

V/LNV SERIES

Installation, Operation, and Service Manual

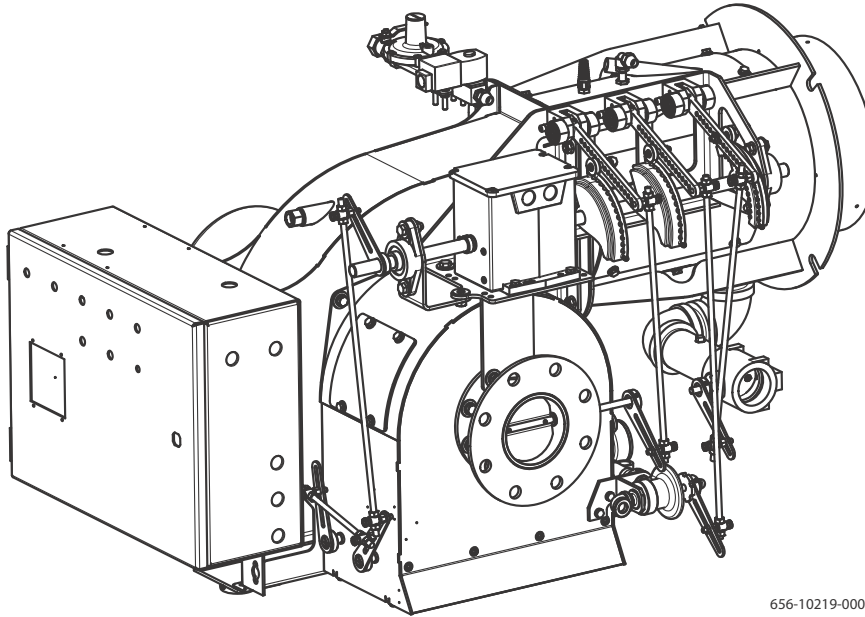


 WARNING

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

V/LNV SERIES

Installation, Operation, and Service Manual



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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-Pressure Atomization
VG	Gas
VL	#2 Oil
VLG	#2 Oil and Gas
LNVG	Gas
LNVLG	#2 Oil and Gas

Model Example: The model number on the nameplate is VLG-45, No. 2 oil and gas burner with input rated at 4,500 MBtu/hr, against furnace pressures up to 2.0" W.C. at 60hz.

NOTE: Firing at higher furnace pressures de-rates the burner by approximately 5% per 1/2 inch of additional pressure. Consult with the factory.

Warning

Burner linkages, cams, fuel metering valves and positioning motors have not been pre-set by the factory for proper combustion and must be set by a qualified and authorized technician. Failure to follow this procedure could result in property damage and personal injury.

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 V 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 VG-VL-VLG Series: Gas, #2 Oil, Gas/Oil Configuration										
Burner Model	Gas Input MBtu/hr	#2 Oil Input US GPH	BHP @80% Eff.	Furnace Pressure ("W.C.)	Blower Motor HP ¹	Blower Motor HP ²	Remote Oil Pump Motor HP ³	Standard Gas Train Pipe Size (in.)	Min. Gas Pressure ("w.c.)	Blower Motor Volt/PH 60 Hz.
V-13-1	1,300	9.3	31	0.4	1/2	3/4	1/2	1	8.6/9.2 ⁵	115/230/1
V-15-1	1,500	10.7	36	0.5	1/2	3/4	1/2	1	11.4/11.7 ⁵	115/230/1
V-17-1	1,700	12.1	40	0.7	1/2	3/4	1/2	1	14.3/14.7 ⁵	115/230/1
V-20-1	2,000	14.3	48	0.9	3/4	1	1/2	1	19.7/20.2 ⁵	115/230/1
V-21-1	2,100	15.0	50	1.0	3/4	1	1/2	1	21.5/22.1 ⁵	115/230/1
V-25-1	2,500	17.9	60	1.2	3/4	1	1/2	1 1/2	9.6/10.4 ⁵	115/230/1
V-30-1	3,000	21.4	71	1.4	3/4	1	1/2	2	8.7	115/230/1
V-34-1	3,400	24.3	81	1.8	3/4	1	1/2	2	10.3	115/230/1
V-35-2	3,500	25.0	83	1.9	1	1 1/2	1/2	2	8.1	115/230/1
V-40-2	4,000	28.6	95	1.2	1	1 1/2	1/2	2	10.4	115/230/1
V-42-2	4,200	30.0	100	1.3	1 1/2 ⁴	2	1/2	2	11.5	208/230/460/3
V-45-2	4,500	32.1	107	1.4	2	2	1/2	2	10.8	208/230/460/3
V-50-2	5,000	35.7	119	1.8	2	3	3/4	2	13.6	208/230/460/3
V-54-2	5,400	38.6	129	2.1	3	3	3/4	2	19.2	208/230/460/3
V-55-2	5,500	39.3	131	2.2	3	3	3/4	2	19.7	208/230/460/3
V-60-3	6,000	42.9	143	2.7	5	-	3/4	2	17.6	208/230/460/3
V-63-3	6,300	45.0	150	1.8	5	-	3/4	2	19.4	208/230/460/3
V-70-3	7,000	50.0	167	2.2	5	-	3/4	2 1/2	15.8	208/230/460/3
V-80-3	8,000	57.1	190	2.8	5	-	1	2 1/2	15.1	208/230/460/3
V-84-3	8,400	60.0	200	3.1	7 1/2	-	1	2 1/2	15.5	460/3
V-90-3	9,000	64.3	214	3.5	7 1/2	-	1 1/2	2 1/2	17.4	460/3
V-100-3	10,000	71.4	238	2.7	10	-	1 1/2	2 1/2	20.5	460/3
V-105-3	10,500	75.0	250	2.8	10	-	1 1/2	2 1/2	44.7	460/3
V-110-3	11,000	78.6	262	3.0	10	-	1 1/2	2 1/2	48.7	460/3
V-120-4	12,000	85.7	286	3.6	15	-	1 1/2	2 1/2	34.2	460/3
V-126-4	12,600	90.0	300	4.3	15	-	1 1/2	2	49.1	460/3
V-147-4	14,700	105.0	350	4.3	15	-	1 1/2	2	2.5 PSI	460/3
V-168-4	16,800	120.0	400	1.0	15	-	1 1/2	2	3.1 PSI	460/3

¹ Motor ratings for gas only or gas/oil burners using a remote oil pump

² Motor ratings for oil only and gas/oil burners using a direct drive oil pump

³ Remote oil pump is optional for frame size 1 and 2 but standard for frame sizes 3 and 4. All pump motors are 115/230/1

⁴ 1 1/2 HP blower motor voltage is 115/230/1

⁵ Low/High and Full Modulation minimum gas pressure

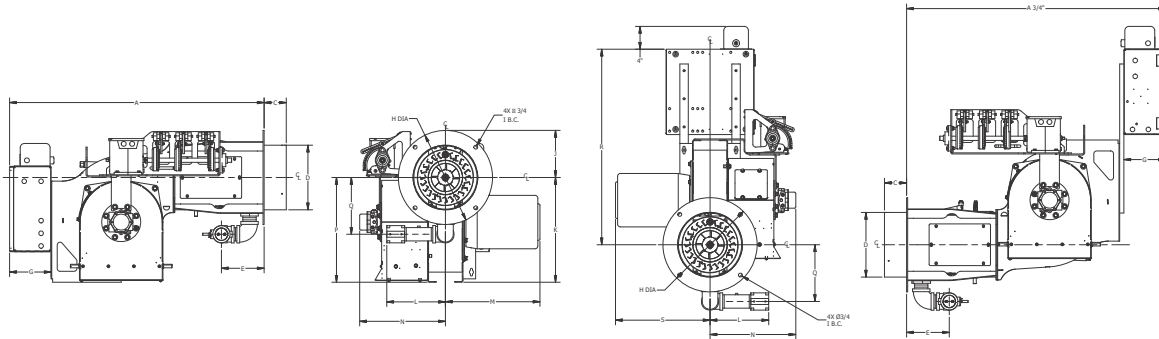
⁶ Lower gas supply pressure configurations available for New York City requirements

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. For total pressure at manifold, add furnace pressure. Oil input based on 140,000 BTU/gal. Consult factory for 50 Hz. applications.

<30 PPM Low NOx Standard Specifications for LNVG-LNVLG Series: Gas, Gas/Oil Configuration										
Burner Model	Gas Input MBtu/hr	#2 Oil Input US GPH	BHP @80% Eff.	Furnace Pressure ("W.C.)	Blower Motor HP	Remote Oil Pump Motor HP	Standard Gas Train Pipe Size (in.)	Min. Gas Pressure ("w.c.)	FGR Line Piping (in.)	Blower Motor Volt/PH 60 Hz.
LNV-13-1	1,300	9.3	31	0.5	3/4	1/2	1	9.2	4	115/230/1
LNV-15-1	1,500	10.7	36	0.6	3/4	1/2	1	11.7	4	115/230/1
LNV-17-1	1,700	12.1	40	0.7	3/4	1/2	1	14.7	4	115/230/1
LNV-20-1	2,000	14.3	48	1.0	3/4	1/2	1	20.2	4	115/230/1
LNV-21-1	2,100	15.0	50	1.1	3/4	1/2	1	22.1	4	115/230/1
LNV-25-1	2,500	17.9	60	1.4	3/4	1/2	1 1/2	10.4	4	115/230/1
LNV-30-2	3,000	21.4	71	1.5	2	1/2	2	8.7	4	115/230/460/3
LNV-34-2	3,400	24.3	81	1.9	3	1/2	2	10.3	4	115/230/460/3
LNV-35-2	3,500	25.0	83	2.0	3	1/2	2	8.1	4	115/230/460/3
LNV-40-2	4,000	28.6	95	1.4	3	1/2	2	10.4	4	115/230/460/3
LNV-42-2	4,200	30.0	100	1.5	3	1/2	2	11.5	4	208/230/460/3
LNV-45-2	4,500	32.1	107	1.6	3	1/2	2	10.8	4	208/230/460/3
LNV-50-2	5,000	35.7	119	2.0	3	1/2	2	13.6	4	208/230/460/3
LNV-54-3	5,400	38.6	129	2.4	5	3/4	2	19.2	4	208/230/460/3
LNV-55-3	5,500	39.3	131	2.5	5	3/4	2	19.7	4	208/230/460/3
LNV-60-3	6,000	42.9	143	3.0	5	3/4	2	17.6	4	208/230/460/3
LNV-63-3	6,300	45.0	150	2.0	5	3/4	2	19.4	4	208/230/460/3
LNV-70-3	7,000	50.0	167	2.5	7 1/2	3/4	2 1/2	15.8	4	460/3
LNV-80-3	8,000	57.1	190	3.2	7 1/2	3/4	2 1/2	15.1	4	460/3
LNV-84-3	8,400	60.0	200	3.5	7 1/2	1	2 1/2	15.5	4	460/3
LNV-90-3	9,000	64.3	214	4.0	10	1	2 1/2	17.4	4	460/3
LNV-100-4	10,000	71.4	238	3.2	15	1 1/2	2 1/2	20.5	6	460/3
LNV-105-4	10,500	75.0	250	3.4	15	1 1/2	2 1/2	44.7	6	460/3
LNV-110-4	11,000	78.6	262	3.6	15	1 1/2	2 1/2	48.7	6	460/3
LNV-120-4	12,000	85.7	286	4.2	15	1 1/2	2 1/2	34.2	6	460/3
LNV-126-4	12,600	90.0	300	4.8	15	1 1/2	2	49.1	6	460/3
LNV-147-4	14,700	105.0	350	4.8	15	1 1/2	2	2.5 PSI	6	460/3

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. For total pressure at manifold, add furnace pressure. Oil input based on 140,000 BTU/gal. Consult factory for 50 Hz. applications.

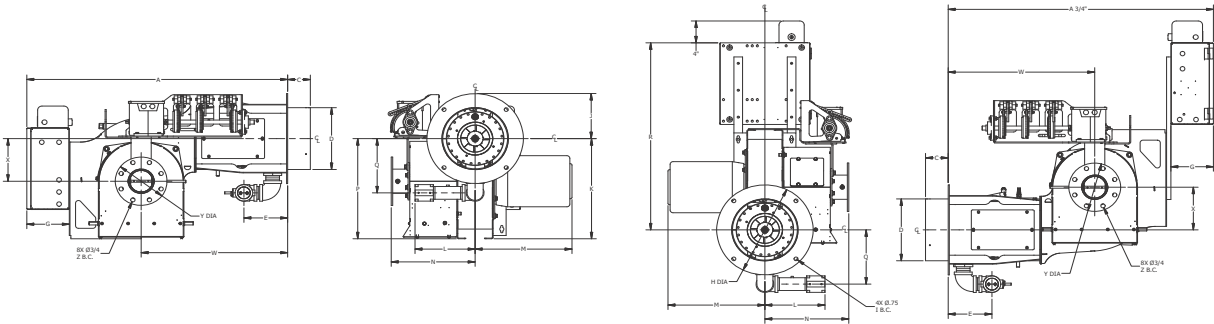
V Series Standard Dimensions - Uncontrolled NOx Configuration



Accompanying dimensions are for layout purposes only.

		Burner Frame Size & Model Number			
	DIM	Size 1	Size 2	Size 3	Size 4
Length in inches					
Overall length	A	37 1/4	40 3/8	45 1/4	51 1/8
Width in inches					
Center line to right side (standard)	M	14	13 5/8	16 7/8	21 7/8
Center line to left side (standard)	N	12 7/16	13 7/8	15 1/4	15 1/4
Center line to right side (inverted)	N	12 7/16	13 7/8	15 1/4	15 1/4
Center line to left side (inverted)	S	14	13 5/8	16 7/8	21 7/8
Height in inches					
Center line to top (standard)	J	9 1/2	9 1/8	8 3/8	9 3/4
Center line to bottom (standard)	K	11 3/4	14 7/16	18 5/8	19 1/4
Center line to burner support (standard)	P	11 3/4	14 7/16	18 5/8	19 1/4
Center line to top (inverted)	R	28	30 5/8	34 3/4	35 1/2
Center line to CL of main gas inlet (inverted)	Q	6 7/8	8 7/8	10 1/8	11 3/4
Blast tube dimensions in inches					
Extension (standard)	C	4	4	4	5
Extension (maximum)	C	5	5	5	6
Diameter	D	8 1/4	10	11 1/2	13 5/8
Panel box depth in inches					
Panel box depth	G	7 3/8	7 3/8	7 3/8	7 3/8
Mounting flange dimensions in inches					
Diameter	H	12 7/8	15	16 3/4	17 1/2
Bolt circle diameter	I	11 1/4	13 1/4	15 1/4	15 3/8
Gas inlet measurement in inches					
Center line to main gas inlet	L	9 5/8	9 5/8	10 1/2	11
Mounting flange to main gas inlet	E	6 7/8	7 1/4	7 5/8	9 1/2

V Series Standard Dimensions - <30 PPM Low NOx Configuration



Accompanying dimensions are for layout purposes only.

		Burner Frame Size & Model Number			
	DIM	Size 1	Size 2	Size 3	Size 4
Length in inches					
Overall length	A	37 1/4	40 3/8	45 1/4	51 1/8
Width in inches					
Center line to right side (standard)	M	14	13 5/8	16 7/8	21 7/8
Center line to left side (standard)	N	12 7/16	13 7/8	14 5/8	17
Center line to right side (inverted)	N	12 7/16	13 7/8	14 5/8	17
Center line to left side (inverted)	S	14	13 5/8	16 7/8	21 7/8
Height in inches					
Center line to top (standard)	J	9 1/2	9 1/8	8 3/8	9 3/4
Center line to bottom (standard)	K	11 3/4	14 7/16	18 5/8	19 1/4
Center line to burner support (standard)	P	11 3/4	14 7/16	18 5/8	19 1/4
Center line to top (inverted)	R	28	30 5/8	34 3/4	35 1/2
Center line to CL of main gas inlet (inverted)	Q	6 7/8	8		
Blast tube dimensions in inches					
Extension (standard)	C	4	4	4	5
Extension (maximum)	C	5	5	5	6
Diameter	D	8 1/4	10	11 1/2	13 5/8
Panel box depth in inches					
Panel box depth	G	7 3/8	7 3/8	7 3/8	7 3/8
Mounting flange dimensions in inches					
Diameter	H	12 7/8	15	16 3/4	17 1/2
Bolt circle diameter	I	11 1/4	13 1/4	15 1/4	15 3/8
Gas inlet measurement in inches					
Center line to main gas inlet	L	9 5/8	9 5/8	10 1/2	11
Mounting flange to main gas inlet	E	6 7/8	7 1/4	7 5/8	9 1/2
Flue gas recirculation (FGR) in inches					
Center line of FGR to mounting flange	W	20 1/4	22 1/8	25 1/2	30 1/4
Center line of burner to center line of FGR	X	4	5 1/4	8	7 1/4
Diameter	Y	9	9	9	11
Bolt circle diameter	Z	7 1/2	7 1/2	7 1/2	9 1/2

V/LNV Series

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WARRANTY POLICY

STARTUP/SERVICE REPORT

1.1 — Overview

V series burners are assembled, wired, and tested at the factory. They are listed by the Underwriters Laboratory (UL), CSD-1, NFPA-85, Factory Mutual (FM), 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 startup, adjust, or service this equipment.

Warning

Burner linkages, cams, fuel metering valves and positioning motors have not been pre-set by the factory for proper combustion and must be set by a qualified and authorized technician. Failure to follow this procedure could result in property damage and personal injury.

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

The burners are available in the following configurations:

	Standard Configuration	Optional Configuration
V13-25	On-Off	Low-High-Off (LHO), Low-High-Low (LHL) or Full Modulation
V30-63	Low-High-Off (LHO)	Low-High-Low (LHL) or Full Modulation
V70-168	Full Modulation	None

1.3 — Operating Controls

1.3.1 — Control Panel

The burner control panel may be integral to the burner or remote, and contains: a flame safeguard programming control, motor relays (starters), and terminal strips mounted internally on a panel subbase. Lights, switches, and a control circuit breaker are mounted externally on the panel.

The following table lists typical panel items. Some or all of the items may be provided depending on the burner configuration selected.

Control	Description
On-Off Burner Switch	To manually turn the burner on or off.
Fuel Selector Switch	Gas-Off-Oil Gas position: Selects gas as the firing fuel. Off position: Burner is off. Oil position: Selects oil as the firing fuel.
Control Circuit Breaker	Supplementary low overcurrent protection only. No larger than 15 amps.
Auto-Manual Modulation Selector Switch	Auto position: Selects boiler modulation control. In this position, the burner will operate automatically in response to load demand. Manual position: Selects 135 ohm potentiometer for manual modulating control.
Manual Modulating Control	135 ohm (for full modulation burners only) 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 the pilot valve is energized (opened). c) MAIN FUEL (green): illuminates when the main fuel valve or valves are energized (open). d) FLAME FAILURE (red): illuminates when the flame safeguard system fails to detect pilot or main flame.



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.

1.3.2 — Flame Safeguard Controls

The flame safeguard controls the burner's operating sequence: pre purge, trial for ignition, main flame and shutdown. This safety control also includes flame detection system to confirm proper operation or cause a manual-reset lockout in the event of a pilot or main flame failure. External controls connected to the flame control's limit circuit, such as the boiler operating control, will trigger normal burner startup, and upon reaching operating set point, normal burner shutdown. Safety devices in the flame control's running interlock circuit, such as the combustion air switch, will cause an immediate safety shut down if conditions are not correct for safe operation. Reference the manufacturer's literature for additional information on either the flame safeguard control or other safety controls.

1.3.3 — Firing Rate Controls (LHL & Full Modulation Burners)

LHL burners use a two position actuator* and linkage to control the air and gaseous fuels (oil burners control oil flow with electric valves). At startup fire, the air damper and fuel valves are positioned for stable low fire operation. When the actuator is commanded to its second position, the linkage drives the air damper and fuel valves open until high fire is reached. LHL burners typically use a boiler-mounted control that keeps the burner at its low fire rate to prevent thermal shock, until conditions are suitable for high fire.

Full modulation burners are capable of firing at any rate between the burner's low and high fire limits. For "single point" modulating systems, a single rotary actuator controls both air and fuel volume via control arms and linkage attached to its shaft. As the actuator rotates from low to high fire, the linkage opens the air damper and fuel metering valves increase the firing rate. Optional "CAM" trim provides additional precision to the air/fuel mix with the use of several discrete set point adjustments across the modulation range. Further combustion efficiency may be achieved with the use of parallel positioning controls which use multiple directly-coupled actuators (linkeageless) to position the air damper, fuel metering valves and, if applicable, flue gas recirculation (FGR) across the modulation range.

1.4 — Combustion Air Handling System

Component	Description
Motor and Blower	The combustion air fan is driven by a 3450 rpm blower motor.
Air Volume Regulator	Air dampers are located in the air inlet housing. The dampers are mechanically linked and actuated by a two position motor or hydraulic cylinder for on-off operation. LHO, LHL or full modulation burners have the dampers mechanically linked to the modulating motor.
Combustion Air Proving Switch	A pressure sensitive differential switch actuated by air pressure created by the blower fan. Contacts close to prove combustion air flow.
Diffuser	Contained by the burner's firing head, an air flow diffuser shapes combustion air flow and improves flame stability.

1.4.1 — Boiler Room Combustion Air

When determining boiler room air requirements, the size of the room, airflow, and velocity of air must be reviewed as follows:

fpm: Feet per Minute

cfm: Cubic Feet per Minute

Size (area) and location of air supply openings in boiler room:	Two (2) permanent air supply openings in the outer walls of the boiler room are recommended. Locate one (1) at each end of the boiler room, preferably 7 foot or lower. This allows air to sweep the length of the boiler.
	A boiler room vent fan is not recommended. Under certain conditions, these fans can cause a light vacuum and “steal” combustion air from the burner resulting in unsatisfactory combustion performance.
	A vent fan in the boiler room is not recommended, as it could create a light vacuum under certain conditions and cause variations in the volume of combustion air. This can result in unsatisfactory burner performance.
	Under no condition should the total area of the air supply openings be less than (1) square foot.
	Size the openings by using the formula: $\text{Area (sq-ft)} = \text{cfm/fpm}$
Amount of air required (cfm):	Combustion Air = Rated bhp x 8 cfm/bhp.
	Ventilation Air = Maximum bhp x 2 cfm/bhp.
	Total recommended air = 10 cfm/bhp – up to 1000 feet elevation. Add 3% more per 1000 feet of added elevation.
Acceptable air velocity in Boiler Room (fpm):	From floor to (7) foot height – 250 fpm
	Above (7) foot height – 500 fpm

Example: Determine the area of the boiler room air supply openings for one (1) 300 hp boiler at 800 feet altitude. The air openings are to be 5 feet above floor level.

1. Air required: $300 \times 10 = 3000$ cfm
2. Air velocity: Up to 7 feet - 250 fpm
3. Area required: $\text{Area} = \text{cfm} = 3000/250 = 12$ sq-ft total
4. Area/Opening: $12/2 = 6$ sq-ft/opening (2 required)

1.5 — Firing Head

Two side access covers provide access to the firing head internal components.

The firing head configuration is dependent upon the heat exchanger it is attached to. Figure 1-1 shows a radial spud firing head typically used on watertube applications while Figure 1-2 illustrates a typical arrangement for firetube applications.

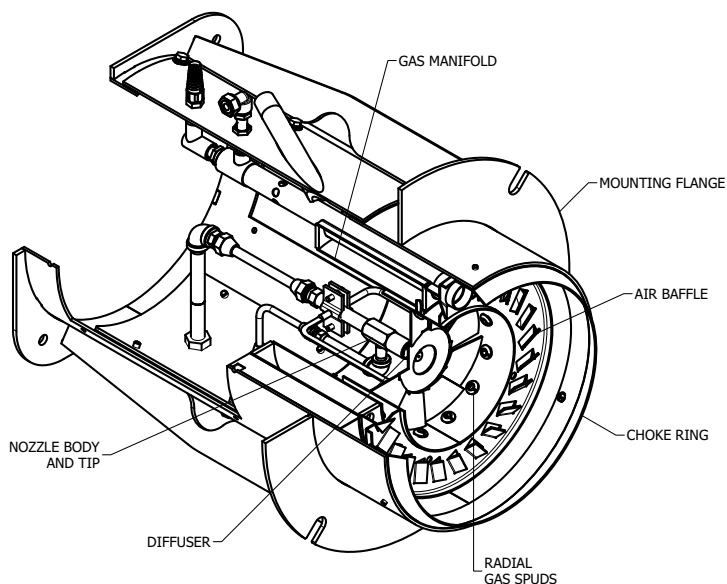


FIGURE 1-1. Burner Housing (Watertube Applications)

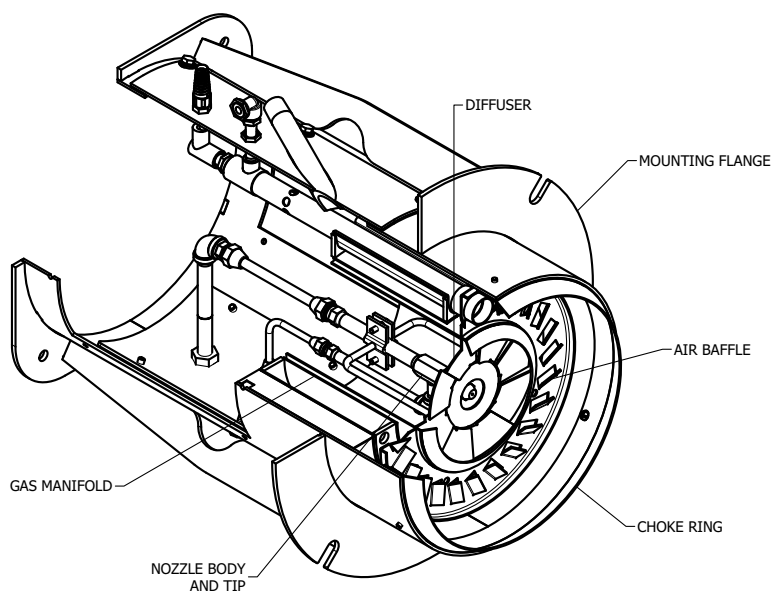


FIGURE 1-2. Burner Housing (Firetube Applications)

1.6 - Oil System

The V series burners pump high pressure fuel oil to the spray nozzle resulting in combustion-ready finely atomized oil spray.

