pumped (by the metering pump) to the common port of a 3-way valve. With the 3-way valve de-energized, the metered oil returns to the tank through the back pressure valve and return line. When the 3-way valve is energized, metered oil is passed on to the burner oil nozzle and atomized by air from the compressor. The proper

strainers, check valves, vacuum, and pressure gauges, etc. should be installed as indicated. All lines should be pressure tested after installation.

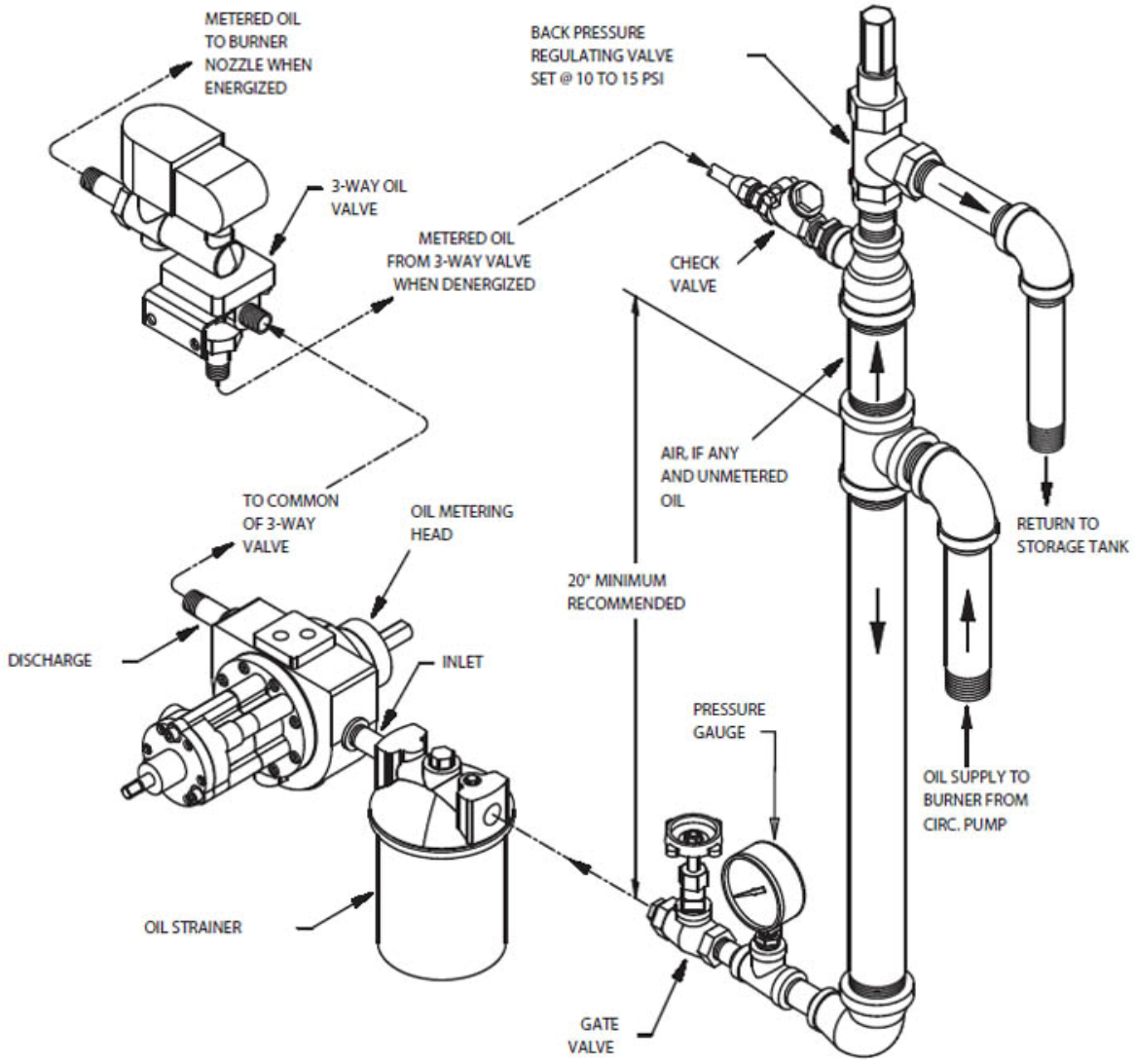


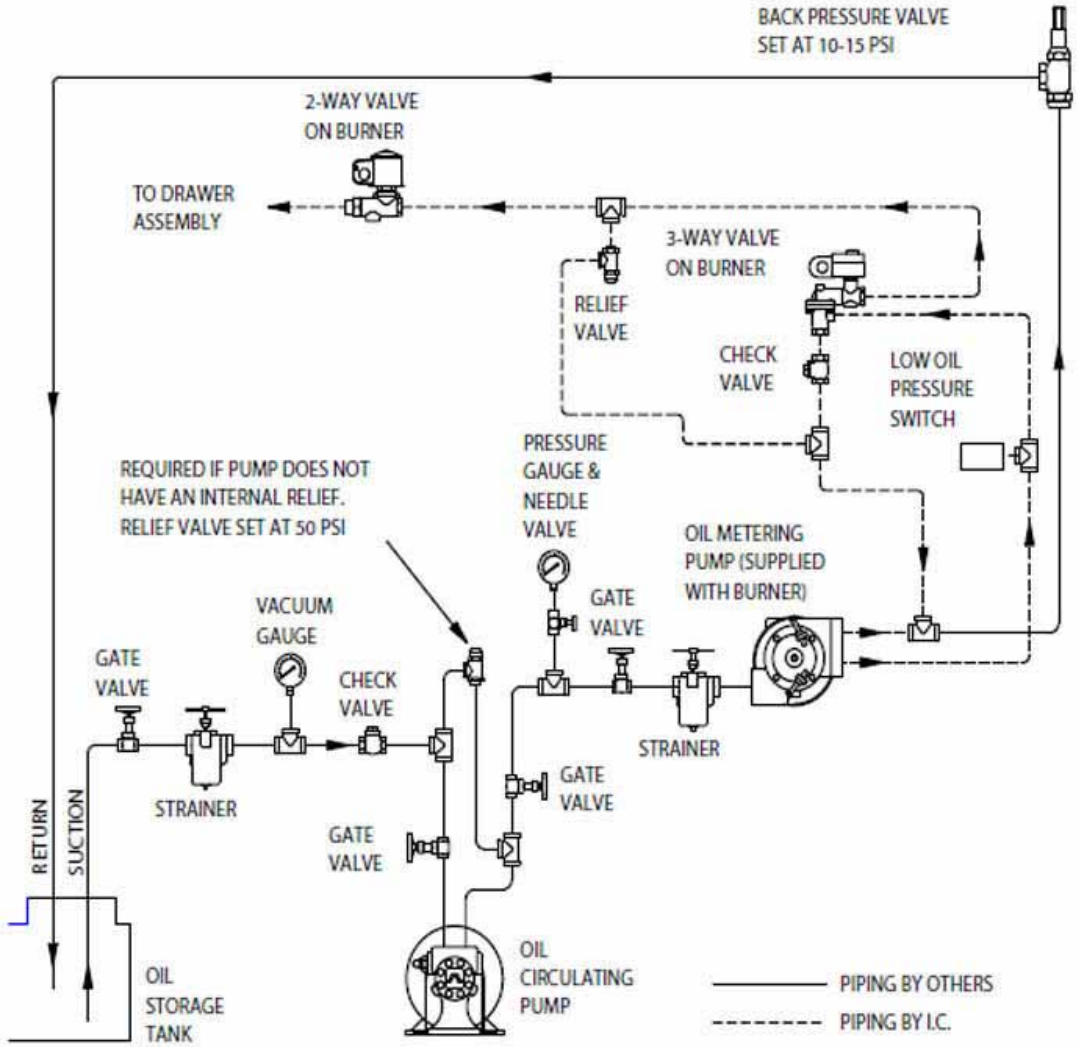
FIGURE 2-5. Typical Oil Supply Loop

2.7 — Oil Circulating Loop Operation

An oil circulating pump provides continuous oil circulation to the circulation loop. A back pressure valve holds 10 to 15 psi on the loop system. With the oil supply line connected only to the oil metering pump inlet, all oil must pass through the pump. During pre-purge, unmetered oil flows through a bypass section of the oil metering pump. Metered oil passes through the metering section to a de-energized 3-way oil valve (common port). Both unmetered and metered oil must pass through the back pressure valve and return to an oil storage tank. The oil metering pump will only meter oil. It will not serve as a circulating pump. At trial for main flame (main fuel), the

3-way oil valve is energized admitting metered oil to the nozzle for atomization and fast smooth ignition. Unmetered oil continues to flow through the bypass section of the oil metering pump and returns to an oil storage tank.

For No. 2 oil, refer to Figure 2-6 and Figure 2-7.



