



***Profire NTXL***  
***Burner***  
***Light Oil, Gas, or Combination***

**Installation  
Operation  
Maintenance**



Manual Part No. 750-291

05/2009

Placed on all Profire burners are warning or caution labels designed to inform the operator of potential hazards and stress important information. These labels are shown below.

 <b>WARNING</b>
<b>FAILURE TO INSTALL AND OPERATE THIS EQUIPMENT IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDED INSTRUCTIONS AND INDUSTRY STANDARDS AND PRACTICES CAN RESULT IN FIRE, EXPLOSION, PROPERTY DAMAGE AND/OR PERSONAL INJURY !! READ THIS MANUAL IN ITS ENTIRETY PRIOR TO ANY ATTEMPT TO COMMISSION THIS EQUIPMENT. INSTALLATION, STARTUP, OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST BE PERFORMED ONLY BY FACTORY AUTHORIZED, EXPERIENCED AND QUALIFIED PERSONEL.</b>

 <b>WARNING</b>
<b>HAZARD OF ELECTRIC SHOCK !!! MORE THAN ONE DISCONNECT MAY BE REQUIRED TO DISCONNECT ALL POWER TO THIS PANEL. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.</b>

 <b>WARNING</b>
<b>READ PRODUCT MANUAL AND FULLY UNDERSTAND ITS CONTENTS BEFORE ATTEMPTING TO OPERATE THIS EQUIPMENT. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.</b>

 <b>WARNING</b>
<b>TO AVOID PERSONAL INJURY FROM MOVING PARTS, SHUT OFF ALL ELECTRICAL POWER BEFORE SERVICING THIS EQUIPMENT.</b>

<b>CAUTION</b>
<b>PROVIDE SUPPORT FOR THIS PANEL TO PREVENT DAMAGE TO THE ELECTRICAL COMPONENTS.</b>

<b>CAUTION</b>
<b>ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD START UP, ADJUST, OR SERVICE THIS EQUIPMENT.</b>

<b>CAUTION</b>
<b>AFTER FINAL FUEL INPUT ADJUSTMENTS ARE MADE, VERIFY FUEL INPUT BY METER IF POSSIBLE.</b>

# ***CLEAVER-BROOKS***

## **Profire NTXL Burner**

### ***Light Oil, Gas, or Combination***

## **Installation, Operation, and Maintenance Manual**



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Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative

**NOTE: If you have a CB HAWK ICS Boiler Control System, refer to Cleaver-Brooks manual 750-229.**

** WARNING**

**DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.**

**DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.**

**FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.**

**TO: Owners, Operators and/or Maintenance Personnel**

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

THE INSTALLATION OF A BURNER SHALL BE IN ACCORDANCE WITH THE REGULATIONS OF AUTHORITIES HAVING JURISDICTION. THE EQUIPMENT MUST BE INSTALLED IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR PROVINCIAL INSTALLATION REQUIREMENTS INCLUDING THE NATIONAL ELECTRIC CODE (NEC) AND ASSOCIATED INSURANCE UNDERWRITERS. WHERE APPLICABLE, THE CANADIAN GAS ASSOCIATION (CGA) B149 AND CANADIAN STANDARDS ASSOCIATION (CSA) B140 AND B139 (FOR OIL BURNERS) CODES SHALL PREVAIL.

OIL AND GAS BURNING EQUIPMENT SHALL BE CONNECTED TO FLUES HAVING SUFFICIENT DRAFT AT ALL TIMES TO ASSURE SAFE AND PROPER OPERATION OF THE BURNER.

DO NOT USE GASOLINE, CRANKCASE OIL, OR ANY OIL CONTAINING GASOLINE

In the event of any conflict or inconsistency between local requirements and the warnings or instructions contained in this manual, please contact Cleaver-Brooks before proceeding.

## MODEL DESIGNATION, SIZES AND INPUT

Model designations are based on the type of fuel(s) to be fired. Burner size is based on firing rate (maximum input in Btu/hr).

MODEL .....	FUEL
NTXLNG .....	Gas
NTXLL .....	#2 Oil
NTXLLG .....	#2 Oil and Gas

BURNER SIZE .....	Maximum Gas Input Btu/hr
336 .....	33,600,000
378 .....	37,800,000
462 .....	42,600,000
504 .....	50,400,000
546 .....	54,600,000
588 .....	58,800,000
630 .....	63,000,000

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

BURNER SIZE .....	Maximum Oil Input U.S.G.P.H.
336 .....	251
378 .....	282
462 .....	330
504 .....	360
546 .....	390
588 .....	420
630 .....	450

Oil input based on No.2 oil at 140,000 Btu/gal

The installation of a burner shall be in accordance with the regulations of authorities having jurisdiction. The equipment must be installed in accordance with applicable local, state or provincial installation requirements, including the National Electric Code (NEC), and insurance underwriters. Where applicable, the Canadian Gas Association (CGA) and Canadian Standard Association (CSA) shall prevail.

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

The burners are designed to burn either gas or No. 2-6 oils as defined by ASTM D396-1978 specifications. Do not use gasoline, crankcase oil, or any oil containing gasoline.

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## A. General



Figure 1-1 ProFire NTXL

CB ProFire burners are assembled, wired and tested at the factory, and are constructed according to the Underwriters Laboratory code. All burners in the Profire series comply, when equipped with optional equipment, to CSD-1, XL GAP (formerly GE GAP/IRI), Factory Mutual (FM), NFPA-85, Including the National Electrical Code (NEC), or other insuring underwriters requirements. Where applicable, the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail. Other regulatory agency control options are available. Installation should also conform to state and local codes governing such equipment. Prior to installation, the proper authorities having jurisdiction are to be consulted, permits obtained, etc.

NTXL gas burners are of the axial flow type, based on low to moderate swirling air jet aerodynamics. The burner uses intensive mixing with counterflow fuel injection to minimize NOX formation. All burners feature ignition by spark-ignited gas pilot flame. With either gas or oil, the burner operates with full modulation. A switch permits changeover from automatic fully modulated firing to manually set firing at any desired rate between minimum and maximum. Additional safeguards assure that the burner always returns to minimum firing position for ignition. The ProFire XL oil burners are of the low pressure, air atomizing (nozzle) type.

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

The operator must be familiar with the individual functioning of all controls to understand the operations and procedures described in the manual. Identify and locate each item in the illustrations as they are described in the following sections.

## B. NT Firing Head Design

The NT burner head's unique core and radially variable pitch swirl blades provide absolute flame stability at all loads.

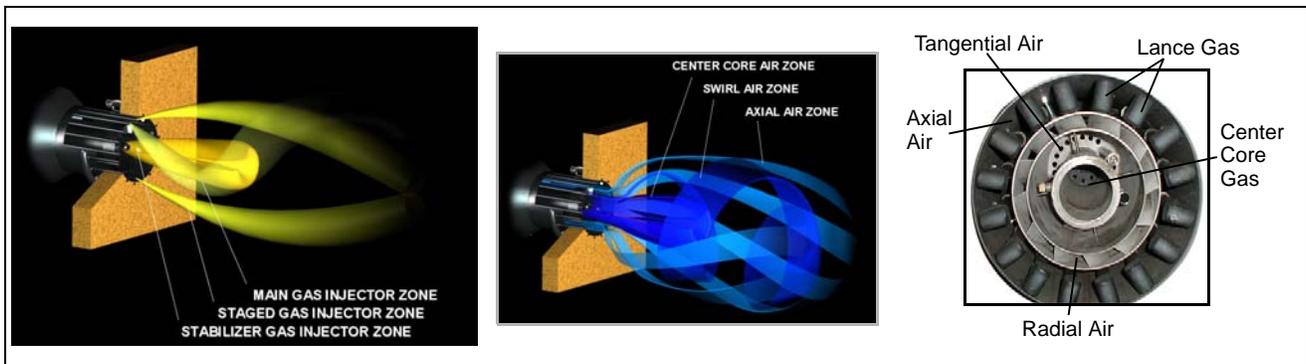


Figure 1-2 NT Firing Head Fuel and Air Flows

The burner head is mounted inside the blast tube. The gas is directed to the various gas paths via connecting piping.

The high fuel-to-air mixing efficiency is obtained from the axial, radial and tangential turbulent air flow field generated at the burner outlet (see **Figure 1-2**). This is combined with high velocity fuel jets, resulting in an optimized and well defined mixing pattern for maximum local mixture uniformity.

Low NO<sub>x</sub> burners (<9 ppm) are more sensitive to atmospheric influences than standard burners, and have a tighter operating range. To meet the resulting requirements for precise and repeatable combustion control, NT burners use a parallel positioning system to regulate fuel, air, and FGR flow throughout the firing range of the burner.

The burner head is straight and cylindrical with no divergent refractory throat. Access to the firing head is provided by swinging open the access cover on the rear of the burner housing. An internal gas pilot is standard on all burners. Pilot gas pressure is adjusted at the pilot pressure regulator. The internal components are removable for cleaning and adjustments.

The head **MUST** extend past the refractory wall by 9 to 12" to ensure proper flame recirculation.

Setting up a burner with an NT firing head is similar to standard burner setup procedures - precise adjustments and accurate monitoring equipment are essential to achieving the burner's operational efficiency potential and low emission capabilities.

## C. Operating Controls

The burner is supplied with a remote control panel and with a burner mounted junction box. In some cases a burner mounted control panel may be supplied.

### Control Panel

The control panel (**Figure 1-3**) contains a flame safeguard programming control, motor starters, relays, time delays and terminal strips mounted internally on a panel sub-base. Lights, switches, potentiometers, a control circuit breaker and flame safeguard displays are mounted externally on the panel as indicated below.

#### 1. ON-OFF BURNER SWITCH - (for gas or oil only)

#### 2. FUEL SELECTOR SWITCH - Gas-Off-Oil

(for combination gas-oil burners only)

Gas position: Selects gas as the firing fuel.

Off position: Burner off.

Oil position: Selects oil as the firing fuel.

**Note:** when changing from oil to gas fuel, allow programmer to complete post purge and shutdown before moving selector switch to gas position. this will allow the interlock circuit to de-energize



**Figure 1-3 Control Panel (CB-Hawk ICS)**



**Figure 1-4 Flame Safeguard**

### **3. CONTROL CIRCUIT BREAKER.**

Supplementary low over current protection only. No larger than 15 amps.

### **4. AUTO-MANUAL MODULATION SELECTOR SWITCH.**

Auto Position: Selects boiler modulation control.

Manual Position: Selects 135 ohm potentiometer for manual modulating control

### **5. MANUAL MODULATING CONTROL (135 ohm)**

Increases or decreases the burner firing rate manually.

### **6. SIGNAL LAMPS.**

- A. POWER ON (white) illuminates when the control circuit is energized (powered).
- B. IGNITION (amber) illuminates when the ignition transformer is powered, and gas pilot valve is energized (opened).
- C. MAIN FUEL (green) illuminates when the main fuel valve or valves (gas or oil) are energized (open).
- D. FLAME FAILURE (red) illuminates when the flame safeguard system fails to detect pilot or main flame.

Other controls included are motor starters to energize the motors and an ignition transformer to provide a high voltage spark for pilot ignition.

### **D. Flame Safeguard Control**

Automatically programs each starting, operating and shutdown cycle in conjunction with operating, limit, and interlock devices. This includes in timed sequence, operation of the blower motor, ignition system, fuel valves and modulating motor. The sequence includes air purge prior to ignition and after burner shutdown. The flame scanner monitors the pilot, both oil and gas flames, and instantly responds to loss of flame.

The control recycles automatically during normal operation, or following a power interruption. It must be manually reset following a safety shutdown. An internal checking circuit, effective on every start, will prevent burner operation in the event the flame relay is held in.

### **E. Combustion Air Handling System**

The axial, radial, and tangential turbulent air flow field generated at the burner outlet is combined with high velocity fuel jets, resulting in an optimized and well defined mixing pattern for maximum local mixture uniformity.

The combustion air handling system consists of several major components:

### 1. Damper Assembly (Figure 1-5).

A multi blade damper regulates the combustion air volume and is positioned by an actuator receiving a signal from the boiler control system. The damper is normally ALMOST CLOSED in the low fire position and opens as the burner drives toward a high fire position. An optional second damper can be installed downstream of the combustion air fan.

### 2. Motor Driven Impeller (Figure 1-6).

The heart of the burner is a backward curved aluminum impeller. The diameter of the impeller determines available air pressure and the width determines air capacity in cubic feet per minute. Alternate motor-impeller combinations are available for 50 cycle or 60 cycle power and for firing against either moderate or high furnace pressure. For higher altitudes and higher furnace pressures, motor and impeller combinations are determined at the factory. The impeller is directly driven by a 3450 rpm motor (variable speed drive recommended).

### 3. Combustion Air Proving Switch

A pressure sensitive switch actuated by air pressure created by the impeller. Contacts close to prove combustion air flow.

## F. Firing Rate Controls

Regardless of the fuel used, burner input is fully modulated between low fire and high fire on boiler demand. Firing rate is controlled by individual actuators for gas (2) or oil, combustion air, FGR, and blower motor VSD. Actuator positioning is configured during the burner commissioning process. Please refer to additional controls documentation where appropriate. If your boiler is equipped with a CB-Hawk ICS control system, refer to CB manuals 750-229 (Hawk ICS) and 750-217 (Parallel Positioning).