1.6.1 — Oil System Components

Component	Description
Fuel Unit	Standard V13-55 have an oil pump flex-coupled to the blower motor; these units may be optionally equipped with a remote pump. The larger V60-168 use a remote pump with separate motor.
Oil Nozzle	Pump pressurized oil discharges from the nozzle in a fine conical spray pattern. The burner's nozzle is sized to provide the burner's high fire rate, rated gallons per hour (gph). Smaller gph nozzles may be used to match burner output to a heat exchanger's required input. Models V13-34 are supplied with simplex nozzles (return flow nozzles optional on V25-34). Models V35-168 are supplied with return flow nozzles.
Nozzle Adapter	A nozzle adaptor provides the means for connecting fuel lines with the nozzle.
Oil Solenoid Valves	Two normally closed (N.C.) and one normally open (N.O.) solenoid valves are part of the oil system on LHO and LHL burners. The two (2) N.C. valves provide positive shutoff of fuel oil while the one N.O. valve cycles the burner to high fire when closed.
Oil Metering Valve	The firing rate is controlled by an adjustable metering valve in the return line. At low fire, the metering valve is open, and is closed at high fire.
Oil Filter	The oil filter prevents foreign matter from entering the burner oil system. This item is provided as an option and shipped loose with the burner.

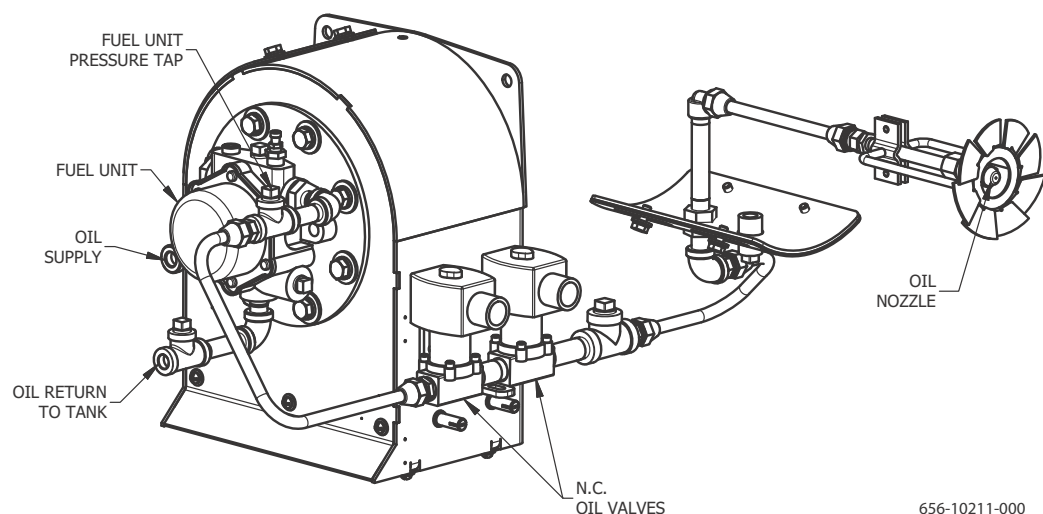


FIGURE 1-3. On-Off Oil System with Integral Pump & Simplex Nozzle (V13-25)

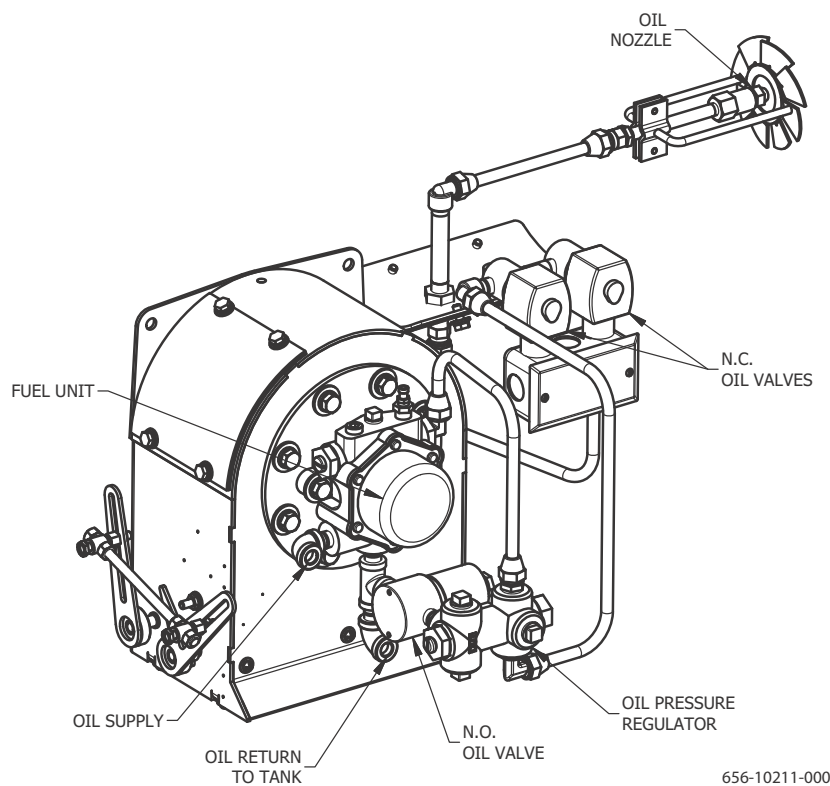


FIGURE 1-4. LHL Oil System with Integral Pump & Simplex Nozzle (V13-34)

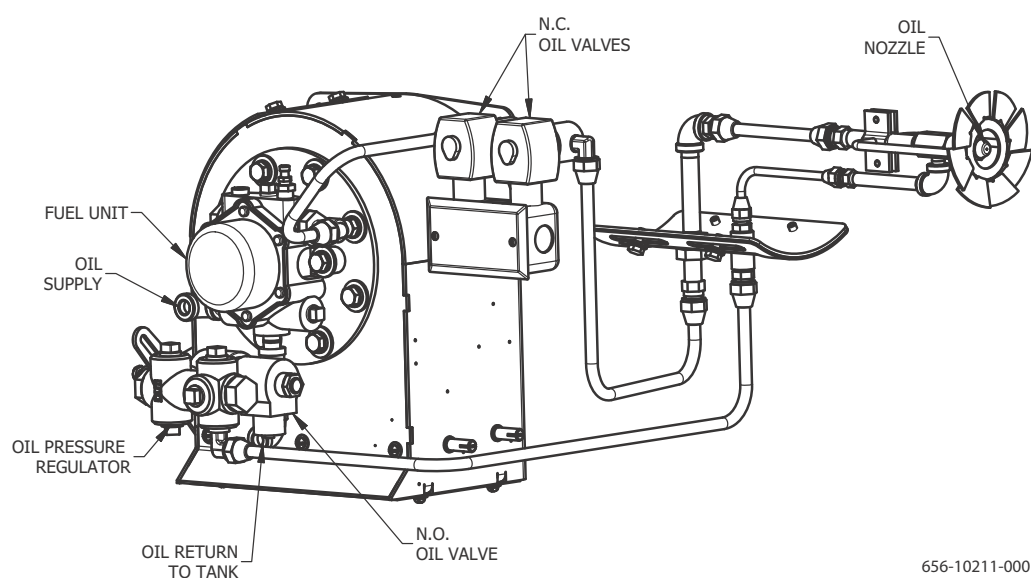


FIGURE 1-5. LHL Oil System with Integral Pump & Return Flow Nozzle (V13-55)

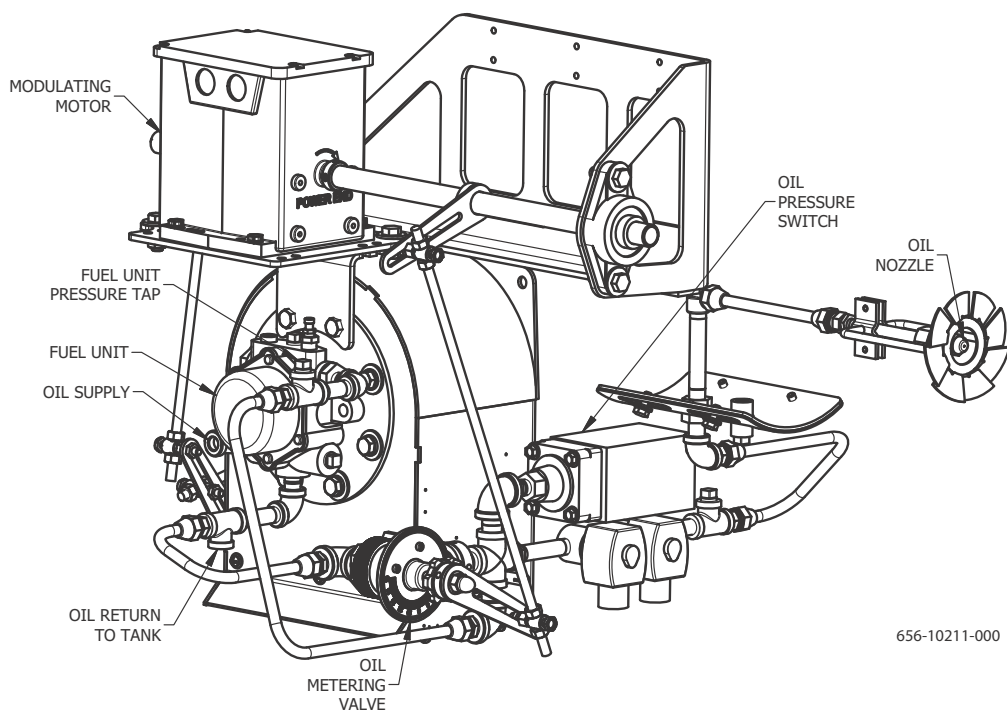


FIGURE 1-6. Full Modulation Oil System with Integral Pump & Simplex Nozzle (V13-34)

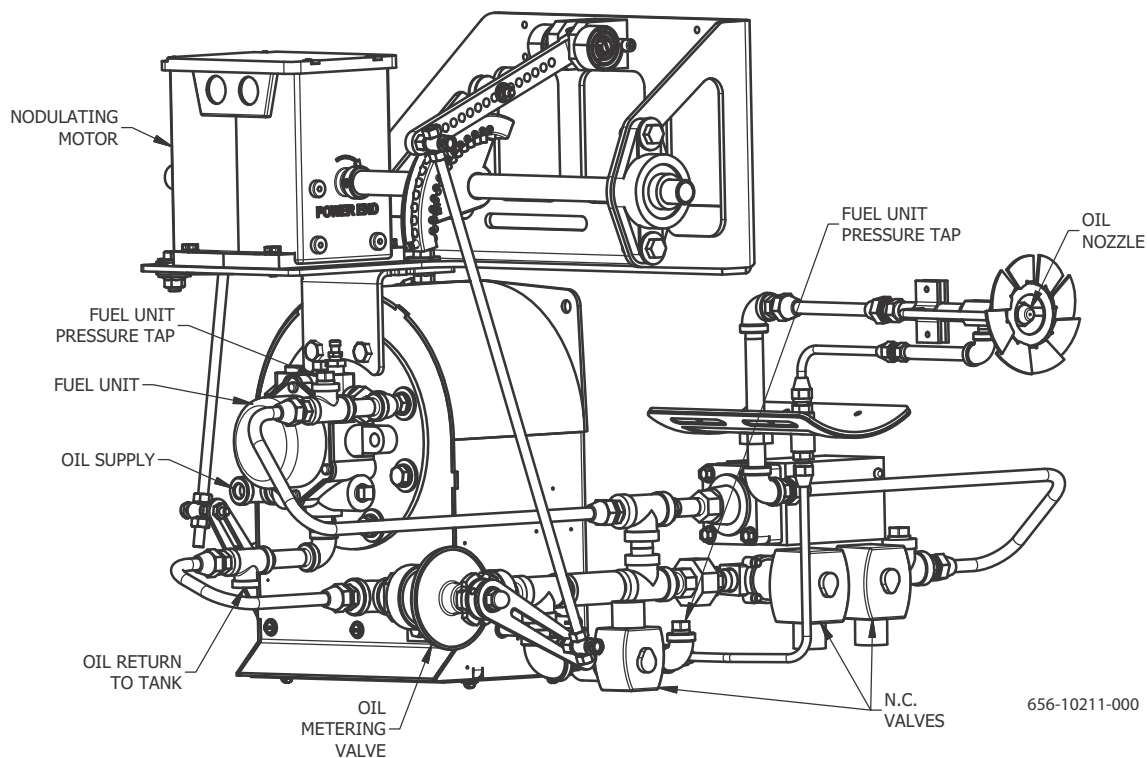


FIGURE 1-7. Full Modulation Oil System with Integral Pump & Return Flow Nozzle (V13-55)

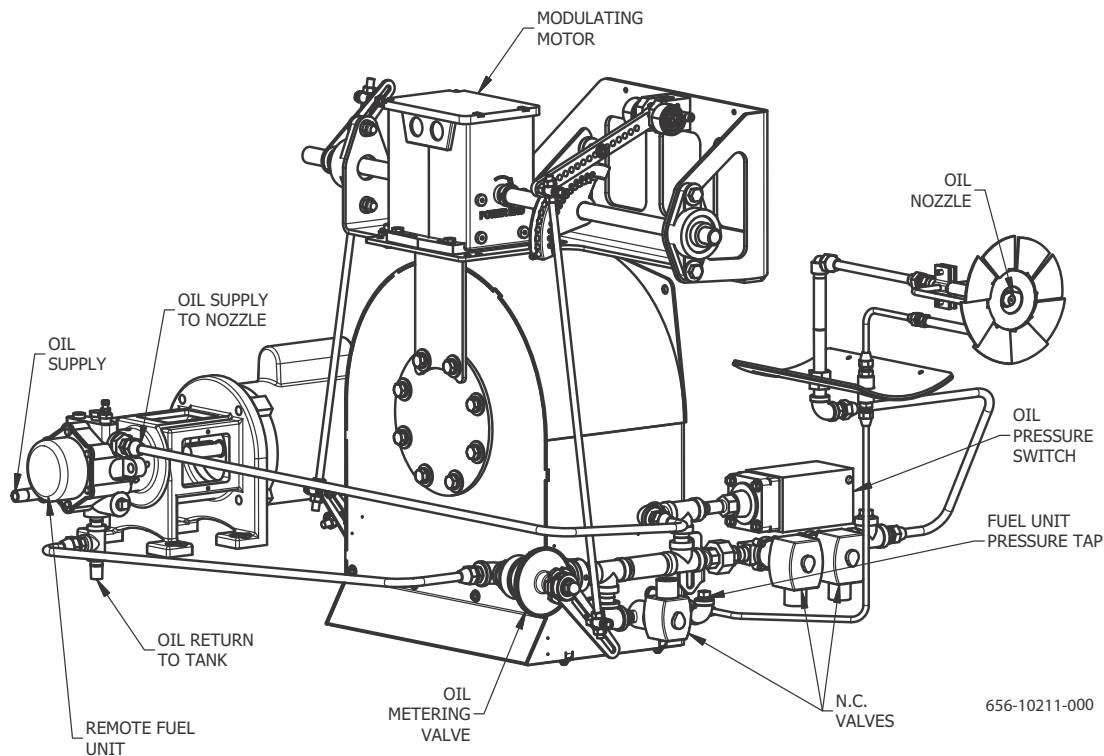


FIGURE 1-8. Full Modulation Oil System with a Remote Pump (V60-168)

1.6.2 — Operation

Fuel oil is delivered to the fuel pump, either by gravity, fuel pump suction, or by a circulating pump, through a fuel oil filter. Pressurized fuel returns to the storage tank until the two solenoid valves open. Straight oil burners (VL13-55) employ direct spark ignition where the oil is ignited when the oil solenoid valves open and the spray contacts the electrical discharge from the direct spark electrodes.

Gas-oil VLG burner use a proven gas pilot where the oil is ignited when the oil solenoid valves open and the oil spray contacts the established gas pilot flame.

On full modulation units, the modulating actuator varies the oil metering valve setting. The metering valve located in the return oil loop reduces the firing rate by opening and allowing more oil to return to the supply tank. Conversely, at high fire, the valve is closed, forcing all oil to exit the spray nozzle.

On LHO/LHL units, bypass piping routes most of the oil back to the storage tank while at low fire. At high fire, a valve blocks the return loop and forces all the oil through the nozzle.

1.7 — Gas Handling 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 adjustable linkage from the modulating motor. Depending upon specific requirements, one or two gas safety shutoff 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.

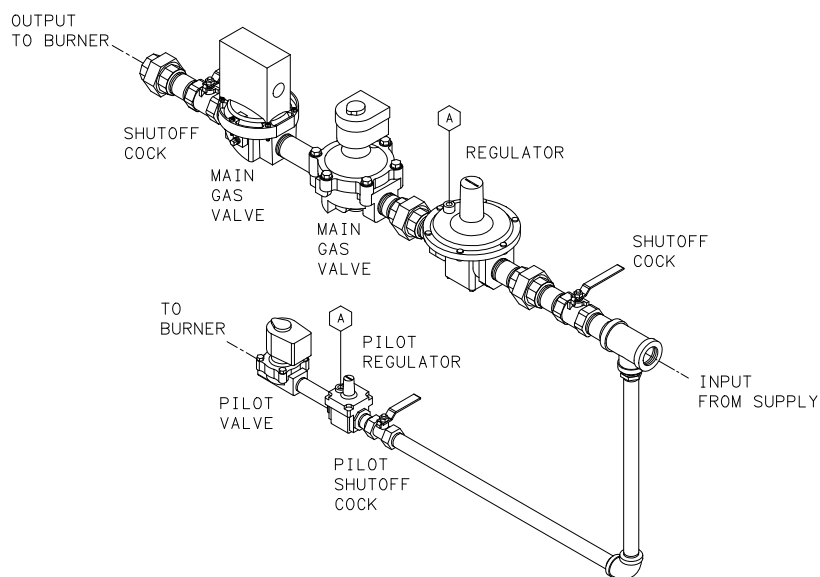
1.7.1 — Main Gas Train Components

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:

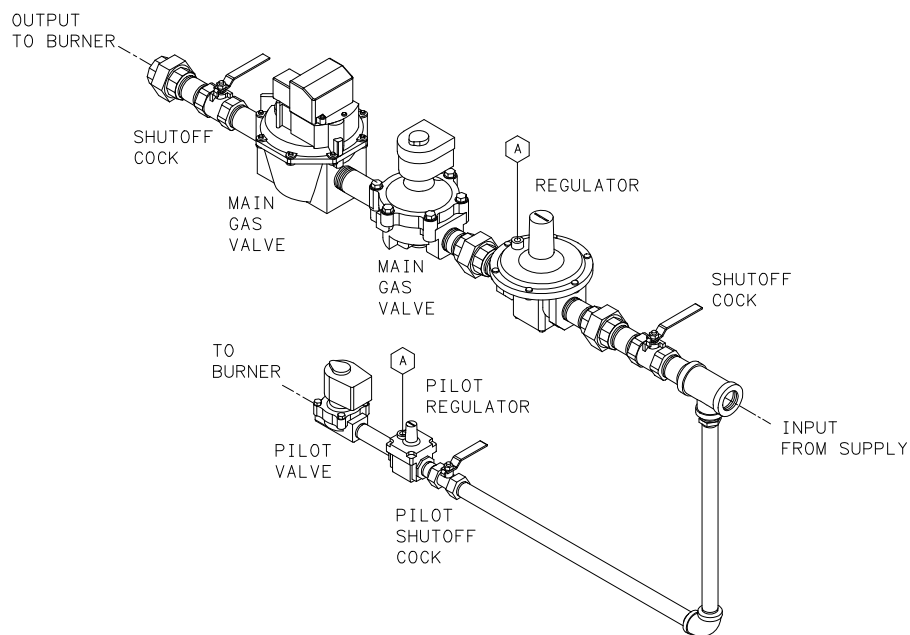
Main Gas Train Component	Description
Gas Volume Valve	The butterfly type valve is positioned by linkage from the modulating motor and controls the gas flow rate.
Main Gas Valves	Electrically operated safety shutoff valve(s) that open to admit gas to the burner. low fire Standard UL burners include: - Models V13-25: diaphragm gas valve & solenoid valve - Models V30-50: one (1) motorized gas valve w/proof of closure or two (2) safety shutoff valves - Models V55-120: one (1) motorized gas valve w/proof of closure and one (1) safety shutoff valve - Models V126-168: two (2) motorized gas valves (two motorized gas valves can be optionally provided on all models)
Main Gas Regulator	Regulates gas train pressure to specified pressure required at the burner manifold. Input is set by main gas pressure regulator adjustment.
Main Gas Cocks	Used for manual shutoff of the gas supply upstream of the pressure regulator. A second shutoff cock downstream of the main gas valve(s) provides a means of testing for leakage through the gas valve(s).
High Gas Pressure Switch (Models V30-168)	A pressure actuated switch that remains closed when gas pressure is below a selected setting. Should the pressure rise above the setting, the switch contacts will open causing the main gas valve(s) to close. This switch requires manual reset after being tripped.
Low Gas Pressure Switch (Models V30-168)	A pressure actuated switch that remains closed when gas pressure is above a selected setting. Should the pressure drop below this setting, the switch contacts will open, causing main gas valve(s) to close. This switch requires manual reset after being tripped.

NOTE: The pilot gas supply connection must be upstream of the main gas pressure regulator.

NOTE: Gas train components upstream of the butterfly valve are shipped loose and are to be mounted by the installer. If a pre-piped and wired gas train is ordered, the components upstream of the first safety shut-off valve are shipped loose and must be mounted by the installer.

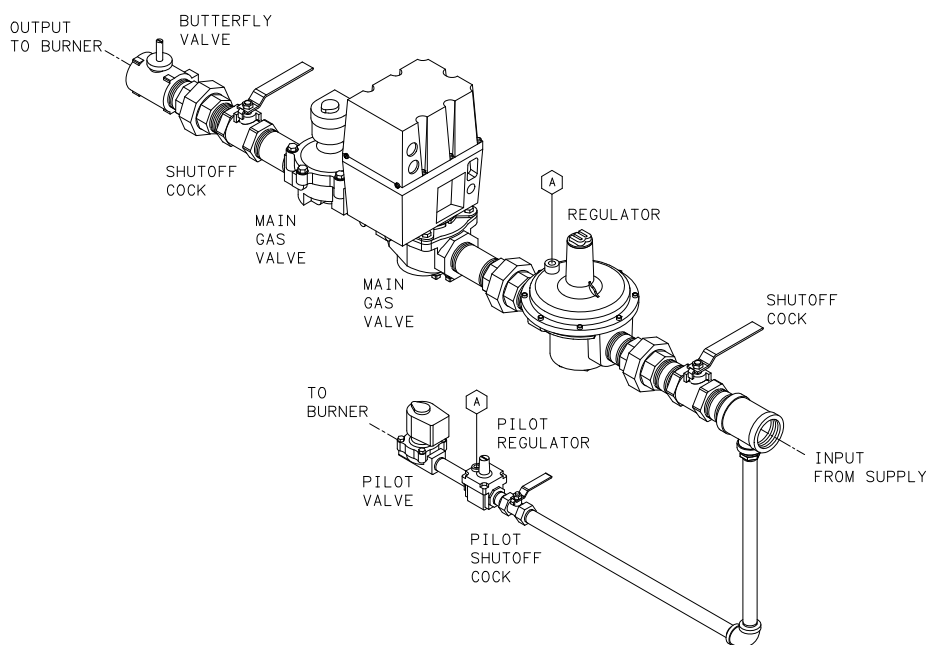


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FIGURE 1-9. Typical Gas Train for On-Off System (V13-25)

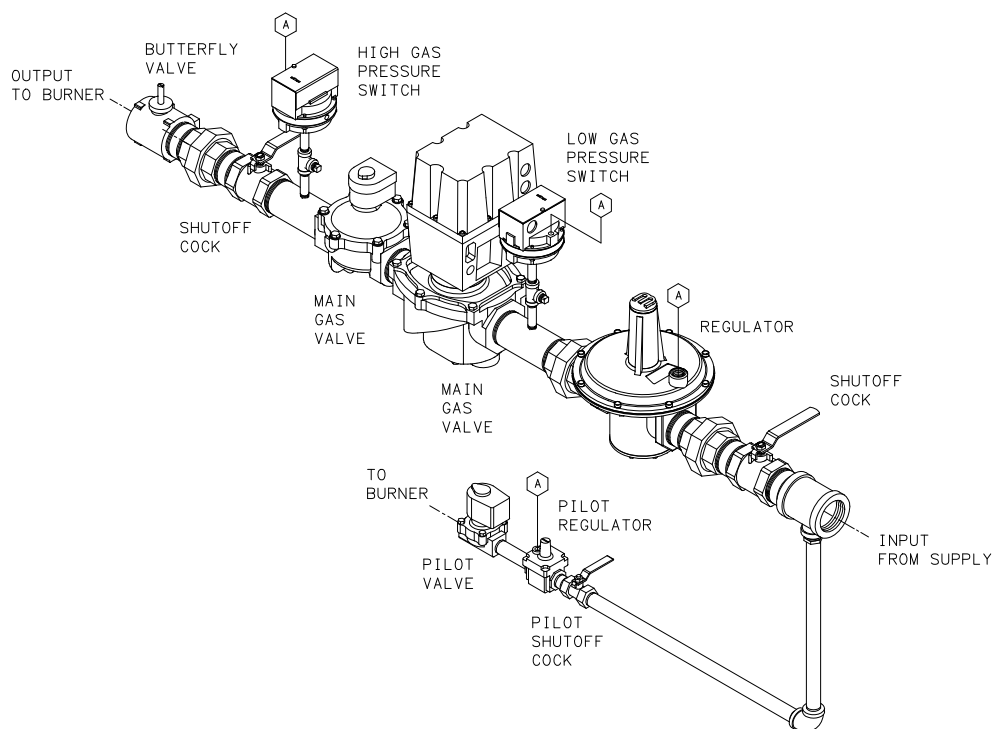
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FIGURE 1-10. Typical Gas Train for LHO System (V13-34)



571-0014

FIGURE 1-11. Typical Gas Train for Full Modulation System (V13-34)



571-0015

FIGURE 1-12. Typical Gas Train for LHO/LHL Systems (V35-63) & Full Modulation Systems (V35-168)

1.7.2 — Pilot Gas Train Components

Models VL 60-168 as well as all VG and VLG models are supplied with a gas pilot system. Oil only models VL 13-55 are supplied with direct spark ignition.

