# S1/LNS1 SERIES

## Installation,
## Operation,
## Service,
## and
## Parts Manual

Industrial Combustion, LLC

**WARNING**

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

IC-1449
1/09

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## OPERATING PRECAUTIONS

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

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

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

These symbols and their meanings are as follows:

### ⚠ WARNING

**FAILURE TO INSTALL AND OPERATE THIS EQUIPMENT IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDED INSTRUCTIONS AND INDUSTRY STANDARDS AND PRACTICES CAN RESULT IN FIRE, EXPLOSION, PROPERTY DAMAGE AND/OR PERSONAL INJURY !!** READ THIS MANUAL IN IT'S ENTIRIETY 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.

### ⚠ WARNING

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

### ⚠ WARNING

READ PRODUCT MANUAL AND FULLY UNDERSTAND ITS CONTENTS BEFOREATTEMPTING TO OPERATE THIS EQUIPMENT. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.

### ⚠ WARNING

TO AVOID PERSONAL INJURY FROM MOVING PARTS, SHUT OFF ALL ELECTRICAL POWER BEFORE SERVICING THIS EQUIPMENT.

### CAUTION

PROVIDE SUPPORT FOR THIS PANEL TO PREVENT DAMAGE TO THE ELECTRICAL COMPONENTS.

### CAUTION

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

### CAUTION

AFTER FINAL FUEL INPUT ADJUSTMENTS ARE MADE, VERIFY FUEL INPUT BY METER IF POSSIBLE

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

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

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

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

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

| MODELS STANDARD | FUEL - AIR ATOMIZATION |
|---|---|
| S1G | GAS |
| S1L | #2 OIL |
| S1LG | #2 OIL and GAS |
| LNS1G | LOW Nox < 30 ppm GAS |
| LNS1LG | LOW NOx #2 OIL and GAS |

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

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

THE S1/SERIES BURNERS ARE DESIGNED TO BURN EITHER GAS OR LIGHT OIL No.1 OR 2 AS DEFINED BY ASTM D396-1978 SPECIFICATIONS, AND HEAVY OILS.
DO NOT USE GASOLINE, CRANKASE OIL, OR ANY OIL CONTAINING GASOLINE.

| BURNER SIZE | MAX.BURNER GAS INPUT MBTU/HR. |
|---|---|
| 462 | 46,200,000 |
| 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 | MAX.BURNER OIL INPUT US G.P.H. |
|---|---|
| 462 | 330 |
| 504 | 360 |
| 546 | 390 |
| 588 | 420 |
| 630 | 450 |

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

# CHAPTER 1
# INTRODUCTION

## A. GENERAL INFORMATION

Industrial Combustion S1/Series burners are assembled, wired and tested at the factory. They are listed by the Underwriters Laboratory, CSD-1, NFPA-85, I.R.I., F.M., including the National Electrical Code (NEC) and associated insurance underwriters. Where applicable, the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail. Other regulatory agency control options are available.

**CAUTION**

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

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

## B. DESCRIPTION

The Industrial Combustion S1/Series oil burners are of the low pressure, air atomizing (nozzle) type. Gas burners are of the peripheral mix type. All burners feature ignition by spark-ignited gas pilot flame. With either fuel, the burner operates with full modulation. A switch permits changeover from automatic fully modulated firing to manually set firing at any desired rate between minimum and maximum. Additional safeguards assure that the burner always returns to minimum firing position for ignition.

S1/Series burners are designed for automatic, unattended operation except for periodic inspection and maintenance. After selecting the proper overload settings for the starter, the rest of the control panel components require little attention except for occasional cleaning.

## C. OPERATING CONTROLS

The burner is supplied with a remote control panel and with a burner mounted junction box.

### CONTROL PANEL

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

**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 OIL-AIR PUMP OR COMPRESSOR TO DE-ENERGIZE

Off position: Burner off.
Oil position: Selects oil as the firing fuel.

3. **CONTROL CIRCUIT BREAKER** - supplementary low overcurrent protection only. No larger than 15 amps.

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

**WARNING**

READ THE FLAME SAFEGUARD MANUAL AND FULLY UNDERSTAND ITS CONTENTS BEFORE ATTEMPTING TO OPERATE THIS EQUIPMENT. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.

## D. FLAME SAFEGUARD CONTROLS

The flame safeguard programmer incorporates a flame sensing cell (scanner) to shut down the burner in the event of pilot flame or main flame failure. Other safety controls shut down the burner based on sequence of operation as shown in the manufacturers flame safeguard manual.

## E. COMBUSTION AIR HANDLING SYSTEM

The combustion air handling system consists of two major components:

1. DAMPER ASSEMBLY.

A multi blade system regulates the combustion air volume and is positioned by a modulating motor. The dampers are normally ALMOST CLOSED in the low-fire position and opens as the burner drives toward a high-fire position.

2. MOTOR DRIVEN IMPELLER.

The diameter of the impeller determines available air pressure and the width determines air capacity in cubic feet per minute. Alternate motor-impeller combinations are available for 50 cycle or 60 cycle power and for firing against either moderate or high furnace pressure. For higher altitudes and higher furnace pressures, motor and impeller combinations are determined at the factory.

## 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 the potentiometer-regulated modulating motor. Combustion air control damper, oil metering valve and/or gas volume butterfly valves are through variable rate rod and lever linkages. The modulating motor rotates 90 degrees from low to high position.

Flow rate through each component is adjusted by positioning the control rods on the levers and the angular position of levers on shafts. Lever on the modulating motor shafts actuate the high fire position proving switch.

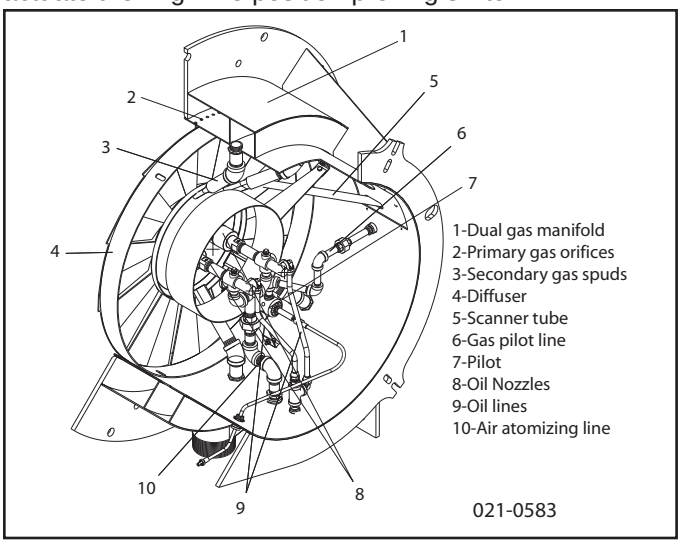



Figure 1-1

## G. FIRING HEAD

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

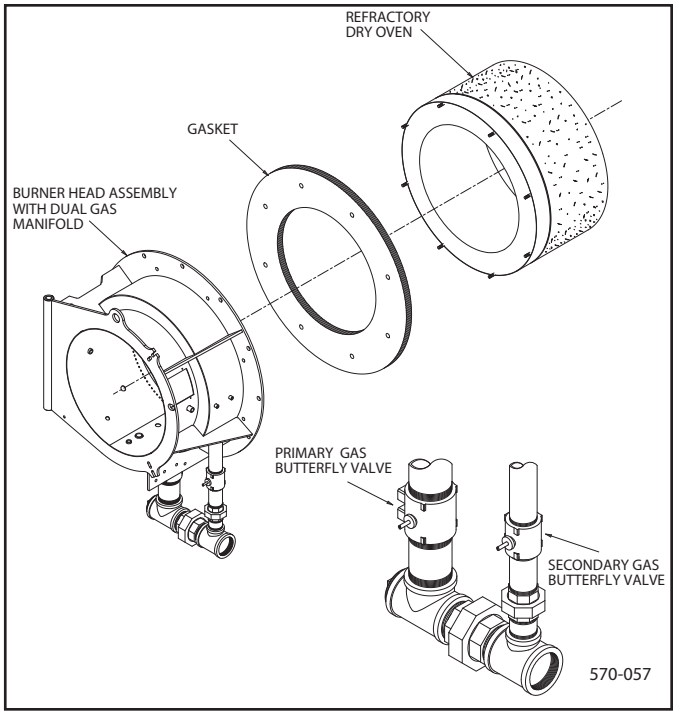



Figure 1-2

## H. OIL SYSTEM AIR ATOMIZING

S1 Model burners use compressed air for atomization. Atomizing air is independent of combustion air. The system is supplied with a separate compressor module for mounting near the burner.

**3-WAY SOLENOID VALVE.**

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

**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.

**OIL STRAINER**

Prevents foreign matter from entering the burner oil system.

**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:

**AIR COMPRESSOR MODULE**

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

**OIL METERING**

The oil metering unit is a MAXON Synchro flow control valve. The multiple screw cam assembly provides mechanical adjustment capabilities to the fuel ratio at each valve position throughout the entire capacity range.

**OPERATION**

Fuel is delivered to the metering system at 50 to 70 psi. Metered oil is delivered to the common port of a 3-way solenoid valve for transfer to the burner nozzle through the normally closed port or back to the storage tank through the normally open port. During pre- and post purge, metered oil is returned to the tank. During normal firing, all metered oil is delivered to the nozzle.

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. 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.

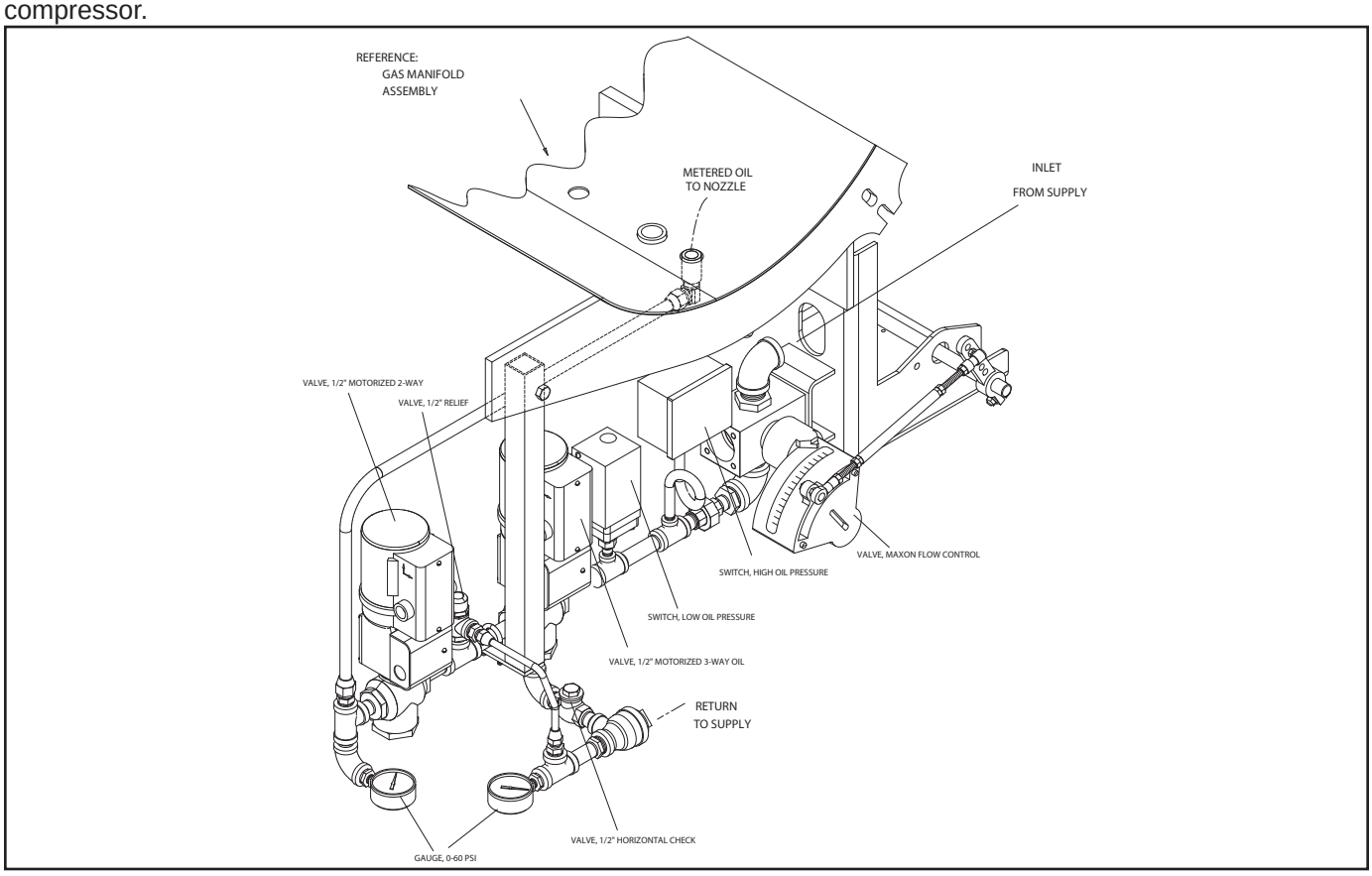



Figure 1-3

## I. GAS SYSTEM

Gas is introduced into the combustion zone from a circular manifold through multiple ports in the blast tube, and through a pre-mix zone. Firing rate is determined by the size and number of ports, by manifold pressure and by combustion zone pressure. The firing rate is regulated by a rotary, butterfly type throttling valve at the manifold inlet. The valve is actuated by an adjustable linkage from the modulating motor. Depending upon specific requirements, one or two safety shutoff, motorized main gas valves are provided for installation in the gas train upstream of the butterfly 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 TRAIN COMPONENTS**

Depending upon the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items. A typical gas train is shown in Figure 1-4.

**GAS VOLUME VALVE.**

Two butterfly type valves are positioned by linkage from the modulating motor and controls the rate of flow of gas.

**MAIN GAS VALVES.**

Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard U.L. burners include: One motorized gas valve w/closure interlock and one standard motorized valve.

**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 pre-selected setting. Should the pressure rise above the setting, the switch contacts will open causing main gas valve(s) to close. This switch requires manual reset after being tripped.

**LOW GAS PRESSURE SWITCH.**

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

## 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.

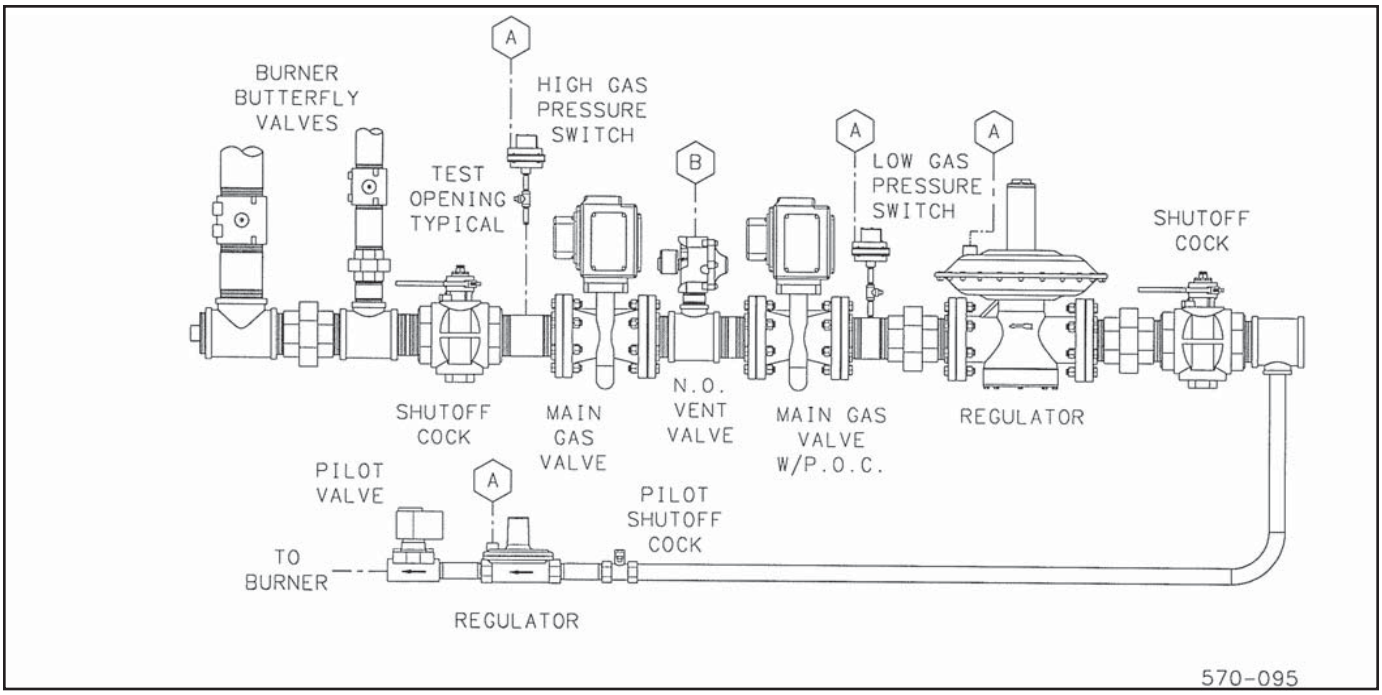



Figure 1-4

**OPERATION**

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

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

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

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

# CHAPTER 2
# INSTALLATION

## A. APPLICATION

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 or combustion cone, shipped with the burner, is shown in Figures 2-1 and 2-2. Securely support the burner pedestal on the floor or foundation. Allow enough clearance at the rear of the burner to allow the housing to swing open for service and maintenance. 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 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.

## C. PACKING PLASTIC REFRACTORY AROUND OVEN

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

## D. SEPARATE COMPRESSOR MODULE

For oil burners supplied with the separate compressor module, piping to the burner is installed as shown in Figure 2-4. Copper tubing for the installation is not supplied with the burner.

## 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 suction loss. Note that the supply line is higher above the burner metering pump inlet to help eliminate air problems. The return line to the tank is connected at the discharge port of the 3-way valve. Note that the return line should be a minimum of 20 inches higher than the supply line. Since air rises to the highest point, it will rise from the supply entrance and pass through the return line and on to the tank. Metered oil is pumped (by the metering pump) to the common port of a 3-way valve. With the 3-way valve de-energized, the metered oil returns to the tank through the back pressure valve and return line. When the 3-way valve is energized, metered oil is passed on to the burner oil nozzle and atomized by air from the compressor. The proper strainers, check valves, vacuum and pressure gauges, etc. should be installed as indicated. All lines should be pressure tested after installation.

**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.

## F. CIRCULATING OIL PUMP

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

## G. OIL PRESSURE REGULATOR

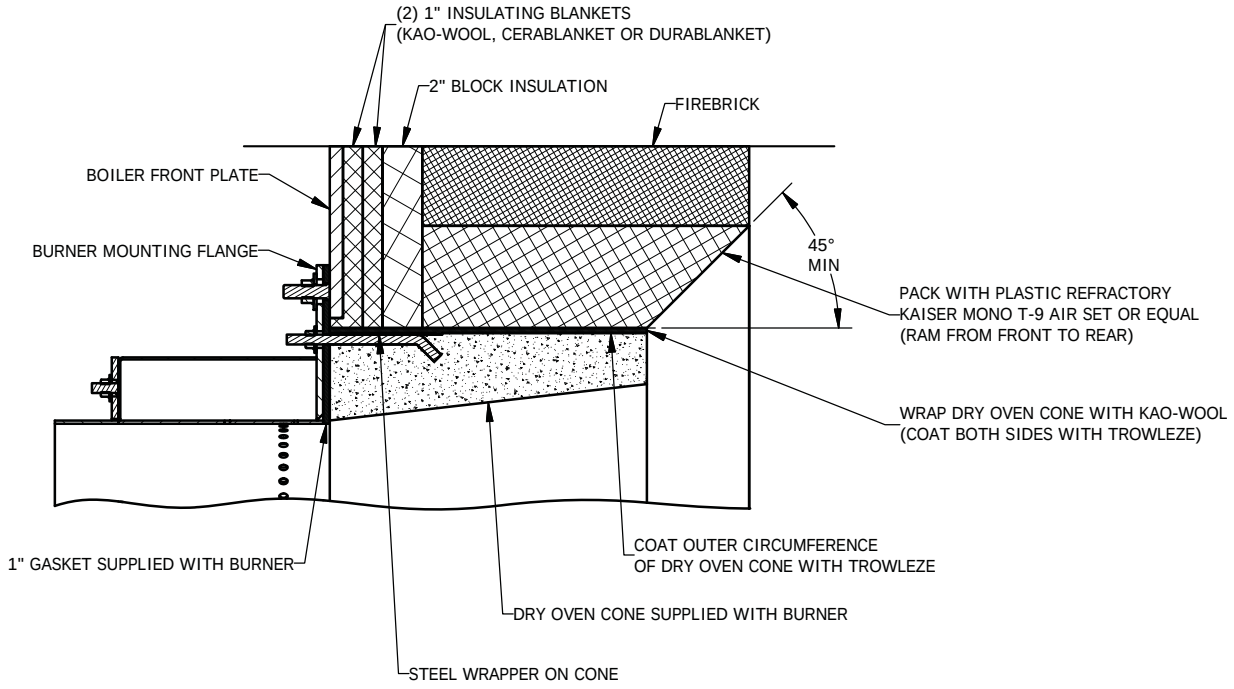
An oil pressure regulator should be installed in the supply line, close to the burner to regulate oil pressure. Oil pressure is 50 to 70 PSI to the metering valve.

## H. GAS PIPING

Refer to Figures, 2-6 for typical gas piping schematics.

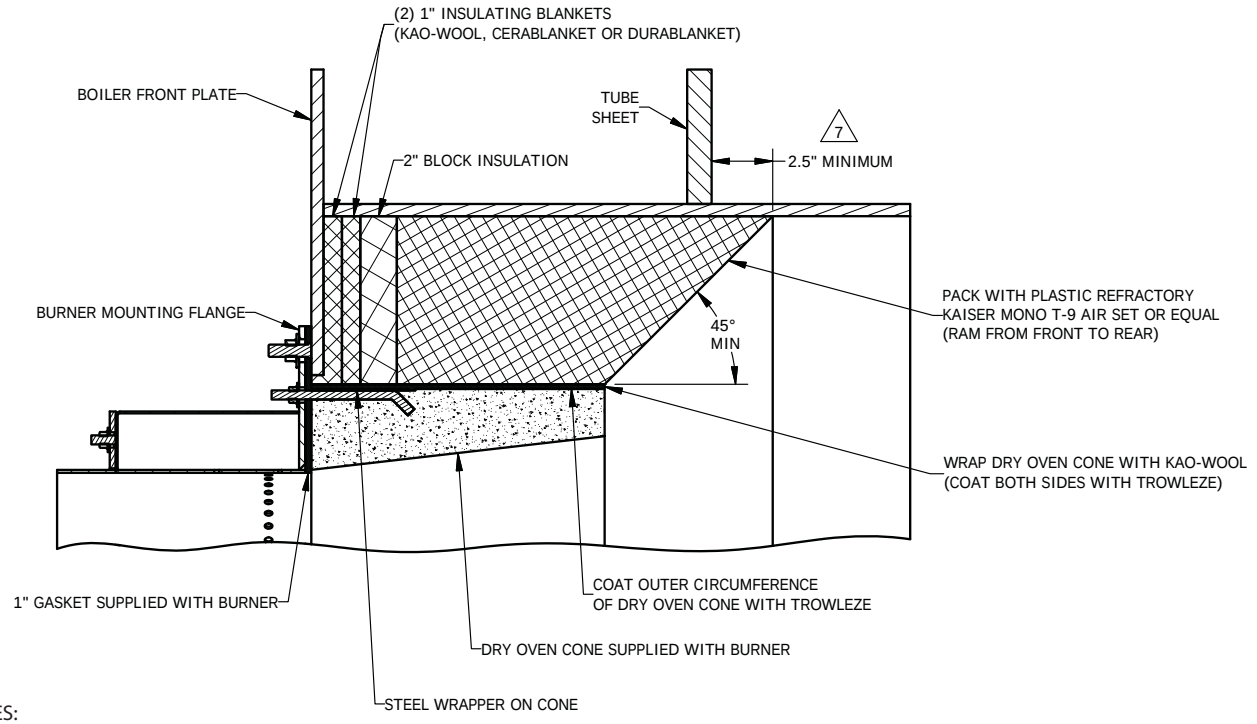
Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet. All piping must be in strict accordance with applicable codes, ordinances and regulations of the supplying utility. In the absence of other codes, piping should be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

Gas train components upstream of the butterfly valve are shipped loose. These components should be mounted by the installer as close to the butterfly valve as practical. Normally, the control train is ordered to suit a particular code




NOTES:
1. LAY THE DRY OVEN ON THE FLOOR WITH THE STUDS UP. CAREFULLY PRESS THE GASKET OVER THE STUDS.
2. LIFT THE DRY OVEN ONTO THE BURNER FLANGE AND GENTLY TIGHTEN THE BOLTS.
3. MAKE SURE THE DRY OVEN IS CENTERED ON THE BURNER FLANGE SO THE SPACE IS EQUAL ALL AROUND THE BURNER BLAST TUBE
4. MAKE SURE THAT NONE OF THE GASKET IS PROTRUDING INTO THE AIR STREAM. TIGHTEN THE DRY OVEN NUTS.
5. WRAP THE DRY OVEN WITH TROWLEZE COATED KAO-WOOL AND LIFT THE BURNER ONTO THE BURNER STUDS AND BOLT SECURELY IN PLACE.
6. FINISH REFRACTORY WORK INSIDE FURNACE.

