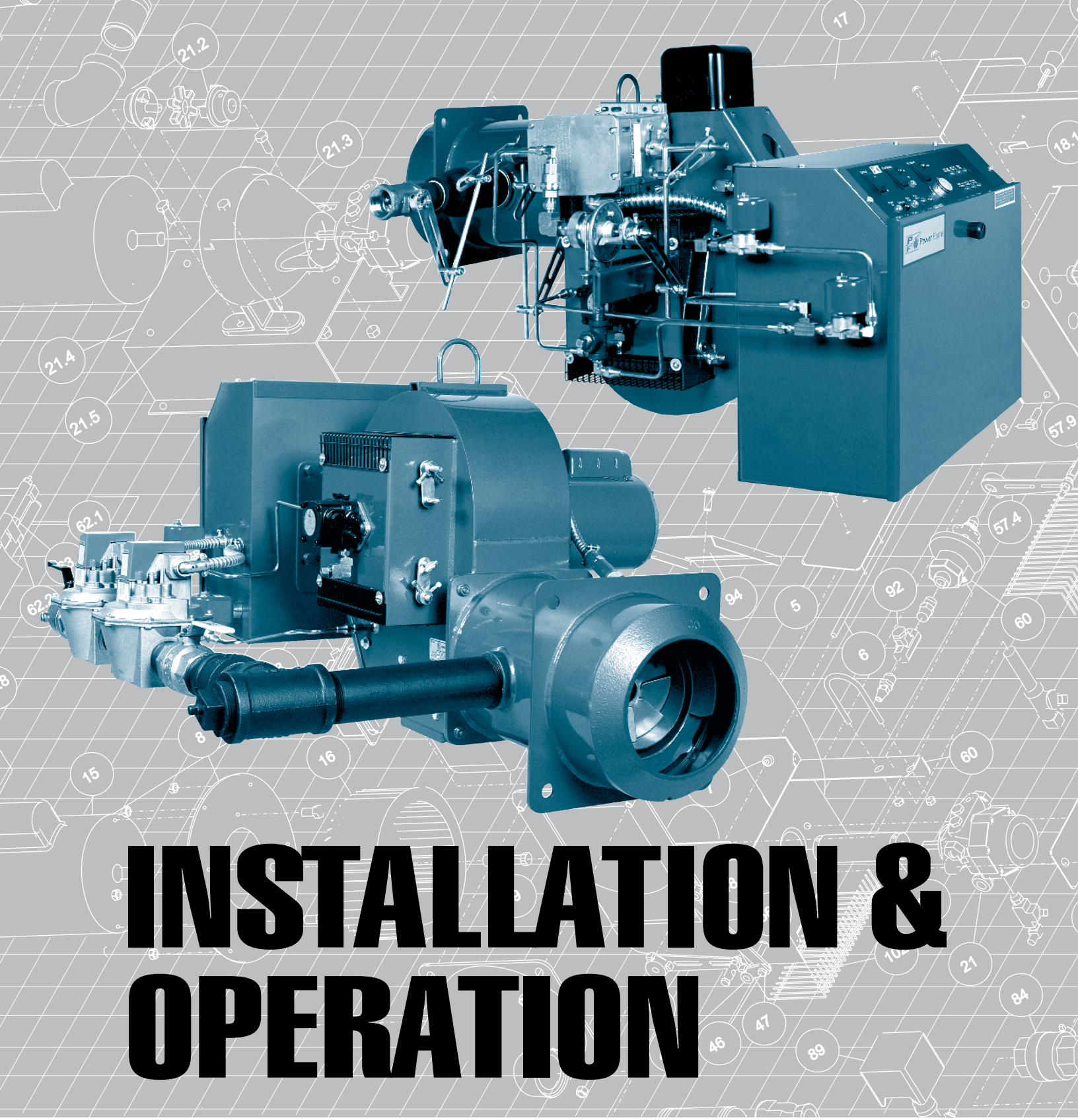


INSTALLATION & OPERATION

C MANUAL

POWER FLAME INCORPORATED

FOR YOUR SAFETY

If you smell gas:
1. Open windows.
2. Do not touch electrical switches.
3. Extinguish any open flame.
4. Call your gas supplier immediately.

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

WARNING

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

NOTICE

Effective 4/1/94 Underwriters Laboratories require that all gas burners firing at inputs of 2,500 MBH and under be supplied with two gas safety valves or one gas valve with proof of closure (Valve seal over travel). The photos in this manual may not depict these specific components. All U.L. listed products shipped after 4/1/94 will comply with the U.L. requirements.

IMPORTANT

THE INSTALLATION OF A BURNER SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF AUTHORITIES HAVING JURISDICTION.

THESE INSTRUCTIONS SHALL REMAIN WITH THE EQUIPMENT FOR SERVICING.

ON OPENING THE OIL SUPPLY VALVE(S) CHECK FOR LEAKS ON THE SUPPLY LINE(S) AND COMPONENTS.

DO NOT TAMPER WITH THE UNIT OR CONTROLS, CALL YOUR SERVICE PERSON.

REGULAR MAINTENANCE SHALL BE PROVIDED TO THE UNIT BY SERVICE PERSONNEL AT LEAST ONCE A YEAR.

CONTENTS

1. GENERAL PRODUCT INFORMATION

Principal of Operation

Power Flame Type C Burners incorporate the principles of pressure atomization for oil and multiple orifice, venturi operation for gas. The total package utilizes the forced draft, flame retention concept. The Type C burner is listed and labeled by Underwriters Laboratories, Inc. Capacities, when fired at 0.2" w.c. positive combustion chamber pressure, range from 3 to 136.4 GPH of commercial grade #2 fuel oil and/or 98 to 19,100 CFH of natural gas. Air for combustion is furnished by an integrally mounted combustion air fan. The Power Flame packaged combustion system can be operated under positive or negative furnace pressures with clean, efficient combustion in a wide range of combustion chamber conditions. (Consult page 6 for appropriate ratings.)

Power Flame Type C Burners are designed to produce greater flame turbulence and reduce flame size. As a result, they require less combustion volume for complete combustion and can be easily fired under positive furnace pressure. Forced draft pressurized operation requires stacks of smaller diameter and height.

The Power Flame C Burner is a totally packaged and factory tested combustion system offering single unit responsibility. The package incorporates accurate control of the fuel-air ratio throughout the firing range with the resultant controlled flame patterns and clean combustion for maximum efficiency.

Combustion air flow is controlled by a multi-louvered damper assembly. The combustion air is supplied by an integral motor-driven blower, which discharges into the burner blast tube assembly. High turbulence flow is controlled by means of an adjustable fan diffuser system. Various system mode operations are obtained by applying appropriate control valves and fuel/air actuators. Units are capable of operating in modes consistent with specific demand requirements, from *fixed* or *on-off* through *full modulation*.

The air/fuel ratio is established at the time of start-up and proven with combustion test equipment to provide the lowest practical oxygen with a clean flame.

A Flame-Safeguard Programmer, available in various control sequences, programs the firing cycle. The operating cycle is sequenced to ensure normal and safe conditions before fuel can be introduced into the combustion area. The complete firing cycle is supervised to ensure that ignition of main flame is properly established and maintained. Both direct spark and gas pilot ignition systems are available. Flame monitoring is provided by optical scanner of the cesium oxide, lead sulfide, cadmium sulfide or ultraviolet types.

The limit circuit includes the operating limit control to maintain set operating pressure or temperature, as well as a high limit control to guard against excessive pressure or temperature. Low water and other similar safety controls can be interlocked into the burner control system to fit specific job and/or code requirements.

The control circuit is normally 120 volts. A control circuit transformer may be furnished to provide the 120 volt control circuit for polyphase motor applications. The control circuit is frequently interlocked with the polyphase motor circuit to shut down the burner in the event of an interruption of the motor current.

Power Flame Type C burners are capable of firing single or multi-fuel applications. (See model selection, page 6, Table 2.)

For multi-fuel burners, fuel changeover may be provided by automatic control, influenced by outside temperature or manual switching. Interlocking relays and timers ensure safe changeover of fuels by means of a timed interruption of firing, long enough to cause a complete recycle of the programmer.

The prewired Control Panel is mounted and wired as an integral part of the burner in accordance with recommendations of Underwriters Laboratories, Inc. and National Electrical Code. Components are wired to numbered terminal strips. Panels and burners are factory fire tested before shipment. Comprehensive wiring and gas and/or oil piping diagrams are furnished with each burner in accordance with individual job or application requirements. Wall mounted or free-standing control panels are also available.

Power Flame C burners are available with control systems to comply with the requirements of Factory Mutual, Industrial Risk Insurers and any special state, municipal, local and utility company codes, including New York City Department of Buildings (MEA), NYC Department of Environmental Protection, Commonwealth of Massachusetts, State of Connecticut Fire Marshall, Illinois School Code and others.

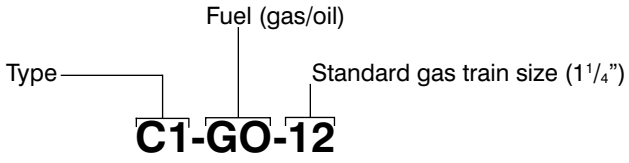
MODEL IDENTIFICATION

The numerical suffix after the letter *C* denotes the burner frame size. The letter *R* inserted immediately after the letter *C* denotes an inverted blower configuration.

The alphabetical designation immediately following the frame size indicates the fuels to be used: *G* is gas only; *O*, oil only; and *GO*, combination gas/oil.

The two numbers following the fuel designation, in all gas and gas/oil listings, denote the standard gas train size. (Selected components may be different pipe sizes than the nominal train size coded.)

10	1” gas train	20	2” gas train
12	1¼” gas train	25	2½” gas train
15	1½” gas train	30	3” gas train



Frame size (see capacity ratings)

Any alphabetical suffix (such as *A*, *B*, *C, S* or *V*, etc.) to the fuel designation denotes special product coding (consult factory).

See page 6 *Standard Burner Ratings and Component Data* for further information.

UNPACKING AND HANDLING

Type C Power Flame burners are usually shipped as a unit with an integrally mounted, prewired control panel. A remote fuel oil pumpset is shipped separately on the larger size oil and oil/gas units. Gas train components may be mounted on the burner or shipped loose for field mounting.

Uncrate burner carefully and check all parts received against the computer generated Burner Specification Sheets supplied by Power Flame. Components not mounted on the burner (shipped loose) are designated with an *L* on the sheets. Claims of shortage or damage must be immediately filled with the carrier.

WARRANTY AND SPARE PARTS INFORMATION

Power Flame offers a 15 month Limited Warranty on all components from the date of shipment. See page 53 for details.

The Owners Information envelope packed with the burner contains a Warranty Registration Card. The Warranty Registration Card is also a request form for a computer generated Spare Parts List. An on-hand supply of spare parts is highly recommended in case of emergency shutdown. The pre-addressed, postage paid Warranty Registration Card should be completed and returned to Power Flame. In the event that the Warranty Registration Card is lost, please contact Power Flame’s Customer Service Department in Parsons, Kansas. All communications with the factory will be handled more efficiently if the burner is identified by the burner model, serial and invoice numbers. This information is stamped into the burner nameplate that is attached to the integral control panel (or to the burner, when remote control panels are supplied).

COMPONENT INFORMATION-GENERAL

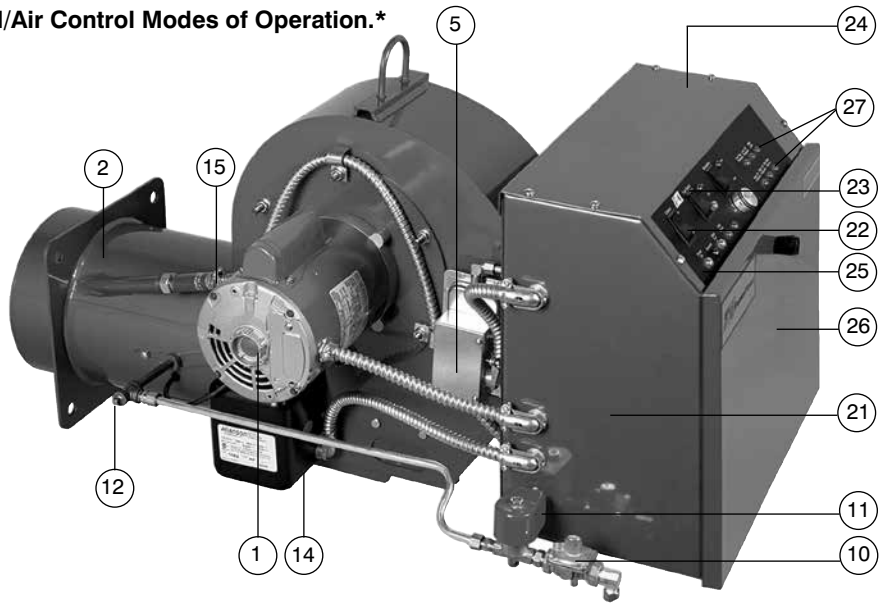
The contents of this manual are general in nature, due to the wide variety of equipment specifications, insurance requirements and state, local and other codes.

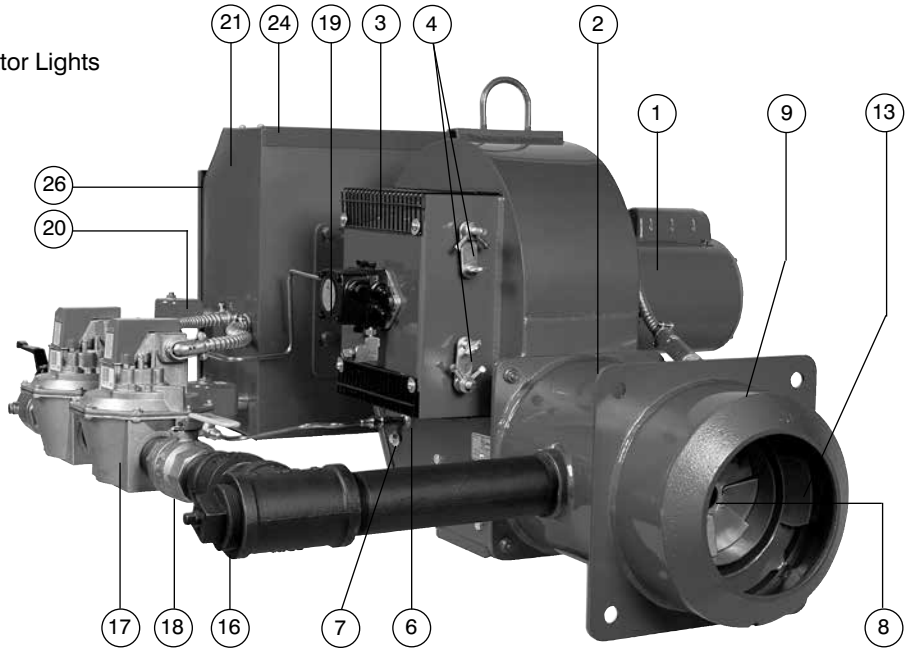
The computer generated Burner Specification Sheets shipped with the burner represent the *as built* version of your specific Power Flame combustion system. Part numbers and component descriptions will match those components supplied. A duplicate set of Burner Specification Sheets is available through Power Flame's Customer Service Department.

Figure 1

Burner Component Identification
Typical for Model CR-GO with On-Off Fuel/Air Control Modes of Operation.*

1. Blower Motor
2. Blast Tube
3. Air Inlet Housing
4. Air Inlet Damper Manual Adjustment Arms
5. Air Flow Switch
6. Drawer Assembly Cover Plate
7. Drawer Assembly Adjustment
8. Air Diffuser
9. Flame Retention Ring
10. Gas Pilot Regulator
11. Gas Pilot Solenoid Valve
12. Gas Pilot Test Tee
13. Gas Pilot Assembly
14. Gas Pilot Ignition Transformer
15. Flame Scanner (Detector)
16. Orifice Tee with Gauge Test Port
17. Automatic Gas Valve
18. Leakage Test Cock
19. Oil Pump
20. Oil Solenoid Valve
21. Control Panel
22. On-Off Switch
23. Fuel Selector Switch
24. Hinged (Total Access) Top Section
25. Light and Switch Circuit Board
26. Removable Total Access Door
27. Optional Board for Sequence Indicator Lights





*The components and arrangements shown are typical for a Model CR-GO combination gas/oil burner. Gas only or oil only units will have similar components relating to their specific fuel. In some cases, the type of components and/or their arrangement may vary from this depiction. For specifics on your system, refer to the technical information supplied with the burner.

Figure 2

Burner Component Identification
Typical for Model C-GO with Low-High-Off or Low-High-Low Fuel/Air Control Modes of Operation.*

1. Blower Motor
2. Blast Tube
3. Air Inlet Housing
4. Air Flow Switch
5. Air Diffuser
6. Flame Retention Ring
7. Gas Pilot Regulator
8. Gas Pilot Solenoid Valve
9. Gas Pilot Test Tee
10. Gas Pilot Assembly
11. Gas Pilot Ignition Transformer
12. Flame Scanner (Detector)
13. Orifice Tee With Gauge Test Port
14. Motorized Gas Valve (Low-High-Off or Low-High-Low)
15. Air Damper Drive Linkage Assembly
16. Leakage Test Cock
17. Gas Premix Adjustment (Optional Feature)
18. Oil Pump
19. Hydraulic Damper Actuator
20. Oil Nozzle
21. Low-High-Off or Low-High-Low Oil Control Train
22. Control Panel
23. Hinged (Total Access) Top Section
24. Removable Total Access Door
25. Test Port

*The components and arrangements shown are typical for a Model C combination gas/oil burner. Gas only or oil only units will have similar components relating to their specific fuel. In some cases, the type of components and/or their arrangements may vary from this depiction. For specifics on your system, refer to the technical information supplied with the burner.

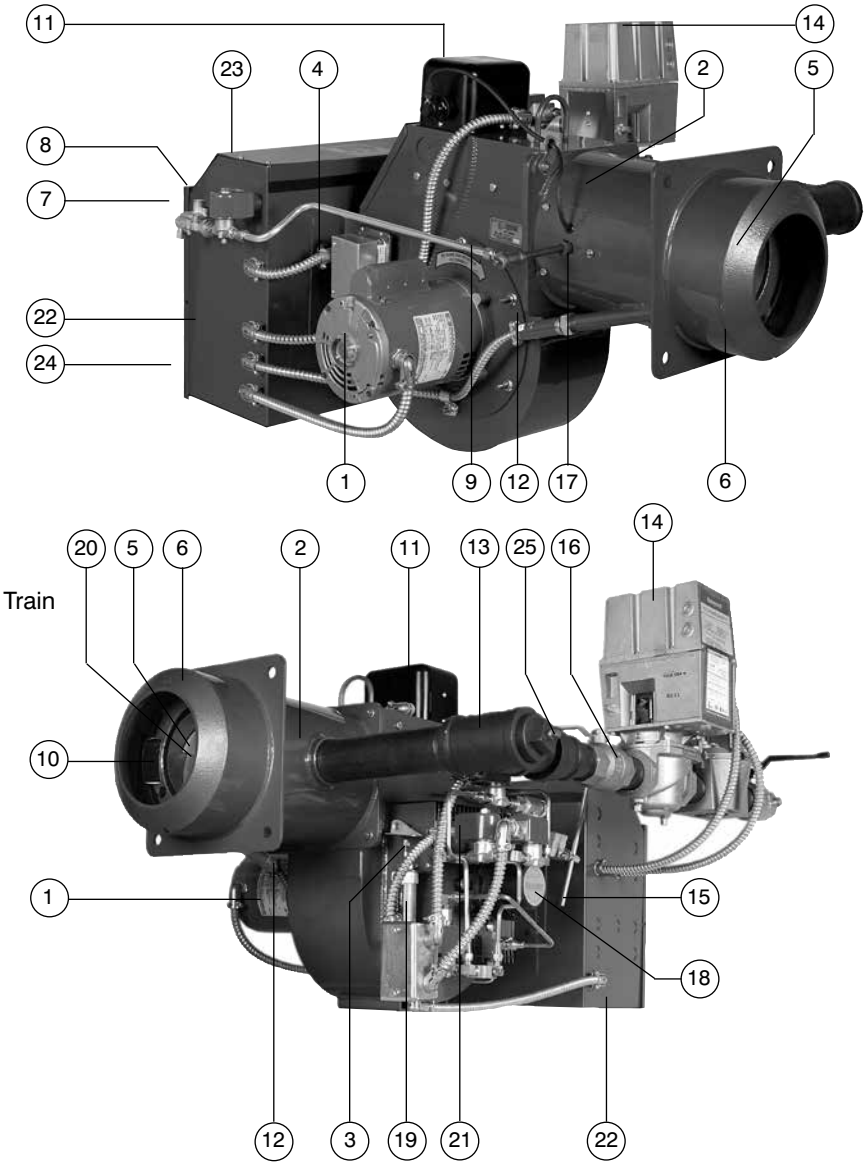
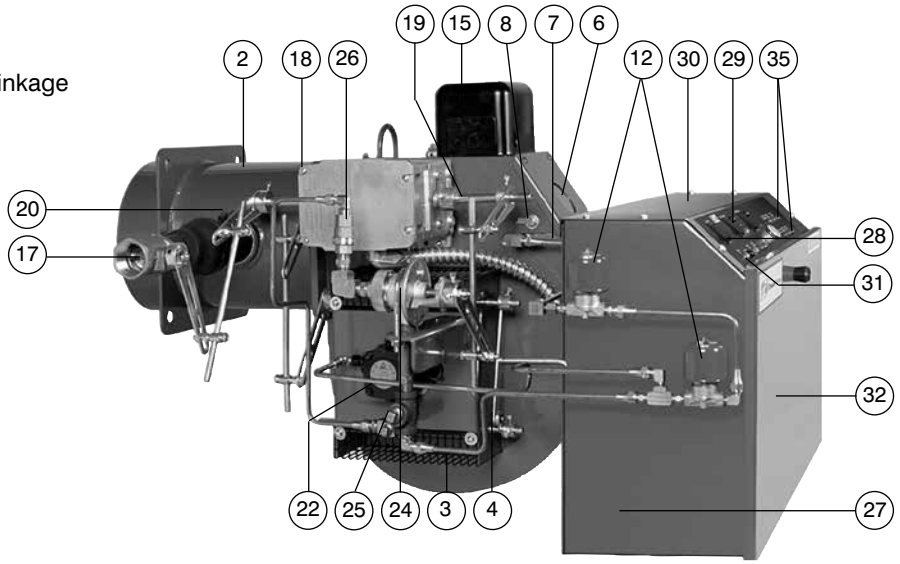


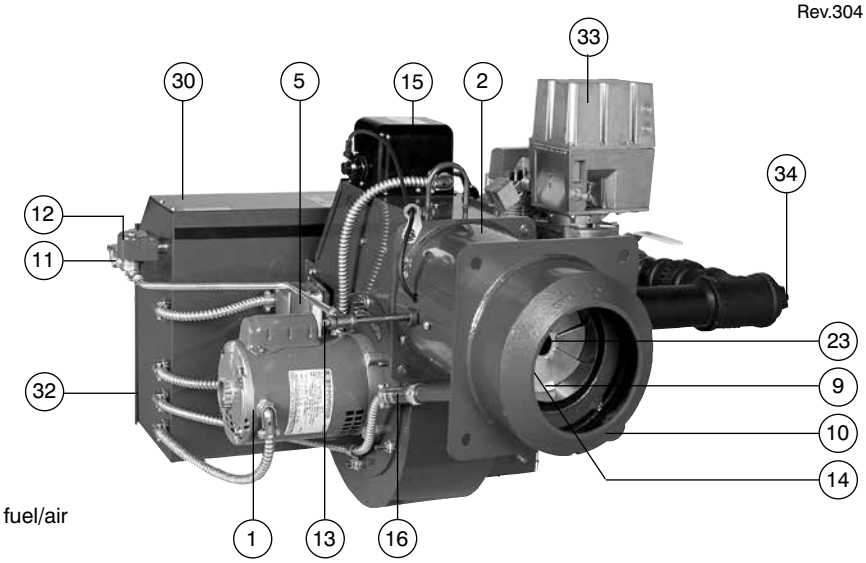
Figure 3

Burner Component Identification
Typical for Model C-GO with Modulating Fuel/Air Control Modes of Operation.*

1. Blower Motor
2. Blast Tube
3. Air Inlet Housing
4. Air Inlet Damper Cross Connecting Linkage
5. Air Flow Switch
6. Flame View Port
7. Drawer Assembly Cover Plate
8. Drawer Assembly Adjustment
9. Air Diffuser
10. Flame Retention Ring
11. Gas Pilot Regulator
12. Gas Pilot Solenoid Valve
13. Gas Pilot Test Tee
14. Gas Pilot Assembly
15. Gas Pilot Ignition Transformer
16. Flame Scanner (Detector)
17. Modulating Butterfly Gas Valve
18. Modulating Drive Motor
19. Jack Shaft and Drive Linkage
20. Gas Pressure Gauge Test Port
21. Gas Premix Adjustment (Optional Feature)



22. Oil Pump
23. Oil Nozzle
24. Modulating Oil Valve
25. Oil Nozzle Bypass Pressure Test Tee
26. Nozzle Return Line Check Valve
27. Control Panel
28. On-Off Switch
29. Fuel Selector Switch
30. Hinged (Total Access) Top Section
31. Light and Switch Circuit Board
32. Removable Total Access Door
33. Motorized Gas Valve
34. Test Port
35. Optional Board for Sequence Indicator Lights



NOTE:
See page 21, Figure 25 for depiction of characterized fuel/air control system.

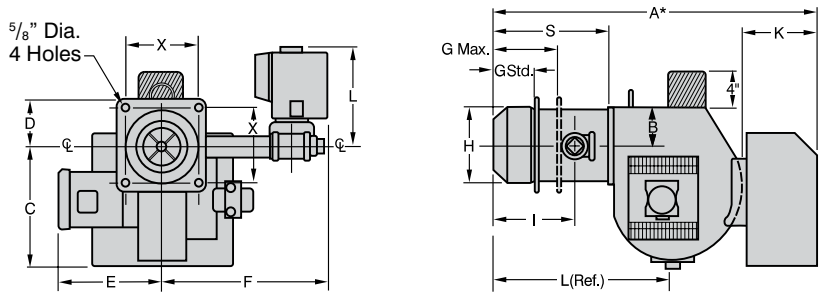
*The components and arrangements shown are typical for a Model C-GO combination gas/oil burner. Gas only (C-G) or oil only (C-O) units will have similar components relating to their specific fuel.

In some cases, the type of components and/or their arrangement may vary from this depiction. For specifics on your system, refer to the technical information supplied with the burner.

Standard Burner Dimensional Data

Figure 4

Model C Configuration

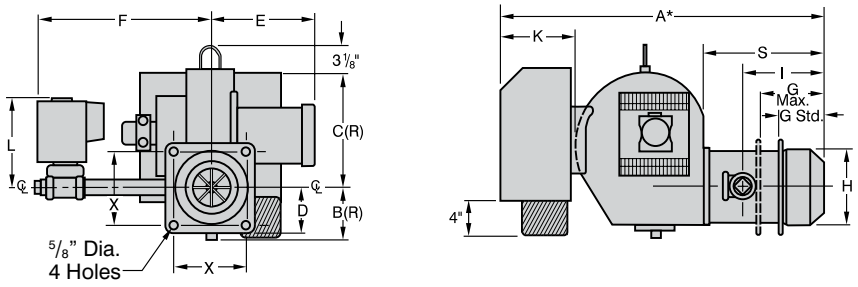


NOTE:
Add 3/8" to "H" for size of opening in boiler front plate.

* Dimension may be reduced by 10¼" by moving panel to appropriate alternate location.

Figure 5

Model CR Configuration



NOTE:
Add 3/8" to "H" for size of opening in boiler front plate.

* Dimension may be reduced by 10¼" by moving panel to appropriate alternate location.

Table 1

Standard Dimensions (Inches)

								F**		G								
Model	A	B	B(R)	C	C(R)	D	E	Gas/ Oil	ST. Oil	STD	MAX*	CAD ST. Oil	H	I	K	L	S	X
C1	**34 1/8**	**3 13/16**	**5 9/16**	**14 1/2**	**14 1/2**	**4 5/8**	**12 1/4**	**20**	**12 3/4**	**3 1/4**	**4 3/4**	**11**	**7 1/4**	**7 3/8**	**10 1/4**	**17 1/8**	**12 5/8**	**7 1/4**
C2	**39 1/8**	**4 1/2**	**6 1/8**	**14 7/8**	**14**	**5 1/4**	**14**	**20**	**13**	**4**	**6 3/4**	**11 1/2**	**8 3/4**	**8 1/2**	**10 1/4**	**18 7/8**	**13 3/8**	**8 1/2**
C3	**44**	**5 1/4**	**7**	**16 5/8**	**15 1/4**	**6**	**16**	**22 3/8**	**14 1/4**	**4 1/2**	**8**	**-**	**10 1/8**	**11 1/2**	**10 1/4**	**22**	**15 1/2**	**10**
C4	**50**	**6 1/4**	**7 5/16**	**18 7/8**	**17 11/16**	**7**	**18 1/2**	**28**	**18**	**6**	**9**	**-**	**12 1/8**	**14 1/4**	**10 1/4**	**26 5/8**	**19 1/8**	**12**
C5	**50**	**6 1/4**	**7 5/16**	**18 7/8**	**17 11/16**	**7**	**18 1/2**	**26 1/2**	**18**	**6**	**9**	**-**	**12 1/8**	**14 1/4**	**10 1/4**	**26 5/8**	**19 1/8**	**12**
C6	**49 7/8**	**6 1/4**	**7 5/16**	**18 7/8**	**17 11/16**	**7 3/4**	**19 7/8**	**26 1/2**	**18**	**5**	**11 3/4**	**-**	**13 5/8**	**14 1/8**	**10 1/4**	**26 1/2**	**19**	**13 1/2**
C7(B)	**51 11/16**	**8 1/8**	**10 1/8**	**24 5/16**	**22 3/8**	**8 3/4**	**18**	**21 13/16**	**21 13/16**	**4 7/8**	**11 1/4**	**-**	**15 5/8**	**13 7/8**	**9 1/8**	**26 1/2**	**19**	**13 1/2**
C8	**56 9/16**	**8 1/8**	**10 1/8**	**27 1/8**	**27 5/8**	**8 3/4**	**20**	**24 3/8**	**24 3/8**	**3 1/4**	**9 5/8**	**-**	**15 5/8**	**12 1/4**	**9 1/8**	**24 7/8**	**17 5/16**	**13 1/2**

* This dimension may be increased. Consult factory.
Note: Dimensions shown are standard, but may vary due to component changes, etc.

** This dimension depicts space required to accommodate a standard gas train, standard oil valves and standard burner mounted pump.