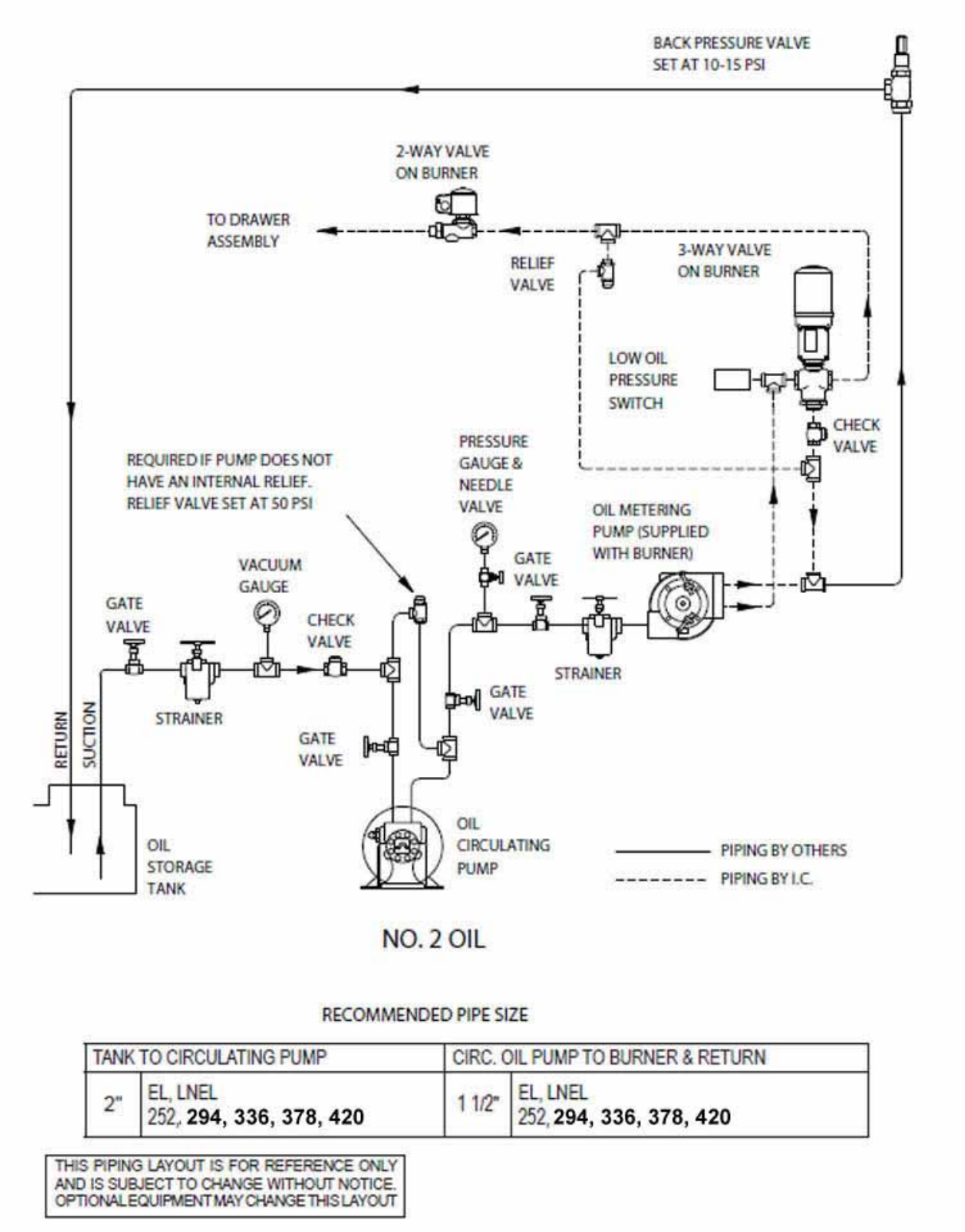
NO. 2 OIL

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	EL, LNEL 84, 105, 147, 168,210	1 1/2"	EL, LNEL 84, 105, 147, 168,210

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT

FIGURE 2-6. No. 2 Oil Loop



RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	EL, LNEL 252, **294, 336, 378, 420**	1 1/2"	EL, LNEL 252, **294, 336, 378, 420**

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT

FIGURE 2-7. No. 2 Oil Loop, with Check Valve

2.8 — Circulating Oil Pump

A circulating oil pump is required to deliver fuel oil from the storage tank to the burner at a minimum of 150% of the maximum burner firing rate. The excess oil allows a margin for piping error, viscosity changes in the fuel oil, and circulating pump wear. Correct pipe sizing is determined by circulating rate, not burner capacity. Install the pump as close to the supply tanks as possible. Suction lift should be as low as possible. Maximum suction of 15" Hg vacuum is good practice for either light or heated heavy oil. The strainer should be installed in the suction line just ahead of the circulating pump to prevent foreign material from entering the pump. Locate the strainer so it may be easily cleaned.

2.9 — Back Pressure Valve

A back pressure valve, similar to Watson McDaniel type "R," needs to be installed on the return line. This valve must be installed in an upright vertical position. Before installing the valve, be sure to blow out the pipe line, removing all dirt, pipe scale and sediment. This type of valve is actuated by the system pressure which enters the body beneath the main valve. Valve loading is provided by a spring that can be adjusted to the desired set pressure.

To adjust the set pressure, remove the top cap, loosen the brass locknut and adjust the pressure with the steel setscrew. By increasing the compression on the spring, screwing down the screw, you increase the set pressure within the limits of the spring range. Reversing the setscrew lowers the set pressure.

Adjust to 10-15 PSI for No.2 oil systems. When the desired pressure is reached, tighten the locknut and replace the top cap and gasket.

2.10 — Gas Piping

Refer to Figures, 1-5 and 1-6 for typical gas piping schematics.

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. Z 223.1 (for Canada, the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail).

Gas train components upstream of the butterfly valve are shipped loose. These components should be mounted by the installer as close to the butterfly valve as practical. Normally, the control train is ordered to suit a particular code or insurance regulation, such as Underwriters Laboratories Inc., CGA, or Factory Mutual.

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 shut-off valve.

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

2.11 — Installation Checklist

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:

- Electrical terminals in the control panel and on all electrical components.
- Pipe fittings and unions.
- Tubing connections.
- Nuts, bolts, screws.

Before operating pumps, metering heads and compressors, make certain that reservoirs are properly filled with the specific lubricant. Open all necessary oil shut-off valves. Do not run compressors, pumps, or metering units without oil.

Before connecting electrical current to any component, be sure the supply voltage is the same as that specified on component nameplates.

Before burner operation, be sure all motors are rotating in the correct direction.

Before firing, make sure that the refractory flame cone is properly sealed to the burner mounting flange and the boiler front plate.

Make certain that the operator in charge is properly instructed in the operation and maintenance procedures.

⚠ Caution

Before opening the gas shutoff valves, read the regulator instructions carefully. Open the shutoff valve slowly to allow inlet pressure to build up slowly in the regulator until it is fully pressurized. Opening the shutoff valve quickly will damage the regulator.

Do not exceed the regulator pressure ratings.

⚠ Caution

Lubricating oil is drained from the air/oil tank before shipment. Before attempting to start the burner, add oil to the recommended level.

CHAPTER 3 Operation

3.1 — Preparations for Starting

When the installation is complete and all electrical, fuel, water, and vent stack connections are made, make certain said connections are tight. The operator should become familiar with the burner, boiler controls, and components. To identify controls and components, refer to contents of Chapter 1. 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 burner programmer. Read and understand starting instructions before attempting to operate the burner. Before attempting to start the burner, the following checks must be made:

Item	Check
Boiler	Check the boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control slightly above the desired temperature. Set modulating controls at the desired temperature or pressure.
Burner	Check the electrical power supply to the burner in accordance with the nameplate voltage on all motors and the control circuit. Check the direction or rotation of the motors. Open the housing to check the electrode setting. Check the gas pilot pressure at the pilot gas regulator. The normal setting is 3” to 6” W.C. 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 sub-base with a screw which, when tightened, completes the connection between the sub-base and chassis contacts. Press the manual reset button to be sure safety switch contacts are closed. 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 level and manipulating by hand. Check the air shutter and adjust low fire setting.
Oil-Air Tank (Lube Oil)	Check the lube oil level in the air-oil tank. Inspect oil level regularly. Loss of oil will damage the compressor. Fill the tank with non detergent SAE30 oil to a level midway up the sight glass. Do not overfill the tank. For a normal environment use SAE10 oil. Change oil every 2000 hours of operations.

3.1.1 — Oil Flow

Refer to piping diagrams. Open all valves in the oil suction and return line. The burner oil metering units are not capable of creating suction. Fuel oil must be supplied to the metering unit at a nominal 10 to 15 psi pressure by a circulating supply pump.

3.1.2 — Oil Pressure

The system pressure is regulated by the back pressure valve. This should be set between 10 to 15 psi at the burner inlet after the temperature stabilizes.

3.1.3 — Firing Preparations for Oil Burners

Prior to initial firing, oil flow pressure and temperature should be verified.

Inspect the compressor lube oil sump level. Add oil to bring the oil level to the midpoint or slightly higher in the reservoir sight glass.

Make certain that the drive belts or couplings are aligned and properly adjusted.

To verify air flow and pressure, momentarily flip the switch “ON” and immediately turn “OFF.” The programmer will continue through its cycle, however, without ignition or energizing the fuel valves. Observe the air pressure gauge. With the compressor running and no oil flow, the pressure should be approximately 10 psi. The schematic flow diagrams in Chapter 1 indicate the flow of fuel and atomizing air.

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.”

3.1.4 — Firing Preparations for 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 let the programmer finish its cycle. Check to see that the gas valve closes tightly. Set the high and low gas pressure switches.

Check for leaks and determine there is adequate gas pressure available at the burner for operating at full capacity. Check with the local utility if necessary. Check gas pressure at the pilot and the main burner. Close the manual gas valve.

3.2 — Electrical Interference Test

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

3.2.1 — Gas Fired

1. Close the pilot and the main line manual gas valves.
2. Start the burner and at the time of the pilot trial, with just the electrical ignition system energized, the flame relay should not pull in (be energized).
3. Upon completion of successful test, proceed with startup procedures.

3.2.2 — Oil Fired

1. Disconnect the electrical power to the burner.
2. Disconnect the electric oil safety shutoff valve.
3. Reconnect electric power to the burner.
4. Close the pilot line manual gas valve, if used.
5. Start the burner and at the time of the pilot trial, with just the electrical system energized, the flame relay should not pull in.
6. Upon completion of successful test, disconnect the power supply,
7. Reconnect oil safety shutoff valve and turn on manual pilot gas valve.
8. Reconnect power supply and proceed with startup procedures.

3.3 — Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. 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.

3.4 — Startup Sequence

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:

- The operating and high limit control (temperature or pressure) are below their cutoff setting.
- All power supply switches are closed.
- Power is present at the control panel.

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

1. Begin starting sequence, with burner switch off, and with all manual valves closed. Switch main power on.
2. When firing oil, open the manual oil valves.
3. When firing on gas, open the main manual gas valve.

4. When firing on gas, manually reset the high and low gas pressure switches.
5. Place the gas.oil selector switch in position for the desired fuel. With all limit and operating controls calling for heat, the burner will follow the Flame Safeguard Sequence.
6. When the burner motor starts, open the gas cock.
7. If firing on gas, when the main fuel lamp lights indicating pilot flame proven, slowly open the second shutoff cock downstream of the main gas valve(s).

Refer to the manufacturer's literature on primary control sequence of operations.

3.5 — Automatic Shutdown

Limit or operating controls open:

1. Fuel valves close. Main fuel lamp goes off. Flame safeguard timer starts.
2. Flame safeguard timer and burner motor stop. Burner is ready for startup on the next call for heat.

3.6 — Manual Shutdown

1. Turn gas/oil selector switch off. The burner shuts down in Automatic Shutdown as above.
2. When the burner motor stops, close all manual valves.

3.7 — Safety Shutdown

1. If at any time during the operating cycle a flame failure occurs, the burner shuts down as in Automatic Shutdown, with an additional post-purge, and the flame failure lamp is energized.