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.

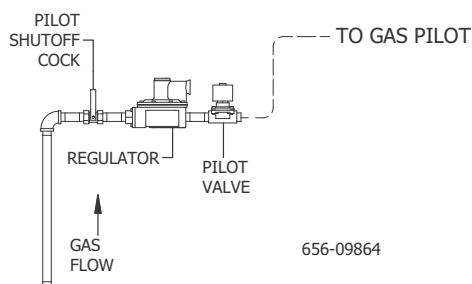


FIGURE 1-13. Pilot Gas Train

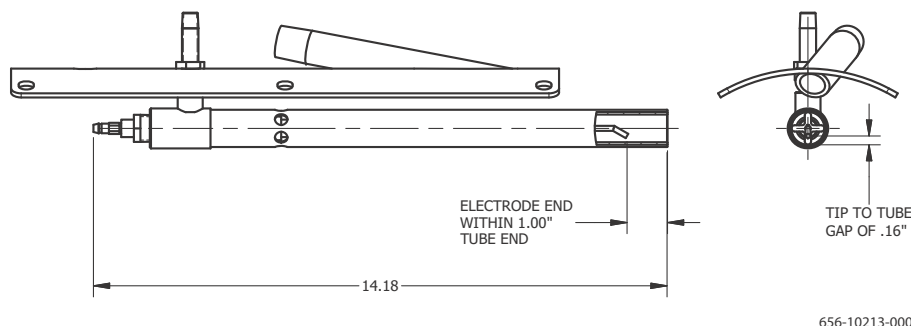


FIGURE 1-14. Gas Pilot

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.

2.1 — Application

Electrical power available is usually 115 volt, 1-phase, 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.

2.2 — Draft Conditions

A boiler or other heating vessel fired with a V series burner does not depend on chimney draft for proper combustion air. Combustion air is supplied by the burner forced draft blower providing adequate air for any normal combustion condition. Since draft control is essential to maximum efficiency, a draft regulator may be required when the vessel is connected to a tall stack or where wind conditions may cause erratic draft. Excessive furnace draft contributes to inefficient burner operation. Sealed boilers may be operated under positive firebox pressure within the capability of the burner.

2.3 — Combustion Air Supply

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

 Warning

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

2.4 — Combustion Chamber Recommendations

2.4.1 — Combustion Chamber Drawings - Firetube Boiler Application

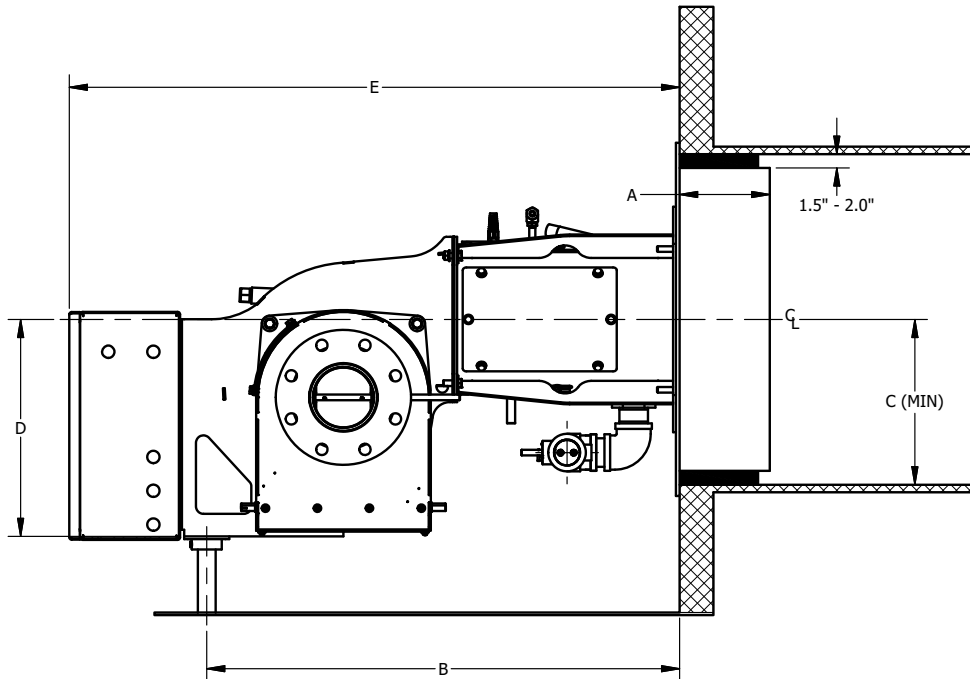


FIGURE 2-1. Standard Configuration for Firetube Boiler

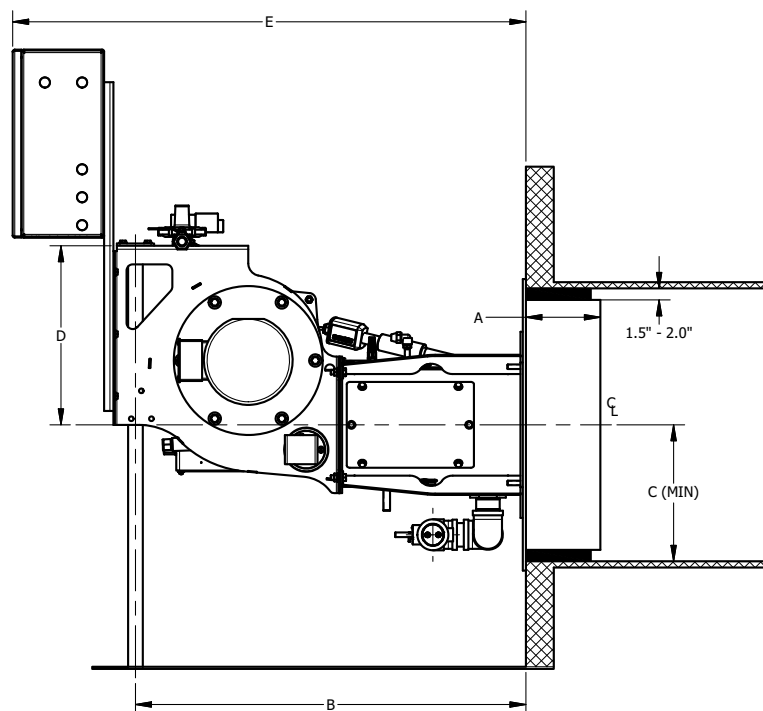


FIGURE 2-2. Inverted Configuration for Firetube Boiler

2.4.2 — Combustion Chamber Dimensions - Inverted and Standard Configuration Firetube Boiler

Burner Model	A	B	C	D	E	Combustion Chamber Min. Length
13	6	28	6	11	37	56
15	6	28	7	11	37	56
17	6	28	7	11	37	56
20	6	28	8	11	37	56
21	6	28	8	11	37	56
25	6	28	8	11	37	56
30	6	28	9	11	37	56
34	6	28	10	11	37	56
35	6	31	10	14	40	62
40	6	31	11	14	40	62
42	6	31	11	14	40	62
45	6	31	12	14	40	62
50	6	31	12	14	40	62
54	6	31	13	14	40	62
55	6	31	13	14	40	62
60	6	36	13	18	46	83
63	6	36	14	18	46	83
70	6	36	14	18	46	83
80	6	36	16	18	46	83
84	6	36	16	18	46	83
90	6	36	16	18	46	83
100	6	36	17	18	46	83
105	6	36	17	18	46	83
110	6	36	18	18	46	83
120	6	43	19	19	53	120
126	6	43	19	19	53	120
147	6	43	20	19	53	120
168	6	43	22	19	53	120

2.4.3 — Combustion Chamber Drawings - Watertube/ Cast Iron Boiler Application(s)

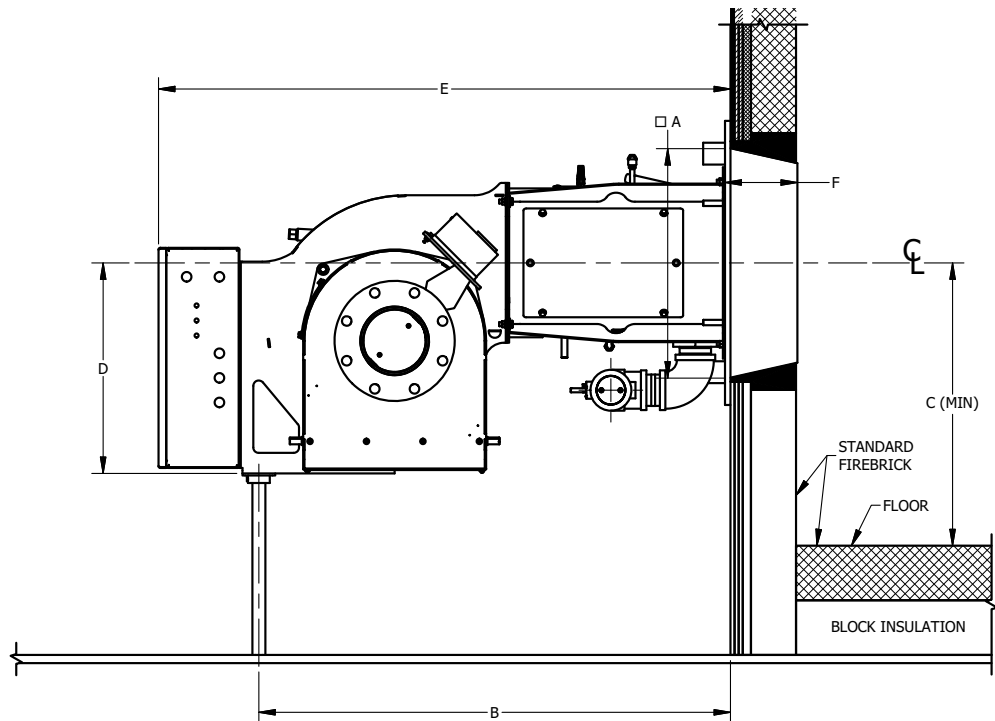


FIGURE 2-3. Standard Configuration for Watertube/ Cast Iron Boiler

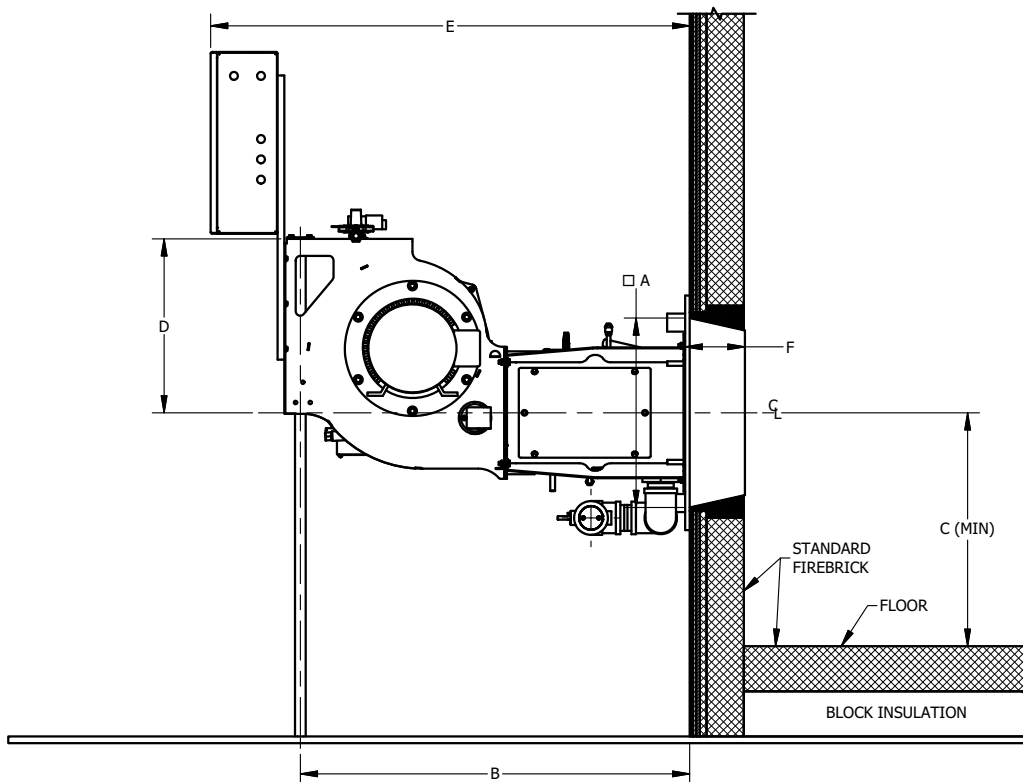


FIGURE 2-4. Inverted Configuration for Watertube/ Cast Iron Boiler

2.4.4 — Combustion Chamber Dimensions - Inverted/ Standard Config. Watertube/ Cast Iron Boiler

Burner Model	A	B	C	D	E	F	Combustion Chamber Min. Width	Combustion Chamber Min. Length
13	15	28	12	11	37	6.63	26	36
15	15	28	12	11	37	6.63	26	36
17	15	28	12	11	37	6.63	26	36
20	15	28	12	11	37	6.63	26	36
21	15	28	12	11	37	6.63	26	36
25	15	28	12	11	37	6.63	26	36
30	15	28	12	11	37	6.63	26	36
34	15	28	12	11	37	6.63	26	36
35	21	31	13.5	14	40	6.63	30	62
40	21	31	13.5	14	40	6.63	30	62
42	21	31	13.5	14	40	6.63	30	62
45	21	31	13.5	14	40	6.63	30	62
50	21	31	13.5	14	40	6.63	30	62
54	21	31	13.5	14	40	6.63	30	62
55	21	31	13.5	14	40	6.63	30	62
60	21	36	15	18	46	6.63	33	83
63	21	36	15	18	46	6.63	33	83
70	21	36	15	18	46	6.63	33	83
80	21	36	15	18	46	6.63	33	83
84	21	36	15	18	46	6.63	33	83
90	21	36	15	18	46	6.63	33	83
100	21	36	15	18	46	6.63	33	83
105	21	36	15	18	46	6.63	33	83
110	21	36	15	18	46	6.63	33	83
120	21	43	18	19	53	6.63	39	120
126	21	43	18	19	53	6.63	39	120
147	21	43	18	19	53	6.63	39	120
168	21	43	18	19	53	6.63	39	120

Refer to pages 2-2 through 2-5 for combustion chamber dimensions for firetube and watertube boiler applications. Combustion chamber dimensions should be adequately sized to prevent flame impingements.

A dry oven refractory is required only to protect surfaces not adequately protected by free circulating water. Basic objectives include:

- Provide adequate combustion space
- Avoid flame impingement
- Protect surfaces not adequately water cooled
- Seal openings

The chamber dimensions listed on the following pages are typical for good practice. Satisfactory results may be achieved with modifications to suit some conditions. Factors such as fuel properties, total combustion volume, and length of flame travel often make fixed requirements impractical. When in doubt, consult the factory. Insulation should be provided between the refractory and the boiler base. Mineral wool, or other material not likely to settle is preferred. The chamber front wall may be constructed of firebrick or insulating firebrick. Insulation should be used between the refractory and front plate. Firebrick, or insulating firebrick should be set in high temperature bonding mortar with provision for expansion.

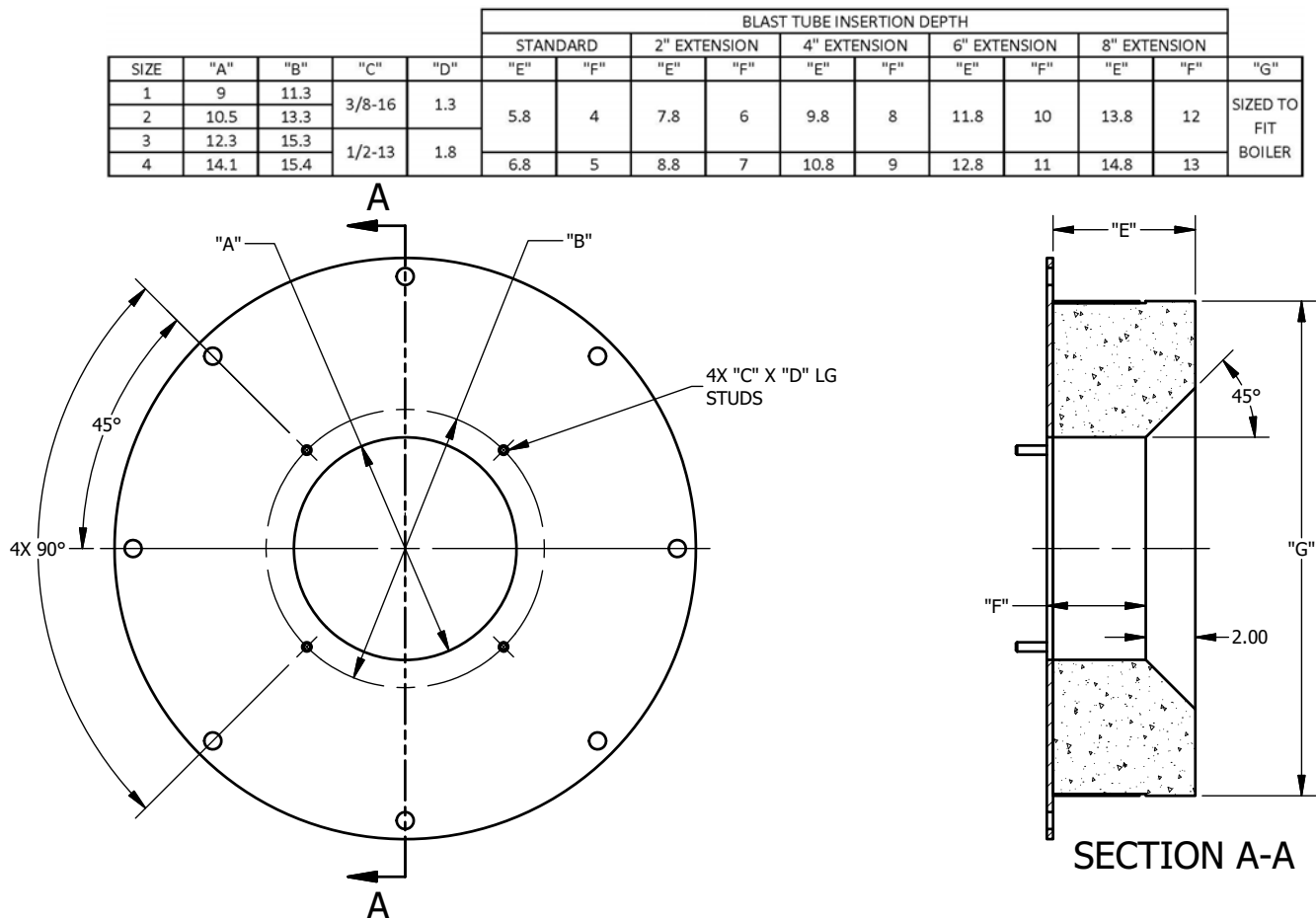
 Caution

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

2.5 — Installation

Prepare the boiler front plate as follows:

1. Determine burner mounting height. Locate and scribe a level horizontal centerline across the mounting face.
2. Locate and scribe a vertical centerline. Be sure stud locations line up where studs will have full support. If they don't, or if the opening is too large, a steel adapter plate, 3/8" minimum, may be welded or bolted in place. Suitable anchors should be provided to hold the refractory in place. The adapter plate must be properly sealed (use insulating rope gasket) to prevent leakage of combustion gases.
3. Using insulating rope gasket, wrap the rope on the inside of the bolt circle, looping the rope around the mounting studs.
4. Set the burner into position for mounting and tighten into place. Standard burners are equipped with a four-hole mounting flange.
5. Permanently support the burner using the pipe support connections.
6. The space between the boiler refractory, water leg, or fire tube and outside diameter of the firing head must be packed with plastic refractory, Kaiser Refractory Mono T-Air Set or equal. Ram plastic refractory from front to rear, parallel to the outside surface of the firing head.


FIGURE 2-5. V Series Refractory Dimensions

2.6 — Packing Plastic Insulation Around Oven (If Dry Oven is Supplied)

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.

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.

2.7 — Oil Piping

2.7.1 — Pressure Atomization Oil Piping

The oil only (VL) and gas-oil (VLG) model burners use pressure atomization. Fuel oil is provided by a burner mounted fuel pump directly coupled to the blower motor via a flexible coupling for models V13-55. A remote pump is used for models V60-168. The suction and return line sizes (two-pipe system) are based on the suction rate of the fuel pump and not the burner firing rate. Pipe size must be selected so that suction vacuum is within suitable limits.

2.7.2 — Two Pipe - Single Burner Operation

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

2.7.3 — Suction Line Sizing

The suction load is determined by:

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

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

NOTE: Refer to the manufacturer's table for line sizing. If further assistance is required, consult factory.

1. Check suction capacity.
2. Measure total pipe length (horizontal and vertical).
3. Read up from the line "total feet of copper tube" to the intersection line of the specific "suction capacity" in gph.
4. Read left to the column "inches of vacuum at fuel unit." This is vacuum required to draw oil through pipe listed at given length.
5. Add 1" of vacuum for every foot of lift.
6. Total inches of vacuum (frictional tube loss plus lift).
7. If total exceeds 15", check next larger pipe size.

2.7.4 — Return Line Sizing

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

2.7.5 — Two Pipe - Multiple Burner System

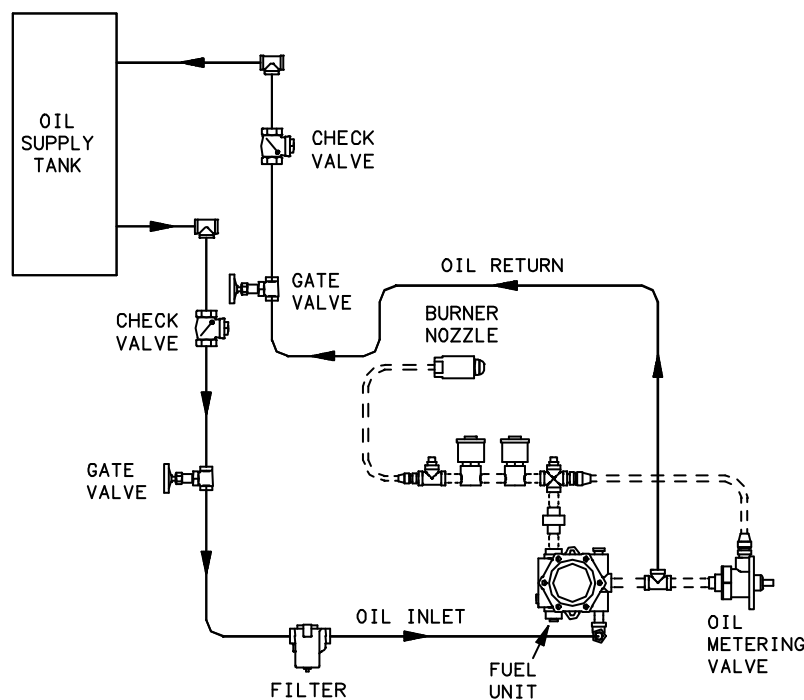
Several options exist for a multiple burner installation. Figure 2-7 is a typical installation showing separate suction lines for each burner with a common return line.

Figure 2-8 shows multiple burners with oil supplied by a transfer pump. The circulating pump is sized in this case for the total suction capacity of all burners. Note that a special pressure regulating valve is required if the fuel unit inlet pressure is above 3 psi.

Figure 2-9 shows an installation using a day tank. A pump supplies oil to the day tank.

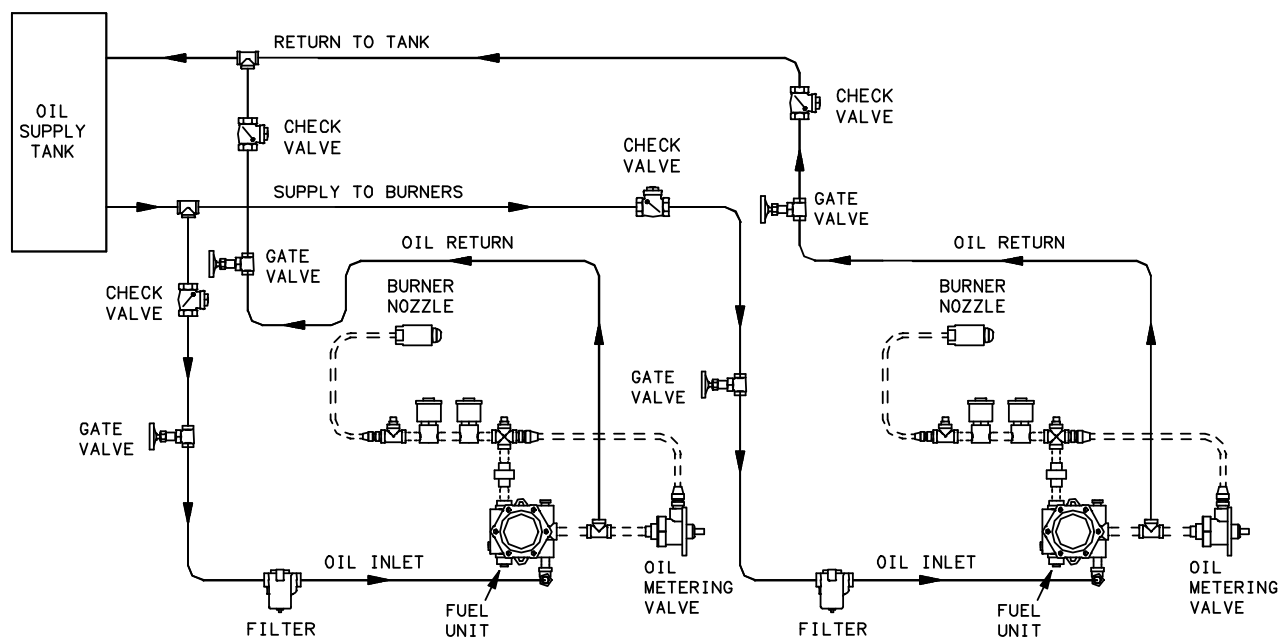
Figure 2-10 shows a flooded loop system. The circulating pump is sized according to the maximum burner firing rate for all burner plus a 30% service factor. The burner return lines feed into the common supply line.