Table 2

Standard Burner Ratings and Component Data Power Flame Certified Capacity 0.2" W.C. Positive Pressure (D)

Burner Model (A)	Standard Flame Sensor (B)	3450RPM Blower Motor H.P.(C)	GPH Maximum	MBTU/HR. Natural Gas Maximum	Nominal Boiler H.P.	Gas Pressure Required Inches W.C. (E) Min.Max.	Standard Gas Train Size (F)	Burner Pump Suction Capacity		
								Burner Mounted Oil Pressure Pump Suction Capacity In GPH(G)	Separate Driven Oil Pressure Pump If Supplied (H)	
									Motor H.P.	Suction Capacity In GPH
Model CGO (Combination Gas/Oil)										
C1-GO-10	**UV**	1/3	**7**	**980**	**23.5**	**5.6-14**	**1"**	**19(J)**	1/3	**19(J)**
C1-GO-12	**UV**	1/3	**9.7**	**1360**	**32.3**	**5.3-14**	**1 1/4"**	**19(J)**	1/3	**19(J)**
C2-GO-15	**UV**	3/4	**15.7**	**2200**	**52.3**	**5.2-14**	**1 1/2"**	**70(K)**	1/3	**70(K)**
C2-GO-20A	**UV**	**1**	**17.5**	**2500**	**60.0**	**4.8-14**	**2"**	**40**	1/3	**40**
C2-GO-20B	**UV**	**1 1/2**	**22**	**3080**	**73.5**	**4.8-14**	**2"**	**40**	1/3	**40**
C3-GO-20	**UV**	**2**	**30**	**4200**	**87.0**	**5.9-14**	**2"**	**105**	1/2	**105**
C3-GO-25	**UV**	**2**	**33.7**	**4718**	**112.0**	**7.0-14**	**2 1/2"**	**105**	1/2	**105**
C3-GO-25B	**UV**	**3**	**37.5**	**5250**	**125.0**	**7.2-14**	**2 1/2"**	**135**	3/4	**135**
C4-GO-25	**UV**	**5**	**45**	**6300**	**150.0**	**8.0-14**	**2 1/2"**	**135**	3/4	**135**
C4-GO-30	**UV**	**5**	**56**	**7840**	**190.0**	**12.1-14**	**3"**	**N/A**	3/4	**135**
C5-GO-30	**UV**	**7 1/2**	**75**	**10500**	**250.0**	**19.9-28**	**3"**	**N/A**	**1**	**250**
C5-GO-30B	**UV**	**7 1/2**	**75**	**10500**	**250.0**	**17.8-28**	**3"**	**N/A**	**1**	**250**
C6-GO-30	**UV**	**10**	**101.5**	**14215**	**340.0**	**26.5-28**	**3"**	**N/A**	**1**	**250**
C7-GO-30	**UV**	**15**	**121.4**	**17,000**	**404.0**	**40-280**	**3"**	**N/A**	**1**	**265**
C7-GO-30B	**UV**	**20**	**126.4**	**17,700**	**421.0**	**40-280**	**3"**	**N/A**	**1**	**265**
C8-GO-30	**UV**	**15**	**136.4**	**19,100**	**454.0**	**50-280**	**3"**	**N/A**	**1**	**265**
Model CG (Gas)										
C1-G-10	**UV**	1/3	**-**	**980**	**23.5**	**5.6-14**	**1"**	**-**	**-**	**-**
C1-G-12	**UV**	1/3	**-**	**1360**	**32.3**	**5.3-14**	**1 1/4"**	**-**	**-**	**-**
C2-G-15	**UV**	1/2	**-**	**2200**	**52.3**	**5.2-14**	**1 1/2"**	**-**	**-**	**-**
C2-G-20A	**UV**	3/4	**-**	**2500**	**60.0**	**4.8-14**	**2"**	**-**	**-**	**-**
C2-G-20B	**UV**	**1**	**-**	**3080**	**73.5**	**4.8-14**	**2"**	**-**	**-**	**-**
C3-G-20	**UV**	**1 1/2**	**-**	**4200**	**100.0**	**5.9-14**	**2"**	**-**	**-**	**-**
C3-G-25	**UV**	**1 1/2**	**-**	**4718**	**112.0**	**7.0-14**	**2 1/2"**	**-**	**-**	**-**
C3-G-25B	**UV**	**3**	**-**	**5250**	**125.0**	**7.2-14**	**2 1/2"**	**-**	**-**	**-**
C4-G-25	**UV**	**3**	**-**	**6300**	**150.0**	**8.0-14**	**2 1/2"**	**-**	**-**	**-**
C4-G-30	**UV**	**5**	**-**	**7840**	**190.0**	**12.1-14**	**3"**	**-**	**-**	**-**
C5-G-30	**UV**	**7 1/2**	**-**	**10500**	**250.0**	**19.9-28**	**3"**	**-**	**-**	**-**
C5-G-30B	**UV**	**7 1/2**	**-**	**10500**	**250.0**	**17.8-28**	**3"**	**-**	**-**	**-**
C6-G-30	**UV**	**10**	**-**	**14215**	**340.0**	**26.5-28**	**3"**	**-**	**-**	**-**
C7-G-30	**UV**	**15**	**-**	**17,000**	**404.0**	**40-280**	**3"**	**-**	**-**	**-**
C7-G-30B	**UV**	**20**	**-**	**17,700**	**421.0**	**40-280**	**3"**	**-**	**-**	**-**
C8-G-30	**UV**	**15**	**-**	**19,100**	**454.0**	**50-280**	**3"**	**-**	**-**	**-**
Model CO (Oil)										
C1-O(S)	**CC**	1/3	**9.7**	**-**	**32.3**	**-**	**-**	**19(J)**	1/3	**19(J)**
C2-OA(S)	**CC**	3/4	**15.7**	**-**	**52.3**	**-**	**-**	**70(K)**	1/3	**70(K)**
C2-OB(S)	**CC(I)**	**1 1/2**	**22**	**-**	**73.5**	**-**	**-**	**40**	1/3	**40**
C3-O	**UV**	**2**	**33.7**	**-**	**112.0**	**-**	**-**	**105**	1/2	**105**
C3-OB	**UV**	**3**	**37.5**	**-**	**125.0**	**-**	**-**	**135**	3/4	**135**
C4-OA	**UV**	**5**	**45**	**-**	**150.0**	**-**	**-**	**135**	3/4	**135**
C4-OB	**UV**	**5**	**56**	**-**	**190.0**	**-**	**-**	**N/A**	3/4	**135**
C5-O	**UV**	**7 1/2**	**75**	**-**	**250.0**	**-**	**-**	**N/A**	**1**	**250**
C5-OB	**UV**	**7 1/2**	**75**	**-**	**250.0**	**-**	**-**	**N/A**	**1**	**250**
C6-O	**UV**	**10**	**101.5**	**-**	**340.0**	**-**	**-**	**N/A**	**1**	**250**
C7-O	**UV**	**15**	**121.4**	**-**	**404.0**	**-**	**-**	**N/A**	**1**	**265**
C7-OB	**UV**	**20**	**126.4**	**-**	**421.0**	**-**	**-**	**N/A**	**1**	**265**
C8-O	**UV**	**15**	**136.4**	**-**	**454.0**	**-**	**-**	**N/A**	**1**	**265**

A. See page 2 for further model number information.

B. The flame sensor shown - UV (Ultra Violet) or CC (Cad Cell). Other flame sensors such as Lead Sulfide and photo cell are available to comply with specifications or codes.

C. If separate pump is supplied, HP may be reduced. For positive pressure applications on C1 burners with integral pump firing over 8 GPH or some OEM boilers, a 1/2 HP motor and oversized fan are required on oil and gas/oil burners.

D. Capacities listed are based on 0.20" W.C. positive pressure. Derate capacities approximately 5% for each +.50" W.C. combustion chamber pressure, except for C5-OB and C5-G(O)-30B, which are rated for 250 BHP at +1.2" W.C. All capacities based on 2000' elevation. Derate capacity by 4% for each additional 1000' elevation.

E. At inlet to main shutoff cock with burner operating at maximum input rate. If auxiliary gas valves are used, C2-G(O)-20A through C4-G(O)-30 inlet pressure of 28" (1#) are permitted when using optional 325-3 pilot regulator.

F. Model numbers will always reflect the standard U.L. listed gas train sizes to correlate with U.L. input listings. The actual train size may vary, depending on local gas supply pressures available.

G. and H. Suction line and oil filter must be sized to provide these suction capacities. ***Do not*** size suction lines or filter capacities based on burner firing rates. See page 11 for further information.

I. C2-OB will be supplied with a UV sensor if firing rate is above 20 GPH (unless specified otherwise).

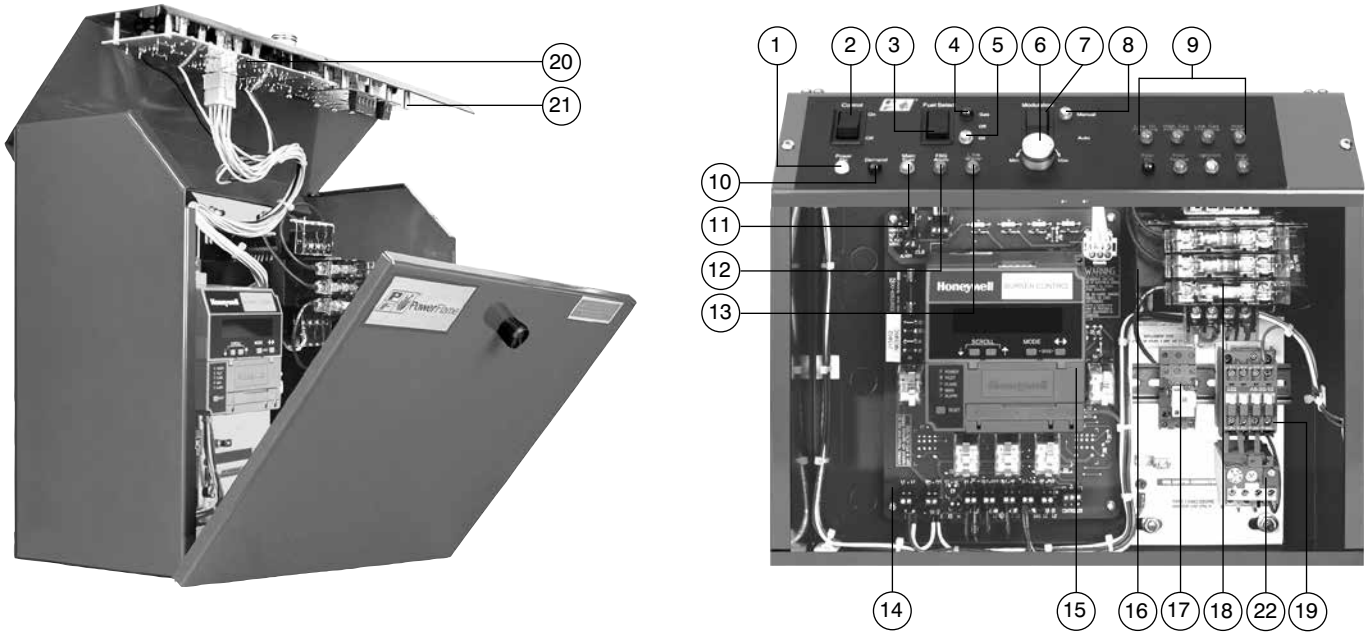
J. The standard pump normally supplied is 19 GPH for On-Off or Modulating and 40 GPH for Fixed Air Low Fire Start, Low-High-Off and Low-High-Low operation. Optional pumps are available which, depending on model specified, could be as high as 70 GPH. Refer to information shipped with the burner and/or consult the factory for specifics.

K. The standard pump normally supplied is 40 GPH for Low-High-Off and Low-High-Low, 70 GPH for On-Off and modulating operation. Optional pumps are available for Low-High-Off and Low-High-Low which could be as high as 70 GPH. Refer to information shipped with the burner and/or consult the factory for specifics.

Control Panel Information

Figure 6

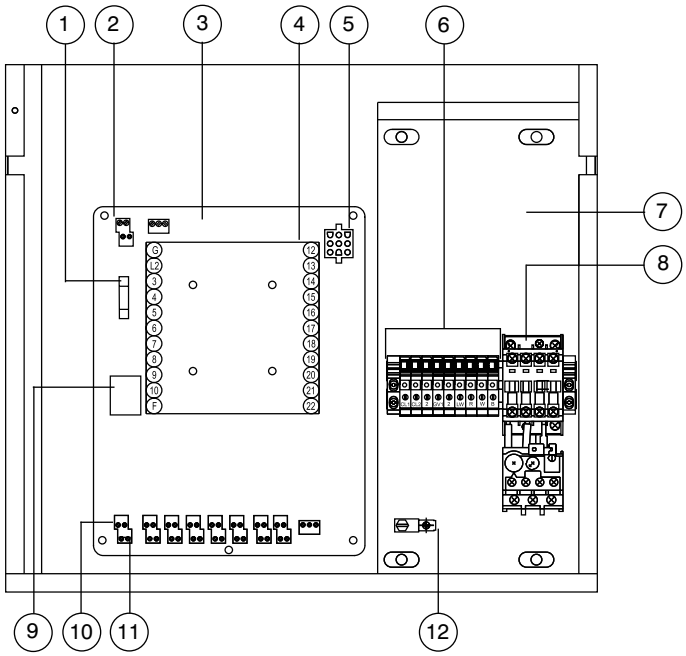
Total Access Control Panel (Patented) Featuring Alpha System™ Circuit Board with Light & Switch Board for a Combination Gas/Oil Modulating Burner



1. Power On Indicator
2. Control Switch
3. Fuel Changeover Switch
4. Gas On Indicator
5. Oil On Indicator
6. Manual Potentiometer
7. Manual-Auto Select Switch
8. Automatic Mode Indicator
9. Auxilary Light Circuit Board Indicators
10. Demand Indicator
11. Main Fuel Indicator
12. FSG Alarm Indicator
13. Customer Selected Indicator
14. Main Circuit Board
15. Flame Safeguard Control
16. Stepdown Control Voltage Transformer
17. DIN Rail Mounted Terminal Strips
18. Primary & Secondary Fuses
19. Motor Starter
20. Light & Switch Circuit Board
21. Auxiliary Light Board Indicators
22. Motor Overloads

Figure 6A

Alpha System™ Typical Layout Drawing

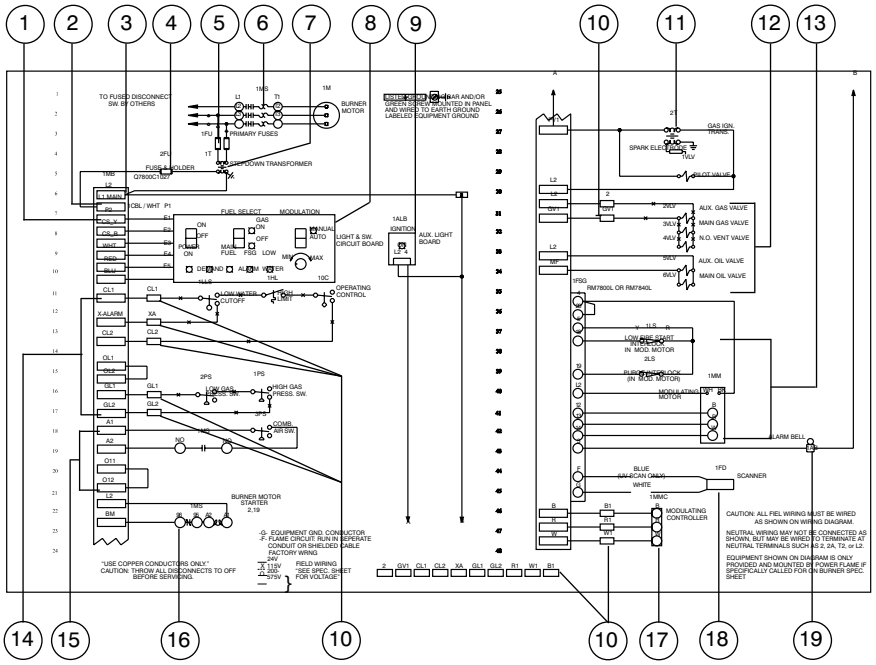


1. Replaceable Fuses
2. (L1 Main) Hot 115 Volt Main Power Connection*
3. Main Circuit Board
4. Flame Safeguard Base On Circuit Board
5. Light & Switch Board Connection
6. Terminal Strip for Field Connection
7. Chassis Plate
8. Motor Starter
9. Replaceable Relays- MY2-AC10/120S Only
10. (L1 Fused) Auxiliary Power Connection (Factory Use Only)
11. (L2) Neutral 115 Volt*
12. Grounding Lug

* L1 Main 115 volt hot incoming power terminal is located at the top of the circuit board. L2 Neutral 115 volt power terminal is located on the lower set of terminals at the bottom of the main circuit board. The L1 Fused terminal located on the lower set of terminals is for factory use only and should not be used for incoming power connections.

Figure 6B

Alpha System™ Circuit Board Typical Electrical Schematic with Light & Switch Circuit Board

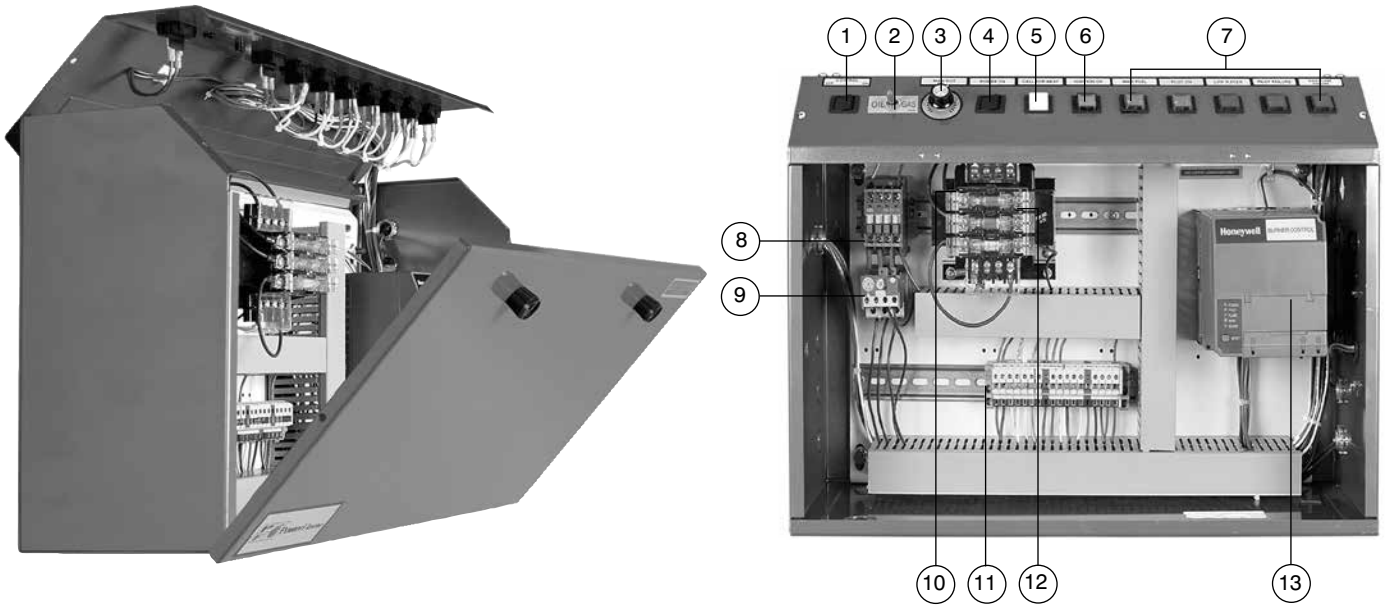


1. Main Circuit Board
2. (L1 Main) Hot 115 Volt Power Connection*
3. (L2) Neutral 115 Volt Wiring Connection*
4. Control Circuit Fuse
5. Primary Fuses
6. Motor Starter
7. Step-Down Transformer
8. Light & Switch Circuit Board
9. Auxiliary Light Board Connection (Typical)
10. Wiring Terminal Strip Identification
11. Gas Ignition Transformer
12. Operating Valve Connections
13. Modulation Motor Connections
14. Limit Device Connections (Typical)
15. Running Interlock Connections
16. Motor Starter Coil
17. Operating Control Connection
18. Flame Detector Connection
19. Alarm Buzzer or Bell

* L1 Main 115 volt hot incoming power terminal is located at the top of the circuit board. L2 Neutral 115 volt power terminal is located on the lower set of terminals at the bottom of the main circuit board. The L1 Fused terminal (not shown) located on the lower set of terminals is for factory use and should not be used for incoming power connections.

Figure 6C

Total Access Control Panel (Patented) For Combination Gas/Oil Modulation Burners



This Total Access Control Panel is typical in general construction and configuration for the fuel and mode of operation indicated. Each burner is shipped with a wiring diagram, as well as specific documentation on specific panel components. Side view of removable front and top panel doors. To remove front panel door, place unlatched door in closed position and lift it up. For total access to components mounted in the top panel, remove the four holding screws and rotate the top panel upward, around the hinge located at the top rear of the panel box.

1. Control Switch
2. Fuel Changeover Switch
3. Manual Potentiometer
4. Manual-Auto Select Switch
5. Power On Indicator
6. Main Fuel Indicator
7. Auxiliary Functions
8. Motor Starter
9. Motor Overloads
10. Stepdown Control Voltage Transformer
11. DIN Rail Mounted Terminal Strips
12. Primary & Secondary Fuses
13. Flame Safeguard Control

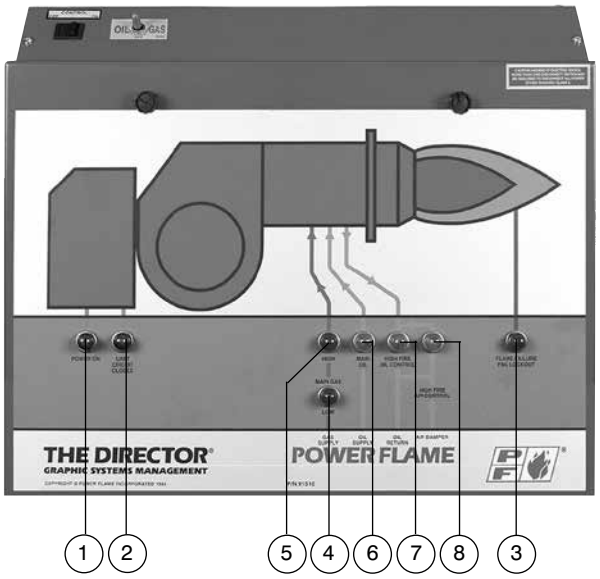
Figure 7

The Director® Annunciation System

The Director® Annunciation System Mounted on removable Total Access front panel door, complete with quick disconnect electrical connection. The Director can be removed from the panel box (see above) and kept in operating mode by using the extended length umbilical cord between the Director and panel box connections.

Annunciation Legend for Gas/Oil Burner with Low-High-Low Operating Mode

1. Power On
2. Limit Circuit Closed
3. Flame Failure (Flame Safeguard Lockout)
4. Main Gas Valve - Low Position
5. Main Gas Valve - High Position
6. Main Oil Valve
7. High Fire Oil System
8. High Fire Air System



INSTALLATION

The installer should contact the local gas utility relative to available supply pressures, limitations on allowable pressures in the building, general piping requirements and applicable codes, restrictions and regulations.

Considerations of these types, as well as written permits and other state, city and local codes, should be discussed with and approved by the appropriate governing bodies.

GAS SUPPLY PIPING

Gas piping should be sized to provide required pressure at the burner train inlet manual shutoff cock, when operating at the maximum desired fuel input.

All gas piping should be appropriately pressure tested to ensure leak free operation. It is recommended that a dirt pocket or trap be piped into the gas supply system just ahead of the burner train inlet manual shutoff cock.

When testing with pressures higher than the maximum pressure ratings of the gas train components, be sure to isolate these components and test their piping for gas leaks with correct pressures only. On some burners, the maximum main gas train and/or pilot gas train components pressure is ½ psig. (14" W.C.).

Refer to Table 3 for information relating to the sizing of gas supply piping. These charts are based on the general flow characteristics of commercially produced black wrought iron pipe. If in doubt regarding flow capabilities of a chosen line size, the next largest size is recommended.

Refer to page 10, Figures 8 and 9 for typical gas piping schematics to meet U.L. requirements in the C burner firing ranges.

Table 3

Capacity of Pipe - Natural Gas (CFH)
With Pressure Drop of 0.3" w.c. and Specific Gravity of 0.60

Pipe Length In Feet	Pipe Size - Inches (IPS)						
	1	1 1/4	1 1/2	2	2 1/2	3	4
10	520	1050	1600	3050	4800	8500	17500
20	350	730	1100	2100	3300	5900	12000
30	285	590	890	1650	2700	4700	9700
40	245	500	760	1450	2300	4100	8300
50	215	440	670	1270	2000	3600	7400
60	195	400	610	1150	1850	3250	6800
70	180	370	560	1050	1700	3000	6200
80	170	350	530	990	1600	2800	5800
90	160	320	490	930	1500	2600	5400
100	150	305	460	870	1400	2500	5100
125	130	275	410	780	1250	2200	4500
150	120	250	380	710	1130	2000	4100
175	110	225	350	650	1050	1850	3800
200	100	210	320	610	980	1700	3500

Note: Use multiplier at right for other specific gravities and pressure drops.

Table 3A

Correction Factors

Specific Gravity Other Than 0.60		Specific Drop Than 0.3	
Specific Gravity	Multiplier	Pressure Drop	Multiplier
0.50	1.10	0.1	0.577
0.60	1.00	0.2	0.815
0.70	0.926	0.3	1.00
0.80	0.867	0.4	1.16
0.90	0.817	0.6	1.42
1.00	0.775	0.8	1.64
Propane - Air		1.0	1.83
1.10	0.740	2.0	2.58
Propane		3.0	3.16
1.55	0.662	4.0	3.65
Butane		6.0	4.47
2.00	0.547	8.0	5.15

Table 4

Equivalent Length of Fittings in Feet

Pipe Size (IPS)	1	1.25	1.5	2	2.5	3	4
Std. Tee through Side	5.5	7.5	9.0	12.0	14.0	17.0	22.0
Std. E11	2.7	3.7	4.3	5.5	6.5	8.0	12.0
45° E11	1.2	1.6	2.0	2.5	3.0	3.7	5.0
Plug Cock	3.0	4.0	5.5	7.5	9.0	12.0	16.0

Table 5

Gas Train Components Supplied for Standard U.L. Burner Requirements
See Gas Flow Schematics this page, Figure 8 and 9 for additional information

Fuel Air Control Modes of Operation	On/Off	Low/High/Off	Low/High/Low	Modulating
Main Gas Cock	XU	XU	XU	XU
Main Gas Pressure Regulator	XU*	XU	XU	XU
High and Low Gas Pressure Switches	OU	X[1]U	X[1]U	X[1]U
Automatic Main Gas Valve	XU*	X	X	XU
Automatic Main Gas Valve with Proof of Closure	O	X[1]	X[1]	X[1]
Main Auxilary Gas Valve	O	X[2]	X[2]	X[2]
Leak Test Gas Cock	XU	X	X	XU
Pilot Cock, Pressure Regulator & Solenoid Valve	X	X	X	X
Modulating Butterfly Valve	N/A	N/A	N/A	X
Side Tee Orifice Assembly	X	X	X	N/A
Main and/or Pilot Gas Pressure Gauge	O	O	O	O

X-Supplied as standard O - Optional N/A - Not available (U) - Unmounted

1. Supplied as standard on inputs of 2,500,000 BTU/hr. and above. Available as an option below 2,500,000 BTU/hr. inputs.
2. Supplied as standard on inputs of 5,000,000 BTU/hr. and above. Available as an option below 5,000,000 BTU/hr. inputs.

* Certain burners will have a combination pressure regulator/ diaphragm gas valve in lieu of a separate regulator and valve.

Canadian electrical and fuel codes require systems that vary from the above. Consult the factory for specific details.

Figure 8

Typical Schematic Gas Piping for Type C Burner, On-Off, Low-High-Off and Low-High-Low System

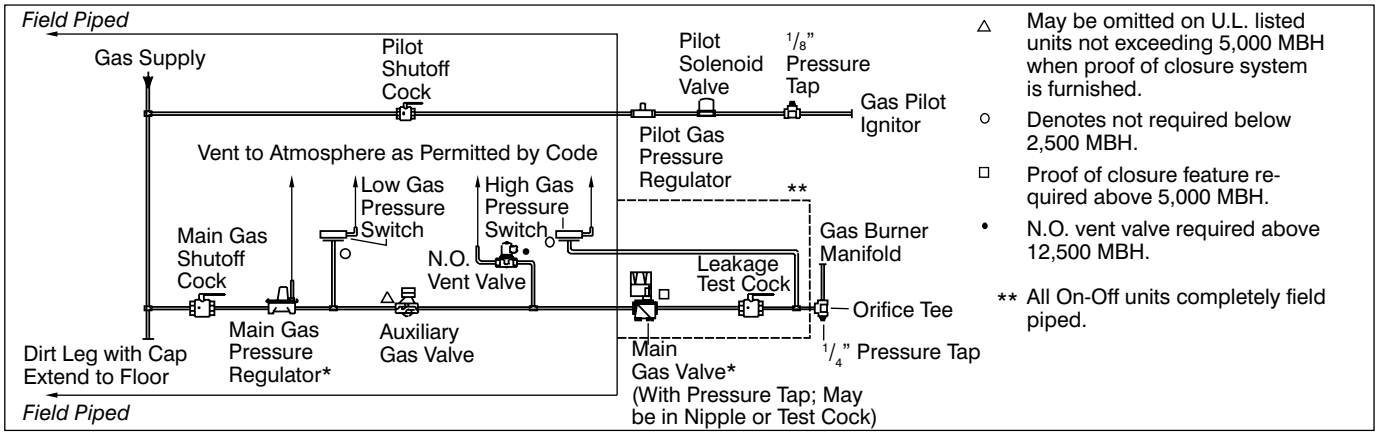
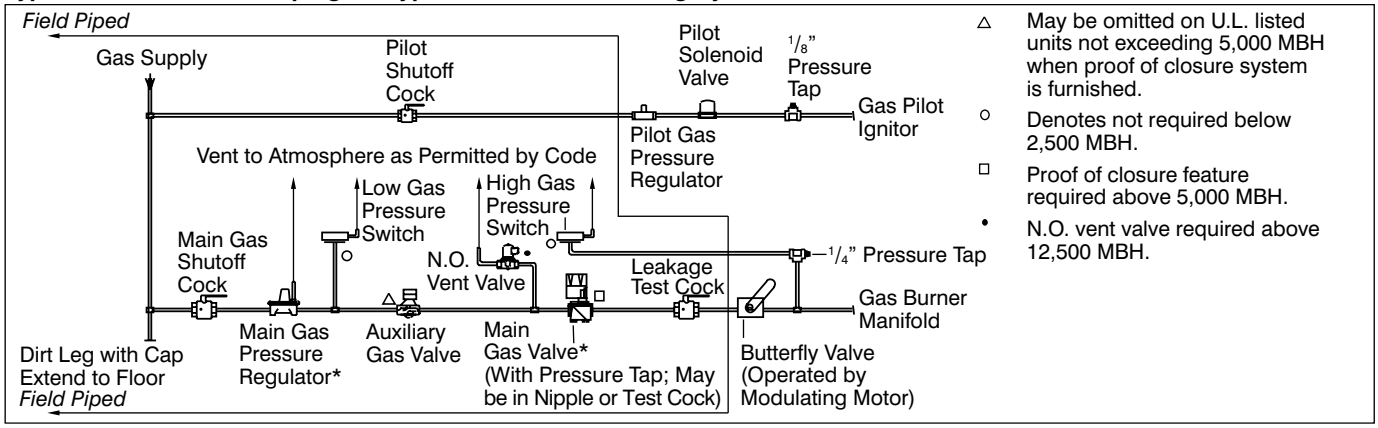


Figure 9

Typical Schematic Gas Piping for Type C Burner, Modulating System



* On some burner models at inputs below 2500 MBH a combination pressure regulator/automatic gas valve may be used in place of the separate main gas pressure regulator and main gas shutoff valve shown in Figure 8 and 9 above. For specifics on your burner refer to the gas piping diagram supplied with the burner.

OIL SUPPLY PIPING

The C burner is designed for use with light grade fuel oils - commercial standard grades #2 or #1.

It is recommended that prior to installation all national, local and other applicable codes be reviewed to ensure total compliance.

It is recommended that prior to installation, NFPA-31 and all other national, state, local and other applicable codes be reviewed to ensure total compliance with their requirements including, but not necessarily limited to, the use of anti-syphon valve(s), oil safety valve(s) (OSV), or other acceptable means to prevent siphoning of the oil when tank is above burner level. Even if such devices are not required by code, they should be considered good installation practice and mandatory when the tank is above burner level.

Do not install manual valves in the return line between the pump and the tank unless required by a specific code. If a manual valve is required, an automatic relief valve must be installed across the manual valve to ensure that oil will bypass directly back to the tank in the event the manual valve is inadvertently left in the closed position.

Use copper tubing with flare fittings or iron pipe on all installations. All units must utilize the proper size and type of suction line oil filters. See this page, Table 6 for recommended Power Flame oil filters.

If the oil storage system has been used with fuel heavier than #2 fuel oil, the entire system should be thoroughly cleaned and flushed before starting up the new system. Utilize fusible link and/or overhead anti-siphon valves as appropriate.

If iron pipe oil lines are used on underground tanks, swing joints utilizing nipples and elbows must be used and joined together, making certain the piping connections are tightened as the tank settles. Keep swing joints in the suction and return lines as close to the tank as possible. Underground tanks should be pitched away from the suction line end of the tank to prevent sediment from accumulating at the suction line entrance. The suction line should be a minimum of 3” from the tank bottom.

Before starting up the system, all appropriate air and oil leak tests should be performed. Make certain that the tank atmospheric vent line is unobstructed.

Refer to page 12, Figure 11 for fuel pump oil piping connection information. Further information relating to burner oil piping can be found in Table 6 this page, Figure 11 on page 12, and on page 13, Figure 12.

Table 6

Oil Pump Suction Capacity and Filter Selection Chart

Gas/Oil Model	Oil Model	GPH Suction Capacity	Power Flame Oil Filter Model	Alternate Oil Filter
C1-GO-10		**70(1)**		**73410 (Fulflo FB-6)**
C1-GO-12	**C1-O and C1-OS**	**70(1)**		**73410 (Fulflo FB-6)**
C2-GO-15	**C2-OA and C2-OAS**	**70(2)**		**73410 (Fulflo FB-6)**
C2-GO-20A	**C2-OB and C2-OBS**	**40**	**70101-100**	**73410 (Fulflo FB-6)**
C2-GO-20B	**C2-OB and C2-OBS**	**40**	**70101-100**	**73410 (Fulflo FB-6)**
C3-GO-20	**C3-O**	**105**	**70101-100**	**73410 (Fulflo FB-10)**
C3-GO-25	**C3-O**	**105**	**70101-100**	**73420 (Fulflo FB-10)**
C3-GO-25B	**C3-O(B)**	**135**	**70101-100**	**73420 (Fulflo FB-10)**
C4-GO-25	**C4-OA**	**135**	**70101-100**	**73420 (Fulflo FB-10)**
C4-GO-30	**C4-OB**	**135**	**70101-100**	**73420 (Fulflo FB-10)**
C5-GO-30(B)	**C5-O(B)**	**250**	**70101-100**	**73290** (#72 1” Hayward with 100 mesh basket)
C6-GO-30	**C6-O**	**250**	**70101-100**	
C7-GO-30(B)	**C7-O(B)**	**265**	**70101-100**	
C8-GO-30	**C8-O**	**265**	**70101-100**	

1. The standard pump normally supplied is 19 GPH for On-Off or Modulating and 40 GPH for fixed air low fire start, Low-High-Off and Low-High-Low operation. Optional pumps are available which, depending on model specified, could be as high as 70 GPH. Refer to information shipped with the burner and/or consult the factory for specifics.