BURNER MOUNTING DETAILS FOR WATERTUBE BOILERS Figure 2-1

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6. FINISH REFRACTORY WORK INSIDE FURNACE.

BURNER MOUNTING DETAILS FOR SCOTCH MARINE BOILERS Figure 2-2

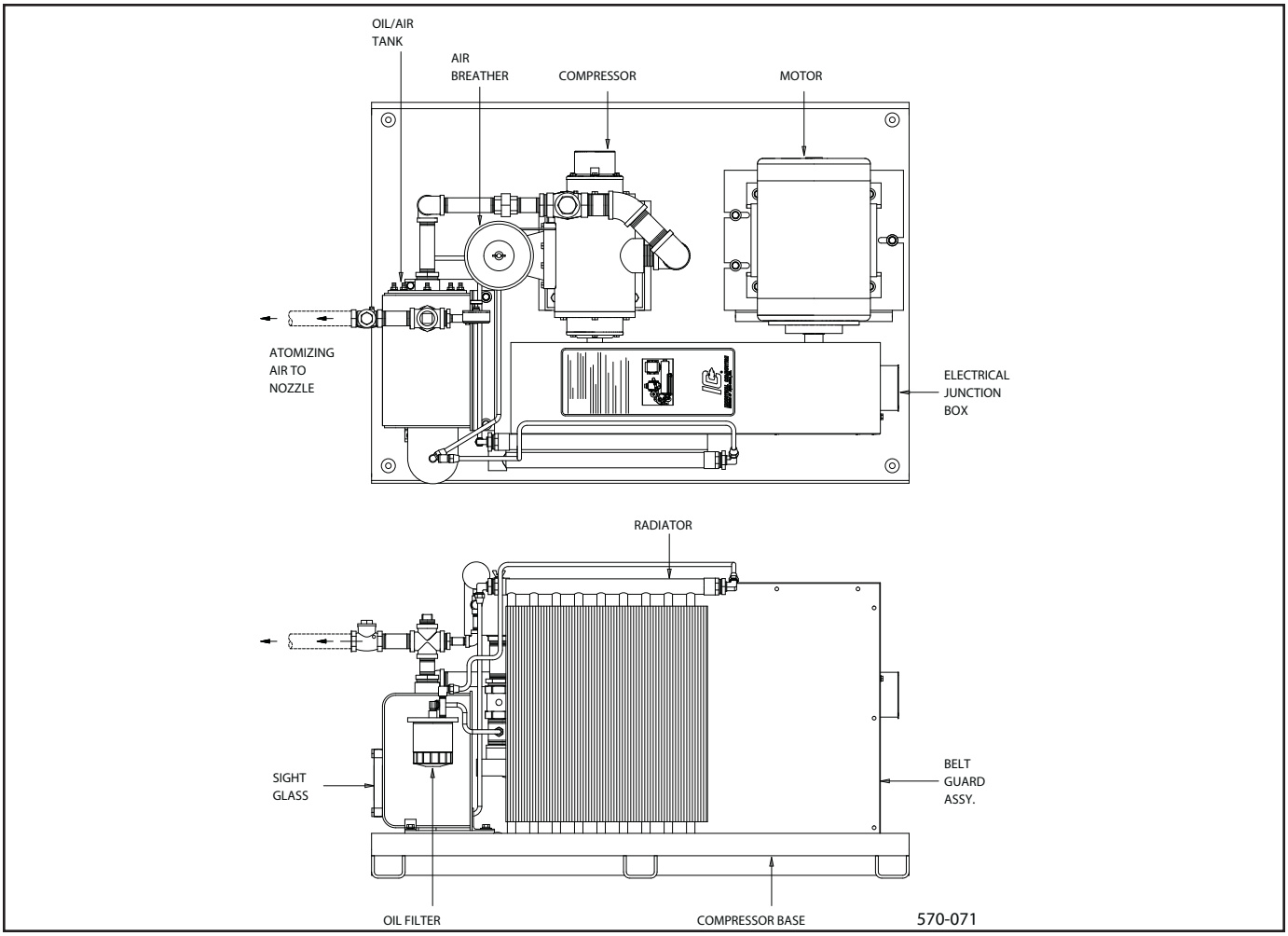



Figure 2-3

or insurance regulation - such as Underwriters Laboratories , Inc., CGA, Factory Mutual, or Industrial Risk Insurance.

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:

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

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

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

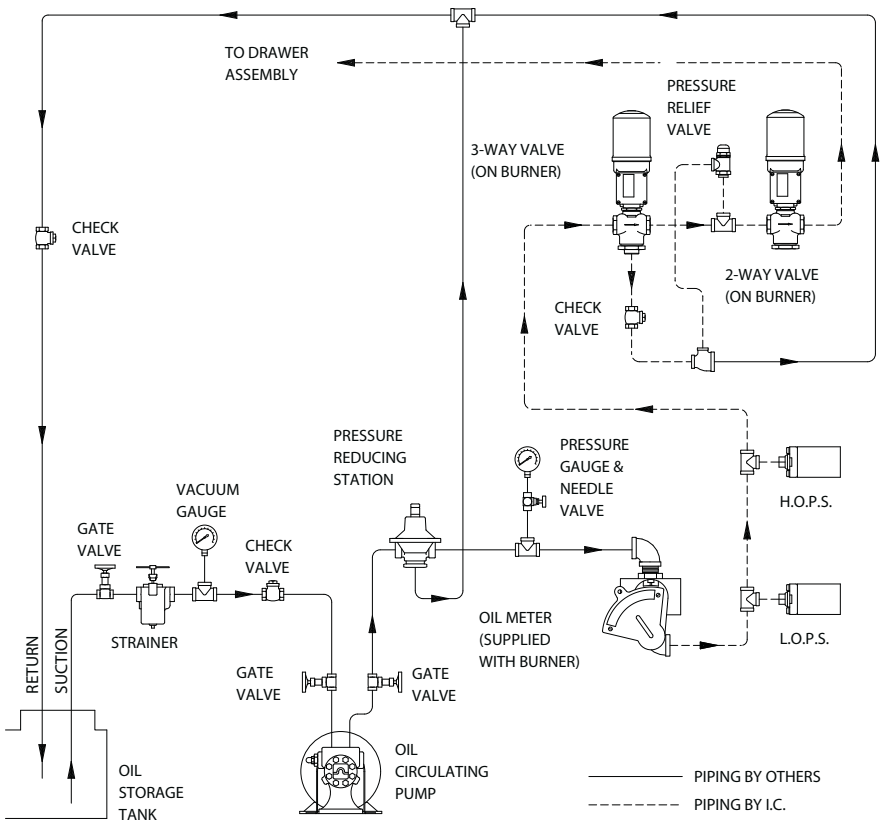
Before burner operation, be sure all motors are rotating in the correct direction. See Motor Rotation Reference on Sec1:13.

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

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

# CAUTION

THE BURNER REFRACTORY CONE 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 GRADUALY INCREASE THE FIRING RATE. FAILURE TO DO SO WILL RESULT IN DAMAGE AND CRACKS IN THE REFRACTORY.




NO. 2 OIL PIPING ARRANGEMENT 570-070

Figure 2-4

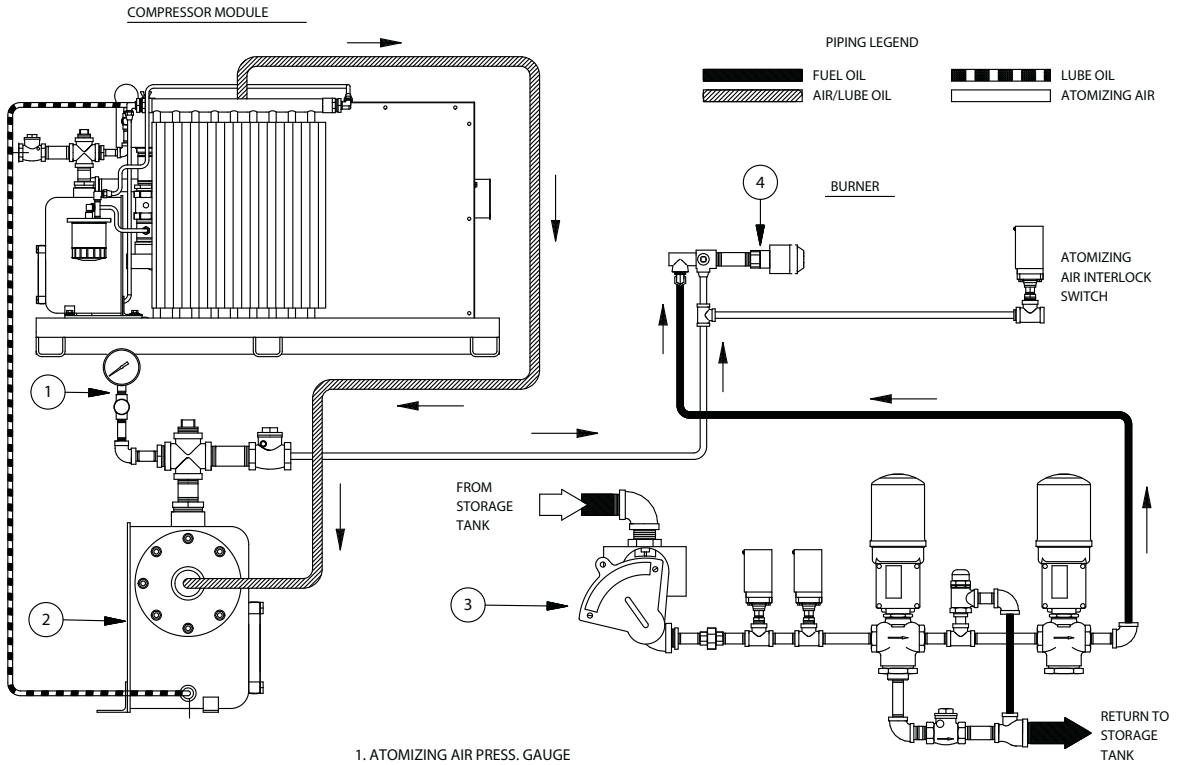
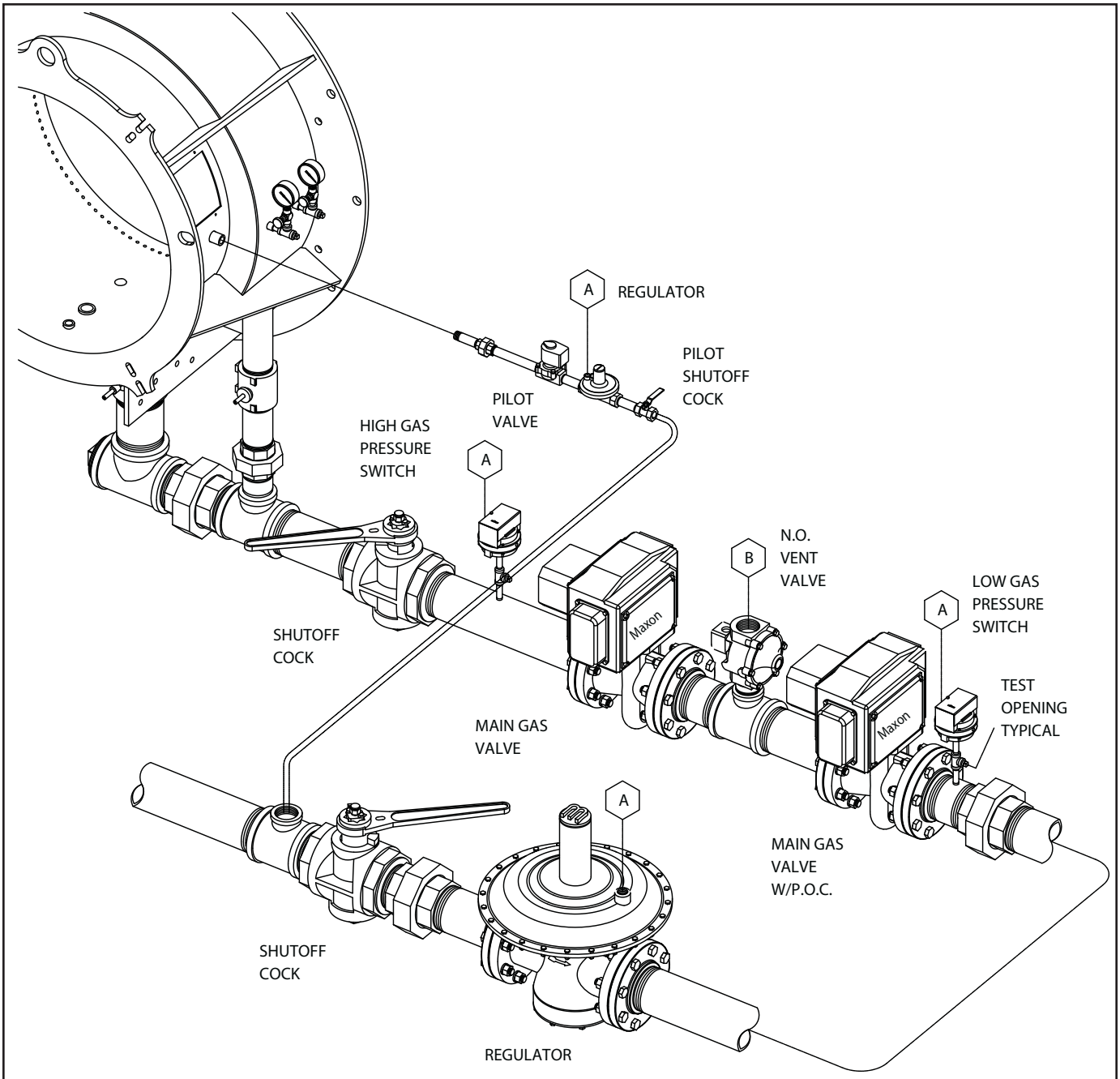



Figure 2-5




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.)