NOTE: Industrial Combustion recommends that all oil firing burners be equipped with an oil strainer (if not included with the burner) to prevent particles from clogging the nozzle. It is essential to follow the strainer manufacturer's maintenance schedule to ensure proper filtration.



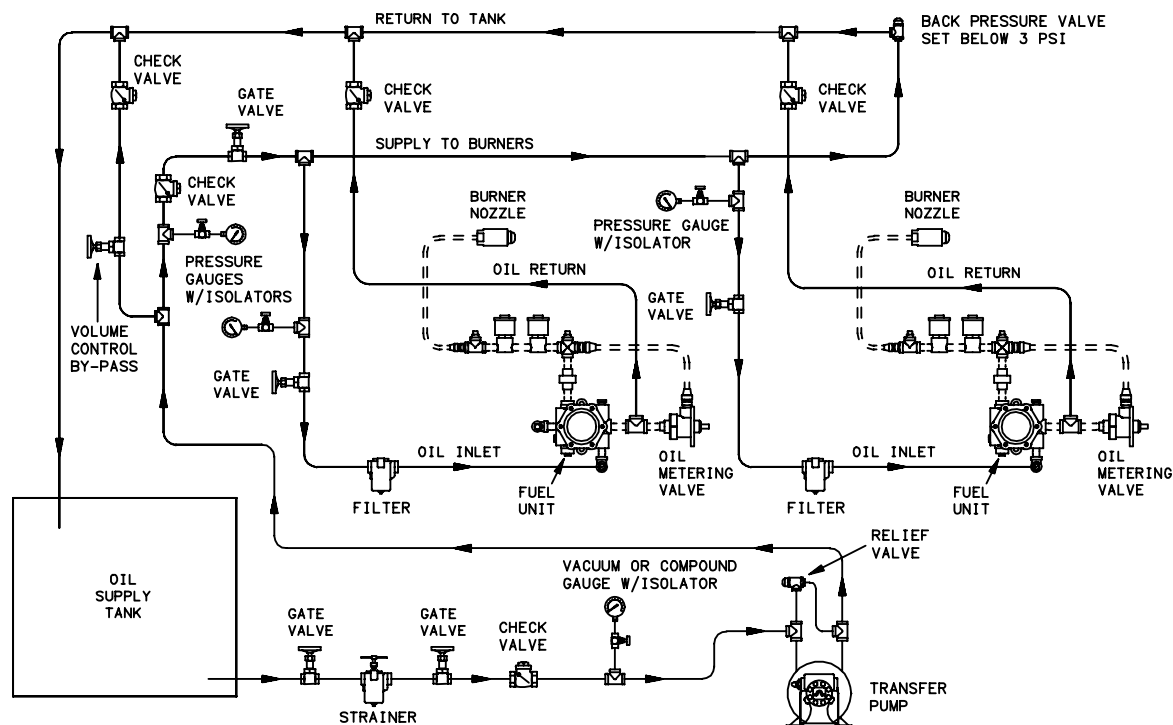
627-01011-000 (altered for single burner)

FIGURE 2-6. Typical No. 2 Oil Loop Single Burner



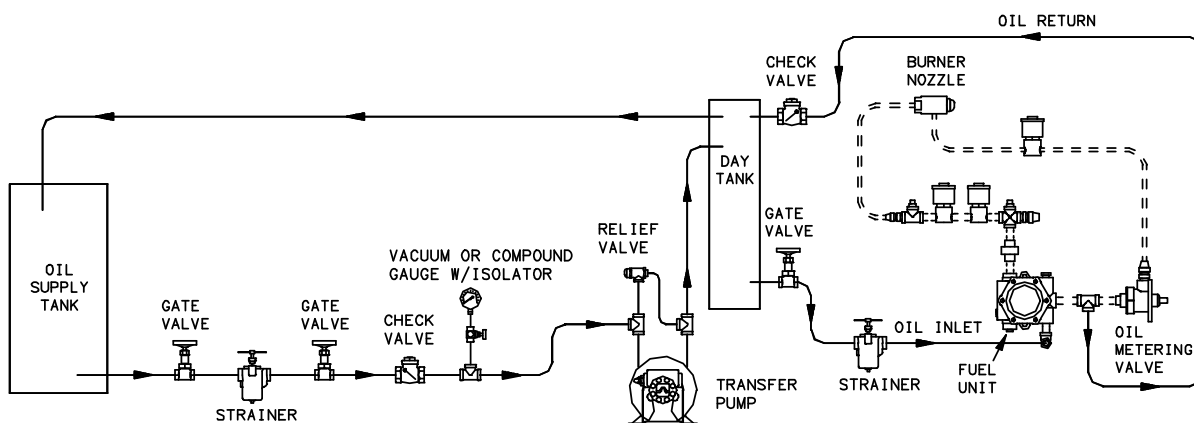
627-01011-000

FIGURE 2-7. Multiple Burners with Separate Suction Lines



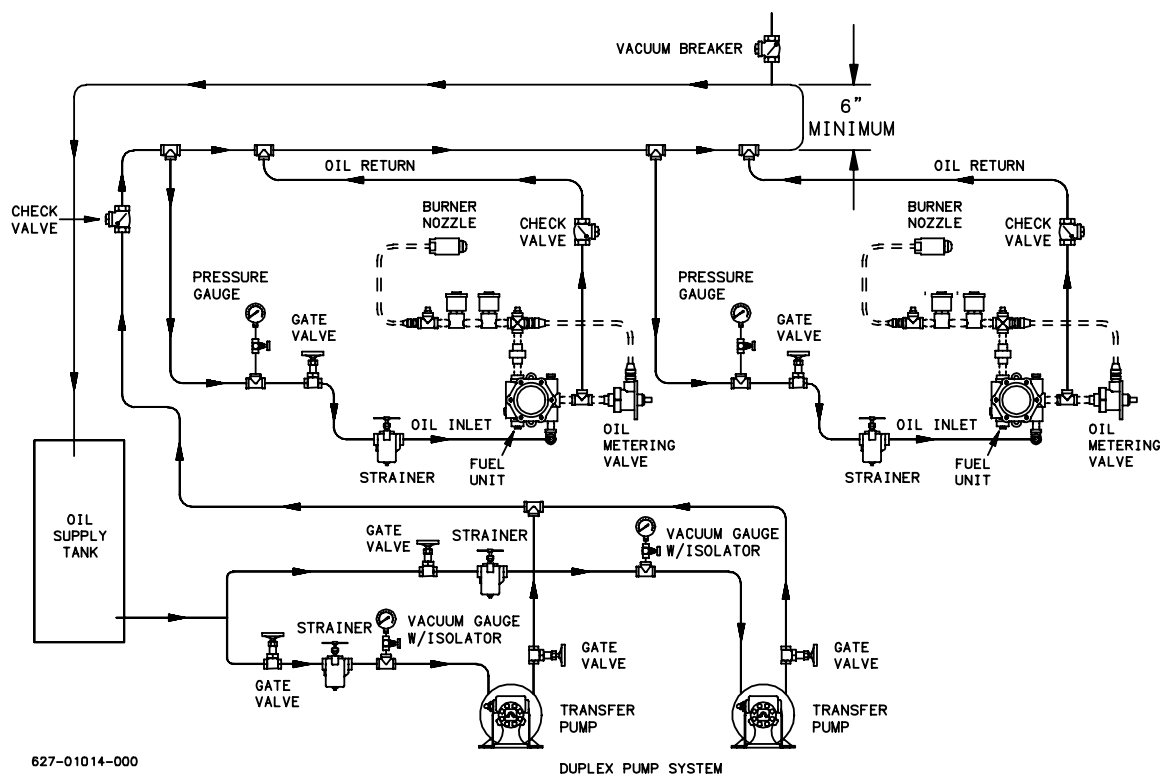
627-01012-000

FIGURE 2-8. Typical Oil Loop for Multiple Burners with Transfer Pump



627-01013-000

FIGURE 2-9. Typical Installation Using Day Tank



627-01014-000

FIGURE 2-10. Typical Flooded Loop System

2.8 — Gas Piping

Refer to Figures 1-9 through 1-12 for typical gas piping arrangements. Normally, the control train is ordered to suit a particular code or insurance regulation, such as UL/cUL, FM, or GAP. Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet.

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

Gas train components upstream of the butterfly valve are shipped loose. These components should be mounted by the installer as close to the butterfly valve as practical. If a pre-piped and wired gas train is ordered, the components upstream of the first safety shutoff valve are shipped loose. These components should also be mounted by the installer.

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

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

The gas piping must be internally clean and free of foreign material. Before using in service, a leak test must be performed (see Section 3).

2.9 — Installation Checklist

1. All burners are carefully assembled and tested at the factory, but before being placed in service all connectors should again be checked for looseness caused during shipment.

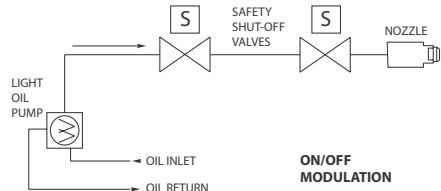
Check:

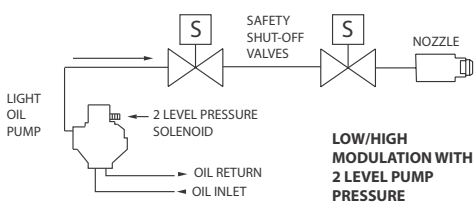
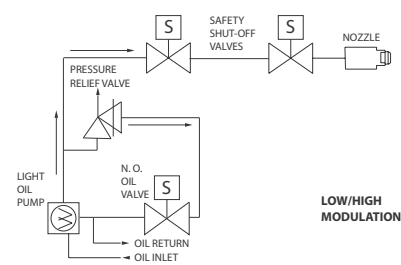
- Electrical terminals in the control panel and on all electrical components.
 - Pipe fittings and unions.
 - Tubing connections.
 - Nuts, bolts, screws.
2. Open all necessary oil shutoff valves. Do not run pumps or fuel unit without oil.
 3. Before connecting electrical current to any component, be sure the voltage is the same as that specified on component nameplates.
 4. Before burner operation, be sure all motors are rotating in the proper direction.
 5. Before firing, make sure the burner firing head and dry areas of the boiler are protected with refractory. The burner mounting flange must be properly sealed against the vessel front plate.
 6. Make certain that the operator in charge is properly instructed in operation and maintenance procedures.

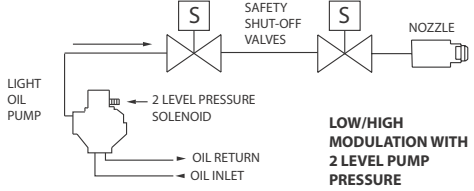
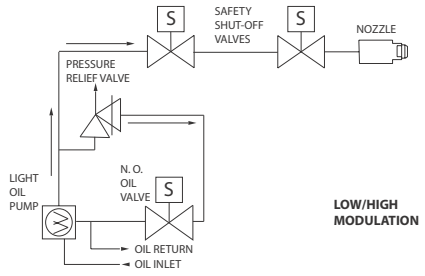
Caution

Before opening the manual gas shutoff valves, read the regulator instructions carefully. The instructions are in the regulator box. Follow the manufacturer's recommendations. Open the shutoff valve on the inlet side of the regulator slowly and carefully to allow inlet pressure to buildup 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.

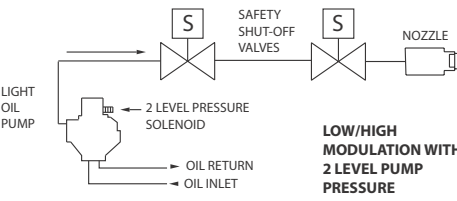
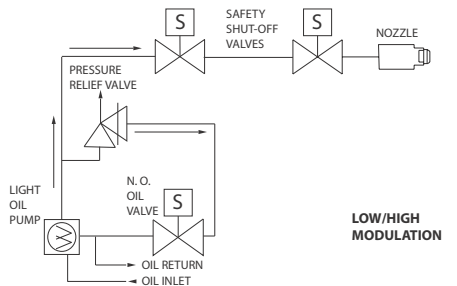
2.10 — Firing Modes

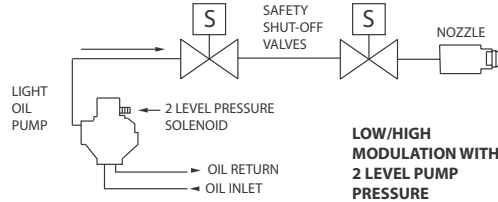
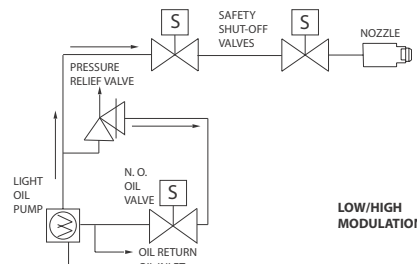
ON-OFF OPERATION				
		Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION:		Fixed two bladed damper.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve. On diaphragm gas valve the time to open can be adjusted by a bleed valve. On models with motorized valves the time to open is fixed at 13 seconds. A manually adjusted gas regulator limits firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. Oil flow rate is fixed based on pump oil pressure and the simplex nozzle's flow rating. 
Operating Sequence	PRE-PURGE:	The damper provided with on-off units is adjusted at the time the burner is installed and is fixed in place. The open damper position allows a fixed rate of air flow during all aspects of burner operation while the blower motor is operational.	Valves are closed.	The valves are closed. The oil pump is operating with pre-purge, but oil is flowing through an internal relief and returning to the supply system.
	STARTUP, IGNITION:		Valves open. To prevent a surge of gas from reaching the manifold, the primary gas valves open at a slowed rate.	The valves open allowing pressurized oil to flow from the pump to the nozzle.
	RUN, MODULATE:		Valves remain open.	Valves remain open.
	SHUT DOWN, POST-PURGE:		On shut down all gas valves close within 1 second.	Valves close immediately. The oil pump is operating with post-purge, but oil is once again relieved to the supply system.
VARIATIONS:		None	None	None

LOW-HIGH-OFF OPERATION - LOW or 60% DAMPER PURGE			
	Combustion Air	Gas	Oil
Operating Sequence	COMPONENTS DESCRIPTION:	A two blade damper is controlled by a two position, spring return actuator with mechanical linkage. For 60% damper purge a mechanical stop is provided on the damper to ensure sufficient air flow is provided during pre-purge. Damper position is controlled by a two position, spring return actuator with mechanical linkage. The actuator also contains a limit switch which is used to actuate the second stage of the oil supply system. (see oil at right)	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. The oil pump has a built in solenoid controlled two level pressure regulating system. Low and high flow rates are set on the pump based on pressure and the nozzle's flow rating. 
	PRE-PURGE:	Damper is in its closed or low fire position. For 60% damper purge this would be against the mechanical stop.	Valves are closed.
	STARTUP, IGNITION:	Damper remains in its low fire starting position.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.
	RUN, MODULATE:	Damper is driven open in 30 seconds by the two position actuator. Low-High-Off burners have no provision to modulate the burner once high fire rate has been achieved.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's low pressure setting. Excess oil is flowing through an internal relief valve and returning to the supply system.
	SHUT DOWN, POST-PURGE:	Damper returns to its start position based on the 25 second closure speed of the mechanical actuator.	The safety shut-off oil valves remain open. The pump's solenoid is energized by the auxiliary switch within the damper actuator as it opens the air damper. Oil pressure is then increased based the pumps high pressure setting. The burner will remain at high fire until demand is satisfied.
VARIATIONS:	None	None	For pumps without the internal dual pressure solenoid an external pressure relief valve and normally open solenoid valve are used. 

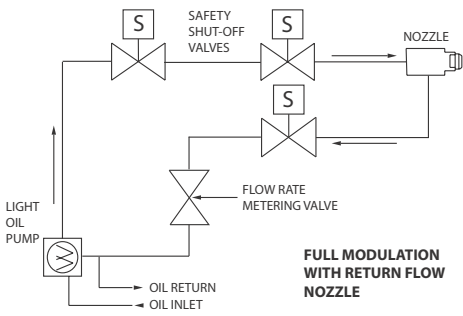
LOW-HIGH-OFF OPERATION - OPEN DAMPER PURGE				
		Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION:		A two blade damper is controlled by a two position, spring return actuator with mechanical linkage. The actuator also contains a limit switch which is used to actuate the second stage of the oil supply system. (see oil at right) A second external switch ensures the damper has returned to the low fire position before ignition is initiated.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in rush" of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering during the drive to the high position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. The oil pump has a built in solenoid controlled two level pressure regulating system. Low and high flow rates are set on the pump based on pressure and the nozzle's flow rating. 
Operating Sequence	PRE-PURGE:	From its closed position the damper is driven open by the flame safeguard control where it remains for the duration of the pre-purge cycle.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION:	Damper returns to the low fire position which is proven through the external switch. The burner is now ready for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valve's low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's low pressure setting. Excess oil is flowing through an internal relief valve and returning to the supply system.
	RUN, MODULATE:	Damper is driven open in 30 seconds by the two position actuator. Low-High-Off burners have no provision to modulate the burner once high fire rate has been achieved.	The gas valves remain in their open position. The actuator begins it's travel to the high fire position opening the gas metering valve. The burner will remain at high fire until demand is satisfied.	The safety shut-off oil valves remain open. The pump's solenoid is energized by the auxiliary switch within the damper actuator as it opens the air damper. Oil pressure is then increased based the pumps high pressure setting. The burner will remain at high fire until demand is satisfied.
	SHUT DOWN, POST-PURGE:	Damper returns to its start position based on the 25 second closure speed of the mechanical actuator.	On shut down all gas valves close within 1 second. The butterfly valve closes in 25 seconds with the two position actuator.	All valves immediately return to their startup or de-energized position. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.
VARIATIONS:		None	None	For pumps without the internal dual pressure solenoid an external pressure relief valve and normally open solenoid valve are used. 

LOW-HIGH-LOW MOD - LOW or 60% DAMPER PURGE

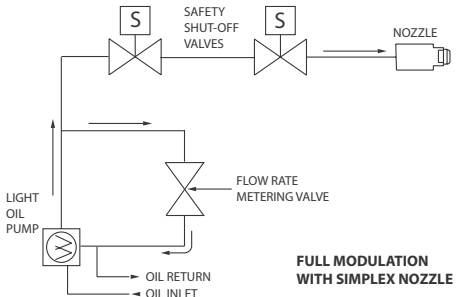
	Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION:	A two blade damper is controlled by a two position, spring return actuator with mechanical linkage. For 60% damper purge a mechanical stop is provided on the damper to ensure sufficient air flow is provided during pre-purge. Power to drive the actuator is routed through a low/auto switch and a remote located modulating control. The actuator also contains a limit switch which is used to actuate the second stage of the oil supply system. (see oil at right).	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in rush" of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering during the drive to the high position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. The oil pump has a built in solenoid controlled two level pressure regulating system. Low and high flow rates are set on the pump based on pressure and the nozzle's flow rating. 
Operating Sequence	PRE-PURGE:	Damper is in its closed or low fire position. For 60% damper purge this would be against the mechanical stop.	Valves are closed.
	STARTUP, IGNITION:	Damper remains in its low fire starting position.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.
	RUN, MODULATE:	Damper is driven open in 30 seconds by the two position actuator. Low-High-Low burners will modulate from the low to high rate positions based on the signal from the modulating control and the selection of the low/auto	The gas valves remain in their open position. The actuator begins it's travel to the high fire position opening the gas metering valve. The burner will then modulate from low to high as described in the combustion air column.
	SHUT DOWN, POST-PURGE:	Damper returns to its start position based on the 25 second closure speed of the mechanical actuator.	On shut down all gas valves close within 1 second. The butterfly valve closes in 25 seconds with the two position actuator.
VARIATIONS:	None	None	For pumps without the internal dual pressure solenoid an external pressure relief valve and normally open solenoid valve are used. 

LOW-HIGH-LOW MOD - OPEN DAMPER PURGE				
	Combustion Air	Gas	Oil	
COMPONENTS DESCRIPTION:	A two blade damper is controlled by a two position, spring return actuator with mechanical linkage. Power to drive the actuator is routed through a low/ auto switch and a remote located modulating control. The actuator also contains a limit switch which is used to actuate the second stage of the oil supply system. (see oil at right) A second external switch ensures the damper has returned to the low fire position before ignition is initiated.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an "in-rush" of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering during the drive to the high position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to the nozzle. The oil pump has a built in solenoid controlled two level pressure regulating system. Low and high flow rates are set on the pump based on pressure and the nozzle's flow rating. 	
Operating Sequence	PRE-PURGE:	From its closed position the damper is driven open by the flame safeguard control where it remains for the duration of the pre-purge cycle.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION:	Damper returns to the low fire position which is proven through the external switch. The burner is now ready for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's low pressure setting. Excess oil is flowing through an internal relief valve and returning to the supply system.
	RUN, MODULATE:	Damper is driven open in 30 seconds by the two position actuator. Low-High-Low burners will modulate from low to high rate positions based on the signal from the modulating control and the selection of the low/auto switch.	The gas valves remain in their open position. The actuator begins its travel to the high fire position opening the gas metering valve. The burner will modulate from low to high as described in the combustion air column.	The safety shut-off oil valves remain open. The pump's solenoid is energized by the aux switch within the damper actuator as it opens the air damper. Oil pressure is then increased based the pump's high pressure setting. The actuator begins its travel to the high fire position opening the gas metering valve. The burner will modulate from low to high as described in the combustion air column.
	SHUT DOWN, POST-PURGE:	Damper returns to its start position based on the 25 second closure speed of the mechanical actuator.	On shut down all gas valves close within 1 second. The butterfly valve closes in 25 seconds with the two position actuator.	All valves immediately return to their startup or de-energized position. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.
VARIATIONS:	None	None	For pumps without the internal dual pressure solenoid an external pressure relief valve and normally open solenoid valve are used. 	

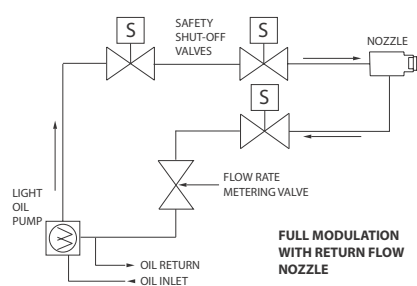
FULL MODULATION - LOW or 60% DAMPER PURGE

		Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION:		A two blade damper is controlled by a proportional modulating actuator (or motor) with mechanical linkage. The actuator is capable of stopping at any point along its 90 degree stroke based on a signal from a remotely connected modulating control or from a burner mounted manual potentiometer selected by an auto/manual selector switch. The actuator also contains an internal switch that ensures the damper is in low fire position before ignition is initiated. For 60% damper purge a mechanical stop is provided on the damper to ensure sufficient air flow is provided during pre-purge.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an “in rush” of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering relative to the actuators position . A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid safety shut off valves initiate the flow of oil from the high pressure pump to a return flow nozzle. In the return line from the nozzle an adjustable oil metering valve limits the amount of oil allowed to return to the pump. The metering valve is connected to the damper actuator with mechanical linkage. 
Operating Sequence	PRE-PURGE:	Damper is in its closed or low fire position. For 60% damper purge this would be against the	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION:	Damper remains in it's low fire starting position. The burner is now ready for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valve low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's pressure setting less the volume of oil returning through the metering valve.
	RUN, MODULATE:	Damper is driven by the modulating actuator to a firing rate position determined by the modulating control or manual potentiometer. Actuator can complete full travel to high fire in 30 sec. Actuator will then continue to adjust firing rate position based on signals from the modulating control until	The gas valves remain in open position. As the actuator begins it's travel to the firing rate position it adjusts the butterfly gas valve increasing the flow of gas to the manifold. The burner continues to modulate as described under the combustion air heading until demand is satisfied.	The safety shut-off oil valves remain open. As the actuator begins it's travel to the firing rate position it is also adjusting the oil metering valve decreasing the amount of oil allowed to return to the pump. This in turn is increasing the pressure and volume of oil at the nozzle. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.
	SHUT DOWN, POST-PURGE:	Damper returns to its starting position based on the 30 second closure speed of the mechanical actuator.	On shut down all gas valves close within 1 second. The butterfly valve closes in 30 seconds with the damper actuator.	All valves immediately close. The metering valve opens to its low fire position in 30 seconds with the damper actuator. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.

FULL MODULATION - LOW or 60% DAMPER PURGE

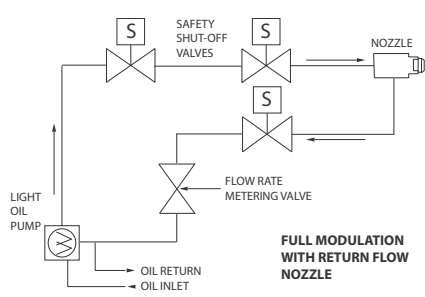
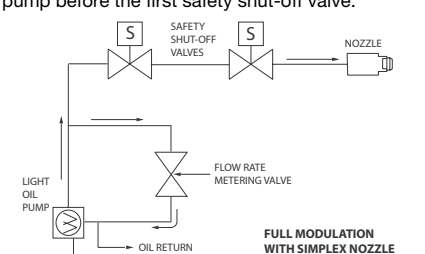
	Combustion Air	Gas	Oil
VARIATIONS:	Options are available for 4-20mA modulating signal conversion or 4-20 proportional modulating actuators. Also optional is an actuator with dual low fire start switch positions for improved turn down in dual fuel situations.	None	On models with a simplex nozzle oil is diverted from the supply line through the meter and back to the pump before the first safety shut-off valve.  FULL MODULATION WITH SIMPLEX NOZZLE

FULL MODULATION - OPEN DAMPER PURGE

		Combustion Air	Gas	Oil
COMPONENTS DESCRIPTION:		A two blade damper is controlled by a proportional modulating actuator (or motor) with mechanical linkage. The modulating actuator is capable of stopping at any point along its 90 degree stroke based on a signal from a remotely connected modulating control or from a burner mounted manual potentiometer which is selected through an auto/manual modulation selector switch. The actuator also contains two internal switches that ensure the damper reach the high fire and low fire positions during purge and before ignition is initiated.	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an “in rush” of gas. A butterfly type gas metering valve is linked directly to the damper actuator and provides gas flow metering relative to the actuators position. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to a return flow nozzle. In the return line from the nozzle an adjustable oil metering valve limits the amount of oil allowed to return to the pump. The metering valve is connected to the damper actuator with mechanical linkage. 
Operating Sequence	PRE-PURGE:	From its closed position the damper is driven open by a signal from the flame safeguard control where the high fire air switch is proven. The damper will remain open for the duration of the pre-purge cycle.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION:	Damper returns to the low fire position which is proven through the internal low fire air proving switch. The burner is now ready for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valve low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's pressure setting less the volume of oil returning through the metering valve.
	RUN, MODULATE:	Damper is driven by the modulating actuator to a firing rate position as determined by the modulating control or manual potentiometer. Actuator can complete full travel to high fire in 30 seconds. Actuator will then continue to adjust firing rate position based on signals from the modulating control until demand is satisfied.	The gas valves remain in their open position. As the actuator begins it's travel to the firing rate position it is also adjusting the butterfly gas metering valve increasing the flow of gas to the manifold. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.	The safety shut-off oil valves remain open. As the actuator begins it's travel to the firing rate position it is also adjusting the oil metering valve decreasing the amount of oil allowed to return to the pump. This in turn is increasing the pressure and volume of oil at the nozzle. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.
	SHUT DOWN, POST-PURGE:	Damper returns to its starting position based on the 30 second closure speed of the mechanical actuator during post purge.	On shut down all gas valves close within 1 second. The butterfly valve closes in 30 seconds with the damper actuator.	All valves immediately close. The metering valve opens to it's low fire position in 30 seconds with the damper actuator. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.