## G. Gas System

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

### Main Gas Components

Depending upon the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items. A typical gas train is shown in **Figure 1-7**

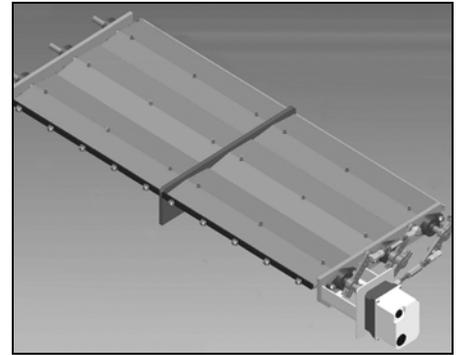


Figure 1-5 Air Damper w/Actuator

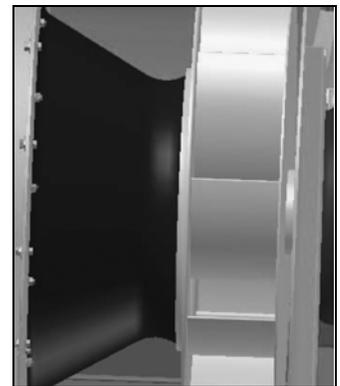


Figure 1-6 Impeller

### **Gas Control Valves**

Two butterfly type valves are positioned by electric actuators and control the rate of flow of gas.

### **Main Gas Valves**

Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard burners include two motorized gas valves w/ closure interlock.

### **Main Gas Regulator**

Regulates gas train pressure to specified pressure required at inlet to gas train. Input is set by main gas pressure regulator adjustment.

### **Main Gas Cocks**

For manual shutoff of the gas supply upstream of the pressure regulator. A second shutoff cock downstream of the main gas valve(s) provides a means of testing for leakage through the gas valve(s).

### **High Gas Pressure Switch**

A pressure actuated switch that remains closed when gas pressure is below a preselected setting. Should the pressure rise above the setting, the switch contacts will open causing main gas valve(s) to close. This switch requires manual reset after being tripped.

### **Low Gas Pressure Switch**

A pressure actuated switch that remains closed when gas pressure is above a preselected setting. Should the pressure drop below this setting, the switch contacts will open, causing main gas valve(s) to close. This switch requires manual reset after being tripped.

## **PILOT GAS TRAIN**

### **Gas Pilot Valve**

A solenoid valve that opens during the ignition period to admit fuel to the pilot. It closes after main flame is established.

### **Gas Pressure Regulator**

Reduces gas pressure to that required by the pilot.

### **Gas Pilot Shut-off Cock**

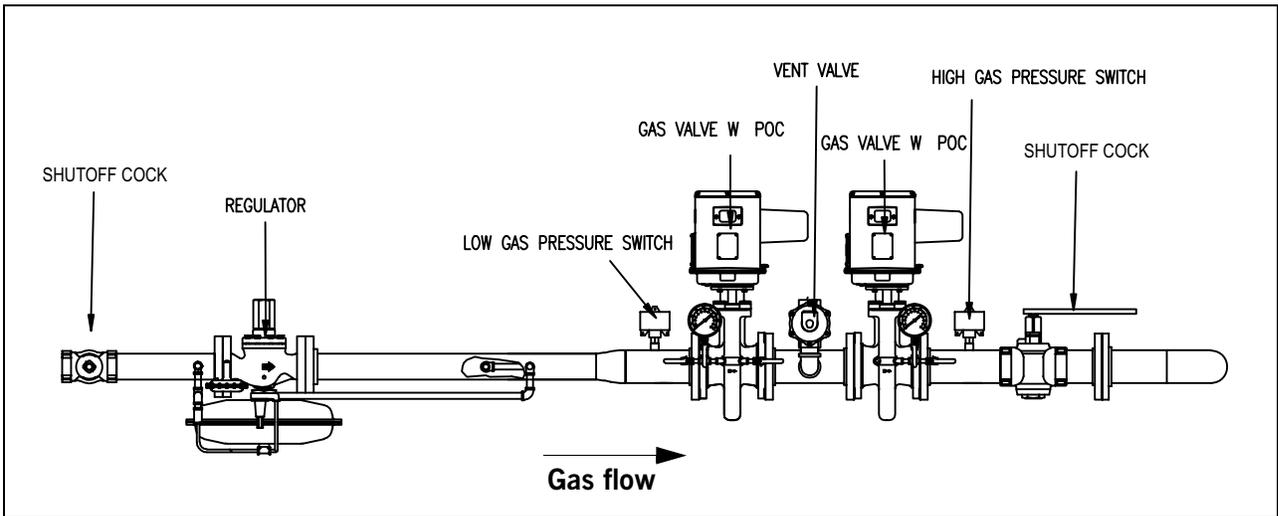
For manually closing the pilot gas supply.

### **OPERATION**

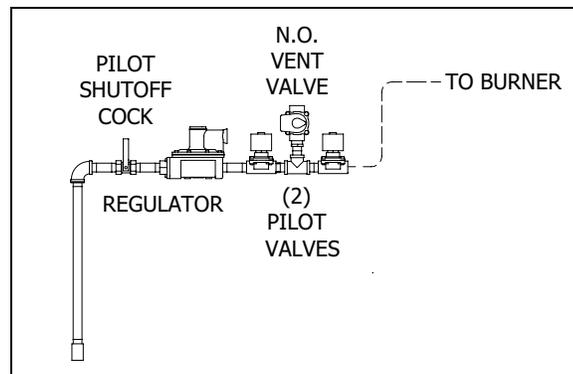
Metered gas flows through the main gas shutoff cock, through the pressure regulator to the automatic gas valves and butterfly valves to the gas manifold.

The butterfly gas valves modulate flow to burner input demand. The butterfly valves are positioned through electric actuators by a signal from the boiler control system. The air control damper is positioned simultaneously by an independent actuator. The automatic gas valve(s) cannot be energized unless the combustion air proving

switch is closed. The low and high gas pressure switches must be closed to prove proper gas pressure.



**Figure 1-7 Main Gas Train**



**Figure 1-8 Pilot Gas Train**

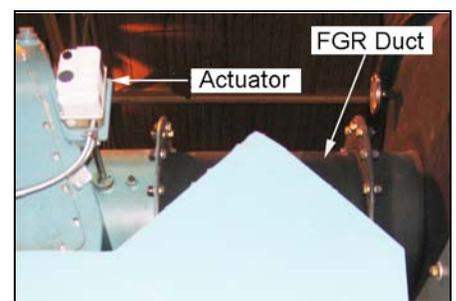
A normally open vent valve, if required, is located between the two automatic gas valves. This valve is shut when the automatic gas valves are open. When the automatic valves are closed, the vent valve is open for venting gas to the outside, should any be present.

### H. NT Series Low NO<sub>x</sub> System

The NTXL burner is designed to guarantee low emissions of < 9 ppm NO<sub>x</sub> and < 50 ppm CO, corrected @ 3% O<sub>2</sub>, when firing natural gas, throughout the firing range.

The burner features an induced Flue Gas Recirculation system (FGR). The flue gases of the boiler are re-circulated through the burner using the combustion air impeller to draw the exhaust gases and mix them with incoming fresh air. An electrically actuated damper controls the flow of FGR to fine tune the FGR/fresh air ratio.

Ducting from the stack or boiler to the burner is by others.



**Figure 1-9 Induced F.G.R. System**

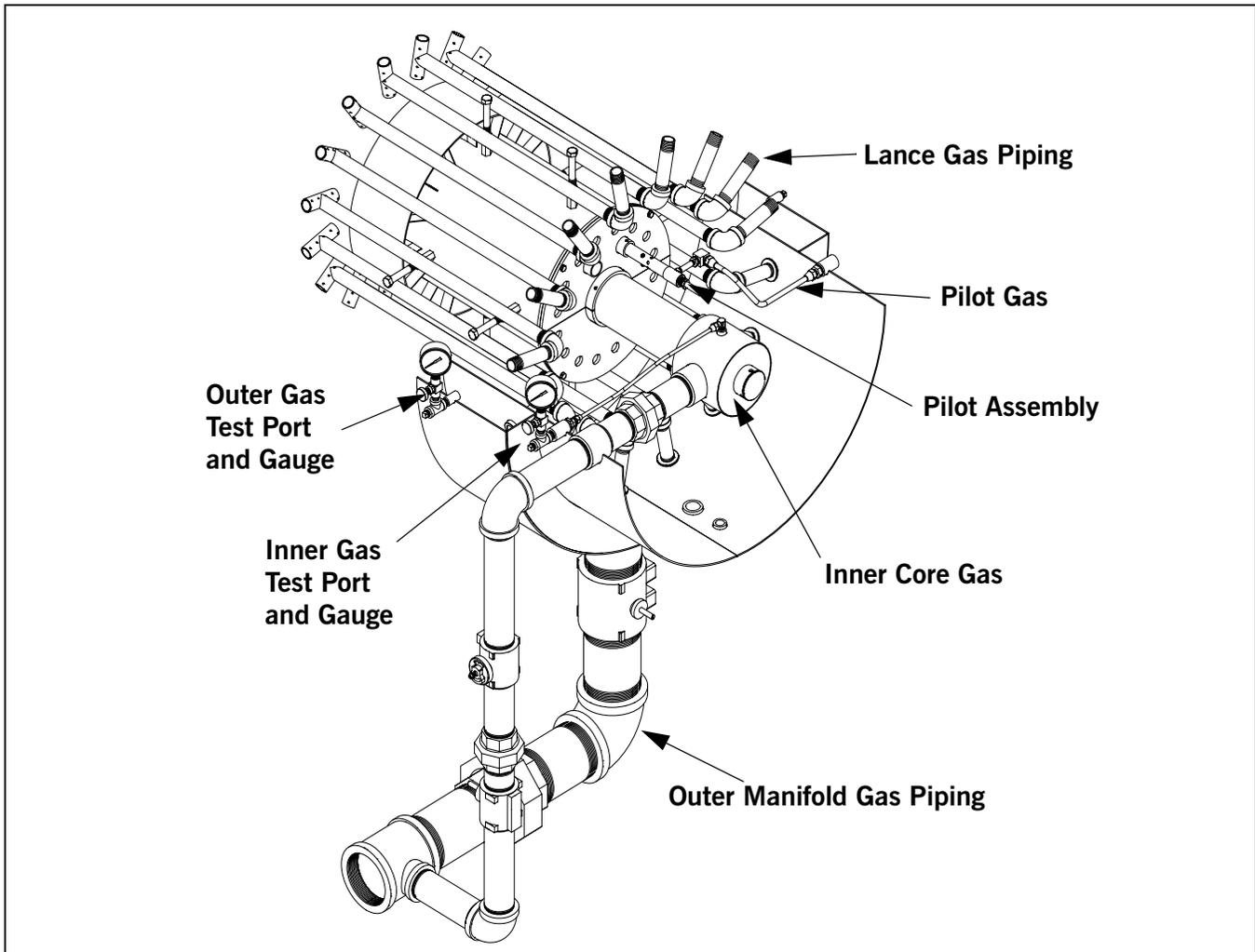


Figure 1-10 Firing Head

### I. Oil System

The burner uses compressed air for atomization. Atomizing air is independent of combustion air. The system is supplied with a separate compressor module for mounting near the burner.

#### 3-Way Regulating Valve

From supply, oil enters the common port of the 3-way regulating valve. During shutdown and purge the SSOVs are closed and upstream fuel returns to the storage tank. When firing oil, the valves are energized/open and metered oil flows to the oil gun/nozzle.

## Nozzle Assembly

The nozzle assembly consists of four main parts: body, compression spring, swirler, and tip. The swirler is held against the nozzle tip by the compression spring. The nozzle body has inlet ports for air and oil lines. Metered fuel oil enters the nozzle body and flows through a tube to the swirler. Oil is forced from the core of the swirler to the side ports where it meets with the atomizing air. Atomizing air enters and passes through the nozzle body to grooves in the swirler, where it mixes with fuel oil. Air/oil passes through grooves and out of the nozzle orifice in a cone of atomized oil. Proper velocity and angle of the fine spray ensures good mixing with the combustion air, providing quiet starts and excellent combustion efficiency. When firing oil, the oil nozzle should be visually inspected and cleaned every week. If continual operation is required a spare oil gun will allow for oil gun replacement for service.

**Atomizing Air Proving Switch** - Pressure actuated switch contacts close when sufficient atomizing air pressure is present. The oil valve will not open unless switch contacts are closed.

**Separate Compressor Module** - All burners have a burner mounted oil metering unit and a separate compressor module. The system functions as follows:

**Atomizing Air** - Shop air is required for the atomizing air. Shop air should be regulated to 80-90 psig and 500 ACFM. Air pressure should be initially set to 10 psig. over the oil pressure. As oil pressure increases the air pressure should maintain a 10 psig. differential.

### OPERATION

Fuel is delivered to the metering system at 50 to 100 psi. From the supply pump, oil is delivered to the common port of a 3-way regulating valve for transfer to the burner nozzle through the normally closed port or back to the storage tank through the normally open port. During pre - and post purge, oil is returned to the tank. During normal firing, all metered oil is delivered to the oil gun/nozzle. For compressed air atomizing applications, air enters a rotary vane compressor through an air cleaner where it is compressed to atomizing pressure. Air flows from the compressor to an air-oil tank which serves the multiple purpose of dampening air pulsation, lube oil mist recovery, lube oil and atomizing air storage.

The compressor rotor is cooled and lubricated continuously by oil under pressure from the air-oil tank. Oil vapor is extracted by a mist eliminator in the upper section of the tank. Atomizing air from the upper tank section is delivered to the nozzle at a constant volume. Air pressure increases as the burner firing rate increases. Atomizing pressure may be adjusted by the valve located on the compressor air breather. The valve allows air to be bled from the tank to the compressor inlet. Delivery rate of the fuel oil metering is controlled by the modulating motor through adjustable linkage.