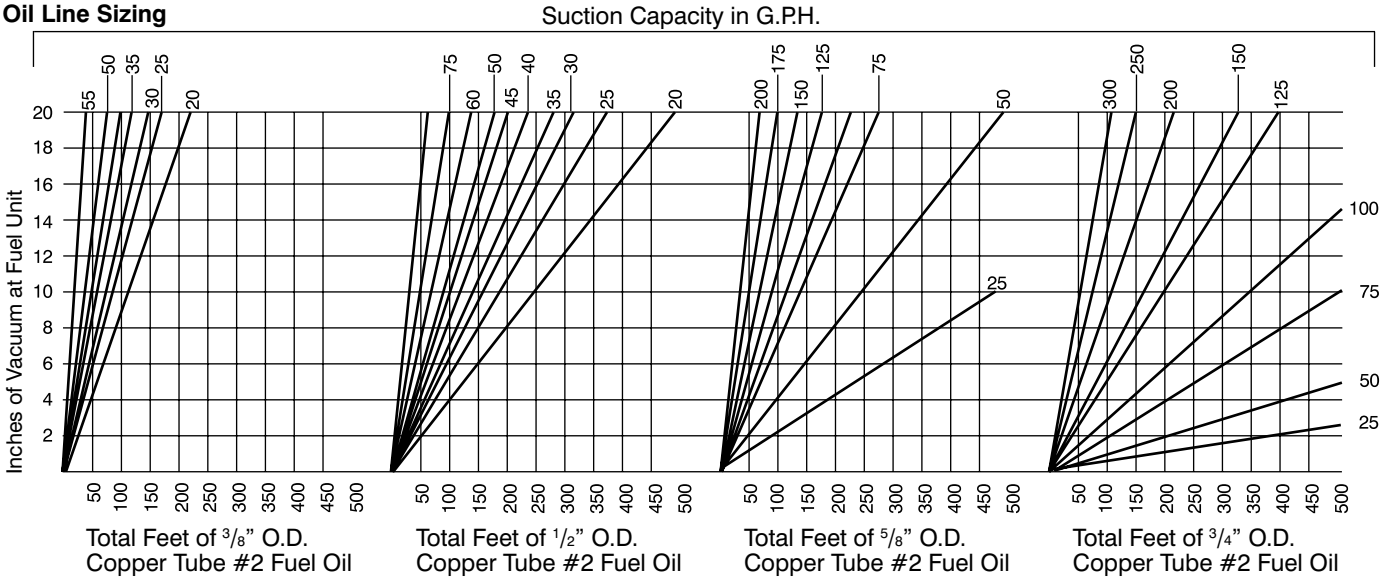
2. The standard pump normally supplied is 40 GPH for Low-High-Off and Low-High-Low and 70 GPH for On-Off and Modulating operation. Optional pumps are available for Low-High-Off and Low-High-Low which could be as high as 70 GPH. Refer to information shipped with the burner and/or consult the factory for specifics.

It is very important to properly size the oil suction line and oil filter, to provide fuel flow to the burner without exceeding 10” suction pressure (vacuum) at the oil pump suction port.

The method to properly size copper tubing is outlined on page 12 (Figure 10). Consult Power Flame Customer Services Department for sizing assistance regarding iron pipe.

Figure 10

Oil Line Sizing



1. Check oil pump *GPH Suction Capacity* shown in Table 6.
2. Measure total tube length (horizontal and vertical) from the end of the line in the tank, to the connection at the oil pump.
3. Choose the appropriate graph above based on the tubing size. Read up from horizontal line *Total Feet of Copper Tube* to *Suction Capacity* in GPH.
4. Read left to the vertical line *Inches of Vacuum at Fuel-Unit*. (This is the vacuum required to draw oil through the length of tubing selected.)
5. If installation has lift (*Lift* is defined as the vertical distance the fuel unit is above the top of the tank,) add 1" of vacuum for every foot of lift.
6. Add the vacuum determined from items 4 and 5 together to determine total inches of vacuum.
7. If total is over 10", move to next larger tubing size chart and re-calculate total inches of vacuum.
8. The instructions above do not allow for any added restrictions, such as line filter, elbows, sharp bends, check valves, etc. Suction line vacuum values for such components vary by manufacturer.

   A Rule of Thumb to determine total vacuum for suction line sizing is to add 10% to vacuum determined from Figure 10 calculations.
9. It is always safe to size the return line from pump to tank at the same size as the selected suction line.

Figure 11

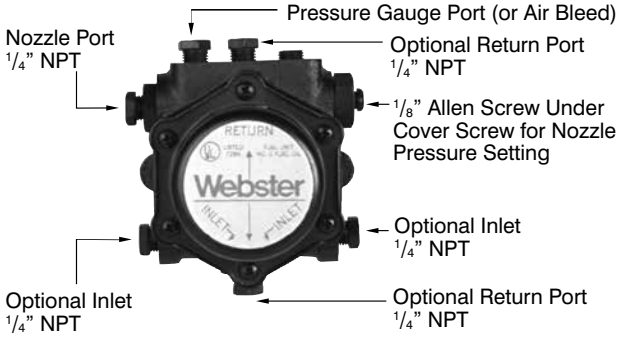
Oil Pump Details

The oil pumps depicted in this section represent the most commonly used models. For models not depicted, such as the Suntec Model J or H, refer to the pump manufacturer's bulletin that is supplied with the burner.

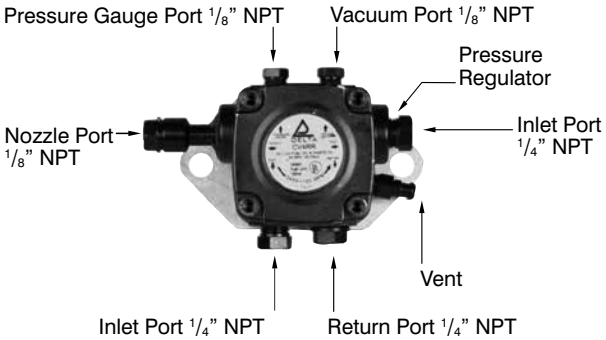
DIRECT DRIVE OIL PUMP

Piping connection may not be identical to blower motor driven pump. See pump information supplied with burners.

WEBSTER 3450 RPM BLOWER MOTOR DRIVEN OIL PUMP



DELTA OIL PUMP DETAIL



SUNTEC TWO STEP PUMP DETAIL

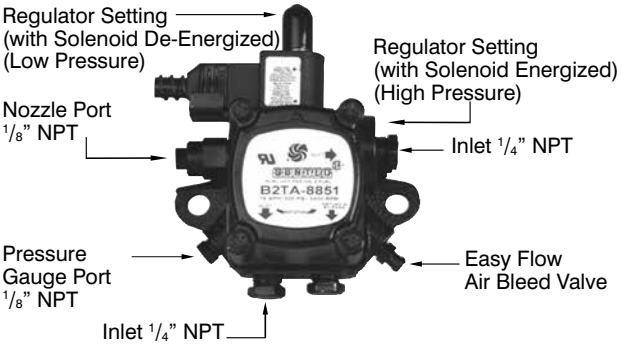
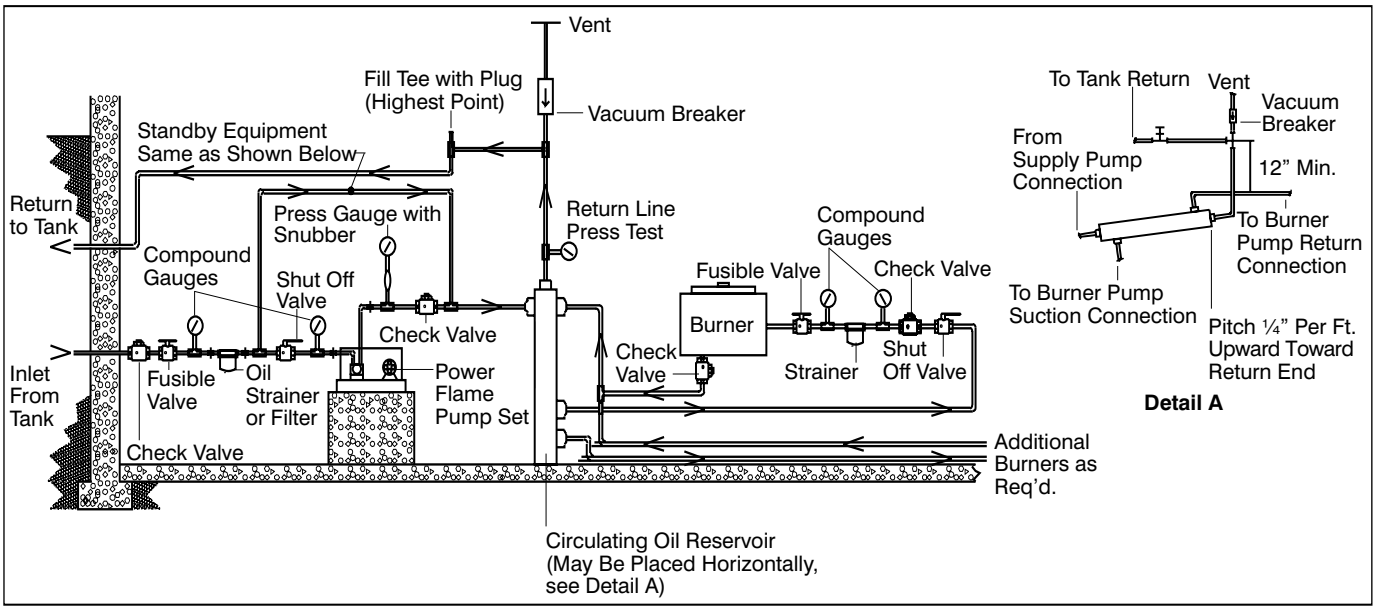


Figure 12

Multiple Burner System Oil Piping Schematic (Flooded Suction)



Combustion Air Requirements

Fresh air required to support combustion, as well as to provide adequate location ventilation, must be supplied. All types of fuel require approximately 12 cubic feet of standard air (sea level at 60 F°) per 1000 BTUs firing rate, for theoretical perfect combustion. In actual practice, a certain amount of excess air is required to ensure complete combustion, but this can vary substantially with specific job conditions. Additional air is lost from the boiler room through barometric dampers, draft diverters and similar venting devices. It is generally accepted that ½ square inch of free air opening (for each gas or oil burner in the room) per 1000 BTU/hr. firing rate will be adequate. Under no circumstances should a boiler room be under negative pressure. Jurisdictional authority relating to combustion air and boiler room ventilation requirements vary widely. In order to make certain of compliance, review NFPA-54 and the controlling authorities should be consulted.

Burner Mounting - General

A properly installed and adjusted burner is the lowest cost maintenance insurance you can buy.

Provisions should be made to provide adequate space around the burner and associated equipment to allow for ease of inspection, maintenance and service.

Observe codes for the minimum clearances to combustible materials.

Provide a suitable burner front plate, consisting of a steel plate of ample thickness to support the weight of the burner and hold it firmly in alignment with the heat exchanger. The front plate must be protected from heat using high temperature refractory on firebox side (as applicable).

To install the burner, a circular opening must be cut in the steel front plate. Four (4) mounting bolts must be installed at proper locations to match the mounting holes provided on the burner mounting flange. (See dimensional drawings, page 5.) The burner mounting flange must be securely attached to the front plate with suitable gasket or non-asbestos, high temperature rope packing to prevent any products of combustion from escaping from the combustion chamber. The burner assembly should be supported at the base of the housing to prevent undue strain on the front plate. (A mounting pedestal is furnished for this purpose.)

Type C burners are furnished with a lifting lug for ease of handling and mounting.

Combustion Chamber - General

Combustion chambers shall be provided as recommended in *Chamber Dimension Charts*, and should be constructed of high temperature refractories, in the form of firebrick or rammed plastic refractory, backed by suitable heat insulating material.

Certain types of heat exchangers, such as warm air furnaces, some hot oil heaters, wet base steel and cast iron packaged firebox boilers and Scotch marine boilers, use the combustion chamber to transfer heat, and therefore do not require refractory or other insulation. If in doubt, consult the heat exchanger equipment manufacturer.

Where boilers are of the mud-leg type, refractory should extend 6" to 8" above the bottom of mud-leg.

All possible points of air infiltration or ex-filtration must be sealed. If the unit is to be fired under positive combustion chamber conditions, extreme care must be taken to ensure that a 100% seal is maintained. The Type C burner is designed to provide all the air required for complete and efficient combustion. Entry or loss of air from sources other than the firing unit will decrease its overall combustion and operational efficiency. See page 14, Figures 13 through 16 and Table 7 for additional information.

Figure 13

Conventional Firebox Boiler

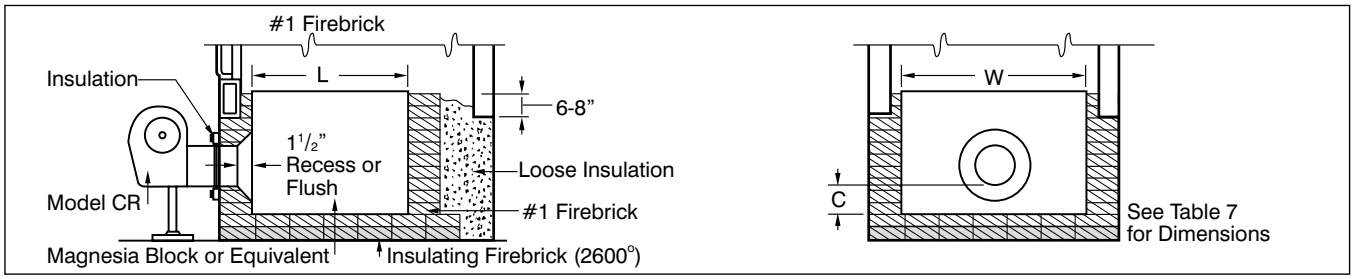


Figure 14

Typical Firedoor Installation - Cast Iron Boiler

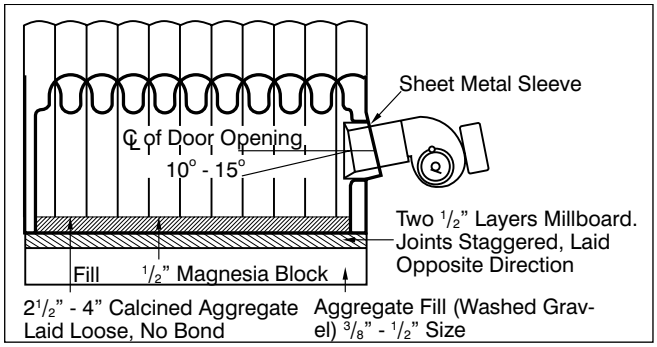


Figure 15

Packaged Firebox Boiler

NOTE:
On oil and gas/oil burners an oil weep hole is located in the bottom section of the blast tube next to the choke ring. Make certain that the refractory is constructed such as to allow oil to evacuate through this hole into the combustion chamber area.

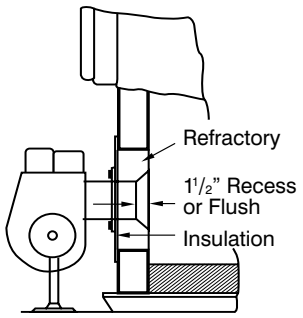
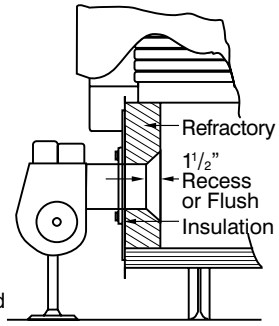


Figure 16

Scotch Marine Boilers

Scotch Marine Boiler Minimum Furnace Tube Inside Dimensions

BHP	Min Inside Dimension	BHP	Min Inside Dimension	BHP	Min Inside Dimension
20	14”	100	22”	300	34”
30	16”	125	22”	350	38”
40	16”	150	24”	400	42”
60	19”	200	28”	450	42”
80	20”	250	34”		



Note: The above minimum dimensions are recommended. If boiler dimensions are less, consult with factory. All burners set through refractory with sleeve to allow field removal. Unlined space between sleeve and burner blast tube closed with non-asbestos high-temp rope or KA-O-Wool.

Table 7

Suggested Firebox Boiler Combustion Chamber Dimensions

Model Number	Gas Input MBTU Hr.	Oil Input GPH #1,#2 Oil	(W) Width	(L) Length	(C) Minimum Tube Height
C1-GO-10, C1-G-10, C1-O	300	2.5	13	17	3
	500	3.5	16	22	3
	800	6	19	25	3
	980	7	20	28	3
C1-GO-12, C1-G-12, C1-O	700	5	13	17	3
	900	6.5	20	28	3
	1150	8	22	30	3
	1260	9	23	33	3
C2-GO-15, C2-G-15, C2-OA	1000	7	21	29	5
	1300	9	23	33	5
	1600	13	25	38	5
	2100	15	27	42	5
C2-GO-20, C2-G-20, C2-OB	1500	11	25	38	5
	2000	14	27	42	5
	2500	18	29	46	5
	2900	22	30	48	5
C3-GO, C3-G, C3-O	2400	17	27	44	5
	3300	24	33	53	6
	4200	30	37	62	8
	5250	37.5	40	68	9

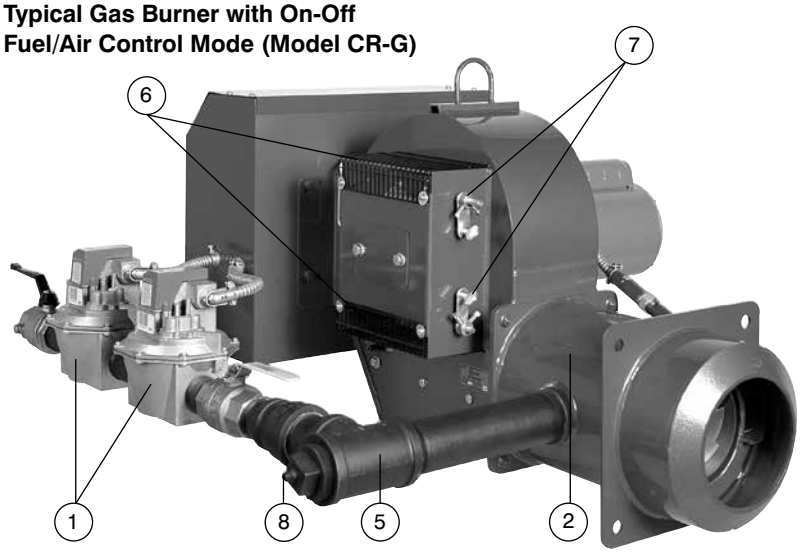
Model Number	Gas Input MBTU Hr.	Oil Input GPH #1,#2 Oil	(W) Width	(L) Length	(C) Minimum Tube Height
C4-GO-30, C4-G-30, C4-OA(B)	4000	29	35	58	8
	5500	40	42	70	9
	7000	50	45	76	12
	7840	56	48	79	13
C5-GO-30(B), C5-G-30(B), C5-O(B)	6000	43	43	72	10
	7500	53	48	79	13
	9000	65	50	80	13
	10500	75	54	84	15
C6-GO-30, C6-G-30, C6-O	8000	57	48	79	13
	10500	75	54	84	15
	12500	89	60	90	17
	14215	101.5	64	95	18
C7-GO-30(B), C7-G-30(B), C7-O(B)	12500	89	60	90	17
	14000	100	64	95	18
	15500	110	68	100	20
	17000	121.4	71	110	23
	17700	126.4	72	112	25
C8-GO-30, C8-G-30, C8-O	14000	100	64	95	18
	15500	110	68	100	20
	17500	125	72	110	24

Note: These dimensions are to serve as a guide only, and may be modified providing approximate area is maintained.

3. MECHANICAL OPERATION OF FUEL/AIR CONTROL MODES

Figure 17

Typical Gas Burner with On-Off Fuel/Air Control Mode (Model CR-G)



MECHANICAL OPERATION: This system uses a combination Diaphragm Gas Valve and Integral Pressure Regulator (1) to control the on-off operation of gas to the Blast Tube (2). A proven spark ignited gas pilot provides ignition for the main flame. Gas flow control rate is accomplished by adjustment of the main gas pressure regulator and by a Limiting Orifice (a limiting orifice is used when the gas flow rate - BTU input - through the gas train components is higher than desired), located in the Orifice Tee fitting (5) at the inlet to the gas manifold. The Air Dampers (6) are adjusted and locked in place with the Air Damper Arms (7) for a fixed firing rate. When the gas pilot* has been proven by the flame detector*, the Diaphragm Gas Valve will open slowly, allowing gas to the Blast Tube. Blast Tube gas pressures are measured at the 1/4" Plugged Gauge Test Port (8) in the Side Orifice Tee. Refer to page 37, Table 10 for orifice sizing information. See page 37, Figure 38 for side orifice detail.

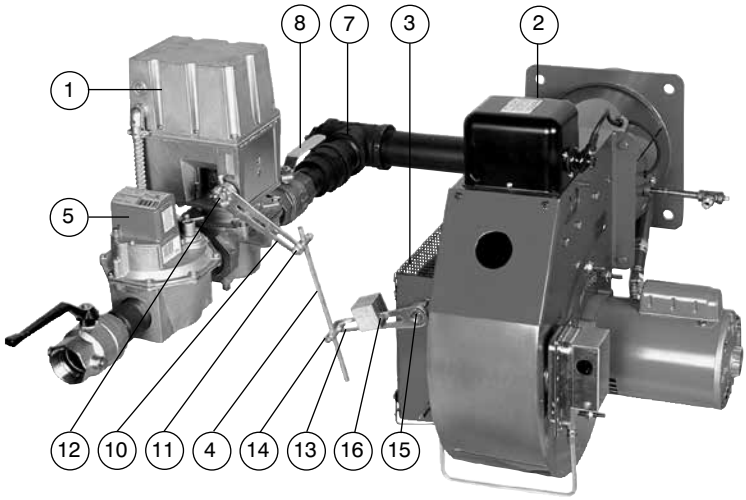
* Not shown in this depiction. See page 3, Figure 1.

Note 1
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Note 2
Optional On/Off systems may be supplied using a separate gas pressure regulator and separate diaphragm or motorized gas valve in place of the combination regulator/valve unit depicted. Other components would remain as described.

Figure 18

Typical Gas Burner with Low-High-Off or Low-High-Low Fuel/Air Control Mode (Model C-G)



MECHANICAL OPERATION: The Low-High-Off system uses a Motorized Gas Valve (1) to control the Low-High-Off operation of gas to the Blast Tube (2), as well as movable Air Dampers (3) by means of the mechanical Linkage (4). Gas flow control rate is accomplished by adjustment of the Main Gas Pressure Regulator (5) and by a Limiting Orifice (when installed) located in the Side Orifice Tee fitting (7) at the inlet piping to the gas manifold. A proven spark ignited gas pilot* provides ignition for the main flame. When the gas pilot* has been proven by the flame detector (scanner)*, the Motorized Gas Valve begins to open, allowing a controlled fuel/air mixture to the Blast Tube for low fire light off - and continues to open, increasing the fuel/air flow until the high fire position has been reached. Firing Head gas pressures are measured at the 1/4" plugged Gauge Test Port (8) in the Side Orifice Tee. Refer to page 37, Table 10 for orifice sizing information. The burner operates at high fire until the system load demand is satisfied, at which time the Motorized Gas Valve closes and the Air Dampers are returned to the light off position in preparation for the next operating cycle. This depiction shows the Linkage in the low fire start position.

The Low-High-Low system is identical to the Low-High-Off system except that - the Motorized Gas Valve (1) has a

Low Fire Operating Position Adjustment in addition to the light off and high fire operating positions. (See manufacturer's bulletin included with the burner.)

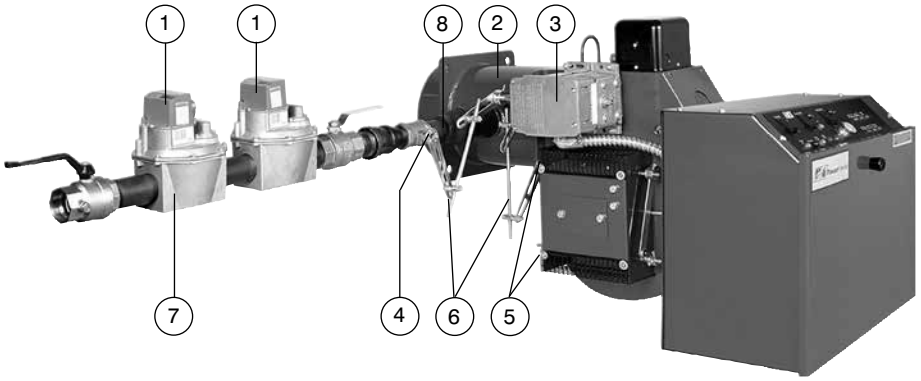
An additional temperature or pressure controller is added to the system, which at a selected preset point will electrically switch the Motorized Gas Valve and Air Dampers (3) to either the low fire or the high fire position, as the system load demand requires. Depending on system load conditions, the burner can alternate indefinitely between the low and the high fire positions without shutting down. When the system demand is satisfied, the Motorized Gas Valve closes (normally the burner will be in the low fire position at this time) and the Air Dampers are returned to the light off position, in preparation for the next operating cycle. The Driver Arm (10) connected to the Motorized Gas Valve will increase the travel of the Air Damper Arm (13) as the Linkage Rod ball joint (11) is moved away from the Gas Valve Crank Shaft (12). The travel of the Air Damper Driven Arm will be increased as the Linkage Rod ball joint (14) is moved toward the Air Damper Axle Shaft (15). When adjusting linkage travel, make certain that the driven arm Linkage Return Iron Weight (16) does not interfere with the Linkage operation - and that all linkage components are free from binding.

***** Not shown in this depiction. See page 4, Figure 2.

Note 1
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 19

Typical Gas Burner with Full Modulation Fuel/Air Control Mode (Model C-G)



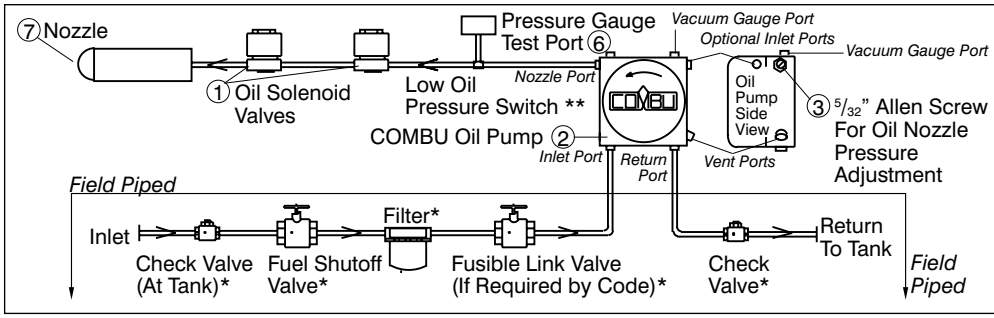
MECHANICAL OPERATION: This Full Modulation system uses a Diaphragm (1) or Motorized Gas Valves to ensure opening and positive closure of the gas source to the Blast Tube (2). A Modulating Motor (3) controls the positioning of a Modulating Butterfly Gas Valve (4) and movable Air Dampers (5) through Mechanical Linkage (6). The gas flow control rate is accomplished through adjustment of the Main Gas Pressure Regulator (7) and the Butterfly Valve. A proven spark ignited gas pilot* provides ignition for the main flame. When the gas pilot has been proven by the flame detector*, the Diaphragm or Motorized Gas Valve opens and allows gas at a rate controlled by the Butterfly Valve to go to the Blast Tube for main flame low fire light off. After a short period of time at the low fire position, the Modulating Motor will drive the Butterfly Valve and the Air Dampers to the high fire position. The burner will stay at high fire until the system pressure or temperature increases to a selected preset point, at which time a modulating type controller will drive the Modulating Motor to low fire, or whatever firing position between low and high fire is required to match the system load demand. The Modulating Motor will continually reposition the firing rate in an effort to exactly match system load demand. Blast Tube gas pressures can be taken at the $^1/_4$" Plugged Test Port (8) located between the Butterfly Valve and the gas Blast Tube. Refer to the Burner Specification computer printout supplied with the burner, for specific high fire gas pressure values. When the system pressure or temperature cutoff point is reached, the Diaphragm or Motorized Gas Valve closes (normally the burner will be at the full low fire position at this time) and the Air Dampers will go to the low fire light off position in preparation for the next firing cycle. This depiction shows the Linkage in the low fire light off position. Refer to page 22, Figure 27 for information on linkage adjustments. Also see page 22 for information on the Varicam™ modulating characterized fuel metering system.

***** Not shown in this diagram. See page 4, Figure 3.

Note 1
Component operational sequencing will vary with specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 20

Typical Oil Burner with On-Off Fuel/Air Control Mode



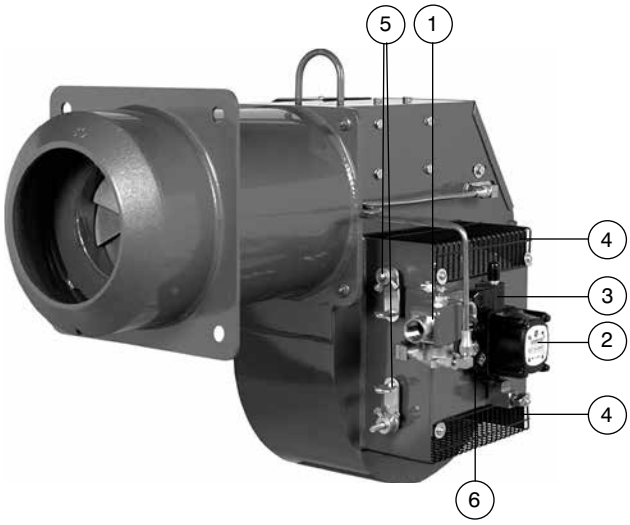
* By Others Unless Specified on Order.

** Burners with Remote Pressure Atomizing Oil Pumps require a Low Oil Pressure Switch.

CAUTION:
All field piped components must be mounted in the proper location and proper direction of oil flow.

CAUTION:
Oil supply pressure to Burner Pump must not exceed 3 PSI per NFPA Code.

DO NOT USE TEFLON TAPE



MECHANICAL OPERATION: The On-Off system uses a single stage, high suction lift Oil Pump (2) with a Simplex Oil Nozzle. A direct spark oil ignition system is standard on typical oil burners (a gas pilot is standard on Gas/Oil burners), but certain insurance company codes could require a spark ignited gas pilot* to provide ignition for the main oil flame. The nozzle oil flow rate is set by adjusting the Oil Pump Pressure Regulating Valve (3). Turn clockwise to increase the pressure and counter-clockwise to decrease the pressure to the Nozzle. Normal nozzle pressure will be 100 to 300 PSI. Refer to page 34, Table 9 to determine specific nozzle pressures and firing rates. Nozzle pressures are taken at the plugged Nozzle Pressure Gauge Port (6). The oil on-off flow to the Nozzle is controlled by the Oil Solenoid Valve (1). The Air Dampers (4) are adjusted and locked in place with the Air Damper Arms (5). The burner operates at one fixed firing rate. See page 12, Figure 11 and pump manufacturer's bulletin packed with the burner for more information.

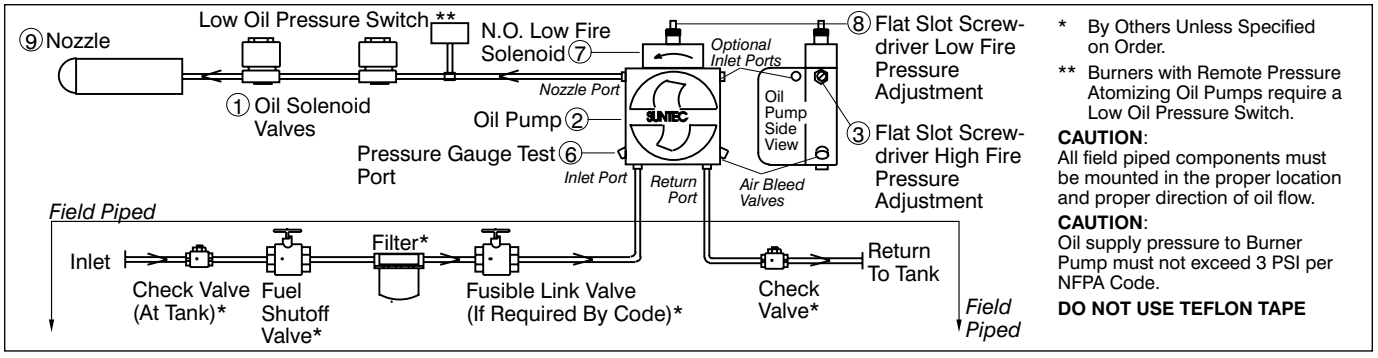
***** Not shown in this depiction. See page 3, Figure 1.

Note 1
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Note 2
The system depicted above is based on the use of an oil pump manufactured by COMBU Incorporated. If your system uses other than a COMBU pump, refer to the oil piping diagram and oil pump manufacturer's bulletin supplied with the burner for specifics pertaining to your system.

Figure 21

Typical Oil Burner with Fixed Air Low Fire Start Fuel/Air Control Mode



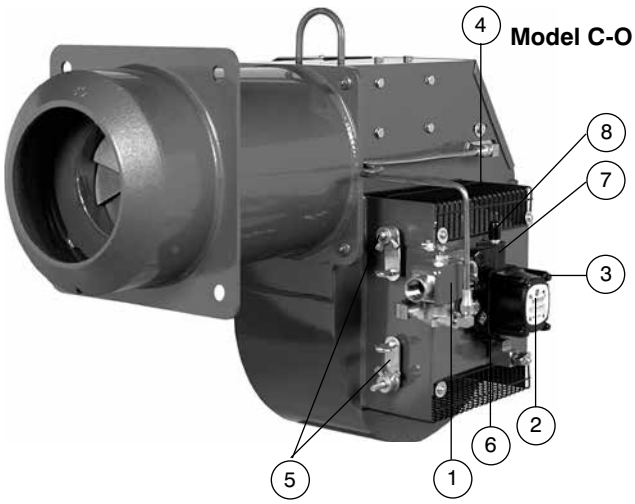
* By Others Unless Specified on Order.

** Burners with Remote Pressure Atomizing Oil Pumps require a Low Oil Pressure Switch.

CAUTION:
All field piped components must be mounted in the proper location and proper direction of oil flow.

CAUTION:
Oil supply pressure to Burner Pump must not exceed 3 PSI per NFPA Code.