FULL MODULATION - OPEN DAMPER PURGE

	Combustion Air	Gas	Oil
VARIATIONS:	Options are available for 4-20amp modulating signal conversion or 4-20 proportional modulating actuators. Also optional is an actuator with dual low fire start switch positions for improved "turndown" in dual fuel situations.	None	On models with a simplex nozzle oil is diverted from the supply line through the meter and back to the pump before the first safety shut off valve. FULL MODULATION WITH SIMPLEX NOZZLE

PARALLEL POSITIONING			
	Combustion Air	Gas	Oil
Operating Sequence	COMPONENTS DESCRIPTION: NOTE: Parallel Positioning systems incorporate independent actuators to control each of the fuel and air metering devices. Customizable “curves” can then be created for each actuator to optimize burner performance. A two bladed damper is controlled by an independent parallel positioning actuator. The remote mounted modulating control	Safety shut off valve(s) are provided to initiate the flow of gas. The primary is a diaphragm or motorized type valve which have delayed opening rates to prevent an “in rush” of gas. A butterfly type gas metering valve is directly coupled to a parallel positioning actuator. A manually adjusted gas regulator limits maximum firing rate.	Pressure Atomization: Two solenoid type safety shut off oil valves initiate the flow of oil from the high pressure pump to a return flow nozzle. In the return line from the nozzle is an adjustable oil metering valve which limits the amount of oil allowed to return to the pump. The metering valve is direct coupled to a parallel positioning actuator. 
	PRE-PURGE: From its closed position the damper is driven open by a signal from the parallel positioning control. The damper will remain open for the duration of the pre-purge cycle.	Valves are closed.	The pump is operational but the valves are closed. Oil is flowing through an internal relief valve and returning to the supply system.
	STARTUP, IGNITION: Damper returns to the low fire position in preparation for startup.	Valves open. To prevent a surge the primary gas valve opens at a slowed rate. Gas flow to the manifold is metered based on the butterfly valves low fire setting.	Safety shut off valves open allowing oil to flow from pump to nozzle. Oil pressure at the nozzle is based on the pump's pressure setting less the volume of oil returning through the metering valve.
	RUN, MODULATE: Damper is driven by its parallel positioning actuator to a firing rate position as determined by the parallel positioning control. The actuator and parallel positioning control will then continue to adjust the damper and fuel actuators position based on signals from remote sensors until demand is satisfied.	The gas valves remain in their open position. The metering valve and actuator increases the flow of gas to the manifold in conjunction with the opening damper however, position adjustments are made based on the fuel “curve” stored in the parallel positioning control's memory. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.	The safety shut-off oil valves remain open. The metering valve and actuator decreases the flow of oil returning to the pump in conjunction with the opening damper however, position adjustments are made based on the fuel “curve” stored in the parallel positioning control's memory. This in turn is increases the pressure and volume of oil at the nozzle. The burner will continue to modulate as described under the combustion air heading until demand is satisfied.
	SHUT DOWN, POST-PURGE: Damper returns to its closed position during or following post purge.	On shut down all gas valves close within 1 second. The butterfly valve returns to it's starting position..	All valves immediately close. The metering valve opens to it's low fire position. The oil pump is operating with post-purge, but oil is flowing through an internal relief valve and returning to the supply system.
VARIATIONS: None		None	On models with a simplex nozzle oil is diverted from the supply line through the meter and back to the pump before the first safety shut-off valve. 

3.1 — Preparations for Starting

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

Read and understand starting instructions before attempting to operate the burner. Check to make certain that all plugs, connections, linkages, etc., are tight. The following checks must be made:

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

3.1.1 — Oil Flow

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

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

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

3.1.2 — Oil Pressure

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

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

3.1.3 — Firing Preparations for Oil Burners

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

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

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

When the conditions covered above and in Chapter 2 are assured, the burner is ready for firing.

3.1.5 — Burner Settings

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

These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position. Refer to Chapter 4 for instructions.

3.1.6 — Combustion Settings

Fuel and air flow rates are individually adjusted at low fire and at high fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (including air temperature, humidity, barometric pressure), and fuel property changes. Refer to the nameplate inside the control panel for minimum and maximum fuel input ratings. Refer to Chapter 4 for instructions.

3.1.7 — Test Equipment

The following tests should be conducted on site:

1. Combustion analyzer with O₂ indication
2. U-Tube manometer, or pressure gauge, to measure gas pressures (Main and Pilot), pressure and vacuum gauge for the oil burners
3. Inclined manometer to measure draft pressures
4. Smoke spot tester for oil burners and CO analyzer for gas fired units
5. Voltmeter/Ammeter
6. Stack thermometer and thermocouples

Warning

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

Warning

Read the flame safeguard manual and fully understand its content before attempting to operate this equipment. If this instruction is ignored, serious injury or death may result.

3.2 — Electrical Interference Test

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

3.2.1 — 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 (should not be energized).
3. Upon completion of a 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 electrical 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 a successful test, disconnect the power supply.
7. Reconnect the oil safety shutoff valve and turn on the manual pilot gas valve.

Reconnect the 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 4" 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 diagram 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 (if applicable).
5. Place the gas-oil selector switch (if applicable) 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 selector switch to the off position. 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.
 - 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.
 - Condition must be corrected and the respective gas pressure switch manually reset before the burner will fire again on gas.



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.

3.8 — Startup and Operating

3.8.1 — Gas Burners

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

The unit should be taken out of service if the unit fails any part of the gas valve leak test. Any defective part must be replaced prior to putting the equipment back into service.

 Warning

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

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.

Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting the butterfly valve and air linkage. Refer to the adjustment section of this manual. Using the combustion analysis instrument, adjust the low fire. Typical combustion analysis for low fire is 5% to 6% O₂ on standard turndown systems, and between 6.5% and 9% for higher turndown systems. Verify the minimum input rate by measuring the gas meter.

When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open the main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.

After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 3% to 4% O₂. Verify maximum input rate by measuring the gas meter.

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

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

3.8.2 — Oil Burners

1. The fuel selector switch should be set to “OIL” and the “ON-OFF” switch is in the “OFF” position. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.

2. Set the “ON-OFF” switch to “ON.” The burner will start and pre-purge. After pre-purge, the ignition transformer will direct spark. If the flame detector proves the presence of a satisfactory pilot, the programmer will proceed to main flame ignition.
3. Make initial air shutter settings for smooth ignition. Return line oil pressure should be set according to guidelines in Chapter 4. Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the oil low fire rate by adjusting the oil return pressure and air linkage. Using the combustion analysis instrument, adjust the low fire. Typical combustion analysis for low fire is 5% to 6% O₂.
4. When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open the main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
5. After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle. In high fire the oil metering valve should be in the fully closed position and the fuel oil pressure should be about 300 psi. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 3.5% to 4% O₂. Verify maximum input rate by measuring the oil meter if available or by weighing the oil.

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

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

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

3.8.3 — Combination Gas-Oil Burners

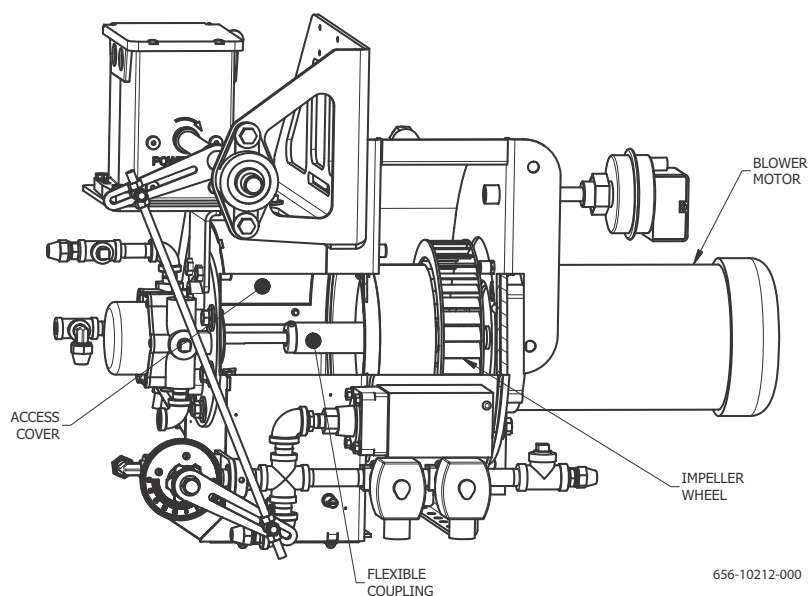
In general, the combination fueled system is to be started first using oil, because, as a fuel, oil has a greater combustion air requirement than natural gas.

Refer to the gas burner or oil burner adjustment procedures and Chapter 4.

Once the adjustments are set for oil, shutdown the burner and restart and adjust the natural gas fuel. Do not readjust the air dampers. The adjustment is made by balancing the fuel input rate against the existing flow of combustion air.

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

NOTE: Size 1 & 2 combination gas/oil units use a direct coupling from the blower motor to the oil pump. When firing gas for an extended period of time, the coupling should be manually removed and replaced only when firing oil. If the coupling is left connected to the blower motor, ensure that there is proper oil circulation at all times to avoid damage to and seizure of the pump.


FIGURE 3-1. Blower Motor and Flexible Coupling

3.8.4 — Fuel Chart Comparison for O₂ - Excess Air - CO₂

O ₂	Excess Air	CO ₂ Natural Gas	CO ₂ Propane	CO ₂ No. 2 Oil	
0.5	2.2	11.4	13.3	14.9	
1.0	4.5	11.2	13.0	14.5	
1.5	6.9	10.8	12.6	14.2	
2.0	9.5	10.5	12.4	13.7	
2.5	12.1	10.3	12.0	13.5	
3.0	15.0	10.0	11.7	13.0	
3.5	18.0	9.6	11.5	12.6	High Fire Range
4.0	21.0	9.4	11.2	12.3	
4.5	24.5	9.1	10.8	11.9	
5.0	28.1	8.8	10.4	11.6	Mid Fire Range
5.5	31.9	8.5	10.0	11.3	
6.0	35.9	8.3	9.8	10.9	
6.5	40.3	8.0	9.5	10.6	Low Fire Range
7.0	44.9	7.7	9.2	10.2	
8.0	55.6	7.5	8.5	9.1	
9.0	67.8	6.9	7.8	8.6	
10.0	82.2	6.4	7.2	7.6	
11.0	99.3	5.8	6.5	7.0	
12.0	121.0	5.2	5.8	6.2	

O ₂	Excess Air	CO ₂ Natural Gas	CO ₂ Propane	CO ₂ No. 2 Oil
13.0	147.0	4.6	5.3	5.4
14.0	181.0	4.0	4.6	4.7
15.0	226.0	3.5	3.9	4.0

NOTE: Carbon Monoxide (CO) PPM should be attainable at levels below 50 PPM on most gun style burners regardless of the fuel being used. In some instances this is not possible due to variables specific to a particular application (ie. furnace dimensions, vessel construction etc.) Most codes limit the maximum CO to <400 PPM.

3.9 — Normal Operation

Normal operation must be with the “MANUAL-AUTO” switch selector on “AUTO.”

In automatic operation, the operating cycle always proceeds sequentially through pre-purge, pilot ignition, main flame ignition, run, and post-purge. The length of 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 Chapters 4 and 5.

3.10 — Shutdown

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

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

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

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 (CO₂), oxygen (O₂), and carbon monoxide (CO). At no time should CO₂ measurements alone be used to indicate proper excess air levels. Only O₂ measurement can definitively show whether sufficient air has been provided for combustion.

4.2.1 — Stack Temperature

Net stack temperature is obtained by subtracting the ambient temperature from the flue gas temperature. A high net stack temperature indicates wasted heat. 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 — Test Equipment

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

1. Combustion analyzer with O₂ indication
2. U-Tube manometer, or pressure gauge, to measure gas pressures (Main and Pilot), vacuum and pressure gauges for oil
3. Inclined manometer to measure draft pressures
4. Smoke spot tester for oil burners and CO analyzer for gas fired units
5. Voltmeter/Ammeter
6. Stack thermometer and thermocouples

4.2.4 — Gas Adjustments

Low-fire combustion analysis is 6% to 9% O₂ and less than .04% CO (400 ppm). A high-fire reading typically is 3% to 5% O₂ and less than .04% CO. The V series burners are capable of operating at low excess air and less than 50 ppm CO levels at all firing rates.

4.2.5 — Fuel Oil Adjustments

Adjust for a “clean fire”. Typically for No. 2 oil, O₂ is 5% to 6% at low-fire and 3.5% to 4.5% 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 — Burner Ignition Adjustment

4.4.1 — Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 4" 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.

To adjust pilot gas pressure, unscrew regulator cap and turn the adjusting screw in or out.

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. Refer to the flame safeguard instruction manual.

Check the pilot electrode setting. The pilot is accessible by loosening the four screws on the side of the firing head and disconnecting the gas line.



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.

4.4.2 — Gas Pilot Turndown Test

For burners equipped with a gas pilot, conduct the following test:

1. Turn the burner switch "ON". This will start the blower motor and initiate the pre-purge sequence. Make sure a pressure gauge 0" to 10" W.C. or a manometer is installed in the pilot line to monitor the pilot gas pressure.

2. When the pilot comes on, put the programmer timer on pilot hold by placing the “RUN-TEST” switch on the flame safeguard to the “TEST” position.
3. Check the flame signal strength. Adjust the flame signal by increasing or decreasing pilot gas pressure with the regulator spring. Normal setting is 4” to 6” W.C.
4. Perform a pilot turndown test by reducing the pilot pressure very slowly until the scanner loses sight of the flame and gives a flame lockout, then reset the adjustment to normal level. Note the minimum pressure level.
5. After adjusting the pressure back to normal level, set the programmer to the “RUN” position. Main flame will come on and the burner is in the low-fire position.
6. Start and stop the burner several times to ensure proper pilot setting.

NOTE: Refer to the flame safeguard control manual instructions.

4.4.3 — Direct Spark Oil Only (VL) Adjustment (V13-55)

Oil only (VL) models V13-55 are equipped with a direct spark ignition. Remove the oil drawer assembly and check the electrode settings and the nozzle size.

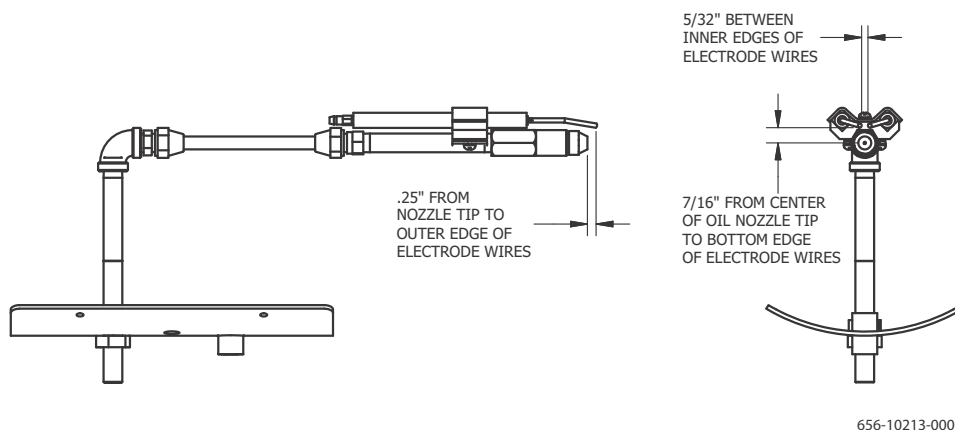


FIGURE 4-1. Direct Spark Ignition - Oil Only (VL) (V13-55)

4.4.4 — Burner Pilot Settings

To ensure reliable and safe burner performance, the location and gap setting of the electrodes, and the relative positions of the burner nozzle, diffuser, and air baffle components must be set correctly. These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position.

The nozzle/diffuser assembly must be removed from inside the burner to enable measurement and adjustment.

1. Lockout and tag the electrical power supply to the burner to prevent inadvertent operation during checking or maintenance activities.
2. Disconnect the high voltage power supply from the oil-spark-ignition electrodes (if installed).
3. Disconnect the oil piping from the side of the firing head.
4. Remove the fasteners that secure the drawer to the side of the burner housing, and remove the complete assembly.

5. For burners with a gas pilot:
 - a. Disconnect the pilot line and loosen the locking screws on the pilot access cover located on the side of the firing head.
 - b. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly. The pilot assembly will slide back and away from the diffuser.
 - c. Turn the assembly and retract it through the access hole.
 - d. Check the electrode position as shown in Figure 4-2.
 - e. Re-assemble in reverse order.

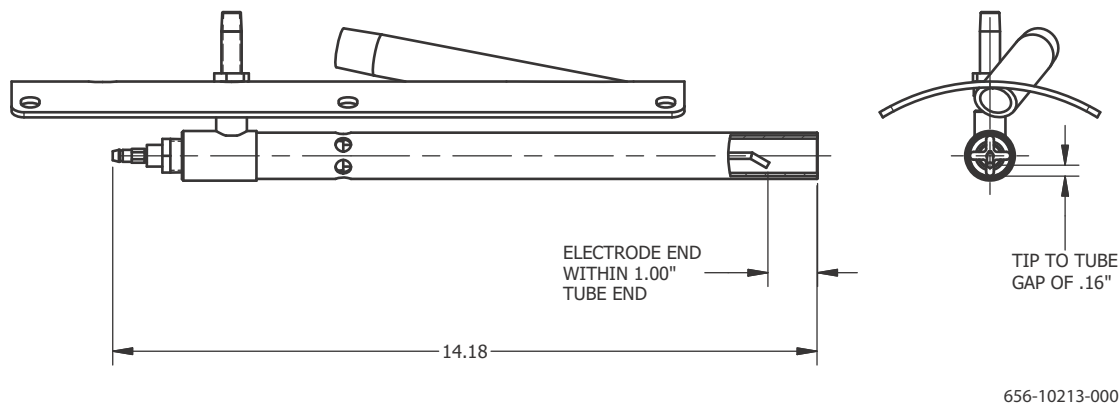


FIGURE 4-2. Gas Pilot

Measure the position of the tip of the nozzle to the diffuser and compare it to the drawer assembly drawings in section 4.4.5 for firetube applications and 4.4.6 for watertube or cast iron applications.

1. Loosen the locking screws on the diffuser clamp.
2. Slide the diffuser clamp along the length of the burner pipe until the correct dimension is obtained.
3. Tighten the diffuser clamp securely to the burner pipe. Apply a lock-tight type compound to the screws before tightening.
4. Carefully install the drawer assembly into the burner. Reconnect the oil line and high voltage power cable to the assembly.

Measure the position of the diffuser to the air baffle and compare it to the drawer assembly drawings in section 4.4.5 for firetube applications and 4.4.6 for watertube or cast iron applications.

1. Measure the distance between the leading edge of the diffuser and the front face of the inner ring on the air baffle assembly.
2. If adjustment is required, loosen the burner pipe locking setscrew located on the rear cap at the top of the fan housing and slide the burner pipe until the correct dimension is obtained.
3. Tighten the burner pipe locking setscrew securely.