⚠ Warning

Read the Flame Safeguard manual and fully understand its contents before attempting to operate this equipment. If the manual is not read and understood, serious personal 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. The combustion chamber must first be purged before re-lighting.

⚠ Warning

Keep fingers away from the combustion air intake below the damper. The damper is actuated with sufficient force to cause severe injury. Always make high and intermediate rate adjustments when the burner has reached low fire position. Do not disturb the low fire setting.

A. The lockout switch on the flame safeguard control must be manually reset before the burner will fire again.

2. If a low water condition occurs, the burner shuts down as in Automatic Shutdown.
3. If a high or low gas pressure condition occurs while firing on gas, the burner shuts down as in Automatic Shutdown.
   A. Condition must be corrected and the respective gas pressure switch manually reset before the burner will fire again on gas.

3.8 — Startup and Operating

3.8.1 — Gas Burners

1. Close the main and pilot gas cocks.
2. Make sure the ON-OFF switch is in the “OFF” position and the fuel selector switch is turned to “GAS.”
3. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
4. Set the MANUAL-AUTO switch in the “MANUAL” position.
5. Set the manual potentiometer in the low fire position.
6. Open the gas pilot cock.
7. 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. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done (see Section 3.2).
8. On initial startup it is recommended that the main gas shutoff cock remains 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 let the programmer finish its cycle.
9. Check to see that the gas valve has closed tightly. If ignition does not occur, turn the burner switch “OFF” and allow the programmer to recycle for a new ignition trial.
10. Turn the burner “ON” and after pilot ignition when the flame relay pulls in, the slow opening, motorized, main gas valve is energized. The main flame should ignite at this time. The gas valve and air damper continue advancing until high fire is reached.
11. 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.
12. Set the gas low fire rate by adjusting the butterfly valve and air linkage.
13. When low fire is adjusted, shut down the burner.
14. 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 an emergency, open the main power switches and close all fuel valves.
15. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
16. Turn the potentiometer switch to the high fire position. Check high fire at this point using combustion instruments.
17. Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings.

High fire combustion analysis typically is 9% to 10.5% CO_2. When conditions covered above are assured, refer to Sections 3.9 and 3.10.

3.8.2 — Oil Burners

1. Set the fuel selector switch to “OIL.” On initial startup of a combination burner, it is recommended that oil firing be adjusted before gas firing. The gas low firing rate is set to match the oil low fire rate.
2. Be sure the ON-OFF switch is in the “OFF” position and the fuel selector switch is on “OIL.”
3. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
4. Be sure the MANUAL-AUTO switch in the “MANUAL” position.
5. Set the manual modulating control potentiometer in the “LOW FIRE” position.
6. Open the pilot gas valve (if used).
7. Set the ON-OFF switch to “ON.” The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done.
8. Observe the primary atomizing air pressure gauge on the air/oil tank. The gauge reading should be approximately 10 psi during pre-purge.
9. When the pilot flame is proven, the programmer will proceed to the main flame position. Allow the burner to operate in low fire, to warm the boiler before moving to high fire. Typically, for No. 2 oil, CO_2 is 8% to 11% at low fire.
10. Turn the manual potentiometer switch to the “HIGH FIRE” position. Check the high fire combustion at this point. Do not disturb previously established low fire adjustment.
11. Allow the burner to return to the low fire position before adjusting high or intermediate settings. The primary atomizing air pressure will increase automatically with the oil flow rate. Typically, for No. 2 oil, CO_2 is 10% to 13% at high fire.

When conditions covered above are assured, refer to Sections 3.9 and 3.10.

3.9 — Normal Operation

Normal operation must be with the MANUAL-AUTO switch set 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 trial 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 instruction given in Chapters 4 and 5.

3.10 — Shutdown

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

1. The fuel valve(s) de-energize and the flame extinguishes. The blower motor continues running during post-purge.
2. At the end of post-purge, the blower motor is de-energized.
3. 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 make the necessary corrections 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.

⚠ Warning

An ultraviolet flame sensor electrical spark interference test must be performed after final adjustment. See Section 3.2 in this chapter for additional information.

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 shipping and installation.

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

4.2 — Combustion Adjustment on Gas and Oil

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).

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. Stack temperature should be as low as possible without causing flue gas condensation.

Stack heat loss can be reduced by decreasing either the temperature or the volume of the flue gas, or both. 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.

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 fuel-air ratio
- Excessive air leaks in the combustion chamber
- Improper fuel oil temperature

4.2.3 — 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% CO_2 and less than .04% CO.

4.2.4 — Fuel Oil Adjustments

Adjust for a “clean fire.” Typically for No. 2 oil CO_2 is 8% to 11% at low fire and 10% to 13% at high fire.

4.3 — 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.

4.3.1 — Gas Fired

1. Close the pilot and main line manual gas valves.
2. Start the burner and at time of pilot trial with just the electrical ignition system energized, the flame relay should not pull in (be energized).
3. Upon completion of successful test, proceed with startup procedures.

4.3.2 — Oil Fired

1. Disconnect the electrical power to the burner.
2. Disconnect the electric oil safety shutoff valve.
3. Reconnect electric power.
4. Close the pilot line manual gas valve, if used.
5. Start the burner and at the time of pilot trial, with just the electrical ignition system energized, the flame relay should not pull in.
6. Upon completion of successful test, disconnect the power supply.
7. Reconnect the oil safety shutoff valve and turn on the manual pilot gas valve.
8. Reconnect the power supply and proceed with startup procedures.

4.4 — Gas System

4.4.1 — 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. Refer to nameplate inside control panel for gas pressure requirements at train inlet and manifold. The pressures listed are based on nominal 1000 Btu/cu ft. natural gas at elevations up to 2000 feet above sea level.

4.4.2 — 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.

4.4.3 — Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. 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 Section 4.3 of this chapter for additional information.

4.4.4 — Main Gas Pressure Regulator

The gas pressure required at the burner manifold is the pres- sure 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.

4.4.5 — Low Gas Pressure Switch

Turn adjusting screw until indicator moves to a pressure setting slightly below the operating gas pressure. The control will break a circuit if pressure is below this set point. 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. The switch must be manually reset after tripping. To reset, allow gas pressure to rise and press the manual reset button.

4.4.6 — High Gas Pressure Switch

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.

4.4.7 — Gas Combustion Adjustment

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

Proper setting of the air-fuel ratios at all rates must be determined by combustion analysis. See Section 4.2 of this chapter for additional information.

NOTE: Check for CO through the entire firing range.

4.5 — Oil System

4.5.1 — Oil Metering System

Fuel oil supply to the separate metering unit must be 10 psi to 20 psi. The oil spray should ignite as soon as the oil solenoid valve opens. If the oil spray fails to ignite, move the metering unit adjustment lever a few degrees counterclockwise. This increases the amount of oil at low fire and makes ignition easier, it will also increase the oil on high fire, and this must be checked later. Once adjusted, the pump should operate with a minimum amount of adjustment. If a burner failure is caused by the oil metering pump, check the following:

1. Oil tanks are not empty.
2. All oil valves between the burner and the tank are open.
3. The suction line is not airbound.
4. The low fire setting has not been disturbed.
5. There is pressure at the separate metering unit, but not exceeding 20 psi.
6. The pump turns freely.
7. The strainer at the suction side of the circulating pump is not clogged.
8. The burner strainer is not dirty.

9. The nozzle is not plugged or carboned. This will show up as excessive primary air pressure.
10. The oil bypass valve is not bypassing the metered fuel oil.

Internal wear of the pump may take place due to the presence of dirt in the oil and in time this will result in excessive clearances which reduce the pump capacity.

If the oil metering pump fails to deliver capacity or meters erratically, replace the oil and air pump as a unit and return the old pump for repair or exchange (where allowed).

4.5.2 — Atomizing Air Pressure

Atomizing air in the air/oil tank is regulated by adjusting valve in the return air line on integral metering units or in the air inlet on air compressor module burners. The air pressure is indicated by the pressure gauge at the air/oil tank.

A minimum of 10 psi air pressure in low fire is suggested. As the firing rate increases, the air pressure also increases. Air pressure will be less with light oils. If any change in atomizing air pressure is made, check ignition several times for reliable light off. Adjustments should be set to obtain reliable ignition with best low and high fire combustion results.

If the required atomizing air pressure cannot be maintained, a lack of lubricating oil may be the cause or the intake filter may be dirty.

4.5.3 — Atomizing Air Proving Switch

The knurled nut between the switch and bellows is turned in to raise pressure setting. The minimum amount of atomizing air is during pre- and post-purge. During pre-purge, adjust switch until it breaks the circuit. Readjust the switch above this circuit breakpoint to actuate under a condition of minimum pressure, but not so close as to cause nuisance shutdowns. Since the pressure of the atomizing air is at minimum when no fuel is present at the nozzle, adjustment of the switch should be made while the unit is purging, but not firing.

4.5.4 — Low Oil Pressure Switch

The low oil pressure switch is adjusted at the minimum setting of 4 psi. Turning the knob clockwise will increase pressure, counterclockwise will decrease pressure.

4.6 — Linkage-Modulating Motor

The linkage consists of adjustable cams, levers, rods and ball joints that transmit motion from the modulating motor to the air damper, gas butterfly valve, and oil metering unit. When properly adjusted, coordinated movement of the air and fuel control devices provide proper fuel/air ratios through the firing range. In linkage adjustments, several important factors serve as guides:

- The modulating motor must be able to complete its full travel range. Restrictions will damage the motor and/or the linkage.
- Lever and rod adjustments should be made with the motor in the low fire position.

The modulating motor will be stopped at the end of its stroke by an internal limit switch. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. 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 flow rate.

4.7 — Cam Trim Adjustment

After low and high fire adjustments are complete, final adjustment is made with the cam assembly to obtain a good air/fuel ratio throughout the entire firing range.The input of combustion air is fixed at any given point in the modulating cycle. The fuel input may be varied to obtain correct flue gas readings. The adjustment is made to the metering cam by means of the 14 adjusting screws which are turned in (clockwise from the hex-socket end) to increase the flow of fuel, and out (counterclockwise from the hex-socket end) to decrease it. A 3/32” hex key is required. It will be necessary to cut off the short end of a hex key to approximately 3/8” to adjust the first two socket head setscrews at the low fire position. Take a combustion analysis at various points of the cam profile. Adjustment can be made without cycling the burner, then operate the automatic modulating cycle to assure satisfactory results. Tighten the locking setscrews.