DO NOT USE TEFLON TAPE



MECHANICAL OPERATION: The fixed air low fire start system uses a two-step, two-stage Oil Pump (2) with a Simplex Oil Nozzle. A direct spark oil ignition system is standard on typical oil burners (a gas pilot is standard on Gas/Oil burners), but certain insurance company codes could require a spark ignited gas pilot* to provide ignition for the main oil flame. The nozzle flow rate pressures are taken at the Plugged Pump Nozzle Pressure Gauge Port (6). The low fire oil flow rate is set by adjusting the Oil Pump Low Pressure Regulator (8). The high fire oil flow rate is set by adjusting the Oil Pump High Pressure Regulator (3). For both high and low fires, turn the adjustment screws clockwise to increase the pressure and counterclockwise to decrease the pressure to the Nozzle. **Approximate low fire pressures** are 150 to 225 psig and high fire, 200 to 300 psig. **Remember, you will be lighting off at full air and reduced fuel. Raise low fire enough to obtain dependable light off with these conditions.** The Air Dampers (4) are adjusted and locked in place with the Air Damper Arms (5) for correct combustion values at the high fire rate. At light off, the Main Oil Solenoid Valve (1) is energized, allowing fuel to flow to the Nozzle. The normally open Low Fire Solenoid Valve (7) allows a reduced amount of oil to the Nozzle for low fire start. When the flame is proven by the flame detector*, the low fire solenoid valve closes, providing full high fire pressure to the Oil Nozzle. The burner operates at the high fire position until the system load demand is satisfied. Refer to page 34, Table 9 for specific nozzle pressures and firing rates. See page 12, Figure 11 and the pump manufacturer's bulletin supplied with the burner for additional information.

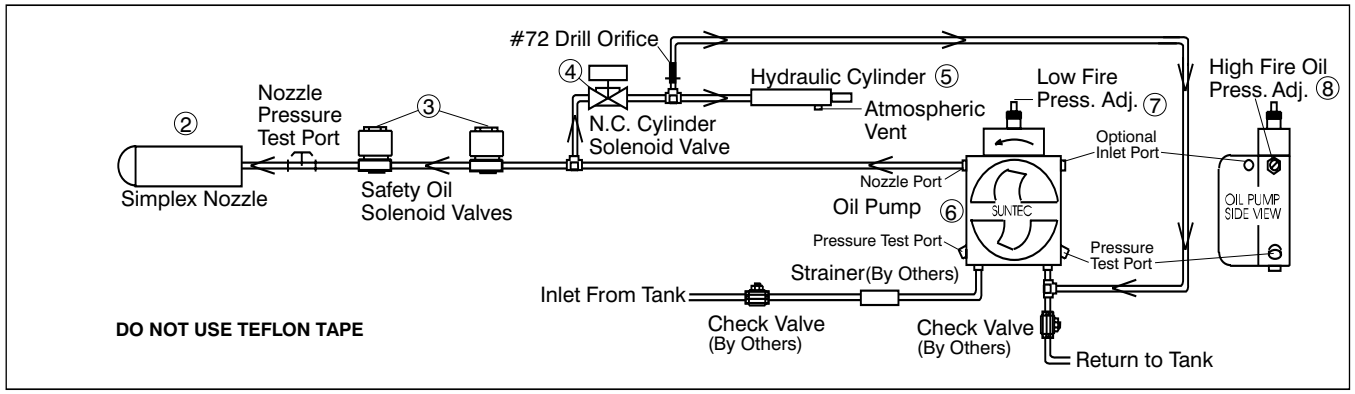
***** Not shown in this depiction. See page 3, Figure 1.

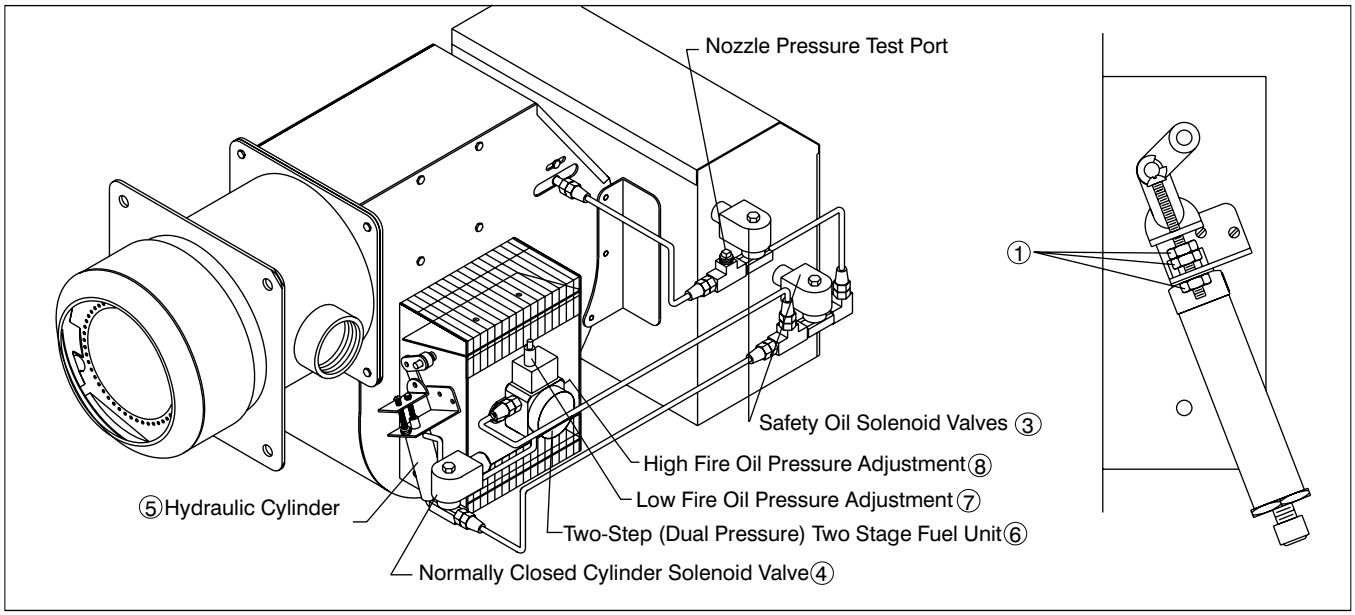
Note 1
The system depicted uses a two-step Suntec oil pump. If a pump that does not have the integral two-step function has been specified and supplied, it will be provided with an N.C. nozzle bypass oil solenoid valve and a separate adjustable low fire relief valve. Refer to the oil piping diagram and the oil pump manufacturer's bulletin supplied with the burner for the specifics on your system.

Note 2
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 22

Typical Oil or Gas/Oil Burner with Reduced Air, Low Fire Start *RALFS*



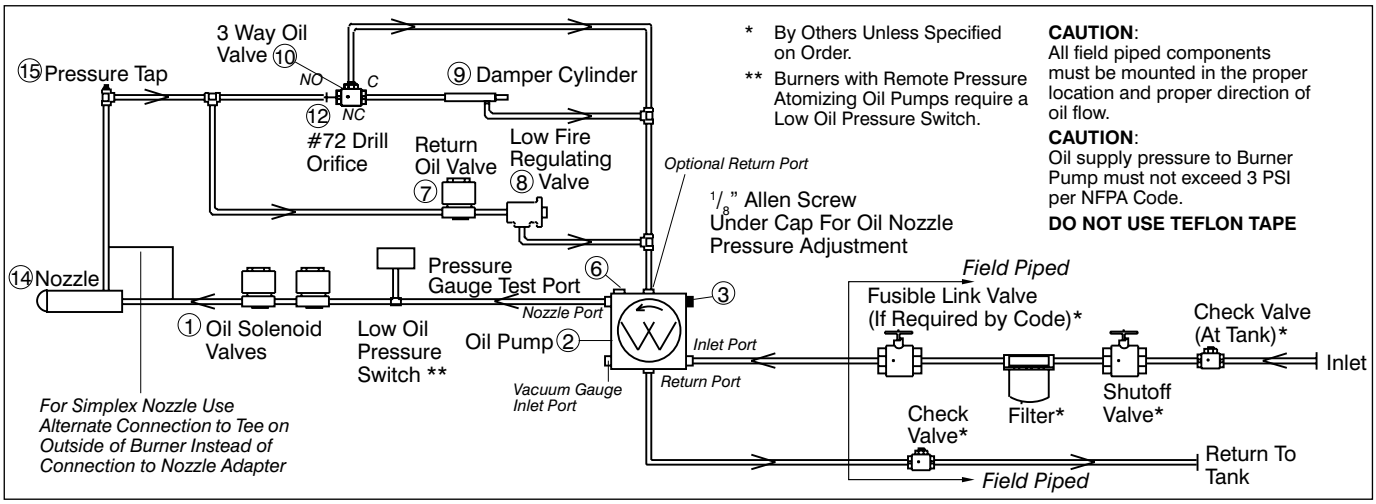


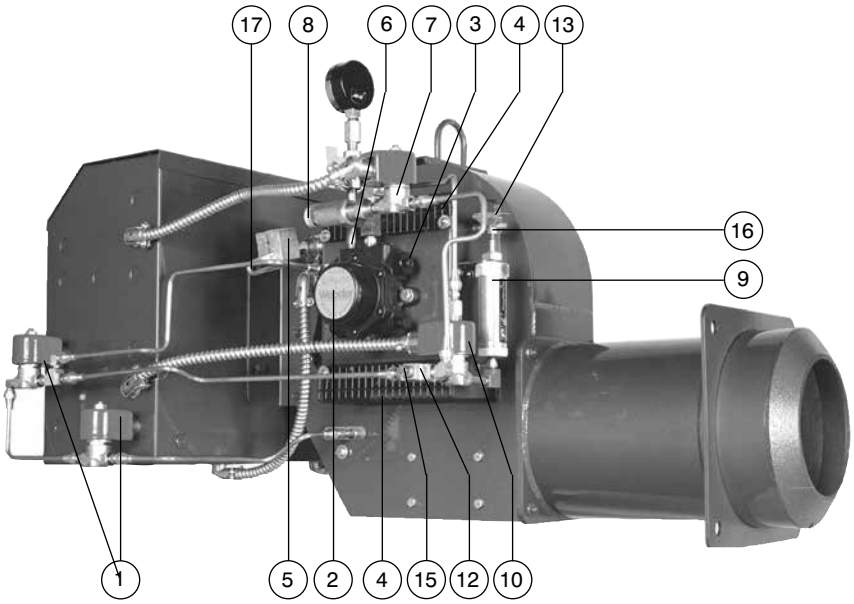
MECHANICAL OPERATION: The RALFS system uses a two step, two stage dual pressure Oil Pump (6), or fuel unit, with a simplex nozzle. Either a direct spark or a gas pilot ignition system may be provided for ignition of the main oil flame. The air damper is spring loaded to an open position suitable for maximum desired capacity and proper combustion.

OIL CYCLE: After a 30 second pre-purge is accomplished, the direct spark ignition transformer is energized. At the same time the normally closed Cylinder Solenoid Valve (4) is energized, moving the Hydraulic Cylinder (5) and air damper to a reduced air setting (combustion air dampers approx. $^{3}/_{8}$" open). Combustion air is to be set by loosening the set screws from the damper arm that connects to the damper shaft. Set the damper opening so as to provide a smooth and immediate light-off. The amount of combustion air needed for this temporary setting should be minimal-just enough to prevent the unit from producing smoke. A smooth light off with minimal air is the objective. The Low Fire Pressure Adjustment (7) or the light-off fuel setting should be set between 90 p.s.i. to 120 p.s.i. After the air dampers have been driven to the reduced air setting or light-off fire position the Safety Oil Solenoid Valves (3) will be energized by the flame safe-guard igniting the low fire oil flame or the light-off flame which is proven by flame sensor (scanner). After approximately five seconds, the normally closed Cylinder Solenoid Valve will be deenergized, causing the combustion air dampers to open to the fixed air setting for maximum desired capacity. The return oil valve (normally open) which is integral to the Suntec two step pump (fuel unit) will now be energized, providing full high fire oil pressure for the oil nozzle. At the same time, the main oil valve terminal on the flame safeguard will be energized and the Safety Oil Solenoid Valves will open. The adjustment for fixed air setting or full fire position will be made with the two bottom $^{1}/_{4}$-20 hex nuts - see item #1. Combustion air dampers should be adjusted to provide $11^{1}/_{2}$ to $12^{1}/_{2}$% CO_2 or 4 to $5^{1}/_{2}$% O_2 at full input (oil high fire rate) with zero smoke. High Fire Oil Pressure (8) setting should be set to the required p.s.i. for high fire oil rate (see burner specification sheet for setting). The low fire should be rechecked for light-off pressure and performance. The gas combustion will be initiated (after 30 seconds pre-purge period) by proof of spark ignited gas pilot (by scanner) which energizes dual gas safety valves. If input for gas is comparable to oil input then previous air damper adjustment for oil combustion should be satisfactory for gas firing.

Figure 23

Typical Oil Burner with Low-High-Off or Low-High-Low Fuel/Air Control Mode Using Webster 22R Oil Pump





MECHANICAL OPERATION: This Low-High-Off system uses a two-stage Oil Pump (2) with a Simplex Oil Nozzle (see note 1, page 19 & 20) or an internal bypass nozzle in conjunction with Movable Air Dampers (4) to provide a low fire start and a high fire run sequence. A direct spark oil ignition system is standard on typical oil burners (a gas pilot is standard on Gas/Oil burners) at firing rates up to 45 GPH, with a spark ignited gas pilot* to ignite the main oil flame above that point. Certain insurance company codes could require the gas pilot system on lower input sizes. Nozzle supply pressure is set by adjusting the Oil Pump Pressure Regulator (3). Turn clockwise to increase the pressure and counter-clockwise to decrease the pressure to the Nozzle. Nozzle supply pressure is taken at the plugged Pump Nozzle Pressure Gauge Port (6). Nozzle supply pressure will normally be approximately 300 PSI at both high and low firing rates. Flow rate pressure for both high and low fire is taken at Bypass Pressure Gauge Tee (15). Low fire pressures are set by adjusting the low fire Regulating Valve (8). Turning the low fire Regulating Valve adjustment nut clockwise will increase the pressure at the Bypass Pressure Test Tee Gauge (increasing the low fire input) and counter clockwise will reduce the pressure at the gauge (decreasing the low fire input). Low fire return pressure will normally be in 60 to 100 PSI range and at high fire in the 180 to 225 PSI range, but both pressures will vary according to the specific nozzle being used, as well as job conditions. At light off, the Main Oil Solenoid Valve (1) is energized, allowing fuel to flow to the Nozzle. At the same instant a portion of the oil bypasses the Nozzle through the adjustable low fire regulating valve, reducing the pressure at the Nozzle as required for low fire rates. When the low fire flame is proven by the flame detector*, the Return Oil Solenoid Valve (7) is deenergized, putting full high fire pump pressure on the Nozzle. Simultaneously, the Three-Way Solenoid Valve (10) is energized, allowing oil into the Hydraulic Cylinder (9) which mechanically drives the Air Damper Arm (13) to the high fire position. The burner operates at full high fire until the system demand is satisfied. Refer to page 31, Table 8 or page 34, Table 9 to determine nozzle return flow pressure and flow rates. This depiction shows the Air Dampers and Hydraulic Cylinder at the low fire light off position.

The Low-High-Low system is identical to the Low-High-Off system, except that an additional pressure or temperature controller is added to the system, which at a selected preset point will electrically switch the burner to either the high or low fire position. When the burner is running at high fire and the controller calls for low fire, the normally closed Oil Solenoid Return Valve (7) (closed at high fire) is energized, reducing nozzle pressure to the low fire rate. Simultaneously, the Three-Way Solenoid Valve (10) is de-energized, allowing oil to flow out of the Hydraulic Cylinder (9) back to the Pump and driving the Air Dampers (4) to the low fire position. Responding to load conditions, the burner can alternate indefinitely between the low and high fire positions without shutting down. When system load demand is satisfied, all fuel valves are de-energized and the Air Dampers are placed in the light off position in preparation for the next firing cycle. The opening distance of the Air Dampers is controlled by positioning the Air Damper Drive Arm (13) relative to the Acorn Nut (16) mounted on the end of the Hydraulic Cylinder piston rod. The maximum travel is with the Damper Drive Arm positioned to be in contact with the hydraulic oil cylinder Acorn Nut at all times. If less travel is desired, set the Air Damper Drive Arm to allow a gap between it and the Acorn Nut. (Depending on Air Damper positioning, it may be necessary to loosen its set screws to attain proper Air Damper opening distance.) The wider the gap (when the burner is off), the less the overall travel when going to the high fire position. When setting the Drive Arm position relative to the Acorn Nut, make certain that the Air Dampers' travel is correct for proper combustion at all firing positions and that there is no binding of the Linkage or Dampers. Make certain the cast iron Linkage Return Weight (5) is secure on its Air Damper Arm (17).

* Not shown in this depiction. See page 4, Figure 2

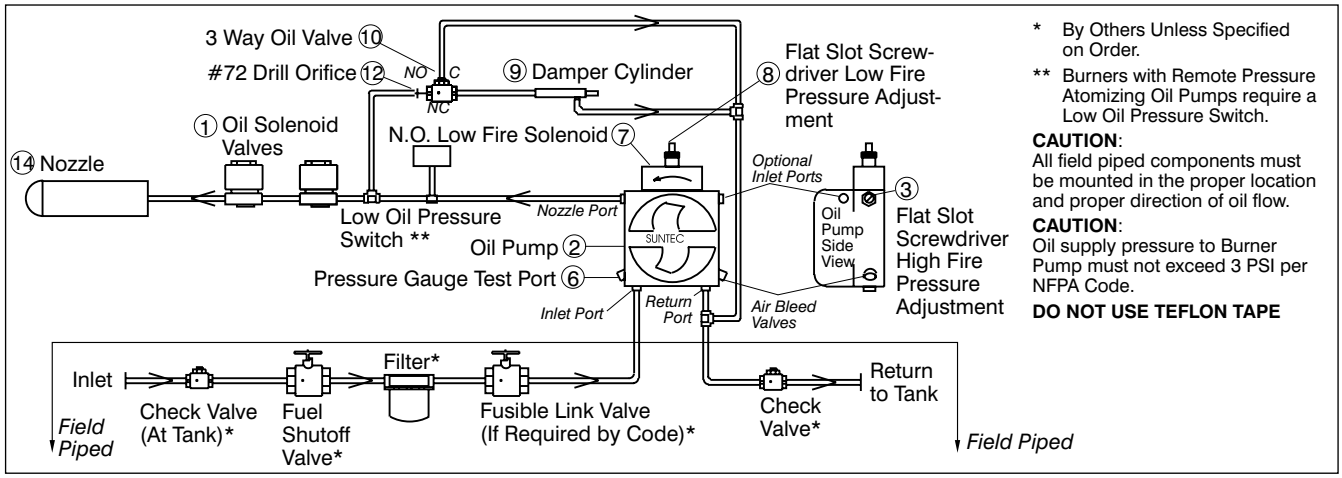
Note 1
The system depicted in Figure 23 uses a Webster Model 22R oil pump. If your system uses a Suntec H model pump, the sequence of operation and the oil components would be identical

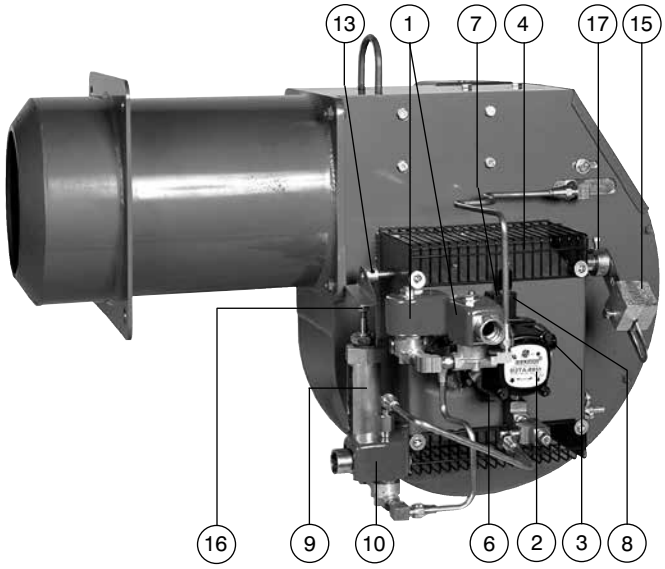
to the Webster 22R system. For additional information on your specific system refer to the oil piping diagram and the oil pump manufacturer's bulletin supplied with the burner.

Note 2
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 24

Typical Oil Burner with Low-High-Off or Low-High-Low Fuel/Air Control Mode Using a Two-Step Oil Pump (Model C-O)





MECHANICAL OPERATION: This Low-High-Off system uses a Two-Step Oil Pump with a Simplex Oil Nozzle (14) in conjunction with movable Air Dampers (4) to provide a low fire start and a high fire run sequence. A direct spark oil ignition system is standard on typical Oil burners (a gas pilot is standard on Gas/Oil burners), but certain insurance company codes could require a spark ignited gas pilot* to provide ignition for the main oil flame. Nozzle flow rate pressure is taken at the $^1/_8$" Plugged Pump Pressure Gauge Port (6). The low fire oil rate is set by adjusting the Oil Pump Low Pressure Regulator (8). The high fire oil flow rate is set by adjusting the Oil Pump High Pressure Regulator (3). For both high and low fires turn the adjustment screws clockwise to increase the pressure and counterclockwise to decrease the pressure to the Nozzle. Approximate low fire oil pressures are 100 to 125 psig and high fire, 200 to 300 psig. Both settings will vary depending upon the specific nozzle size selected and job conditions. See pages 31-34, Tables 8 & 9 for specific nozzle pressures and flow rates. At light off the Main Oil Solenoid Valves (1) are energized, allowing fuel to the Nozzle. A normally open pump mounted Oil Solenoid Valve (7) allows a controlled flow of oil to the Nozzle in accordance with the pressure setting of the pump low fire adjustment. When the low fire flame is proven by the flame detector*, the pump mounted, normally open Solenoid Valve is energized (closes), putting full high fire pump pressure on the nozzle. Simultaneously, the Three-Way Solenoid Valve (10) is energized, allowing oil into the Hydraulic Oil Cylinder (9) which mechanically drives the Air Damper Arm (13) to the high fire open position. The burner operates at full high fire until the system demand is satisfied. This depiction shows the Air Dampers and the Hydraulic Cylinder at the low fire light off position.

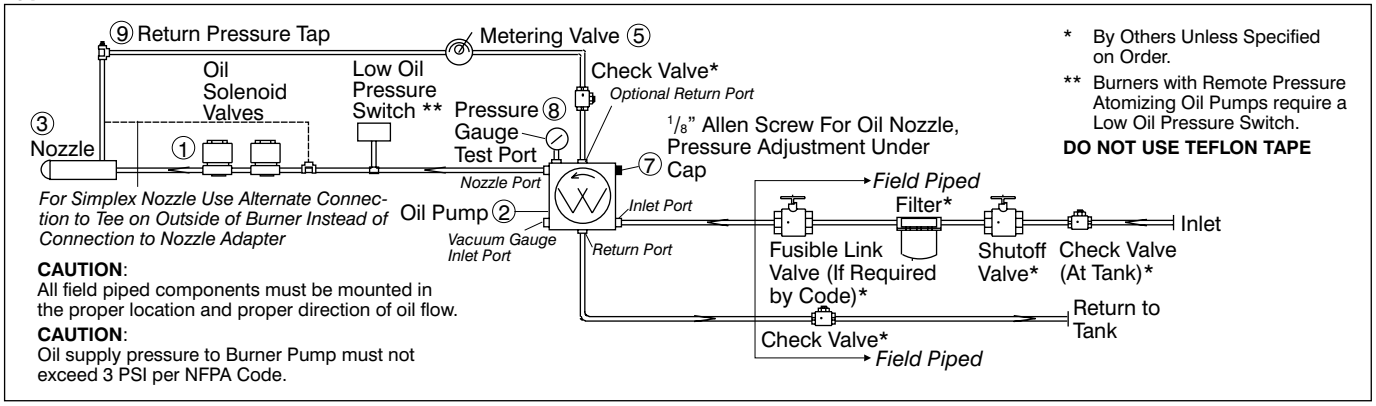
The Low-High-Low systems are identical to the Low-High-Off system, except that an additional temperature or pressure controller is added to the system. At a selected preset point, it will electrically switch the Oil Valves and Air Damper components to place the firing rate either in the low or the high fire run position. When the burner is running at high fire and the controller calls for low fire, the normally open pump mounted Solenoid Valve (7) (which is closed at high fire) is de-energized (opens), reducing nozzle pressure to the low fire rate. Simultaneously, the Three-Way Solenoid Valve (10) is de-energized, allowing oil to flow out of the Hydraulic Cylinder back to the Pump (2) and driving the Air Dampers (4) to the low fire position. Depending on load conditions, the burner can alternate indefinitely between the low and the high fire positions without shutting down. When system demand is satisfied all fuel valves are de-energized and the Air Dampers are placed in the light off position for the next start up. The Air Damper position for low fire run and light off position are one and the same in this system. The opening distance of the Air Dampers is controlled by positioning the Air Damper Drive Arm (13) relative to the Acorn Nut (16) mounted on the end of the Hydraulic Cylinder (9) piston rod. The maximum travel is with the Damper Drive Arm positioned to be in contact with the hydraulic oil cylinder Acorn Nut at all times. If less travel is desired, set the Air Damper Drive Arm to allow a gap between it and the Acorn Nut. (Depending on Air Damper positioning, it may be necessary to loosen its set screws to attain proper Air Damper opening distance.) The wider the gap (when the burner is off), the less the overall travel when going to high fire position. When setting the Drive Arm position relative to the Acorn Nut, make certain that the Air Damper travel is correct for proper combustion at all

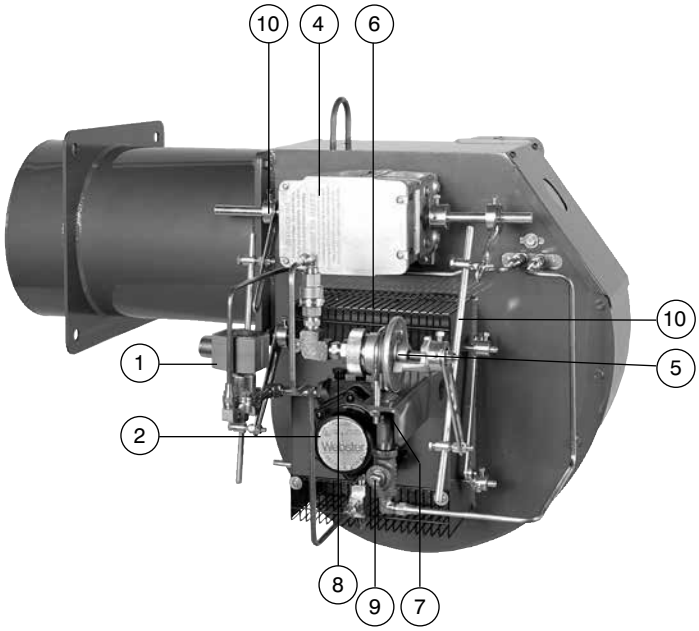
firing positions and that there is no binding of the Linkage or Dampers. Make certain the cast iron Linkage Return Weight (15) is secure on its Linkage Arm (17).

***** Not shown in this depiction. See page 4, Figure 2.

Figure 25

Typical Oil Burner with Full Modulation Fuel/Air Control (Model C-O)





MECHANICAL OPERATION: The Full Modulation system uses a two-stage Oil Pump (2) with an internal bypass type Oil Nozzle (See page 19 & 20, note 1). A Modulating Motor (4) controls the positioning of the Air Dampers (6) and the Modulating Oil Valve (5) in the nozzle return line through mechanical linkage. A direct spark oil ignition system is standard on typical oil burners (a gas pilot is standard on Gas/Oil burners) at firing rates up to 45 GPH, with a spark ignited gas pilot* to ignite the main oil flame above that point. Certain insurance company codes could require the gas pilot system on lower input sizes. At main flame light off the normally closed Oil Valve (1) is energized, allowing oil to flow to the Nozzle. The Modulating Oil Valve is adjusted to allow a controlled amount of oil to bypass the Nozzle, which keeps the pressure reduced to the nozzle for low fire light off. Nozzle oil supply pressure is set by adjusting the Oil Pump pressure regulator (7). Turn clock-wise to increase the pressure and counter-clockwise to decrease the pressure to the nozzle. The low fire nozzle pressures should be taken at the plugged Oil Pump Gauge Port (8) and should be approximately 300 PSI with pressure at the Nozzle Bypass Gauge Port (9) from 60 to 100 PSI, these pressures varying with nozzle size and job conditions. A typical low fire oil flow setting on the Modulating Oil Valve would be number 7, but will vary with job conditions. After a brief period of time for the low fire flame to stabilize, the Modulating Motor will drive the Fuel/Air Linkage (10) to the high fire position. At this point the Air Dampers will be full open (or as required for good combustion) and the Modulating Oil Valve will be at the *closed* position and the nozzle bypass line will be fully closed, putting full oil pressure to the Nozzle. The Oil Pump Pressure Gauge Port pressure reading will show approximately 300 PSI and pressures at the bypass pressure gauge port will be 180 to 225 PSI, although this will vary with the specific nozzle size being used. Refer to page 34, Table 9 to determine specific nozzle pressures and firing rates. A modulating temperature or pressure controller will now modulate the firing rate to match the load demand of the system, while maintaining proper fuel/air ratios. Prior to reaching the system pressure or temperature operating control cut off point, the burner should be at or near the low fire operating position. At the end of the firing cycle, the normally closed Oil Valve will be de-energized and the Modulating Motor will position the Air Dampers and Modulating Valve to the low fire position, ready for the next start up sequence. This depiction shows the Linkage in the low fire light off position.

See page 22, Figure 27 for linkage adjustment information. Also see page 22, Figure 28 for information on the Varicam™ modulating characterized fuel metering system.

***** Not shown in this depiction. See page 4, Figure 3.

Note 1
Some modulating Low-High-Off and Low-High-Low burners will be supplied with simplex, rather than internal bypass type, oil nozzles. The mechanical operation of the simplex nozzle system is essentially the same as the internal bypass system - except that low fire oil pressures should be set at 100 to 125 psig (adjust to suit job conditions) and high fire oil pressures at 280 to 300 psig at the oil pump nozzle pressure gauge test port. Refer to the Burner Specification sheet shipped with the burner and/or page 34, Table 9 for high fire oil pressures and flow rates.

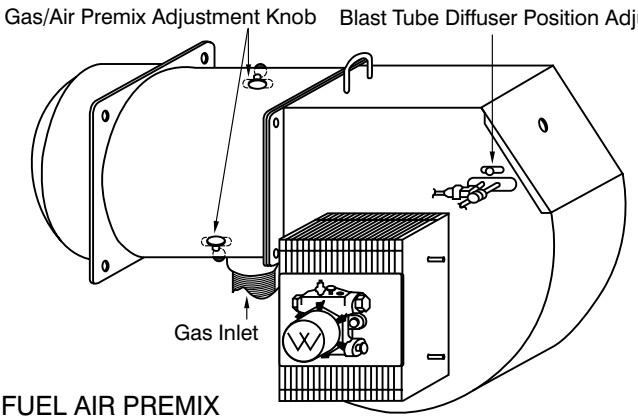
The oil pump depicted in the oil flow schematic above is as manufactured by Webster Electric Company Inc. If the pump on your burner is not Webster, refer to the oil pump bulletin shipped with the burner for specific adjustment information. Also see page 12, Figure 11.

Note 2
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Note 1
Component operational sequencing will vary with the specific Flame Safeguard Control being used. Refer to the specific Flame Safeguard Control bulletin supplied with the burner for complete information.

Figure 26

Gas or Gas/Oil Burner Fuel/Air Premix Adjustment - Gas, Oil or Gas/Oil Burner Diffuser Adjustment



FUEL AIR PREMIX ADJUSTMENT(OPTIONAL)

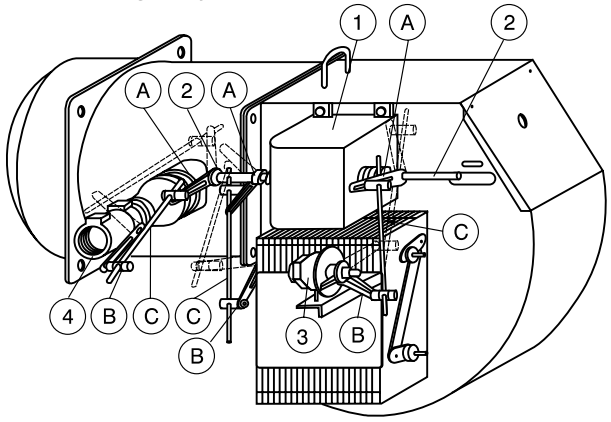
The adjustable premix blast tube (optional) incorporates an adjustable gas/air premix within the burner firing head. The premix configuration is primarily used for cylindrical combustion chambers or high heat release pressurized fireboxes. Moving the adjustment knob back increases the premix air; moving it forward decreases the premix air. Generally, the best (quietest/smoothest) operation is in the full forward position with minimum premix air. The premix adjustment is set at the factory in the full forward position. To attain the best combustion results for specific job conditions, change position in small increments.

DIFFUSER POSITION ADJUSTMENT

Moving the blast tube diffuser assembly fore or aft on gas or oil firing will move the flame front (point of retention) in order to attain the best (quietest/smoothest) combustion for specific job conditions. If the initial midway point factory setting does not provide satisfactory results, move fore or aft in small increments to achieve the best combustion results. If unit is oil or combination gas/oil, the attached, flexible copper oil nozzle line will move fore or aft with the assembly. When firing on oil, moving the assembly forward will tend to broaden the flame pattern and moving it back will narrow the flame pattern. Similar results are obtained on gas, but observation of sound and combustion tests are the best determinants of results on either gas or oil.

Figure 27

Gas/Oil Linkage Adjustment For Full Modulation Standard System



Typical general linkage arrangement for combination gas/oil full modulation burner, shown in low fire light off position. Dotted lines indicate approximately high fire position. When making adjustments, make certain the motor can make its full 90° stroke without any linkage binding.