570-0076

BURNER MOUNTING DETAILS FOR SCOTCH MARINE BOILERS Figure 2-6

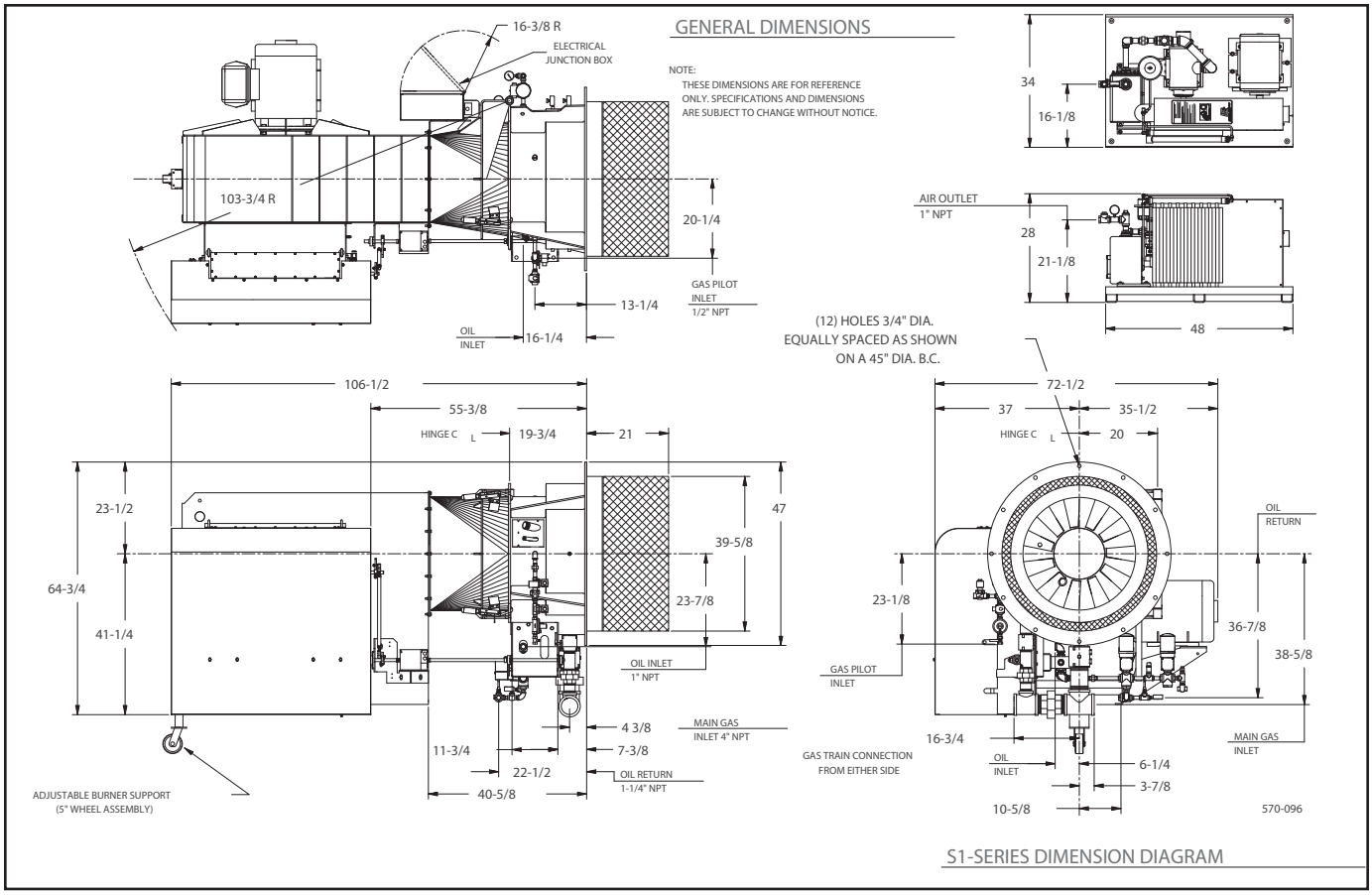



Figure 2-7

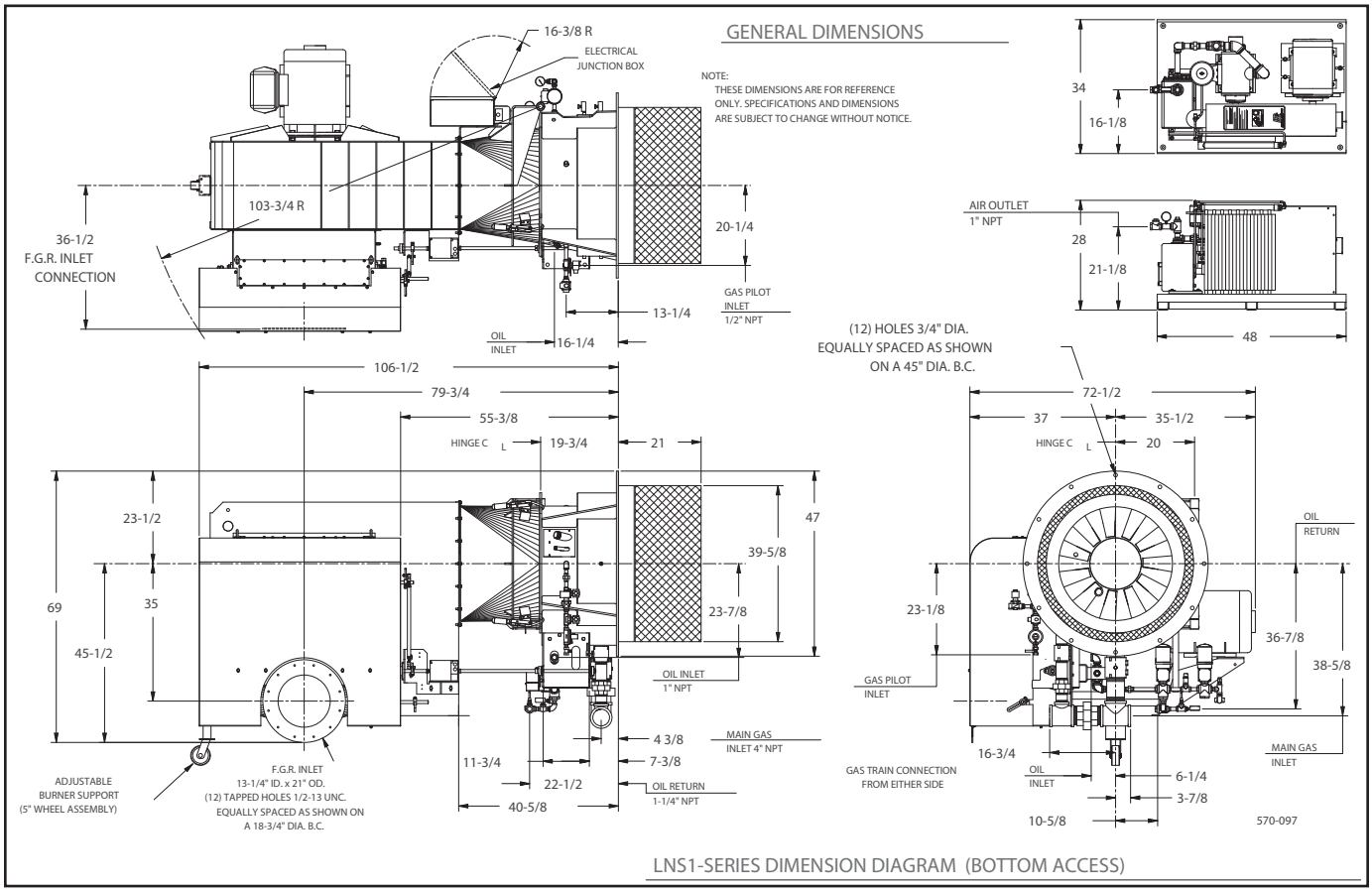



Figure 2-8

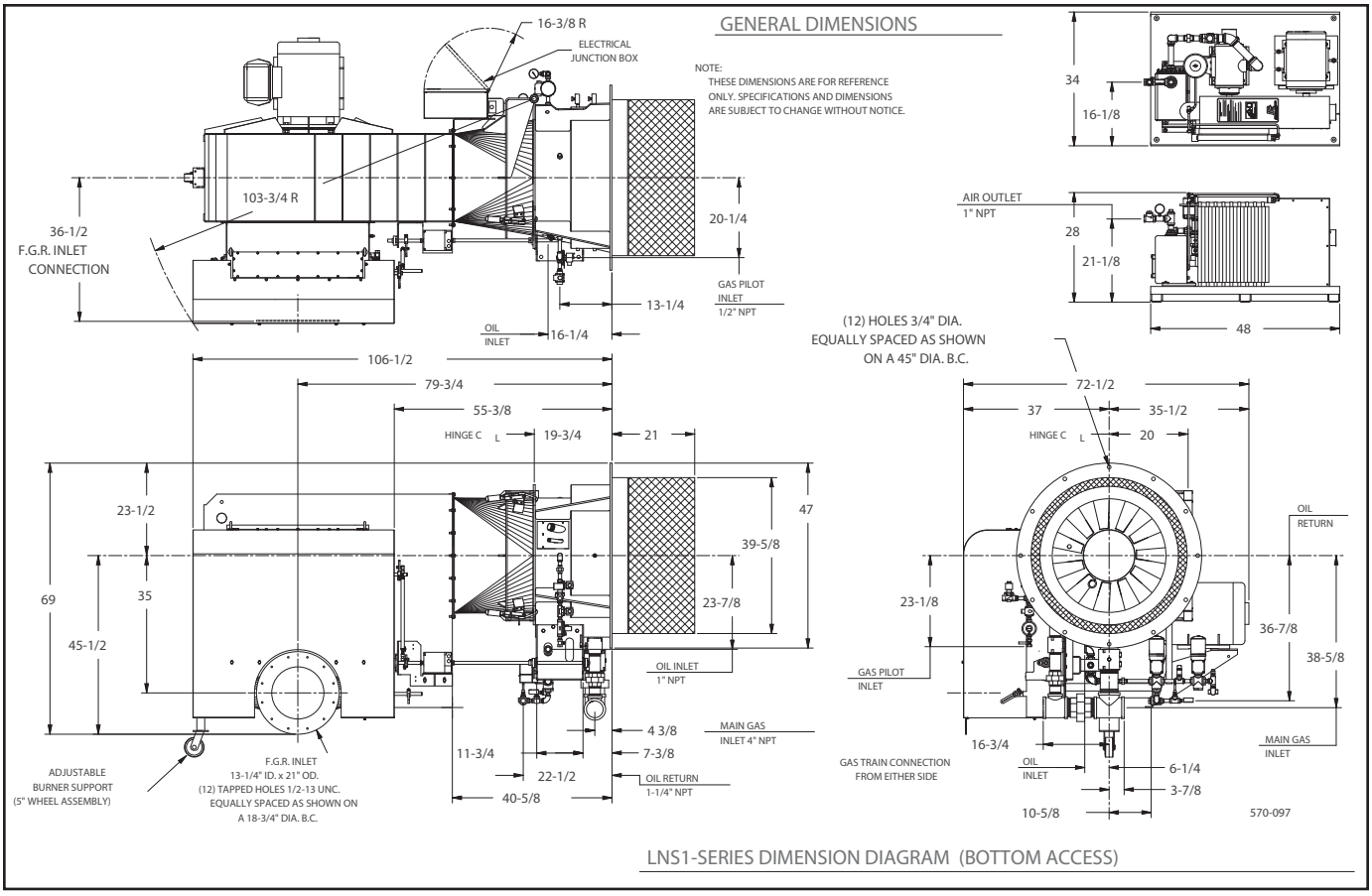



Figure 2-9

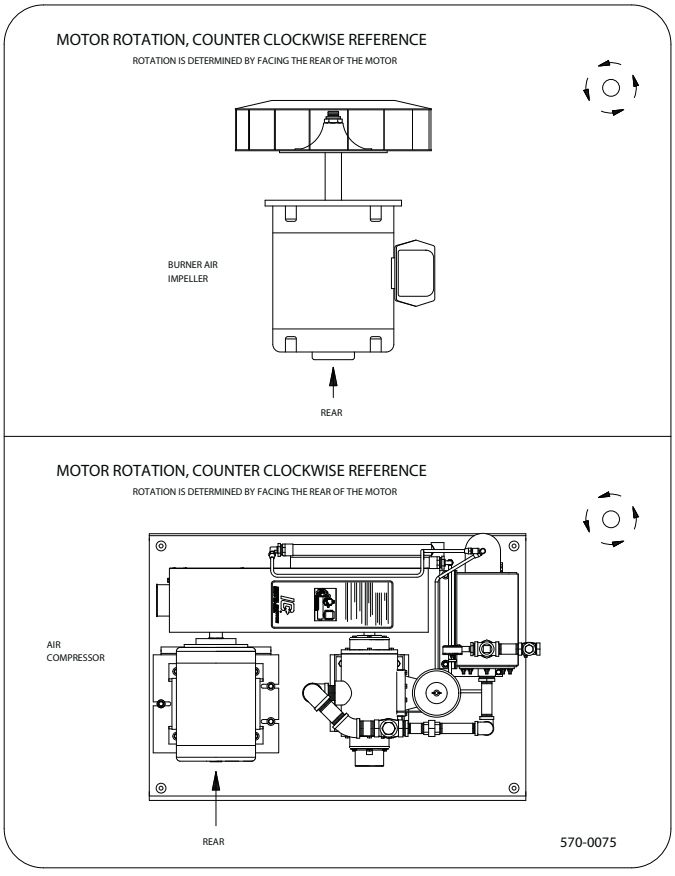



Figure 2-10

## 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. DO NOT EXCEED THE REGULATOR PRESSURE RATINGS.

## CAUTION

LUBRICATING OIL IS DRAINED FROM THE AIR OIL TANK BEFORE SHIPMENT. BEFORE ATTEMPTING TO START THE BURNER, ADD OIL TO THE RECOMMENDED LEVEL .

# CHAPTER 3
# OPERATION

## A. PREPARATIONS FOR STARTING

When the installation is complete and all electrical, fuel, water and vent stack connections are made, make certain said connections are tight. The operator should become familiar with the burner, boiler controls and components. To identify controls and components, refer to contents of Chapter 1. Adjustment procedures given in Chapter 4 should be reviewed prior to firing. The wiring diagram should also be studied along with the operating sequence of burner programmer.

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

**1. BOILER.**

Check the boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control sightly above the desired temperature. Set modulating controls at the desired temperature or pressure.

**2. BURNER.**

Check the electrical power supply to the burner in accordance with the nameplate voltage on all motors and the control circuit. Check the direction or rotation of the motors. Open the housing to check the electrode setting. Refer to Chapter 5, Figure 5-2, Sec1:30. Check the gas pilot pressure at the pilot gas regulator. Normal setting is 18" to 20" W.C.

For protection in shipment, the flame safeguard control chassis is shipped unmounted. Check all screw connections before attaching flame safeguard chassis to base. Screw must be secure to assure low resistance connections. The relay chassis is mounted on the sub-base with a screw which, when tightened, completes the connection between the sub-base and chassis contacts. Press manual reset button to be sure safety switch contacts are closed.

Check control linkage for proper movement of the air volume damper and fuel metering components. This can be done by loosening the linkage at the actuator level and manipulating by hand.

Check the air shutter and adjust low-fire setting.

**3. FIRING PREPARATIONS FOR OIL BURNERS.**

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

Inspect the compressor lube oil sump level. Add oil to bring the oil level to the midpoint or slightly higher in the reservoir sight glass. Fill with non-detergent SAE30 oil. Make certain that the drive belts or couplings are aligned and properly adjusted.

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

If the burner is a dual fuel model, make certain that the main gas shut off cock is closed and the fuel selector switch set to “OIL”.

**OIL FLOW.**

Open all valves in the oil suction and return line. The burner oil metering units are not capable of creating suction. Fuel oil must be supplied to the metering unit at a nominal 50 to 70 psi pressure by a circulating supply pump.

A vacuum (or compound pressure-vacuum) gauge should be installed in the oil suction line, and its reading noted. This gauge indicates the tightness of the suction system.

**4. OIL- AIR TANK (LUBE OIL).**

Check the lube oil level in the air-oil tank. Inspect oil level regularly. Loss of oil will damage the compressor. Fill the tank with **non detergent** SAE30 oil to a level midway up the sight glass. Do not overfill the tank.

For normal environment use SAE30 oil. For a 32 degree F. and below environment use SAE10 oil. Change oil every 2000 hours of operation.

**5. FIRING PREPARATIONS FOR GAS BURNERS.**

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

On combination fuel models, set the selector switch to gas. On initial start-up, it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequences to determine that the main gas valve opens. Turn the burner switch "OFF" and let programmer finish its cycle. Check to see that gas valve closes tightly. Set the high and low gas pressure switches.

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

## B. ELECTRICAL INTERFERENCE TEST

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

**1. GAS FIRED.**

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

Upon completion of successful test, proceed with start-up proceedures.

**2. OIL FIRED**

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

## C. GAS PILOT FLAME ADJUSTMENT

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 18" to 20" WC when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame.

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

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

## D. START-UP SEQUENCE

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

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

Refer to the manufacturers literature on programming controls and burner wiring diagrams for detailed information.

1. Begin starting sequence, with burner switch off, and with all manual valves closed. Switch main power on. (Power On) light.
2. When firing oil, open the manual oil valves.
3. When firing on gas, open the main manual gas valve.
4. When firing on gas, manually reset the high and low gas pressure switches.
5. Place the gas / oil selector switch in position for desired fuel. With all limit and operating controls calling for heat, the burner will follow the Flame Safeguard Sequence below.
6. When the burner motor starts, open the gas cock.
7. If firing on gas, when the main fuel lamp lights indicating pilot flame proven open the the manual leak test valve.

| Time in Seconds | External Operation |
|---|---|
| 0 | Provided the fuel valve is proven closed the burner motor and flame safeguard timer will start. |
| 7 | Air flow must be proven before ignition, or the flame safeguard will lockout. If the interlock circuit opens during a firing period, the burner will shut off and the flame safeguard will lockout. |
| 60 | Firing on gas and providing the air flow and low-fire have been proven, the pilot ignition transformer and ignition lamp are energized and the gas pilot valve opens to ignite the pilot. |
| 70 | Firing on oil, providing air flow and pilot have been proven, the main fuel lamp lights. When on gas or oil, the main valve opens to ignite the burner at low fire. |
| 80 | The pilot ignition transformer is de-energized, and the main safety shut-off pilot valve closes, scanner proves main flame only. If the low/auto swtich is in the auto position, the following will occur:<br><br>On gas, the butterfly valve and the burner air louvre moves to "low-fire" position. On oil, the metering pump and the burner air louvre moves to "low-fire" position. |
| 100 | "Normal run" position. Burner continues. |

## E. AUTOMATIC SHUTDOWN

| | Limit or operating controls open: |
|---|---|
| 100 | Fuel valves close. Main fuel lamp goes off. Flame safeguard timer starts. |
| 115 | Flame safeguard timer and burner motor stop. Burner is ready for start-up on the next call for heat. |

## F. MANUAL SHUTDOWN

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

## G. SAFETY SHUTDOWN

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

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

2. If a low water condition occurs, the burner shuts down as in Automatic Shutdown.
3. If a high or low gas pressure condition occurs while firing on gas, the burner shuts down as in Automatic Shutdown.

A. Condition must be corrected and the respective gas pressure switch manually reset before the burner will fire again on gas.

## H. START-UP AND OPERATING

### GAS BURNERS

Close the main and pilot gas cocks. Make sure the "ON-OFF" switch is in the "OFF" position and the fuel selector switch on "GAS". Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
Set the "MANUAL-AUTO" switch in the "MANUAL" position.
Set the manual potentiometer in low fire position.
Open the gas pilot cock.

Set the "ON-OFF" switch to "ON". The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot solenoid are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done. Refer to Paragraph B.

On initial start-up it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through prepurge and pilot sequence. Then determine that main gas valve opens. When this is confirmed, turn the burner switch "OFF" and let programmer finish its cycle. Check to see that gas valve has closed tightly. If ignition does not occur, turn the burner switch "OFF" and allow programmer to recycle for a new ignition trial.

Turn burner "ON" and after pilot ignition when the flame relay pulls in, the slow opening, motorized, main gas valve is energized. Slowly open the downstream manual shutoff gas cock. Main flame should ignite at this time. The gas valve and air damper continue advancing until high fire is reached.

Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting butterfly valve and air linkage. When low fire is adjusted, shut down burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.

Turn the potentiometer switch to the high fire position. Check high fire at this point using combustion instruments.

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

High fire combustion analysis typically is 9 to 10.5 percent $CO_2$. When conditions covered above are assured, refer to Sections I and J.

### OIL BURNERS

The fuel selector switch should be set to "OIL". On initial start-up of a combination burner, it is recommended that oil firing be adjusted before gas firing. Gas low firing rate is set to match oil low fire rate.

Be sure the "ON-OFF" switch is in the "OFF" position and the fuel selector switch is on "OIL". Actuate the manual reset button of the flame safeguard control to close the safety switch contacts. Be sure the "MANUAL-AUTO" switch is in "MANUAL" position. Set manual modulating control potentiometer in "LO" fire position.Open the pilot gas valve (if used).

Set the "ON-OFF" switch to "ON". The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done. Refer to Chapter 4, Sections C and D.

Observe the primary atomizing air pressure gauge on the air/oil tank. The gauge reading should be approximately 10 psi during pre-purge.

When the pilot flame is proven, the programmer will proceed to the main flame position. Allow the burner to operate in low fire, to warm the boiler before moving to high-fire.

Typically, for No. 2 through 4 oil, $CO_2$ is 8 to 11 percent at low fire.

Turn the manual potentiometer switch to the high fire position. Check high fire combustion at this point. Do not disturb previously established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings. The primary atomizing air pressure will increase automatically with the oil flow rate.

Typically, for No. 2 oil, $CO_2$ is 10 to 13 percent at high fire.

When conditions covered above are assured, refer to sections I and J

## I. NORMAL OPERATION

Normal operation must be with the "MANUAL-AUTO" switch selector at "AUTO".

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

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

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

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

## J. SHUTDOWN

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

The fuel valve(s) de-energize and flame extinguishes. The blower motor continues running during post-purge.

At the end of the post-purge, the blower motor is de-energized. The programmer returns to its starting position and stops. Unit is ready to restart.

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

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

**⚠ WARNING**

AN ULTRAVIOLET FLAME SENSOR ELECTRICAL SPARK INTERFERENCE TEST MUST BE PERFORMED AFTER FINAL ADJUSTMENT. SEE THIS SECTION PARAGRAPH "B" FOR ADDITIONAL INFORMATION.

# CHAPTER 4
# ADJUSTMENTS

## A. GENERAL

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

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

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

## B. COMBUSTION ADJUSTMENT ON GAS AND OIL

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

The proper settings of air-fuel ratios **must** be determined by flue gas analysis. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. Instruments are available to measure carbon dioxide ($CO_2$), oxygen ($O_2$), and carbon monoxide (CO).

### STACK TEMPERATURE

Net stack temperature is obtained by subtracting the ambient temperature from the flue gas temperature. A high net stack temperature indicates wasted heat. Stack temperature should be as low as possible without causing flue gas condensation.

Stack heat loss can be reduced by decreasing either the temperature or the volume of the flue gas, or both. Flue gas temperature is reduced by improving heat transfer or by reducing excess combustion air. A certain amount of excess air is necessary to complete combustion. More efficient burners require minimum excess air.

### SMOKE MEASUREMENT

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

Smoky combustion can result from: Improper air delivery, insufficient draft, improper fuel viscosity, improper fuel-air ratio, excessive air leaks in the combustion chamber, or improper fuel oil temperature.

### GAS ADJUSTMENTS

Low fire combustion analysis typically is 7 to 9 percent $CO_2$ and less than .04 percent CO (400 ppm). High fire reading typically is 9 to 10.5 percent $CO_2$ and less than .04 percent CO.

### FUEL OIL ADJUSTMENTS

Adjust for a “clean fire”. Typically for No. 2 oil, $CO_2$ is 8 to 11 percent at low fire and 10 to 13 percent at high fire, with a maximum of #1 spot (ATSM D2156 Shell-Bacharach scale).

## C. ELECTRICAL INTERFERENCE TEST

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

### GAS FIRED

Close the pilot and main line manual gas valves.

Start the burner and at time of pilot trial with just the electrical ignition system energized, the flame relay should **not** pull in (i.e. be energized).

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

### OIL FIRED

Disconnect the electrical power to the burner.

Disconnect the electric oil safety shutoff valve.

Reconnect electric power. Close the pilot line manual gas valve, if used.

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

Upon completion of successful test, disconnect power supply. Reconnect oil safety shutoff valve and turn on manual pilot gas valve. Reconnect power supply and proceed with start-up procedures.

## D. GAS SYSTEM

### GAS PRESSURE

Gas must be supplied at a pressure high enough to overcome the pressure loss in the burner gas train and furnace pressure while running at full input. Refer to nameplate inside control panel for gas pressure requirements at train inlet and manifold. The pressures listed are based on nominal 1000 Btu/cu ft natural gas at elevations up to 2000 feet above sea level.

### GAS FLOW

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

**NOTE**

WHEN CHECKING THE INPUT RATE, MAKE SURE NO OTHER EQUIPMENT IS OPERATING ON THE SAME METER.

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.

**MAIN GAS PRESSURE REGULATOR**

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

> **⚠ WARNING**
>
> AN ULTRA-VIOLET FLAME SENSOR ELECTRICAL SPARK INTERFERENCE TEST MUST BE PERFORMED AFTER FINAL ADJUSTMENT. SEE SECTION C OF THIS CHAPTER FOR ADDITIONAL INFORMATION.

**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.

**GAS COMBUSTION ADJUSTMENT**

After operating for a sufficient period of time to assure a warm boiler, make adjustments for most efficient combustion.The butterfly gas valve directly controls the rate of flow. The low fire light-off setting should be regarded as preliminary until proper gas pressure for high fire operation is established.

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

When proper gas flow is obtained, take a flue gas analysis reading.

With the high fire air-fuel ratio established, the gas pressure regulator needs no further adjusting.

Recheck low fire and adjust if necessary.

Proper setting of the air/fuel ratios at all rates must be determined by combustion analysis.

**GAS VALVES ADJUSTMENT**

The secondary valve feeds gas to the inner spuds. A slot in the valve stem in relationship to the shut/open scale on the valve indicates the blade position. Both low and high-fire positions are approximate. Adjustments to the valve should be made on the secondary valve linkage arm. To increase the travel, move the linkage arm closer to the pivot point. To decrease the travel, move the linkage arm away from the pivot point. The primary valve which feeds the outer spuds should be adjusted as normal. See Diagrams 4-5 at the end of this section for adjustments.

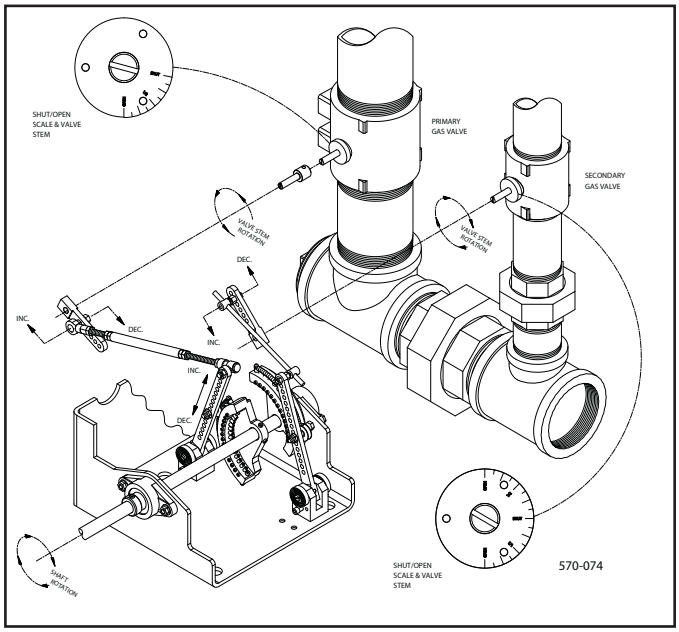



Figure 4-1

## CAM TRIM ADJUSTMENT

**Fine tuning the modulating cam.**

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

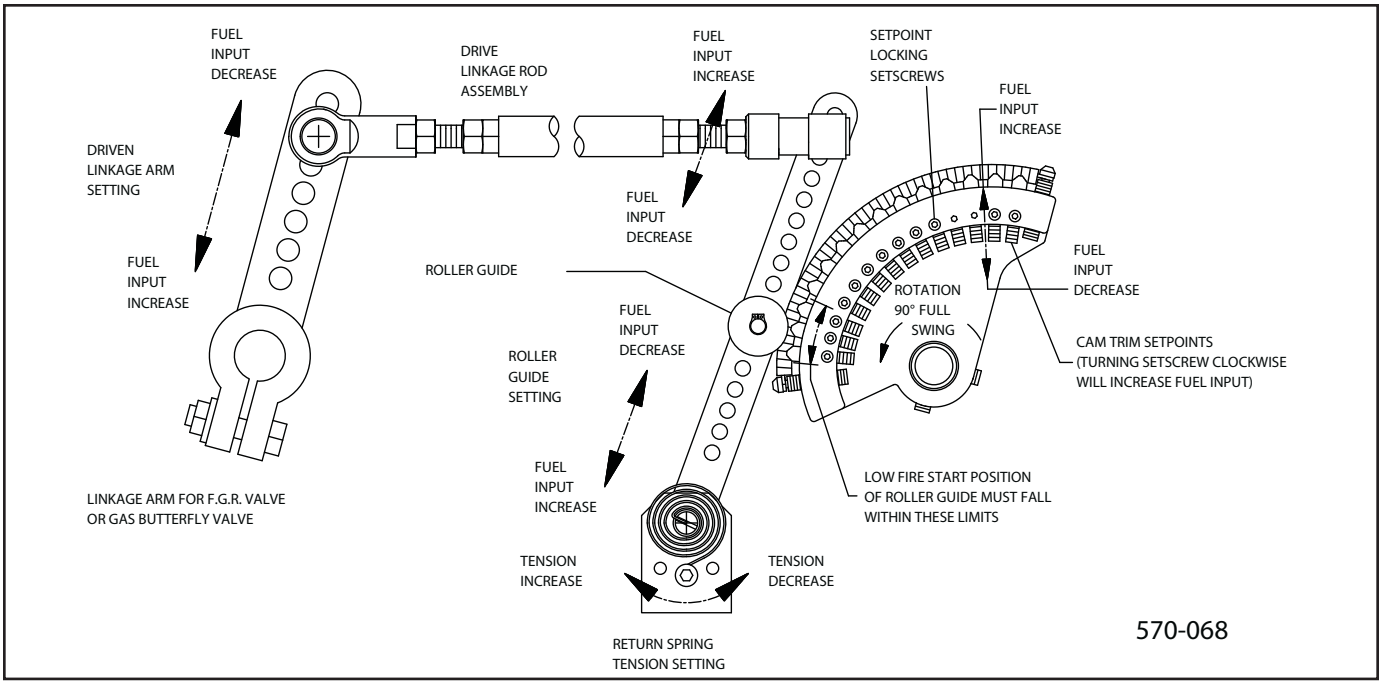



Figure 4-2

automatic modulating cycle to assure satisfactory results. Tighten the locking set screws.

## E. OIL SYSTEM

### OIL METERING SYSTEM.

Fuel oil supply to the integral metering unit must be 50 to 70 psi. The oil spray should ignite as soon as the oil solenoid valve opens. If a burner failure occurs, check the following:

1. See that the oil tanks are not empty.
2. That all oil valves between the burner and the tank are open.
3. That the suction line is not airbound.
4. That the low-fire setting has not been disturbed.
5. That there is pressure at the integral metering unit, but not to exceed 80 psi.
6. That the circulating pump turns freely.
7. Check for a clogged strainer at the suction side of the circulating pump.
8. Check for a dirty burner strainer.
9. Check for a plugged or carboned nozzle. This will show up as excessive primary air pressure.
10. That the oil by-pass valve is not by-passing the metered fuel oil.

To adjust the metering valve, proceed as follows:
1. Check that the air dampers are closed.
2. During pre-purge, check that the valve travels its full quadrant range from minimum to maximum.
3. The oil flow is adjusted by screwing "in" the locking allen screws located on the side of the valve. With SYNCHRO valve at minimum position, screw down (clockwise) to permit fuel flow to the burner. Once your flame is established and refined at this position, screw all remaining screws down at least the same level as your first adjusting screw.
4. A preliminary setting can be established with all the remaining screws. Generally each succeeding screw needs to be screwed in approximately one full turn deeper than its preceding screw. A smooth "stair-step" gradient preset at this point from low to high will simplify the remaining adjustment steps.
5. Adjust each screw to match the air supply and obtain a clean fire. Take combustion analysis as referred in section B.
6. Advance valve to the #2 screw position and adjust.
7. Progressively work your way up through each adjusting screw position, developing a smooth progression slope from your first screw to the maximum position. Take combustion readings at each point. To adjust the flame at any position, you must move the flow control valve to the number you desire to adjust. This aligns the adjusting screw directly on top of the fuel valve plunger. A resulting adjustment of the screw is directly applied to the fuel valve plunger and its interconnected valve body linkage.
8. Refine adjustments as needed, always turning valve so that position indicator matches screw being adjusted. To avoid possible damage to cam strips, always turn all higher numbered screws in as far as the last one adjusted. For more fuel, turn screw in (clockwise). For less fuel, turn screw out (counter-clockwise). If screw must be turned in flush with carrier casting, increase fuel pressure and re-adjust.
9. Cycle burner from minimum to maximum and refine adjustments if necessary. Always set flow control valve to the numbered position you wish to adjust.
See Diagram 4-6 for adjustments.