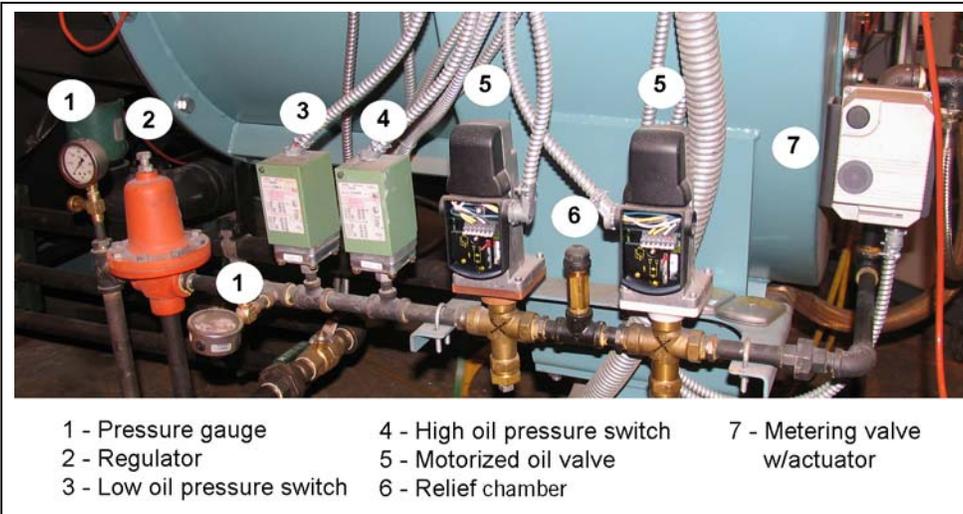


**Figure 1-11 Oil nozzle - spring, swirler, and tip**

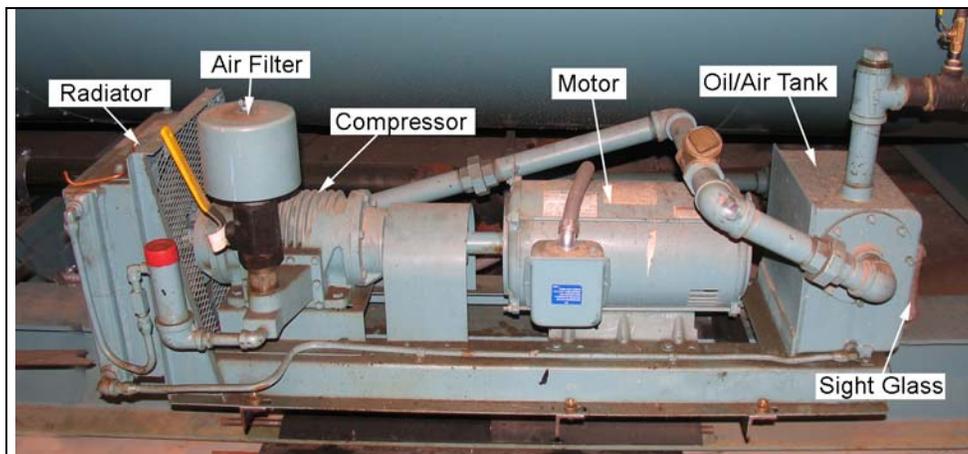
### Caution

The Oil gun must be allowed to cool before disassembling. Failure to follow this caution could result in equipment damage.

Plant air/steam atomization are alternate atomization options. For specifications and requirements, contact your authorized CB representative or the factory service dept.



**Figure 1-12 Oil System**



**Figure 1-13 Compressor for atomizing air**







## Section 2 Installation

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## A. Electrical Connection

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

## B. Installation

Locate the burner properly. The burner is designed for operation with the blast tube level. Do not tilt burner up or excessively downward. Installation of the refractory oven is shown in Figure 2-1. Securely support the burner pedestal on the floor or foundation. Allow enough clearance at the rear of the burner for the access door to swing open for service and maintenance.

The face of the boiler and burner flange must be sealed with the gasket provided with the burner. Carefully place the gasket over the dry oven bolts before it is mounted onto the burner flange. The I.D. of the dry oven is slightly larger than the blast tube I.D. Make sure the dry oven and burner blast tube are concentric. Due to bolt hole tolerances, the dry oven may have to be shifted to accomplish this. After the dry oven nuts are properly tightened, the burner and dry oven assembly can then be mounted into the boiler.

### Caution

The burner refractory is air-cured only. Heat-curing must be initiated at initial start-up. Run the burner at low fire for a period of 6 to 8 hours before starting to gradually increase the firing rate. Failure to do so will result in damage and cracks in the refractory.

## C. Packing Insulation Around Oven

The gaps between the dry oven and furnace and between the dry oven and firing tube should be packed with Superwool blanket insulation P/N 872-01075. Apply refractory coating P/N 872-00225 to hold the insulation in place (see Figure 2-1).

## D. Atomizing Air

For oil burners shop air must be provided at 80-100 psig and 500 ACFM.

## E. Typical Oil Supply Loop

Continuous oil circulation must be supplied to the burner at a rate of 50 percent greater than the high fire burning rate. The oil circulating pump should be located as close as possible to the storage tank to keep suction lines short and minimize to prevent suction loss. The return line to the tank is connected at the discharge port of the three-way regulating valve. Note that the return line should be a minimum of 20 inches higher than the supply line. From supply, oil enters the common port of the 3-way regulating valve. During shutdown and purge the SSOVs are closed and upstream fuel returns to the storage tank. When firing oil, the valves are energized/open and metered oil flows to the oil gun/nozzle.

The proper strainers, check valves, vacuum and pressure gauges, etc. should be installed as indicated. An oil strainer is shipped loose with the burner. All lines should be pressure tested after installation.

## F. Circulating Oil Pump

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

## G. Oil Pressure Regulator

An oil pressure regulator should be installed in the supply line, close to the burner to regulate oil pressure. Oil pressure is 50 to 100 PSI to the 3-way regulating valve.

## H. Gas Piping

Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet. All piping must be in strict accordance with applicable codes, ordinances and regulations of the supplying utility. In the absence of other codes, piping should be in accordance with the following standards: "National Fuel Gas Code" NFPA No. 54, ANSI No. Z 223.1. (for Canada: the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail).

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

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

The gas pilot supply line must be connected upstream of the main gas regulator. If a reducing bushing is required between the house piping and the burner piping, it should be close to the burner shut-off valve. The gas piping must be internally clean and free of foreign material. Before using in service, a leak test must be performed.

## I. Installation Checklist

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

- Electrical terminals in the control panel and on all electrical components.

### Caution

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

### Caution

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

**Notice**

FGR piping from the stack to the burner is not supplied with the burner and is installed by the contractor.



**Important**

It is suggested that all FGR piping be sch.#40, 14 I.D. and be covered with a minimum of 2 inches of insulation

- Pipe fittings and unions.
- Tubing connections.
- Nuts, bolts, screws.
- Before operating pumps and compressors, make certain that reservoirs are properly filled with the specific lubricant. Open all necessary oil shut-off valves. **Do not** run compressors or pumps without oil.
- Before connecting electrical current to any component, be sure the supply voltage is the same as that specified on component nameplates
- Before burner operation, be sure all motors are rotating in the correct direction.
- Before firing, make sure that the refractory flame cone is properly sealed to the burner mounting flange and the boiler front plate.

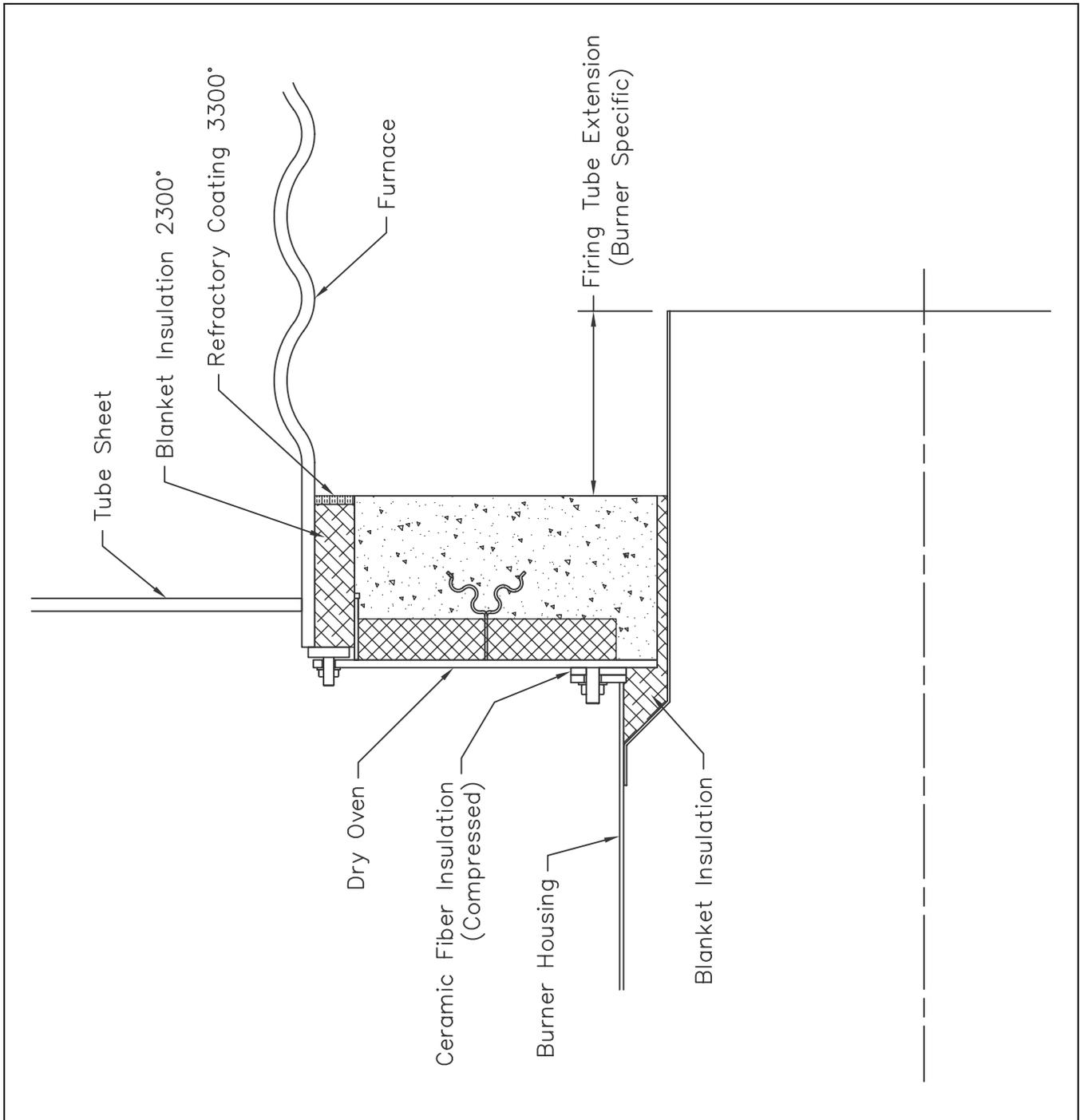
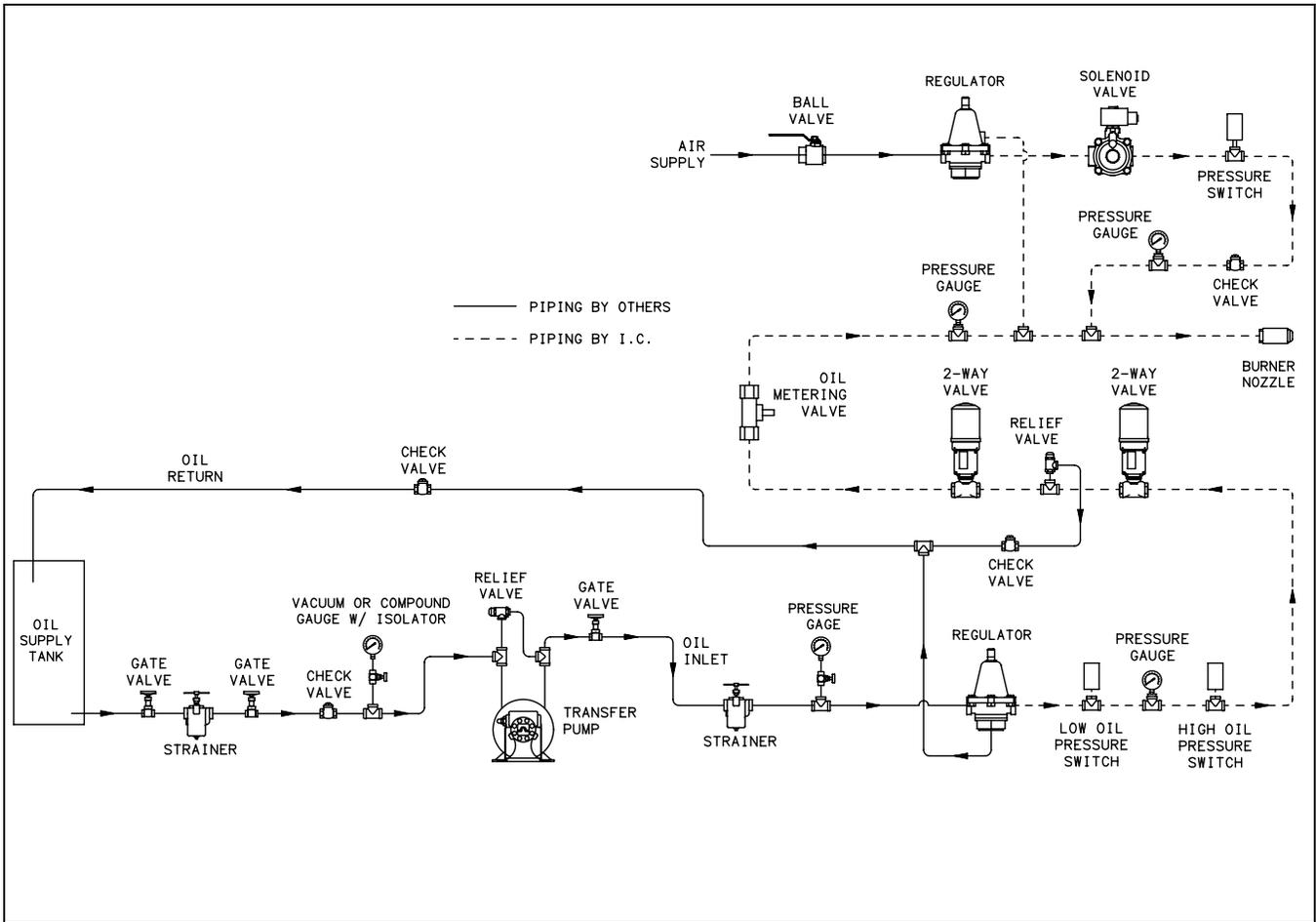


Figure 2-1 Dry Oven Installation



**Figure 2-2 No. 2 Oil / Atomizing Air Piping Arrangement**

**Caution**

Lubricating oil is drained from the air-oil tank before shipment. before attempting to start the burner, add oil to the recommended level. fill tank with non-detergent SAE 30 oil to a level midway up the sight glass. Remove the oil filter, fill with oil, and re-install. Do Not Overfill Tank.