NOTE: It is essential that the cam spring, cam follower bearing wheel, and cam follower arm at the pivot point be greased sparingly every month to ensure smooth operation of the cam assembly. Regular automotive bearing grease should be used.

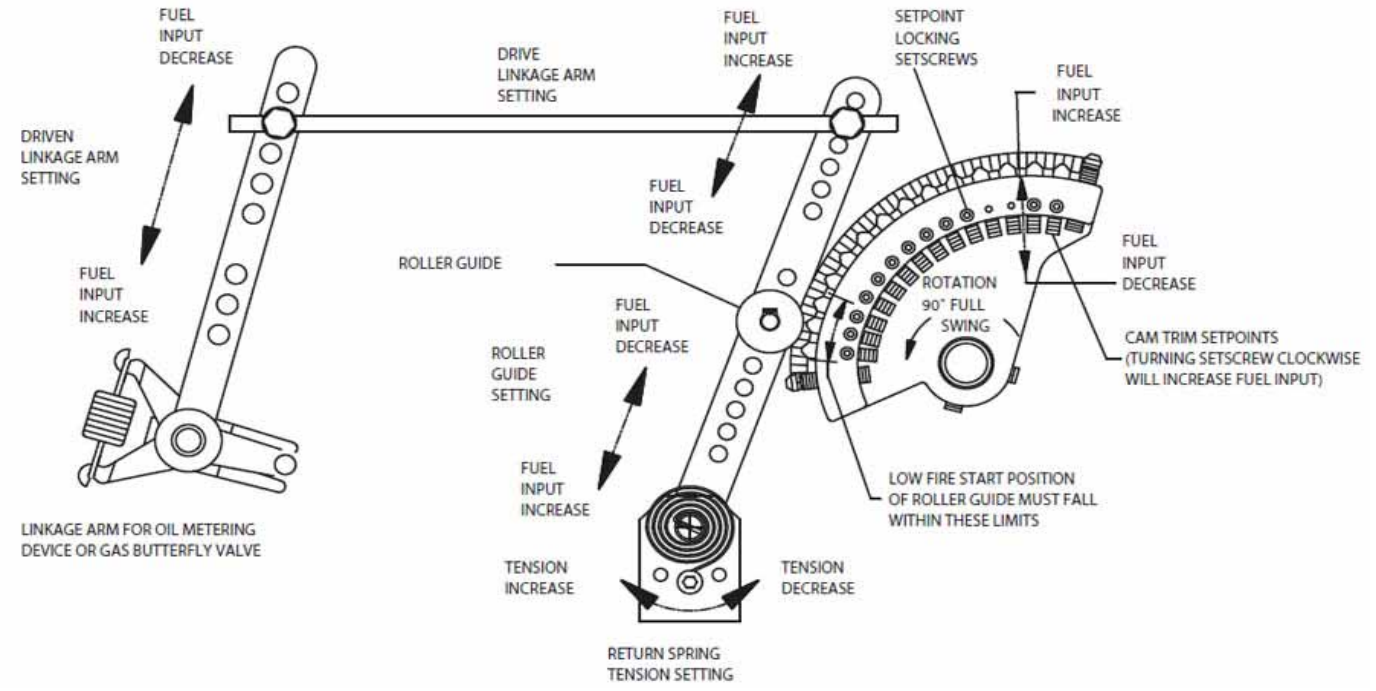


FIGURE 4-1. Cam Trim Adjustment

4.8 — Parallel Positioning Adjustment

For parallel positioning systems refer to the control manufacturer's documentation and to the accompanying wiring diagram for information on adjusting the system. In a properly tuned parallel positioning system the independent actuators for fuel, air, and FGR (if so equipped) will be coordinated to provide optimum combustion throughout the firing range.

4.9 — Firing Rate Controls

Firing rate adjustments are made at the modulating motor linkages to the combustion air inlet damper, air-oil metering pump, and main gas butterfly valve. Settings are determined by the operating length of the levers and the angular position on the shafts. Increasing the lever lengths on damper, pump or valve decreases the flow rate. Driving and driven levers are approximately parallel, but the angles can be adjusted to vary the rate of change. The most rapid rod travel occurs when the lever is perpendicular to the rod. The closer the rod comes to being parallel with the lever, the slower the rod moves. ALWAYS allow the burner to return to low fire position before adjusting high or intermediate settings. DO NOT alter low fire settings.

Normally, the air control damper will be approximately 1" open in low fire position. Excessive opening in low fire can cause pilot ignition problems. Air to the pilot is supplied under pressure to compensate for variations in furnace pressure, but the damper must be in low fire position for reliable ignition.

⚠ Warning

Keep fingers away from the air intake below the damper. The damper is actuated with sufficient force to cause severe injury.

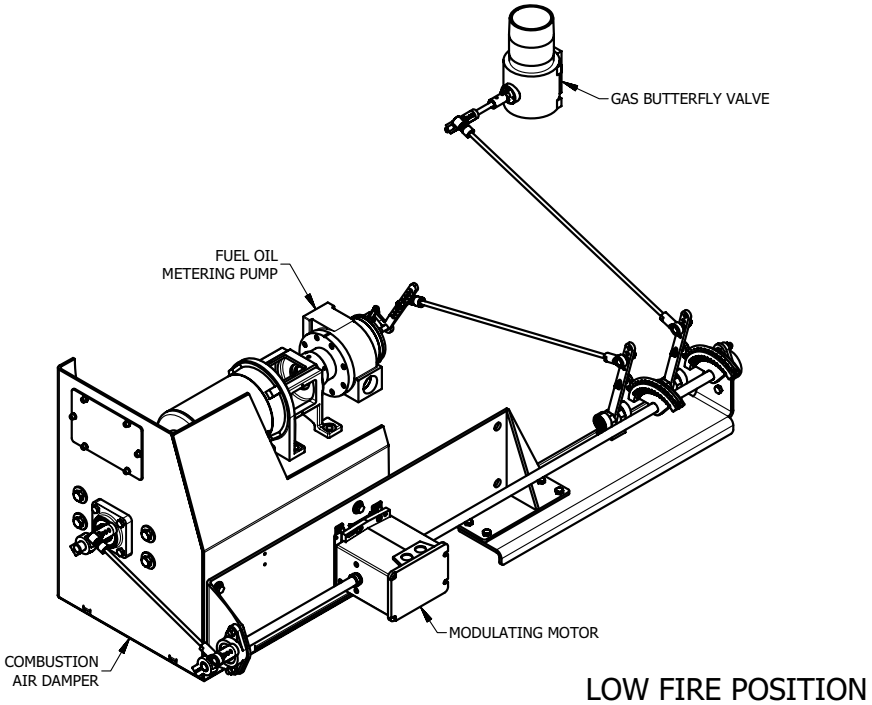


FIGURE 4-2. Firing Rate Control Positions

CHAPTER 5

Maintenance

5.1 — Overview

⚠ Warning

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 removed. They must be replaced, and securely anchored before testing, adjusting, or running the burner or burner related equipment.

⚠ Caution

It is important that you provide support for the housing when in the open position to prevent damage to the hinges and other components.

A maintenance program avoids unnecessary down time, 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.

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.

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 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 lock out 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.

5.3 — Impeller and Inlet Cone

Proper clearance between the impeller and the inlet housing set at 3/8” nominal. Adjust the inlet cone so it is centered in the inlet of the impeller and tighten the bolts. There should be no contact between the inlet cone and the impeller. Inserting a bar through the impeller blade and using it as a lever will only damage the blade and also void the impeller warranty.

5.4 — Firing Head Inspection

Disconnect the damper linkage, release the impeller housing latches, and swing the housing open for access to the firing head. Inspect the flame scanner lens to be sure it is clean Inspect the lead wire to the ignition electrode. It must be firmly attached and the insulation should be clean and free of cracks. The oil nozzle should be inspected periodically depending on the grade of oil burned and the cleanliness of the environment.

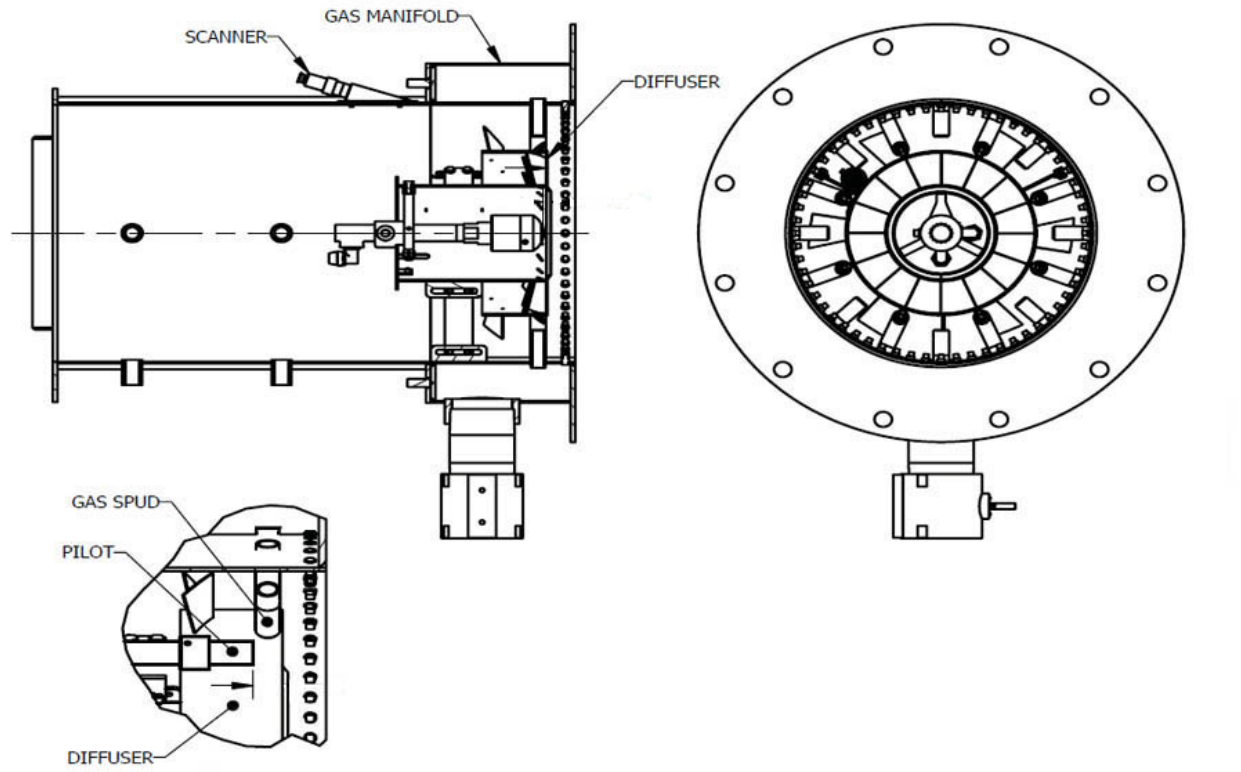
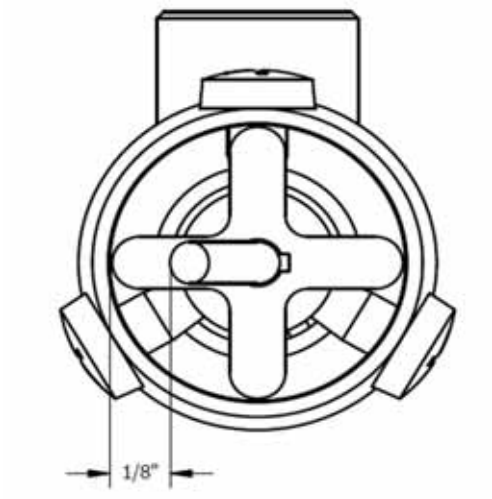