### ATOMIZING AIR PRESSURE.

Atomizing air in the air/oil tank is regulated by adjusting

valve in the return air line on integral metering units or in the air inlet on air compressor module burners. The air pressure is indicated by the pressure gauge at the air/oil tank. A minimum of 10 psi air pressure in low fire is suggested. As the firing rate increases, the air pressure also increases. Air pressure will be less with light oils. If any change in atomizing air pressure is made, check ignition several times for reliable light off. Adjustments should be set to obtain reliable ignition with best low and high fire combustion results. If the required atomizing air pressure cannot be maintained, a lack of lubricating oil may be the cause or the intake filter may be dirty.

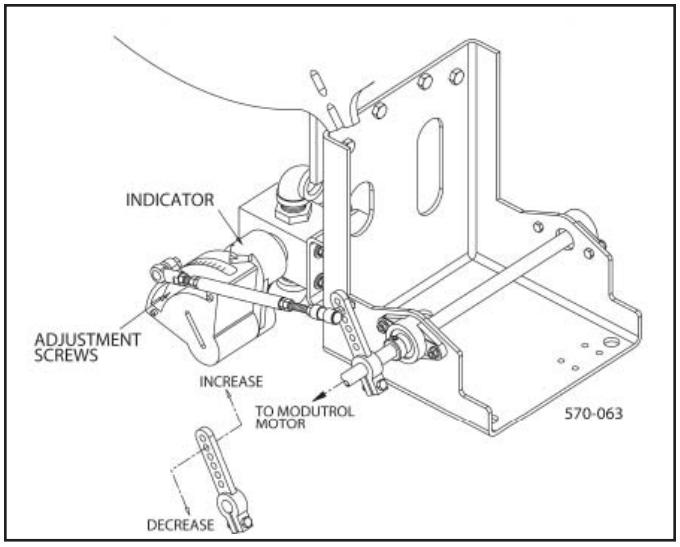



Figure 4-3

**ATOMIZING AIR PROVING SWITCH.**

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

## F. LINKAGE-MODULATING MOTOR

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

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

The modulating motor will be stopped at the end of its stroke by an internal limit switch. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. The closer the rod comes to parallel with the lever, the slower the rod moves. The angles of the driven levers on the jackshaft can be adjusted to vary the rate of good air/fuel ratio throughout the entire firing range. The input of combustion air is fixed at any given point in the modulating cycle. The fuel input may be varied to obtain correct flue gas readings. The adjustment is made to the metering cam by means of the 14 adjusting screws which are turned in (clockwise from the hex-socket end) to increase the flow of fuel, and out (counterclockwise from the hex-socket end) to decrease it. A 3/32" hex key is required. It will be necessary to cut off the short end of the hex key to approximately 3/8" to adjust the first two socket head setscrews at the low fire position. Take a combustion analysis at various points of the cam profile. Adjustment can be made without cycling the burner; then operate the automatic modulating cycle to assure satisfactory results. Tighten the locking set screws.

## G. FIRING RATE CONTROLS

Firing rate adjustments are made at the modulating motor linkages to the combustion air inlet damper, oil metering valve and main gas butterfly valve. Settings are determined by the operating length of the levers and the angular position on the shafts. Increasing the lever lengths on damper, pump or valve decreases the flow rate. Driving and driven levers are approximately parallel, but the angles can be adjusted to vary the rate of change. The most rapid rod travel occurs when the lever is perpendicular to the rod. The closer the rod comes to being parallel with the lever, the slower the rod moves. **ALWAYS** allow the burner to return to low fire position before adjusting high or intermediate settings. **DO NOT** alter low fire settings. Normally, the air control damper will be almost closed in low fire position. For best pilot operation, the damper should be set as low as possible. Excessive opening in low fire can cause pilot ignition problems. Air to the pilot is supplied under pressure to compensate for variations in furnace pressure, but the damper must be in low fire position for reliable ignition. (See Figure 4-4, 4-7, 4-8)

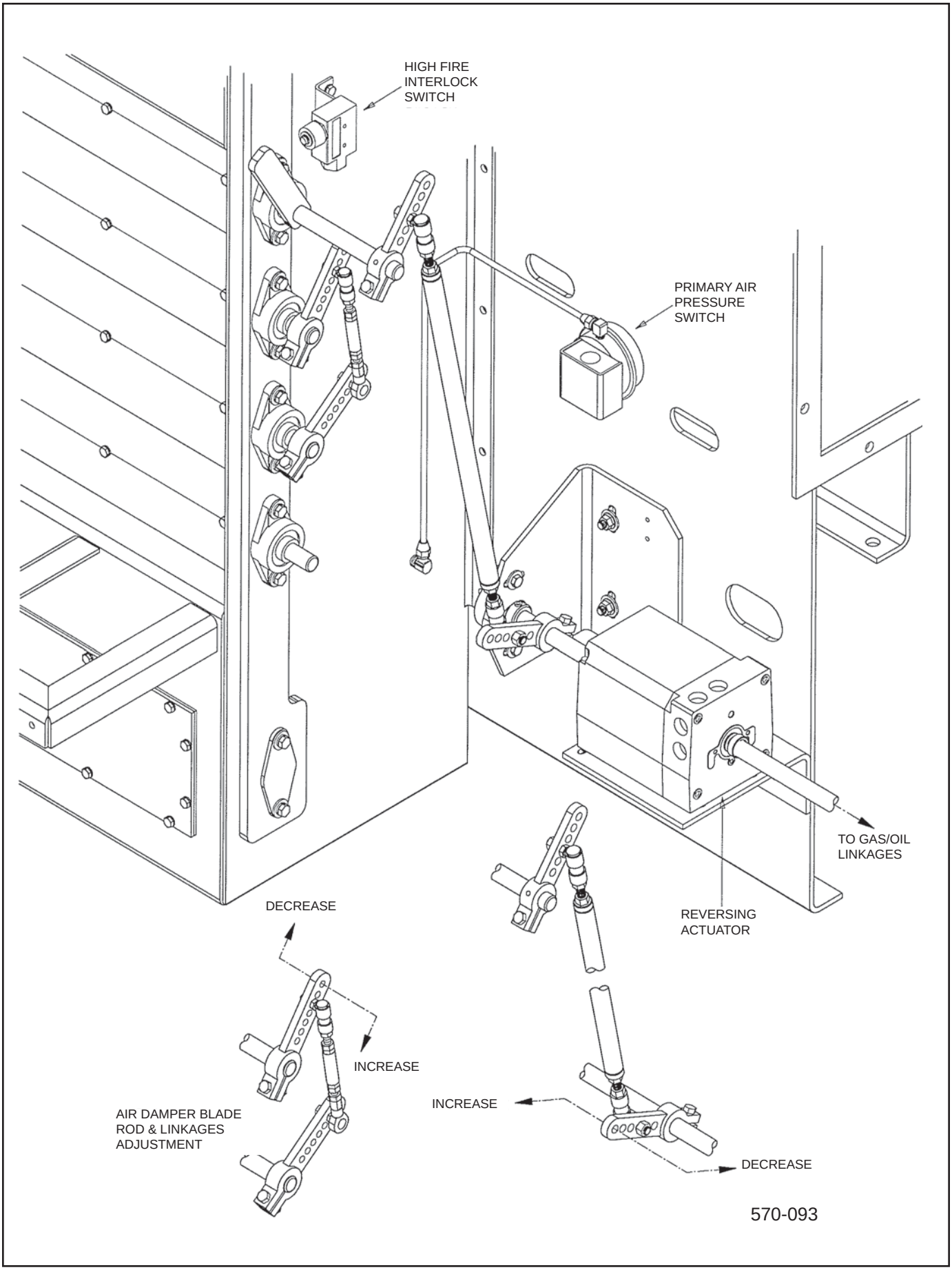
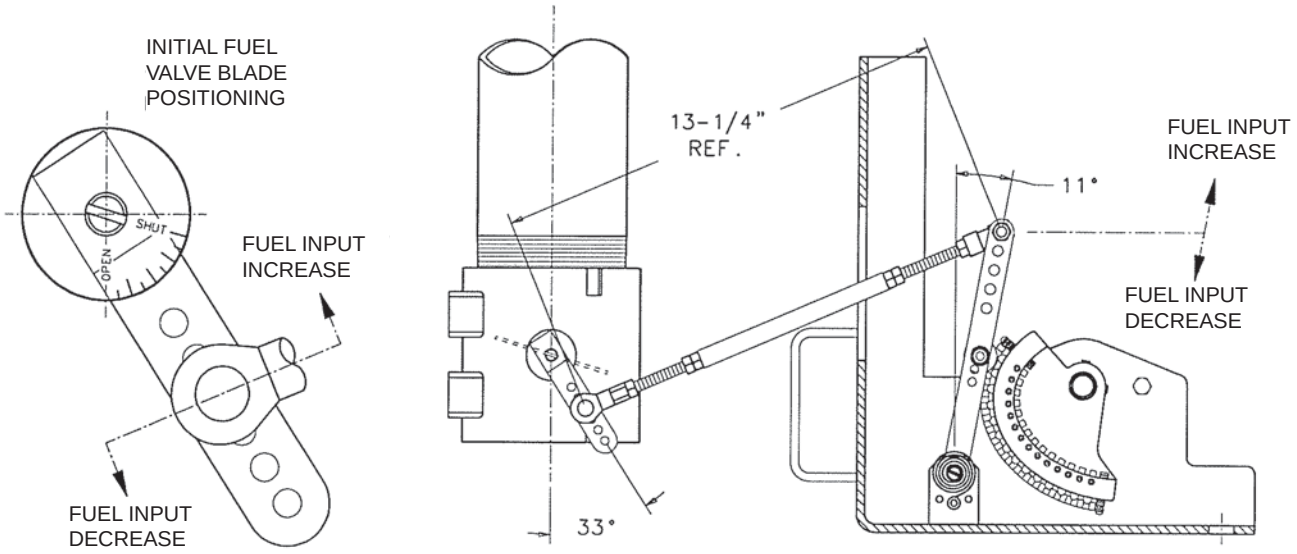

HIGH FIRE
INTERLOCK
SWITCH
PRIMARY AIR
PRESSURE
SWITCH
TO GAS/OIL
LINKAGES
REVERSING
ACTUATOR
DECREASE
INCREASE
AIR DAMPER BLADE
ROD & LINKAGES
ADJUSTMENT
INCREASE
DECREASE
570-093

Figure 4-4

## PRIMARY GAS LINKAGE
(SHOWN AT LOW-FIRE POSITION)




## SECONDARY GAS LINKAGE
(SHOWN AT LOW-FIRE POSITION)

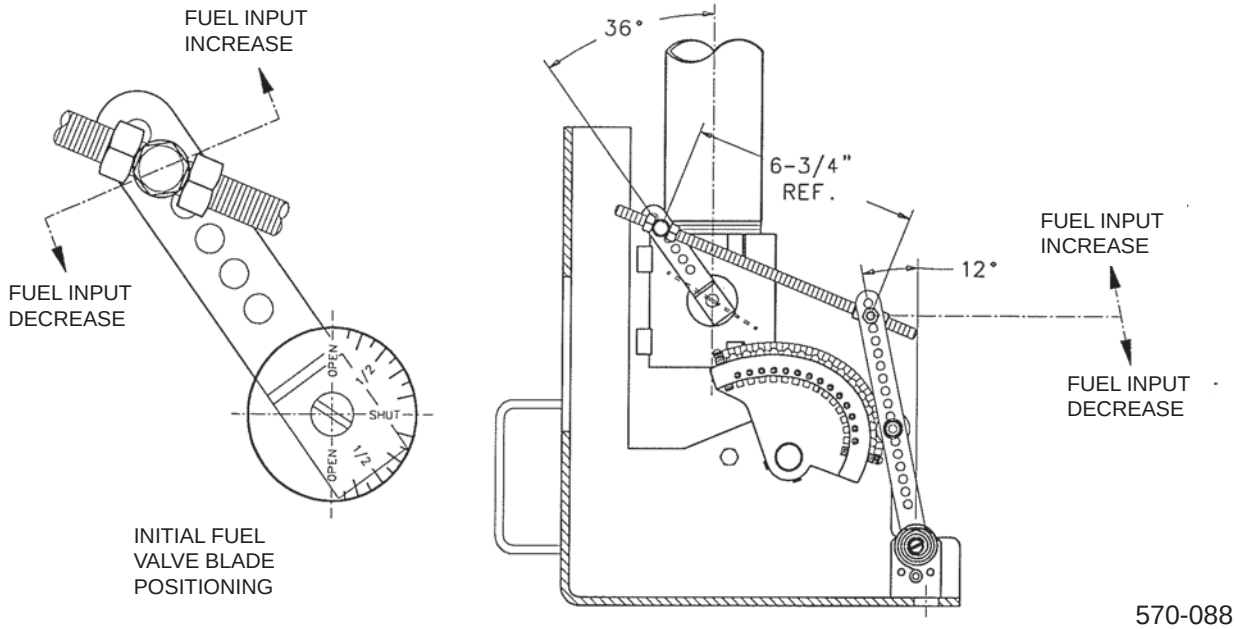
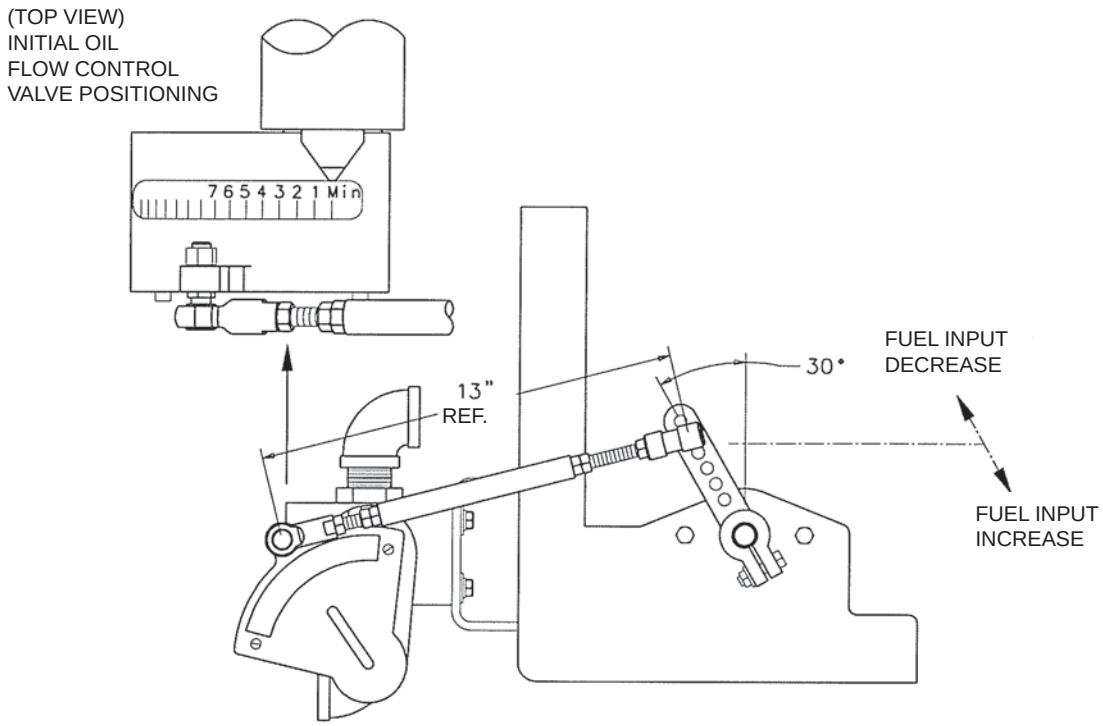
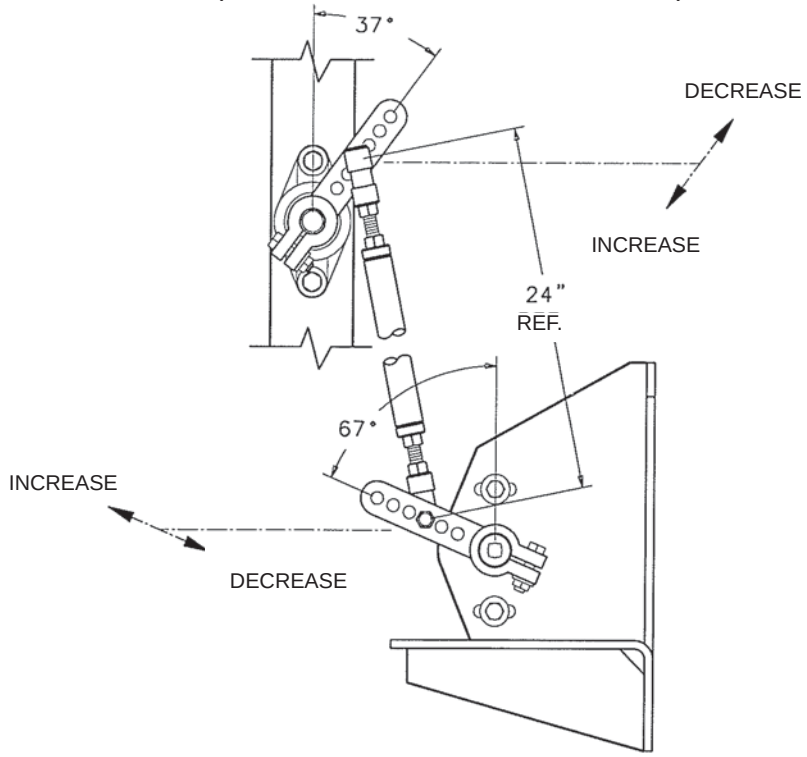