- (A) 1) FULL SIZE (1/4" OR LARGER) PIPE TO BE RUN FROM THE VENT OPENING TO OUTSIDE OF BUILDING.
  - 2) NO TRAPS ALLOWED IN VENT LINE.
  - 3) VENT LINE SHALL TERMINATE AWAY FROM ALL DOORS AND WINDOWS.
  - 4) PROVISIONS SHALL BE MADE TO PREVENT FOREIGN OBJECTS FROM ENTERING VENT PIPING.
- (B) 1) NORMALLY OPEN VENT VALVE LINE SHALL BE HALF OF THE MAIN GAS TRAIN PIPING SIZE. (3/4" MIN.)

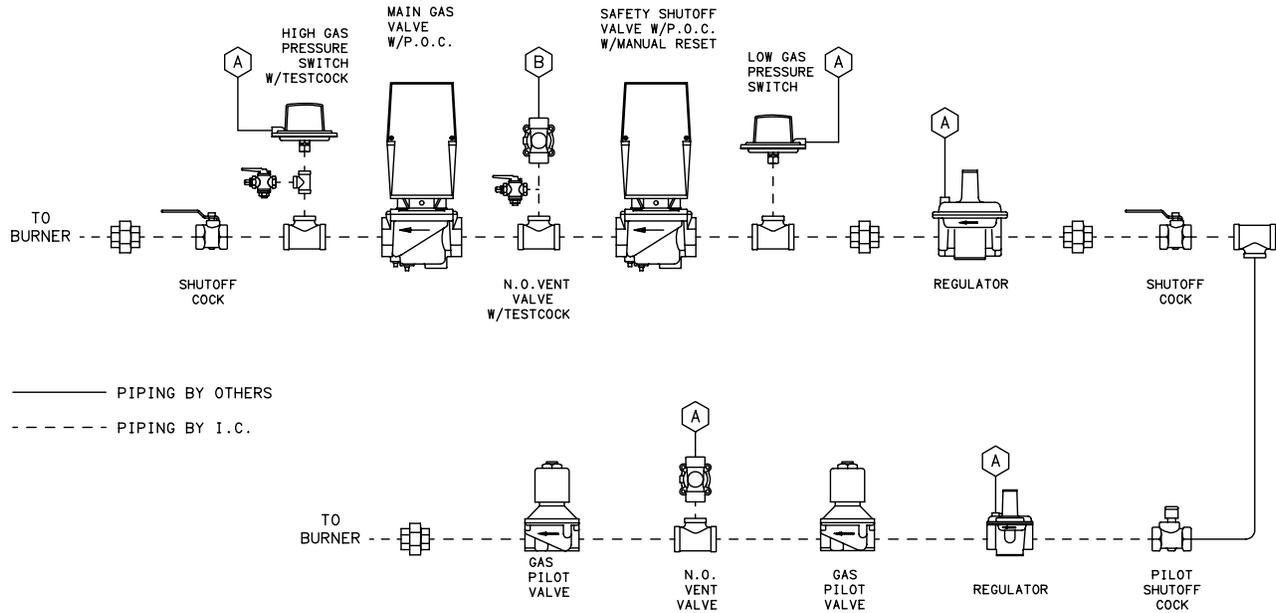


Figure 2-3 Gas Piping Arrangement





## Section 3

# Sequence of Operation

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Loss of Flame	3-7

**Note:** The make or model of the program relay provided will vary depending upon job specifications. The following sequence applies regardless of the make or model. Please refer to the Wiring Diagram (WD) for your specific installation.

## A. General

This section outlines the electrical sequencing of various controls through the pre-purge, ignition, run, and shutdown cycles of the burner.

The program relay establishes the sequence of operation and directs the operation of all other controls and components to provide an overall operating sequence.

The sequences outlined here employ specific nomenclature to aid in applying the text to the wiring diagram.

The burner and control system are in starting condition when the following conditions exist:

1. Boiler water is up to the correct level, closing the low-water cutoff switch.
2. The operating limit pressure control (steam boiler) or the operating limit temperature control (hot water boiler) and high limit pressure or temperature control are below their cutoff setting.
3. All applicable limits are correct for burner operation.
4. Reset manual reset (water, fuel pressure, operating limits).

All entrance switches are closed and power is present at the line terminals of:

1. Blower motor starter
2. Air compressor motor starter (if provided)
3. Oil pump motor starter (if provided)

The sequences do not attempt to correlate the action of the fuel supply system or feedwater system except for the interlock controls that directly relate to the action of the program relay. Chapter 4 and Chapter 6 contain operating instructions and specific information on setting, adjusting, and troubleshooting the controls.

## B. Circuit and Interlock Controls

The burner control circuit is a two-wire system designed for 115 VAC, 60 Hz, single-phase power.

The electrical portion of the boiler is made up of individual circuits with controls that are wired in a manner designed to provide a safe workable system. The program relay provides connection points for the interconnection of the various circuits.

The controls used vary depending upon the fuel oil or gas and the specific requirement of applicable regulatory bodies. Refer to the boiler wiring diagram to determine the actual controls provided. The circuits and controls normally used in the circuits follow and are referred to in the following sequence of operation.

### Limit Circuit

- Burner switch (BS)
- Operating limit control (OLC) – pressure or temperature
- High limit control (HLC) – pressure or temperature

- 
- Low-water cutoff (LWCO)
  - Gas-oil selector switch (GOS) – (Combination burner only)
  - Low gas pressures switch (LGPS)
  - High gas pressure switch (HGPS)
  - Fuel valve over travel interlock circuit
  - Main gas valve auxiliary switch (MGVAS)

**Blower Motor Starter Circuit**

- Blower motor starter (BMS)
- Air compressor motor starter (ACMS) (if provided)

**Running Interlock Circuit**

- Blower motor starter interlock (BMSI)
- Combustion air proving switch (CAPS)
- Atomizing air proving switch (AAPS) (if provided)

**Low Fire Proving Circuit**

- Low fire switch (LFS)

**Pilot Ignition Circuit**

- Gas pilot valve (GPV)
- Ignition transformer (IT)
- Gas pilot vent valve (GPVV) (if provided)

**Flame Detector Circuit**

- Flame detector (FD)

**Main fuel valve circuit**

- Main gas valve (MGV)
- Main gas vent valve (MGVV) (if provided)
- Oil valve (OV)
- Main fuel valve light (FVL)

**Firing Rate Circuit**

- Modulating damper motor (MDM)
- Manual-automatic switch (MAS)
- Manual flame control (MFC)
- Modulating control (MC)

**High Fire Proving Circuit**

- High fire switch (HFS)

**Running Interlock and Limit Circuit**

- Low oil pressure switch (LOPS)
- High oil temperature switch (HOTS)
- Auxiliary low-water cutoff (ALWCO)

To comply with requirements of insurance underwriters such as Factory Mutual (FM), Industrial Risk Insurers (IRI) or others, additional interlock devices may be used in addition to the circuits mentioned here.

## C. Sequence of Operation — Oil or Gas

On a combination fuel unit, the gas/oil switch must be set for the proper fuel.

The following sequence occurs with power present at the program relay (PR) input terminals and with all other operating conditions satisfied.

### 1. Pre-purge Cycle

When the burner switch (BS) is turned “on,” and controls wired in the “limit” and “fuel valve interlock” circuits are closed and no flame signal is present, the “blower motor start circuit” is powered energizing the blower motor starter (BMS). The load demand light (LDL) turns on. When firing oil, the air compressor motor starter (ACMS) (if provided) is also powered.

At the same time, the program relay signals the modulating damper motor (MDM) to open the air damper. The damper begins to open and drives to its full open or high fire position. Opening the damper motor allows a flow of purging air through the boiler prior to the ignition cycle.

On all boilers the circuitry will include a high fire switch (HFS). The purpose of the switch is to prove that the modulating damper motor (MDM) has driven the damper to the open position during the pre-purge cycle.

The controls wired into the “running interlock circuit” must be closed within 10 seconds after the start sequence. In the event any of the controls are not closed at this time, or if they subsequently open, the program relay will go into a safety shutdown.

At the completion of the high fire purge period, the program relay signals the modulating damper motor (MDM) to drive the air damper to its low fire position.

To assure that the system is in low fire position prior to ignition, the low fire switch (LFS) must be closed to complete the “low fire proving circuit.” The sequence will stop and hold until the modulating damper motor (MDM) has returned to the low fire position and the contacts of the low fire switch (LFS) are closed. Once the low fire switch is closed, the sequence is allowed to continue.

**Note:** The ignition trial cannot be started if flame or a flame simulating condition is sensed during the pre-purge period. A safety shutdown will occur if flame is sensed at this time.

### 2. Ignition Cycle

The ignition transformer (IT) and gas pilot valve (GPV) are energized from the appropriate pilot ignition terminal.

The pilot flame must be established and proven by the flame detector (FD) within a 10 second period in order for the ignition cycle to continue. If for any reason this does not happen, the system will shut down and safety lockout will occur.

With a proven pilot, the main fuel valve(s) (OV or MGV) is energized and the main fuel valve light (FVL) in the panel is lighted. The main flame is ignited and the trial period for proving the main flame begins. It lasts 10 seconds for light oil and/or natural gas. At the end of the proving period, if the flame detector still detects main flame, the ignition transformer and pilot valve are deenergized and pilot flame is extinguished.

**Note:** If the main flame does not light, or goes out, the fuel valve will close. The safety switch will trip to lock out the control. See 'Flame Loss Sequence' below.

 **Warning**

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

### 3. Run Cycle

With main flame established, the program relay releases the damper actuator from its low fire position to control by either the manual flame control or the modulating control, depending upon the position of the manual-automatic switch (MAS). This allows operation in ranges above low fire.

With the MAS set at automatic, subsequent modulated firing will be at the command of the modulating control, which governs the position of the fuel, air damper, and FGR actuators.

**Note:** Normal operation of the burner should be with the switch in the automatic position and under the direction of the modulating control. The manual position is provided for initial adjustment of the burner over the entire firing range. When a shutdown occurs while operating in the manual position at other than low fire, the damper will not be in a closed position, thus allowing more air than desired to flow through the boiler. Excess air flow subjects the pressure vessel metal and refractory to undesirable conditions.

The burner starting cycle is now complete. The load demand light (LDL) and the FVL remain lit. Demand firing continues as required by load conditions.

### 4. Burner Shutdown — Post Purge

The burner will fire until steam pressure or water temperature in excess of demand is generated. With modulated firing, the actuators should return to their low fire positions before the operating limit control (OLC) opens. When the limit control circuit is opened, the following sequence occurs:

1. The main fuel valve circuit is deenergized, causing the main fuel valve (MGV) or (OV) to close. The flame is extinguished. The control panel lights (LDL) and (FVL) are turned off. The blower motor continues to run to force air through the boiler for the post purge period.

2. The blower motor start circuit is deenergized at the end of the post purge cycle and the shutdown cycle is complete.
3. The program relay is now ready for subsequent recycling, and when steam pressure or water temperature drops to close the contacts of the operating control, the burner again goes through its normal starting and operating cycle.

### **D. Flame Loss Sequence**

The program relay will recycle automatically each time the operating control closes, or after a power failure. It will lockout following a safety shutdown caused by failure to ignite the pilot, or the main flame, or by loss of flame. Lockout will also occur if flame or flame simulating condition occurs during the pre-purge period or any time the burner switch is open.

The control will prevent start-up or ignition if limit circuit controls or fuel valve interlocks are open. The control will lock out upon any abnormal condition affecting air supervisory controls wired in the running interlock circuit.

---

 **Caution**

---

The lockout switch must be manually reset following a safety shutdown. The cause for loss of flame or any unusual condition should be investigated and corrected before attempting to restart. Failure to follow these instructions could cause damage to the equipment.

#### **1. No Pilot Flame**

The pilot flame must be ignited and proven within a 10-second period after the ignition cycle begins. If not proven within this period, the main fuel valve circuit will not be powered and the fuel valve(s) will not be energized. The ignition circuit is immediately deenergized and the pilot valve closes, the reset switch lights and lockout occurs immediately.

The blower motor will continue to operate. The flame failure light and the alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed.

#### **2. Pilot But No Main Flame**

When the pilot flame is proven, the main fuel valve circuit is energized. The pilot flame will be extinguished 10 seconds later. The flame detecting circuit will respond to deenergize the main fuel valve circuit within 2 to 4 seconds to stop the flow of fuel. The reset switch lights and lockout occurs immediately. The blower motor will continue to operate.

The flame failure light and alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

### **3. Loss of Flame**

If a flame outage occurs during normal operation and/or the flame is no longer sensed by the detector, the flame relay will trip within 2 to 4 seconds to deenergize the fuel valve circuit and shut off the fuel flow. The reset switch lights and lockout occurs immediately. The blower motor continues operation. The flame failure light and alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

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

The program relay has the capability to self-diagnose and to display a code or message that indicates the failure condition. Refer to the control bulletin for specifics and suggested remedies. Familiarity with the program relay and other controls in the system can be obtained by studying the contents of the manual and this bulletin.