FIGURE 5-1. **Firing Head Assembly**

5.5 — Pilot and Ignition Electrode



The ignition transformer requires little attention other than making sure the ignition wire is firmly attached to the transformer and the electrode. Be sure the wire insulation is in good condition and not grounded. Failure to keep the ignition electrode clean and properly set can cause faulty operation. Refer to Figure 5-2 for electrode gap setting and position. The pilot assembly is supported by a socket in the diffuser and gas inlet tube. No adjustment is required except proper positioning of the electrode wire.

FIGURE 5-2. **Pilot Electrode Gap**

5.6 — 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.

5.7 — Oil Nozzle

Successful burner operation requires use of the proper style nozzle tip and keeping the orifice clean. Standard nozzle tips furnished on the burners are of a special emulsifying type which delivers a spray of extreme fineness and at an angle which insures proper mixing with the air stream. Unsatisfactory performance and loss of efficiency can result from the use of nonstandard nozzle tips. If the burner flame becomes stringy or lazy, it is possible that the nozzle spring is not properly in place or the nozzle is clogged. This problem is usually indicated by an abnormally high reading on the atomizing air pressure gauge on the air-oil tank. To remove the nozzle:

1. Disconnect the oil and air tubes to the nozzle assembly.
2. Loosen the three 1/4” screws holding the nozzle spider bracket to the diffuser.
3. Withdraw the nozzle and bracket assembly.

To clean the nozzle tip and swirler:

1. Unscrew the tip from the nozzle body. Use care not to distort the tube.
2. Hold the nozzle body in a vise or use two wrenches, one on the body and one on the tip.
3. Disassemble the nozzle tip.
4. Carefully clean all parts in solvent and reassemble the nozzle.

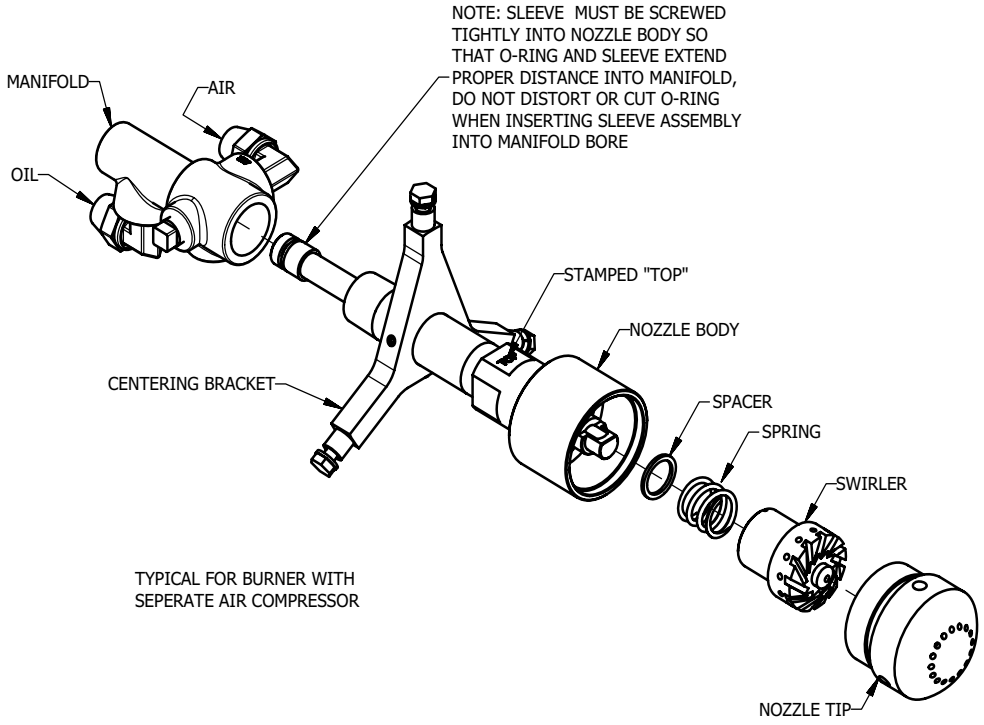


FIGURE 5-3. Oil Nozzle Assembly

To insure proper atomizing, the tip must be screwed in tightly with the swirler seating spring pressing the swirler tight against the nozzle tip. Turn the swirler a few times to be sure it fits snugly in the nozzle and the spring is pressing the two parts firmly together. When reinstalling, be sure the nozzle is centered with the proper distance from the diffuser.

⚠ Caution

Do not attempt to use wire or a sharp metal tool to clean the nozzle orifice as this will distort the fine orifices and ruin the nozzle. Use a sharp pointed piece of soft wood.

5.8 — Diffuser

The diffuser is factory set and does not require attention under normal operating conditions. If fouled with carbon, the diffuser should be removed for cleaning:

1. First remove the electrode leads, the gas pilot assembly, air and oil tubes before you attempt to remove the diffuser.
2. Mark the diffuser relative position to the blast tube, with a scribed or pencil line where the three mounting screws are located, to insure that the diffuser is placed back in the same position.
3. Remove the three screws holding the diffuser to the blast tube and slowly pull the diffuser along the blast tube towards the firing head.
4. Clean all carbon from the diffuser vanes and reinstall in reverse order of disassembly aligning the diffuser with the scribed marks.
5. When reinstalling, be sure the diffuser is centered with the proper distance.

5.9 — Firing Rate Controls

Check all rods and linkages, Make sure all connections are tight. Adjust if necessary. Perform a combustion test as explained in Chapter 4, and readjust the burner if necessary.

5.10 — Burner Mounting Inspection

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. Replace the gasket if necessary. Inspect the burner head for signs of discoloration. A change the head color paint might indicate gas leakage between the dry oven and the boiler refractory. If leakage occurs, refer to Chapter 2, Section 2.4, for proper sealing procedure.

NOTE: It is essential that the cam spring, cam follower bearing wheel, and cam follower arm at the pivot point be greased sparingly every month to ensure smooth operation of the cam assembly. Regular automotive bearing grease should be used.

5.11 — Fuel Oil System

5.11.1 — Fuel Oil Circulating Pump

Failure of the circulating pump to deliver sufficient oil may be due to one of the following reasons:

- Insufficient fuel oil in the storage tank.
- Suction line or check valve clogged.
- Air leaks or air traps in the suction line. If the line has a high point at which an air trap can occur, the line must be changed.
- Oil strainer clogged (line strainer or burner strainer).
- Suction line piping too small (see Chapter 2).
- Pump rotating in wrong direction.
- Three-phase pump motor operating on single-phase because of fuse failure.
- Low voltage applied to pump motor.

NOTE: Heavy fuel oil sometimes will not leak out through a suction line joint when the burner is idle, but the same joint may allow air leakage inward when a vacuum is created in the line by pump action. The cause of a pulsating burner fire can often be traced directly to air leakage in the oil suction line. Always be sure the suction line joints are absolutely air tight.

⚠ Caution

Do not attempt field repair of the compressor. Installation of a new compressor is mandatory. Send the old compressor in for repair or exchange (where allowed).

⚠ Caution

Do not attempt to disassemble the oil metering pump in the field. Any attempt will void the warranty or the exchange policy.

5.11.2 — Primary Air Pump or Compressor

The air compressor itself requires little maintenance, however, its life is dependent upon sufficient clean, cool lubricating oil. The oil level in the air-oil tank must be checked regularly. Lack of oil will damage the compressor. Disassembly or field repairs to the air compressor are not recommended. Check the air-oil tank sight glass for proper oil level. The level should be kept at midpoint up the glass. The compressor rotor must turn freely. All tube connections must be air tight.

Alignment of the compressor and motor sheaves and proper belt tension are important.

Belt tension is adjusted according to the displacement on the belt with thumb pressure. The displacement should be 3/8 to 1/2 inch.

To adjust, loosen the two bolts on the compressor mounting flange and the three setscrews which hold the compressor in place.

The mounting flange is slotted at the top, which permits belt tightening. If the slot in the mounting flange is insufficient for obtaining proper belt tension, the modular base has two extra holes for this purpose.

Move the top bolt to the next hole and adjust. Tighten bolts and setscrews. Replace belt guards. If belt becomes frayed or cracked, replace it.

⚠ Caution

The metering pump is lubricated by fuel oil and must not be operated longer than one minute if it's not pumping oil. Failure to comply will result in premature pump failure and void any warranty implied or otherwise.

5.11.3 — Air Cleaner

Never operate the compressor without the air cleaner in place. The cleaner should be cleaned at regular intervals. The correct oil level must be maintained in the air cleaner. Use the same oil used for air compressor lubrication.

5.11.4 — Air-Oil Tank

Check the lube oil level in the air-oil tank. Inspect oil level regularly as loss of oil will damage the compressor. Change oil every 2000 hours of operation. The air-oil tank should be drained once a year and thoroughly flushed. Remove the mist eliminator pads from the upper section of the tank, wash thoroughly in kerosene and dry. Refill with non detergent SAE30 oil to a level midway up the sight glass. For normal environment use SAE30 oil. For a 32 º F and below environment use SAE10 oil.

5.11.5 — Oil Level Sight Gauge

The oil level sight gauge can be cleaned by removing it from the air-oil tank and soaking it in a detergent solution. If cleaning the gauge proves unsatisfactory, replace it.