Figure 4-5

## OIL FLOW CONTROL VALVE
(SHOWN AT LOW-FIRE POSITION)



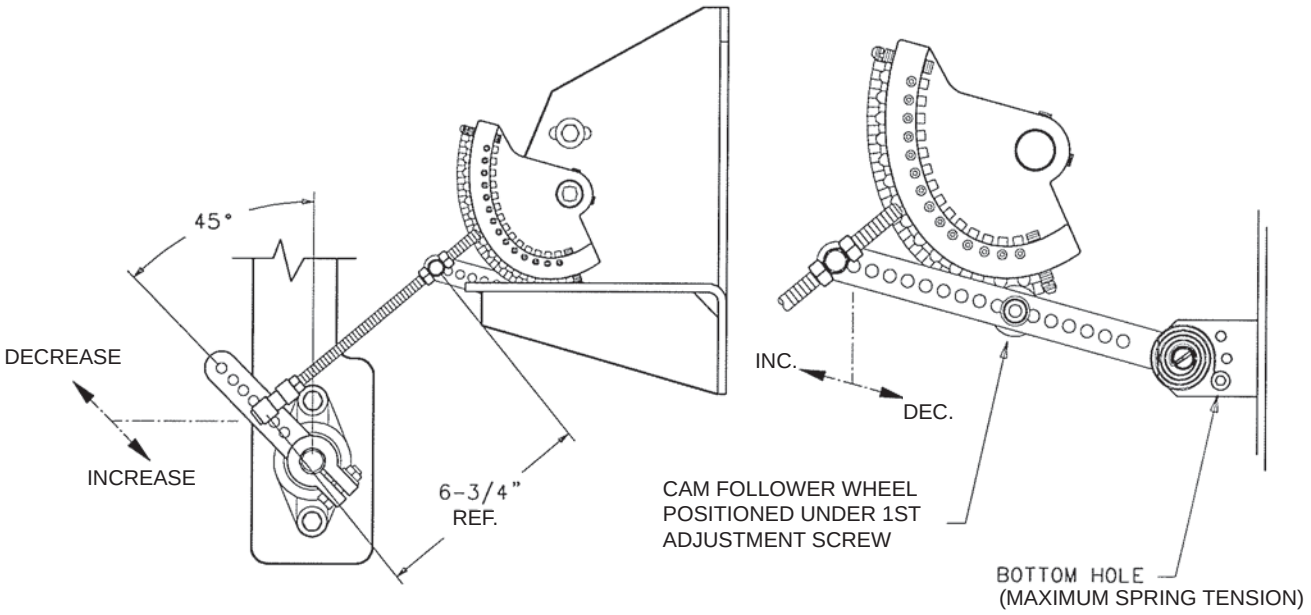

## AIR DAMPER DRIVE LINKAGE
(SHOWN AT LOW-FIRE POSITION)




570-089

Figure 4-6

## F.G.R. BLADE LINKAGE (BOTTOM ACCESS)
(SHOWN AT LOW-FIRE POSITION)




## F.G.R. BLADE LINKAGE (TOP ACCESS)
(SHOWN AT LOW-FIRE POSITION)

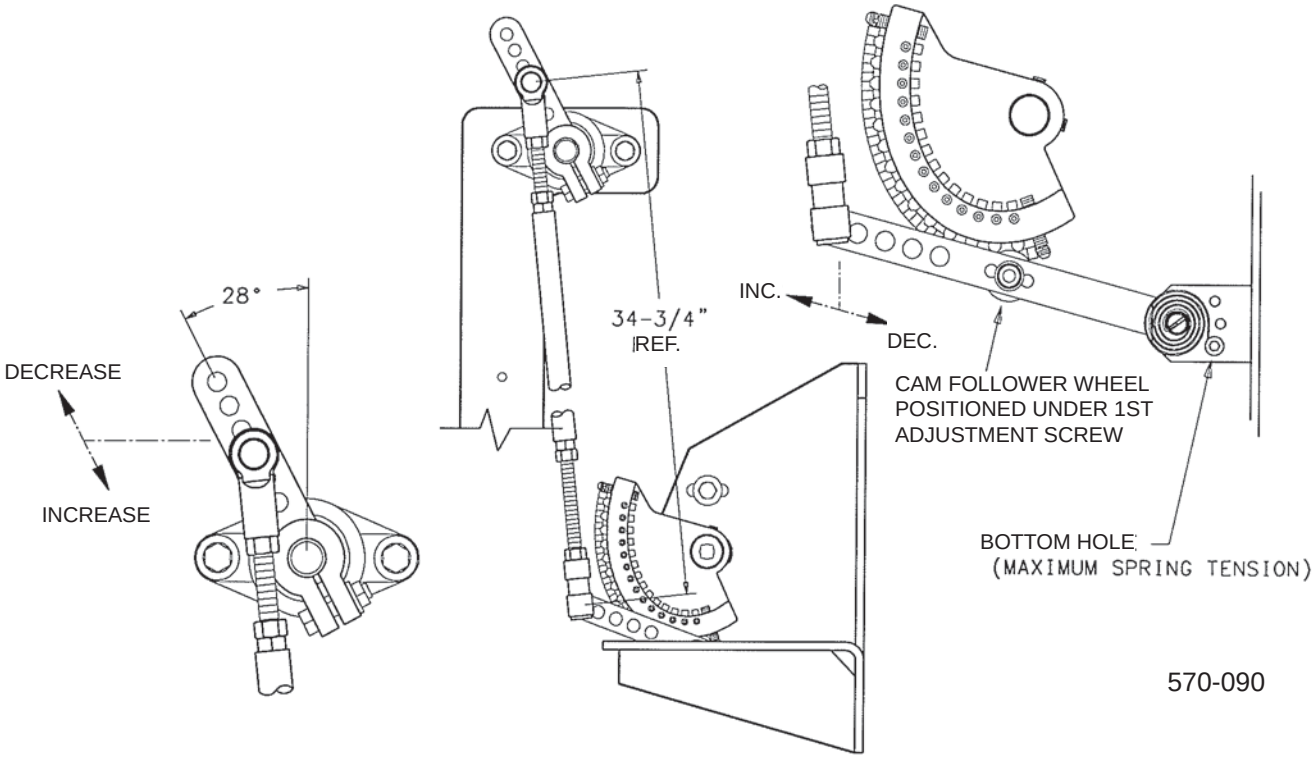



Figure 4-7

# AIR DAMPER BLADE LINKAGES
(SHOWN AT LOW-FIRE POSITION)

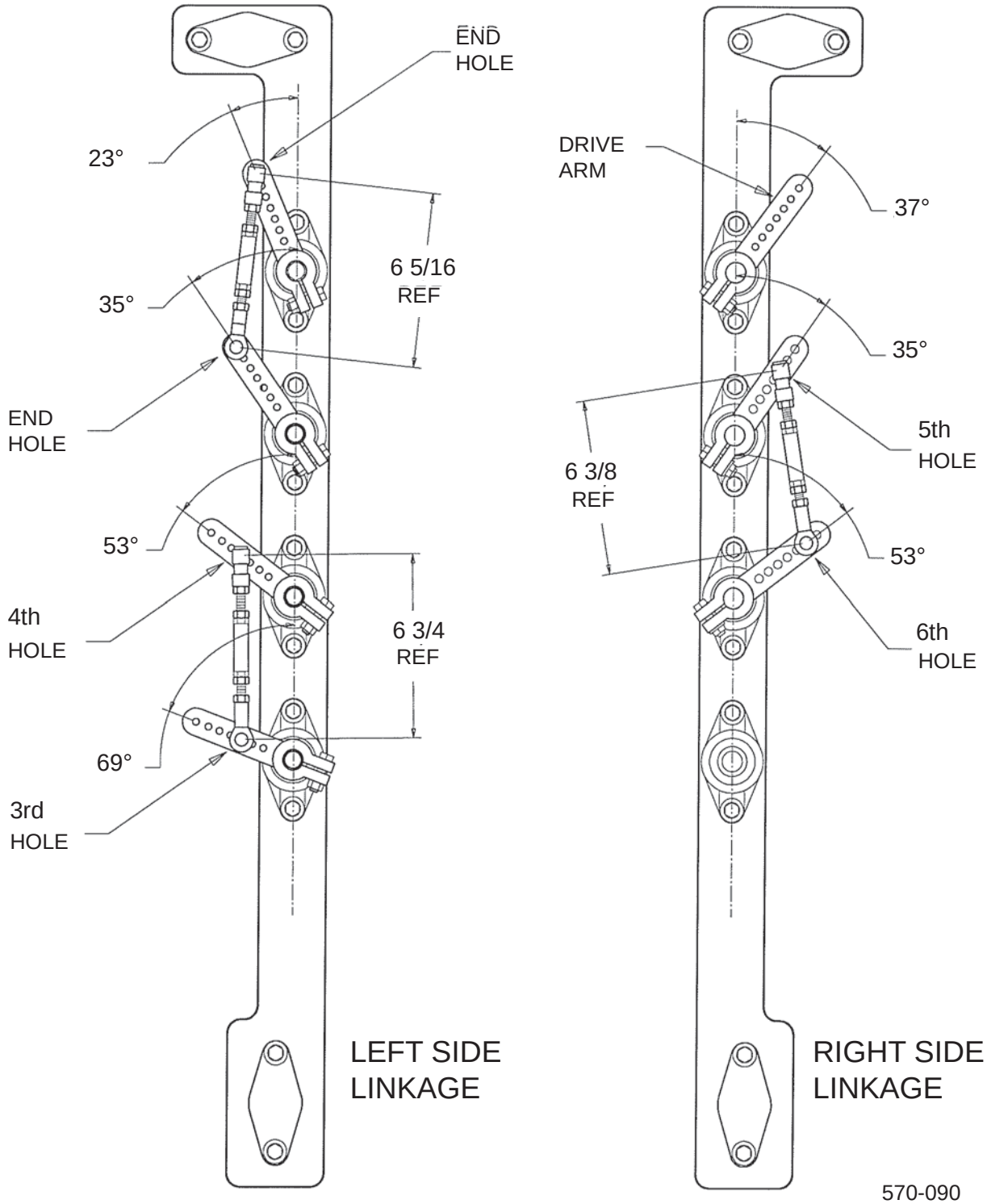



Figure 4-8

# CHAPTER 5
# MAINTENANCE

## ⚠ WARNING

ANY COVER PLATES, ENCLOSURES, OR GUARDS ANCHORED TO THE BURNER, OR ANY BURNER RELATED EQUIPMENT, MUST REMAIN IN POSITION AT ALL TIMES. ONLY DURING MAINTENANCE AND SERVICE SHUTDOWN CAN THESE COVER PLATES, ENCLOSURES, OR GUARDS BE REMOVED. THEY MUST BE REPLACED, AND SECURELY ANCHORED BEFORE TESTING, ADJUSTING, OR RUNNING THE BURNER OR BURNER RELATED EQUIPMENT.

## CAUTION

IT IS IMPORTANT THAT YOU PROVIDE SUPPORT FOR THE HOUSING WHEN IN THE OPEN POSITION TO PREVENT DAMAGE TO THE HINGES AND SUBSEQUENT COMPONENTS.

### 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. 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.

### C. PROGRAMMING CONTROL

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

### D. FIRING HEAD INSPECTION

Disconnect the damper linkage, release the impeller housing latch and swing the housing open for access to the firing head. Inspect the flame scanner lends to be sure it is clean and the support tube is in proper position to sight the flame through the hole in the diffuser. 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.

### 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 5-1, for electrode gap setting and position. The pilot assembly is supported by a socket in the diffuser and gas inlet tube. No adjustment is required except proper positioning of the electrode wire.

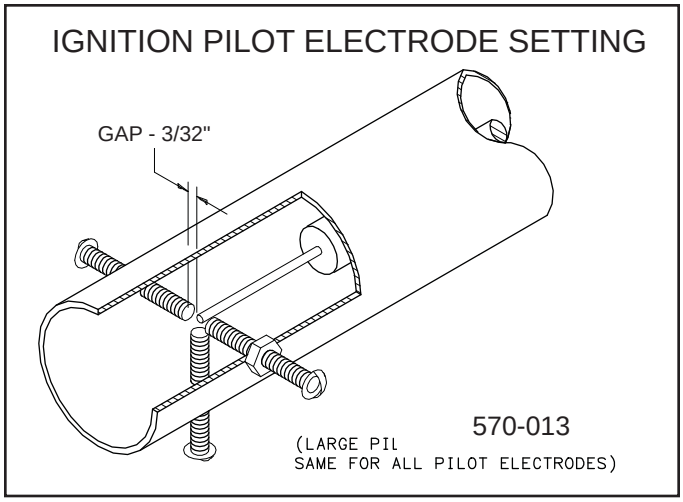
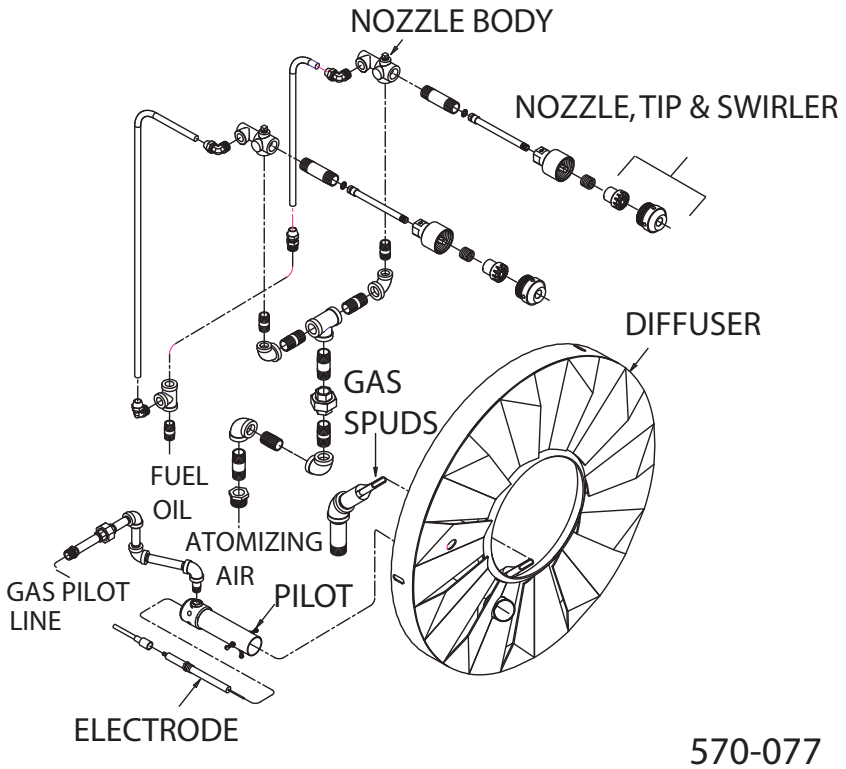


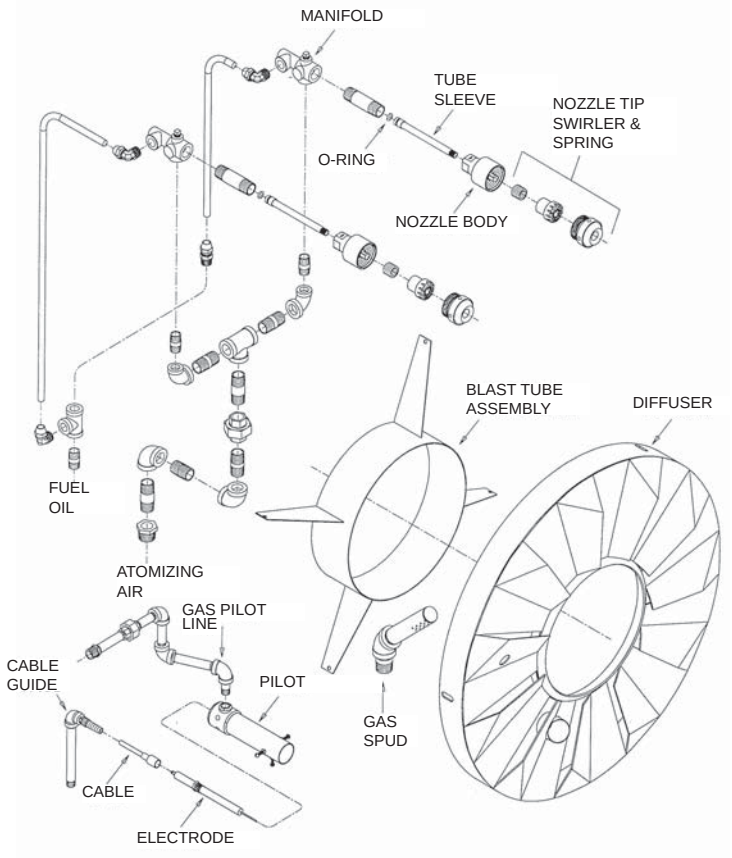

Figure 5-1

### 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.




S1 STANDARD DRAWER ASSEMBLY




LNS1 DRAWER ASSEMBLY

Figure 5-2

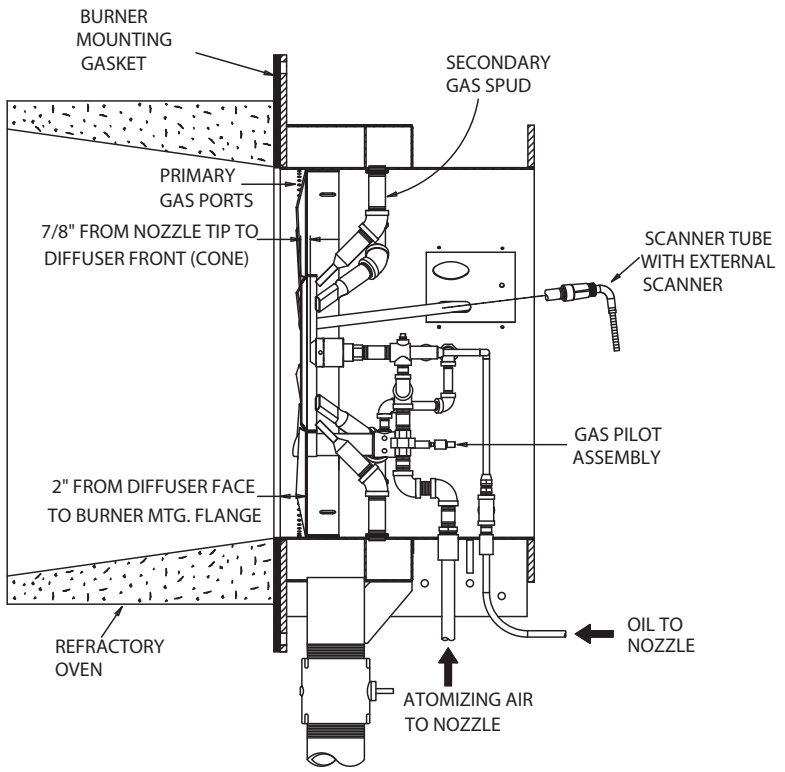



Figure 5-3

## CAUTION

DO NOT ATTEMPT TO USE WIRE OR A SHARP METAL TOOL TO CLEAN THE NOZZLE ORIFICE AS THIS WILL DISTORT THE FINE ORIFICE AND RUIN THE NOZZLE. USE A SHARP POINTED PIECE OF SOFT WOOD.

## NOTE

IT IS ESSENTIAL THAT THE CAM SPRING, CAM FOLLOWER BEARING WHEEL AND CAM FOLLOWER ARM AT THE PIVOT POINT BE GREASED SPARINGLY EVERY MONTH TO ENSURE SMOOTH OPERATION OF THE CAM ASSEMBLY. REGULAR AUTOMOTIVE BEARING GREASE SHOULD BE USED.

### G. OIL NOZZLE

Successful burner operation requires use of the proper style nozzle tip and keeping the orifice clean. Standard nozzle tips furnished on the burners are of a special emulsifying type which delivers a spray of extreme fineness and at an angle which insures proper mixing with the air stream. Unsatisfactory performance and loss of efficiency can result from the use of nonstandard nozzle tips. If the burner flame becomes stringy or lazy, it is possible that the nozzle spring is not properly in place or the nozzle is clogged. This problem is usually indicated by an abnormally high reading on the atomizing air pressure gauge on the air-oil tank. To remove the nozzle, disconnect the oil and air tubes to the nozzle assembly. Refer to Figure 2. 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 and reassemble the nozzle. To insure proper atomizing, the tip must be screwed in tightly with the swirler seating spring pressing the swirler tight against the nozzle tip. Turn the swirler a few times to be sure it fits snugly in the nozzle and the spring is pressing the two parts firmly together. When reinstalling, be sure the nozzle is centered with the proper distance from the diffuser.

### H. DIFFUSER

The diffuser is factory set and does not require attention under normal operating conditions. If fouled with carbon, the diffuser should be removed for cleaning. First remove the electrode and scanner leads, the gas pilot assembly, air and oil tubes and the nozzle support assembly, before you attempt to remove the diffuser. Mark the diffuser relative position to the blast tube, with a scribed or pencil line where the three mounting screws are located, to insure that the diffuser is placed back in the same position. Remove the three screws holding the diffuser to the blast tube and slowly pull the diffuser along the blast tube towards the firing head. Keep the diffuser as parallel as possible. If it should became stuck or tight, do not apply any tool which would distort the shape or blade configuration. A small wooden block tapped gently against the diffusers outer edge will help expedite its removal. Clean all carbon from the diffuser vanes and reinstall in reverse order of disassebly

aligning the diffuser with the scribed marks. Do not attempt to drive the diffuser back along the blast tube with anything other than a small block of wood tapped against the diffuser's outer edge. When reinstalling, be sure the diffuser is centered.

## I. FIRING RATE CONTROLS

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

## J. 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, Section D for proper sealing procedure.

## K. FUEL OIL SYSTEM

### 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.

### PRIMARY 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 setscrews. Replace belt guards. If belt becomes frayed or cracked, replace it.

**CAUTION**

DO NOT ATTEMPT FIELD REPAIR OF THE COMPRESSOR. INSTALLATION OF A NEW COMPRESSOR IS MANDATORY. SEND THE OLD COMPRESSOR IN FOR REPAIR OR EXCHANGE (WHERE ALLOWED).

### AIR CLEANER

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

### OIL-AIR TANK

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

### OIL LEVEL SIGHT GAUGE

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

### COMPRESSOR OIL FILTER (Lube Oil Strainer)

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

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

### 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.

## L. 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 the valve fails to operate. After replacement, cycle the valve with the fuel shutoff to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

**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 drection 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.

**CAUTION**

ALL POWER MUST BE DISCONNECTED BEFORE SERVICING THE VALVES.

## M. ELECTRICAL SYSTEM

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

**ELECTRIC MOTORS.**

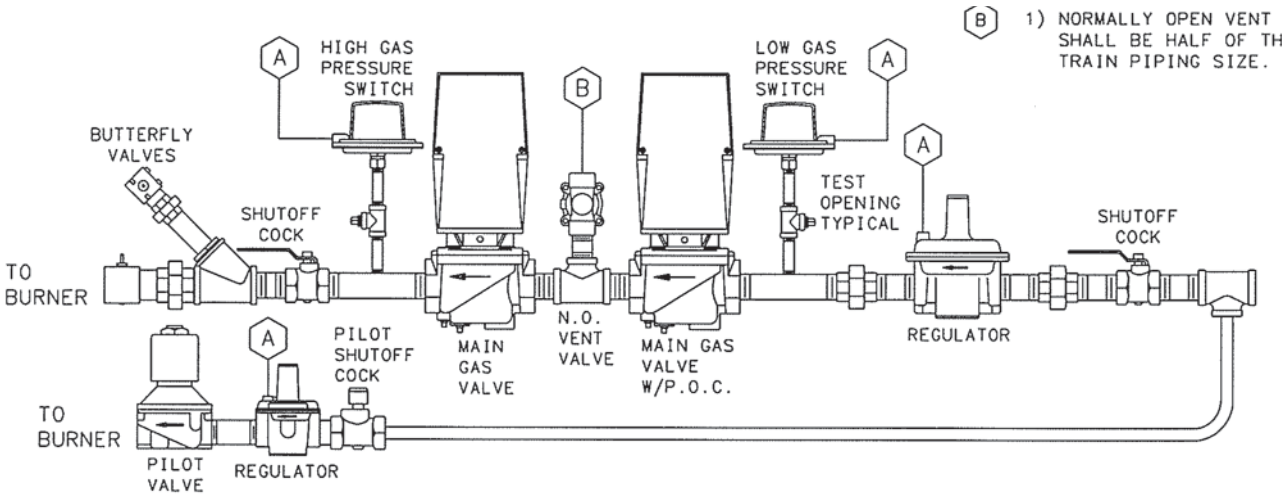
Motor supply voltage must not vary more than 10 percent from nameplate ratings. At initial start-up and at least once a year thereafter, check the motor current with a meter while the burner is in high fire position. If the reading exceeds the nameplate rating plus service factor, determine the cause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

## N. 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.

## O. COMMON VENT LINE




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 SHALL BE HALF OF THE MAIN GAS TRAIN PIPING SIZE (3/4" MIN.).

561-098

TYPICAL GAS TRAIN

Figure 5-4

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

# CHAPTER 6
# TROUBLE SHOOTING

**WARNING**

TROUBLE SHOOTING SHOULD BE PERFORMED ONLY BY PERSONNEL WHO ARE FAMILIAR WITH THE EQUIPMENT AND WHO HAVE READ AND UNDERSTOOD THE CONTENTS OF THIS MANUAL. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

**WARNING**

DISCONNECT AND LOCK OUT THE MAIN POWER SUPPLY IN ORDER TO AVOID THE HAZARD OF ELECTRICAL SHOCK. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

## A. AWARENESS

Chapter 6 assumes that:

1. The unit in question has been properly installed and that it has been running for some time.

2. The operator has become thoroughly familiar with both the burner and the manual by this time.

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

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

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

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

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

NEVER ATTEMPT TO CIRCUMVENT ANY OF THE SAFETY FEATURES.

**WARNING**

THE CAUSE FOR LOSS OF FLAME OR ANY OTHER UNUSUAL CONDITION SHOULD BE INVESTIGATED AND CORRECTED BEFORE ATTEMPTING TO RESTART. FAILURE TO DO SO MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

**WARNING**

DO NOT REPEAT UNSUCCESSFUL LIGHTING ATTEMPTS WITHOUT RECHECKING THE BURNER AND PILOT ADJUSTMENTS. DAMAGE TO THE BOILER OR SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.

**WARNING**

DO NOT RE-LIGHT THE PILOT OR ATTEMPT TO START THE MAIN BURNER, EITHER OIL OR GAS, IF THE COMBUSTION CHAMBER IS HOT AND/OR IF GAS OR OIL VAPOR COMBUSTION GASES ARE PRESENT IN THE FURNACE OR FLUE PASSAGES OR WHEN EXCESS OIL HAS ACCUMULATED. PROMPTLY CORRECT ANY CONDITIONS CAUSING LEAKAGE. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

## B. EMERGENCY SHUT DOWN

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

# TROUBLE SHOOTING

| PROBLEM | SOLUTION |
|---|---|
| **BURNER DOES NOT START** | 1. No voltage at program relay power input terminals.<br>a. Main disconnect switch open.<br>b. Blown control circuit fuse.<br>c. Loose or broken electircal connection. |
| | 2. Program relay safety switch requires resetting |
| | 3. Limit circuit not completed - no voltage at end of limit circuit program relay terminal.<br>a. Pressure or temperature is above setting of opeartion control.<br>b. Water below required level.<br>Low-water light (and alarm horn) should indicate this condition.<br>Check manual reset button, if provided, on low-water control.<br>c. Fuel pressure must be within settings of low pressure and high pressure switches.<br>d. Check burner air proving switch and high fire limit switch.<br>e. Heavy oil fired unit-oil temperature below minimum settings. |
| | 4. Fuel valve interlock circuit not completed.<br>a. Fuel valve auxiliary switch not closed. |
| **NO IGNITION** | 1. Lack of spark.<br>a. Electrode grounded or porcelain cracked.<br>b. Improper electrode setting.<br>c. Loose terminal on ignition cable; cable shorted.<br>d. Inoperative ignition transformer.<br>e. Insufficient or no voltage at pilot ignition circuit terminal. |
| | 2. Spark but no flame.<br>a. Lack of fuel - no gas pressure, closed valve, empty tank, broken line, etc. |
| | 3. Low fire switch open in low fire proving circuit.<br>a. Damper motor not closed, slipped cam, defective switch.<br>b. Damper jammed or linkage binding. |
| | 4. Running interlock circuit not completed.<br>a. Combustion or atomizing air proving switches defective or not properly set.<br>b. Motor starter interlock contact not closed. |

# TROUBLE SHOOTING

| PROBLEM | SOLUTION |
|---|---|
| **PILOT FLAME, BUT NO MAIN FLAME** | 1. Insufficient pilot flame. |
| | 2. Gas fired unit.<br>a. Manual gas cock closed.<br>b. Main gas valve inoperative.<br>c. Gas pressure regulator inoperative. |
| | 3. Limit circuit not completed - no voltage at end of limit circuit program relay terminal.<br>a. Oil supply cut off by obstruction, closed valve, or loss of suction.<br>b. Supply pump inoperative.<br>c. No fuel.<br>d. Main oil valve inoperative.<br>e. Check oil nozzle, gun and lines. |
| | 4. Flame detector defective, sight tube obstructed or lens dirty. |
| | 5. Insufficient or no voltage at main fuel valve circuit terminal. |
| **BURNER STAYS IN LOW FIRE** | 1. Pressure or temperature above modulating control setting. |
| | 2. Manual-automatic switch in wrong position. |
| | 3. Inoperative modulating motor. |
| | 4. Defective modulating control. |
| | 5. Binding or loose linkages, cams, setscrews, etc. |
| **SHUTDOWN OCCURS DURING FIRING** | 1. Loss or stoppage of fuel supply. |
| | 2. Defective fuel valve; loose electrical connection. |
| | 3. Flame detector weak or defective. |
| | 4. Scanner lens dirty or sight tube obstructed. |
| | 5. If the programmer lockout swtich has not tripped, check the limit circuit for an opened safety control. |

# TROUBLE SHOOTING

| PROBLEM | SOLUTION |
|---|---|
| **SHUTDOWN OCCURS DURING FIRING (cont).** | 6. If the programmer lockout switch has tripped.<br>a. Check fuel lines and valves.<br>b. Check flame detector.<br>c. Check for open circuit in running interlock circuit.<br>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).<br>a. Slipping linkage.<br>b. Damper stuck open.<br>c. Fluctuating fuel supply.<br>Temporary obstruction in the fuel line.<br>Temporary drop in gas pressure.<br>Orifice gate valve accidentally opened (heavy oil) |
| | 8. Interlock device inoperative or defective. |
| | 9. Air in the oil lines. Bleed lines. |

| | |
|---|---|
| **MODULATING MOTOR DOES NOT OPERATE** | 1. Manual/automatic switch in wrong position. |
| | 2. Linkage loose or jammed. |
| | 3. Motor does not drive to open or close during pre-purge or close on burner shutdown.<br>a. Motor defective.<br>b. Loose electrical connection.<br>c. Damper motor transformer defective. |
| | 4. Motor does not operate on demand.<br>a. Manual/automatic switch in wrong position.<br>b. Modulating control improperly set or inoperative.<br>c. Motor defective<br>d. Loose electrical connection.<br>e. Damper motor transformer defective. |

# LNS1 SERIES

## Installation,
## Operation,
## and
## Service Manual

Industrial Combustion, LLC

**WARNING**

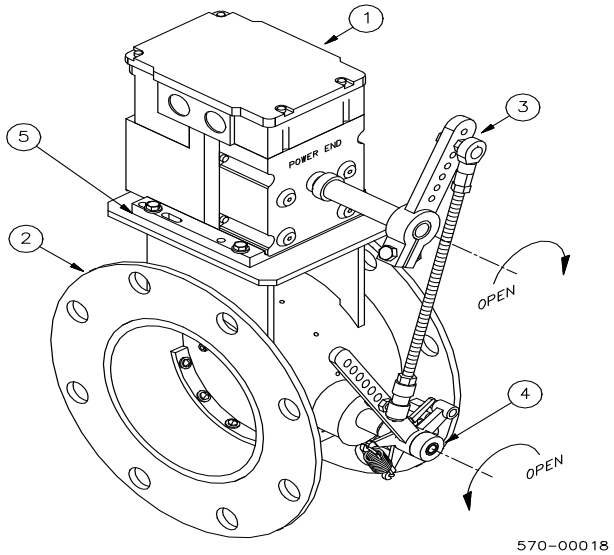
ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD START- UP, ADJUST, OR SERVICE THIS EQUIPMENT.