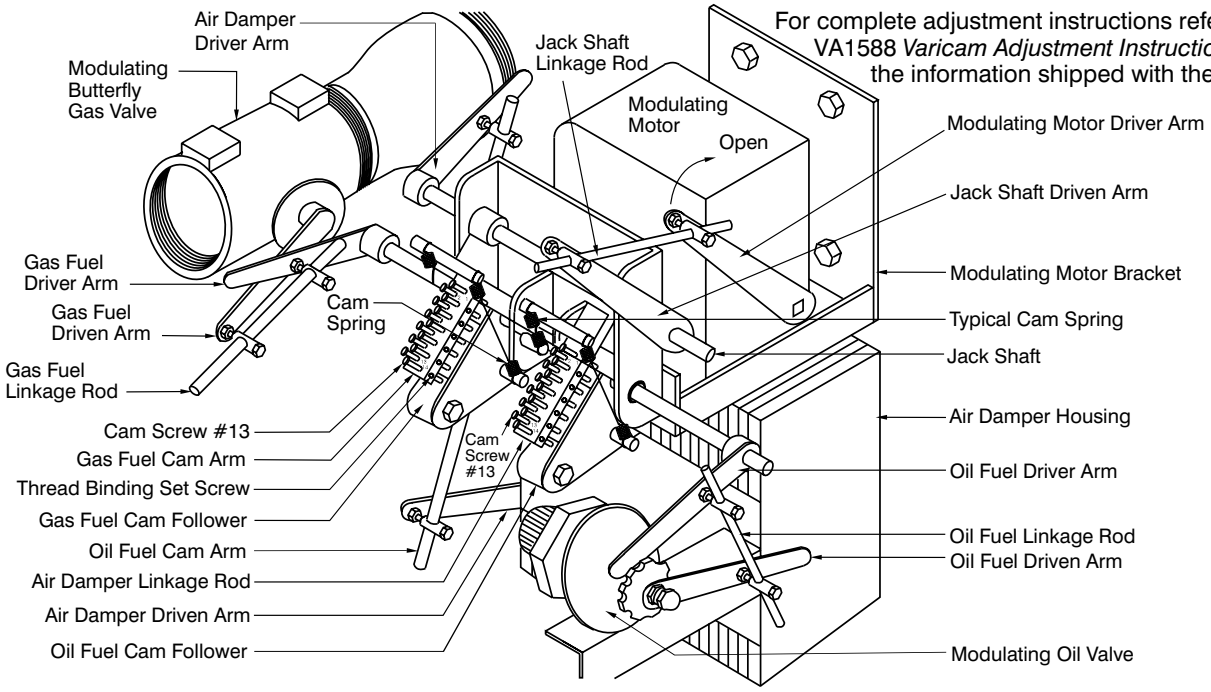
Driver Arms (A) connected to the Modulating Motor (1) Jack Shaft (2) will increase the travel of the Driven Arms (B) as the Linkage Rod (C) ball joint is moved away from the Jack Shaft. The travel of the Driven Arms will be increased as the Linkage Rod ball joint is moved toward the shaft of the driven device.

1. Modulating Motor
2. Jack Shaft
3. Modulating V Port Oil Valve
4. Modulating Butterfly Valve

A. Driver Arms
B. Driven Arms
C. Linkage Rods

Figure 28

Gas/Oil - Detail and Adjustments on Modulating Varicam™ Characterized Fuel Metering System.



For complete adjustment instructions refer to bulletin VA1588 *Varicam Adjustment Instructions* included in the information shipped with the burner.

4. GENERAL START UP PROCEDURES-ALL FUELS

All Fuels - General Start Up
A thoroughly qualified burner technician should be employed to provide the initial burner start up, as well as any subsequent servicing.

A representative of the owner and/or the person or persons responsible for operating and maintaining the unit should be present during the initial start up. A service representative may also be required by the local utility on gas fired equipment. Instructions regarding the proper care and maintenance of the unit should be outlined with these people present.

Before beginning start up, the start up technician should thoroughly study and become completely familiar with the exact sequence of operation and all other details of the specific flame safeguard control system being used. This information will be found in bulletins printed and supplied by Honeywell or Fireye. A copy of this bulletin was supplied with the burner.

After the burner is mounted and all wiring and piping has been completed, tested and determined to be correct, the following procedures are recommended:

For combination gas/oil units; the gas side operation should be set up first to *clock the gas meter*, allowing precise gas inputs to be determined. Once the gas operation is complete, the oil side can be set up easily by correlating the CO_2 values of the two fuels. See page 41, Table 13, *CO_2-O_2 Ratio Curves for Fuel Oils and Gases*.

If it is anticipated that the Gas/Oil burner will rarely run on oil; it is recommended that the blower motor driven oil pump drive coupling be removed - and replaced only when required for oil firing. If, however, the pump coupling is left connected to the blower motor, it is essential to ensure that the pump has a good oil supply, when the burner is operating on the gas cycle, so that it will not run dry. Be certain on initial start up that the pump is adequately primed to prevent against mechanical seizure caused by lack of oil. The pump warranty will be voided if the pump is run without adequate oil supply.

1. Make a general inspection tour of the equipment room to ensure that the installation is complete. Check piping, controls, and wiring. When using the Alpha System™ Circuit Board, check wiring connections before powering the unit. See page 7 & 8 for connection diagram. NOTE: L1 Main 115 volt hot incoming power terminal is located on the lower set of terminals at the bottom of the main circuit board. The L1 Fused terminal located on the lower set of terminals is for factory use only and should not be used for incoming power connections.
2. Close main and checking gas cocks. Open suction line manual oil valves and others as appropriate.
3. Tighten all screws on terminal blocks in control cabinet in case some may have loosened in shipment.
4. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
5. Check fuses in main panel and in burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. Determine that voltage supply is correct to motor starter line connections and to control circuit line connections. If a control circuit transformer is supplied, make certain its primary voltage matches the line voltage being supplied. (A 230 volt transformer does not produce proper control voltage when supplied with 208 volts.)
6. Check breaching and stack to ensure that they are open and unobstructed.
7. Check blower (and oil pump motor, as applicable) rotation by momentarily making contact of the motor starters. Proper rotation is imprinted on the fan housing and (if supplied) the remote oil pump set assembly.
8. Check operating controls, limit controls, low water cut-off, flame safeguard control reset, high and low gas pressure switches (if used) and low fire interlock switch (if used) and all other applicable interlocks. All contacts should be closed (an exception will be found on jobs using the low gas pressure switch; this switch should be open until the main gas cock is opened). If a low oil pressure switch is used, its contacts will remain open until the oil pump is running and the low oil pressure cut-in point is reached.
9. Do not repeatedly recycle the burner, so as to allow any unburned fuel in the combustion chamber.
10. Specific instructions relative to component sequencing are provided in the flame safeguard manufacturer's bulletin which is included with the documentation shipped with the burner. Refer to Honeywell and Fireye literature regarding the clipping of jumpers or setting of DIP switches in connection with the pilot establishing period, flame failure action, and air flow switch failure features.
11. Proper test equipment must be used in order to achieve maximum system operational reliability and fuel efficiencies. See page 24 for equipment lists.
12. All fuel/air adjustments should be made to achieve required input rate, satisfactory combustion test values, flame stability and appearance.
13. Every new burner start up should employ the use of the *Burner Start Up Information and Test Data* sheets on pages 46 and 47.

Information on Fuel/Air Modes of Operation for Combination Gas/Oil Units (also see Section 3, page 15)

General Information

Specific adjustments and mechanical operation of the various modes of fuel/air control for straight gas and straight oil burners are included in this manual. This information should be used to properly adjust each fuel for combination gas/oil units. The following information is offered as additional guidance.

Gas On/Off System Combined with Oil On/Off System

The air dampers are adjusted and locked in place for the most efficient operation for both fuels. Refer to the mechanical operation of the Gas On/Off and Oil On/Off systems for adjustment details (pages 15, 16 and 17).

Gas On/Off System with Oil On/Off Fixed Air Low Fire Start System

The air dampers are adjusted and locked in place for the most efficient high fire operation for both fuels. Smooth light off on gas is achieved by the use of a slow opening diaphragm or motorized gas valve, which, once energized, allows gas flow to steadily increase from the initial light off volume up to the high fire volume. Smooth light off on oil is achieved by the use of a solenoid oil valve bypass system which allows a reduced amount of oil to be burned at light off and then switching to the high fire rate once the low fire has been established. Refer to the mechanical operation of the Gas On/Off system and the Oil Fixed Air Low Fire Start system

for specific adjustment details (pages 15 and 17).

Gas On/Off System with Oil Reduced Air, Low Fire Start RALFS
See page 18.

Gas Low/High/Off System with Oil Low/High/Off System

For Gas - movable air dampers are adjusted to provide a smooth light off position and then moved to the high fire position through mechanical linkage from a motorized gas valve. The air dampers are adjusted to open to provide maximum combustion efficiency at the gas high fire input rate. For oil - the same air dampers are operated by a hydraulic oil cylinder which, through mechanical linkage, is adjusted to provide a smooth light off and then open to a point where the highest combustion efficiencies will be achieved at the high fire input rate. Smooth oil light off is further achieved by the use of a solenoid oil valve bypass system, which allows a reduced amount of oil to flow at light off and then switches to the high fire rate (simultaneously energizing the hydraulic oil cylinder) once low fire has been established.

The mechanical linkage from the gas valve is physically arranged so that the hydraulic oil cylinder (which is non-operational when burning gas) has no effect on the gas linkage adjustments. Similarly, the gas valve (which is non operational when burning oil) has no effect on oil linkage adjustments. It should be noted that when the hydraulic oil cylinder moves the air dampers, the movement of the air dampers will cause the motorized gas valve linkage to move up and down with the opening and closing of the hydraulic oil cylinder. The motorized gas valve linkage is *free floating,* and even though it moves with the oil cylinder operation, it cannot cause any gas flow to pass through the motorized gas valve. Refer to the mechanical operation of the Gas Low-High-Off system and the Oil Low-High-Off system for specific adjustment details (pages 15, 19 and 20).

Note
The oil side operation can be supplied with either a Suntec or a Webster oil pump. Refer to the mechanical operation for the specific system for adjustment details.

Gas Low/High/Low System with Oil Low/High/Low System

Refer to the above explanation of Gas Low/High/Off System and Oil Low/High/Off System. The Gas Low/High/Low Systems are identical in operation, except that an additional temperature or pressure control is added to the system, which at a selected preset point will electrically switch the motorized gas valve (which is a different model number than the Low/High/Off motorized gas valve) to an adjustable *Low Fire* position. This low fire position is an adjustment that is designed internal to the gas valve and, depending upon the specific manufacturer of the valve, will be found either in the valve wiring compartment or under a removable cap on top of the valve. Refer to the valve manufacturer's product bulletin supplied with the burner for specific details.

For the Low/High/Low system oil side operation, the additional temperature or pressure control will also cause the solenoid oil valves, hydraulic oil cylinder and air dampers to go to a *low fire position* at the same preset temperature or pressure as the gas side operation. The oil side low fire position is one and the same position as the light off position, i.e., the air dampers and oil pressures have identical settings (as compared to the gas side -which can be adjusted, if desired, to have different settings for *light off* and *low fire*). Refer to the mechanical operation of the Gas Low-High-Low system and the straight Oil Low-High-Low system for specific adjustment details (pages 15, 19 and 20).

Note
The oil side operation can be supplied with either a Suntec or a Webster oil pump. Refer to the mechanical operation for the specific system for adjustment details.

Gas Full Modulation System with Oil Full Modulation System

The Gas system uses an automatic diaphragm or motorized gas shutoff valve to control the on/off flow of the gas. The Oil system employs an oil solenoid valve to control the on/off flow of oil to the oil nozzle. A modulating motor controls the modulated positioning of a butterfly type Gas Proportioning Valve while a V ported metering oil valve provides the modulating function in the oil nozzle return line. The modulating motor also controls the positioning of the combustion air dampers, through appropriate sequencing - providing low fuel/air input for a smooth low fire start and an infinite number of fuel/air positions between full low and high fire. Additional finite fuel/air adjustments are provided when the optional Power Flame Varicam™ characterized fuel metering system is used (optional).

When firing Gas the oil metering valve will open and close because it is linked to the modulating motor; however, the oil solenoid shutoff valve remains closed, and no oil is allowed to flow to the nozzle. Similarly, when firing Oil, the butterfly gas valve will open and close because it is linked to the modulating motor; however, the main automatic gas supply shutoff valve (motorized or diaphragm type) remains closed, so no gas is allowed to flow to the burner head.

Refer to the mechanical operation of the Gas Full Modulation system and the Oil Full Modulation system (pages 16 and 21, as well as page 22 entitled *Gas/Oil - Linkage Adjustment Full Modulation - Standard System*) for specific adjustment detail. If supplied, also refer to page 22, covering *Detail and Adjustments on Modulating Varicam™ Characterized Fuel Metering System.*

Burner Start Up and Service Test Equipment Required

The following test equipment is required to ensure proper start-up and adjustment of burner equipment to obtain maximum efficiency and reliability of operation. See page 40 for CO_2/O_2/ Excess Air Curves.

For Any Fuel	For Gas	For Oil
CO_2 indicator or O_2 analyzer	CO indicator	Compound vacuum/pressure gauge - 0-30" vacuum/0-30 PSIG 0-400# oil pressure gauge (two required for internal bypass type oil nozzles)
Stack thermometer	U-Tube manometer or calibrated 0-10" and 0-35" W.C. pressure gauges	Smoke tester
Draft gauge or inclined manometer	(Higher pressure ranges may be necessary depending upon gas inlet supply pressure.)	
Combination volt/ammeter		
D.C. microammeter or D.C. voltmeter, as required by Flame Safeguard programmer selection		

Note:
When firing gas fuels, it is possible to attain CO_2 readings that appear to be acceptable (i.e., 8%, 9%, 10%, etc.) while actually producing an unsafe condition. At such CO_2 readings, a deficiency of air will create the formation of CO (carbon monoxide) in the flue gases. Therefore, when firing gas, test for CO to make certain that the burner is adjusted so that it has an *excess,* rather than a *deficiency*, of air. CO is a dangerous product of incomplete combustion and is associated with combustion inefficiency and increased fuel cost.

5. GAS START UP

NOTICE

Refer to page 23 *General Start Up Procedures - All Fuels* and Section 3 for mechanical operation detail of specific modes of burner operations. Combination Gas/Oil systems should also refer to page 23, *Information on Fuel/Air Modes of Operation for Combination Gas/Oil Units.*

General Information

Some applications may require the burner to function at the low end of its rated capacity. As a result, the two combustion air inlets may supply more air than is required for efficient combustion. In such instances, it may be desirable to operate the system using only one combustion air inlet and one combustion air inlet damper. This may be accomplished by removing cross connecting linkage between dampers and locking the unused damper in a fixed, closed position. One way of locking the damper is to use a 10-24 machine screw through the hole in the linkage arm, and drill and tap the air inlet housing, or use two nuts on the screw and let the screw bear against the air inlet housing.

Air diffuser movement (fore and aft) may be necessary to produce the best flame pattern or smoothest operation. See page 22 *Gas, Oil or Gas/Oil Burner Diffuser Adjustment* for further information.

Gas and Gas/Oil burners for Scotch marine and other selected applications incorporate a gas/air premix adjustment. This adjustment is identified by diametrically opposed adjustment knobs on the blast tube. See page 22 *Gas or Gas/Oil Burner Fuel/Air Premix Adjustment* for further information.

Burner Start Up Sequence Instructions

1. Prior to burner start up - contact the local gas company to determine if any correction factors have to be applied to their indicated meter flow rates. This information is important as relates to achieving specific heat exchanger BTU/HR inputs. Refer to page 41 for additional combustion analysis information and to page 6 for firing rate information.
2. Refer to the gas piping diagram furnished with the burner. Check gas piping, controls and valves for leaks and compliance with codes.
3. Check all linkages. If the system is a packaged burner/heat exchanger system, the linkage was probably set when the system was test fired at the heat exchanger manufacturer's factory. It should, however, be checked to ensure that it was not damaged in shipment. On conversion units (where the burner and heat exchanger are mated in the field), the linkage will have to be set to suit the particular operating conditions.
4. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
5. Remove the pilot assembly and check for proper settings of the spark gap, tightness of electrode in its bracket and firm connections of the electrode cable. (See page 39 and 40.)
6. Close main, checking and pilot gas cocks. Install one gas pressure gauge to read burner firing head pressure (use a 0-10" W.C. gauge or a manometer). See Section 3 for pressure sensing locations. Install a second gas pressure gauge to read gas supply pressure between the main gas cock and the inlet to the main gas pressure regulator (use a 0-35" W.C. gauge or as appropriate). If there is no tapping in this location, install a tee at the point where the pilot gas supply is connected to the main gas line. Slowly open the main gas cock in order to determine that the incoming gas pressure is within the specified limits of the main and pilot gas pressure regulators, automatic fuel valves and gas pressure switches. Many systems are rated for a maximum gas supply pressure of 14" W.C. If pressure exceeds this value, consult the first page of the Burner Specification Sheet and/or gas component product bulletins supplied with the burner to ensure that the supplied system can operate properly at the elevated supply pressure.
7. Disconnect pilot line at inlet to the pilot gas pressure regulator and purge air from the pilot gas line. Purging of gas lines must be done in accordance with NFPA 54 of the National Fire Protection Association's National Fuel Gas Code. After the air is purged from the gas supply system, close the pilot cock and reconnect the pilot line. Leave the pilot cock closed.
8. Install required system measuring devices:
a) appropriate flame signal meter to the flame safeguard control; b) manometer (or 0-10" W.C. gauge) in the pilot test tee port: c) stack thermometer and CO_2 or O_2 sample line to the breaching; and d) draft gauge to the combustion chamber test point.
9. It is strongly recommended that an automatic gas valve *bubble leak test* be performed in accordance with the gas valve manufacturer's instructions on every new installation and periodically afterwards in order to ensure that the valve is functioning according to the manufacturer's specifications. It is also suggested that the test be conducted during a normal prepurge burner operation. This test will reveal any problems that relate to incorrect wiring of the automatic gas valve that could cause premature energization of the valve.

* Note: Although Underwriters Laboratories permits higher readings of CO (Carbon Monoxide), it is desirable to obtain readings between 0 and 100 PPM, depending on local codes and heat exchanger manufacturer's recommendations.

10. Set the air dampers approximately 1/4" open, and with both pilot and leak test gas cocks closed, open the main gas cock (to allow the low gas pressure switch, if supplied, to make its circuit). With the control switch in the *Off* position, apply power to the burner through the main burner disconnect switch. Switch the burner panel *On*/*Off* switch to the *On* position momentarily to determine that the blower rotation is correct.

11. Restart the burner. Perform an initial spark pick-up test. With the pilot gas cock closed, the burner will go through a blower prepurge period, after which the gas pilot ignition transformer will be energized, although no pilot will be established. (At no time should there be any flame signal reading, nor the main gas valve attempt to open.) At the end of the pilot trial for ignition and blower purge period, the flame safeguard control should shut the system down in a safety lock-out mode, requiring manual reset of the flame safeguard control to restart the burner. If a flame signal is detected, verify the flame retention tab and ignition electrode are properly positioned, per Figures 33-37 on pages 36 and 37.

12. Wait three minutes, reset the flame safeguard control safety switch (restarting the burner) and open the pilot gas cock. When the blower prepurge period ends and the burner is energized--if the flame safeguard control has a stop/run switch-- stop the timer while the pilot is on, visually check the pilot flame size and stability and make adjustments as required. See page 39 for pilot ignition adjustments. If the burner has automatic air damper operation (dampers moved by the automatic gas valve or modulating motor) and the Flame Safeguard control does not have a timer *stop*/*run* switch, it will be necessary to keep the air dampers in the pilot light off (low air flow) position by temporarily electrically disconnecting the motorized gas valve or modulating motor to complete pilot adjustments. Recycle the burner several times to make certain pilot operation is reliable.

13. With pilot adjustments completed, reset the timer switch to the *Run* position, which will allow the sequence to proceed to the automatic gas valve energizing position. If the motorized gas valve or modulating motor wires have been disconnected, shut the burner off and reconnect electrically to allow normal automatic air damper operation.

14. When the main automatic gas valve begins to open, slowly open the checking gas cock to light off the main flame. The main flame should light immediately. If not, it may be necessary to eliminate air from the main gas line and/or adjust main gas pressure regulator flow rates.

15. Adjust the burner as necessary to provide smooth ignition of the main flame. If the flame signal drops significantly when the main automatic gas valve opens, slightly increase the pilot gas pressure to attain a stable flame signal value.

16. For On/Off burners - adjust the main gas pressure regulator to achieve the proper main flame gas input. Set and lock the air dampers to provide 8 1/2 to 10% CO_2 (Carbon Dioxide) and little or no* CO (Carbon Monoxide). Make certain the gas pilot operates reliably at the final fuel/air settings.

17. For Low/High/Off burners - adjust the main gas pressure regulator in combination with the air damper linkage operation to achieve 8 1/2 to 10% CO_2 (Carbon Dioxide) and little or no* CO (Carbon Monoxide) at the full high fire input rate position. Make certain the linkage operates smoothly and without binding or overtravel of the air damper stops.

18. For Low/High/Low burners - adjust the main gas pressure regulator in combination with the air damper linkage operation to achieve 8 1/2 to 10% CO_2 (Carbon Dioxide) and little or no* CO (Carbon Monoxide) at the full high fire input rate position. Make certain the linkage operates smoothly and without binding or overtravel of the air damper stops. Run burner to the low fire position and lock motorized gas valve internal low fire adjustment to a setting that will attain 7 to 9% CO_2 at the desired low fire input rate.

19. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.

20. See items 32 through 36 in this section for recommended limit control and other control devices operational checkout.

* See note on Page 25.

Burners Designed for Full Modulation Operation

After completing pilot adjustments and other procedures as appropriate in items 1 through 16 above, proceed with modulating adjustments as follows:

21. Initial adjustments should be made at the low fire position. All Power Flame burners are factory tested and adjusted. However, to determine that the metering butterfly valve is, in fact, in the low fire position, observe the end of the metering valve shaft. The slot in the end of the shaft indicates the position of the valve. When the slot is in the horizontal position (parallel with the gas flow direction), the valve is fully open. Refer to page 22, Figure 27 for linkage adjustment information and page 22, Figure 28 for adjustment information on the Varicam™ characterized fuel metering system.

22. Turn the burner on and let it advance to the main flame light off position. Take action as necessary to hold the linkage at the low fire position by using a manual potentiometer or electrically disconnecting the modulating motor. Power Flame burners are tested at the factory and linkage adjustments for modulation are made at that time. Note that the factory settings relate to good operation while firing into open test pits, and therefore will normally not relate directly to absolute fuel/air ratios while firing under specific field conditions. It is suggested that the factory settings be noted and marked on the linkage prior to proceeding with final adjustment. In this manner those settings can be restored as initial reference points, if need be.

23. With the burner in the *factory set* low fire position, adjust air and fuel linkage to good fuel/air ratio low fire settings

(7 - 9% CO_2, little or no* CO). Mark the linkage at the new settings.

24. Increase the firing rate to the midway point. Set the fuel/air ratios to achieve good combustion values (7-9% CO_2, little or no* CO). Mark the linkage as a reference point for this new mid fire position.

25. Increase the rate to high fire position and repeat the test done for the mid point adjustment. Results should range in the area of $8^1/_2$ to 10% CO_2, with little or no* CO. The metering device setting and air damper openings should be marked and noted to obtain high fire reference points. Note that an additional point of the fire adjustment may be obtained by modifying the regulated gas pressure delivered to the burner metering device. The burner pressure regulator is used to obtain this adjustment and can be used within available pressure limits to obtain optimum firing conditions.

26. Operate the modulating lever arm on the modulating motor through the three previously referenced points. Minor setting modifications may be required to ensure that the reference points are acquired.

27. Tighten (finger tight) the hex bolt to the linkage rod at the swivel on the modulating motor driver arms and run the motor through its full travel to ensure that the linkage is *free* and that limits on the metering device and air dampers are not exceeded.

28. Determine that the required gas input rate is being achieved by clocking the gas flow at the gas meter.The gas utility should be consulted to determine if any correction factors have to be applied to the indicated meter flow rates. Refer to page 41 for additional combustion analysis information and to page 6 for additional firing rate information.

29. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.

30. Tighten all linkages and permanently mark settings.

31. Limit control check should be made as follows:
    A) Permit the burner to run until the limit control settings have been reached.
    B) The burner should turn off when the set temperature or pressure has been reached. If the burner is Low/High/Low or Modulating, set the controls so that the burner will go to the low fire position before the operating limit control turns the burner off.
    C) After a differential pressure or temperature drop, the burner should restart automatically.
    D) With the unit running normally, open the blow down valve and remove water to the point below the Low Water Cut Off Setting. The burner should turn off and restart automatically when the proper water level is re-established. (If a manual reset type Low Water Cut Off is used, it will have to be reset.)

32. Set and check operation of:
    A) Low and high gas pressure switches. See gas pressure switch manufacturer's instructions for detailed procedures. Units with mercury switching device must be properly leveled.
    (1) For initial start up:
    Once the burner's normal operational gas pressure has been set, adjust the low and high gas pressure switches as follows:
    (a) Low gas pressure switch. With the burner running, slowly close the main gas train manual shutoff cock and adjust the switch to open its circuit when the pressure falls below its normal value. The burner will shut down. Open the manual gas shutoff cock to the full open position and manually reset the Low Gas Pressure Switch. The burner will restart.
    (b) High gas pressure switch. With the burner running, adjust the switch to a point where the switch opens its circuit. The burner will shut down. Manually reset the switch and readjust the cutout point to be made at the normal operating pressure, but to open if the pressure goes slightly above normal.
    B) All burner and heat exchanger controls and operating devices.
    C) Blower Combustion Air Flow Switch
    (1) Shut burner power off.
    (2) Disconnect both wires at the air flow switch and temporarily clip them together. Make sure that they cannot ground against anything, since they will be powered with 110 volts during the test.
    (3) Put a continuity meter across the common and normally open terminals on the air switch.
    (4) Close the gas train checking cock.
    (5) Start the blower motor. The meter should read electrical continuity as soon as the blower starts.
    (6) Disconnect the blower motor lead wire or the wire which energizes coil of motor relay (starter), or open the main power disconnect switch to the burner. Within 4 to 5 seconds after the blower motor is de-energized, the meter should indicate an open air flow switch circuit (no continuity).
    (7) If the switch does not open in 4 to 5 seconds, readjust accordingly. Turn the air flow switch adjustment screw clockwise to shorten cut-off response time, and counter-clock-wise to lengthen cut-off response time.
    (8) Turn the burner power off. Remove the shorting clip from the two disconnected wires and let them hang loose. (They will be powered with 110 volts, so don't let them ground out.)
    (9) Open the gas train checking cock. Turn the burner on. With the wires disconnected, the burner should go into a purge cycle, although neither the ignition nor the main fuel valve circuits will be energized. If they do energize, there is a wiring problem. Correct as required.
    (10) Turn power off. Reconnect the air flow switch wires to the air flow switch terminals. Place burner back into normal operation.

33. The *Owner's Operating Instructions,* page 51 of this manual, should be posted in a clearly visible location close to the burner.

34. If the burner operation is abnormal, refer to Section 7, *Trouble Shooting Suggestions,* as well as trouble shooting information included in the flame safeguard manufacturer's bulletin shipped with the burner. It is also strongly suggested that all test procedures outlined in the flame safeguard control manufacturer's bulletin be conducted.

35. Complete the *Burner Start Up Information and Test Data* sheets on pages 46 and 47.

* See note on Page 25.

6. OIL START UP

Notice

Refer to page 23 *General Start Up Procedures - All Fuels* and Section 3 for mechanical operation detail of specific mode of operation. Combination Gas/Oil systems should also refer to page 23, *Information on Fuel/Air Modes of Operation for Combination Gas/Oil Units.*

General Information

Power Flame Type C oil burners are of the pressure atomizing forced draft type, using a single simplex or bypass type nozzle system. On/Off burners use a simplex nozzle. Fixed air low fire start burners use a simplex nozzle with a bypass valve to allow reduced oil nozzle pressures at light off. Low/High/Off and Low/High/Low burners have movable air dampers and may use a single simplex or bypass type oil nozzle with a bypass valve to allow reduced oil pressures at light off and at low fire. Modulating burners have movable air dampers and use a single simplex or bypass type oil nozzle with a proportioning metering valve in the nozzle return line to allow modulated fuel inputs from low to high fire.

Some applications may require the burner to function at the low end of its rated capacity. As a result, the two combustion air inlets may supply more air than is required for efficient combustion. It may therefore be desirable to operate the system using only one combustion air inlet and one combustion air inlet damper.

This may be accomplished by removing cross connecting linkage between dampers and locking the unused damper in a fixed position.

One way of locking the damper is to use a 10-24 machine screw through the hole in the linkage arm, and drill and tap the air inlet housing or use two nuts on the screw and let the screw bear against the air inlet housing.

Air diffuser movement (fore and aft) may be necessary to produce the best flame pattern or smoothest operation. See page 22, *Gas, Oil or Gas/Oil Burners Diffuser Adjustment,* for further information.

Gas and Gas/Oil burners for Scotch marine and other selected applications incorporate a gas/air premix adjustment. This adjustment is identified by diametrically opposed adjustment knobs on the blast tube. See page 22, *Gas or Gas/Oil Burner and Fuel/Air Premix Adjustment* for further information.

Burner Start Up Sequence

1. Check oil and gas piping (if applicable) for leaks, and check all controls for compliance with codes and insurance requirements.
2. Check all linkages. If the system is a packaged burner/heat exchanger system, the linkage was probably set when the system was fire tested at the heat exchanger manufacturing factory. It should, however, be checked to ensure that it was not damaged in shipment. If the system is a conversion unit (burner and heat exchanger are mated in the field), the linkage will have to be set to suit the particular operating conditions.
3. Do not secure flame safeguard control into its wiring base until it has been determined that there are no shorts or grounds in the system.
4. Install oil pressure and vacuum gauges. See Section 3 for mechanical operation and oil gauge location for the specific system. Check suction line to be sure manual valve is open and that check valves are opening in the proper direction of oil flow. Check oil filter for tightness. There should be no manual valve in the return line from pump to tank.
5. Direct Spark Oil Ignition. Remove oil nozzle gun and check electrode settings and ensure that oil nozzle size is correct. Electrode gap should be approximately $^1/_8$" and set forward to correspond with the nozzle spray angle. Do not set electrodes so that oil can impinge on them. See pages 35 and 36 for detailed information on oil ignition systems.
6. Gas Pilot Oil Ignition. Remove the pilot assembly and check for the proper setting of the ignition electrode spark gap. Install a manometer or 0-10" W.C. gas pressure gauge in the pilot gas pressure test port. See page 39 for details on gas pilot adjustments. Disconnect the pilot gas line at the inlet to the pilot gas pressure regulator and bleed air out of the pilot line. Make certain that the gas pressure to the pilot regulator does not exceed the regulator or pilot solenoid valve rating. When bleeding air from the pilot line system, do not allow the venting of gas into the room.
7. Install required systems measuring devices:
   A) appropriate flame signal meter to the flame safeguard control
   B) stack thermometer, CO_2 and Smoke Test sample line in the breaching
   C) draft gauge to the combustion chamber test point
8. With the burner panel control switch in the *Off* position, apply power to the burner through the main burner disconnect switch. Switch the burner panel *On/Off* switch to the *On* position momentarily to determine that the blower motor (and separate oil pump set motor, if supplied) is running in the right rotation.
9. Appropriate steps must be taken to transfer the oil from the tank to the burner. It is imperative that the system be primed prior to operation. The system priming may be achieved by closing the manual valve in the oil suction line and priming the oil pump through the pump gauge pressure port. Priming can also be accomplished through the oil filter on the suction line, if it is of the removable top type. When replacing the oil filter cap, be sure to attain a vacuum tight seal. Start the burner with the suction line manual valve closed. Let the burner run until the vacuum gauge indicates a high vacuum, then quickly open the manual valve in the suction line. This combination of priming and high suction should pull the oil from the tank to the burner, provided that there are no leaks and the line is properly sized. See page 12 Figure 10 for proper line size.

10. Refer to the burner wiring diagram and flame safeguard control information supplied with the burner to determine the specific firing sequence relating to limit and interlock circuits.

11. Set the air damper approximately 1/4" open and start the burner. The ignition circuit will be energized after the blower prepurge period (if supplied) has been completed and all limit and other interlock circuits have been closed. If the unit has a gas pilot, allow it to come on and adjust it for proper ignition and flame signal. For flame safeguard controls having a timer *Stop*/*Run* test switch, place the switch in the *Stop* position, caus ing the ignition timing sequence to stop while air and gas pressure adjustments are being made. See page 39 for details on gas pilot ignition adjustments.

    Cycle the burner several times to make certain the pilot is operating reliably. Shut the pilot gas cock and cycle the burner through prepurge. With the gas shut off, the pilot valve and ignition transformer will energize, but there will be no pilot and the unit will shut down on safety lockout.

    There should be no evidence of a flame signal reading or should the main oil solenoid valve attempt to open.

12. When a Gas Pilot is used to ignite the main oil, there will be a period of time when only the pilot will be on. The flame scanner must first detect the pilot Then, in a given number of seconds, the main oil solenoid valve will be energized. For direct spark ignited oil units, the ignition spark and main oil solenoid valve will be energized at the same time. As soon as the oil flame is detected by the flame scanner, the ignition spark will be de-energized (interrupted ignition), unless the burner is equipped with intermittent spark operation, which keeps the spark on during the burning cycle.

13. For burners equipped with gas pilots, perform an initial Spark Pickup Test. With the pilot gas cock closed, the burner will go through a blower prepurge period, after which the gas pilot ignition transformer will be energized, although no pilot will be established. (At no time should there be any flame signal reading, nor should the main gas valve attempt to open.) At the end of the pilot trial for ignition and blower purge period, the flame safeguard control should shut the system down in a safety lockout mode, requiring manual reset of the flame safeguard control to restart burner. If a flame signal is detected, verify the flame retention tab and ignition electrode are properly positioned, per Figures 33-37.