5.11.6 — Compressor Oil Filter (Lube Oil Strainer)

The lube oil strainer prevents foreign materials from entering the compressor. The strainer screen must be cleaned at regular intervals.

The screen is easily removed for cleaning by unscrewing the bottom plug. Immerse in solvent and thoroughly clean.

5.11.7 — Oil Strainers

Oil strainers should be cleaned frequently to maintain a free and full flow of fuel. The strainer screen must be removed and cleaned at regular intervals. The screen should be removed and cleaned thoroughly by immersing it in solvent and blowing it dry with compressed air. Light oil strainers should be cleaned each month. Heavy oil strainers should be checked and cleaned as often as the experience indicates the necessity.

5.12 — Gas System

⚠ Caution

All power must be disconnected before servicing the valves.

5.12.1 — Motorized Main Gas Valves

Should the valve fail to operate, check for voltage at the valve. Make certain that the main shutoff cock is closed prior to testing. The actuator is not field repairable nor should it be disassembled. Replace the actuator if the valve fails to operate. After replacement, cycle the valve with the fuel shutoff to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

5.12.2 — Solenoid Valves

A slight 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 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 manufacturer's bulletin for correct procedure in coil replacement.

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

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

5.13 — Electrical System

Because of the many types of flame safeguard systems applicable to this equipment, complete descriptions of all E Series burner electrical systems are beyond the scope of this manual. An individual electrical schematic drawing is shipped with each burner and complete operation and troubleshooting instructions are available from the various flame safeguard system manufacturers.

5.13.1 — Electric Motors

Motor supply voltage must not vary more than 10 percent from nameplate ratings. At initial startup and at least once a year thereafter, check the motor current with a meter while the burner is in high fire position. If the reading exceeds the nameplate rating plus service factor, determine the cause and correct it immediately. In dusty locations, clean the motor regularly to assure adequate cooling. Lubricate in accordance with the manufacturer's instructions.

5.14 — Extended Shutdown

When shutting down the burner for an extended period of time, the operator should use the following general guidelines to protect the burner from its surrounding elements. This will add to the operating 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. Remove the flame safeguard control and store in a dry atmosphere.

5.15 — Recommended Maintenance Schedule

TABLE 1.

Item	Service By	Remarks
DAILY		
Gauges, Monitors, Indicators	Operator	Make visual inspection and record readings in log.
Instrument & 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 & Main Fuel Valves	Operator	Open limit switch. Make audible and visual check. Check valve position indicators, and 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 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 linkage for tightness. Tighten if required.
MONTHLY		
Low Fan Pressure Interlock	Operator	Manually adjust until switch opens.
High & Low Gas Pressure Interlocks	Operator	Refer to instructions. Manually adjust until switch opens.
Scanner & 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 adjustment.
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 lock out 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 trouble shooting that much easier. Costly down-time or delays can be prevented by systematic checks of actual operation against the normal sequence to deter-

mine the stage at which performance deviates from normal. Following a set routine may help to detect obvious conditions, often ones that are relatively simple to correct.

If an obvious condition is not apparent, check the 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 terminal on the terminal boards in the control cabinet or entrance box. Refer to the wiring schematic supplied for terminal identification.

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. Damage to the boiler or serious personal injury or death may result.

⚠ Warning

Do not relight 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 follow these instructions could 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 shut off 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 re-starting the unit. Follow instructions in Chapter 3 for starting and operating.

6.3 — Problem/Possible Causes

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. Fuel valve interlock circuit not completed. a. Fuel valve auxiliary switch not closed.
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.
	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.

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. 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.
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. Orifice gate valve accidentally opened (heavy oil).
	8. Interlock device inoperative or defective.
	9. Air in the oil lines. Bleed lines.

Problem	Possible Causes
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 Accessories

7.1 — Overview

The Profire E Series burners are available with a wide selection of accessories. This section will cover some of the most popular accessories.

7.2 — Steam Atomizing System

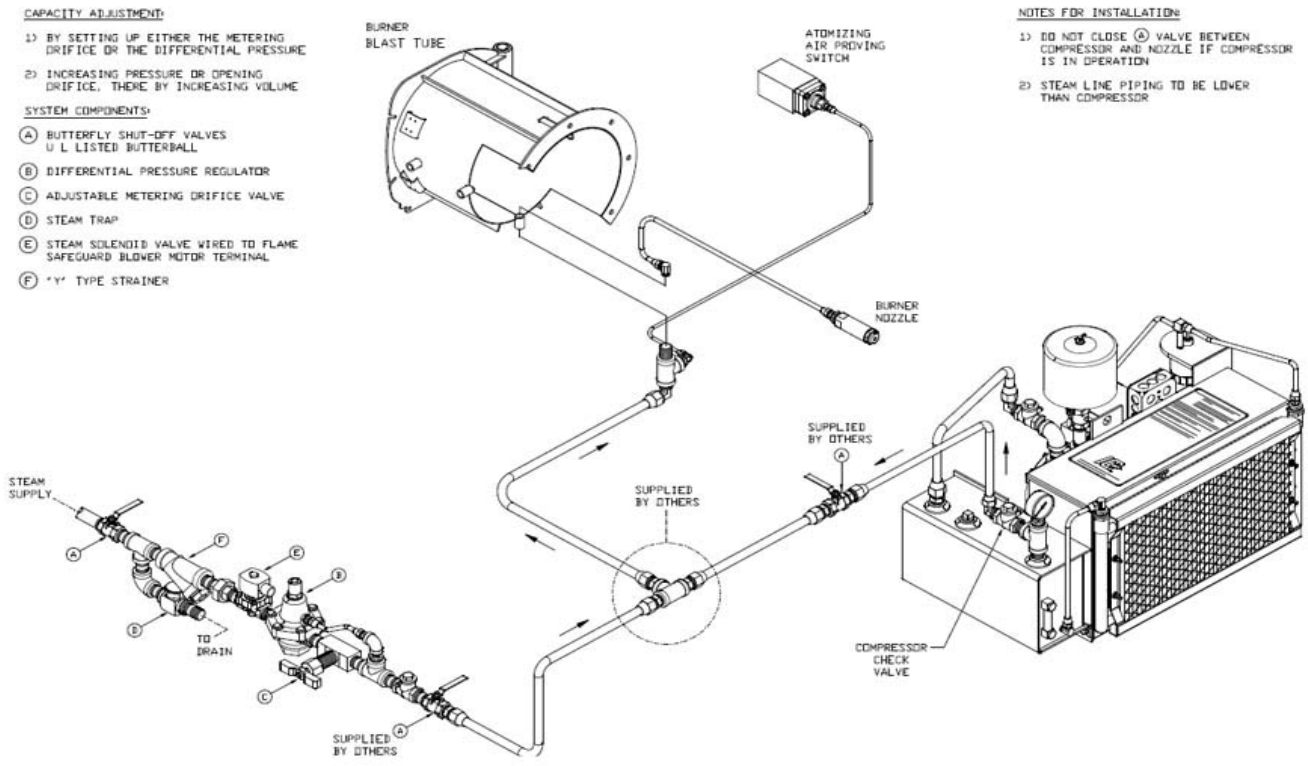
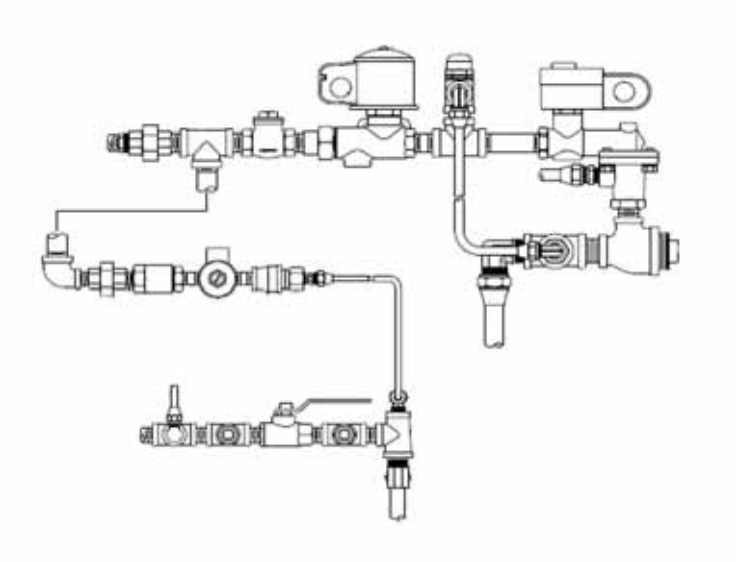


FIGURE 7-1. Steam Atomizing System

The steam atomizing line is shipped loose and must be piped and wired to the burner as shown in the diagram below. Refer to the wiring diagram for the electrical connection. The air compressor is used for cold oil startup. Start the boiler with the air atomizing system first. Once the boiler reaches operating pressure, shut down the unit, close the shut-off valve on the air line and open the one on the steam line. Set the Air / Steam switch to the Steam position. Restart the unit with the steam atomizing system. You must have a minimum of 70 PSI at the inlet of the steam regulator. Open the needle valve to its maximum. Adjust your steam pressure with the regulator to have 30 PSI on the discharge side of the regulator. While the unit is purging, screw in and adjust the needle valve to have 10-15 PSI in low fire. Install a pressure gauge to monitor the pressure. One or two regulator is supplied depending on the boiler operating steam pressure. Follow the instructions in the Chapter 4, Adjustments, to set up the burner. Fine tune the steam atomizing with the needle valve.

7.3 — Air Purge System (optional)



The nozzle line air purge option is used to purge the oil out of the nozzle line using the air compressor on a burner shutdown. The air purge line is mounted and piped on the burner. The air line from the compressor to the air purge line is by others.

FIGURE 7-2. Air Purge System

7.4 — Plant Air System

The E Series burners are able to operate with a plant air system instead of the standard IC compressor. In such cases, the burner is supplied with an atomizing air regulating line.

Adjust the air pressure with the regulator and fine tune with the needle valve to have 10-15 psi on low fire. Refer to Chapter 4 to setup the burner.