Knowledge of the system and its controls will make troubleshooting much easier. Costly down time or delays can be prevented by systematic checks of the actual operation against the normal sequence to determine the stage at which performance deviates from normal. Following a routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

Remember, a safety device, for the most part, is doing its job when it shuts down or refuses to operate. Never attempt to circumvent any of the safety features.

Preventive maintenance and scheduled inspection of all components should be followed. Periodic checking of the relay is recommended to see that a safety lockout will occur under conditions of failure to ignite either pilot or main flame, or from loss of flame.





## Section 4

# Commissioning - Starting, Operating and Adjustments

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Prestart Tasks and Checklist — All Fuels .....	4-3
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## A. General

Instructions are all based upon installation being complete and all electrical, fuel, water and vent stack connections are made.

The operator should be familiar with the burner, boiler, and all controls and components. Instructions for adjusting major components are given in this Section and should be reviewed prior to firing. The wiring diagram should also have been studied, along with the firing sequence outlined in Section 3.

Verify supply of fuel and proper voltage. Check for blown fuses, open circuit breakers, dropped out overloads, etc. Check reset of all starters and controls having manual reset features. Check the lockout switch on the programmer and reset if necessary.

Check to see that water column gauge glass isolation valves are open, and that feedwater pump controls operate correctly. The boiler should be filled with water to the proper operating level using water of ambient temperature. Be sure that treated feedwater is available and used. In hot water applications, the entire system should be filled and vented. On a steam boiler, open the vent valve to vent air displaced during filling. Leave the vent valve open until the escape of steam is noted after the burner is operating.

Check all linkage for full and free movement of the shutter and metering valves. The check can be done by loosening the linkage at the damper motor connecting arm and manipulating the linkage by hand.

Check for rotation of all motors by momentarily closing the motor starter or relay. The blower impeller rotation is counter-clockwise, when viewed from the motor side of the burner. The atomizing air pump rotation is clockwise when viewed from its drive end.

### Warning

It is recommended that the starting instructions be read completely until they are thoroughly understood, before attempting to operate the burner, rather than performing each operation as it is read for the first time. Failure to follow these instructions could result in serious personal injury or death.

### Warning

Prior to firing a boiler, be sure that discharge piping from safety valves or relief valves, and discharge piping from all blowdown and drain valves, is piped to a SAFE point of discharge, so that emission of hot water or steam cannot possibly cause injury. Failure to follow these instructions could result in serious personal injury or death.

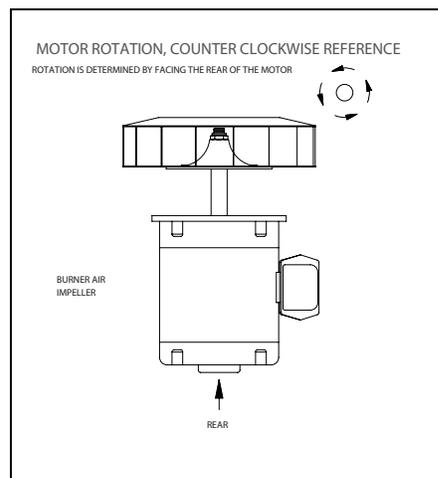


Figure 4-1 Check Motor Rotation

## B. Preparation for Initial Start-Up

### 1. Prestart Tasks and Checklist — All Fuels

Before proceeding with system start-up and adjustment, be sure that overall installation is complete. Review the boiler Operation and Maintenance Manual carefully to verify that the boiler is properly set up for operation. Check that all shipped-loose items (those items not installed when shipped) have been correctly installed. Verify the supply of fuel. Check to make sure the burner is wired as shown on the wiring diagram. Ensure that all control wiring terminals are tight.

Complete the following checklist in preparation for system startup:

1. Confirm that the fuel and electrical connections have been completed in accordance with the applicable codes and insurance requirements (if necessary), and that connections comply with the piping schematic and wiring diagram. A copy of the wiring diagram is located inside the control panel.
2. Check the combustion air fan motor for correct rotational direction.
3. Check that the boiler is filled with water to the proper level, and that all circulating pumps (hot water units) are correctly installed and operational.
4. A representative of the gas utility should turn on the gas. Verify that there is proper gas pressure at the gas train, and pilot, if this is a gas or combination burner. See the burner specification plate for minimum and maximum natural gas pressure requirements. The data label is located inside the control panel. Make sure that the correct regulator and spring are installed in the main and pilot line. With the gas train pressurized, verify that the motorized main gas valves shut tightly, with no leakage past these valves.
5. For oil burners confirm that the plant air supply has adequate flow and pressure to provide the correct oil atomizing requirement.
6. Check that the flame safeguard has been properly installed inside the control panel.
7. Verify that the prestart checklist for the boiler has been thoroughly completed.
8. Provide the following test equipment on site:
  - A. Combustion analyzer for O<sub>2</sub>.
  - B. U-tube manometer, or pressure gauge, to measure gas pressures (main and pilot).
  - C. Inclined manometer to measure draft pressures.
  - D. Smoke spot tester for oil fired units. (CO analyzer for gas fired burners).
  - E. Voltmeter.
  - F. Thermometers and thermocouples.



#### Important

All work on the burner should be performed by qualified persons knowledgeable in applicable codes.



#### Caution

Attempting initial burner start-up with insufficient knowledge of the equipment and start-up procedures can result in serious damage to the equipment. The operator must be totally familiar with the entire start-up and adjustment process before attempting to operate the burner.

## 2. Actuator setup

Actuator travel will normally be factory pre-set, but should be verified before commissioning the controls. Refer to the control manuals and any additional manufacturer's documentation. If your boiler is equipped with CB-Hawk ICS controls, refer to CB manuals 750-229 (Hawk ICS) and 750-217 (Parallel Positioning).

Before commissioning, check all actuator couplings for secureness. Ensure any set screws are tightened and/or shear pins are in place.

## 3. Air and Fuel Controls

The combustion system fuel and air controls have been factory adjusted, and the unit has been test fired before it was shipped. Regardless of preliminary adjustment and operation, it may be necessary to readjust the controls for local conditions:

- The fuel flow controls may require adjustment to establish the rated fuel input over the full range of firing-rate modulation.
- The air controls may need to be adjusted, relative to the established fuel flow rates, to provide the correct amount of air for complete, efficient combustion.
- Gas pressure to the regulator must be a minimum of 10 psig.
- The inner and outer manifold pressures must be balanced to provide a stable flame. The balancing of the inner and outer manifold gas pressures will vary somewhat, depending on altitude, weather and barometric conditions.

Fuel and air adjustments are similar on all ProFire burners, whether gas-fired, oil-fired, or combination gas/oil fired. The following topics describe air and fuel flow rate adjustments, and the combustion set-point objectives for optimum combustion performance:

### Air Flow Control

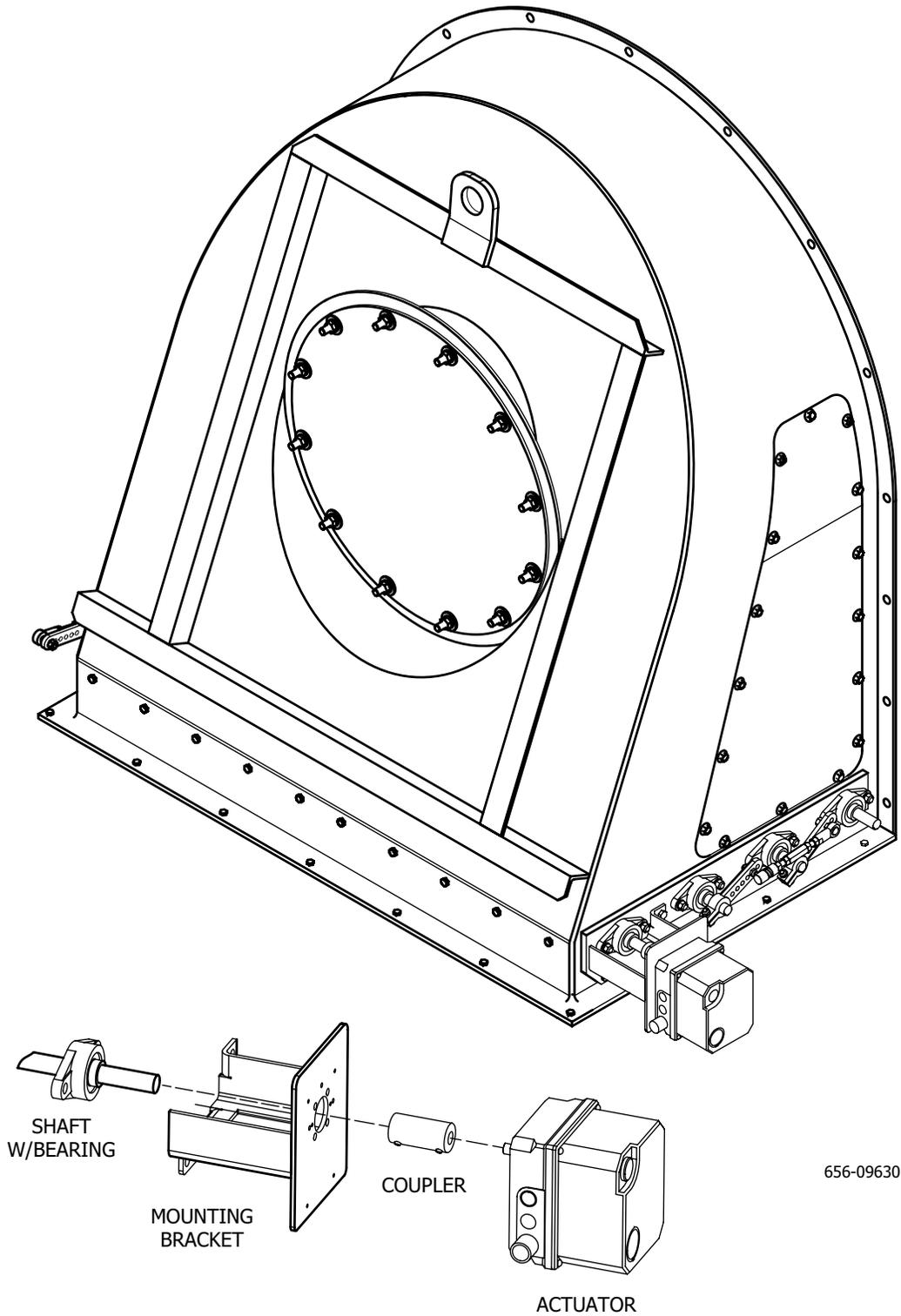
ProFire burners incorporate a multi-blade air shutter combustion air control system.

The multi-blade system consists of independent blades that can be adjusted to provide more or less combustion air throughout the firing rate range.

The air damper is linked to the damper actuator and the damper linkage can be adjusted to increase or decrease the air opening rate. The air damper is almost closed in the low fire position and fully open in high fire.

Refer to Figures 4-2 and 4-3.

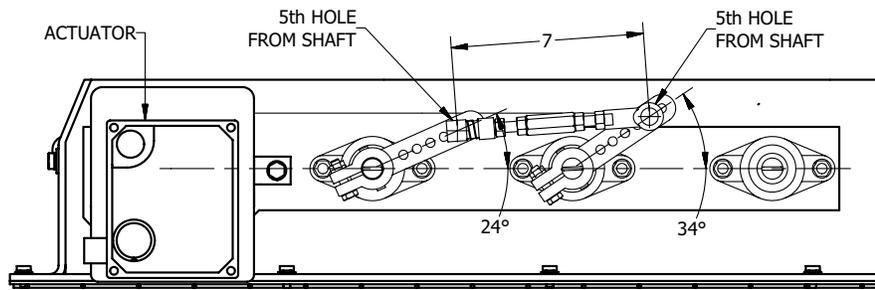
Figure 4-2



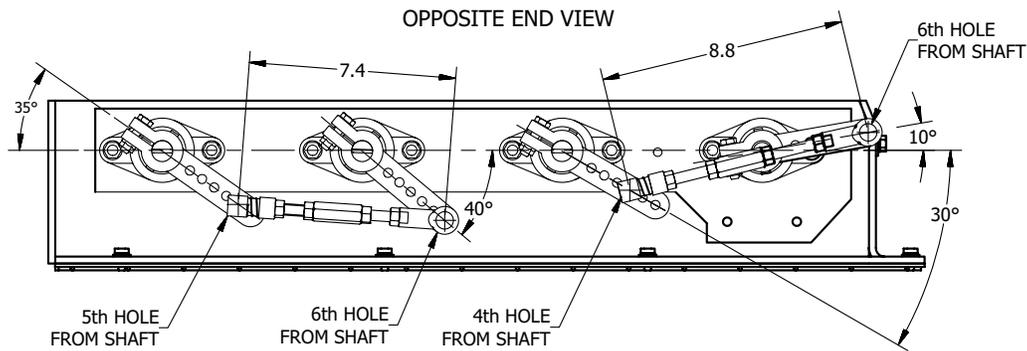
NOTES

- 1 - POSITION OF DAMPER BLADES MAY BE DETERMINED BY MARKINGS ON BLADE SHAFT'S.
- 2 - ENSURE COUPLER SET SCREWS ARE TIGHT AT ALL TIMES.

**Figure 4-3**



**AIR DAMPER BLADE LINKAGES**



NOTES  
 1 - ENSURE ALL LINKAGE HARDWARE IS SECURELY FASTENED.

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**Fuel and Air Flow Settings**

Fuel and air flow rates can be individually adjusted at low fire and at high fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (including air temperature, humidity, barometric pressure,) and fuel property changes. Adjustments may be required to meet certain environmental emissions criteria, such as NO<sub>x</sub> or CO. Combustion adjustments also vary with specific system applications.

Turndown capability for oil is less than that for natural gas. Therefore, on combination fueled burners, gas turndown performance may be restricted (or determined) by the excess air and fuel turndown levels set initially for oil combustion.