4.4.5 — Drawer Assemblies for Firetube Boiler Applications

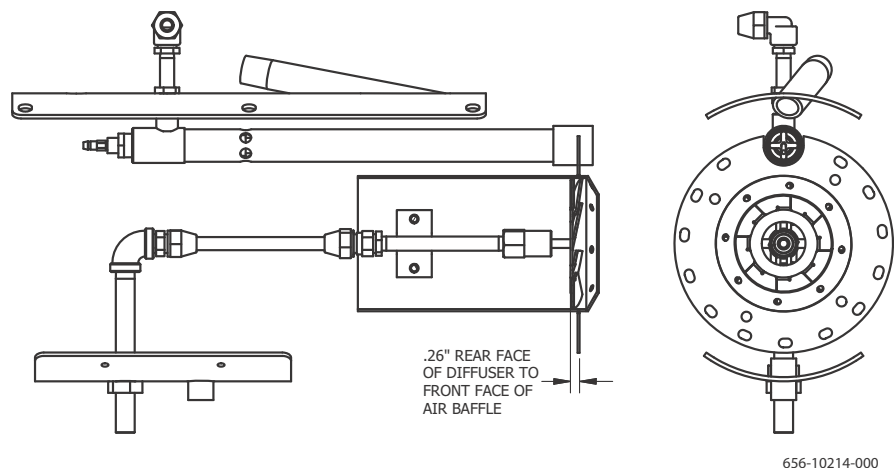


FIGURE 4-3. Drawer Assembly for (VG) Gas Only (V13-34) - Firetube

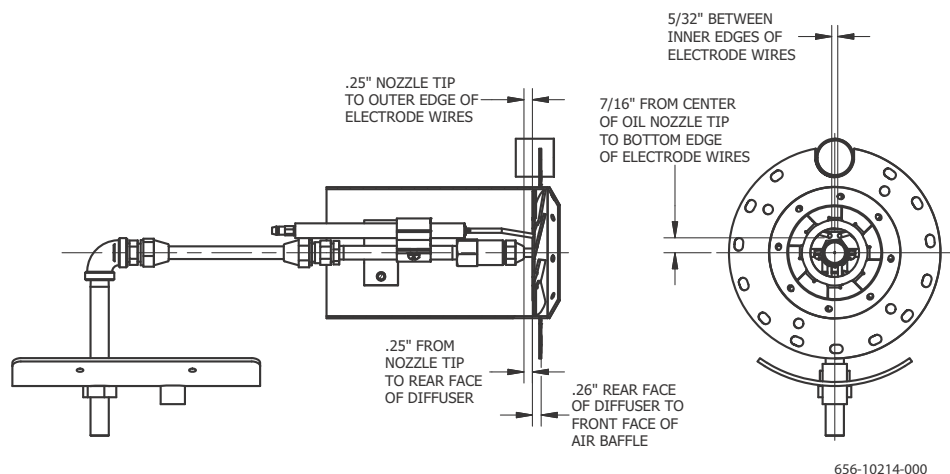


FIGURE 4-4. Drawer Assembly for (VL) Oil Only (V13-34) - Firetube

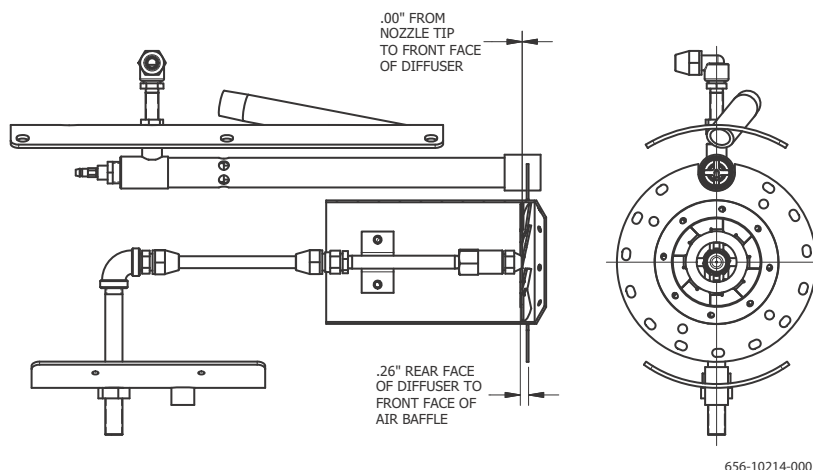


FIGURE 4-5. Drawer Assembly for (VLG) Gas/Oil (V13-34) - Firetube

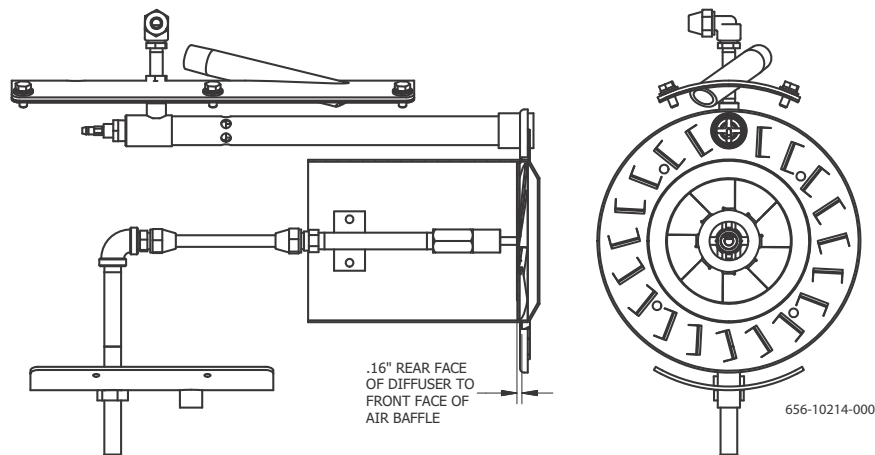


FIGURE 4-6. Drawer Assembly for (VG) Gas Only (V35-55) - Firetube

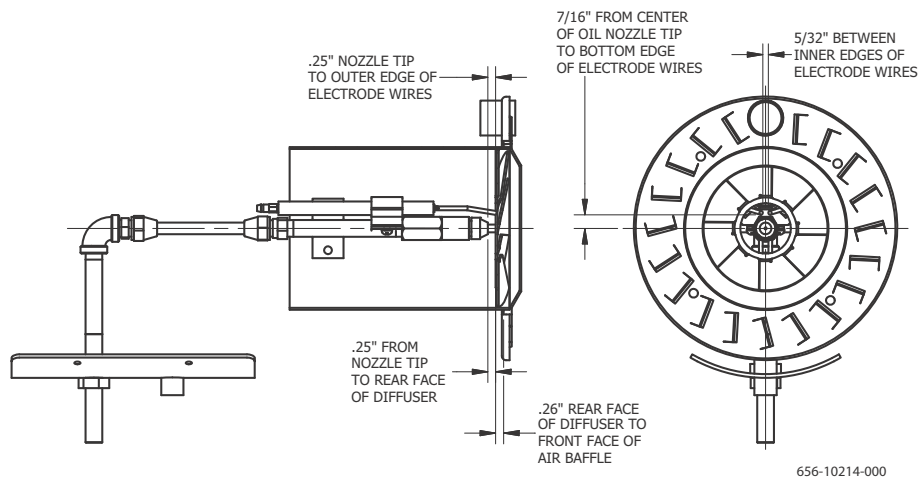


FIGURE 4-7. Drawer Assembly for (VL) Oil Only (V35-55) - Firetube

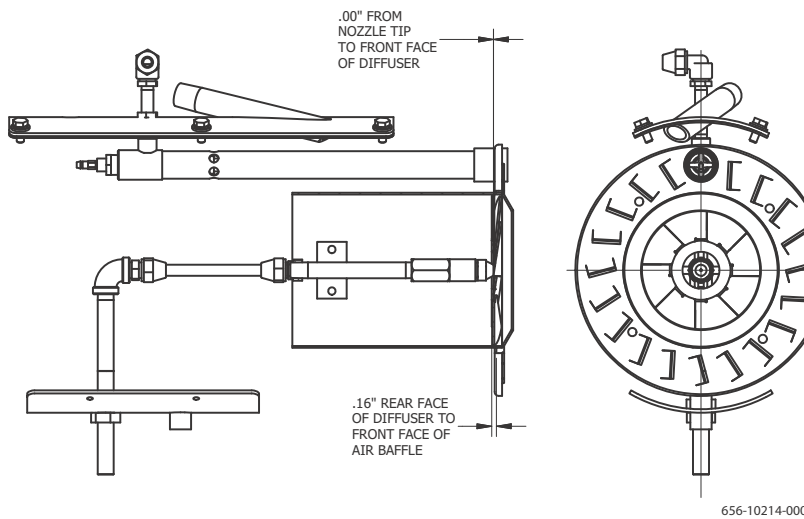
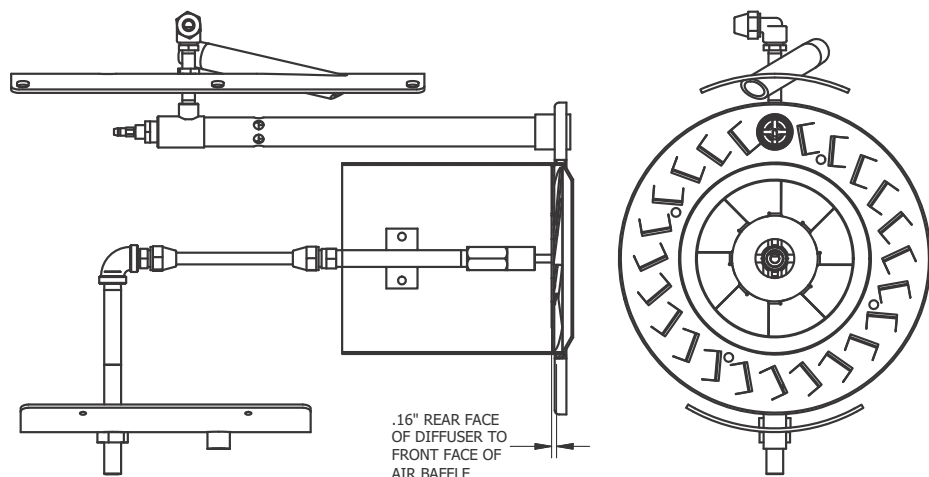
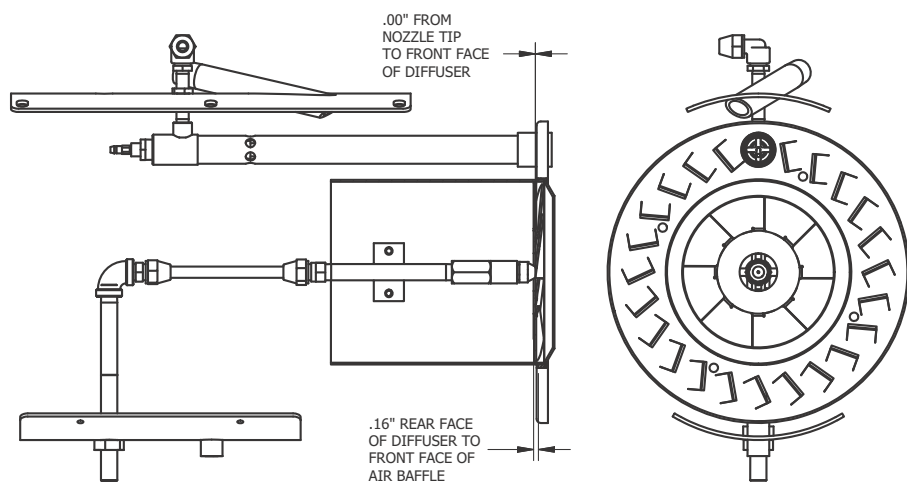


FIGURE 4-8. Drawer Assembly for (VLG) Gas/Oil (V35-55) - Firetube



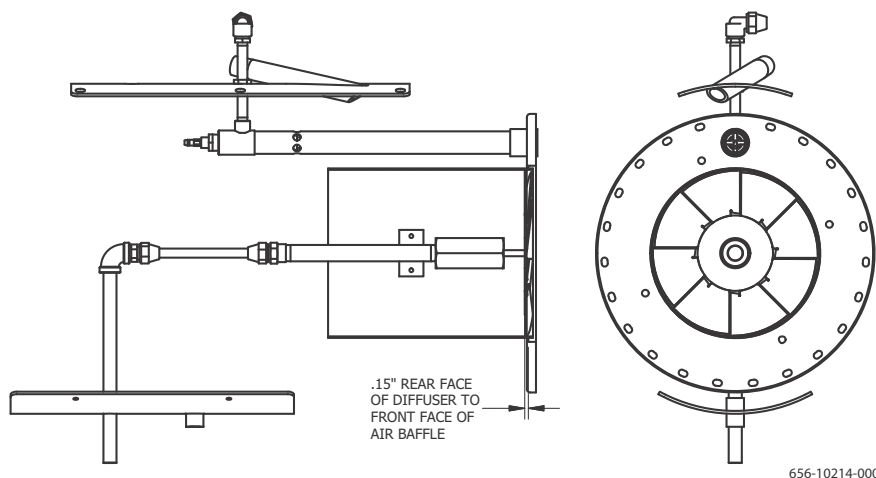
656-10214-000

FIGURE 4-9. Drawer Assembly for (VG) Gas Only (V60-110) - Firetube



656-10214-000

FIGURE 4-10. Drawer Assembly for (VLG) Gas/Oil (V60-110) - Firetube



656-10214-000

FIGURE 4-11. Drawer Assembly for (VG) Gas Only (V120-168) - Firetube

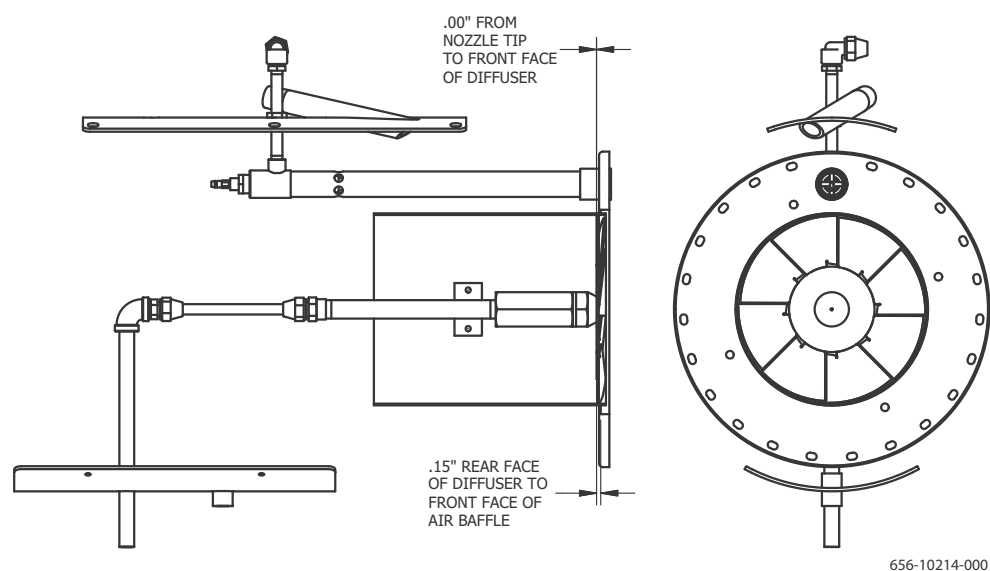


FIGURE 4-12. Drawer Assembly for (VLG) Gas/Oil (V120-168) - Firetube

4.4.6 — Drawer Assemblies for Watertube/Cast Iron Boiler Applications

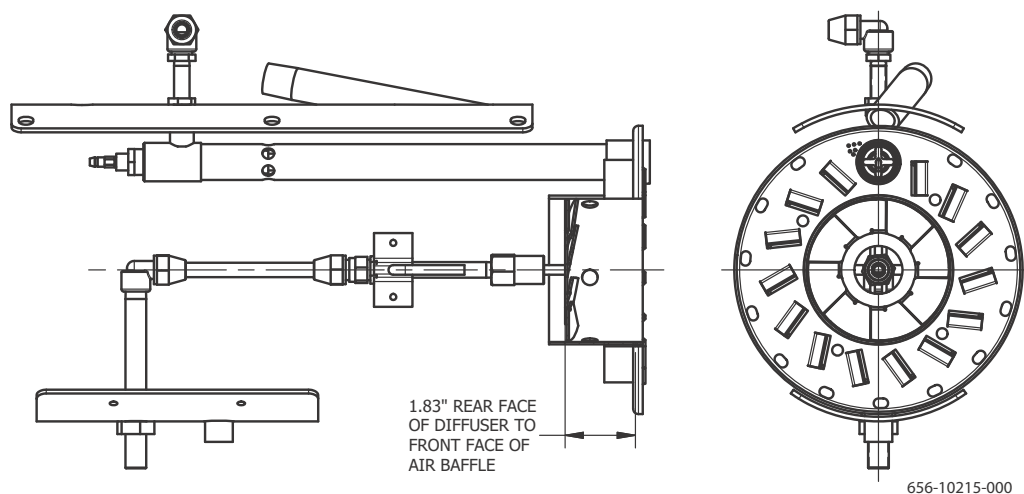


FIGURE 4-13. Drawer Assembly for (VG) Gas Only (V13-34) - Watertube/ Cast Iron

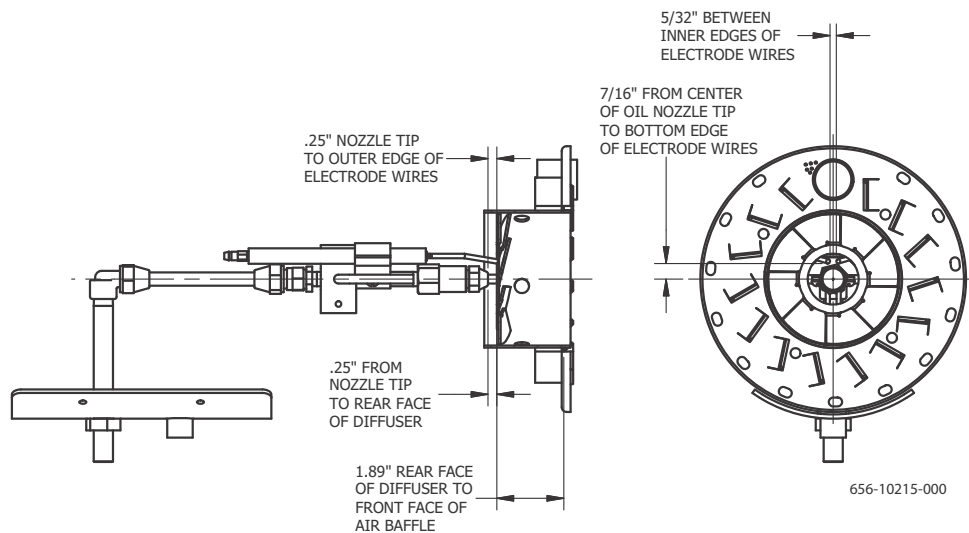


FIGURE 4-14. Drawer Assembly for (VL) Oil Only (V13-34) - Watertube/ Cast Iron

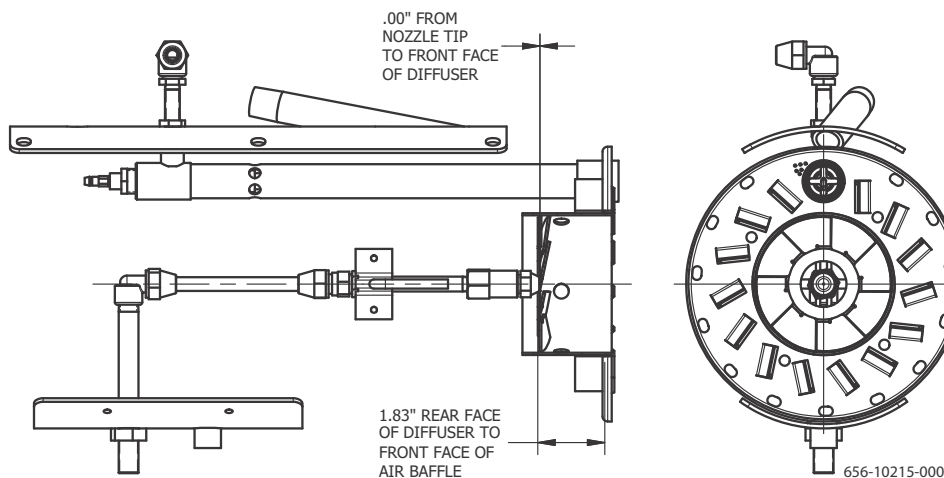


FIGURE 4-15. Drawer Assembly for (VLG) Gas/Oil (V13-34) - Watertube/ Cast Iron

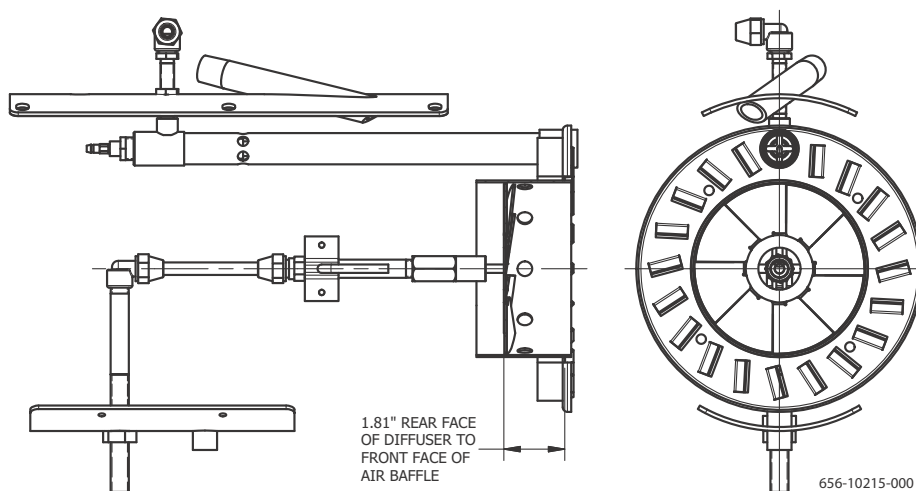


FIGURE 4-16. Drawer Assembly for (VG) Gas Only (V35-55) - Watertube/ Cast Iron

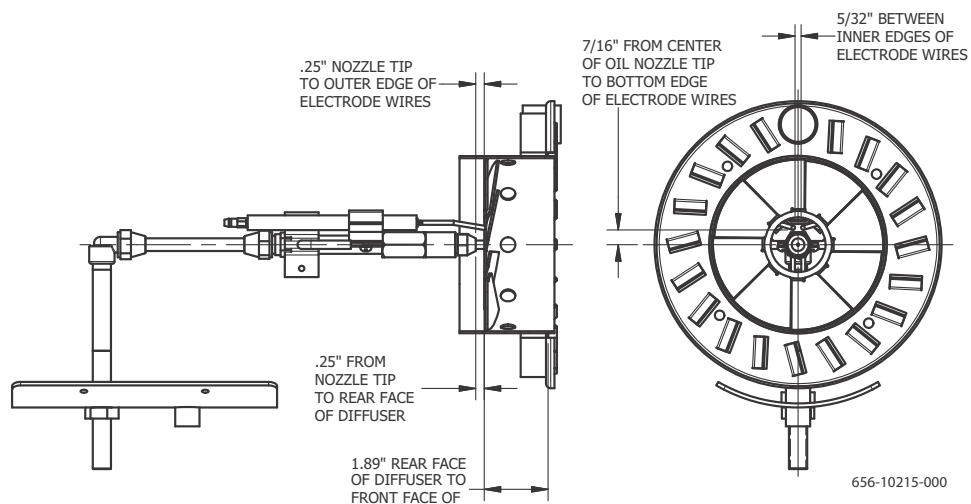


FIGURE 4-17. Drawer Assembly for (VL) Oil Only (V35-55) - Watertube/ Cast Iron

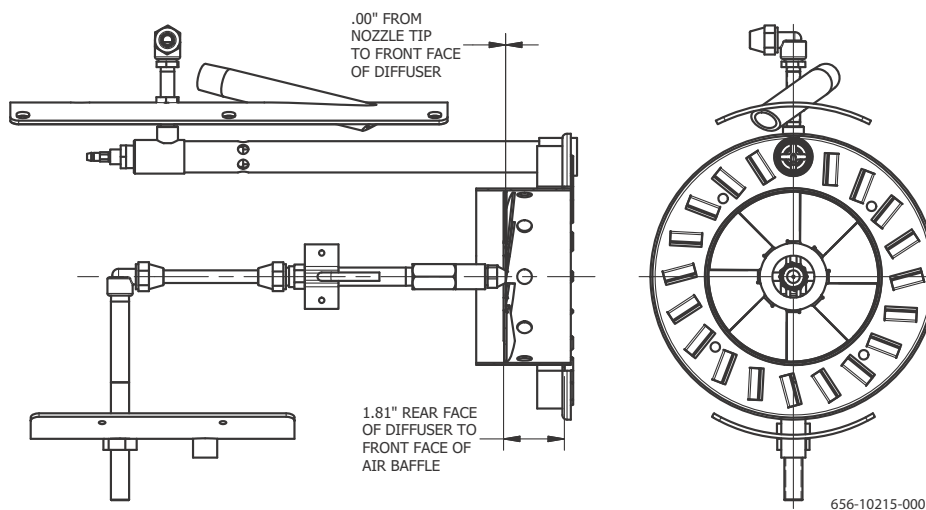


FIGURE 4-18. Drawer Assembly for (VLG) Gas/Oil (V35-55) - Watertube/ Cast Iron

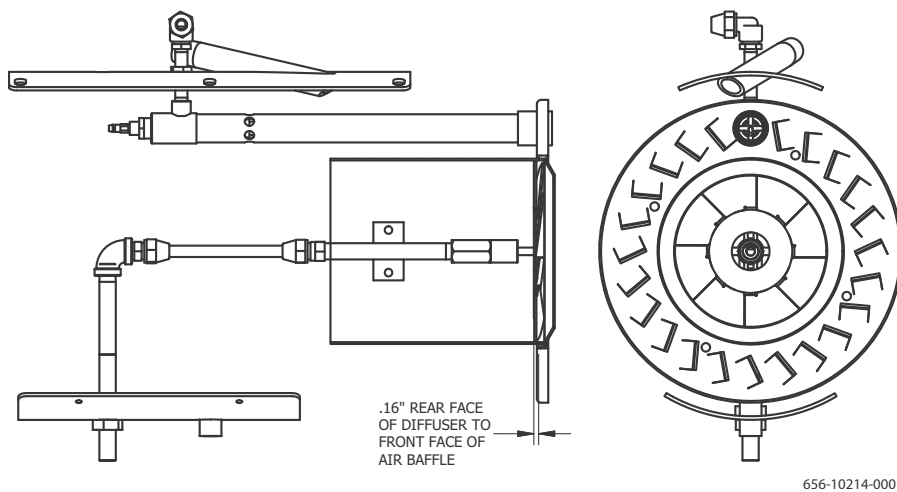


FIGURE 4-19. Drawer Assembly for (VG) Gas Only (V60-110) - Watertube/ Cast Iron

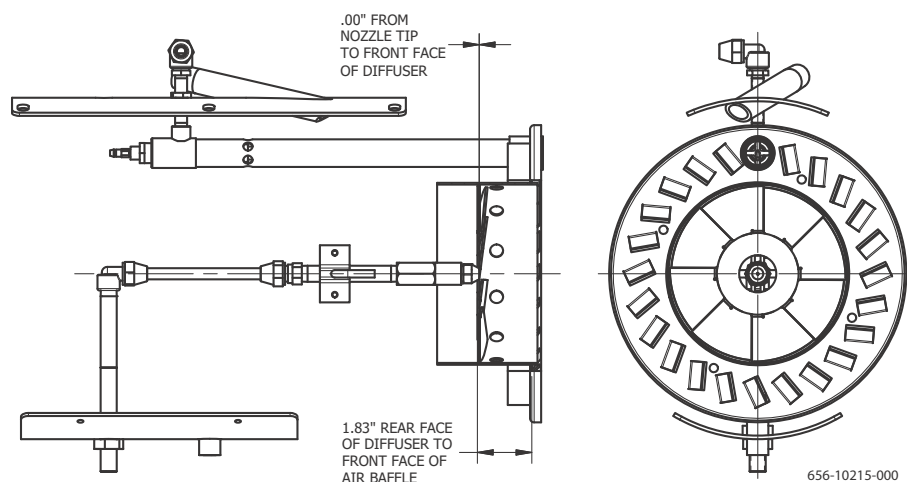


FIGURE 4-20. Drawer Assembly for (VLG) Gas/Oil (V60-110) - Watertube/ Cast Iron

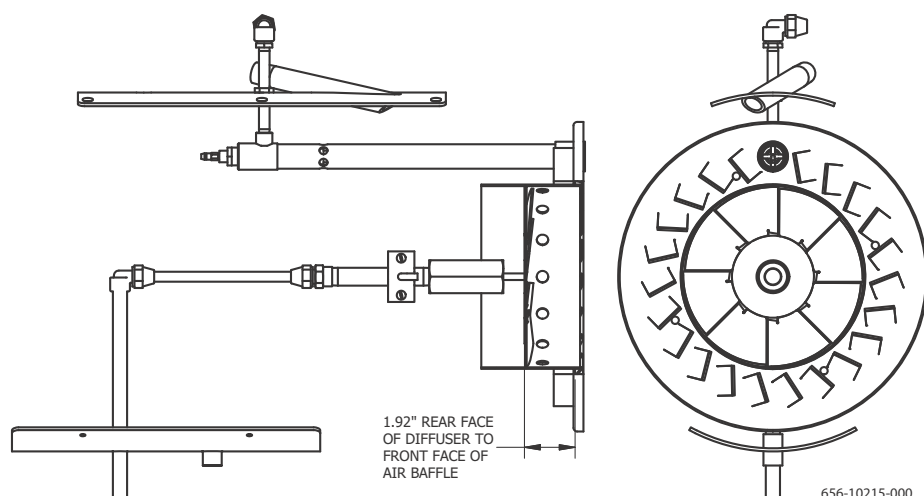


FIGURE 4-21. Drawer Assembly for (VG) Gas Only (V120-168) - Watertube/ Cast Iron

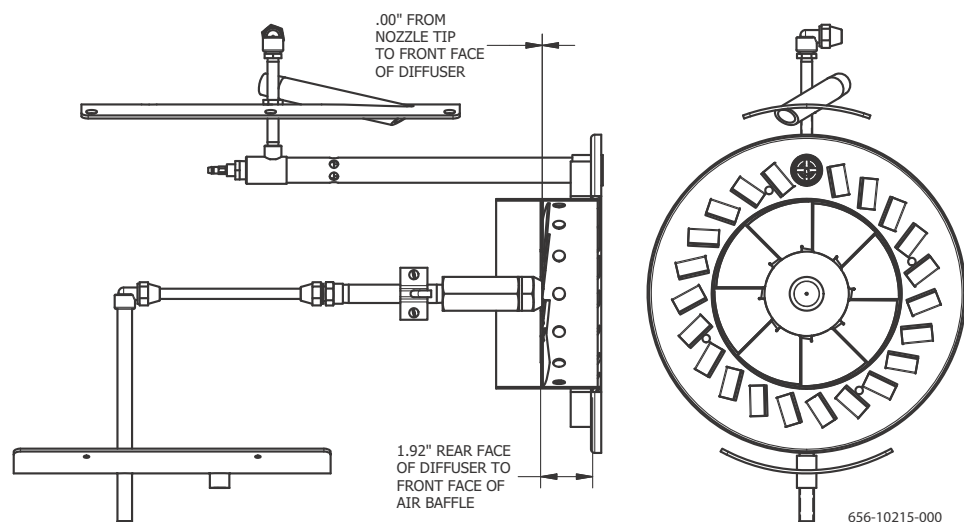


FIGURE 4-22. Drawer Assembly for (VLG) Gas/Oil (V120-168) - Watertube/ Cast Iron

4.5 — Gas System

Refer to the burner data plate located inside the control panel door. The nameplate will list the following burner information:

- burner and control voltage
- phase
- cycle
- motor amperage
- maximum and minimum fuel input settings
- manifold pressure (at zero furnace pressure - add the furnace pressure to get the correct manifold pressure at maximum firing rate)

These procedures assume that the pre-startup tasks, check list, electrical interference test, and pilot turndown tests have been performed in accordance with the instructions in this manual.