# CHAPTER 7
# LOW NOx SYSTEM

This section covers the adjustments for the Low NOx burners. The Low NOx burners are equipped with a Flue Gas Recirculation system (F.G.R.). The flue gases are duct to the air housing and the burner combustion air fan is used to pull flue gases from the stack. The F.G.R. rate is controlled by a damper blade linked to the modutrol motor. Top or bottom connection is used with a flanged adaptor to the damper box. Fresh air and F.G.R. is mixed and injected in the combustion zone. All F.G.R. duct piping should be covered with a minimum of 2" of insulation and supported as required. The burner is designed to operate with < 30 ppm NOx corrected @ 3% O2 throughout the firing range, when firing natural gas. The following controls are used for a safe operation of the system.

## A. F.G.R. SHUTOFF VALVE. (Figure 7-1)

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




1. MODUTROL MOTOR
2. F.G.R. SHUTOFF VALVE
3. LINKAGE ARM
4. LINKAGE ARM ASSEMBLY
5. GASKET

Figure 7-1

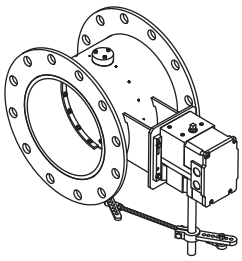
## B. F.G.R. DAMPER ASSEMBLY (Figure 7-3, 7-4)

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

The F.G.R. damper regulates the volume of combustion air. Position of the damper blade is controlled by a modutrol motor. The damper blade in the low fire position is normally almost closed. The F.G.R. damper and F.G.R. control valve blades open as the modutrol motor drives toward the high fire position where flue gas is pulled into the regulated combustion air flow above the damper blade as controlled by the F.G.R. control valve. Combustion air mixed with flue gas is passed on through the blast tube to the combustion zone. Follow the instructions in Chapter 4 for the adjustment procedures.

**NOTE**

IT IS SUGGESTED THAT ALL F.G.R. PIPING BE SCH #40, 14" I.D., AND BE COVERED WITH A MINIMUM OF 2" OF INSULATION



WARNING:
THE F.G.R. SHUTOFF VALVE SHOULD NEVER BE MOUNTED IN THIS POSITION! THE MODUTROL MOTOR CAN NOT BE MOUNTED VERTICALLY, (VERTICAL IS DEFINED BY THE AXIS OF THE MOD. MOTOR SHAFT) DAMAGE TO THE MODUTROL MOTOR WILL RESULT.

Figure 7-2

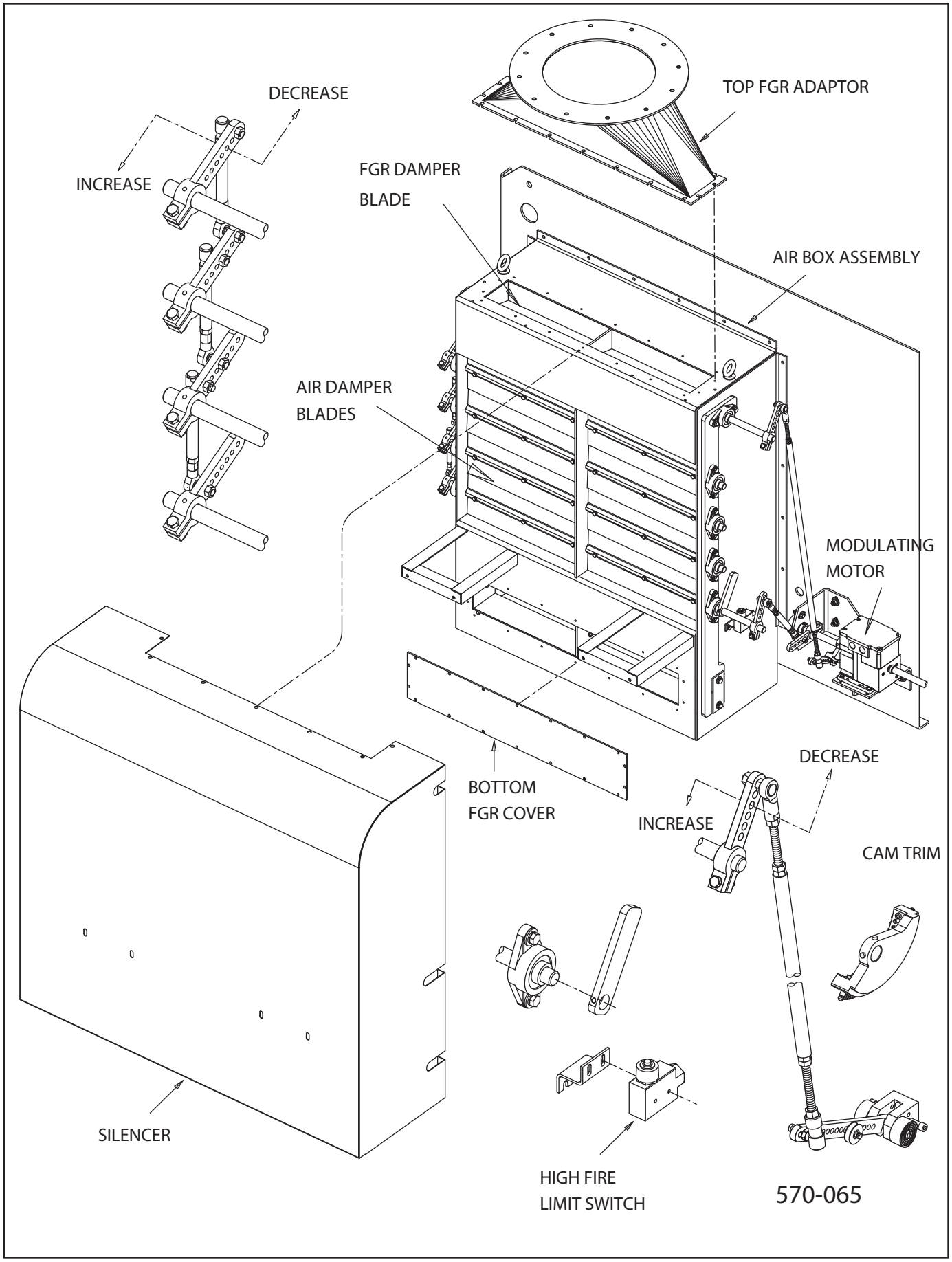

DECREASE
INCREASE
TOP FGR ADAPTOR
FGR DAMPER
BLADE
AIR BOX ASSEMBLY
AIR DAMPER
BLADES
MODULATING
MOTOR
BOTTOM
FGR COVER
DECREASE
INCREASE
CAM TRIM
SILENCER
HIGH FIRE
LIMIT SWITCH
570-065

Figure 7-3

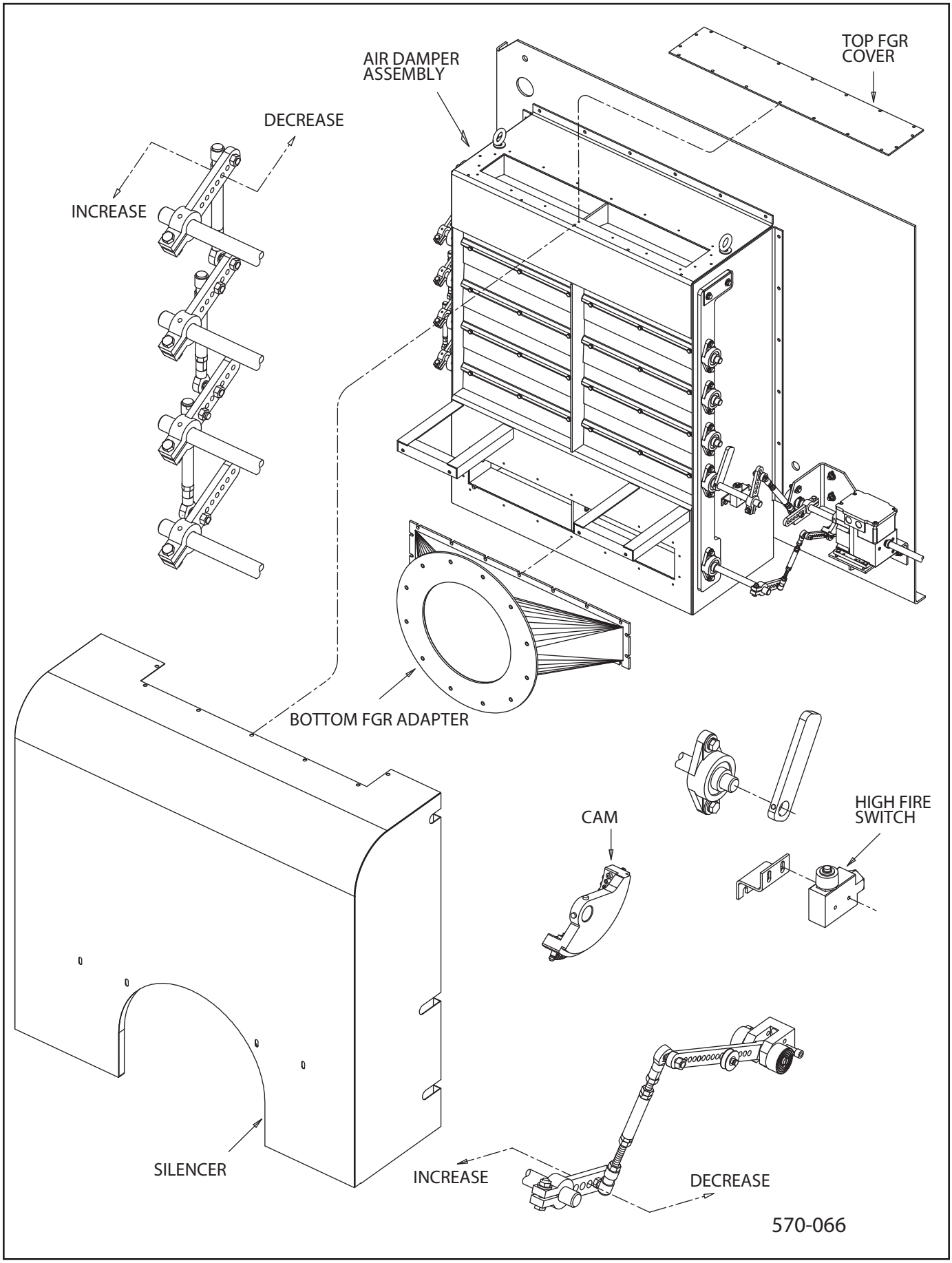

TOP FGR
COVER
AIR DAMPER
ASSEMBLY
DECREASE
INCREASE
BOTTOM FGR ADAPTER
CAM
HIGH FIRE
SWITCH
SILENCER
INCREASE
DECREASE
570-066

Figure 7-4

# Warranty Policy

## A. LIMITED WARRANTY

The Company warrants that at the time of shipment, the equipment manufactured by it shall be merchantable, free from defects in material and workmanship and shall possess the characteristics represented in writing by the Company. The Company's warranty is conditioned upon the equipment being properly installed and maintained and operated within the equipment's capacity under normal load conditions with competent supervised operators. Equipment, accessories and other parts and components not manufactured by the Company are warranted only to the extent of and by the original manufacture's warranty to the Company; In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer than the Company's warranty covering equipment manufactured by the Company.

## B. EXCLUSIONS FROM WARRANTY

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

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

## C. WARRANTY ADJUSTMENT

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

## D. SPARE AND REPLACEMENT PARTS WARRANTY ADJUSTMENT

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

## E. LIMITATION OF LIABILITY

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

# START-UP / SERVICE REPORT

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

A copy of the start-up report MUST be returned to IC in order to validate the warranty of the burner.

Burner Model _____ Serial Number _____ Start-up Date _____

| Test Conducted | GAS | | | OIL | | |
|---|---|---|---|---|---|---|
| | Low | 50% | High | Low | 50% | High |
| Firing Rate MMBtu / gph | | | | | | |
| Stack Temp (Gross) $^{O}$F | | | | | | |
| Room Temp $^{O}$F | | | | | | |
| O2% | | | | | | |
| CO2% | | | | | | |
| CO (PPM) | | | | | | |
| NOx (PPM) | | | | | | |
| Smoke (Bacharach) | | | | | | |
| Combustion Eff.% | | | | | | |
| Stack Draft "W.C. | | | | | | |
| Furnace Pressure "W.C. | | | | | | |
| Blast tube Pressure "W.C. | | | | | | |
| Steam Pressure PSIG | | | | | | |
| Water Temperature $^{O}$F | | | | | | |
| Supply oil pressure PSIG | | | | | | |
| Return oil pressure PSIG | | | | | | |
| Vacuum oil pump "HG | | | | | | |
| Oil Temperature | | | | | | |
| Atom. air pressure | | | | | | |
| Gas Pressure @ Burner Manifold "W.C. | Inner Manifold | | | | | |
| | Outer Manifold | | | | | |
| Center Gas pressure "W.C. | | | | | | |
| Gas Pressure @ Regulator Inlet PSIG | | | | | | |
| Gas Pressure @ Regulator Outlet PSIG | | | | | | |
| Pilot Gas Pressure @ Regulator Outlet "W.C. | | | | | | |
| Flame Signal Main | Low | | 50% | | High | |

| Control Checks | Test | Set Point |
|---|---|---|
| Low Water Cut Off | | |
| Aux. LWCO | | |
| High Water Cut Off | | |
| Operating Limit | | |
| High Limit | | |
| Operating Control | | |
| Stack Temp Interlock | | |
| Flame Failure | | |
| Combustion Air Switch | | |
| High Purge Switch | | |
| Low Fire Interlock | | |
| Oil Pressure Switch | | |
| Oil Valve with P.O.C. Interlock | | |
| High Gas Pressure Switch | | |
| Low Gas Pressure Switch | | |
| Gas Valve P.O.C. Interlock | | |
| Pilot Turndown Test | | |
| Flame Signal Pilot | | |

**(For Low NOx Burners)**

| | | |
|---|---|---|
| Blast Tube Temp. Interlock | | |
| FGR Line Purge Switch | | |
| FGR Valve P.O.C. Switch | | |

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

Adjusted by:

Date:

Accepted by:

(Signature Required)

# PRODUCT SATISFACTION SURVEY

Burner Model _____ Serial Number _____

As a requirement of our ISO certification, please fill-in this form and return to Industrial Combustion.
Please rate your satisfaction with the following:

| | Poor | Good | Excellent |
|---|---|---|---|
| Delivery time | | | |
| Apperance of equipment after delivery | | | |
| Piping and tubing | | | |
| Wiring | | | |
| All components arrived with equipment | | | |
| Ease of start-up | | | |
| Performance of equipment | | | |
| Quality of information provided | | | |
| Sales | | | |
| Engineering | | | |
| Service | | | |
| Parts | | | |
| Overall way any problems were handled | | | |

Comments:

Date: _____ By: _____

# S1 / LNS1 SERIES

## Parts Manual

Industrial Combustion, LLC

# S1 & LNS1 SERIES PARTS SECTION

**INSTRUCTIONS FOR THE USE OF THIS PART BOOK**
WHEN ORDERING REPAIR PARTS, PLEASE INCLUDE PART NUMBER, THE BURNER SERIAL NUMBER, MODEL, SIZE, AND VOLTAGE. THE INFORMATION CAN BE OBTAINED FROM THE BURNER NAMEPLATE AND THE VOLTAGE FROM THE DATA LABEL ON THE PANEL DOOR.

WHEN ORDERING FAN WHEELS, GIVE THE OVERALL DIAMETER, WIDTH, BORE, MANUFACTURER, AND MOTOR HP.

THIS PARTS BOOK DOES NOT INCLUDE SUCH COMMON HARDWARE ITEMS AS NUTS, WASHERS, ELECTRICAL PARTS, COPPER TUBING, FLARE FITTINGS, AND PIPE. ITEMS SUCH AS THESE CAN BE READILY PURCHASED LOCALLY.

THE FOLLOWING PARTS ARE SOLD ON EXCHANGE BASIS:

OIL-AIR METERING PUMPS, OIL AND AIR PUMPS, BEARING ASSEMBLY, AIR MODULATORS, AND RELIEF VALVES.

**PARTS SHIPPING POLICY**
ALL ORDERS FOR STOCKED ITEMS WILL BE PROCESSED AND READY FOR SHIPMENT WITHIN (24) HOURS OF ITS RECEIPT.

AIR SHIPMENTS (U.P.S. OR OTHERWISE) WILL BE SHIPPED THE SAME DAY IF ORDER IS RECEIVED BEFORE 2:30 P.M. (WEATHER PERMITTING).

GROUND SHIPMENTS TO WISCONSIN AND BORDERING STATES WILL BE SHIPPED THE SAME DAY UPON REQUEST.

ALL PARTS ORDERS AND EXHCNAGE PARTS MUST BE SENT TO:

**INDUSTRIAL COMBUSTION**
**351 -21st STREET**
**MONROE, WISCONSIN 53566**

**PLANT PHONE: (608) 325-3141**
**FAX: (608) 325-4379**

**PARTS DIRECT: (608) 325-5003**
**FAX: (608) 329-3190**

**RETURN GOODS PROCEDURES (CREDIT OR REPLACEMENT PARTS)**

Defective WARRANTY PARTS OR PARTS to be repaired are not to be returned to the PARTS DEPARTMENT without calling for a RETURN GOODS AUTHORIZATION NUMBER.

1) Before any item is RETURNED, PLEASE CALL THE PARTS DEPARTMENT TO OBTAIN AN **RGA** (RETURN GOODS AUTHORIZATION) NUMBER. PLEASE HAVE THE FOLLOWING INFORMATION AVAILABLE WHEN CALLING:

   A) PART NUMBER OF ITEM
   B) DESCRIPTION OF ITEM
   C) REASON FOR THE RETURN WITH A FULL DESCRIPTION OF THE DEFECT(S)
   D) PARTS ORDER OR SALES ORDER ITEM WAS PURCHASED ON
   E) NAME, ADDRESS, AND DATE OF INSTALLATION
   F) DO YOU WANT CREDIT OR REPLACEMENT BEING ISSUED

2) Once an **RGA** number HAS BEEN ISSUED, THE ITEM MAY BE RETURNED. YOU WILL HAVE THIRTY (30) DAYS TO RETURN THE ITEM FROM THE DATE OF THE **RGA** BEING ISSUED OR THERE WILL BE A 10% HANDLING CHARGE.

3) RETURNED GOODS MUST HAVE THE **RGA** NUMBER APPEARING ON THE ADDRESS LABEL ATTACHED TO THE OUTSIDE OF THE BOX BEING RETURNED. IF THE **RGA** NUMBER IS NOT ON THE LABEL, YOUR CREDIT MAY BE DELAYED AND THERE WILL BE A $50.00 SERVICE CHARGE FOR PAPERWORK. ALL NEW PARTS RETURNED TO THE FACTORY WILL BE CHARGED WITH A 25% RESTOCKING FEE.

**PLEASE NOTE**:
FAILURE TO PROVIDE COMPLETE AND CORRECT INFORMATION MAY RESULT IN DELAYED OR CREDIT REFUSAL.

RETURN OF WARRANTY PARTS: WARRANTY PARTS MUST BE RETURNED TO THE FACTORY FREIGHT PREPAID, WITHIN THIRTY (30) DAYS AFTER A NEW PART HAS BEEN RECEIVED OR THERE WILL BE A 10% HANDLING CHARGE.

SHIPPING CHARGES: ON A WARRANTY PART, WE WILL ASSUME STANDARD SHIPPING CHARGES. THIS DOES NOT INCLUDE SPECIAL HANDLING SUCH AS AIR FREIGHT, U.P.S. NEXT DAY AIR SERVICE, OR U.P.S. SECOND DAY AIR SERVICE, ETC.

**MOTOR WARRANTY POLICY:**
THE FOLLOWING PROCEDURE MUST BE USED FOR PROPER REPLACEMENT AND/OR REPAIR OF ELECTRIC MOTORS THAT HAVE FAILED UNDER WARRANTY.

1) Remove motor from unit and take motor to a **MANUFACTURER AUTHORIZED SERVICE STATION.**

2) The service station will determine the warranty status by **INSTALLATION DATE OF THE UNIT, AND DATE OF FAILURE,** along with the age of the motor, determined by the **CODE DATE.**

3) If the unit is within warranty, the unit will be inspected for cause of failure and repair requirements.

4) If the unit is within warranty limitations, the service station will repair on a **"NO CHARGE"** basis.

5) If the repairs are extensive, the service station will contact the motor manufacturer warranty manager to decide if the motor is to be repaired or replaced.

**EXCEPTION TO THE ABOVE PROCEDURE:**
EMERGENCY SITUATIONS MAY DICTATE THAT BECAUSE OF THE DISTANCE BETWEEN USER AND AUTHORIZED SERVICE STATIONS, SEVERE DAMAGE OR INTERRUPTIONS MAY RESULT.

THE FOLLOWING PROCEDURE SHOULD BE USED:

1) SELECT A KNOWLEDGEABLE MOTOR REPAIR SHOP.

2) REPAIR SHOP TO CONTACT MOTOR MANUFACTURER WARRANTY REPAIR MANAGER, DETAILING REPAIRS NECESSARY ALONG WITH THE COMPLETE NAMEPLATE DATA BEFORE ANY REPAIRS ARE MADE.

3) IF ANY PROBLEMS OCCUR, THE INDUSTRIAL COMBUSTION PARTS DEPT. WILL PROVIDE ASSISTANCE.