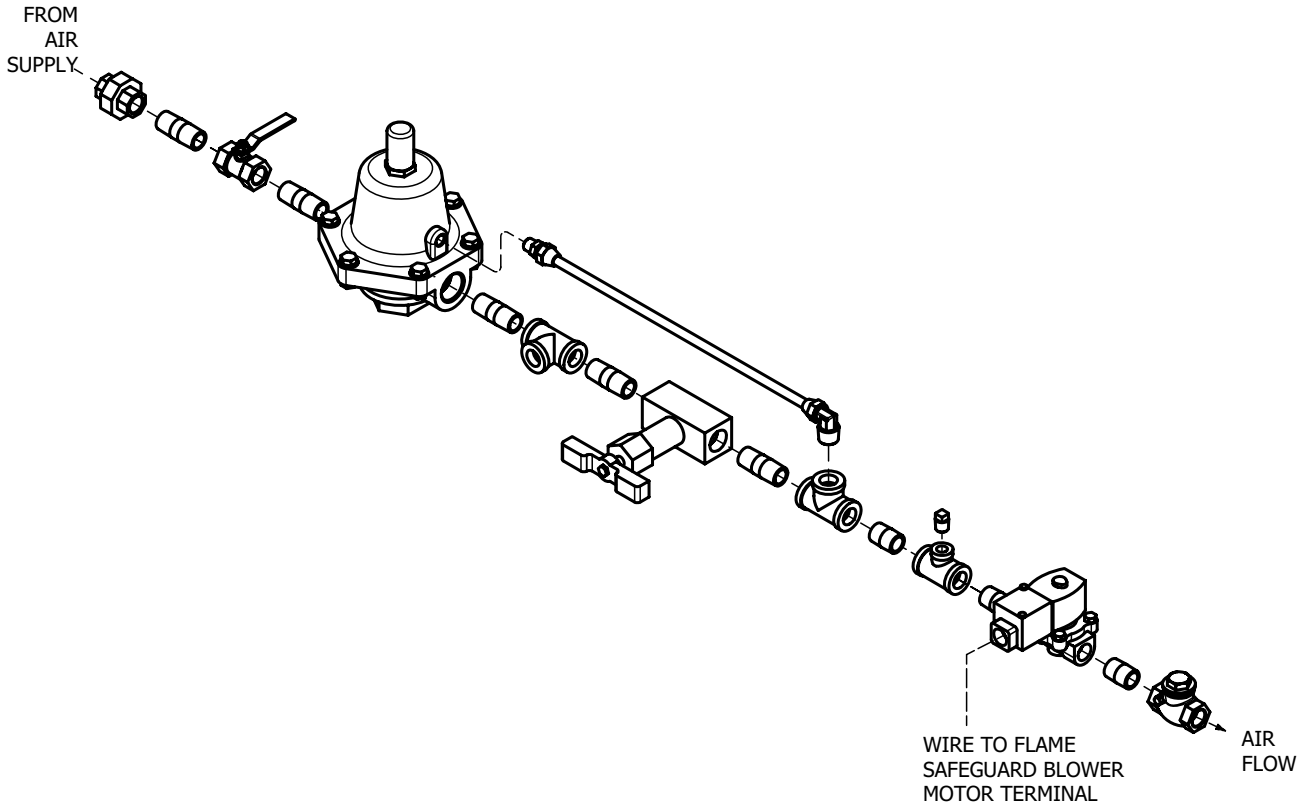
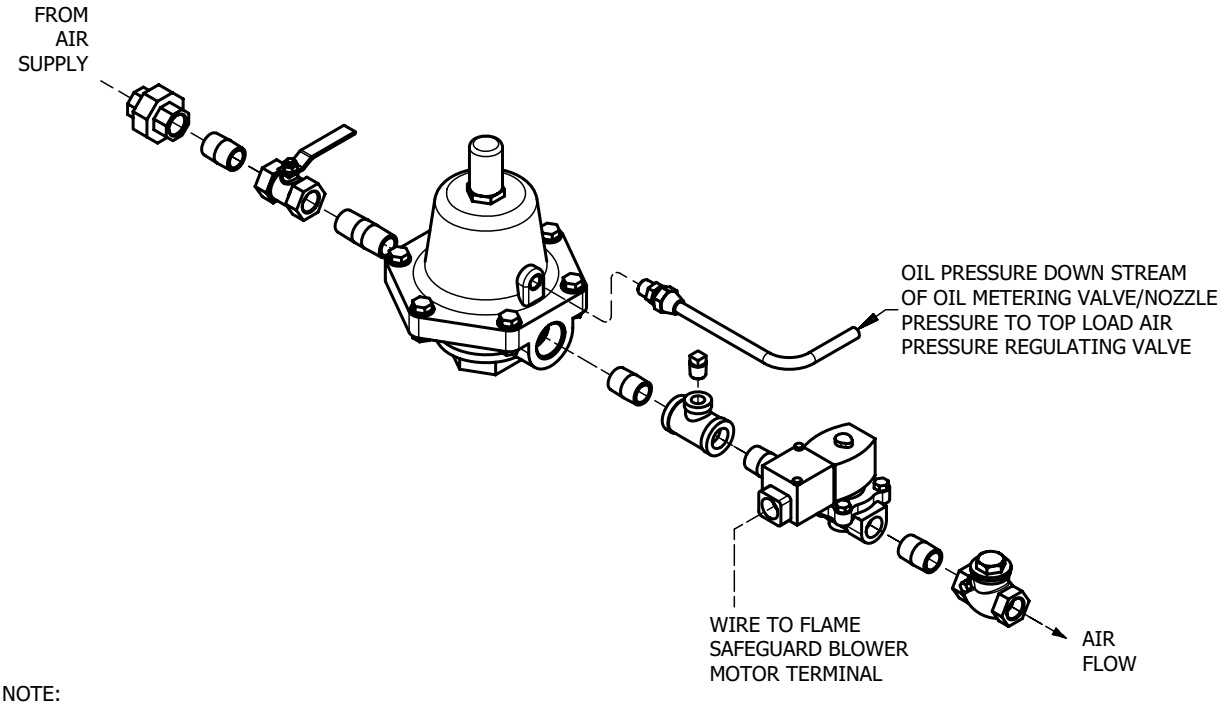


FIGURE 7-3. Plant Air System/Top Loaded with Air



NOTE:
1 - AIR PRESSURE REGULATOR SHOULD HAVE TRIM KIT
TO ALLOW OIL OVER REGULATOR

FIGURE 7-4. Plant Air System/Top Loaded with Oil

CHAPTER 8 LNE Series FGR System

NOTE: Check all burner and FGR wiring before operating the unit. Turn all power off when working with any wiring. Power must be turned off at the disconnect to the boiler. Boiler operation and FGR adjustment must be done by a qualified Cleaver-Brooks service representative.

8.1 — Description

The Profire Flue Gas Recirculation (FGR) system is designed to reduce NO_x emissions from boilers retrofitted with Profire burners by adding a percentage of flue gas to the combustion process. A burner combustion air fan is used to pull flue gas from the stack through the FGR duct and inject it into the combustion zone.

Typical sizing for the FGR ducts are shown in Figure 8-4. All FGR duct piping should be covered with a minimum of 2" of insulation, and supported as required. The following controls are used in the FGR duct for safe operation of the system.

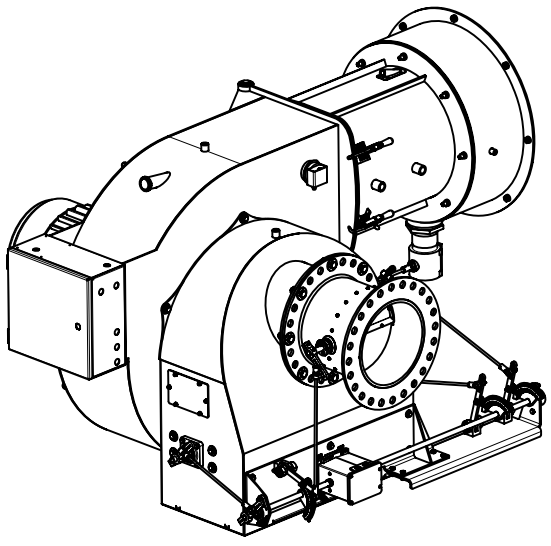


FIGURE 8-1. General Layout of the Burner

8.2 — FGR Shutoff Valve

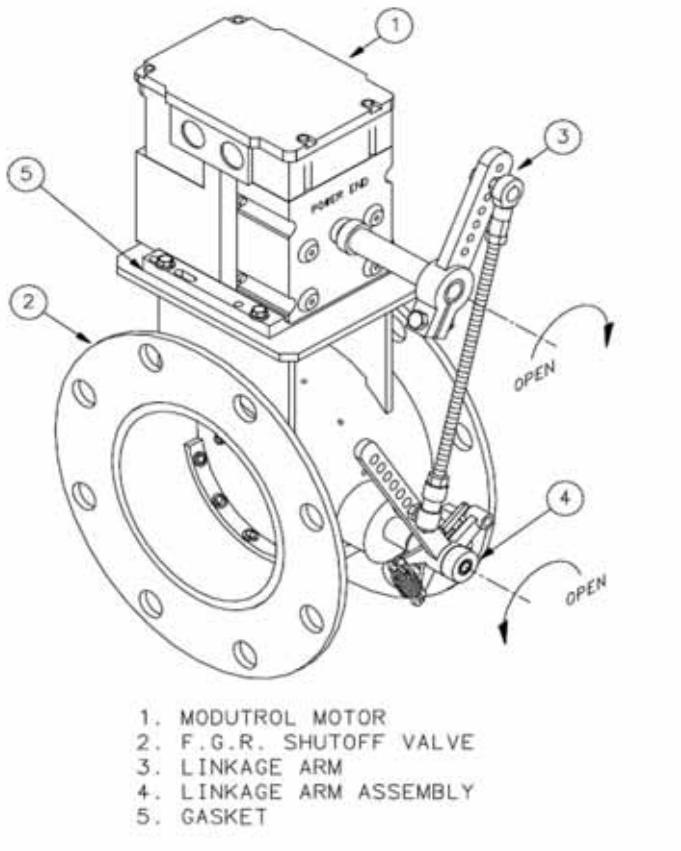


FIGURE 8-2. FGR Shutoff Valve

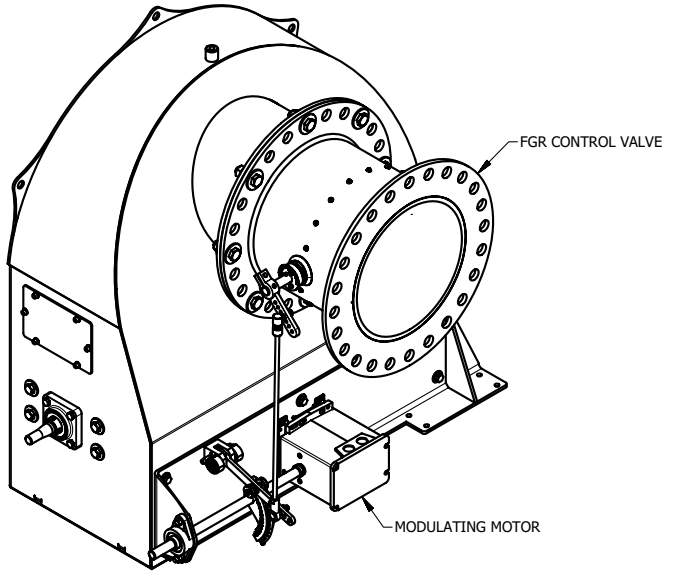
The FGR Shutoff valve is located as close to the stack as possible. A modutrol motor with a 90º stroke opens and closes the FGR shutoff valve in 15 seconds. Proof of closure for the shutoff valve is provided by an auxiliary switch in the modutrol motor. The modutrol motor has a maximum temperature rating of 150º F. This valve should never be mounted with the motor shaft in a vertical position. Damage to the modutrol motor will result. During pre-purge and post-purge, the FGR shutoff valve is closed to prevent any unused gas fumes from returning to the combustion zone.