For most efficient combustion, allow the boiler to fully warm up before making adjustments. Refer to the boiler instruction manual for the boiler control settings.

4.5.1 — 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.

4.5.2 — 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.

4.5.3 — Main Gas Pressure Regulator

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

4.5.4 — 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.

4.5.5 — 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.

4.5.6 — 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.

4.5.7 — On-Off Gas Burner Adjustment

On-Off gas burners are typically equipped with a pressure regulator and a solenoid operated diaphragm gas valve to control the on-off operation of the burner. Adjustments are made by matching the correct fuel-air ratios.

1. Open the manual gas shutoff cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on top and turn the adjustment screw clockwise to increase pressure, or counterclockwise to decrease pressure.

NOTE: Maximum valve inlet pressure for the V4944 is 0.5 psi. If line pressure is greater, an over pressure device is to be installed downstream of the main gas regulator. (CSD-1-CF160)

3. Turn the burner switch to the "ON" position.
4. Adjust the burner for a smooth ignition of the main flame. The bleed valve adjustment controls the opening of the V48 valve. When the controller is not calling for heat, the coil is de-energized. The plunger in the 3-way actuator is in the "DOWN" position so the bleed port is closed and the supply port is open. Gas flows into the top part of the valve. The gas pressure on top of the diaphragm, the weight, and the

spring hold the valve closed. On call for heat, the controller contacts close and the coil is energized. This pulls the plunger to the “UP” position, opening the bleed port and closing the supply port. The gas in the top of the valve flows out through the bleed port. This reduces the pressure on top of the diaphragm, allowing the gas pressure below to lift the diaphragm and open the valve.

5. Adjust the high-fire gas input to match maximum rating. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record your readings and pressures. high-fire is typically 3.0% to 4.0% O₂ with a target value of less than 50 ppm CO.
6. After completing all adjustments, replace the regulator gaskets and slotted aluminum screw cap. Tighten all linkages and marked settings. The burner should be adjusted to provide correct fuel flow at a constant rate, as indicated on the burner data plate. Complete the Startup Report.

4.5.8 — Low-High-Off/Low Gas Burner Adjustment

The gas burner adjustments on a Low-High-Off system consist of the gas pressure regulator, gas butterfly valve, low and high gas pressure switches and an air damper assembly.

The auxiliary switch inside the M436 Mod motor makes or breaks the high-fire gas. See Figure XYZ for switch adjustment. The Low-High-Low boiler control energizes the M436 motor, driving it to high-fire. When the boiler control de-energizes the M436, a built-in return spring drives it to the low-fire position.

All gas only (VG) V13-55 models use a butterfly gas valve to control the gas flow to the burner. The M436 Mod motor controls the position of the valve.

1. Open the manual gas shutoff cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on the top and turn the adjustment screw clockwise to increase pressure, or clockwise to decrease pressure.
3. Turn the burner switch to the “ON” position. The burner will start in the low-fire position.
4. After a few seconds, the O₂ analyzer should have an accurate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4% to 6% at low-fire for standard turndown systems on gas and 6% to 9% O₂ for high turndown systems, with the target value of less than 50 ppm CO. To obtain the proper readings, adjust the air shutter and low-fire regulator pressure.
5. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).
6. Bring the burner to the high-fire position. Adjust the high-fire gas input to match maximum rating. At high-fire, the butterfly valve should be near the full open position. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record the readings and pressures. high-fire is typically 3% to 4% O₂ with less than 50 ppm CO.
7. Adjust the low and high gas pressure switches by turning the adjusting screw until the indicator moves to a pressure slightly lower than normal operating pressure for the low gas pressure switch, and slightly higher for the high gas pressure switch (usually 20% below and 20% higher than normal pressure).
8. Verify low-fire and high-fire rate by clicking the meter as previously explained.
9. After completing all adjustments, replace the regulators, gaskets, and slotted aluminum screw caps. Tighten all linkages and marked settings. The burner should be adjusted to provide correct fuel flow at a constant rate, as indicated on the burner data plate. Complete the Startup Report.

4.5.9 — Full Modulation Gas Burner Adjustment

The burner adjustments on a full modulation gas burner consist of the gas pressure regulator, butterfly gas valve, low and high gas pressure switches (model V30-168), and air dampers.

1. Open the manual gas shutoff cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on the top and turn the adjustment screw clockwise to increase pressure, or clockwise to decrease pressure.
3. Set the “MANUAL-AUTO” switch to the “MANUAL” position.
4. Position the manual flame control potentiometer in the “CLOSED” (low-fire) position.
5. Turn the burner switch to the “ON” position. The burner will start and be in the low-fire position.
6. After a few seconds, the O₂ analyzer should have an accurate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4% to 6% at low-fire for standard turndown systems on gas and 6% to 9% O₂ for high turndown systems, with the target value of less than 50 ppm CO. To obtain the proper readings, adjust the air shutter and low-fire regulator pressure.
7. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water). Then increase the fuel input to the boiler by turning the manual flame control potentiometer towards “OPEN” in small increments. This will cause the butterfly valve to open, allowing more gas into the burner.
8. At each point allow the burner to operate for a few minutes before recording the O₂, CO, and pressure readings. Observe that the O₂ and CO levels remain within an acceptable limit. Adjust the pressure regulator as necessary to correct this situation. Continue to do this until the burner reaches high-fire (the potentiometer is at the “OPEN” position).
9. Adjust the high-fire gas input to match maximum rating. At high-fire, the butterfly valve should be near the full open position. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record the readings and pressures. High-fire is typically 3% to 4% O₂ with less than 50 ppm CO as a target value.
10. Modulate the burner to low-fire. Verify the readings. The burner should be adjusted to provide correct fuel flow at a constant rate, as indicated on the burner data plate.
11. Adjust the low and high gas pressure switches by turning the adjusting screw until the indicator moves to a pressure slightly lower than normal operating pressure for the low gas pressure switch, and slightly higher for the high gas pressure switch (usually 50% below and 50% higher than normal pressure, respectively).
12. Tighten all linkages and marked settings. Complete the Startup Report.
13. Turn the “MANUAL-AUTO” switch to “AUTO”. The burner will now modulate according to the load demand to the boiler.

4.5.10 — Low NO_x Full Modulation Combination Gas Burner Adjustment

LNV burners are equipped with an FGR (flue gas recirculation) valve to lower the NO_x emissions. An adjustable cam is provided to adjust the FGR valve position throughout the firing range on gas. Follow the steps for gas from Section 4.4.12 with the following additions:

1. Make sure the FGR valve is in the nearly closed position.
2. Start the burner and hold at low-fire until the boiler is at the proper operating pressure or temperature.

3. With an analyzer in the stack, adjust the FGR valve cam screw to obtain <30 ppm NO_x levels.

NOTE: Do not adjust the burner below <20 ppm. Unstable combustion and high CO emissions will result.

4. Monitor O₂ and CO levels during this process. The introduction of FGR into the combustion chamber will lower the flue O₂ levels. Too much FGR may induce high levels of CO in the flue gas. It may be necessary to adjust the air damper blades to raise the O₂ to proper low-fire values. If the proper NO_x values can not be reached by adjusting the cam screw, the FGR linkage will have to be adjusted as well.
5. Once the low-fire setting is complete, continue with the instructions above, adjusting the cam at each screw to obtain the proper NO_x values. Verify the values modulating back to low-fire and adjust accordingly.

4.6 — Oil System

Refer to the burner data plate located inside the control panel door. The nameplate will list the following burner information:

- burner and control voltage
- phase
- cycle
- motor amperage
- maximum and minimum fuel input settings
- manifold pressure (at zero furnace pressure - add the furnace pressure to get the correct manifold pressure at maximum firing rate)

These procedures assume that the pre-startup tasks and check list have been performed in accordance with the instructions in this manual.

For most efficient combustion, allow the boiler to fully warm up before making adjustments. Refer to the boiler instruction manual for the boiler control settings.

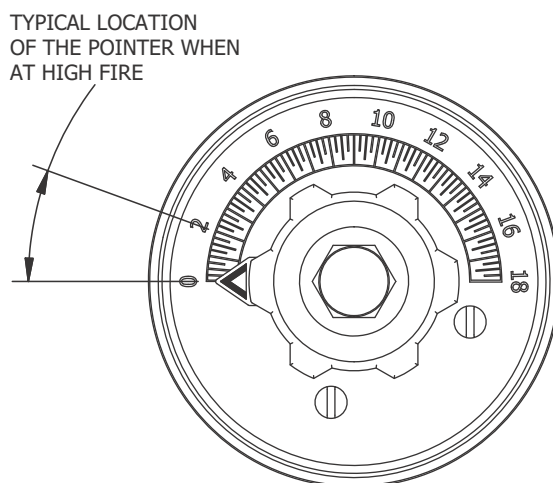


FIGURE 4-23. Oil Metering Adjustment Knob

4.6.1 — On-Off Oil Burner Adjustment

On-Off burners use the Suntec B2TC-8931 oil pump model. High-fire pressure adjustment is 200 - 300 psi (solenoid energized), and low-fire pressure adjustment is 100 - 200 psi (solenoid de-energized).

1. Briefly push in the starter contact and release to ensure that the blower motor and oil pump are rotating in the correct direction.
2. Turn the burner switch to the “ON” position.
3. Make sure a pressure gauge, 0 - 600 psi range, is installed downstream of the solenoid valves. Adjust the burner for a smooth ignition of the main flame. Disconnect the wiring to the solenoid on the Suntec B2TC-8931 oil pump. Loosen and remove the knurled nut on the solenoid. Adjust the screw, clockwise to increase the low-fire oil pressure, and counterclockwise to decrease the low-fire oil pressure, until a smooth ignition of the oil flame is obtained and a satisfactory low-fire oil flame is established. Turn the burner off and restart to ensure smooth ignition is obtained at the set low-fire pressure. Replace knurled nut and tighten finger tight.
4. Adjust the high-fire oil input to match the maximum rating. Turn the burner off and reconnect the wiring to the solenoid valve. Restart the burner and allow the burner to go through ignition and low-fire. When the solenoid energizes, the oil pump discharge pressure is at high-fire pressure. The high-fire pressure adjustment screw is located on the oil pump body. Adjust the screw, clockwise to increase the pressure and counterclockwise to decrease the pressure, until the correct amount of oil pressure is obtained. The high-fire oil pressure should be 300 psi. High-fire is typically 3.5% to 4.5% O₂, with less than No.1 smoke (Bacharach). The burner should be adjusted to provide the correct amount of fuel flow at a constant rate at high-fire position as indicated on the burner data plate located inside the control panel.
5. Tighten all linkages and marked settings. Complete the Startup Report.

4.6.2 — Low-High-Off/Low Oil Burner Adjustment

The Suntec B2TD-8842 oil pump is typically incorporated and is a two-stage, two-step oil pump. The low-fire pressure adjustment is 100 - 200 psi (solenoid de-energized). High-fire pressure adjustment is 200 - 300 psi (solenoid energized).

1. Turn the burner switch to the “ON” position.
2. Adjust low-fire with the oil pressure regulating valve to have approximately 100 to 200 psi, and adjust the air shutter for a clean fire. Record the combustion reading from the flue gas analyzer, normally 3.5% to 4.5% O₂ and less than No. 1 smoke (Bacharach). To adjust the oil pressure regulating valve, remove the lockscrew and adjust the pressure by turning the allen screw clockwise to increase pressure, and counterclockwise to decrease pressure.
3. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).
4. Adjust high-fire fuel input to match maximum oil pressure. At high-fire, the pressure should be 300 psi. Verify and record the readings and pressures. High-fire is typically 3.5% to 4.5% O₂ with less than No. 1 smoke (Bacharach). The burner should be adjusted to provide correct fuel flow at a constant rate, at the low-fire and high-fire position as indicated on the burner data plate.
5. Tighten all linkages and marked settings. Complete the Startup Report.

4.6.3 — Full Modulation Oil Burner Adjustment

The oil burner adjustments consist of the oil metering valve and air damper shutters. The oil metering valve position (indicated by a scale on the valve) will vary the oil pressure to the nozzle. Models V13 to V34 use a simplex oil nozzle, while models V35 to V168 use a return flow oil nozzle. An oil pressure gauge should be

installed in the return line to monitor the oil pressure. At low-fire, the pressure range in the return line should be between 40 and 80 PSI with the oil metering valve position set between 6 and 8 on the scale. At high-fire, the return line pressure will vary from 135 to 200 PSI dependent upon the brand of the oil nozzle. At high-fire, the oil metering valve position will be approximately 2 on the scale.

1. Set the “MANUAL-AUTO” switch on the “MANUAL” position.
2. Position the manual flame control potentiometer in the “CLOSED” (low-fire) position.
3. Turn the burner switch to the “ON” position. The burner will start and be in the low-fire position.
4. Adjust low-fire with the metering valve position to have approximately 80 to 90 psi, and adjust the low-fire air shutter for a clean fire. Record the combustion reading from the flue gas analyzer, normally 4.5% to 6.5% O₂ and less than No. 1 smoke (Bacharach).
5. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water). Then increase the fuel input to the boiler by turning the manual flame control potentiometer towards “OPEN” in small increments. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle.
6. At each point, allow the burner to operate for a few minutes before recording the O₂, CO, smoke, and pressure readings. Observe that your O₂ and CO levels remain within an acceptable limit. Adjust the oil pressure as necessary to correct this situation. For burners with the cam trim option, adjust the cam screws throughout the range to obtain correct O₂ and CO levels. Continue to do this until the burner reaches high-fire (the potentiometer is at the “OPEN” position).
7. Adjust the high-fire fuel input to match maximum oil pressure. At high-fire, the metering valve should be in the fully closed position and the pressure should be 300 psi. Verify and record the readings and pressures. high-fire is typically 3.5% to 4.5% O₂ with less than No. 1 smoke (Bacharach). Adjust the high-fire excess air rate using the high-fire shutter adjustment.
8. Modulate the burner to low-fire. Verify the readings once again. The burner should be adjusted to provide correct fuel flow at a constant rate, at the low-fire and high-fire position as indicated on the burner data plate.
9. Tighten all linkages and marked settings. Complete the Startup Report.
10. Turn the “MANUAL-AUTO” switch to “AUTO”. The burner will now modulate according to the load demand to the boiler.

4.7 — Combination Gas-Oil System

In general, the combination fueled system is to be started first using oil, because as a fuel, oil has a greater combustion air requirement than natural gas. After being completely adjusted for oil combustion, the burner is restarted and adjusted using natural gas as fuel. Combustion adjustment of the combination burner for natural gas involves balancing the input rate only against the existing flow of combustion air, as established initially for oil.

NOTE: Do not readjust the air shutter when turning the combination burner for combustion of natural gas.

NOTE: For burners equipped with a Siemens modulation motor, fuel-air adjustments for each fuel are independent of each other. Refer to the Siemens modulating motor product literature for proper adjustment.

4.7.1 — On-Off Combination Gas-Oil Burner Adjustment

1. Turn the fuel selector switch to the “OIL” position.
2. Turn the burner switch to the “ON” position.
3. Proceed with startup and adjustments using the same procedures as explained in Section 4.5.1.
4. After the system has been completely adjusted for oil firing, place the burner switch to “OFF” and position the fuel selector switch to “GAS”.
5. Proceed with startup and adjustments using the same procedures as explained in Section 4.4.10. Do not alter the air settings set for oil.

4.7.2 — Low-High-Off/Low Combination Gas-Oil Burner Adjustment

1. Turn the fuel selector switch to the “OIL” position.
2. Turn the burner switch to the “ON” position.
3. Proceed with startup and adjustments using the same procedures as explained in Section 4.5.2.
4. After the system has been completely adjusted for oil firing, place the burner switch to “OFF” and position the fuel selector switch to “GAS”.
5. Proceed with startup and adjustments using the same procedures as explained in Section 4.4.11. Do not alter the air settings set for oil. Correct the O₂ levels by adjusting the butterfly valve for models V35-55, and the regulators low and high pressures for models V13-34.

4.7.3 — Full Modulation Combination Gas-Oil Burner Adjustment

1. Set the “MANUAL-AUTO” switch to the “MANUAL” position.
2. Position the manual flame control potentiometer in the “CLOSED” (low-fire) position.
3. Turn the fuel selector switch to the “OIL” position.
4. Turn the burner switch to the “ON” position.
5. Proceed with startup and adjustments using the same procedures as explained in Section 4.5.3.
6. After the system has been completely adjusted for oil firing, place the burner switch to “OFF” and position the fuel selector switch to “GAS”.
7. Proceed with startup and adjustments using the same procedures as explained in Section 4.4.12. Do not alter the air settings set for oil. Correct the O₂ levels by adjusting the butterfly valve.

4.8 — Modulation Control**4.8.1 — Linkage Control Adjustment**

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 linkage.
- Lever and rod adjustments should be made with the motor in 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.

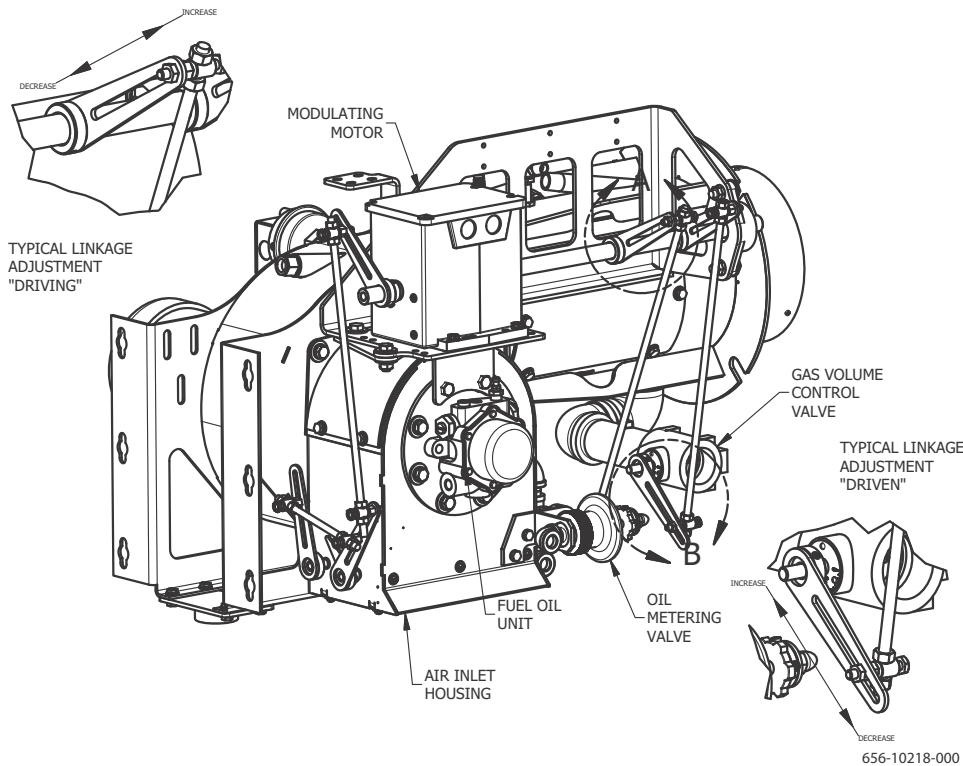


FIGURE 4-24. Linkage Adjustment

4.8.2 — 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.

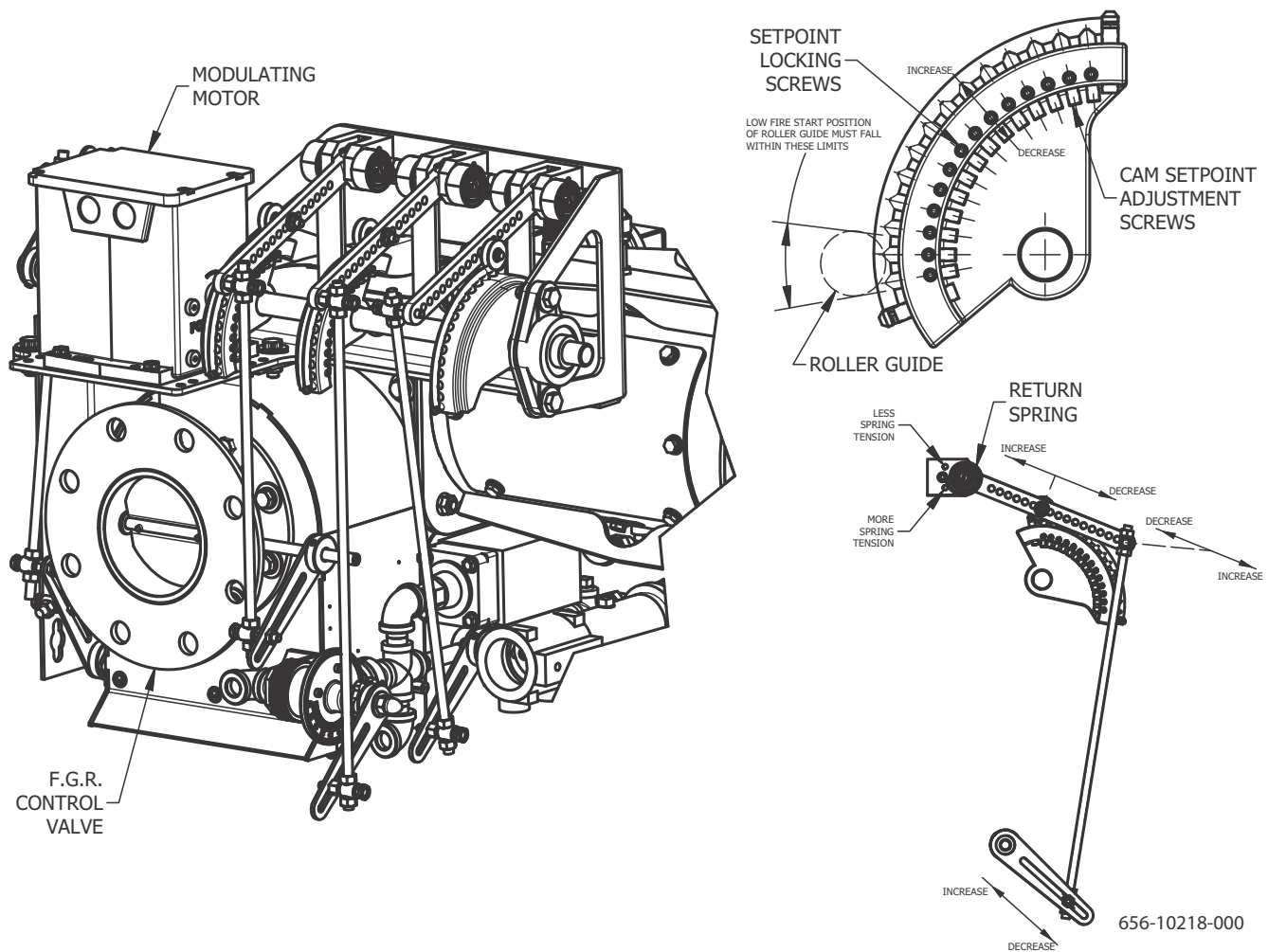


FIGURE 4-25. Cam Trim Adjustment

4.8.3 — 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 — Air and Fuel Controls

4.9.1 — Air Flow Control

The V series burners have a two-blade air shutter design. Both blades are coupled together and are attached to the modulation motor. Changing the positions of the linkage rods on the linkage control arms will change the way the damper blades open and close.

4.9.2 — Fuel and Air Flow Settings

Fuel and air flow rates can be individually adjusted at low-fire and high-fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (air temperature, humidity, barometric pressure), and fuel property changes. Adjustments may be required to meet certain environmental emissions criteria, such as NO_x or CO. Combustion adjustments also vary with specific system applications.

Turndown capability for oil is less than that of natural gas. On combination fueled burners, gas turndown performance may be restricted by the excess air and fuel turndown levels set for oil combustion.

Excess air (O₂) and unburned fuel (CO) levels in boiler flue gases are used to determine combustion efficiency and fuel and air input adjustments. The system should be adjusted to a minimum excess air quantity that provides low levels of unburned fuel with sufficient remaining O₂ to cope with normal atmospheric and fuel related changes. Unburned fuel is measured as CO when burning natural gas, and smoke spots when burning oil.

The burner should be set up and maintained to yield smoke spot levels less than No. 1 spot (ASTM D2156 Shell Bacharach Scale) to minimize soot and buildup in the boiler.

 Warning

Keep fingers away from the air inlet area of the damper. The damper is actuated with sufficient force to cause severe injury.