**FAILURE TO FOLLOW THE NEXT PROCEDURE WILL RESULT IN REPAIRS BEING MADE AT THE CUSTOMERS EXPENSE.**

***MARATHON ELECTRIC - ELECTRIC MOTORS WARRANTY REPAIR PROCEDURE**

THE FOLLOWING PROCEDURE MUST BE USED FOR PROPER REPLACEMENT AND/R REPAIR OF MARATHON ELECTRIC MOTORS THAT HAVE FAILED UNDER WARRANTY.

1) END USER WILL REMOVE MOTOR FROM UNIT AND TAKE FAILED MOTOR TO MARATHON ELECTRIC AUTHORIZED SERVICE STATION.

2) SERVICE STATION WILL DETERMINE WARRANTY STATUS BY INSTALLATION DATE OF UNIT AND DATE OF FAILURE ALONG WITH AGE OF MOTOR DETERMINED BY DATE CODE.

3) IF WINTHIN WARRANTY LIMITATIONS, UNIT WILL BE INSPECTED FOR CAUSE OF FAILURE AND REPAIR REQUIREMENTS. DETERMINATION WILL BE MADE THAT FAILURE WAS CAUSED BY DEFECT IN MATERIALS OR WORKMANSHIP AND NOT BY MISUSE, ABUSE, ACCIDENT, OR OTHER EXCLUSIONS LISTED IN OUR WARRANTY.

4) IF MINOR REPAIR IS REUIRED, SERVICE STATION WILL REPAIR MOTOR AND RETURN TO USER ON A "NO CHARGE" BASIS.

5) IF MAJOR REPAIR (REWIND) IS REQUIRED, SERVICE STATION MAY:

   A) REWIND MOTOR AND RETURN TO USER ON A "NO CHARGE" BASIS IF USER REQUIREMENT IS NOT AN EMERGENCY AND REPAIR CAN BE MADE WITHIN MARATHON ELECTRIC PRICE GUIDELINES, OR

   B) NAMEPLATE WILL BE REMOVED AND ALONG WITH A REPORT OF CAUSE OF FAILURE WILL BE GIVEN TO THE USER.

6) USER WILL PRESENT NAMEPLATE AND REPORT TO DISTRIBUTOR.

7) DISTRIBUTOR WILL FURNISH USER WITH A NEW MOTOR, NO CHARGE, EITHER FROM HIS INVENTORY OR SECURE REPLACEMENT UNIT DIRECT FROM PARENT ORGANIZTION.

*MARATHON ELECTRIC
WARRANTY REPAIR PROCEDURE, DPN-79-113
ELECTRIC MOTORS, 48-215 FRAME

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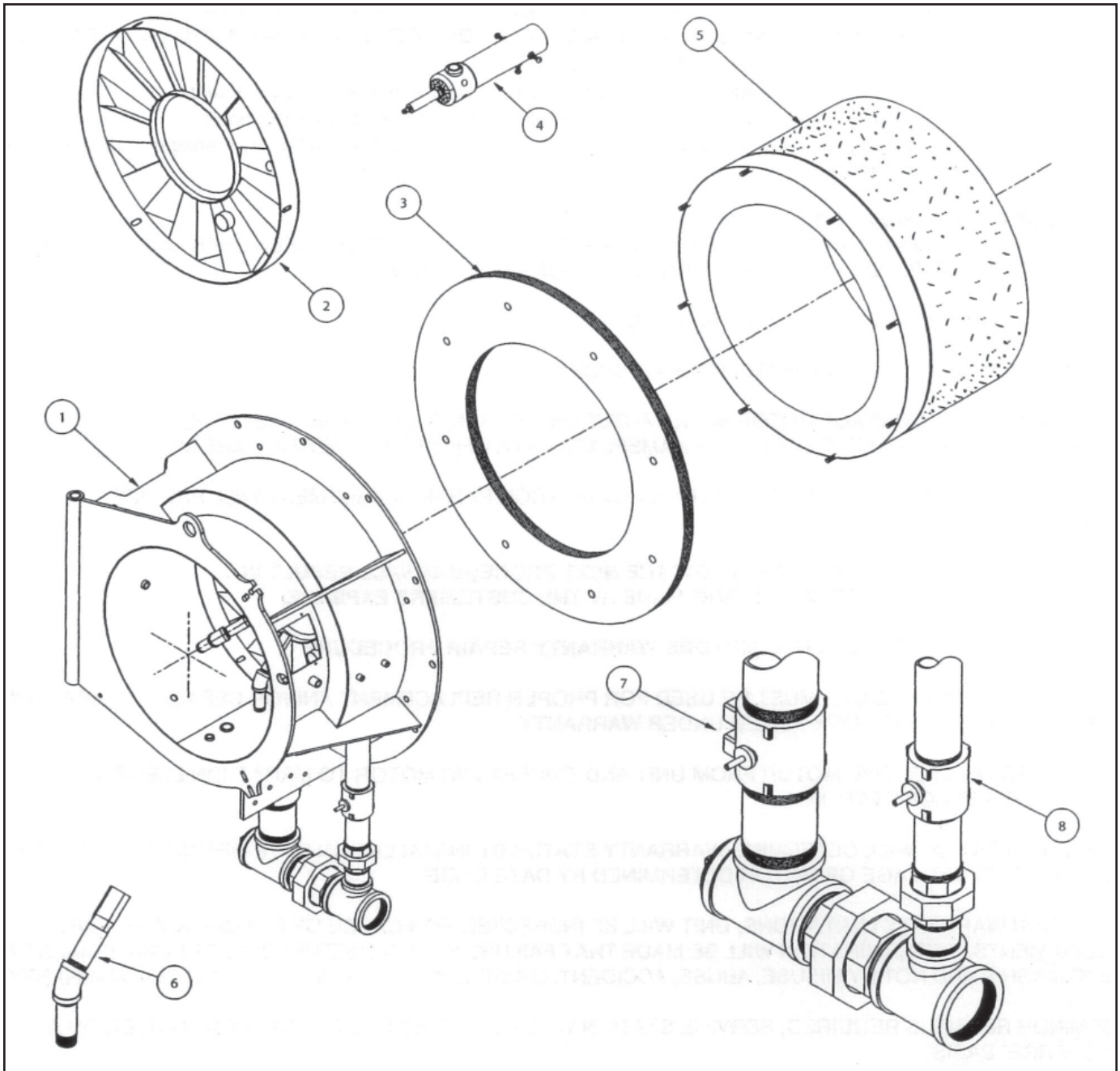
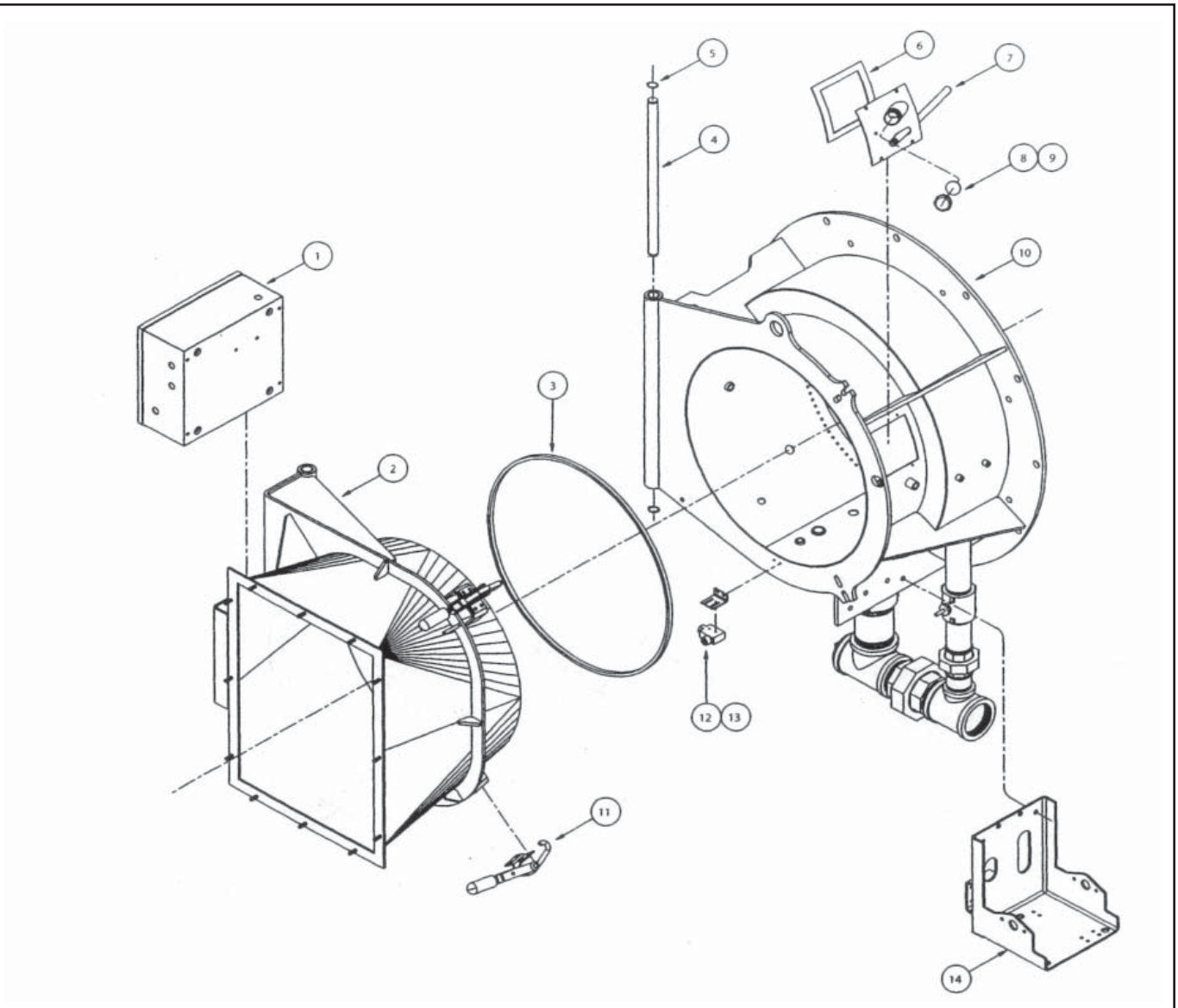


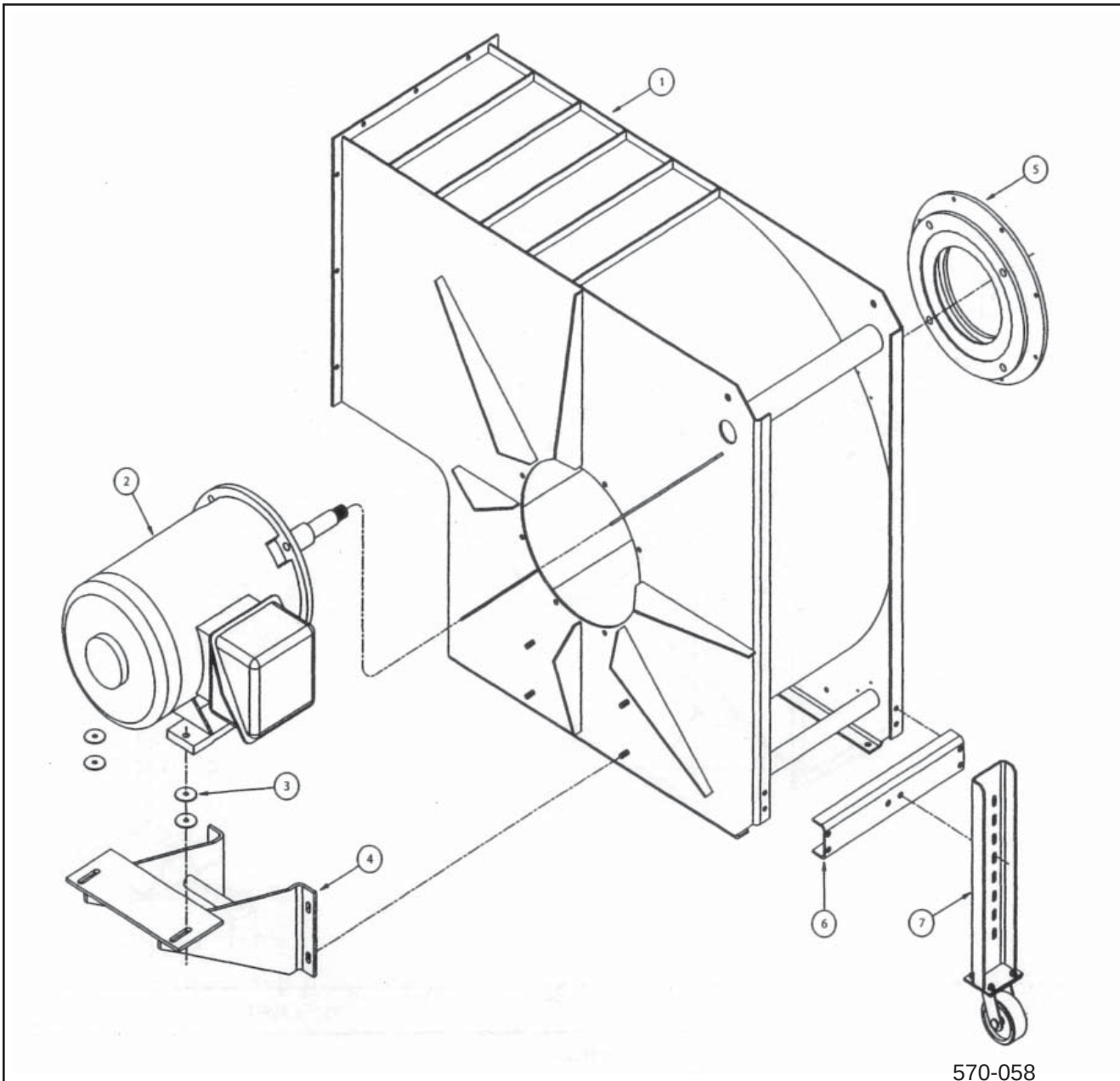

570-057

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 040-00446 | GAS MANIFOLD ASSEMBLY |
| 2 | 1 | 275-00567 | DIFFUSER ASSEMBLY - MODELS 462 & 504 |
| 2 | 1 | 275-00568 | DIFFUSER ASSEMBLY - MODELS 546, 588 & 630 |
| 3 | 1 | 032-01146 | DRY OVEN GASKET |
| 4 | 1 | 048-00197 | GAS PILOT ASSEMBLY |
| 5 | 1 | 279-00141 | DRY OVEN ASSEMBLY |
| 6 | 1 | 042-00101 | SECONDARY GAS SPUD ASSEMBLY |
| 7 | 1 | 940-01195 | 4" NPT FULL PORT GAS BUTTERFLY VALVE |
| 8 | 1 | 940-01230 | 2-1/2" NPT FULL PORT GAS BUTTERFLY VALVE |



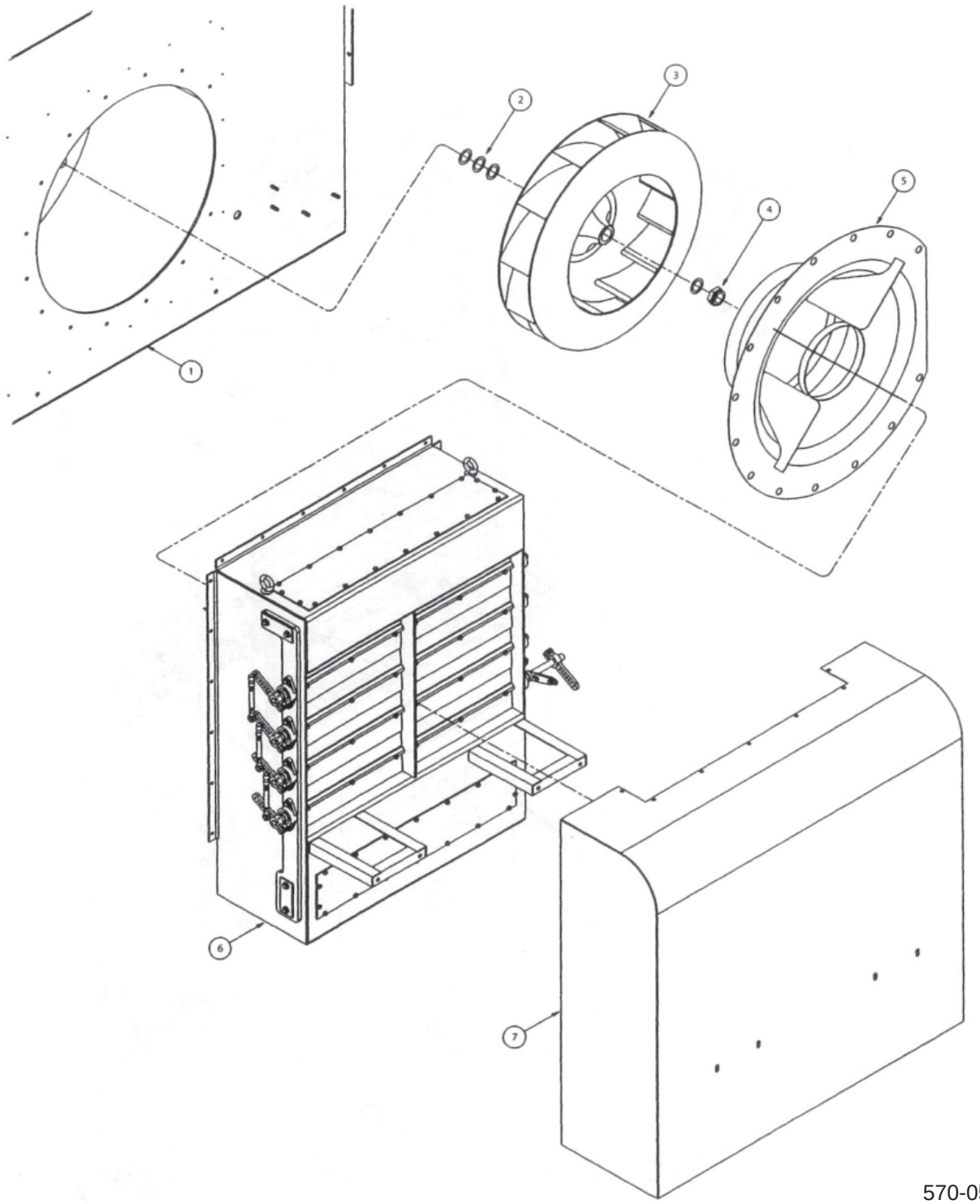

570-060

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 119-477 | JUNCTION BOX |
| 2 | 1 | 040-0448 | TRANSITION HOUSING |
| 3 | 1 | 032-1060 | FAN HOUSING SEAL GASKET |
| 4 | 1 | 56-290 | HINGE PIN |
| 5 | 1 | 914-205 | RETAINING SNAP RING |
| 6 | 1 | 32-1127 | ACCESS COVER GASKET |
| 7 | 1 | 19-593 | SCANNER AND ACCESS COVER |
| 8 | 1 | 031-00036 | SIGHT GLASS |
| 9 | 1 | 869-184 | SIGHT GLASS NUT |
| 10 | 1 | 040-00446 | GAS MANIFOLD ASSEMBLY (MANIFOLD ONLY) |
| 11 | 2 | 043-00013 | TOGGLE CLAMP LATCH |
| 12 | 1 | 836-301 | SAFETY INTERLOCK SWITCH |
| 13 | 1 | 10-1018 | SWITCH BRACKET |
| 14 | 1 | 085-0939 | BURNER SUPPORT |



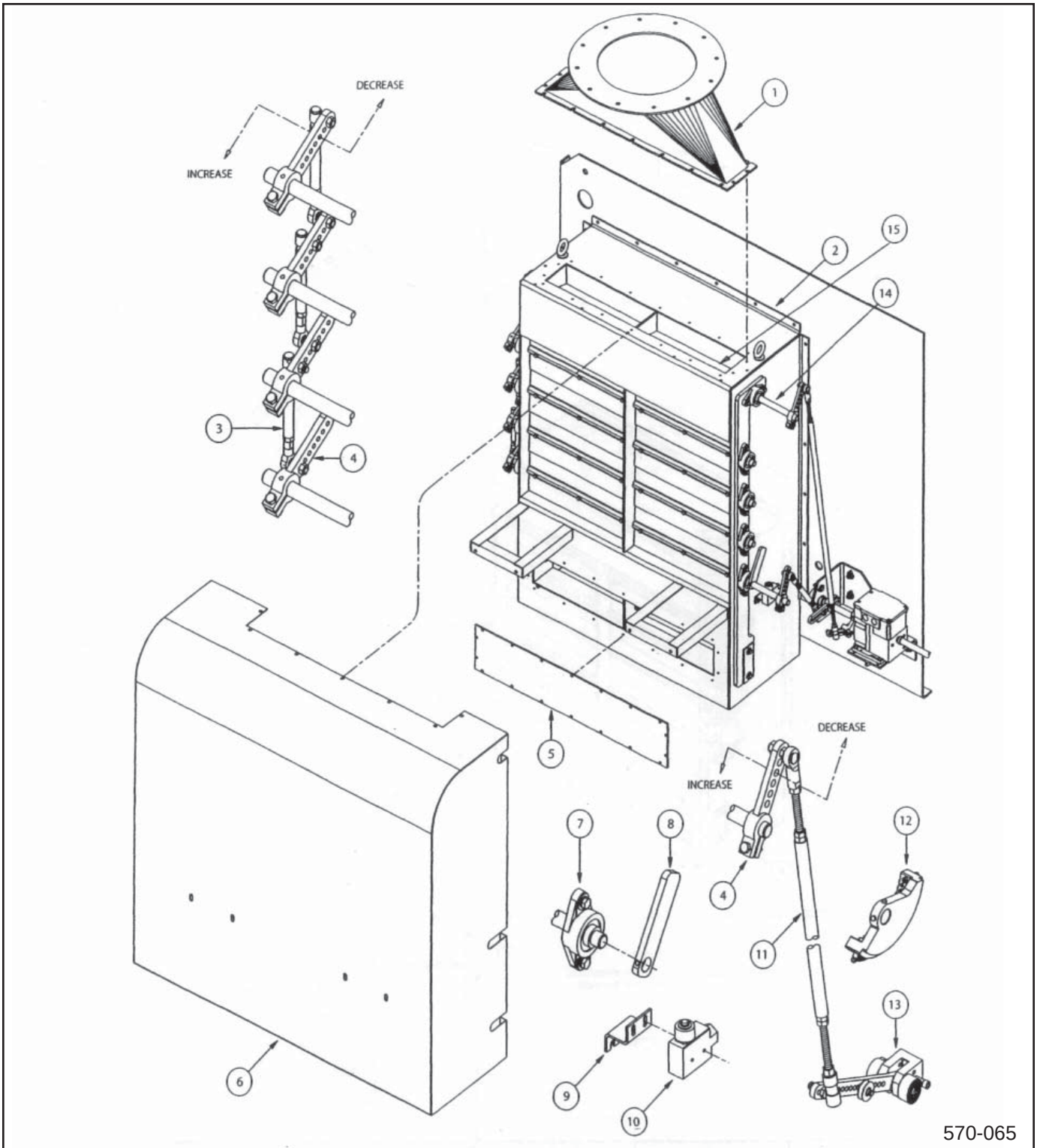

570-058

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 040-0465 | HOUSING |
| 2 | 1 | 894-01368 | MOTOR 60 HP - MODELS 462 |
| 2 | 1 | 894-01372 | MOTOR 75 HP - MODELS 504, 546, 588 & 630 |
| 3 | 4 | 152-00017 | RUBBER CUSHION |
| 4 | 1 | 085-0925 | MOTOR BRACKET SUPPORT - 60 HP MOTOR |
| 4 | 1 | 085-0923 | MOTOR BRACKET SUPPORT - 75 HP MOTOR |
| 5 | 1 | 077-0256 | MOTOR MOUNTING FLANGE |
| 6 | 1 | 008-01838 | LEG SUPPORT BRACKET |
| 7 | 1 | 085-0943 | WHEEL ASSEMBLY |