Excess air (O<sub>2</sub>) and unburned fuel (CO) levels in boiler flue gases are used to determine combustion efficiency and as a tool in adjusting

fuel and air inputs. The system should be adjusted to the minimum excess air quantity that provides low levels of unburned fuel with sufficient remaining oxygen to cope with normal atmospheric and fuel related changes. Unburned fuel is measured as carbon monoxide (CO) when burning natural gas, and smoke spots when burning oil.

ProFire burners are capable of operating at CO levels of less than 50 ppm at all firing rates. The burner should be set up and maintained to yield smoke spot levels less than a #1 spot (ASTM D2156 Shell-Bacharach Scale) to minimize soot buildup in the boiler.

## **C. Combustion Adjustment on Gas and Oil**

Efficient combustion cannot be properly judged by flame appearance, although it may help in making preliminary settings. The proper settings of air-fuel ratios **must** be determined by flue gas analysis. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. Instruments are available to measure carbon dioxide (CO<sub>2</sub>), oxygen (O<sub>2</sub>) and carbon monoxide (CO).

### **1. Fuel Supply**

Before initial start-up, verify that all fuel connections are tight. Fuel supply lines should be securely connected, correctly supported, and leak tested.

The gas train for gas-fired, or combination gas/oil, burners is provided with the overall burner package. Configuration of the appropriate gas train is based on minimum requirements established by Underwriter's Laboratories/CGA and the responsible insurance carrier if applicable.

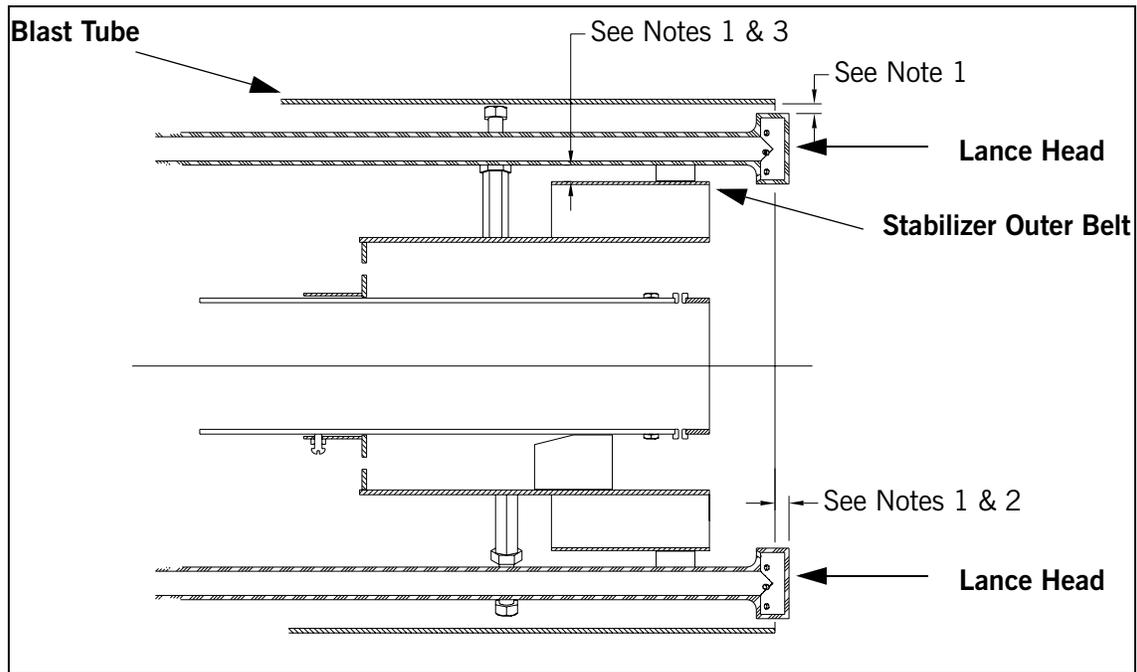
The pilot gas train is supplied with the burner, and is shipped loose.

Fuel oil piping for oil-fired systems is shown pictorially in Section 2 (Installation). In this circuit, an oil supply line from the oil tank is connected to the inlet port of the oil pump, and an oil return line from the pump circulates excess oil from the pump back to the oil supply tank.

Before burner start-up, the two oil solenoid valves are in the closed (de-energized) position and the oil metering valve is in its most closed position. Under this condition (with the pump operating), oil cannot flow to the oil burner nozzle, but circulates through the 3-way oil regulating valve bypass to return line and back to the oil tank. When the flame safeguard control calls for the main flame, the two oil solenoid valves are electrically energized. After opening, oil flows through the nozzle at the low-fire flow rate.

### **2. Burner Settings**

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



**Figure 4-4 Firing Head Alignment**

**Notes:**

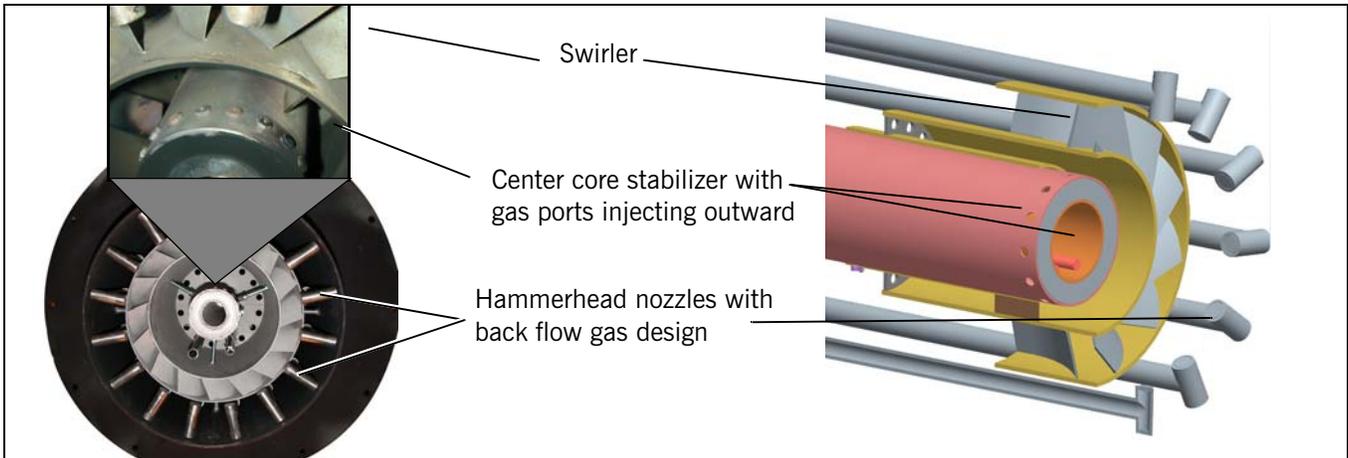
- (1) Check the spacing at these areas to ensure consistent clearances (approximately 1/8"). Adjust components if required.
- (2) All **lances** should project past (or be nested within) the **Blast Tube** by the same amount.
- (3) All lance heads should be equally spaced from the Blast Tube I.D.

**Notice**

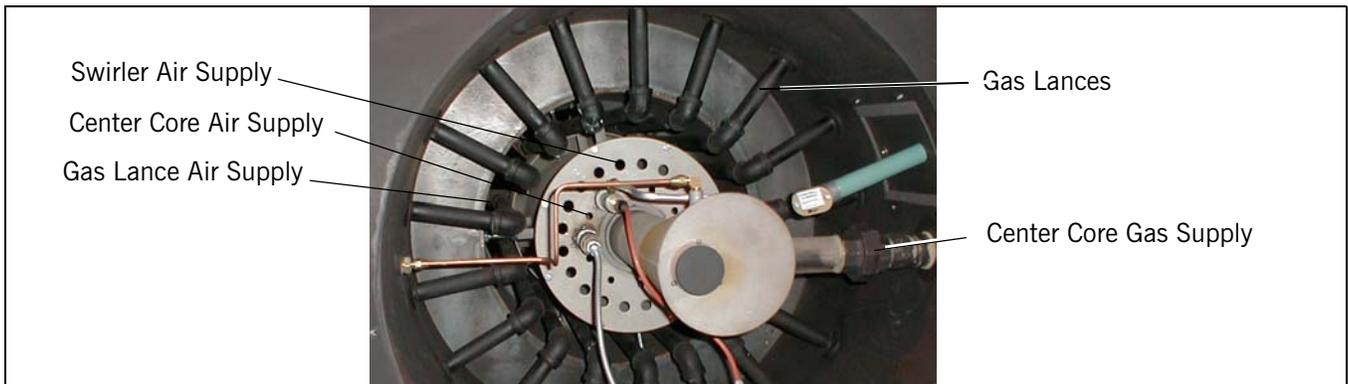
The gap between the lances and the blast tube must be consistent around the entire inside diameter of the blast tube. Centering and concentricity is critical for all NT burner head components.

Verify the following:

- Burner drawer center tube and Firing head center tube must be concentric and aligned for free fit of the oil gun. Even on gas only jobs, these two components should be carefully aligned to ensure proper gas and air delivery.
- Ensure the oil nozzle is centered in the firing head center tube (and cone if equipped). Prior to closing the rear door, verify correct nozzle positioning



**Figure 4-5 Gas and Air Supply Channels, NT Burner Head (Front)**



**Figure 4-6 Gas and Air Supply Piping, NT Burner Head (Rear)**

### 3. Spark Pickup Test

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

#### **GAS FIRED**

Close the pilot and the main line manual gas valves.

Startup the burner, the burner runs through prepurge, when the burner gets to pilot trial for ignition, switch the flame safety to TEST mode. The flame signal should read zero. During the trial for pilot ignition with spark only, the flame relay should not pull in (i.e. be energized).

Upon completion of successful test, proceed to remaining start-up procedures.

#### **OIL FIRED**

Shut off the manual oil valve and manual pilot gas valve.

Startup the burner, the burner runs through prepurge, when the burner gets to pilot trial for ignition, switch the flame safety to TEST mode. The flame signal should read zero. During the trial for pilot ignition with spark only, the flame relay should not pull in (i.e. be energized).

 **Warning**

If the flame signal is strong enough (greater than zero) when doing the spark pickup test the burner should not be operated. Call Cleaver-Brooks service representative for service advice. Failure to follow this warning could result in serious personal injury or death.

**Note:** Once all areas check out and are properly aligned, proceed to the next section. Do not continue if the listed areas have not been reviewed for accuracy.

#### **4. Gas Pilot Flame Adjustment**

The gas pilot flame is regulated by adjusting the pressure setting of the gas pilot regulator. Normal setting is 18" to 20" inches of water column, when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame. To adjust pilot gas pressure, unscrew regulator cap and turn the adjusting screw in or out.

Although it is possible to visibly adjust the size of the pilot flame, for best accuracy obtain a DC volt or micro amp reading of the flame signal. The flame safeguard amplifier has a meter jack for this purpose. At initial start-up and during planned maintenance, test the pilot flame signal, pilot turndown, and safety switch lockout.

Start and stop the burner several times to ensure proper pilot setting and reliable light off.

#### **D. Commissioning Boiler (gas)**

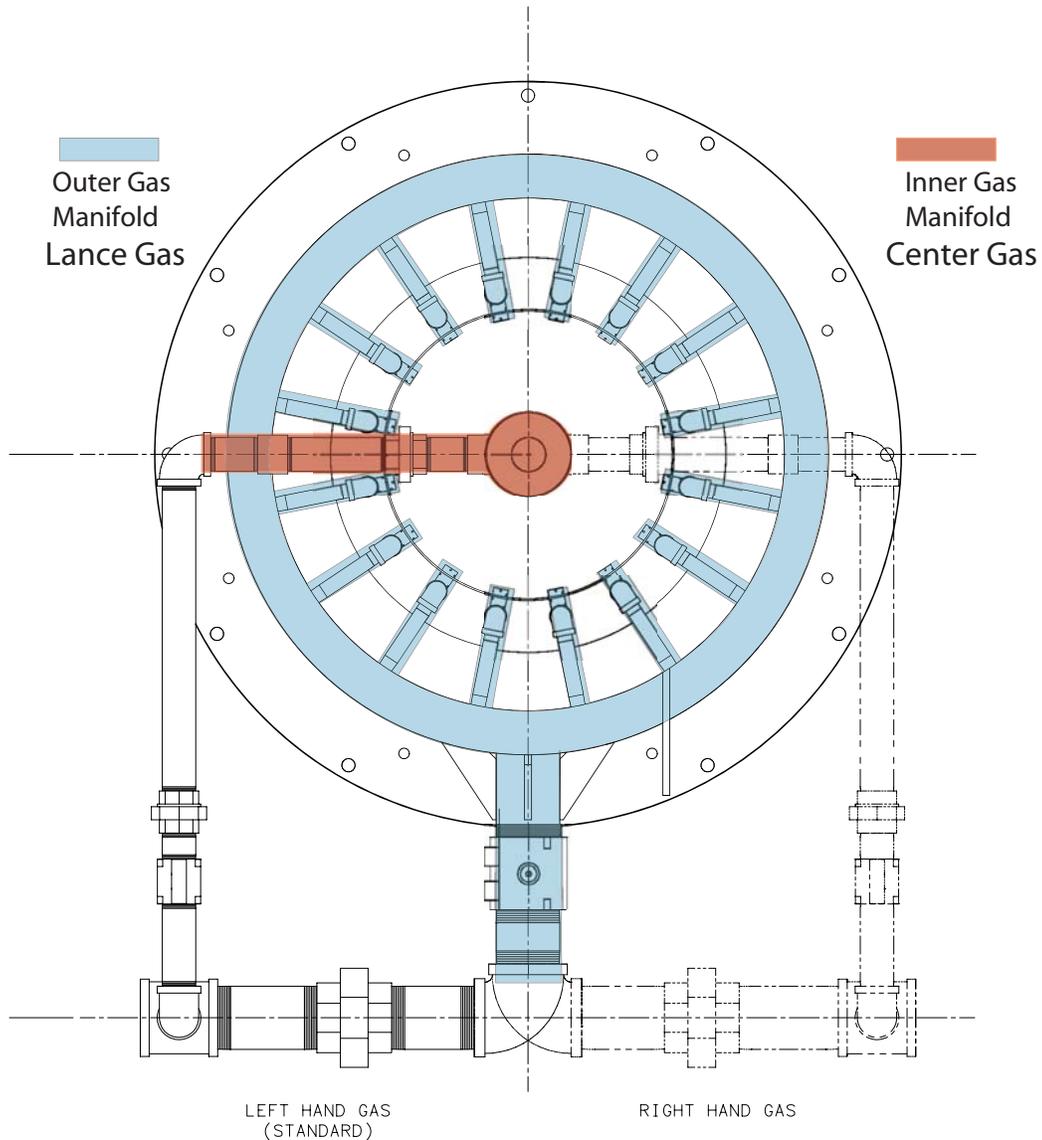
The NT firing heads have two separate gas manifolds, (Lance Gas Manifold and Center Gas Manifold) and a separate butterfly valve and actuator for each manifold. The fuel pressure in each manifold should be near equal throughout the firing range.