14. **Pilot Verification. <u>Critical</u>. See Page C26, Item 12.**

15. If the burner is direct spark ignited, either remove the flame scanner from its sight pipe or electrically disconnect the main oil solenoid valve and start the burner. In either of the above tests, the flame safeguard control will not detect any flame and should go into a safety lockout mode requiring manual reset of the flame safeguard safety lockout switch.

16. There must be no indication of oil pressure at the nozzle until the main oil valve is programmed to open. Should a pressure reading be obtained prior to that time, it is an indication that the main oil valve has been mis-wired or is leaking.

17. Restart the burner and allow normal sequencing to bring on gas pilot ignition or the direct spark ignition. Once the main solenoid oil valve is energized, the oil flame should be established immediately. If not, shut the system down and make corrections as required. Do not repeatedly recycle the burner, such as to allow any accumulation of unburned fuel in the combustion chamber.

18. **For small *On*/*Off* burners** with a simplex nozzle, adjustments consist primarily of attaining correct fuel/air ratios. Adjustments should be set to obtain11-12 1/2% CO_2 and no more than a #2 smoke (Bachrach). The burner can usually be set to burn at a 0 smoke reading. Oil pump pressures will be set anywhere from 200 to 300 psig. See page 34, Table 9 for additional information.

19. **Fixed Air Low Fire Start burners** with simplex nozzles require correct fuel/air ratios for high fire and should be set with no more than a #2 smoke at high fire with 11 - 12 1/2% CO_2. 0 smoke should be attainable. Low fire nozzle pressures are set to achieve smooth light off with the air dampers fixed in the operating (high fire) position. See page 34, Table 9 for additional information. High fire nozzle pressures will be from 200 to 300 psig.

20. **Gas On/Off System with Oil Reduced Air, Low Fire Start RALFS**. See page 18, Figure 22.

21. **Low/High/Off or Low/High/Low modes of operation** (both having automatic air dampers) should have initial adjustments made at the light off position. See Section 3 for mechanical operation of the specific system. After the *light off* fuel/air adjustments are made (which on a Low/High/Low oil burner is the same as the *Low Fire* position), run the burner to the high fire position and make adjustments as required for good operation. Adjustments should provide 11 - 12 1/2% CO_2 with no more than a #2 smoke (0 smoke is usually attainable) at high fire and 8 - 10% CO_2 with no more than a #2 smoke on low fire (0 smoke is usually attainable) for Low/High/Low systems. For systems with two-step pumps using simplex nozzles or internal bypass nozzles, the oil pressures at the nozzle supply pump gauge port will generally be from 100 to 125 psig at low fire and 200 to 300 psig at high fire. For systems with pumps that do not have the two-step operation and employ the internal bypass nozzle, the nozzle supply pump gauge port will generally be from 270 to 300 psig at both low and high fires. The nozzle bypass line pressure at low fire will generally be from 60 to 125 psig and 180 to 225 psig at high fire. Tighten all linkages and permanently mark all settings. See page 31, Table 8 and page 34, Table 9 for additional information.

22. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.

23. See items 35 through 37 in this section for recommended limit control and other control devices operational checkout.

Burners designed for Full Modulation operation. After completing procedures as appropriate in items 1-15 above proceed with modulating adjustments as follows:

24. The modulating motor is connected by linkage to the air inlet dampers and a fuel metering valve located in the oil nozzle return line controls a modulated fuel input from low to high fire. Each control point has its own multi position arm, so that proper air/fuel ratios can be achieved throughout the entire firing range. Initial adjustments should be made at the low fire position (low fuel/air flow). All Power Flame burners are factory tested and adjusted. However, to determine that the metering valve is, in fact, in the low fire position, observe the pointer on the metering valve shaft. The pointer must be pointing toward the #6 or #7 position on the dial for North American valves, or 4 1/2 to 9 on Hauck valves. As the burner runs from low to high fire, it will proceed from the low fire setting towards the 0 position on the dial (i.e., the valve will be fully closed at high fire).Refer to page 22, Figure 27 for linkage adjustment information and page 22,Figure 28 for adjustment information on the Varicam™ characterized fuel metering system.

25. Turn the burner on and let it advance to the main flame light off position, taking action as necessary to hold the linkage at the low fire position by using a manual potentiometer or electrically disconnecting the modulating motor. Power Flame burners are test fired at the factory, and linkage adjustments for modulation are made at that time. Note that the factory settings relate to good operation while firing into open test pits, and will therefore not normally relate directly to the absolute fuel/air ratios while firing under specific field conditions. It is suggested that the factory settings be noted and marked on the linkage prior to proceeding with final adjustment. This will allow a return to those settings as initial reference points, if need be.

26. On internal bypass nozzle systems, oil pressure at the pump nozzle port will generally be between 270 and 300 psig from low to high fire. At certain input ranges of burner models C4 and C5, nozzle pressure may fall off to approximately 240 psig when in the low fire position. For oil pressure settings on simplex nozzle systems, refer to page 34, Table 9.

27. On internal bypass nozzle systems, typical low fire nozzle bypass line pressures will generally be in the area of 60 to 90 psig. High fire nozzle bypass line pressures will generally be in the range of 200 to 225 psig, but these pressures can vary, depending upon the nozzle selected for a particular firing application. Refer to page 31, Table 8 for specific nozzle bypass line pressures. Refer to page 34, Table 9 for simplex nozzle systems and pressures.

28. With the burner in the *factory set* low fire position, adjust air and fuel linkage to good fuel/air ratio low fire settings (8 - 10% CO_2 and #0 - #2 smoke reading). Mark the linkage at the new settings.

29. Increase the firing rate to the midway point. Set the fuel/air ratios to achieve good combustion values (9 - 11% CO_2 and #0 to #2 smoke reading). Mark the linkage as a reference point for this new mid-fire position.

30. Increase the rate to the high fire position and repeat the tests done for the mid-point adjustment. Results should be in the area of $12^1/_2$% CO_2 and no more than #2 smoke. The metering device setting and air damper openings should be marked and noted to obtain the high fire reference points.

31. Operate the modulating lever arm on the modulating motor through the three previously determined reference points. Minor setting modifications may be required to ensure that the reference points are acquired.

32. Tighten (finger tight) the hex bolt to the linkage rod at the swivel on the modulating motor driver arms, and run the motor through its full travel to ensure that linkage is *free* and that the limits on the metering device and air dampers are not exceeded.

33. Intermittently operate the burner until the water is warm in the boiler, or follow specific initial firing recommendations provided by the heat exchanger manufacturer.

34. Tighten all linkages and permanently mark settings.

35. Limit control check should be made as follows:
    A) Permit the burner to run until the limit control settings have been reached.
    B) The burner should turn off when the set temperature or pressure has been reached. If the burner is Low/High/Low or Modulating, set the controls so that the burner will go to the low fire position before the operating limit control turns the burner off.
    C) After the differential pressure or temperature drop, the burner should start automatically.
    D) With the unit running normally, open the blowdown valve and remove water to the point below the low water cutoff setting. The burner should turn off and restart automatically when the proper water level is re-established. (If manual reset type low water cutoff is used, it will have to be reset.)
    E) Set and check operation of:
        (1) Low Oil Pressure Switch (if supplied). Set at 80% of low fire oil pressure. Check visually, or test electrically to confirm that circuit opens at the proper oil pressure.
        (2) Blower Combustion Air Flow Switch (if supplied).
            (a) Shut burner power off.
            (b) Disconnect both wires at the air flow switch and temporarily clip them together. Make sure that they cannot ground against anything, since they will be powered with 110 volts during the test.
            (c) Put a continuity meter across the two terminals.
            (d) Disconnect the wire to the main automatic oil valve.
            (e) Start the blower motor. The meter should read electrical continuity as soon as the blower starts.
            (f) Disconnect the blower motor lead wire, or open the main power disconnect switch to the burner. Within 4 to 5 seconds after the blower motor is de-energized, the meter should indicate an open air flow switch circuit (no continuity).
            (g) If the switch does not open in 4 to 5 seconds, readjust accordingly. Turn the air flow switch adjustment screw clockwise to shorten cut-off response time, and counter-clockwise to lengthen cut-off response time.
            (h) Turn the burner power off. Remove the shorting clip from the two disconnected wires and let them hang loose. (They will be powered with 110 volts, so do not let them ground out.)
            (i) Reconnect the wire to the main automatic oil valve. Turn the burner on. With the air flow switch wires disconnected, the burner should go into a purge cycle, but neither the ignition nor the main fuel valve circuits will be energized. If they do energize, there is a wiring problem. Correct as required.
            (j) Turn power off. Reconnect the air flow switch wires to the air flow switch terminals. Place burner back into normal operation.
        (3) All burner and heat exchanger controls and operating devices.

36. The *Owner's Operating Instructions*, page 51 of this manual, should be posted in a clearly visible location close to the burner.

37. If the burner operation is abnormal, refer to Section 7 *Trouble Shooting Suggestions*, as well as trouble shooting information in the flame safeguard

manufacturer's bulletin shipped with the burner. It is also strongly suggested that all test procedures outlined in the flame safeguard control manufacturer's bulletin be conducted.

38. Complete the *Burner Start Up Information and Test Data* sheets on pages 46 and 47.

7. SERVICING AND COMPONENT ADJUSTMENTS

General Information on Internal Bypass Oil Nozzle Systems

1. The system is designed to use 300 PSI pressure at the nozzle inlet at low and high fire (and throughout the range on modulating systems). The firing rate is changed by an adjustable bypass arrangement that allows more or less oil to bypass the nozzle and flow to the return line. Low fire pressures at the bypass pressure test tee will generally be from 60 to 100 PSI, with high fire bypass pressures from 180 to 225 PSI. These pressures will vary depending upon the nozzle size selection and specific job firing conditions. See this page, Table 8 for flow rates, sizing and pressure information.

2. Smoky fires with apparent large droplet size in the spray pattern are generally caused by low nozzle or return flow pressures. To properly check the system, it is necessary to verify both nozzle supply and return pressures. Also check to make certain that the nozzle adapter and strainer are not partially plugged.

3. Careless cleaning or handling of the nozzle may damage the orifice, causing heavy streaks in the oil spray. This will also show up as large droplets or sparks in the flame.

4. Off center fires, low bypass line pressures and safety lockouts (due to poor spray pattern and ignition failure) may result from plugged slots in the nozzle distributor head. When such situations are observed, the nozzle should be removed, disassembled and cleaned.

5. Excessive *after squirt* of oil is caused by air in the system. Be sure air is not trapped in pressure gauges, overhead oil lines or fittings. A leaking check valve on the bypass return line from the nozzle can create the same effect.

6. The Teflon seal should stay on the nozzle when servicing. On some sizes of burners using Delavan 30630 and 30637 Series nozzles, the Teflon seal stays in the nozzle adapter. If it is damaged through careless handling, the resulting leak will cause an increase in the burning rate, when the bypass line is closed at high fire.

7. High turn down ratios are a distinct advantage of internal bypass systems. It is possible, however, to adjust for a low fire so small that the flame is being *chilled.* The fire will look excellent and appear bright and uniform, but a combustion efficiency test will reveal high smoke content and low CO_2. To correct this situation, increase the oil flow or decrease the air, or both. Be sure to test with proper instruments to ensure good, clean efficient combustion throughout the firing range.

Figure 29

Internal Bypass Oil Nozzle Components

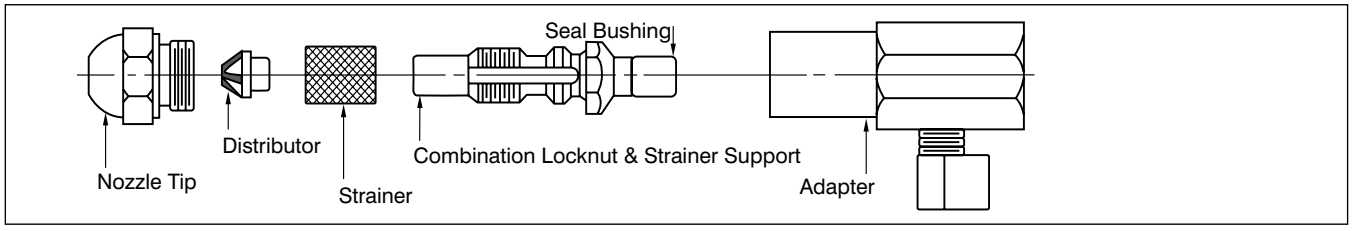


Table 8

Internal Bypass (Return Flow) Nozzle Data

HAGO

Nozzle Size 100 PSIG Nominal Rating GPH #2 Fuel Oil	Supply Pressure to Nozzle 300 PSIG at All Rates*							
			Reduced Firing Rates					
By-Pass (Return) Closed	Approx. High Fire Rate GPH 300 PSIG By-Pass (Return) Closed	Approx. High Fire By-Pass (Return) Pressure PSIG By-Pass (Return) Closed	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH
4.5	**7.3**	**207**	**180**	**5.5**	**150**	**4.4**	**120**	**3.1**
5.0	**8.5**	**196**	**150**	**5.9**	**120**	**4.4**	**90**	**2.8**
5.5	**9.0**	**209**	**180**	**7.0**	**150**	**5.2**	**120**	**3.8**
6.0	**10.2**	**190**	**150**	**7.0**	**120**	**5.1**	**90**	**3.1**
6.5	**10.8**	**195**	**150**	**7.6**	**120**	**5.2**	**90**	**3.4**
7.0	**11.5**	**202**	**150**	**7.1**	**120**	**5.1**	**90**	**3.5**
7.5	**12.6**	**181**	**150**	**10.0**	**120**	**7.1**	**90**	**4.8**
8.0	**13.3**	**197**	**180**	**11.6**	**150**	**8.2**	**120**	**5.5**
9.0	**15.2**	**200**	**180**	**12.5**	**150**	**8.9**	**120**	**6.0**
9.5	**15.9**	**178**	**150**	**12.0**	**120**	**8.0**	**90**	**5.1**
10.0	**17.2**	**202**	**180**	**13.8**	**150**	**9.6**	**120**	**6.3**

HAGO

Nozzle Size 100 PSIG Nominal Rating GPH #2 Fuel Oil By-Pass (Return) Closed	Supply Pressure to Nozzle 300 PSIG at All Rates*							
	Approx. High Fire Rate GPH 300 PSIG By-Pass (Return) Closed	Approx. High Fire By-Pass (Return) Pressure PSIG By-Pass (Return) Closed	Reduced Firing Rates					
			Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH
10.5	17.5	202	150	11.4	120	8.0	90	5.4
11.0	19.3	203	150	11.4	150	11.4	120	7.9
11.5	20.0	192	180	17.8	150	12.8	120	8.5
12.0	20.1	194	180	18.1	150	13.0	120	9.1
12.5	21.6	196	180	18.6	150	13.4	120	8.9
13.0	22.2	205	180	17.8	150	12.9	120	8.8
13.5	23.2	192	180	21.0	150	14.8	120	10.5
14.0	24.0	208	180	18.9	150	13.3	120	8.5
14.5	24.6	207	180	18.6	150	14.1	120	9.2
15.0	26.0	199	180	21.8	150	15.6	120	10.4
16.0	26.8	190	180	24.9	150	18.2	120	11.9
17.0	29.0	206	180	23.4	150	16.9	120	11.5
17.5	29.2	204	180	24.4	150	18.1	120	12.2
18.0	29.8	206	150	20.0	120	15.3	90	11.1
19.0	32.4	202	180	27.8	150	20.2	120	14.1
19.5	33.4	185	150	24.3	120	17.1	90	11.3
20.0	35.2	185	150	26.5	120	18.3	90	12.1
21.0	36.4	190	150	26.2	120	18.8	90	13.1
21.5	37.0	192	150	26.8	120	18.4	90	12.8
22.0	37.3	192	150	26.0	120	19.6	90	13.6
24.0	41.6	190	150	29.7	120	21.7	90	15.1
26.0	42.4	198	150	29.5	120	22.1	90	15.8
28.0	46.0	198	150	31.6	120	23.8	90	17.9
30.0	49.3	196	150	35.9	120	28.3	90	21.6
32.0	53.0	192	150	40.3	120	31.2	90	23.9
35.0	57.1	205	150	40.1	90	26.1	70	22.5
40.0	65.3	198	150	49.3	90	31.9	70	27.8
45.0	74.6	188	150	61.9	90	43.8	70	39.7
50.0	83.0	175	150	73.7	90	51.2	70	46.1

MONARCH

Nozzle Size 100 PSIG Nominal Rating GPH #2 Fuel Oil By-Pass (Return) Closed	Supply Pressure to Nozzle 300 PSIG at All Rates*							
	Approx. High Fire Rate GPH 300 PSIG By-Pass (Return) Closed	Approx. High Fire By-Pass (Return) Pressure PSIG By-Pass (Return) Closed	Reduced Firing Rates					
			Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH
4.5	7.8	205	180	7.7	60	3.4	-	-
5.0	8.2	195	180	7.6	120	4.9	60	3.6
5.5	9.3	180	120	4.6	60	3.5	-	-
6.0	10.4	215	180	5.9	120	4.4	60	3.1
6.5	11.5	225	180	6.3	120	4.8	60	3.6
7.0	10.6	220	180	7.9	120	5.4	60	3.6
7.5	12.3	205	180	7.6	120	5.4	60	4.1
8.0	12.5	200	180	7.7	120	5.0	60	3.5
9.0	14.4	200	180	9.1	120	5.9	60	3.9
9.5	15.4	210	180	9.4	120	6.2	60	4.3
10.5	16.0	220	180	9.8	120	6.5	60	4.3
12.0	19.4	210	180	12.5	120	8.1	60	4.9
13.5	23.3	210	180	18.5	120	10.8	60	6.6
15.5	25.5	220	180	13.9	120	9.0	60	6.8
17.5	28.2	225	220	22.4	180	17.0	120	10.9
19.5	30.6	235	220	23.6	180	17.4	120	10.3
21.5	33.5	240	220	26.4	180	19.4	120	11.9
24.0	35.1	230	220	33.4	180	24.3	120	14.4
28.0	48.7	215	180	40.2	120	21.1	60	11.1
30.0	51.6	225	220	50.6	180	38.0	120	23.2
35.0	58.5	200	180	38.0	120	32.6	60	15.7
40.0	68.3	190	180	54.3	120	40.5	60	22.2
45.0	76.2	180	180	66.0	120	49.6	60	29.4
50.0	83.9	165	120	61.9	-	-	-	-

DELAVAN VARI-FLO 33769

Nozzle Size 100 PSIG Nominal Rating GPH #2 Fuel Oil By-Pass (Return) Closed	Supply Pressure to Nozzle 300 PSIG at All Rates*							
	Approx. High Fire Rate GPH 300 PSIG By-Pass (Return) Closed	Approx. High Fire By-Pass (Return) Pressure PSIG By-Pass (Return) Closed	Reduced Firing Rates					
			Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH
4.5	**7.5**	**162**	**120**	**5.0**	**100**	**4.0**	**70**	**3.0**
5.0	**8.5**	**136**	**120**	**7.0**	**105**	**6.0**	**75**	**4.0**
5.5	**9.2**	**150**	**130**	**8.0**	**120**	**7.0**	**80**	**4.0**
6.0	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
6.5	**10.8**	**160**	**160**	**9.0**	**120**	**7.0**	**80**	**4.0**
7.0	**12.0**	**141**	**125**	**10.0**	**110**	**8.0**	**67**	**4.0**
8.0	**13.0**	**158**	**130**	**10.0**	**120**	**8.0**	**85**	**5.0**
9.0	**15.0**	**132**	**100**	**10.0**	**90**	**7.5**	**60**	**5.0**
9.5	**15.0**	**158**	**120**	**10.0**	**110**	**7.5**	**80**	**5.0**
10.0	**16.0**	**150**	**-**	**-**	**-**	**-**	**-**	**-**
12.0	**20.0**	**154**	**118**	**16.0**	**94**	**12.0**	**70**	**8.0**
14.0	**23.0**	**160**	**120**	**17.0**	**100**	**11.0**	**85**	**8.0**
16.0	**26.0**	**144**	**115**	**17.0**	**100**	**15.0**	**75**	**10.0**
18.0	**30.0**	**165**	**135**	**22.0**	**110**	**15.0**	**80**	**10.0**
20.0	**32.0**	**160**	**120**	**24.0**	**100**	**18.0**	**80**	**14.0**
22.0	**36.0**	**155**	**120**	**27.0**	**100**	**20.0**	**82**	**15.0**
24.0	**41.0**	**144**	**120**	**30.0**	**100**	**25.0**	**72**	**15.0**
26.0	**43.0**	**150**	**100**	**35.0**	**100**	**27.0**	**65**	**15.0**
28.0	**47.5**	**148**	**120**	**40.0**	**100**	**30.0**	**65**	**16.0**
30.0	**51.0**	**138**	**85**	**40.0**	**75**	**30.0**	**50**	**17.0**
35.0	**60.0**	**175**	**115**	**40.0**	**90**	**30.0**	**60**	**20.0**
40.0	**68.0**	**115**	**70**	**45.0**	**50**	**35.0**	**20**	**23.0**
45.0	**76.0**	**166**	**120**	**60.0**	**85**	**40.0**	**50**	**25.0**
50.0	**85.5**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

***** When Supply Pressure to Nozzle is Lower Than 300 PSIG the By-Pass (Return) and Firing Rates Will be Reduced Somewhat. Consult Factory for Further Information.

DELAVAN VARI-FLO 30630 and 30637

Nozzle Data		Supply Pressure to Nozzle 300 PSIG at All Rates Except Alternate Firing*							
Nozzle Size 300 PSIG Nominal Rating GPH #2 Fuel Oil By-Pass (Return) Closed	Model Number	Approx. High Fire Rate GPH 300 PSIG By-Pass (Return) Closed	Approx. High Fire By-Pass (Return) Pressure PSIG By-Pass Return) Closed	Alternate Firing		Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH	Approx. By-Pass (Return) Pressure PSIG	Approx. Firing Rate GPH
				Approx. Alternate Nozzle Pressure PSIG	Approx. GPH				
35.0	**#30630**	**35.0**	**157**	**-**	**-**	**140**	**32.0**	**100**	**18.7**
37.5	**#30630**	**37.5**	**180**	**-**	**-**	**140**	**28.6**	**100**	**13.8**
40.0	**#30630**	**40.0**	**191**	**-**	**-**	**140**	**25.4**	**100**	**16.7**
45.0	**#30630**	**45.0**	**192**	**-**	**-**	**140**	**30.6**	**100**	**16.5**
50.0	**#30630**	**50.0**	**185**	**-**	**-**	**-**	**-**	**86**	**16.7**
55.0	**#30630**	**55.0**	**182**	**-**	**-**	**91**	**18.3**	**-**	**-**
60.0	**#30630**	**60.0**	**178**	**-**	**-**	**94**	**20.0**	**-**	**-**
65.0	**#30630**	**65.0**	**165**	**-**	**-**	**85**	**21.7**	**-**	**-**
70.0	**#30630**	**70.0**	**174**	**-**	**-**	**88**	**23.3**	**-**	**-**
80.0	**#30630**	**-**	**154**	**265**	**75**	**78**	**25.0**	**-**	**-**
80.0	**#30637**	**-**	**-**	**260**	**74**	**85**	**24.7**	**-**	**-**
80.0	**#30637**	**-**	**-**	**280**	**78**	**90**	**26.0**	**-**	**-**
80.0	**#30637**	**80.0**	**157**	**-**	**-**	**65**	**27.0**	**-**	**-**
90.0	**#30637**	**-**	**-**	**260**	**83**	**90**	**27.7**	**-**	**-**
90.0	**#30637**	**-**	**-**	**280**	**86**	**85**	**28.7**	**-**	**-**
90.0	**#30637**	**90.0**	**165**	**-**	**-**	**80**	**30.0**	**-**	**-**
100.0	**#30637**	**-**	**136**	**260**	**93**	**90**	**31.0**	**-**	**-**
100.0	**#30637**	**-**	**151**	**280**	**97**	**90**	**32.0**	**-**	**-**
100.0	**#30637**	**100.0**	**165**	**-**	**-**	**90**	**32.3**	**-**	**-**
125.0	**#30637**	**-**	**161**	**260**	**115.0**	**90**	**38.0**	**-**	**-**
125.0	**#30637**	**-**	**163**	**280**	**120.0**	**90**	**39.0**	**-**	**-**
125.0	**#30637**	**125.0**	**175**	**-**	**-**	**90**	**41.0**	**-**	**-**
150.0	**#30637**	**-**	**161**	**260**	**140.0**	**90**	**45.0**	**-**	**-**
150.0	**#30637**	**-**	**163**	**280**	**145.0**	**90**	**50.0**	**-**	**-**
150.0	**#30637**	**150.0**	**175**	**-**	**-**	**90**	**56.0**	**-**	**-**

***** When Supply Pressure to Nozzle is Lower Than 300 PSIG the By-Pass(Return) and Firing Rates Will be Reduced Somewhat. Consult Factory for Further Information.

Table 9

OIL NOZZLE FLOW RATES

Simplex Nozzle System (Monarch PLP or Equivalent Solid or Semi Solid)
Flow Rate vs Pressure

Capacity in GPH #2 Oil

100# Nominal Rating	120#	140#	160#	180#	200#	220#	240#	260#	280#	300#
2	**2.1**	**2.3**	**2.4**	**2.6**	**2.7**	**2.9**	**3.0**	**3.1**	**3.2**	**3.3**
2.5	**2.6**	**2.8**	**3.0**	**3.2**	**3.4**	**3.6**	**3.7**	**3.8**	**4.0**	**4.1**
3	**3.2**	**3.4**	**3.6**	**3.8**	**4.0**	**4.2**	**4.4**	**4.7**	**4.8**	**5.0**
3.5	**3.7**	**3.9**	**4.2**	**4.5**	**4.7**	**4.9**	**4.2**	**5.4**	**5.8**	**5.9**
4	**4.2**	**4.5**	**4.8**	**5.1**	**5.4**	**5.6**	**5.9**	**6.2**	**6.4**	**6.7**
4.5	**4.7**	**5.0**	**5.4**	**5.7**	**6.1**	**6.3**	**6.6**	**7.0**	**7.2**	**7.4**
5	**5.3**	**5.6**	**6.0**	**6.4**	**6.8**	**7.1**	**7.3**	**7.7**	**7.9**	**8.2**
5.5	**5.7**	**6.1**	**6.5**	**7.0**	**7.3**	**7.7**	**8.0**	**8.4**	**8.6**	**9.1**
6	**6.3**	**6.7**	**7.2**	**7.7**	**8.1**	**8.5**	**8.8**	**9.2**	**9.5**	**9.9**
6.5	**6.8**	**7.2**	**7.9**	**8.3**	**8.8**	**9.2**	**9.5**	**10.0**	**10.3**	**10.7**
7	**7.3**	**7.9**	**8.3**	**9.0**	**9.4**	**9.9**	**10.3**	**10.7**	**11.2**	**11.4**
7.5	**7.8**	**8.5**	**8.9**	**9.6**	**10.0**	**10.5**	**11.0**	**11.5**	**11.9**	**12.2**
8	**8.3**	**9.1**	**9.5**	**10.3**	**10.8**	**11.3**	**11.8**	**12.3**	**12.8**	**13.0**
9	**9.4**	**10.1**	**10.8**	**11.5**	**12.0**	**12.8**	**13.2**	**13.9**	**14.4**	**14.8**
10	**10.4**	**11.2**	**12.0**	**12.8**	**13.4**	**14.2**	**14.7**	**15.4**	**16.0**	**16.6**
11	**11.5**	**12.5**	**13.3**	**14.2**	**15.0**	**15.6**	**16.2**	**17.0**	**17.7**	**18.2**
12	**12.5**	**13.6**	**14.5**	**15.3**	**16.2**	**17.0**	**17.7**	**18.5**	**19.2**	**19.8**

Oil Nozzle Servicing

1. Nozzles used on Power Flame Type C burners are of two types: simplex and internal bypass. The simplex nozzle is normally used on smaller burners in the three to eight gallons per hour range. The bypass nozzle is used for larger inputs requiring higher turndown or more sophisticated air/fuel control. Both types of nozzles have GPH ratings stamped on the side. Stamped ratings are based on 100 psig except models 30630 and 30637 which are based on 300 psig. The burners operate in the 300 psig range. See pages 31 through 34, Tables 8 and 9 for flow rates, pressure and sizing information.
2. When removing or replacing the oil nozzle and electrode assembly, take care to prevent damage to the ignition wire.
3. The nozzles should be removed from the nozzle adapter by use of the proper wrench. They should be disassembled and thoroughly cleaned with a liquid solvent (preferably non-flammable) and a brush.
4. Do not use a screwdriver, wire brush or similar metallic objects to clean nozzles. Damage to orifices or spray slots result in off-center or *sparky* fires.
5. The nozzle should be seated firmly in the nozzle adapter to prevent leaks.
6. If a nozzle is damaged or burned, replace it.
7. The entire oil tube and nozzle assembly (the oil drawer assembly) may be removed for ease of service.
8. When cleaning and taking the nozzle apart, do not force it.
9. For additional information on bypass nozzles, see page 30. Note that the Teflon seal in the Monarch F80BPS and Delavan 33769 nozzles is an integral part of the nozzles and that if the seal is removed accidentally, the nozzle must be replaced. On the Delavan 30630 and 30637 nozzles, the seal normally remains in the nozzle adapter. When the nozzle is removed from the adapter, the seal should also be removed and replaced with a new seal.

Oil Pump or Oil Flow Problems and Typical Solutions

NO OIL DELIVERED

1. Reversed pump rotation
2. Suction lift too high (See page 12, Figure 10)
3. Air leak in suction line
4. Pump not primed, or has lost prime
5. Pump coupling not installed properly
6. Pump defective
7. Line plugged
8. Valve closed

NOISY PUMP

1. Air leak in suction line
2. Pump not securely mounted
3. Vibration caused by bent shaft or misalignment
4. Pump overloaded
5. Suction line vacuum so high that vapor forms within the liquid (see page 12, Figure 10)

PUMP LEAKS

1. Cover bolts need tightening; gasket broken or defective
2. Mechanical seal (used on certain models) may be scratched, due to dirt
3. Inlet head pressure too high. Install a pressure reducing valve set at 3 psig or less
4. Oil line fitting not tight

For additional oil pump information, refer to the oil pump manufacturer's product bulletin supplied with the burner.

CAPACITY TOO LOW

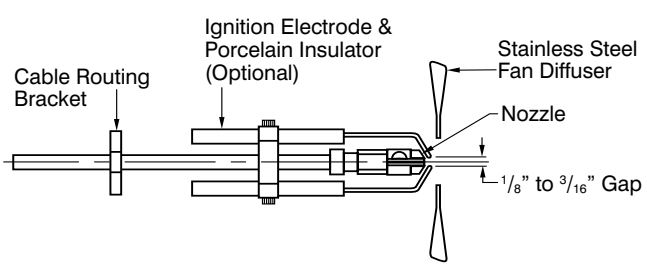
1. Suction lift too high (see page 12, Figure 10)
2. Air leak in suction line
3. Suction line too small (see page 12, Figure 10)
4. Check valve or strainer is obstructed or dirty
5. Mechanical defects - pump badly worn or seal defective

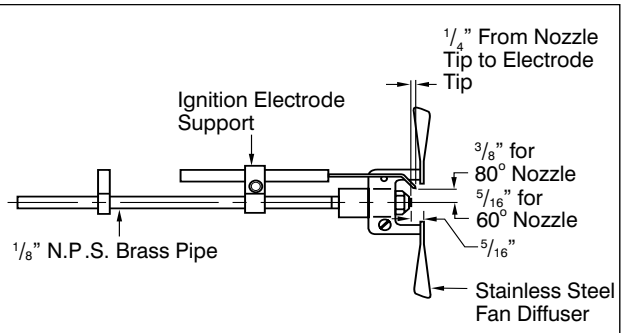
Direct Spark Oil Ignition Adjustments

1. The ignitor assembly should be removed and cleaned regularly. The porcelain insulators should be kept clean and must be replaced if cracked.
2. The spark gap must be set in accordance with the dimensions noted. (Refer to Figures 30, 31, 32). Ensure that the distance between the electrodes and the nozzle (or diffuser) is greater than the spark gap.
3. The electrodes should not extend closer than $^1/_8$" to the spray angle of the nozzle to prevent carboning. A nozzle spray angle check card is available and may be used to check electrode position.
4. The high tension wires and clips between the transformer and ignitor electrodes should be checked periodically for deterioration.

Figure 30

Oil Drawer Assembly *Tip Point* Ignition Electrode Setting

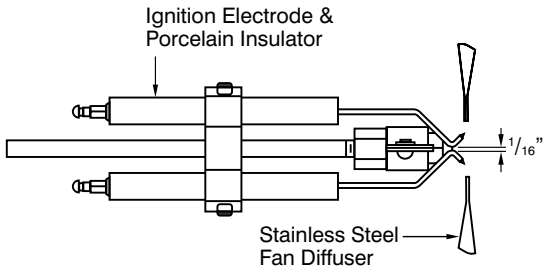


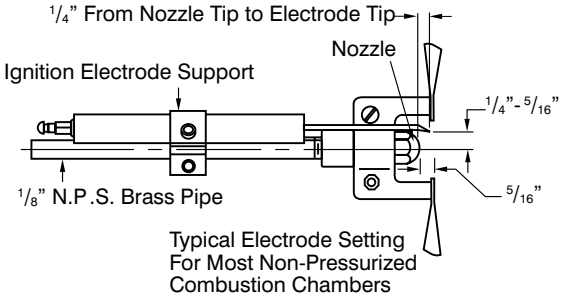


Certain OEM applications may require alternate settings. Setting of electrodes closer to center of nozzle and/or farther forward may be required.