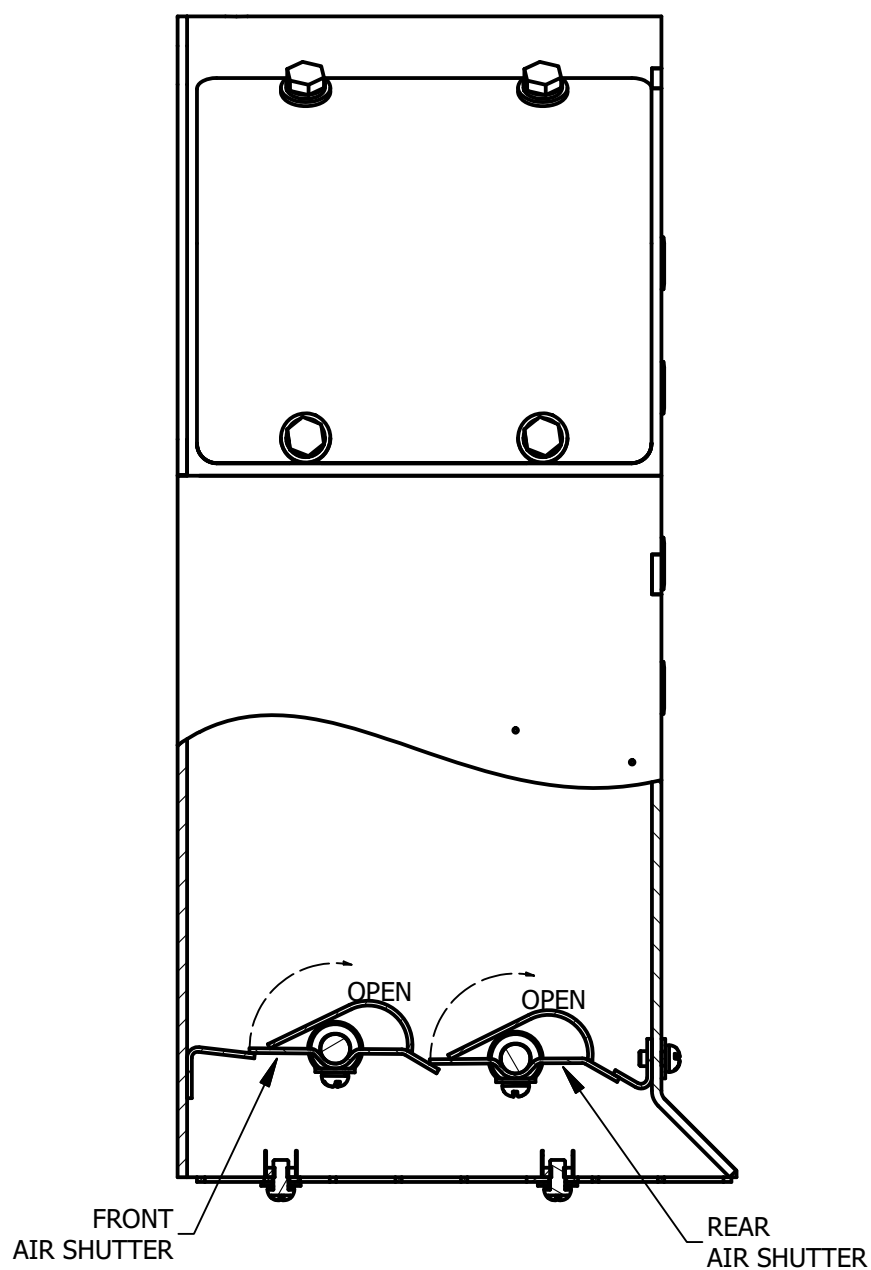


FIGURE 4-26. Front and Rear Shutters

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

 Warning

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

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

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

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

5.2 — Control System

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

Warning

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

5.2.1 — Programming Control

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

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

5.3 — Air Handling System

A balanced blower wheel requires minimal maintenance. Check for dirt buildup and clean the blades as required. Inspect the impeller hub and blades for cracks. Replace if any are noticed. Make sure the air inlet cone fits inside the impeller.

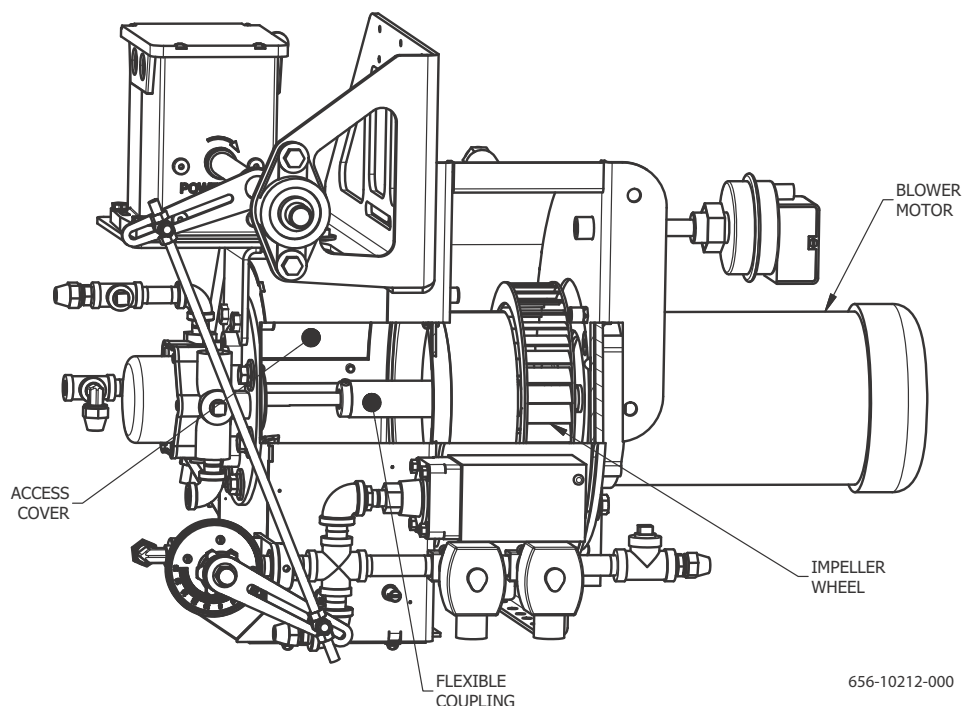


FIGURE 5-1. Air Handling System

5.4 — 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.

5.5 — Firing Head Inspection

Open side access panels to view the drawer assembly. 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.

If fibrous material is discovered in the gas spud ports, remove the gas spud and back flush with shop air. Further inspection of gas piping and gasket connections must be made to isolate the contaminate source. Be sure to orientate the gas spuds in the correct position when reassembling the gas spuds.

5.5.1 — Drawer Assembly

The drawer assembly may be removed for inspection and/or service. For drawer assembly drawings, refer to section 4.4.4 for firetube applications and 4.4.5 for watertube or cast iron applications.

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

5.6 — Pilot and Ignition Electrode

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

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

On direct spark oil units, once the drawer assembly has been removed, check the electrode to nozzle gap and adjust if necessary. Refer to the pilot and drawer assembly drawings in Chapter 4.

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

1. Close the gas pilot cock.
2. Disconnect the pilot gas supply line.
3. Remove the screws on the pilot access plate.
4. Disconnect the pilot gas supply line.
5. Remove the screws on the pilot access plate.
6. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly.
7. The pilot gun assembly will slide back away from the flame side of the burner.
8. Once the pilot assembly is clear of the burner head bracket, turn the pilot assembly and retract it through the access hole.
9. Inspect the electrode and adjust the gap if necessary.
10. Thoroughly clean and adjust the porcelain insulated electrodes.
11. Correct all variations from the clearance dimensions.
12. If the insulation on the high voltage cables becomes cracked or charred, install new cables. Ignition cable should not be exposed to moisture, abrasion, or rough handling.
13. See that the connectors are in perfect contact with the cable end. Unscrewing the snap portion of the connector will show whether this is true.

5.7 — Flame Scanner

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

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.

5.8 — Oil Nozzle

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

5.9 — 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 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.

5.10 — 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.

5.11 — Burner Mounting Inspection

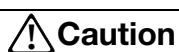
The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. If leaking occurs, refer to Chapter 2 for proper sealing procedures.

5.12 — Oil System

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

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

5.13 — Gas System



All power must be disconnected before servicing the valves.

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

5.13.1 — Solenoid Valves

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

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

5.13.2 — 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 operations.

5.14 — Electrical System

Because of the many types of flame safeguard systems applicable to this equipment, complete descriptions of all 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.

5.14.1 — 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.

5.15 — Checking Flame Failure

5.15.1 — Pilot Flame Failure

1. Shut off the main fuel supply and close the gas pilot shutoff cock.
2. The pilot ignition circuit will be energized at the end of the pre-purge period. There should be an ignition spark, but no flame. Since there is no flame to be detected, the program relay will signal the condition.
3. The ignition circuit will de-energize and the control will lock out on a safety shutdown and the flame failure light will be activated.
4. The blower will run through post-purge and stop. Turn the burner switch off and reset the safety switch. Re-open the gas pilot shutoff cock and re-establish main fuel supply.

5.15.2 — Failure to Light Main Flame

1. Shut off the main fuel supply and leave the gas pilot shutoff cock open.
2. Turn the switch on. The pilot will light upon completion of the pre-purge period. The main fuel valves will be energized, but there should be no main flame.
3. The fuel valves de-energize within four seconds after the main burner ignition trial ends. The control will lock out on a safety shutdown.
4. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge and stop. Turn the burner switch off and reset the safety switch. Re-establish main fuel supply.

5.15.3 — Loss of Flame

1. With the burner in normal operation, shut off the main burner fuel supply to extinguish main flame.
2. The fuel valves will be de-energized and the relay will signal the condition within four seconds. The control will then lock out on a safety shutdown.
3. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge period and stop.

Turn the burner switch off and reset the safety switch. Re-establish the main fuel supply.

5.16 — 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 burner control and store in a dry area.

5.17 — Maintenance Flow Chart Recommended Test Schedule

Item	Service By	Remarks
DAILY		
Gauges, Monitors, Indicators	Operator	Make Visual Inspection and record readings in log.
Instrument and Equipment Settings	Operator	Make visual check against recommended specifications.
Low Water, Fuel Cutoff and Alarms	Operator	Refer to instructions.
WEEKLY		
Firing Rate Control	Operator	Verify factory settings.
Igniter	Operator	Make visual inspection. Check flame signal strength.
Pilot and Main Fuel Valves	Operator	Open limit switch. Make audible and visual check. Check valve position indicators, 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 linkages for tightness. Tighten if required.
MONTHLY		
Low Fan Pressure Interlock	Operator	Manually adjust until switch opens.
High and Low Gas Pressure Interlocks	Operator	Refer to instructions. Manually adjust until switch opens.
Scanner and Diffuser	Operator	Check, inspect and clean for soot buildup.
Pilot Assembly	Operator	Check for loosening of components, erosion or carbon buildup.
ANNUALLY		
Strainer (Oil Units)	Operator	Replace or clean the oil strainer element.
Impeller	Operator	Inspect and clean the combustion impeller.
Combustion Test	Service Tech	Perform a complete combustion test. Adjust burner if necessary. Read and log data.
Pilot Turndown Test	Service Tech	Required after any adjustment to flame, scanner, or pilot adjustment.
Operating Controls	Service Tech	Refer to instructions.

 Warning

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

 Warning

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

6.1 — Awareness

Chapter 6 assumes that:

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

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

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

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

Familiarity with the programmer and other controls in the system may be obtained by studying the contents of this manual. Knowledge of the system and its controls will make troubleshooting that much easier. Costly downtime or delays can be prevented by systematic checks of actual operation against the normal

sequence to determine the stage at which performance deviates from normal. By following a set routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

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

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 person injury or death may result.

 Warning

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

6.2 — Emergency Shutdown

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

6.3 — Troubleshooting

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

Problem	Possible Causes
Pilot Flame, but No Main Flame	1. Insufficient pilot flame.
	2. Gas fired unit: a. Manual gas cock closed. b. Main gas valve inoperative. c. Gas pressure regulator inoperative.
	3. Oil fired unit: a. Oil supply cut off by obstruction, closed valve, or loss of suction. b. Supply pump inoperative. c. No fuel. Broken, loose, or missing oil pump coupling. d. Main oil valve inoperative. e. Check oil nozzle, gun, and lines.
	4. Flame detector defective, sight tube obstructed or lens dirty.
	5. Insufficient or no voltage at main fuel valve circuit terminal.
Burner Stays in Low-Fire	1. Pressure or temperature above modulating control setting.
	2. Manual-automatic switch in wrong position.
	3. Inoperative modulating motor.
	4. Defective modulating control.
	5. Binding or loose linkages, cams, setscrews, etc.
Shutdown Occurs During Firing	1. Loss or stoppage of fuel supply.
	2. Defective fuel valve, loose electrical connection.
	3. Flame detector weak or defective.
	4. Scanner lens dirty or sight tube obstructed.
	5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
	6. If the programmer lockout switch has tripped: a. Check fuel lines and valves. b. Check flame detector. c. Check for open circuit in running interlock circuit. d. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.
	7. Improper air/fuel ratio (lean fire). a. Slipping linkage. b. Damper stuck open. c. fluctuating fuel supply. - Temporary obstruction in the fuel line. - Temporary drop in gas pressure.
	8. Interlock device inoperative or defective.
	9. Air in the oil lines. Bleed lines.

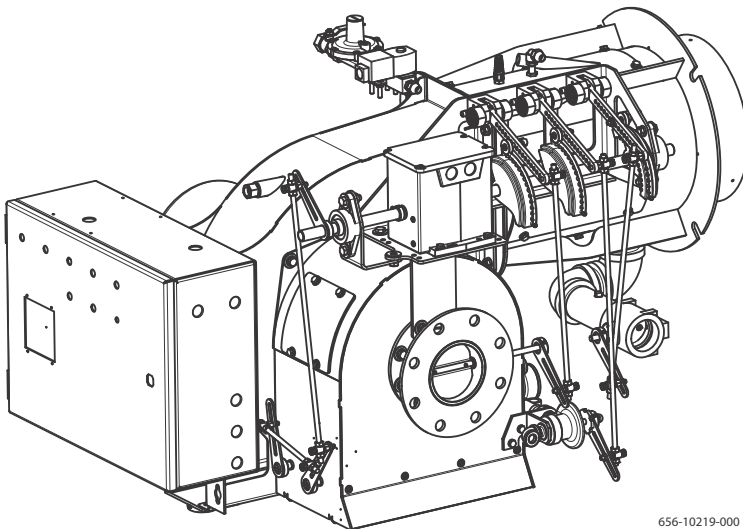
Problem	Possible Causes
Modulating Motor Does Not Operate	1. Manual/automatic switch in wrong position.
	2. Linkage loose or jammed.
	3. Motor does not drive to open or close during pre-purge or close on burner shut-down. a. Motor defective. b. Loose electrical connection. c. Damper motor transformer 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.

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 Industrial Combustion service representative.

7.1 — Description

The LVN burner is designed to guarantee low emissions of <30 ppm NO_x and <50 ppm CO, corrected at 3% O₂ when firing natural gas. The burner features an induced Flue Gas Recirculation system (FGR). The flue gases of the boiler are recirculated through the burner using the combustion air impeller to draw the exhaust gases from the stack through the FGR duct and mix them with incoming fresh air. An electrically actuated damper controls the flow of FGR to fine tune the FGR/fresh air ratio.

Ducting from the stack or boiler to the burner is done by others. All FGR duct piping should be covered with a minimum of 2" of insulation. The following controls are used in the FGR duct for safe operation of the system.



656-10219-000

FIGURE 7-1. General Layout of the Burner

7.2 — FGR Duct Sizing

Ducting from the stack or boiler to the burner is done by others. Typical sizing for the FGR ducts is shown below. All FGR duct piping should be covered with a minimum of 2" of insulation. The following controls are used in the FGR duct for safe operation of the system.

Minimal Pipe Size (Schedule 10 Pipe) (in.)								
Burner Model	Maximum Feet From Burner to Boiler Stack							
	20'	30'	40'	50'	75'	100'	150'	200'
LVN-SIZE-1	4	4	4	4	6	6	6	6
LVN-SIZE-2	4	4	4	4	6	6	6	6
LVN-SIZE-3	4	4	4	4	6	6	6	6
LVN-SIZE-4	6	6	6	6	8	8	8	8

Equivalent Lineal Feet for Schedule 10 Pipe Fittings (ft.)							
Pipe Fittings	Nominal Pipe Size						
	6"	8"	10"	12"	14"	16"	18"
45° Elbow	8.0	10.7	13.3	16.0	18.7	21.3	24.0
90° 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.

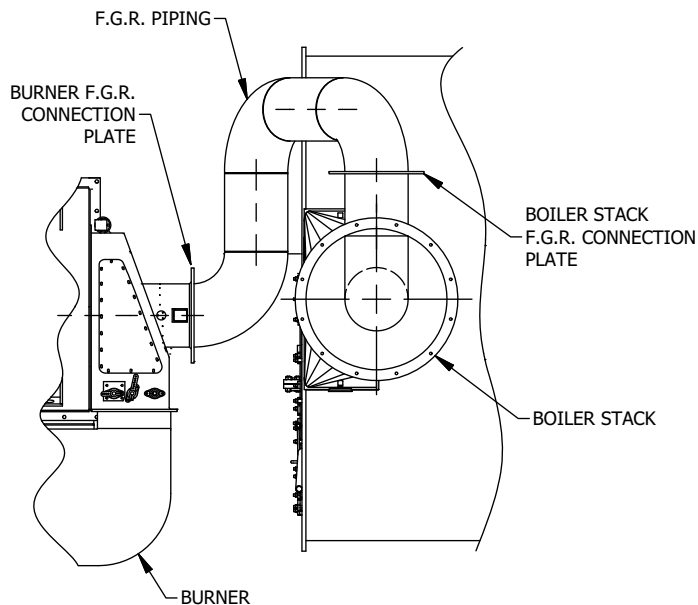
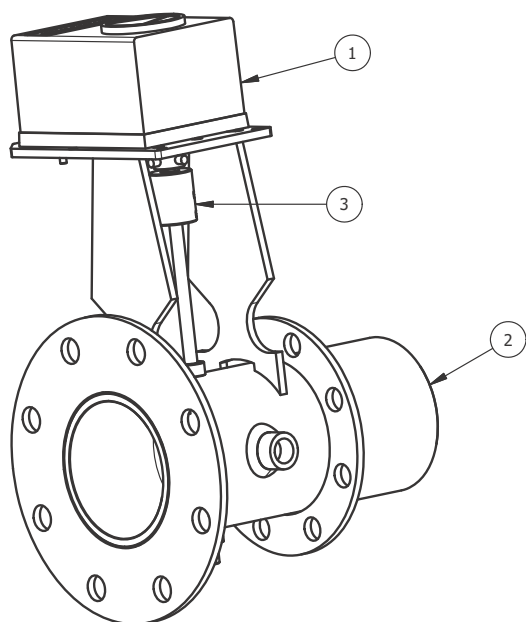


FIGURE 7-2. FGR Connection to Boiler Top View

7.3 — FGR Shutoff Valve

The FGR shutoff valve is located as close to the stack as possible. A modutrol motor with a 90° 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 150° 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.



- 1. MODUTRON MOTOR
- 2. F.G.R. SHUTOFF VALVE
- 3. COUPLER, ASSEMBLY

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FIGURE 7-3. FGR Shutoff Valve

7.4 — 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 actuator with linkage connections coordinates the air, fuel and NO_x control devices to provide proper fuel/air/NO_x ratios through the firing range. The actuator must be able to complete its full travel range. Restrictions will damage the motor and/or the linkage. The actuator transmits motion directly to the FGR control valve.

7.4.1 — Low NOx Full Modulation Combination Gas-Oil Burner Adjustment

LNV burners are equipped with an FGR valve to lower the NOx emissions. An adjustable cam is provided to adjust the FGR valve position throughout the firing range on gas. Follow the steps for gas from Section 4.4.12 with the following additions:

1. Make sure the FGR valve is in the nearly closed position.
2. Start the burner and hold at low-fire until the boiler is at the proper operating pressure or temperature.
3. With an analyzer in the stack, adjust the FGR valve cam screw to obtain <30 ppm NOx levels.

NOTE: Do not adjust the burner below <20 ppm. Unstable combustion and high CO emissions will result.

4. Monitor O₂ and CO levels during this process. The introduction of FGR into the combustion chamber will lower the flue O₂ levels. Too much FGR may induce high levels of CO in the flue gas. It may be necessary to adjust the air damper blades to raise the O₂ to proper low-fire values. If the proper NOx values can not be reached by adjusting the cam screw, the FGR linkage will have to be adjusted as well.

Once the low-fire setting is complete, continue with the instructions above, adjusting the cam at each screw to obtain the proper NOx values. Verify the values modulating back to low-fire and adjust accordingly.

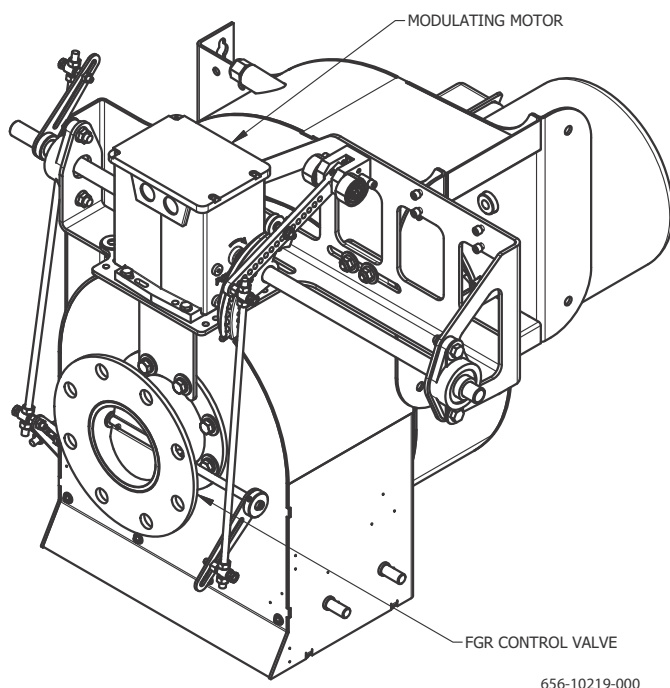
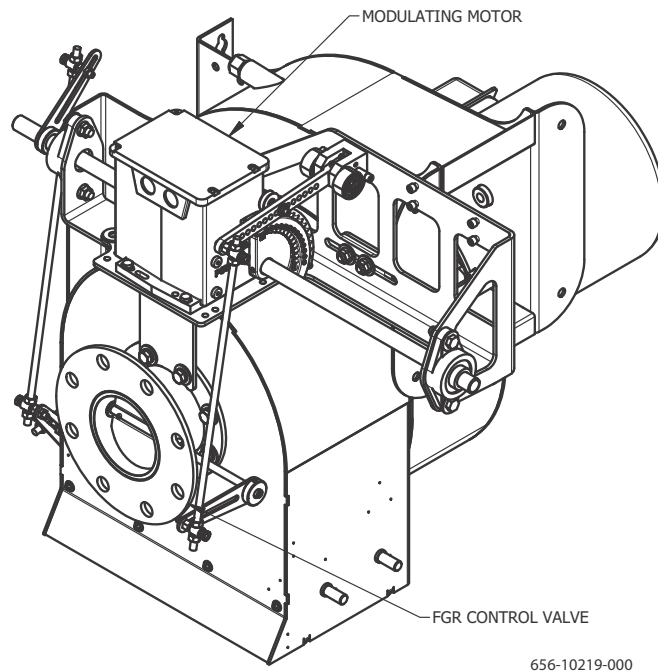


FIGURE 7-4. FGR Control Valve - Low-Fire Position



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FIGURE 7-5. FGR Control Valve - High-Fire Position

7.5 — 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.

7.6 — 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° F below the minimum stack temperature at low fire (nominal 200° F). After the stack temperature rises above the set point, the interlock closes and allows the burner to modulate.

7.7 — 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 200° F maximum. An external scanner is used on the low emission burners.

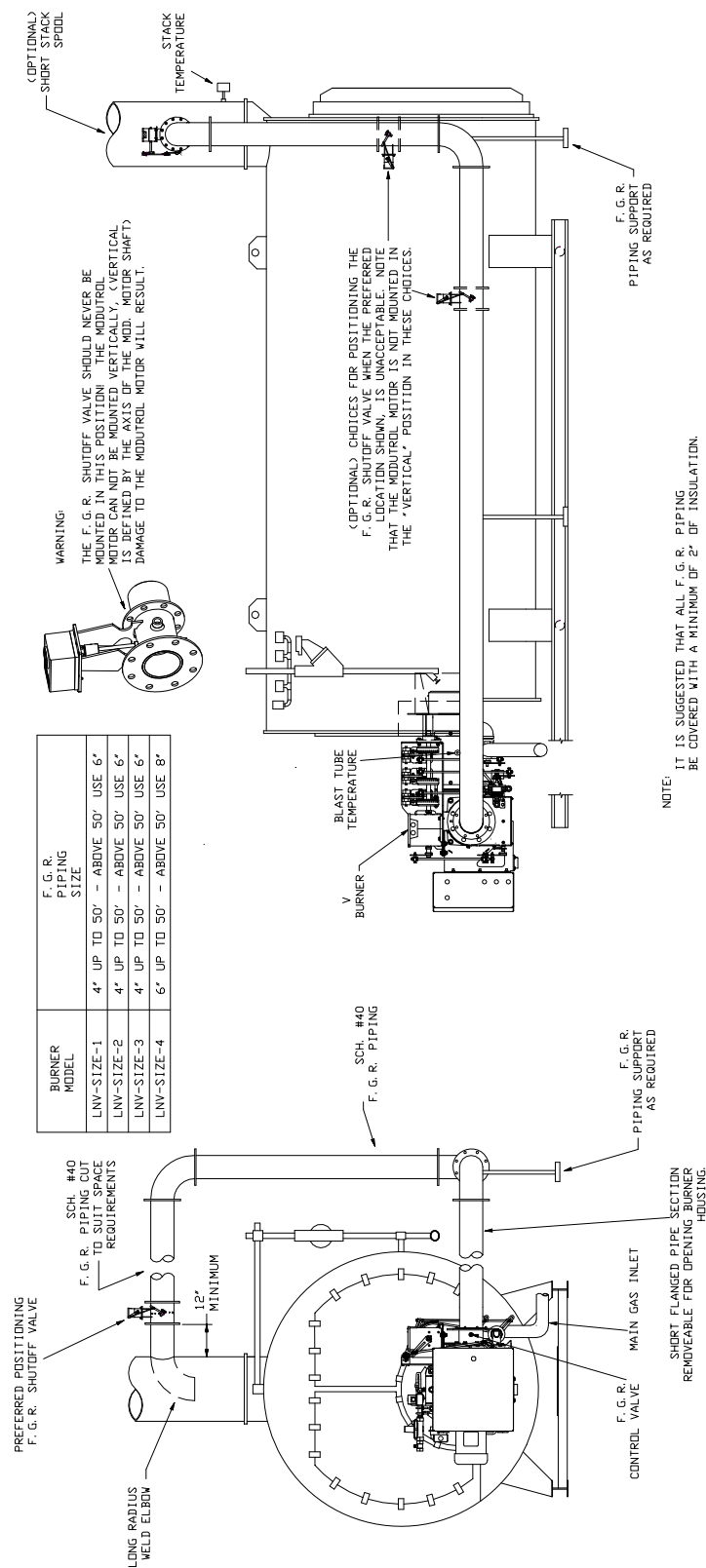


FIGURE 7-6. Temperature Interlocks

Warranty Policy

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

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

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

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

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

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

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

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

Startup/Service Report

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

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

Burner Model _____ Serial Number _____ Startup Date _____

Electric Motors	Voltage			Amperage		
	L1	L2	L3	L1	L2	L3
Control Voltage						
Blower Motor						
Air Compressor						
Air-Oil or Metering						
Test Conducted	Gas			Oil		
	Low	50%	High	Low	50%	High
Firing Rate MMBtu/gph						
Stack Temp (gross) ° F						
Room Temp ° 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 ° 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)