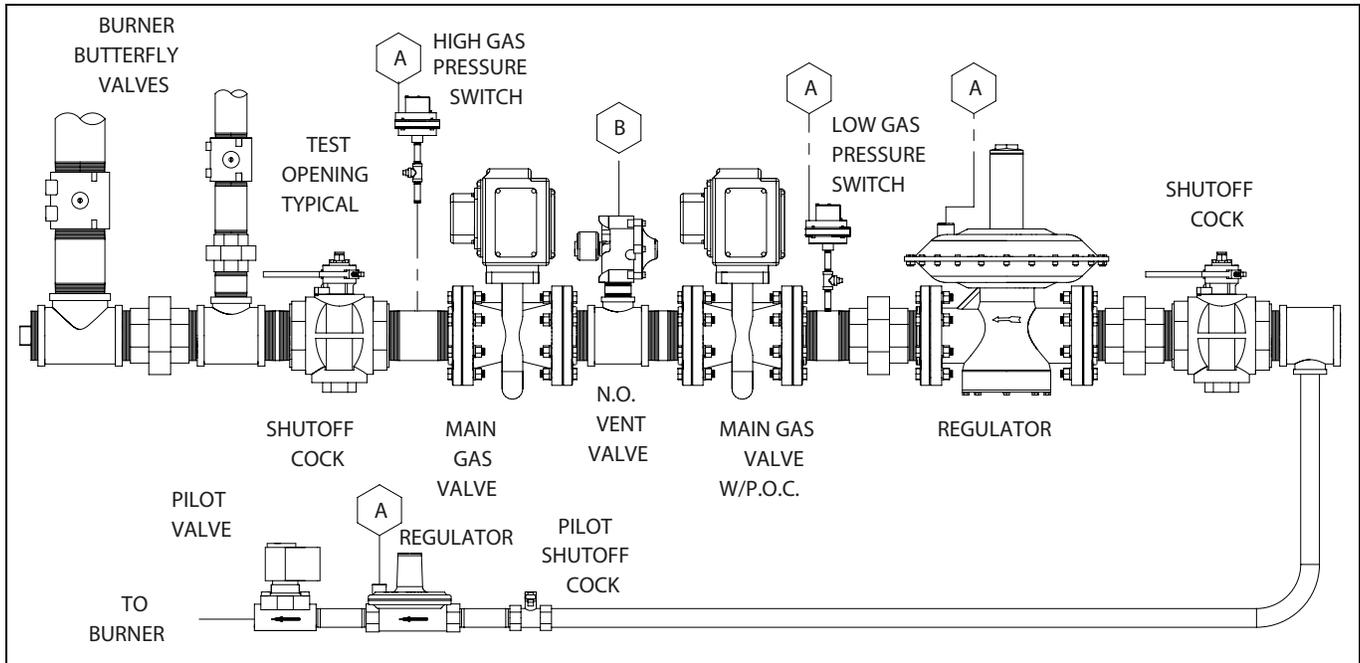
Start burner and establish low fire flame. Bring boiler up to operating temperature. Adjust the air, fuel and FGR valves to match the burner name plate low fire gas pressure while maintaining 5-6% O<sub>2</sub> in the flue gas. At this point the low fire air is adjusted. Slowly bring the burner up to high fire while maintaining 4.5-5.5% O<sub>2</sub>. Set the gas manifold pressure by adjusting the main gas regulator to match the burner manifold pressure listed on the burner name plate for high fire input (It is recommended that high and low fire inputs be checked against a gas meter, if available).

At this time start working the burner back to low fire while maintaining 4.5-5% O<sub>2</sub> and the desired NO<sub>x</sub> level (also maintain close or equal pressures in both gas manifolds).

At the low fire operating position recheck low fire gas pressures and fuel input. Manually modulate the burner from low fire to high fire verifying combustion and smooth burner operation.

**Figure 4-7 Inner and outer gas manifolds**





**Figure 4-8 Gas Train**

At this time the high and low gas pressure switches can be set using the following procedure:

**Low Gas Pressure Switch**

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

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

**High Gas Pressure Switch**

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

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

## E. Commissioning Boiler (Oil)

Turn the fuel selector switch to Oil. Adjust the oil pressure at the supply pump to 80 psi. Adjust the air supply pressure to 50 psig. Start burner and establish low fire flame. Bring boiler up to operating temperature. Adjust the air, fuel and FGR valves to match the burner name plate low fire oil pressure while maintaining 5-6% O<sub>2</sub> in the flue gas. At this point the low fire air is adjusted. Slowly bring the burner up to high fire one setpoint at a time while maintaining 4.5-5.5% O<sub>2</sub>. Set the oil pressure by adjusting the regulator at the oil supply pump to match the burner name plate for high fire input.

It is recommended that high and low fire inputs be checked against a oil meter, if available.

At this time start working the burner back to low fire one setpoint at a time while fine tuning to maintain 4.5-5% O<sub>2</sub> and the desired NO<sub>x</sub> level.

At the low fire operating position recheck low fire oil pressure and fuel input. Manually modulate the burner from low fire to high fire verifying combustion and smooth burner operation.

Verify the various gas pressures with the information on the burner Data Plate

At this time the Atomizing Air and high and low oil pressure switches can be adjusted using the following procedures;

### Atomizing Air Pressure

Atomizing air pressure is regulated by adjusting the regulator for plant air. The air pressure is indicated by the pressure gauge at the oil gun. A minimum of 10 to 12 psi air pressure at low fire is suggested. As the firing rate increases, the air pressure also increases. Air pressure will be less with light oils. If any change in atomizing air pressure is made, check ignition several times for reliable light off. Adjustments should be set to obtain reliable ignition with best low and high fire combustion results.

### Atomizing Air Proving Switch

The knurled nut between the switch and bellows is turned in to raise the atomizing air pressure setting. The minimum atomizing air pressure is developed during pre- and post-purge. During pre-purge, adjust the atomizing air pressure proving switch until it breaks the circuit. Readjust switch above this circuit break point to actuate under a condition of minimum pressure, but not so close as to cause nuisance shutdowns. Air pressure against the Bourdon tube actuates two single pole, single throw mercury switches, which when made completes a circuit, proving the presence of atomizing air. Since the pressure of the atomizing air is at minimum when no fuel is present at the nozzle, adjustment of the switch should be made while the unit is purging, but not firing.

### High and low oil pressure switches



Figure 4-9 Fuel Selector Switch

The high oil pressure switch is set 1-2 psig. over the maximum system pressure. The low oil pressure switch is set 1-2 psig. below the minimum system pressure.

## F. Operating

Normal operation of the burner should be with the switch in the automatic position, and with the burner firing under the direction of the modulating control. The manual position is provided for initial adjustment of the burner over the entire firing range. When a shutdown occurs while operating in the manual position at other than low fire, the damper will not be in a closed position, thus allowing more air than desired to flow through the boiler. As the resulting hot flame to cool air cycling subjects the pressure vessel metal and refractory to undesirable stress conditions.

With the switch set at "AUTO," the burner will operate on a modulating basis according to the load demand.

The burner will continue to operate with modulated firing until the operating limit pressure or temperature is reached, unless:

- The burner is manually turned "OFF."
- A low-water condition is detected by low-water level control.
- The electrical or fuel supply is interrupted.
- The combustion air pressure, fuel pressure, or atomizing air pressure drops below minimum level.

There can be other reasons for shutdown such as motor overload, flame outages, tripped circuit breakers, blown fuses, or through other interlock devices in the circuitry.

When the burner is shut down normally, by either the operating limit control or by manually switching the burner off, the load demand light no longer glows.

Shutdown through conditions causing safety or interlock controls to open will actuate the flame failure light (and alarm if so equipped) and the load demand light will remain lit. The cause of this type of shutdown will have to be located, investigated, and corrected before operation can be resumed. Refer to the troubleshooting section in Section 5.

## G. Shutdown

When the operating limit control setting is reached to open the circuit or if the burner switch is turned "OFF," the following sequence occurs.

The fuel valve is de-energized and the flame is extinguished. The timer begins operation and the blower motor continues running to force air through the furnace in the post-purge period.

At the end of the programmed post-purge period, the blower motor is turned off. The timer has returned to its original starting position and stops. The unit is ready to restart.



### **Important**

When adjusting a burner for NO<sub>x</sub>, a combustion analyzer properly calibrated must be used at all times.



## Section 5 Troubleshooting

Burner Does Not Start . . . . .	5-2
No Ignition . . . . .	5-3
Pilot Flame, But No Main Flame . . . . .	5-3
Burner Stays in Low Fire . . . . .	5-3
Shutdown Occurs During Firing . . . . .	5-4

 **Warning**

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

 **Warning**

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

This chapter assumes that the unit has been properly installed and adjusted, and that it has been running for some time. It is further assumed that the operator has become thoroughly familiar with both burner and manual by this time. The points under each heading are set down briefly as possible causes, suggestions or clues to simplify locating the source of trouble. Methods of correcting the trouble, once it has been identified, may be found elsewhere in this manual.

If the burner will not start or operate properly, this trouble-shooting chapter should be referred to for assistance in pinpointing problems that may not be readily apparent.

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

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

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

## A. Burner Does Not Start

### 1. No voltage at program relay power input terminals.

- A. Main disconnect switch open.
- B. Blown control circuit fuse.
- C. Loose or broken electrical connection.

### 2. Program relay safety switch requires resetting.

### 3. Limit circuit not completed — no voltage at end of limit circuit program relay terminal.

- A. Pressure or temperature is above setting of operation control (Load demand light will not glow).
- B. Water below required level.
  1. Low-water light (and alarm horn) should indicate this condition.
  2. Check manual RESET button, if provided, on low-water control.
- C. Fuel pressure must be within settings of low pressure and high pressure switches.

**4. Fuel valve interlock circuit not completed.**

- A. Fuel valve auxiliary switch not closed.

**B. No Ignition****1. Lack of spark.**

- A. Electrode grounded or porcelain cracked.
- B. Improper electrode setting.
- C. Loose terminal on ignition cable; cable shorted.
- D. Inoperative ignition transformer.
- E. Insufficient or no voltage at pilot ignition circuit terminal.

**2. Spark but no flame.**

- A. Lack of fuel — no gas pressure, closed valve, empty tank, broken line, etc.
- B. Inoperative pilot solenoid.
- C. Insufficient or no voltage at pilot ignition circuit terminal.
- D. Too much air.

**3. Low fire switch open in low fire proving circuit.**

- A. Damper motor not closed, defective switch.
- B. Damper jammed.

**4. Running interlock circuit not completed.**

- A. Combustion or atomizing air proving switches defective or not properly set.
- B. Motor starter interlock contact not closed.

**5. Flame detector defective, sight tube obstructed, or lens dirty.****C. Pilot Flame, but No Main Flame****1. Gas fired unit:**

- A. Manual gas cock closed.
- B. Main gas valve inoperative.
- C. Gas pressure regulator inoperative.

**2. Oil fired unit:**

- A. Oil supply cut off by obstruction, closed valve, or loss of suction.
- B. Supply pump inoperative.
- C. No fuel.
- D. Main oil valve inoperative.
- E. Check oil nozzle, gun and lines.

3. Flame detector defective, sight tube obstructed or lens dirty.
4. Insufficient or no voltage at main fuel valve circuit terminal

#### **D. Burner Stays in Low Fire**

1. Pressure or temperature above modulating control setting.
2. Manual-automatic switch in wrong position.
3. Defective modulating control.

#### **E. Shutdown Occurs During Firing**

1. Loss or stoppage of fuel supply.
2. Defective fuel valve; loose electrical connection.
3. Flame detector weak or defective.
4. Lens dirty or sight tube obstructed.
5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
6. If the programmer lockout switch has tripped:
  - A. Check fuel lines and valves.
  - B. Check flame detector.
  - C. Check for open circuit in running interlock circuit.
  - D. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.
7. **Improper air/fuel ratio (lean fire).**
  - A. Damper stuck open.
  - B. Fluctuating fuel supply.
    1. Temporary obstruction in fuel line.
    2. Temporary drop in gas pressure.
8. Interlock device inoperative or defective.

 **Warning**

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

 **Warning**

Do not repeat unsuccessful lighting attempts without rechecking the burner and pilot adjustments. Damage to the boiler or serious personal injury or death may result.

 **Warning**

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

 **Important**

In case of emergency, shut down the burner by turning the On-Off switch to the “Off” position. Turn the fuel selector switch to the “Off” position. Shut off the main manual fuel shut off valves on the fuel supply line. The unit can also be shut down with the main electrical power disconnect. Inspect the burner carefully and troubleshoot before re-starting the unit.