Figure 31

Oil Drawer Assembly *Jacobs Ladder* Electrode Settings





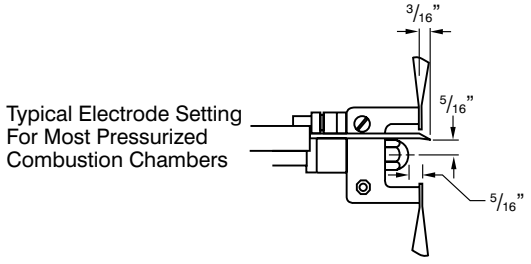
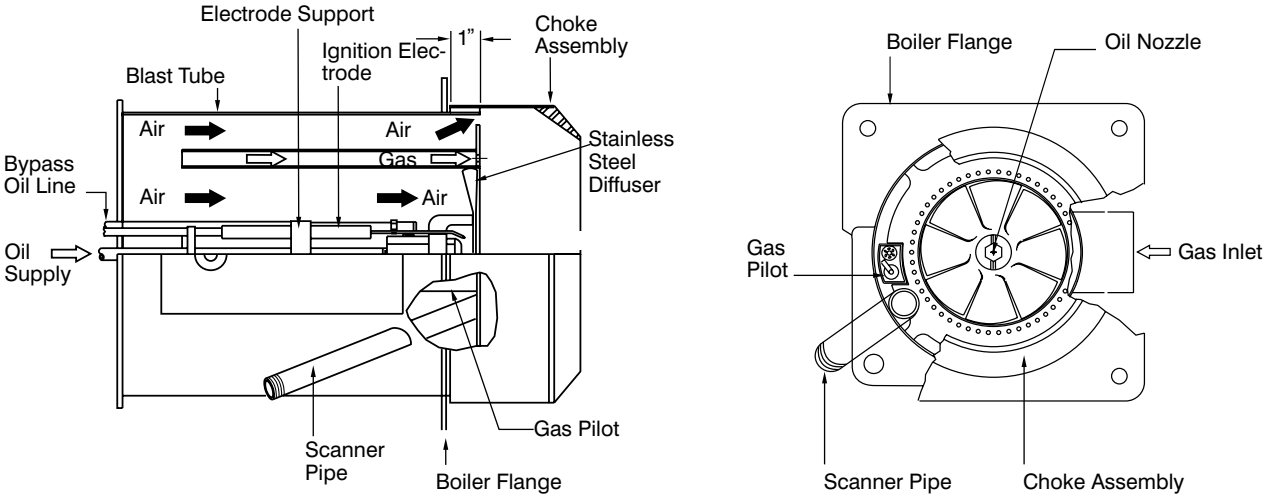


Figure 32

Gas/Oil Burner Firing Head Cutaway View
Showing Direct Spark Ignition On Oil, Gas Pilot Main Gas Flame Ignition - Using A Common Scanner For Both Fuels



NOMINAL FAN DIFFUSER OPENINGS: C1- 1/4", C2 - 3/8", C3 through C8 - 5/8"

JOB CONDITIONS such as high altitude may require adjustment of diffuser blades to alternate settings. Certain OEM applications may require settings of diffuser blades or electrodes not listed or shown. Setting of electrodes closer to center of nozzle and or farther forward may be required.

Figure 33

C5B Gas Gun Assembly

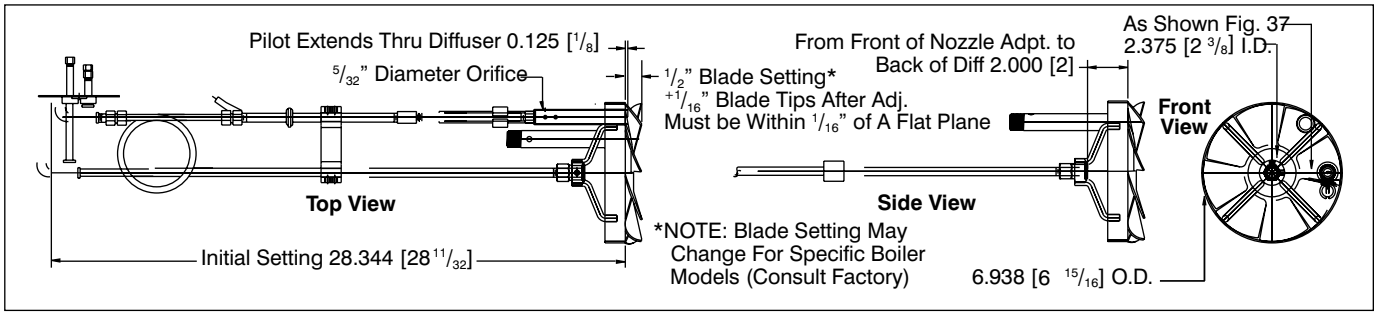


Figure 34

C6 Gas Gun Assembly

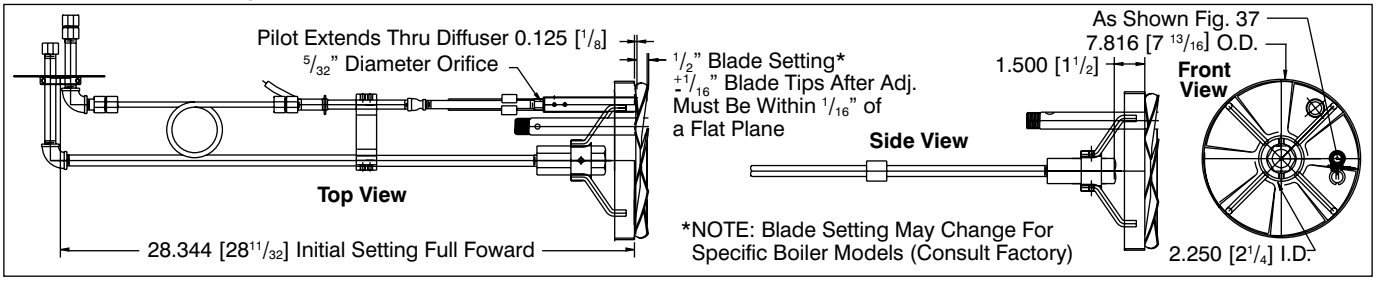


Figure 35

C5B-C6 Gas/Oil Gun Assembly

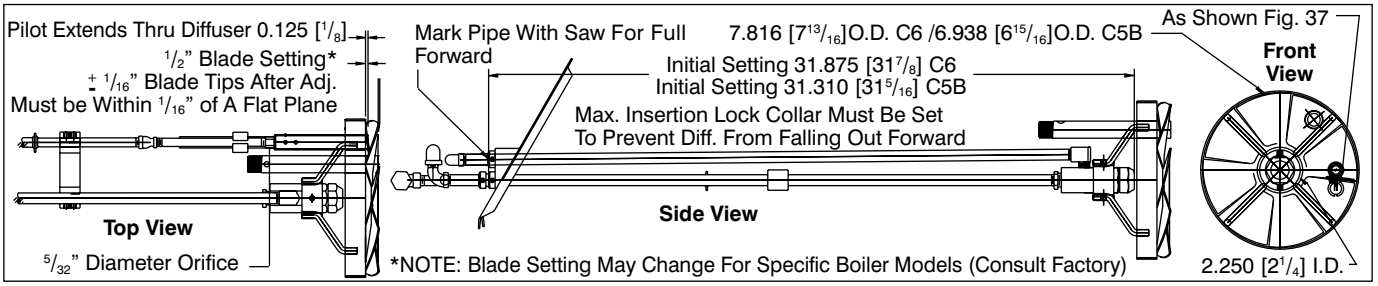


Figure 36

C7/C8 Gas and Gas/Oil Gun Assembly

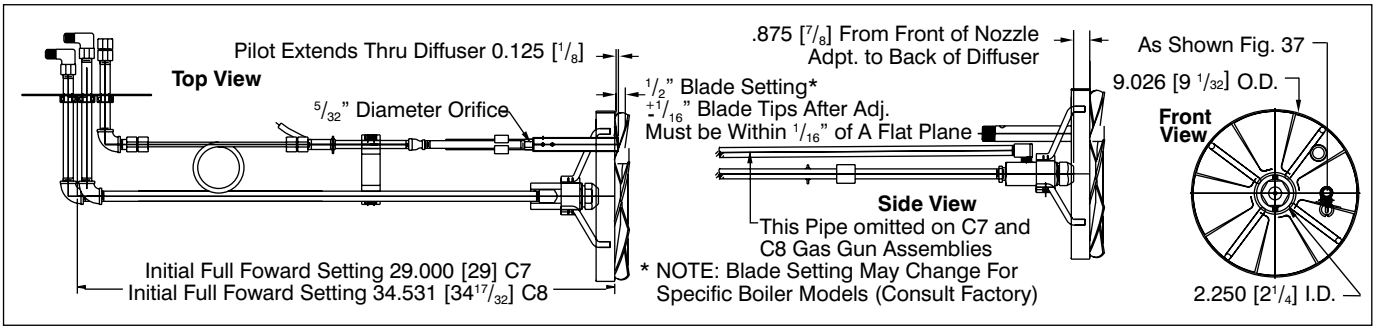


Figure 37

C5B-C8 Gun Mounted Pilot Assembly

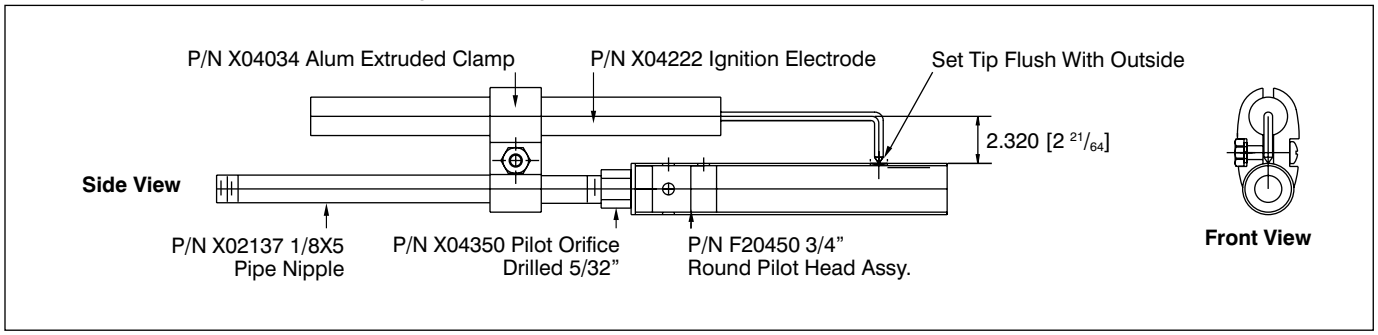
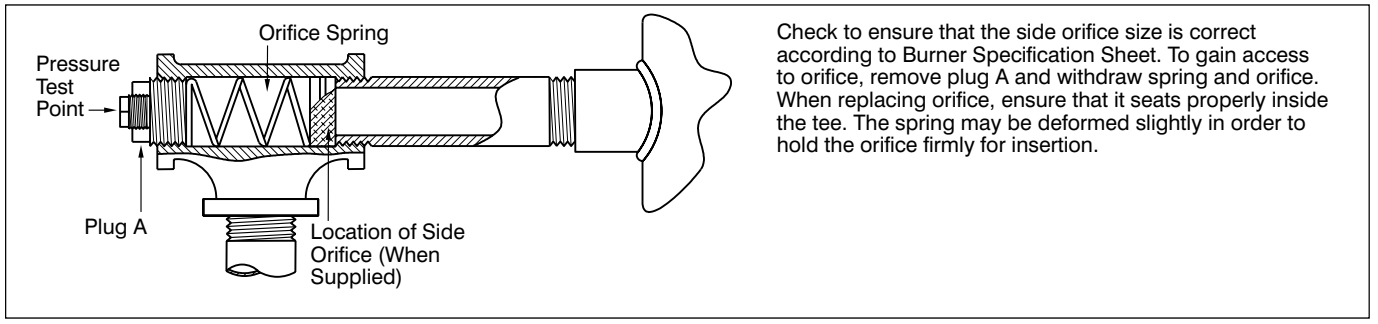


Figure 38

Location of Side Orifice (When Supplied)



Check to ensure that the side orifice size is correct according to Burner Specification Sheet. To gain access to orifice, remove plug A and withdraw spring and orifice. When replacing orifice, ensure that it seats properly inside the tee. The spring may be deformed slightly in order to hold the orifice firmly for insertion.

Table 10

Gas Burner Orifice Sizing Information (See this page Figure 38 for side orifice detail.)

BURNER MODEL	MBTU INPUT	ORIFICE IDENTIFICATION I.P.S.SHOULDER NOMINAL O.D. INCHES	(A) LIMITING ORIFICE INSIDE DIAMETER INCHES		(B) APPROXIMATE ORIFICE PRESSURE (INCHES W.C.) OR TEE PRESSURE IF NO ORIFICE SIZE IS SHOWN	
			NATURAL GAS	PROPANE GAS	NATURAL GAS	PROPANE GAS
C1-G(O)	**250**	1 1/2	**5/16**	**15/64**	**3.0**	**4-5**
With	**300**	1 1/2	**11/32**	**1/4**	**3.0**	**4-5**
Standard	**350**	1 1/2	**3/8**	**17/64**	**3.0**	**4-5**
Nozzle	**400**	1 1/2	**13/32**	**9/32**	**3.0**	**4-5**
Mix Tube	**450**	1 1/2	**27/64**	**19/64**	**3.0**	**4-5**
30 9/64	**500**	1 1/2	**7/16**	**5/16**	**3.0**	**4-5**
	550	1 1/2	**15/32**	**21/64**	**3.0**	**4-5**
	600	1 1/2	**1/2**	**11/32**	**3.0**	**4-5**
	650	1 1/2	**17/32**	**23/64**	**3.0**	**4-5**
	700	1 1/2	**9/16**	**3/8**	**3.0**	**4-5**
	750	1 1/2	**19/32**	**13/64**	**3.0**	**4-5**
	800	1 1/2	**5/8**	**13/32**	**3.0**	**4-5**
	850	1 1/2	**11/16**	**27/64**	**3.0**	**4-5**
	900	1 1/2	**25/32**	**7/16**	**3.0**	**4-5**
	950	1 1/2	**13/16**	**29/64**	**3.0**	**4-5**
	1000	1 1/2	**27/32**	**15/32**	**3.0**	**4-5**
	1100	1 1/2	**7/8**	**31/64**	**3.0**	**4-5**
	1200	1 1/2	**NONE**	**1/2**	**3.0**	**4-5**
	1300	1 1/2	**NONE**	**17/32**	**3.5**	**4-5**
	1350	1 1/2	**NONE**	**35/64**	**3.8**	**4-5**

Table 10 (Continued)

Gas Burner Orifice Sizing Information (See page 37, Figure 38 for side orifice detail.)

BURNER MODEL	MBTU INPUT	ORIFICE IDENTIFICATION I.P.S.SHOULDER NOMINAL O.D. INCHES	(A) LIMITING ORIFICE INSIDE DIAMETER INCHES		(B) APPROXIMATE ORIFICE PRESSURE (INCHES W.C.) OR TEE PRESSURE IF NO ORIFICE SIZE IS SHOWN	
			NATURAL GAS	PROPANE GAS	NATURAL GAS	PROPANE GAS
C2-G(O) With Standard Nozzle Mix Tube 40 11/64	1300	2	13/16	17/32	3.2	4-5
	1400	2	7/8	35/64	3.0	4-5
	1500	2	1	9/16	3.0	4-5
	1600	2	1-1/16	37/64	3.0	4-5
	1700	2	1-1/8	19/32	3.0	4-5
	1800	2	1-1/4	39/64	3.0	4-5
	1900	2	15/16	5/8	3.0	4-5
	2000	2	NONE	41/64	3.0	4-5
	2100	2	NONE	21/32	3.2	4-5
	2200	2	NONE	43/64	3.4	4-5
	2300	2	NONE	11/16	3.5	4-5
	2400	2	NONE	45/64	3.6	4-5
	2500	2	NONE	23/32	3.8	4-5
	2750	2	NONE	3/4	4.2	4-5
	3000	2	NONE	25/32	4.8	4-5
	3080	2	NONE	51/64	5.0	4-5
C3-G(O) With Standard Nozzle Mix Tube 50 #10 Holes	2750	2 1/2	1-5/16	3/4	3.5	4-5
	3000	2 1/2	1-27/64	25/32	3.5	4-5
	3250	2 1/2	1-5/8	13/16	3.5	4-5
	3500	2 1/2	NONE	27/32	3.3	4-5
	3750	2 1/2	NONE	7/8	3.7	4-5
	4000	2 1/2	NONE	29/32	4.3	4-5
	4250	2 1/2	NONE	15/16	4.8	4-5
	4500	2 1/2	NONE	31/32	5.4	4-5
	4718	2 1/2	NONE	1	5.8	4-5
C3-G(O)-25B With ADJ Premix Tube 50 9/32 Holes	4250	2 1/2	1-5/8	15/16	3.5	4-5
	4500	2 1/2	1-29/32	31/32	3.3	4-5
	4750	2 1/2	2	63/64	3.4	4-5
	5000	2 1/2	NONE	1-1/64	3.5	4-5
	5250	2 1/2	NONE	1-1/32	3.7	4-5
C4-G(O) With Standard Nozzle Mix Tube 60 7/32 Holes	4000	3	1-7/16	29/32	3.2	4-5
	4500	3	1-9/16	31/32	3.4	4-5
	5000	3	2	1-1/64	3.4	4-5
	5500	3	NONE	1-1/16	3.5	4-5
	6000	3	NONE	1-1/8	4.0	4-5
	6500	3	NONE	13/32	5.0	4-5
	7000	3	NONE	1-3/16	6.0	4-5
	7500	3	NONE	1-7/32	6.8	4-5
	7840	3	NONE	1-15/64	7.4	4-5
C5-G(O) With Standard Nozzle Mix Tube 60 7/32 Holes	5500	3	NONE	1-1/16	1.9	4-5
	6000	3	NONE	1-1/8	2.5	4-5
	7000	3	NONE	1-3/16	3.2	4-5
	8000	3	NONE	1-1/4	4.5	4-5
	9000	3	NONE	1-3/8	6.5	4-5
	10000	3	NONE	1-7/16	8.0	4-5
	10500	3	NONE	1-1/2	8.1	4-5
C5-G(O)-30B C6-G(O)-30 C7-G(O)-30(B) C8-G(O)-30	Require adjustable premix tubes. Gas pressure data for these burners is included with shipment.					

(A) Limiting orifices are not generally used on natural gas for higher ratings of On/Off, Low-High-Off, Low-High-Low units or any ratings of modulating units as the butterfly functions as a variable orifice. Modulating L.P. gas units require a properly sized limiting orifice.

(B) Approximate pressure for initial start-up. Final pressure should be determined after checking actual flow with gas meter. Stack temperature, CO_2, O_2 and firebox pressure will help in determining actual input when gas meter is not available for this unit.

Consideration should be given to magnitude of furnace pressure. Furnace pressure must always be added to above orifice pressures, which are based on neutral furnace pressure.

Burners equipped with optional adjustable premix tubes will provide flows shown at slightly lower pressures. Most fixed premix tubes will require slightly higher pressures. When available supply pressure is too low to provide above, orifice may be enlarged or removed and proper adjustment made on gas pressure regulator.

Table 11

Pilot Orifice Schedule

BURNER MODEL		DRILL SIZE NATURAL GAS	DRILL SIZE PROPANE GAS
C1-G(O)	**Standard 6" Fan**	**#36**	**#48**
	Optional 7x3 or 7 5/8 x 3 1/2 Fan	**#30**	**#48**
C2-G(O)	**Standard 7x3 Fan**	**#36**	**#48**
	Standard 7 5/8 x 3 1/2 Fan	**#36**	**#48**
	Optional 8 3/8 x 3 1/2 Fan	**#36**	**#48**
C3-G(O)	**Standard 8 3/8 x 3 1/2 Fan**	**#30**	**#48**
	Optional 9x4 Fan	**#30**	**#48**
C4-G(O)	**Standard 8 3/8 x 4 1/2 Fan**		
	Standard 9x4 or 9x5 1/2 Fan	**#30**	**#48**
C5-G(O)	**Standard 10 3/4 x 5 1/2 Fan**	**#30**	**#48**
C5-G(O)-B	**Standard 10 3/4 x 5 1/2 Fan**	5/32	5/32
C6-G(O)	**Standard 10 3/4 x 5 1/2 Fan**	5/32	5/32
C7-G(O)	**Standard 12 5/8 x 5 Fan**	5/32	5/32
C8-G(O)	**Standard 22 x 2 3/8 Fan**	5/32	5/32

Gas Pilot Ignition Adjustment

Excessive gas pressure and insufficient air may be the most common causes of pilot ignition failure. Burners with automatic air dampers linked to the gas valve or damper motor should have pilot gas pressures as follows:

C1-0	(Gas Pilot) C1-GO-10, C1-GO-12 With Std. #36 Orifice	2 1/2" - 3 1/2" W.C.
	With 7" Fan & #30 Pilot Orifice	1 1/2" - 2 1/2" W.C.
C2-OA	(Gas Pilot) C2-G(O))-15	2" - 4" W.C.
C2-OB	(Gas Pilot) C2-G(O)-20A(B)	1 1/2"-3" W.C.
C3-O	(Gas Pilot) C3-G(O)-20, C3-G(O)-25	1 1/2"-2" W.C.
C4-O	(Gas Pilot) C4-G(O)-25,C4-G(O)-30	1 1/2"-2" W.C.
C5-O(B)	(Gas Pilot) C5-G(O)-30, C5-G(O)-30B	1 1/2"-2" W.C.
C6-O	(Gas Pilot) C6-G(O)-30	1 1/2"-3" W.C.
C7-O(B)	(Gas Pilot) C7-G(O)-30, C7-G(O)-30B	2-4" W.C.
C8-O	(Gas Pilot) C8-G(O)-30	2-4" W.C.

Fixed fire (on-off) burners with manually adjustable dampers may need slightly higher pressures, but in any event do not increase pressure beyond that required for a stable flame signal. Gas pressure should be read at the test tee on the pilot gas supply pipe with a manometer or 0-10" W.C. gauge. Look for stability of gas pressure at all times. For burners equipped with automatic air dampers (linked to the gas valve or damper motor), there is a tendency to set the air dampers in a closed, barely open position. This action may produce insufficient air for dependable pilot ignition. Air damper openings should be at least 1/4" on each damper or 1/2" on one, with the other nearly closed. Some job conditions or heat exchangers may require larger air damper openings or different gas pressures than those shown above. For dependable pilot ignition, always use air damper setting to provide MOST air and LOWEST pilot gas pressure setting allowable for good pilot signal at all times. On fixed fire (on-off) burners the manually adjust-able air damper setting will need to match air for proper CO_2 setting. The following steps should be taken:

1. Remove pilot assembly and check for proper orifice size (the orifice size is stamped into the hex brass fitting connected to the pilot head nozzle assembly) and spark gap. The spark gap between the electrode and the outside radius of the gas pilot assembly should be 1/16" - 3/32". Do not set spark to arc against the pilot head nozzle. See page 40, Figures 40 and 41.
2. Close checking cock (test cock). Start up burner and stop flame safeguard control timer with *check* switch during pilot ignition. Access to *check* switch on Fireye D Series is best obtained by using a small right angle tool, such as an Allen Wrench. If there is no check switch, disconnect wire which energizes main automatic gas valve, so that air damper is not actuated.
3. Observe pilot signal with DC voltmeter or micro-ammeter and reduce pilot gas pressure to a point where the signal is erratic or reduced substantially from initial reading.
4. Raise the pilot gas pressure to the point where the signal is again stable. Remove scanner and use a mirror to view the pilot flame through the scanner pipe (a live flame from cigarette lighter or butane torch may be needed to keep scanner actuated). Be sure to get full coverage of scanner pipe by pilot flame.

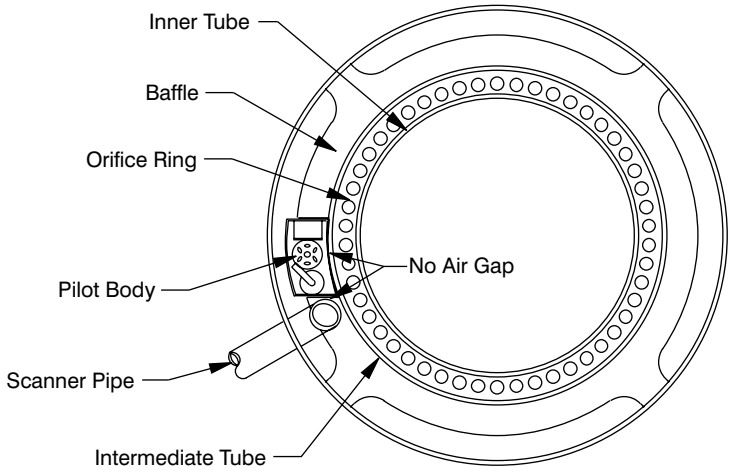
   Release *check* switch or reconnect main automatic gas valve (see step #2) and observe meter as main gas valve opens and moves air damper. If there is a drop in signal as this happens, increase pilot pres sure slightly until signal is steady at all times.

   Refer to page 40, *Gas Pilot Flood Test* as another means of determining proper pilot fuel/air mixture.

   Refer to item 11, page 26 for Spark Pickup Test.

Figure 39

Pilot Case to Gas Manifold Adjustment



Pilot case to gas manifold adjustment is very important. As depicted, the inside radius of the pilot body must be tight against the outside radius of the gas manifold.

The bottom of the pilot body must also be tight against the notched portion of the baffle ring, just slightly above the scanner pipe. If there is an air gap between the pilot body and the gas manifold and/or the baffle ring, the resulting air flow may prevent the pilot flame from being swept downward across the scanner pipe.

Pilot Spark Ignition Electrode Adjustment

The arc from the electrode tip should jump from the tip to the body of pilot housing and should be lined up with the hole in the backside of pilot housing, so that the blower air passing through this hole will cause the arc to *flag* or move around. Normal spark gap should be 1/16" - 3/32". Electrode should not be moved so far forward that the pilot flame will impinge on the porcelain insulator. This condition will cause the porcelain to crack and break off at the point of flame impingement.

Figure 40

C1 & C2 Ignition Electrode Adjustment

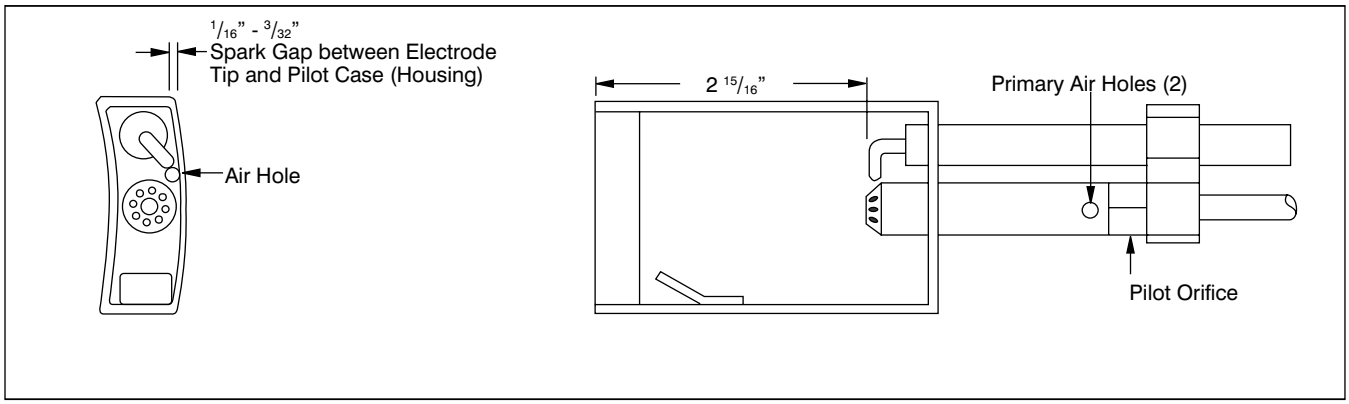
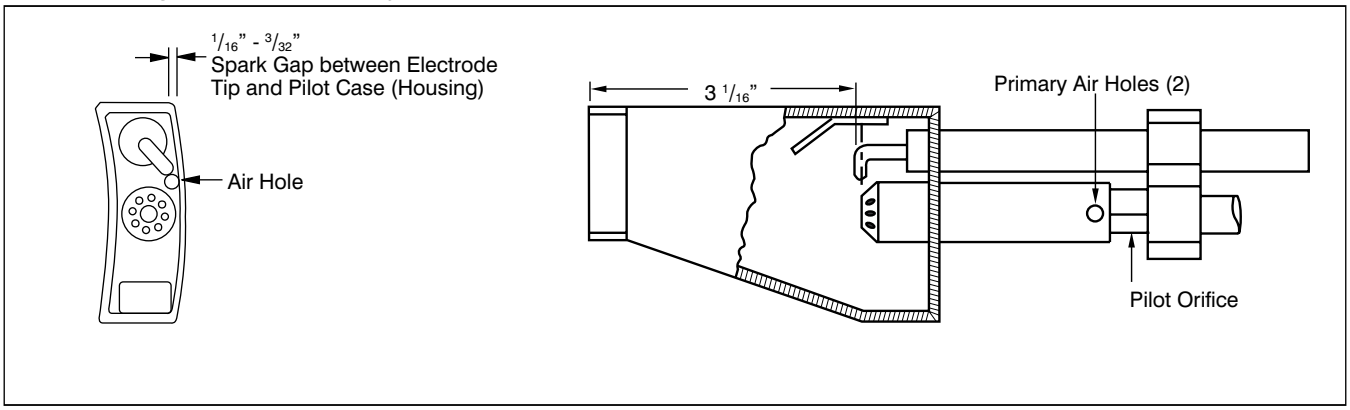


Figure 41

C3, C4 & C5 Ignition Electrode Adjustment



For C5B, C6, C7 and C8 Pilot Ignition Electrode Adjustment, see Figure 37, page 37.

Gas Pilot Flood Test

Many pilot problems are caused by a poor mixture of gas and air at the point of ignition (ignition spark gap). The cause of this poor mixture condition is usually excessive gas flow or insufficient air (air dampers are closed too far).

Once the pilot is adjusted and felt to be correct - it is suggested that the following test be accomplished to further verify that the pilot will be reliable.

1. Turn the burner off and shut the manual leak test cock in the main gas train. (This valve should always be closed when making pilot adjustments.)
2. If the burner is Low/High/Off, Low/High/Low or Modulating, take steps to keep the fuel air linkage in the pilot light off position. If the flame safeguard control has a timer *check* switch, it can be placed in the test position. If the flame safeguard control does not have the timer switch, it may be necessary to disconnect the power wire to the motorized gas valve.
3. Install a 0 to 10" W.C. gas pressure gauge or a manometer in the pilot test tee fitting. Plug an appropriate flame signal meter into the flame safeguard control.
4. Disconnect the high tension ignition leadwire at the ignition transformer secondary terminal. Either hold onto the insulated portion or let the free ignition wire hang loose, so that it is not able to come into contact with the bare ignition terminal on the transformer.
5. Start the burner and let it go through the prepurge period. As soon as the pilot ignition circuit is energized (listen for the sound of the solenoid valve opening or watch the pilot gas pressure gauge), let about 3 to 4 seconds lapse and then CAREFULLY (the ignition transformer is putting out 6000 volts) touch the ignition leadwire to the transformer terminal secondary.

   If the pilot fuel/air mixture and ignition electrode are adjusted correctly, the pilot will light instantly and the flame signal reading will be steady and of the correct value. If the pilot does not light instantly, then readjust the pilot gas pressure and/or the air dampers and/or the ignition electrode setting according to the information provided in this manual.
6. Turn the burner off. Reconnect the ignition leadwire to the ignition transformer secondary terminal. Set the *check* switch in the flame safeguard control for automatic operation. Reconnect any wires that have been disconnected to hold the motorized gas valve in the pilot position. Open the checking gas cock, turn the burner on and verify that the pilot lights and proves instantly, providing good, smooth ignition of the main gas flame.
7. If Gas Pilot Flood Test is successful, it is not always a guarantee of correct pilot air/fuel mixture, but a failure will almost always indicate an excessively rich mixture.

Flame Safeguard Control Flame Signal Values

This curve correlates the relative values of O_2 and CO_2 for the fuels listed, as well as the percentage of excess air at given O_2 and CO_2 values.

Example: Following the dotted line on the vertical axis from 4% O_2 to curve *H* and the dotted line on the horizontal axis to the left, the % excess air column shows that 4% O_2 equals 25% excess air.

Following the vertical dotted line axis again from curve H to fuel A (Natural Gas) and the horizontal axis to the left, the % CO_2 column shows that 4% O_2 and 25% excess air correlate to 9 1/2% CO_2 for Natural Gas.

Again following the 4% O_2 vertical axis fo fuel line E (#2 Fuel Oil) and to the left to the CO_2 column shows that 4% O_2 and 25% excess air correlate to 12 1/2 % CO_2 on #2 Fuel Oil.

This chart can be used to determine required CO_2 or O_2 values (and therefore equivalent BTU input values) for the secondary fuel when the burner has been properly adjusted for the primary fuel inputs.