8.3 — FGR Control Valve

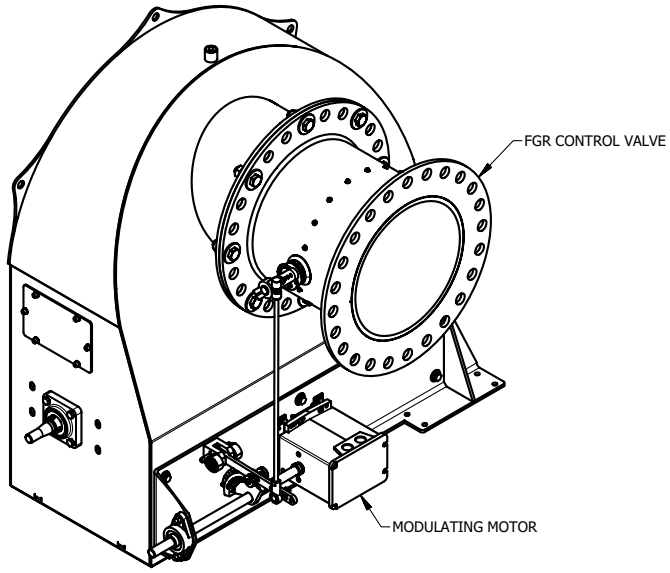
⚠ Warning

Before starting the boiler, make sure the control valve is closed. The boiler must never be operated if the control valve is open. This will result in hot combustion gases flowing backwards in the system. This will damage the system and can cause bodily harm.

The FGR control valve is mounted to the FGR damper on the burner. A burner mounted modutrol motor with link- age connections coordinates the air, fuel and NO_x control devices to provide proper fuel/air/NO_x ratios through the firing range. The modutrol motor must be able to complete its full travel range. Restrictions will damage the motor and/or the linkage. Linkage consists of adjustable levers, rods and ball joints that transmits motion from the modutrol motor to the FGR control valve. Lever and rod adjustments should be made with the motor in the low fire position. The angles of the driven levers on the modutrol motor jackshaft can be adjusted to vary the rate of change. The closer the rod is to the level, hub, the less distance the rod and control valve blade will travel.



FGR - LOW FIRE



FGR - HIGH FIRE

FIGURE 8-3. FGR Control Valve and Control Positions

8.4 — Air/FGR Damper Assembly

The Air/FGR damper regulates the volume of combustion air. Position of the rotary damper blade is controlled by a modutrol motor.

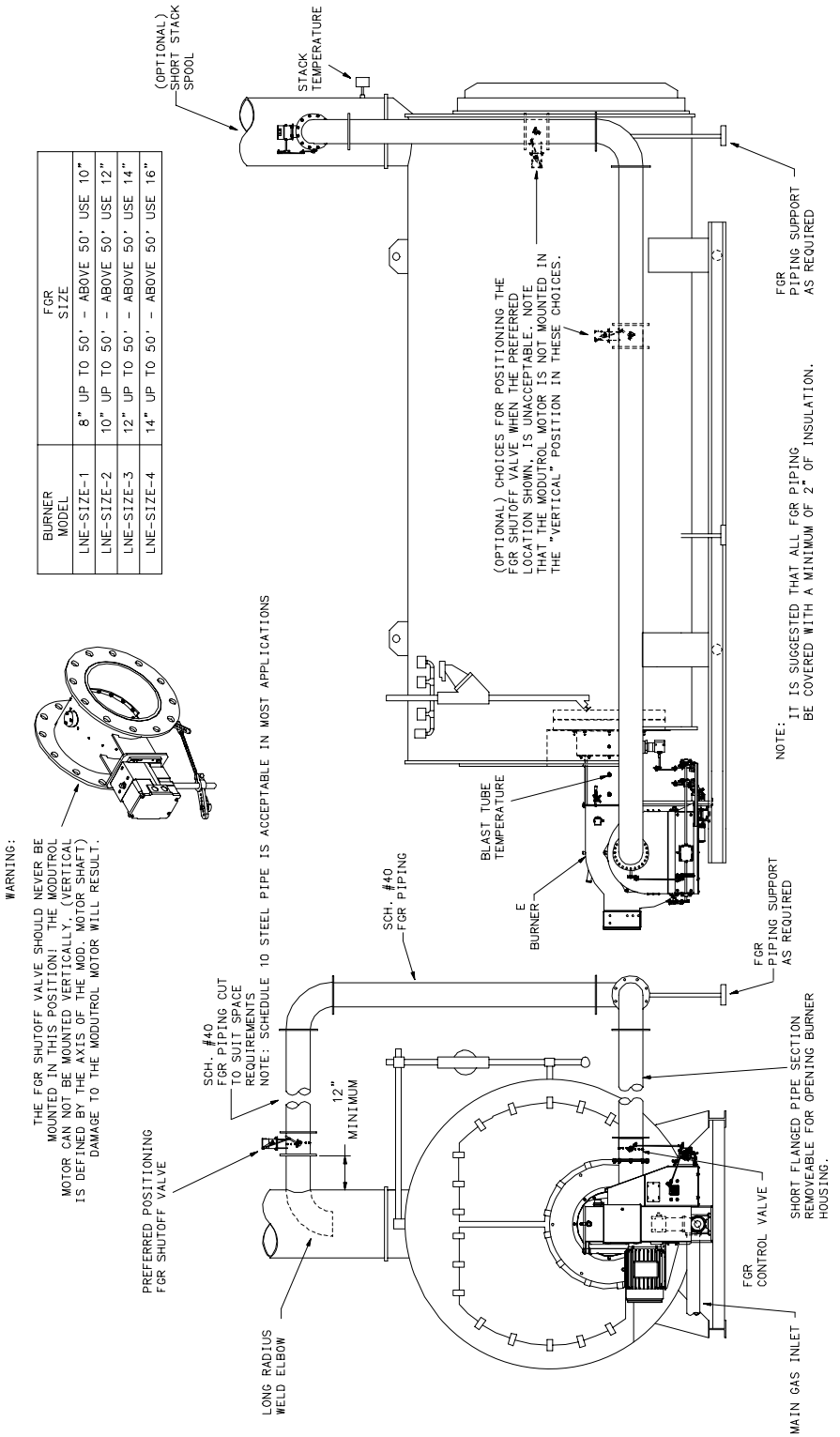
The damper blade in the low fire position is normally approximately 1" open at low fire. The Air/FGR damper and FGR control valve blades open as the modutrol motor drives toward the high fire position where flue gas is pulled into the regulated combustion air flow above the damper blade as controlled by the FGR control valve. Combustion air mixed with flue gas is passed on through the blast tube to the combustion zone.

8.5 — Blast Tube Temperature Interlock

An optional blast tube temperature interlock device monitors air temperature in the blast tube area of the burner. If the blast tube temperature rises above 200º F maximum. An external scanner is used on the low emission burners.

8.6 — Stack Temperature Interlock

An optional stack temperature interlock device monitors flue gas temperature in the stack. The stack temperature interlock is used as a low fire hold device. The stack temperature interlock is set at 25 degrees F below the minimum stack temperature at low fire (nominal 200º F). After the stack temperature rises above the set point, the interlock closes and allows the burner to modulate.



BURNER MODEL	FGR SIZE
LNE-SIZE-1	8" UP TO 50' - ABOVE 50' USE 10"
LNE-SIZE-2	10" UP TO 50' - ABOVE 50' USE 12"
LNE-SIZE-3	12" UP TO 50' - ABOVE 50' USE 14"
LNE-SIZE-4	14" UP TO 50' - ABOVE 50' USE 16"

FIGURE 8-4. Temperature Interlocks

Minimal Pipe Size (Schedule 10 Pipe)								
Burner Model	**Maximum Feet From Burner to Boiler Stack**							
	20'	**30'**	**40'**	**50'**	**75'**	**100'**	**150'**	**200'**
LNE-84	8"	8"	8"	8"	10"	10"	10"	12"
LNE-105	8"	8"	8"	8"	10"	10"	10"	12"
LNE-126	8"	8"	8"	8"	10"	10"	10"	12"
LNE-147	8"	8"	8"	8"	10"	10"	10"	12"
LNE-168	10"	10"	10"	10"	12"	12"	14"	14"
LNE-210	10"	10"	10"	10"	12"	12"	14"	14"
LNE-252	10"	10"	10"	10"	12"	12"	14"	14"
LNE-294	12"	12"	12"	12"	14"	14"	16"	16"
LNE-336	12"	12"	12"	12"	14"	14"	16"	16"
LNE-378	12"	12"	12"	12"	14"	14"	16"	16"
LNE-420	12"	12"	12"	12"	14"	14"	16"	16"

Equivalent Lineal Feet for Schedule 10 Pipe Fittings							
Pipe Fittings	Nominal Pipe Size						
	6"	8"	10"	12"	14"	16"	18"
45º Elbow	8.0'	10.7'	13.3'	16.0'	18.7'	21.3'	24.0'
90º Elbow	15.0'	20.0'	25.0'	30.0'	35.0'	40.0'	45.0'
LG R 90 Elbow	10.0'	13.5'	17.0'	20.0'	23.5'	26.7'	30.0'

Schedule 40 pipe pressure drops will be slightly higher/greater.

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 Cleaver-Brooks 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)

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.