***Notes***



## Section 6 Inspection and Maintenance

General . . . . .	6-2
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Checking Flame Failure . . . . .	6-3
Firing Head Inspection . . . . .	6-4
Pilot and Ignition Electrode . . . . .	6-4
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 **Warning**

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

## **A. General**

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

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

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

## **B. Electrical System**

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

### **Control System**

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

### **Programming Control**

This control requires no adjustment, nor should any attempt be made to alter contact settings or timing logic. Those programmers with contacts may require occasional cleaning. If so, follow instructions given in the manufacturer's bulletin. Never use abrasive materials. The manufacturer's bulletin also contains troubleshooting information. The flame detector lens should be cleaned as often as conditions demand. A periodic safety check procedure should be established to test the complete safeguard system. Tests should verify safety shutdown with a safety lock out upon failure to ignite the pilot or the main flame, and upon loss of flame. Each of these conditions should be checked on a scheduled basis. The safety check procedures are contained in the manufacturers bulletin.

### **Electric Motors.**

Motor supply voltage must not vary more than 10 percent from nameplate ratings. At initial start-up and at 1 year thereafter, check the motor current with a meter while the burner is in high fire position. If the reading exceeds the nameplate rating plus service

factor, determine the cause and correct it immediately. In dusty locations, clean the motor regularly to assure adequate cooling. Lubricate in accordance with the manufacturer's instructions.

## C. Checking Flame Failure

### Checking Pilot Flame Failure

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

### Checking Failure To Light Main Flame

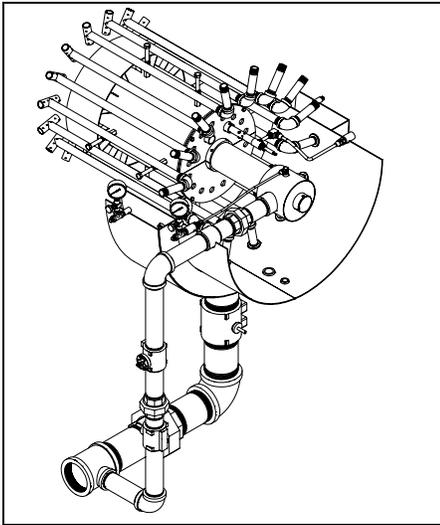
Leave the gas pilot shutoff cock open. Shut off the main burner fuel supply. Turn the switch on. The pilot will light upon completion of the pre-purge period. The main fuel valves will be energized, but there should be no main flame. The fuel valves de-energize within 4 seconds after the main burner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

### Checking Loss of Flame

With the burner in normal operation, shut off the main burner fuel supply to extinguish main flame. The fuel valves will be de-energized and the relay will signal the condition within 4 seconds. The control will then lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge period and stop. Turn the burner switch off. Reset the safety switch. Re-establish main fuel supply.

 **Caution**

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



**Figure 6-1 NT Firing Head**

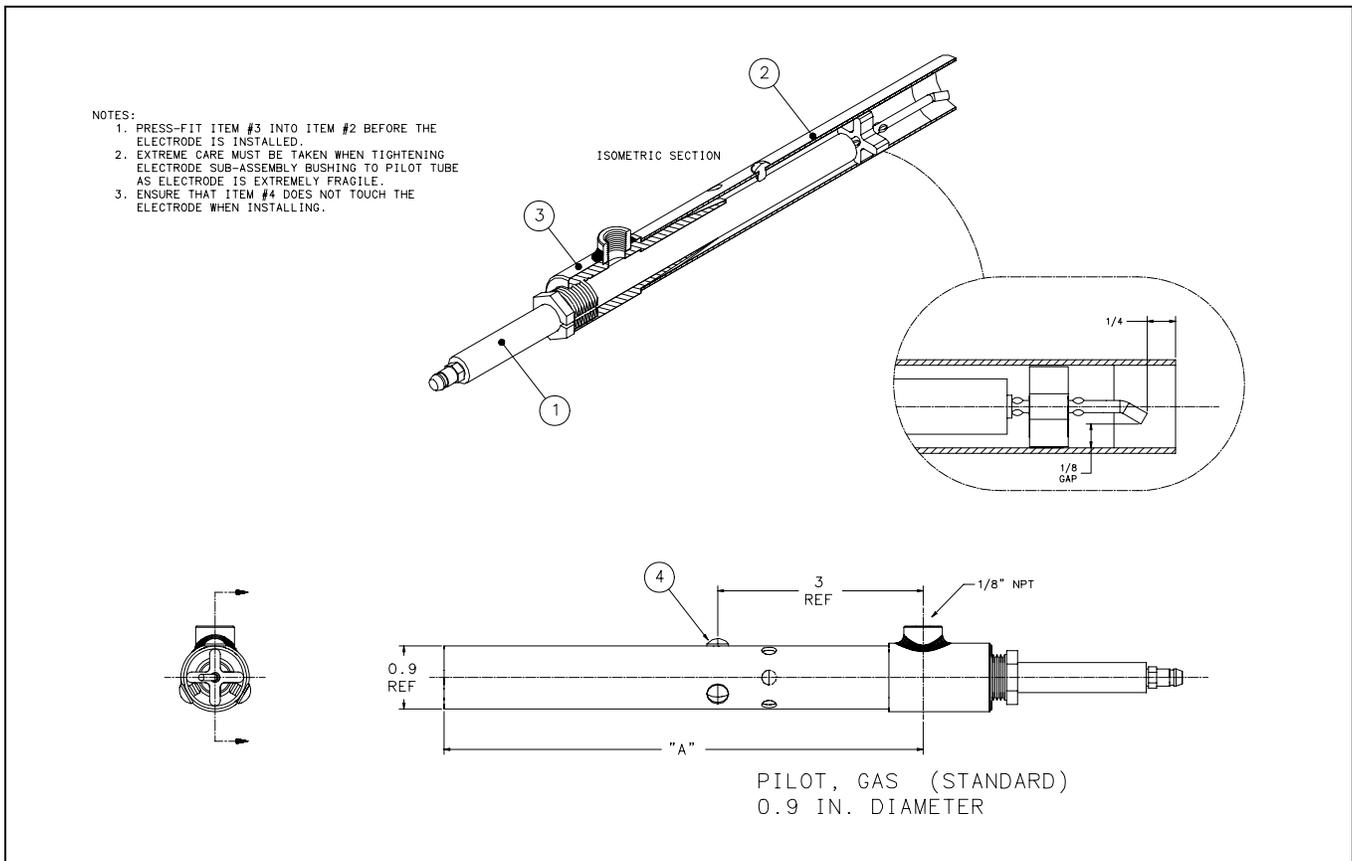
### **D. Firing Head Inspection**

Open rear door or side access panels to view cassette. Inspect the flame scanner lens to be sure it is clean and the support tube is in proper position to sight the flame. Inspect the lead wire to the ignition electrode. It must be firmly attached and the insulation should be clean and free of cracks. The oil nozzle should be inspected periodically depending on the grade of oil burned and the cleanliness of the environment.

If fibrous material is discovered in the gas lance ports, disassemble the lance and back flush with shop air. Further inspection of connection hoses and gaskets must be made to isolate the contaminant source. Be sure when reassembling the lances to orientate the gas orifices in the correct position

### **E. Pilot and Ignition Electrode**

The ignition transformer requires little attention other than making sure the ignition wire is firmly attached to the transformer and the electrode. Be sure the wire insulation is in good condition and not grounded. Failure to keep the ignition electrode clean and properly set can cause faulty operation. Refer to Figure 6-3, for electrode gap setting and position. The pilot assembly is supported by a socket in the diffuser and gas inlet tube. No adjustment is required except proper positioning of the electrode wire. To remove pilot, first shut off the pilot manual shutoff cock, and disconnect the ignition wire. Unscrew the pilot line at the pilot union, and pull the pilot out. Check electrode gap for wear and carbon buildup. Clean and adjust gap setting. Re-assemble the pilot in reverse order. Open the pilot line shutoff cock and re-adjust the pilot flame using the instructions in the Commissioning section of this manual.



**Figure 6-2 Electrode Setting**

## F. Flame Scanner

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

## G. Oil Nozzles

Successful burner operation requires use of the proper style nozzle tip and keeping the orifices clean. Standard nozzle tips furnished on the burners are of a special emulsifying type which delivers a spray of extreme fineness at an angle which ensures proper mixing with the air stream. Unsatisfactory performance and loss of efficiency can result from the use of nonstandard nozzle tips. If the burner flame becomes stringy or lazy, or wetting on the refractory cone is noticed, it is possible that the nozzle spring is not properly in place or the nozzle is clogged.

### Important

When replacing a nozzle tip and swirler assembly, make sure a new spring is installed to ensure proper fit.



**Figure 6-3 Disassembling Oil Nozzle**

This problem is usually indicated by an abnormally high reading on the atomizing air pressure gauge on the oil gun. To remove the nozzle, disconnect the oil and air tubes to the nozzle assembly. To clean the nozzle tip and swirler, unscrew the tip from the nozzle body. Use care not to distort the tube. Hold the nozzle body in a vise or use two wrenches, one on the body and one on the tip. Disassemble the nozzle tip. Carefully clean all parts in solvent. Use a brass brush on the nozzle tip. The orifices should be cleaned with a wood toothpick or similar device. Do not use wire or a drill to clean nozzle tip.

When reinstalling, be sure the nozzle is centered in the blast tube.

## **H. Air Handling system**

The backward inclined impeller requires minimal maintenance. Check for dirt buildup and clean the blades as required. Inspect the impeller hub and blades for cracks. Replace if any are noticed. When removing and installing the impeller it is mandatory to use an impact wrench to remove the lock nut. Shims are used on the motor shaft to position the impeller. Make sure the air inlet cone fits inside the impeller.

## **I. Burner Mounting Inspection**

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. If leakage occurs, refer to Chapter 2, Figure 2-3 and 2-4 for proper sealing procedure.

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## J. Oil System

Inspect the complete system for any sign of leaks. Check inlet and return oil pressures to assure they are maintained as originally set.

### Fuel Oil Circulating Pump.

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

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

### Air Compressor.

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

Alignment of the compressor and motor sheaves and proper belt tension are important. Belt tension is adjusted according to the displacement on the belt with thumb pressure. The displacement should be 3/8 to 1/2 inch.

To adjust, loosen the two bolts on the compressor mounting flange and the three setscrews which hold the compressor in place. The mounting flange is slotted at the top, which permits belt tightening. If the slot in the mounting flange is insufficient for obtaining proper belt tension, the modular base has two extra holes for this purpose. Move the top bolt to the next hole and adjust. Tighten bolts and set screws. Replace belt guards. If belt becomes frayed or cracked, replace it.

### Oil Strainers

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

 **Caution**

All power must be disconnected before servicing the valves.

## K. Gas System

### Motorized Main Gas Valves.

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

### Solenoid Valves.

A slight hum from the solenoid is normal when the coil is energized. Should the valve fail to operate, check that there is voltage at the valve coil. If there is no voltage at coil, check for loose wiring connections. If there is proper voltage at the valve coil and the valve still fails to open, replace the coil. Refer to manufacturer's bulletin for correct procedure in coil replacement. Should it become necessary to replace the complete valve, be sure that the flow is in the direction of the arrow on the body. Test for gas leaks and check valve action several times to ensure proper operation before attempting to relight burner.

### Gas Pressure regulators

Check the gas pressure at the outlet of the regulator on the main and pilot lines. Check for abnormal reading and against original pressures set at initial start-up.

### Gas Pressure Switches

Inspect the low and high pressure switches settings and correct response to pressure variations.

## L. Extended Shutdown

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

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

## M. Recommended Inspection Schedule

<p><b>Daily</b></p> <ul style="list-style-type: none"> <li>Check gauges, monitors, and indicators</li> <li>Check Instrument and equipment settings</li> <li>Check combustion visually</li> <li>Record flue gas temperature</li> <li>Record oil pressures and temperatures</li> <li>Record gas pressures</li> <li>Record atomizing air pressure</li> <li>Record flame signal strength</li> </ul>
<p><b>Weekly</b></p> <ul style="list-style-type: none"> <li>Check for tight closure of fuel valves</li> <li>Check fuel and air connections</li> <li>Check indicating lights and alarm</li> <li>Check operating and limit controls</li> <li>Check safety and interlock controls</li> <li>Check for leaks, noise, vibration, unusual conditions, etc.</li> <li>Check ignition system</li> <li>Check oil pump and burner strainers, filters. Clean as required</li> </ul>
<p><b>Monthly</b></p> <ul style="list-style-type: none"> <li>Inspect burner system</li> <li>Inspect for flue gas leak</li> <li>Inspect for hot spots</li> <li>Analyze combustion</li> <li>Inspect oil and gas systems for leaks</li> <li>Inspect refractory</li> <li>Check nozzle and diffuser, clean as required</li> </ul>
<p><b>Semi-Annually</b></p> <ul style="list-style-type: none"> <li>Clean oil pump strainer, filter</li> <li>Clean compressor air cleaner, oil filter, and air-oil separator</li> <li>Check air pump coupling alignment, and belt tension</li> <li>Remove and clean nozzle line oil heater</li> <li>Inspect burner components</li> <li>Check combustion, and adjust if required</li> </ul>
<p><b>Annually</b></p> <ul style="list-style-type: none"> <li>Clean boiler</li> <li>Clean breeching</li> <li>Check operation of safety and relief valves</li> <li>Check and adjust all limit controls, and safety interlocks</li> <li>Check all vent lines</li> <li>Check nozzle, swirler, and spring for wear, replace as required</li> <li>Check all fuel valves</li> <li>Clean strainers and filters</li> <li>Clean compressor assembly</li> <li>Adjust burner and controls with a complete combustion test</li> </ul>



### Important

Refer to the boiler operation and maintenance manual for boiler inspection schedule. The boiler controls, low water cut off, blow down, and feed water system, require periodic maintenance. Insurance regulations and local laws require periodic inspection of the pressure vessel by an authorized inspector.







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