Table 12

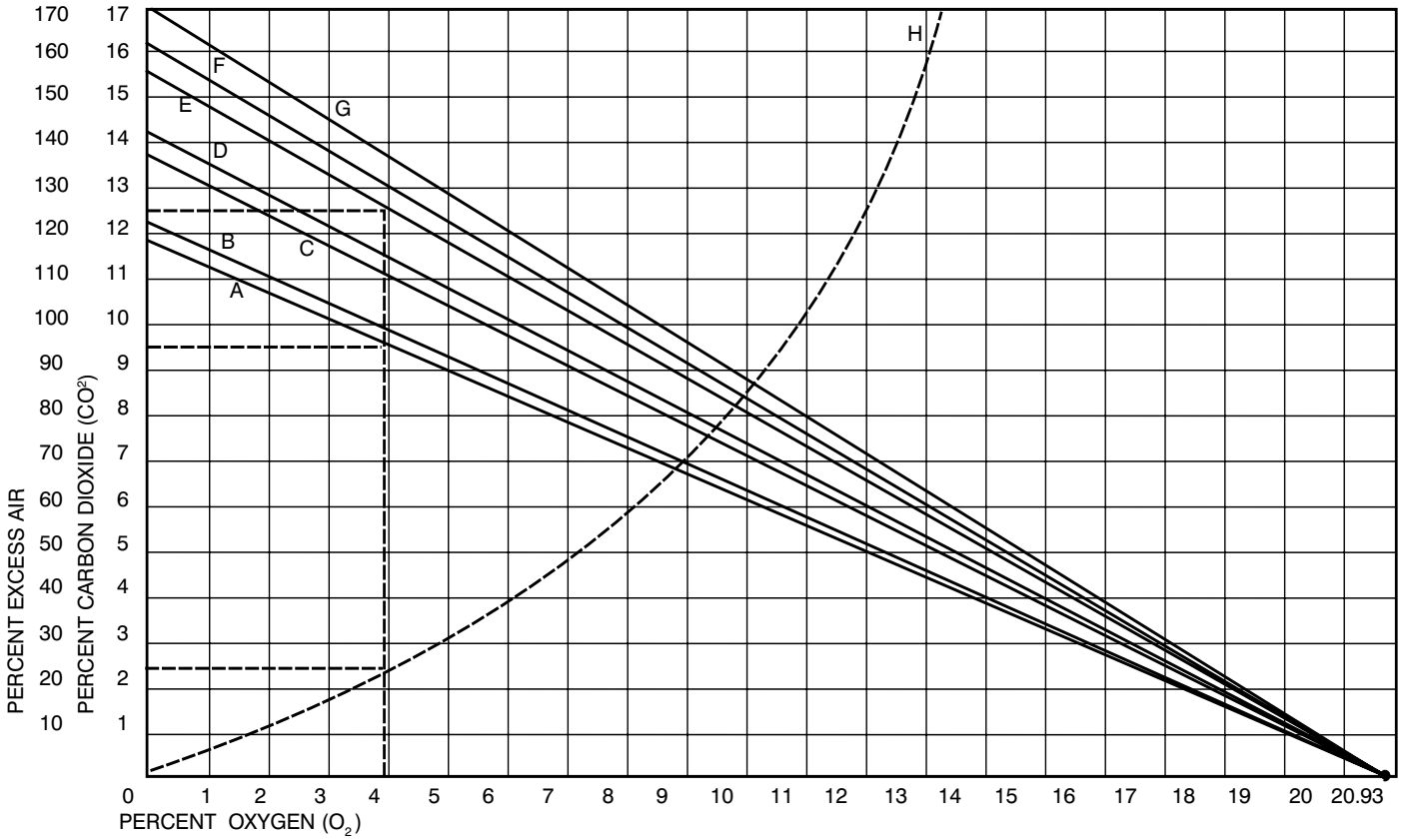
Acceptable Stable Pilot and/or Main Flame Current Readings

Control	Photocell or Flame Rod	U.V.	Lead Sulfide
R7795A or C	**N/A**	**3 1/2 microamps**	**N/A**
R7795B or D	**2 microamps**	**N/A**	**N/A**
R479A (D)	**2 microamps**	**1 1/2 microamps**	**N/A**
R4140M (G,L) or BC7000	**2-5 microamps**	**3 1/2 - 7 1/2 microamps**	**2-5 microamps R7248A Red Amp 3 1/2 microamps R7248B Red Amp**
R7800	**1.25-5.0 DC Volts**	**1.25-5.0 DC Volts**	**N/A**
TFM - 2(3) or MII	**14-17 DC Volts[1]**	**N/A**	**N/A**
UVM - 2(3)(5) or MII	**N/A**	**5-6 DC Volts**	**N/A**
D Series	**15-25 DC Volts**	**15-25 DC Volts**	**15-25 DC Volts**
E110	**10 min., 20 or greater normal**	**10 min., 20 or greater normal**	**N/A**

1. 4-10 Microamps - with microammeter in series with S - 2 wire to flame rod.

Table 13

CO_2- O_2 Ratio Curves for Fuel Oils and Gases



CURVE	FUEL	MAXIMUM CO_2%
A	**Nautral Gas**	**11.7**
B	**Natural Gas**	**12.1**
C	**Propane**	**12.1**
D	**Butane**	**14.0**

CURVE	FUEL	MAXIMUM CO_2%
E	**#2 Fuel Oil**	**15.2**
F	**#5 Fuel Oil**	**16.0**
G	**#6 Fuel Oil**	**16.9**
H	**Excess Air vs. O_2**	

TROUBLE SHOOTING SUGGESTIONS GAS, OIL OR GAS/OIL BURNER

GENERAL

1. Burner Fails to Start

A. Defective On/Off or fuel transfer switch. Replace.

B. Control circuit has an open control contact. Check limits, low water cutoff, proof of closure switch and others as applicable.

C. Bad fuse or switch open on in-coming power source. Correct as required.

D. Motor overloads tripped. Reset and correct cause for trip out.

E. Flame safeguard control safety switch tripped out. Reset and determine cause for apparent flame failure.

F. Loose connections or faulty wiring. Tighten all terminal screws and consult wiring diagram furnished with the burner.

G. Frozen oil pump shaft preventing blower motor operation. Replace oil pump.

H. Flame safeguard control starting circuit blocked due to flame relay being energized. Possible defective scanner--replace. Possible defective amplifier--replace. Scanner actually sighting flame due to leaking fuel valve--correct unwanted flame cause. Defective flame safeguard control--replace.

I. Defective blower motor. Repair or replace.

2. Occasional Lockouts for No Apparent Reason

A. Gas pilot ignition failure. Refer to pilot adjustment section and readjust to make certain that ignition is instant and that flame signal readings are stable and above minimum values. Use a manometer or 0 to 10" W.C. gas pressure gauge on pilot test tee to make certain that pressure is as recommended.

B. Check for proper settings on direct spark oil ignition electrodes. Make certain that gap is not too wide and that *light-off* oil pressure is as recommended in Section 3.

C. Gas pilot ignition and direct spark oil ignition. Verify that there are no cracks in the porcelain and that transformer end and electrode end plug in connections are tight.

D. Loose or broken wires. Check all wire nut connections and tighten all terminal screw connections in panel and elsewhere as appropriate.

E. With flame safeguard controls that incorporate the air flow switch in the non-recycling circuit, ensure that when main flame lights, the air flow switch is not so critically set as to allow occasional momentary opening of the air switch contacts.

F. Occasional low voltage supply. Have local utility correct. Make certain that the burner control circuit transformer (if supplied) is correct for the voltage being supplied.

G. Occasional low gas supply pressure. Have local utility correct.

H. Air leak in oil suction line or check valve not holding. Correct as required.

GAS OPERATION

1. Burner Motor Runs, but Pilot Does Not Light

A. Gas supply to burner shut off--make sure all manual gas supply valves are open. Automatic high pressure valve at meter such as *Sentry* type tripped shut due to high gas pressure--reset valve and correct cause for trip out.

B. Pilot solenoid valve not opening--listen and feel for valve actuation. Solenoid valve not being powered--check electrical circuitry. Replace coil or entire valve if coil is burned out.

C. Defective gas pilot regulator--replace.

D. Gas pressure too high or too low at pilot orifice. Check orifice size in gas pilot assembly. Replace if incorrect. Refer to gas pilot adjustments for correct settings. Readjust as required.

E. Defective ignition transformer--replace. Incorrect ignition electrode settings--refer to gas pilot adjustments for correct settings.

F. Defective flame safeguard control or plug in purge timing card. Replace as required.

G. Air flow switch not making circuit--check out electrically and correct pressure adjustment on switch if required. Defective air flow switch--replace. Air switch negative pressure sensing tube out of position--reposition as necessary.

2. Burner Motor Runs and Pilot Lights, but Main Gas Flame is Not Established

A. Main shut off or test cock closed. Check to make certain fully open.

B. Pilot flame signal reading too low to pull in flame safeguard relay. Refer to gas pilot settings section and readjust as required.

C. Defective automatic main or auxiliary gas shut off valves. Check electrical circuitry to valves. Replace valves or correct circuitry as required.

D. Main diaphragm shut off valve opening too slowly. Adjust bleed on valve.

E. Defective flame safeguard control or plug in amplifier. Check and replace as required.

F. Butterfly valve set incorrectly on modulating burner. Readjust as required.

G. Main gas pressure regulator atmospheric vent line obstructed. Correct.

H. Defective main gas pressure regulator--replace. Misadjusted main gas pressure regulator--readjust to meet required operational values.

3. Carbon Monoxide Readings on Gas Firing

A. Flame impingement on *cold* heat transfer surfaces caused by excessive firing rate. Reduce firing rate to correct input volume.

B. Flame impingement on cold combustion chamber surfaces due to undersized combustion chamber. Refer to chamber size charts, pages 14 and/or contact factory for additional information.

C. Incorrect gas/air ratios. Readjust burner to correct CO_2/O_2 levels, reducing CO formation to appropriate level. See NOTE on page 25 and page 41, Table 13 for additional information.

4. Gas High Fire Input Cannot Be Achieved

A. Gas company pressure regulator or meter operating incorrectly, not allowing required gas pressure at burner train inlet. Have gas company correct.
B. Gas cock upstream of train inlet not fully open. Check and correct.
C. Gas line obstructed. Check and correct.
D. Gas train main and/or leak test cocks not fully open. Check and correct.
E. Gas supply line between gas company regulator and burner inlet too small. Check supply pressure at meter, determine pressure drop and increase line size as required, or raise supply pressure to compensate for small line. Do not raise pressure so high that under static (no flow) conditions the pressure exceeds the maximum allowable pressure to the gas train components on the burner.
F. Burner gas train components sized too small for supply pressure. Increase component size as appropriate.
G. Automatic gas valve not opening fully due to defective operation. Replace gas valve.
H. Side tee (limiting) orifice (if supplied) too small. Replace with correct size.
I. On modulating burner, butterfly valve not fully opened. Readjust.
J. Defective main gas pressure regulator. Replace.
K. Incorrect spring in main gas pressure regulator. Replace as required.
L. Main gas pressure regulator vent line obstructed. Check and correct.
M. Normally open vent valve (if supplied) not closing when automatic gas valves open. Check to see if valve is fully closed when automatic valves are open. Replace vent valve, if not closing fully.

OIL OPERATION

1. Burner Motor Runs, but Direct Spark Ignited Oil Flame is Not Established

A. Defective or incorrect size oil nozzle. Remove and clean or replace.
B. Low oil pressure. Check with gauge for correct *light-off* pressure.
C. Defective oil pump. Replace.
D. Defective oil solenoid valve. Replace.
E. Oil pump coupling loose or defective. Replace or tighten as required.
F. Low oil pressure switch (if supplied) defective or incorrectly set. Adjust or replace switch.
G. Ignition transformer defective. Replace.
H. Ignition electrode set incorrectly. Remove electrodes and reset.
I. Ignition electrodes cracked and grounding out spark. Replace electrodes.
J. Ignition leadwire defective and grounding spark out. Replace.
K. Ignition plug in connections at transformer or electrodes loose. Tighten.
L.. Air flow switch (if provided) not making. Reset pressure or replace.
M. Defective flame safeguard control or plug in purge timer card. Replace.
N. Air dampers held in high fire position due to mechanical binding of linkage. Readjust linkage.
O. Loose wiring connections. Check and tighten all connections.

2. Oil Flame Ignites, but then Flame Safeguard Control Locks Out on Safety

A. Flame scanner lens dirty. Remove and clean.
B. Scanner sight tube blocked or dirty. Check and clean.
C. Flame scanner defective. Replace.
D. Defective oil nozzle causing unstable flame and scanning problems. Replace oil nozzle.
E. Fuel/air ratios incorrect, resulting in unstable or smoky flame causing scanner flame sighting problem. Readjust ratios for clean stable flame.
F. Defective flame safeguard amplifier or control. Replace as appropriate.

3. Oil Flame Extremely Smoky at Light Off or in Low Fire Position

A. Defective or incorrect size oil nozzle. Replace.
B. Fuel/air ratio incorrect. Readjust.
C. N.C. oil solenoid valve in oil nozzle return line not opening. Check electrical circuitry and replace valve if defective.
D. On two-step pump - N.O. pump mounted solenoid valve malfunctioning. Replace valve or pump.

4. Light Off Oil Flame Is Established and Proven, but Burner Will Not Attempt to Go to the High Fire Position

A. Low/High/Low or Modulating burner high fire temperature or pressure control could be defective or not set to call for high fire. Readjust or replace control.
B. Loose wires or incorrectly wired. Verify wiring and tighten all connections.
C. Flame safeguard control or high fire panel switching relay (if supplied) defective. Verify and correct as required.
D. High fire 3 way solenoid valve defective. Replace.
E. Hydraulic oil cylinder defective. Replace.
F. On two-step pump - N.O. solenoid valve defective (not closing). Replace pump or valve.
G. Linkage mechanically binding. Readjust linkage.
H. On modulating system - defective modulating motor. Replace.

5. Low Oil Flame Is Established and Proven, but Flame Out Occurs in Transition from Low Fire to High Fire

A. On Low/High/Off or Low/High/Low system - N.C. oil solenoid valve in nozzle return line not closing (or leaking). Check valve operation and replace if necessary.
B. On two-step oil pump - N.O. solenoid valve defective (not closing). Replace valve or pump.
C. Defective or incorrect size oil nozzle. Replace.
D. High fire oil pressure too low. Readjust.
E. Air dampers set too far open at low fire, which causes flame to blow out in starting to high fire. Readjust dampers.
F. Oil pump coupling loose or defective. Tighten or replace.
G. Defective oil pump. Replace.
H. Linkage mechanically binding. Readjust.
I. Make certain the #72 orifice into the N.C. side of the 3 way valve has not been removed.
J. On modulating systems - fuel/air ratios set incorrectly, causing flame to blow out when going to high fire. Readjust linkage.

6. White Smoke Formation on Oil Firing

A. Oil/Air ratios incorrect due to excess air, or oil flow is too low. Readjust for proper fuel input, CO_2 and smoke reading.

7. Gray or Black Smoke Formation on Oil Firing

A. Impingement on cold combustion chamber surfaces due to undersized chamber, or incorrect oil nozzle spray angle for application. This could also result in carbon formation on chamber surfaces. Refer to chamber sizing, page 14, Figure 16 and page 14, Table 7 for additional information. If chamber is the correct size, change nozzle spray angle in order to shorten or narrow the flame as required.

B. Defective or dirty oil nozzle. Replace or clean nozzle.

C. Incorrect oil/air ratios. Readjust burner to correct CO_2 and smoke levels.

D. Oil pressure too low resulting in poor atomization. Readjust.

E. Impingement of raw oil spray on the blast tube choke ring or oil nozzle air diffuser. Make certain that the diffuser is seated firmly against the oil nozzle adapter shoulder, except on C5-OB, C5-GO-30B and larger burners or other special applications indicated on burner data shipped with the unit. See page 35, Figures 30, 31 and 32 for additional information. Position the oil gun assembly fore or aft in the blast tube to assist in elimination of oil spray on the blast tube choke ring.

8. Oil High Fire Input Rate Cannot Be Achieved

A. Oil nozzle size too small. Remove nozzle and check markings. Replace with correct size nozzle.

B. Nozzle defective—replace. Nozzle mesh filter dirty—clean or replace.

C. Oil supply pressure to nozzle too low. Readjust.

D. Oil pump defective. Replace.

E. On Low/High/Off and Low/High/Low systems - N.C. oil solenoid valve in nozzle return line not closing (or leaking). Check valve operation and replace if necessary.

F. On two-step pump - N.O. pump mounted oil solenoid valve defective (not closing). Replace valve or pump.

G. Oil pump coupling loose (slipping) or defective. Replace.

H. Linkage mechanically binding. Readjust.

I. On modulating burner, oil nozzle return line metering valve set incorrectly. Readjust to attain required nozzle bypass pressure.

J. Oil suction line too small or partially blocked. Make vacuum test while at high fire. If the vacuum is in excess of 10" HG, consult line sizing chart on page 12. Make line size changes, if required.

K. Blocked or dirty suction line oil filter. Replace or clean.

L. Manual valves in suction line not fully open. Check and correct.

M. Suction line check valve or foot valve operating incorrectly. Check and correct.

N. Vent system on oil tank blocked creating vacuum on tank, with high vacuum and lowered oil flow to burner. Check and correct.

Additional trouble shooting information can be found in the Flame Safeguard Control bulletin supplied with the burner.

8. MAINTENANCE

General Information

Only qualified service technicians should make mechanical or electrical adjustments to the burner and/or associated control equipment.

Preventative maintenance can usually be performed by building maintenance personnel.

Always follow the information provided in the *Owner Operating Instructions* on page 51. These should be conspicuously posted in the burner room at the time of the initial burner installation and start up.

Always turn the power supply off to the burner and close manual fuel valves as appropriate for routine maintenance.

Make sure that combustion and ventilation fresh air sources to the burner room remain clean and open.

Periodically check all electrical connections and make sure the flame safeguard control chassis is firmly connected to its wiring base.

Refer to manufacturer's product bulletins supplied with the burner for maintenance on the flame safeguard control and other components.

PERIODIC CHECK LIST

Item	Frequency	Checked By	Remarks
Gages, monitors, and indicators	Daily	Operator	Make visual inspection and record readings in log
Instrument and equipment settings	Daily	Operator	Make visual check against heat exchanger manufacturer's recommended specifications
Firing rate control	Weekly Semiannually Annually	Operator Service Technician ServiceTechnician	Verify heat exchanger manufacturer's settings Verify heat exchanger manufacturer's settings Check with combustion test
Flue, vent, stack, or outlet damper	Monthly	Operator	Make visual inspection of linkage, check for proper operation
Combustion air	Monthly	Operator	All sources remain clean and open
Ignition System	Weekly	Operator	Make visual inspection, check flame signal strength if meter-fitted (see *Combustion safety controls*)
Fuel Valves			
Pilot and main	Weekly	Operator	Open limit switch-make aural and visual check-check valve position indicators and check fuel meters if so fitted
Pilot and main gas or main oil	Annually	Service Technician	Perform leakage tests-refer to valve manufacturer's instructions
Combustion safety controls			
Flame failure	Weekly	Operator	Close manual fuel supply for (1) pilot, (2) main fuel cock, and/or valves(s): check safety shutdown timing; log
Flame signal strength	Weekly	Operator	If flame signal meter installed, read and log; for both pilot and main flames, notify service organization if readings are very high, very low, or fluctuating; refer to flame safeguard manufacturer's instructions
Pilot turndown tests	As required/annually	Service Technician	Required after any adjustments to flame scanner mount or pilot burner; verify annually-refer to flame safeguard manufacturer's instructions
Refractory hold in	As required/annually	Service Technician	See *Pilot turndown tests*
High limit safety control	Annually	Service Technician	Refer to heat exchanger manufacturer's instructions
Operating control	Annually	Service Technician	Refer to heat exchanger manufacturer's instructions
Low draft, fan, air pressure, and damper	Monthly	Operator	Refer to this manual and control manufacturer's instructions
High and low gas pressure interlocks	Monthly	Operator	Refer to instructions in this manual
Low oil pressure interlocks	Monthly	Operator	Refer to instructions in this manual
Fuel valve interlock switch	Annually	Service Technician	Refer to valve manufacturer's instructions
Purge switch	Annually	Service Technician	Refer to fuel/air control motor manufacturer's instructions
Low fire start interlock	Annually	Service Technician	Refer to fuel/air control motor manufacturer's instructions
Automatic changeover control (dual fuel)	At least annually	Service Technician	Under supervision of gas utility
Inspect burner components		Service Technician	Refer to this manual and control component manufacturer's instructions
Remove oil drawer assembly	Annually	Service Technician	Remove and clean
Check blower motor and blower wheel for cleanliness. Remove and clean as necessary	Annually	Service Technician	Remove and clean
Remove, inspect and clean gas pilot assembly	Annually	Service Technician	Remove and clean

Refer to heat exchanger manufacturer's instructions for general inspection procedures and for specific testing and inspection of all liquid level controls, pressure/temperature relief and other applicable items.

If you have any questions about the procedures listed above-or questions relating to components or devices on your unit not specifically covered in the above-contact our Service Department at **(620)421-0480** for assistance.

9. START UP INFORMATION & TEST DATA

The following information shall be recorded for each burner start up:

Power Flame Model No. _____ Invoice No. _____ Serial No. _____

Installation Name _____ Start Up Date _____

Start Up Contractors Name _____ Phone _____

Name of Technician Performing Start Up _____

Type of Gas Natural ☐LP ☐Other _____ Fuel Oil Grade No. _____

Gas Firing

Gas Pressure at Train Inlet
Burner in Off Position_____ "W.C.

Gas Pressure at Train Inlet
Low Fire _____
High Fire _____

Gas Pressure at Firing Head
Low Fire _____
High Fire _____

Gas Pressure at Pilot Test Tee
_____

Power Supply
Volts_____ Ph_____ Hz_____
Control Circuit Volts_____
Blower Motor amps at high fire_____
_____

Flame Signal Readings
Pilot _____
Low Fire _____
High Fire _____

CO_2 or O_2 (Specify)
Low Fire _____
High Fire _____

CO
Low Fire _____
High Fire _____

Input Rate BTU/HR
Low Fire _____
High Fire _____

Over Fire Draft
Low Fire _____
High Fire _____

Stack Outlet Test Point Draft
Low Fire _____
High Fire _____

Net Stack Temperature
Low Fire _____
High Fire _____

Combustion Efficiency
Low Fire _____ %
High Fire _____ %

NOx Measured
Low Fire _____
High Fire _____

Oil Firing

High Fire Vacuum Reading at Oil Pump Inlet_____ "H.G.

Gas Pressure at Pilot Train Inlet
(If applicable) _____

Gas Pressure at Pilot Test Tee
(If applicable) _____

Oil Nozzle Supply Pressure
Low Fire _____
High Fire _____

Oil Nozzle Bypass Pressure
Low Fire _____
High Fire _____

Power Supply
Volts_____ Ph_____ Hz_____
Control Circuit Volts_____
Blower Motor amps at high fire
_____
Remote Oil Pump Motor amps at high fire _____

Flame Signal Reading
Pilot (If applicable) _____
Low Fire _____
High Fire _____

GPH Firing Rate
Low Fire _____
High Fire _____

CO_2 or O_2 (Specify)
Low Fire _____
High Fire _____

Bachrach Scale Smoke Number
Low Fire _____
High Fire _____

Over Fire Draft
Low Fire _____
High Fire _____

Stack Outlet Test Point Draft
Low Fire _____
High Fire _____

Net Stack Temperature
Low Fire _____
High Fire _____

Combustion Efficiency
Low Fire _____ %
High Fire _____ %

NOx Measured
Low Fire _____
High Fire _____

Control Settings

General	Gas	Oil
Operating control cut out setting _____	Low gas pressure switch _____ in.	Low oil pressure switch _____ lbs.
Operating control cut in setting _____	High gas pressure switch _____ in.	High oil pressure switch _____ lbs.
Limit control cut out setting _____		
Limit control cut in setting _____		

Operation Checklist

Checked For Proper Operation of:	Yes	No		Yes	No
Low water cut off	( )	( )	Barometric damper	( )	( )
High water cut off	( )	( )	Boiler room combustion air and ventilation provisions correct	( )	( )
Flame safeguard control ignition failure	( )	( )			
Flame safeguard control main flame failure	( )	( )	Oil tank vent system checked	( )	( )
Burner air flow switch	( )	( )	All oil lines checked for leaks	( )	( )
Induced draft fan controls	( )	( )	All gas lines checked for leaks	( )	( )
Over fire draft controls	( )	( )	Gas lines and controls properly vented	( )	( )
Fresh air damper end switch	( )	( )	Other system components (specify)	( )	( )

Notified _____ of following system deficiencies: _____

NOTES

2001 South 21st St., Parsons, KS 67357, 620-421-0480, 620-421-0948 FAX

POWER FLAME INCORPORATED

10. OWNER OPERATING INSTRUCTIONS

FOR YOUR SAFETY

If you smell gas:
1. Open windows.
2. Do not touch electrical switches.
3. Extinquish any open flame.
4. Call your gas supplier immediately.

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

WARNING

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

IMPORTANT PRECAUTIONS

1. Never attempt to light burner with paper or other materials.
2. Never experiment with the burner.
3. Never change the fuel or air adjustments without consulting with the burner service company.
4. Never attempt to light the burner if combustion chamber contains any unburned fuel or gases.
5. Never throw waste paper, rags, garbage, or other waste materials into the combustion chamber.
6. Never wash out heating equipment room without first covering the burner with waterproof material.

START UP

Preparation for Start Up - All Fuels

1. Ensure that the system is in working order. If heat exchanger is a boiler, ensure that proper water level is available.

   Oil burner - make sure that the oil tank has an adequate fuel level and that the fuel is the proper grade.
2. Set the burner control panel switch to the *OFF* position.

   Combination Gas/Oil burner - Set the fuel selector switch to the fuel to be burned.
3. Turn the thermostat or operating control down to its lowest setting.
4. Check fuses and replace as necessary.
5. Depress the flame safeguard programming control reset button.

Start Up - Gas Burner

1. Manually open and close the main gas shut off cock, leak test cock and pilot cock to determine that they operate freely. Open all three cocks. (Reset low gas pressure switch if supplied.)
2. Set the main power switch and burner panel control switch to the *ON* position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.
3. The burner blower motor will start and after a suitable prepurge period (this will vary with the type of flame safeguard control supplied - but will usually be a minimum of 30 seconds to a maximum of 90 seconds) the burner pilot will light, after which the main flame will be established.
4. If the system does not respond properly, contact your qualified burner service company.
5. When burning gas on a Combination Gas/Oil unit that has a blower motor driven oil pump, open all oil line valves. Oil must circulate through the oil pump, even when burning gas.

Start Up - Oil Burner

1. Open all valves in oil lines.
2. If pilot gas ignation system is supplied - open and close the pilot gas cock to determine that it is operating freely. Open the pilot gas cock.
3. Set the main power switch and burner panel control switch to the *ON* position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.
4. The burner blower motor will start. Depending upon the type of flame safeguard control supplied, the fuel ignition system may energize within 1 or 2 seconds after the blower motor starts or could be as long as 90 seconds.
5. If the system does not respond properly, contact your qualified burner service company.

EXTENDED SHUT DOWN

1. Place main power switch and burner control panel switch to the *OFF* position.
2. Close all valves in gas and oil lines.
3. Cover burner to protect it from dust and dampness.

MAINTENANCE

1. See *Maintenance* section in burner manual for suggestions on periodic maintenance and service.

Burner Service Company _____ Date of Installation _____

Address _____ Telephone _____

Remove this page and post near burner

POWER FLAME INCORPORATED
LIMITED WARRANTY TYPE C BURNERS

Power Flame Incorporated, hereinafter called the Seller, of 2001 South 21st Street, Parsons, Kansas, hereby warrants its equipment manufactured by it and bearing its nameplate (hereinafter called Warranted Equipment) in the respects and exclusively for the benefit of those users described herein. THIS LIMITED WARRANTY SHALL EXTEND SOLELY TO THOSE PERSONS WHO ARE OWNERS OF THE WARRANTED EQUIPMENT DURING THE WARRANTY PERIOD HEREINAFTER DEFINED AND WHO USE SUCH WARRANTED EQUIPMENT IN THE PROJECT AND FOR THE PURPOSES FOR WHICH SUCH WARRANTED EQUIPMENT WAS ACQUIRED FROM THE SELLER. The Seller warrants its equipment to be free from defects in the material and workmanship under normal use and service for fifteen (15) months from date of shipment. Burner blast tube (Firing Head) is warranted for a full five (5) years. EXCLUDED FROM ANY COVERAGE UNDER THIS WARRANTY ARE DEFECTS IN WARRANTED EQUIPMENT FROM DAMAGE IN SHIPMENT, FAULTY INSTALLATION, MISUSE OR NEGLIGENCE. If any person becomes entitled to a claim under this warranty, such person shall, as a condition precedent to securing warranty performance, return the Warranted Equipment to the Seller's plant, 2001 South 21st Street, Parsons, Kansas, transportation prepaid. If the Warranted Equipment thus returned is found by the Seller to be defective for a cause and within a time covered by this Warranty, such equipment shall be repaired or replaced without charge; and returned to its owner or job site at the Seller's cost for transportation and handling. If inspection of the Warranted Equipment discloses defects not covered by this Warranty, the Seller shall notify the owner. Said equipment, at the owner's option (to be determined thirty (30) days from the date of notification), may be repaired or replaced at the expense of the owner and Seller's regular charges shall apply. Owner shall assume the cost for transportation and handling. Equipment which is repaired or replaced shall carry a warranty equal to the unexpired portion of the original warranty. The Seller will commence inspection of any Warranted Equipment returned to it for warranty claim within seven (7) working days after the arrival of such Warranty Equipment at Seller's plant, and shall complete any repairs required under this warranty within sixty (60) days after such arrival, unless Seller shall sooner notify said owner of reasonable cause for delay beyond control of Seller. Warranty obligations hereunder will be performed only between the hours of 9:00 a.m. and 4:00 p.m. Monday through Friday and excluding holidays. Any person believing himself entitled to warranty performance hereunder is required to notify the Warranty Claims Department of Power Flame Incorporated, 2001 South 21st Street, Parsons, Kansas, prior to return of any Warranted Equipment for repair hereunder.

IN ALL EVENTS, SELLER WILL NOT BE LIABLE FOR AND WILL NOT REIMBURSE ANY LABOR, MATERIAL, OR OTHER REPAIR CHARGES INCURRED BY ANYONE OTHER THAN SELLER ON ANY WARRANTY EQUIPMENT, UNLESS SUCH CHARGES HAVE BEEN SPECIFICALLY AUTHORIZED IN ADVANCE IN WRITING BY SELLER. ANY WARRANTY IMPLIED BY LAW WITH RESPECT TO THE MERCHANTABILITY OR FITNESS OF THE WARRANTED EQUIPMENT IS HEREBY LIMITED TO THE DURATION OF THE WARRANTY PERIOD HEREUNDER.

THE SELLER WILL NOT IN ANY EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ATTRIBUTABLE TO THE WARRANTED EQUIPMENT.

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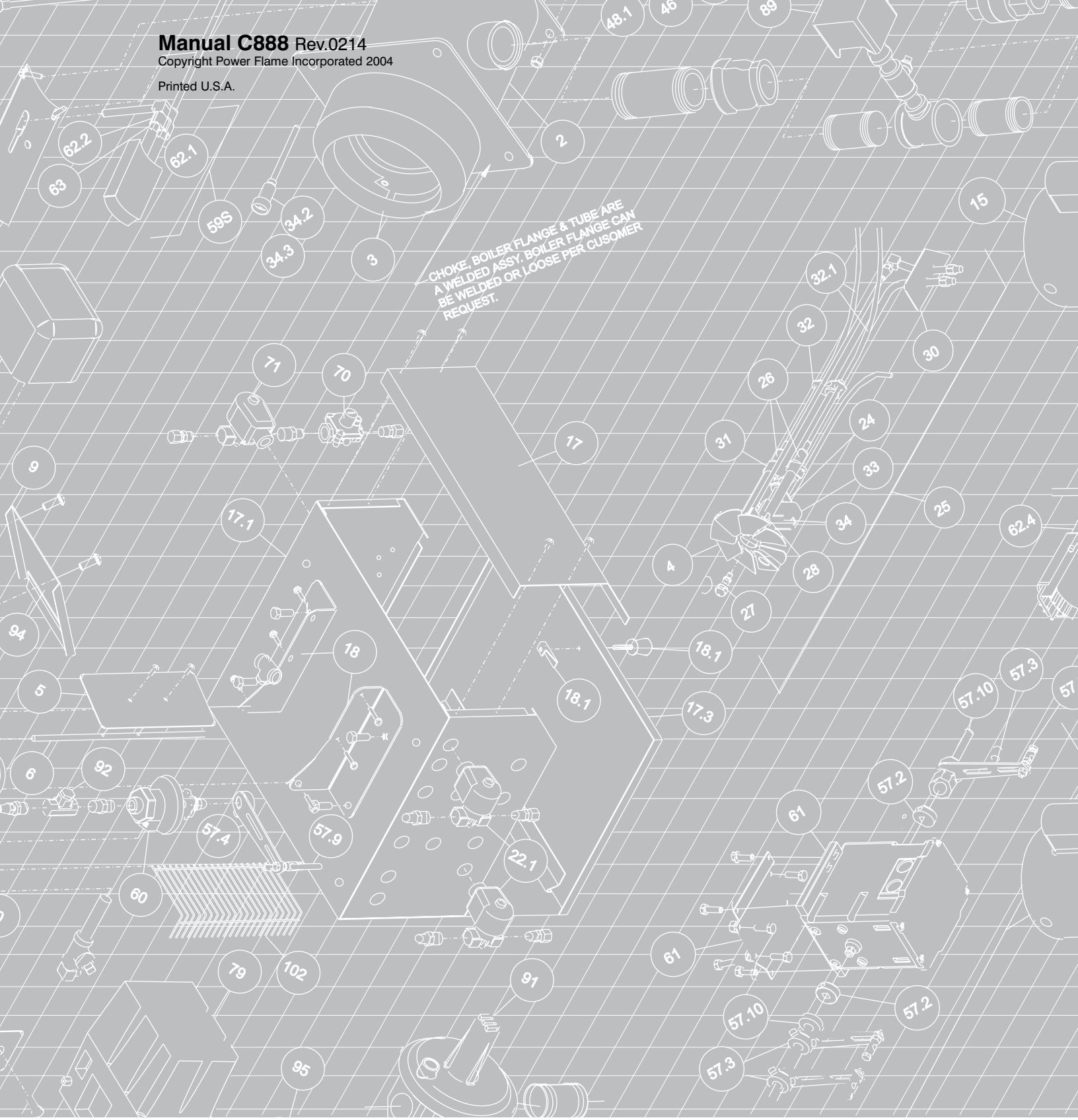

Power Flame®

The Power to Manage Energy

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