570-059

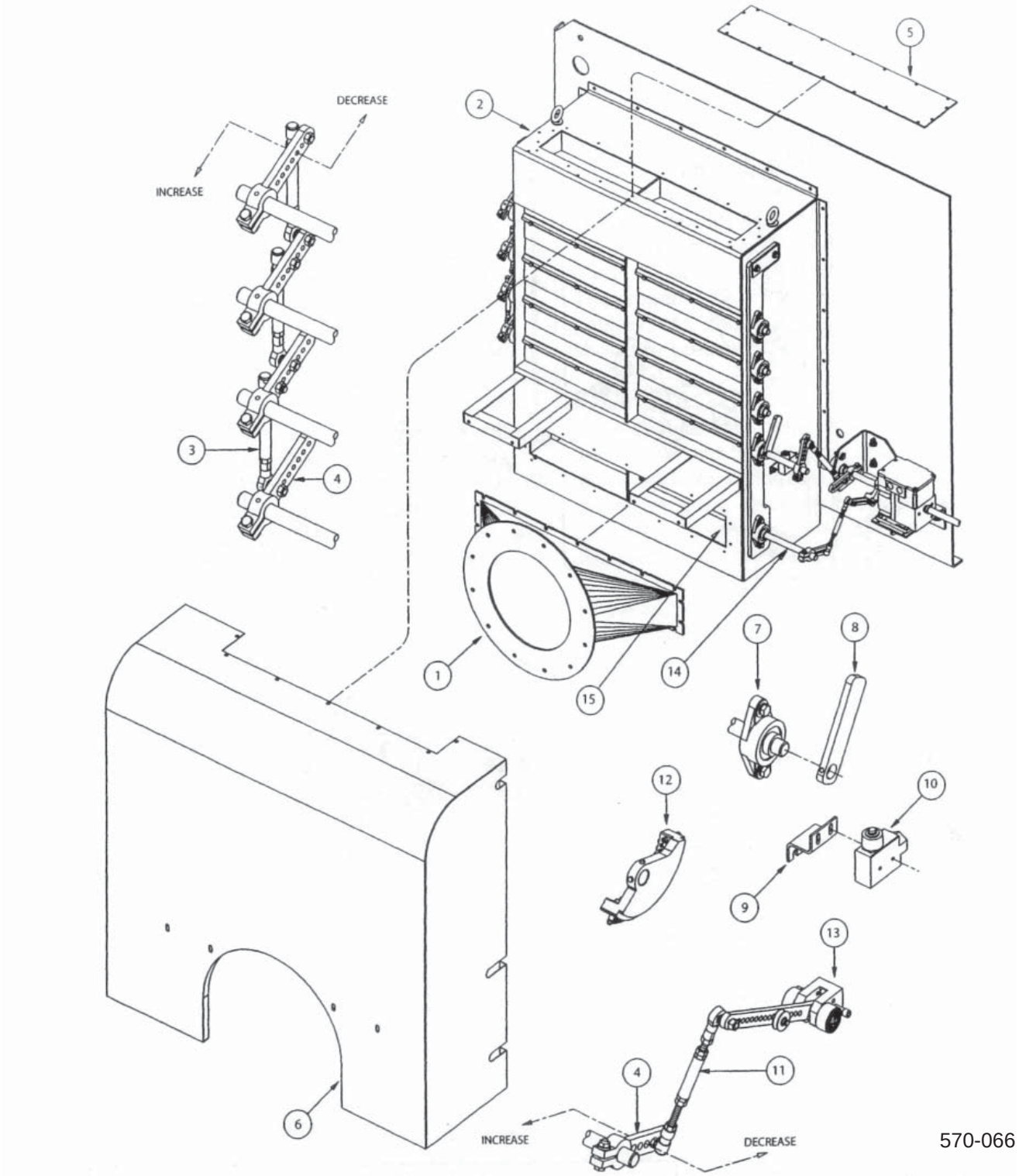
| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 040-0465 | BURNER HOUSING |
| 2 | 1 | 091 - | SPACER |
| 3 | 1 | 192-0344 | IMPELLER - 60 HP MOTOR - MODELS 462 |
| 3 | 1 | 192-0327 | IMPELLER - 75 HP MOTOR - MODELS 504, 546, 588 & 630 |
| 4 | 1 | 869-00185 | HEX LOCK NUT |
| 5 | 1 | 265-0148 | AIR INLET CONE ASSEMBLY |
| 6 | 1 | 427-0206 | AIR DAMPER BOX ASSEMBLY |
| 7 | 1 | 461-138 | SILENCER ASSEMBLY |




570-065

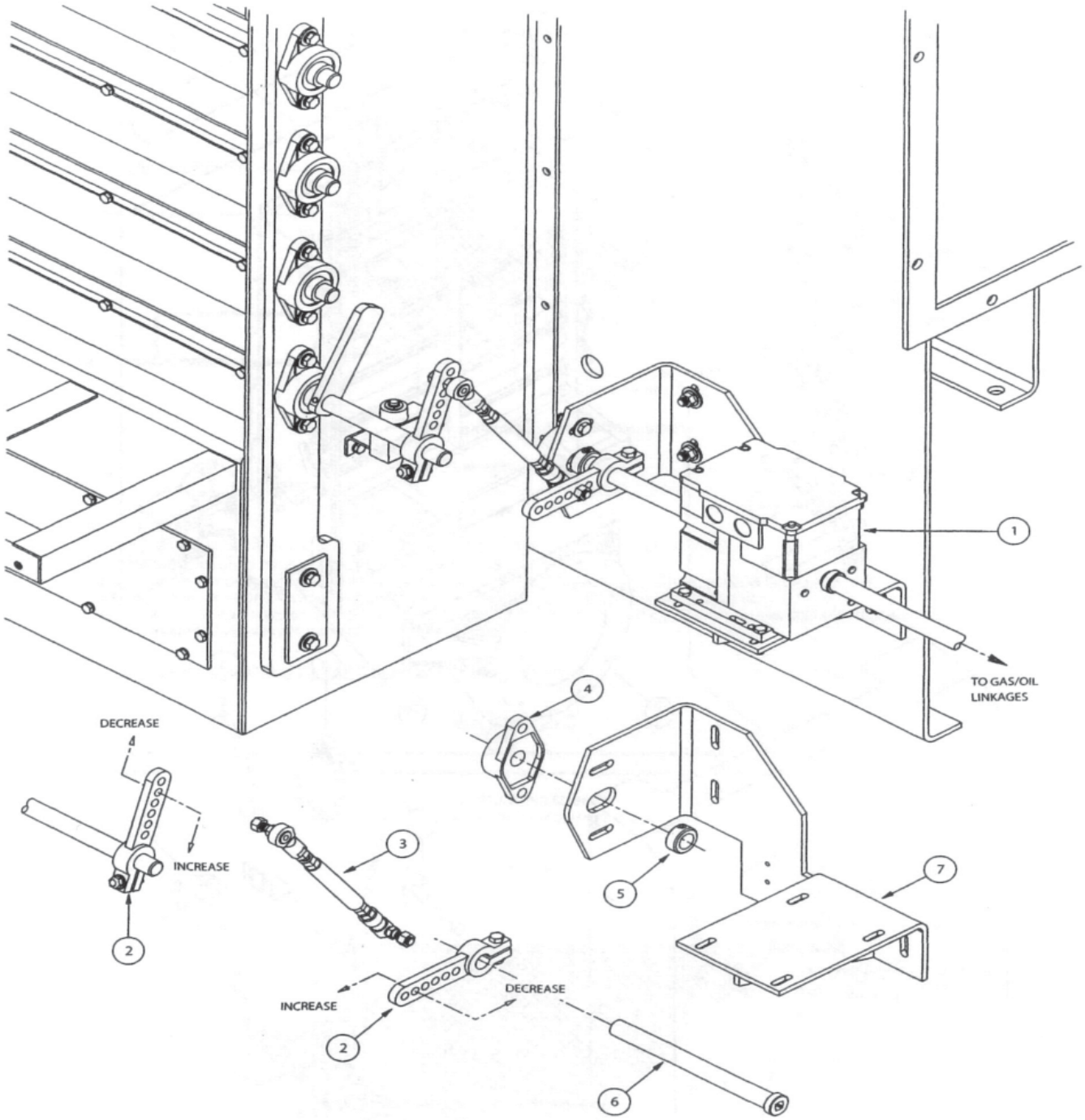
| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 097-00364 | FGR TRANSITION ASSEMBLY |
| 2 | 1 | 427-00206 | DAMPER BOX ASSEMBLY |
| 3 | 3 | 067-00485 | LINKAGE ROD ASSEMBLY |
| 4 | 4 | 002-00141 | LINKAGE ARM |
| 5 | 1 | 019-00581 | FGR OPENING COVER |
| 6 | 1 | 461-00138 | SILENCER ASSEMBLY |
| 7 | 1 | 807-00341 | BEARING |
| 8 | 1 | 002-00378 | LINKAGE ARM |

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 9 | 1 | 008-01272 | SWITCH MOUNTING BRACKET |
| 10 | 1 | 836-00301 | HIGH FIRE INTERLOCK SWITCH |
| 11 | 1 | 067-00355 | LINKAGE ROD ASSEMBLY |
| 12 | 1 | 313-00015 | CAM ASSEMBLY |
| 13 | 1 | 476-00082 | CAM TRIM ARM ASSEMBLY |
| 14 | 1 | 067-00472 | FGR CONTROL BLADE SHAFT |
| 15 | 1 | 005-00525 | FGR CONTROL BLADE |



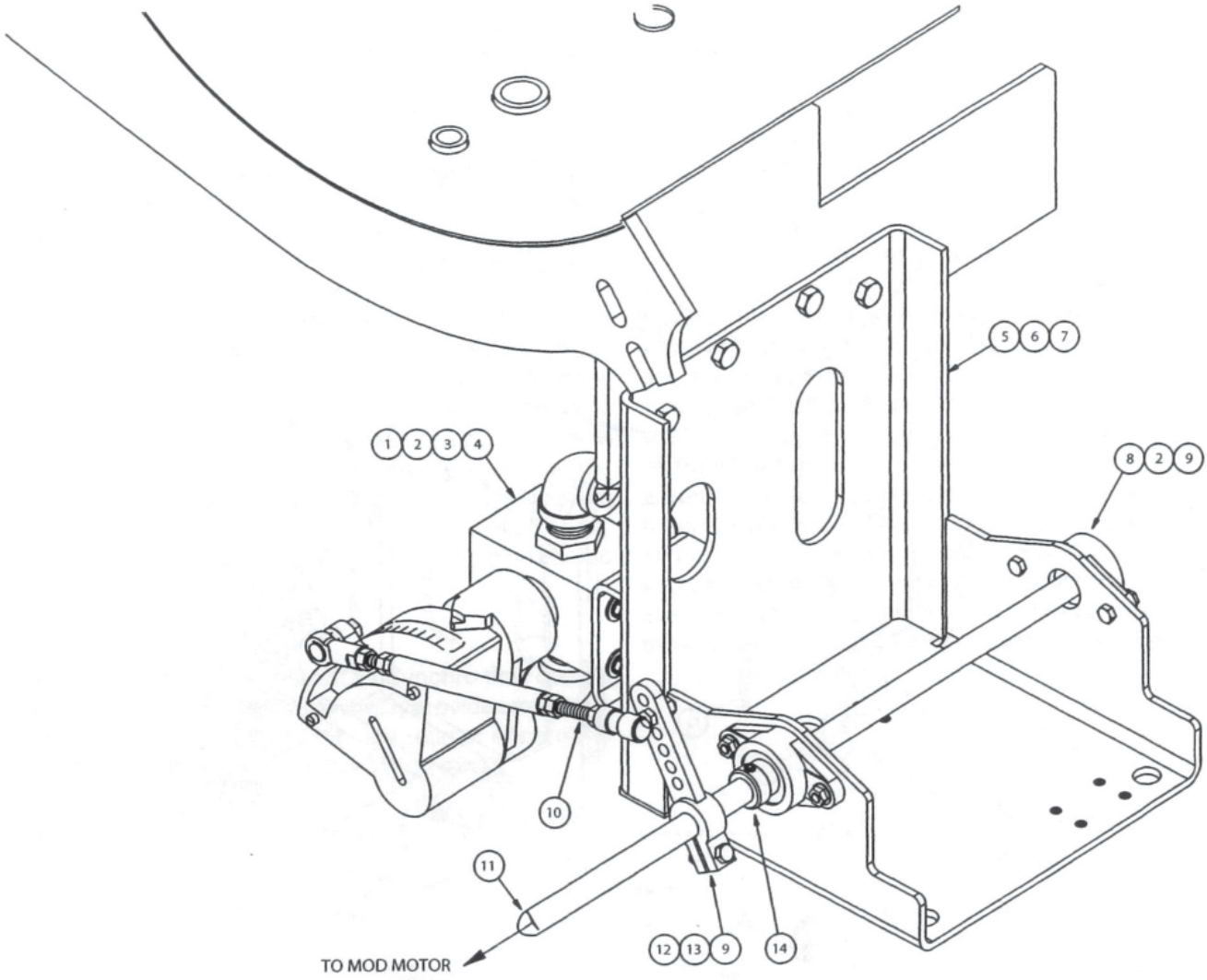

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 097-00364 | FGR TRANSITION ASSEMBLY |
| 2 | 1 | 427-00206 | DAMPER BOX ASSEMBLY |
| 3 | 3 | 067-00485 | LINKAGE ROD ASSEMBLY |
| 4 | 4 | 002-00141 | LINKAGE ARM |
| 5 | 1 | 019-00581 | FGR OPENING COVER |
| 6 | 1 | 461-00136 | SILENCER ASSEMBLY |
| 7 | 1 | 807-00341 | BEARING |
| 8 | 1 | 002-00378 | LINKAGE ARM |

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 9 | 1 | 008-01272 | SWITCH MOUNTING BRACKET |
| 10 | 1 | 836-00301 | HIGH FIRE INTERLOCK SWITCH |
| 11 | 1 | 067-00448 | LINKAGE ROD ASSEMBLY |
| 12 | 1 | 313-00015 | CAM ASSEMBLY |
| 13 | 1 | 476-00082 | CAM TRIM ARM ASSEMBLY |
| 14 | 1 | 067-00472 | FGR CONTROL BLADE SHAFT |
| 15 | 1 | 005-00525 | FGR CONTROL BLADE |



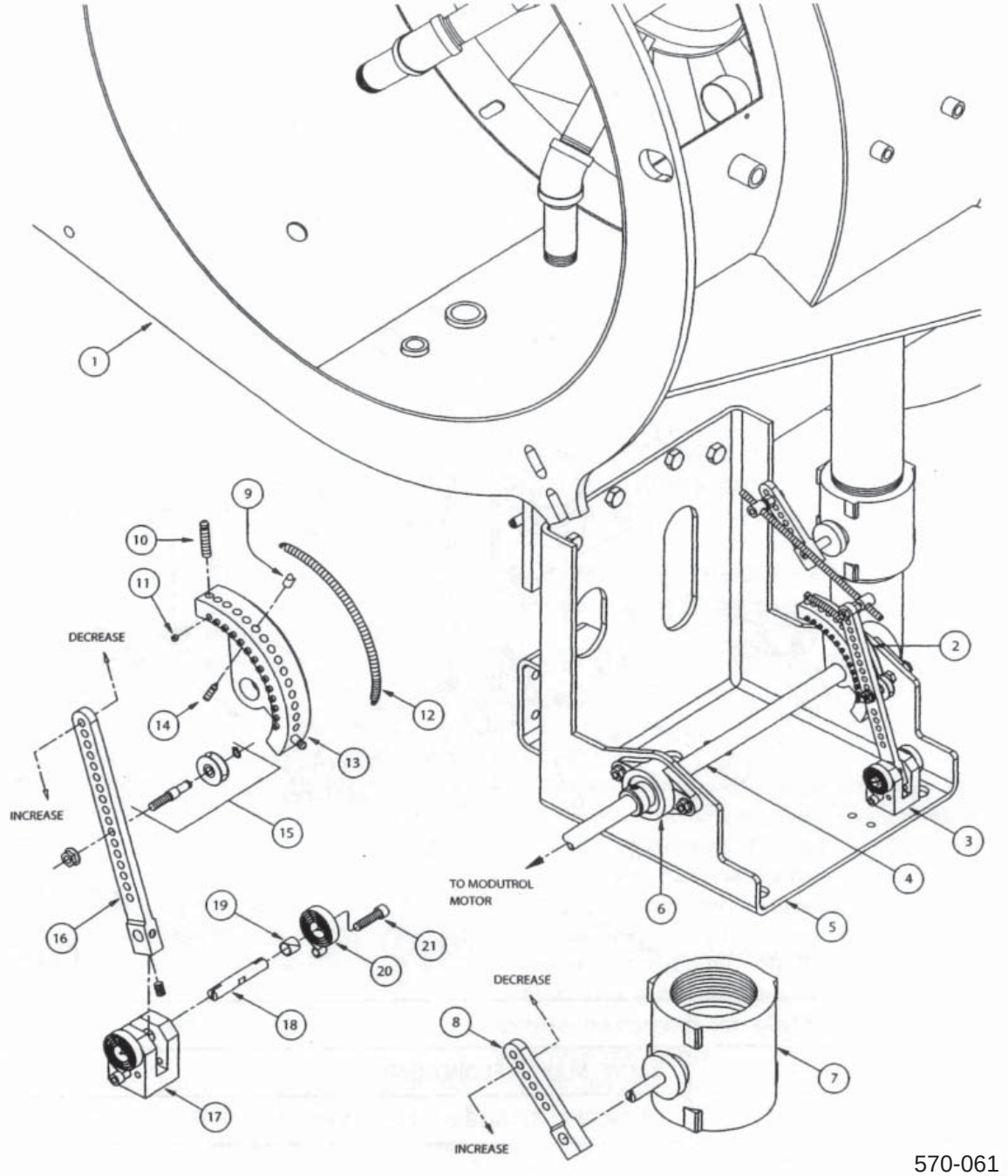

570-064

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 894-1346 | MOD MOTOR |
| 2 | 1 | 002-259 | LINKAGE ARM |
| 3 | 1 | 67-490 | LINKAGE ROD ASSEMBLY |
| 4 | 1 | 807-344 | BEARING |
| 5 | 1 | 18-149 | COLLAR |
| 6 | 1 | 010-0309 | BUSHING ASSEMBLY |
| 7 | 1 | 008-1832 | MOD MOTOR BRACKET ASSEMBLY |




035-0490

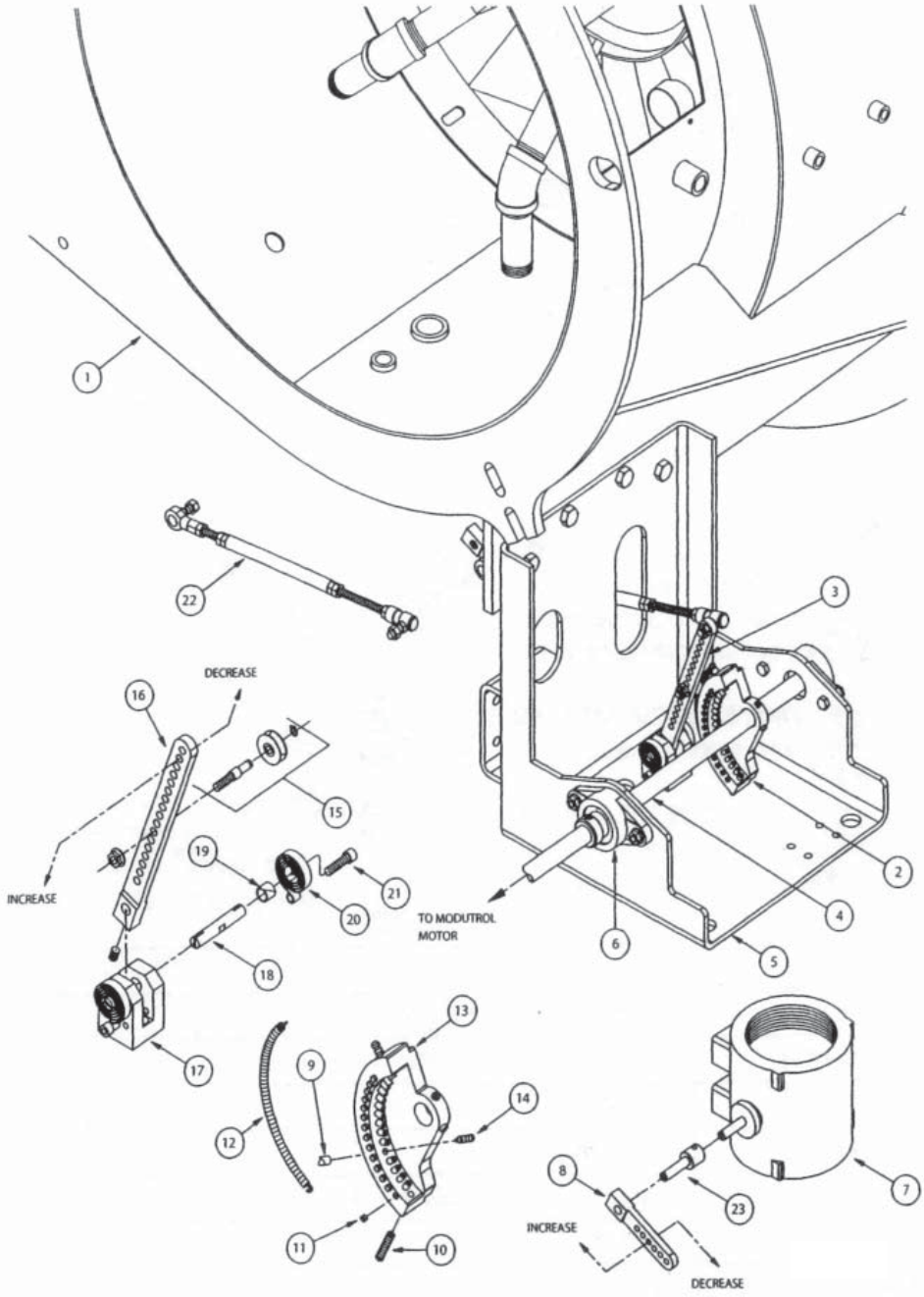
| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 940-01516 | VALVE, MAXON FLOW CONTROL |
| 2 | 8 | 868-00104 | CAPSCREW, 5/16-18 X 1" LG. HEX HD |
| 3 | 4 | 952-00114 | WASHER, 5/16" LOCK |
| 4 | 4 | 952-00253 | WASHER, 5/16" FLAT |
| 5 | 1 | C-085-0939 | SUPPORT ASSEMBLY, BURNER & LINKAGE |
| 6 | 4 | 868-00102 | CAPSCREW, 1/2-13 X 1-1/2" LG. HEX HD |
| 7 | 4 | 869-00209 | NUT, 1/2" SPINLOCK |
| 8 | 2 | 807-00344 | BEARING, FLANGED |
| 9 | 5 | 869-00206 | NUT, 5/16" SPINLOCK |
| 10 | 1 | B-067-0487 | ROD, LINKAGE ASSEMBLY |
| 11 | 1 | 010-00343 | BUSHING ASSEMBLY (REF. B-010-0307) |
| 12 | 1 | A-002-0259 | ARM, LINKAGE |
| 13 | 1 | 868-00128 | CAPSCREW, 5/16-18 X 1-1/4" LG. HEX HD |
| 14 | 1 | 018-00149 | COLLAR |




570-061

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 040-00446 | MANIFOLD ASSEMBLY |
| 2 | 1 | 313-14 | CAM ASSEMBLY - LEFT HAND |
| 3 | 1 | 476-84 | CAM FOLLOWER ASSEMBLY |
| 4 | 1 | 10-343 | BUSHING ASSEMBLY |
| 5 | 1 | 085-0939 | BURNER SUPPORT |
| 6 | 1 | 807-344 | BEARING, FLANGED 2PT, 3/4" SHAFT |
| 7 | 1 | 940-1230 | 2-1/2" FULL PORT VALVE |
| 8 | 1 | 002-00014 | LINKAGE ARM |
| 9 | 16 | 847-00260 | GUIDE, CAM SPRINGS |
| 10 | 2 | 71-24 | SCREW, SPRING FASTENER |
| 11 | 1 | 860-301 | SCREW LOCKING SET KIT (16 PER KIT) |

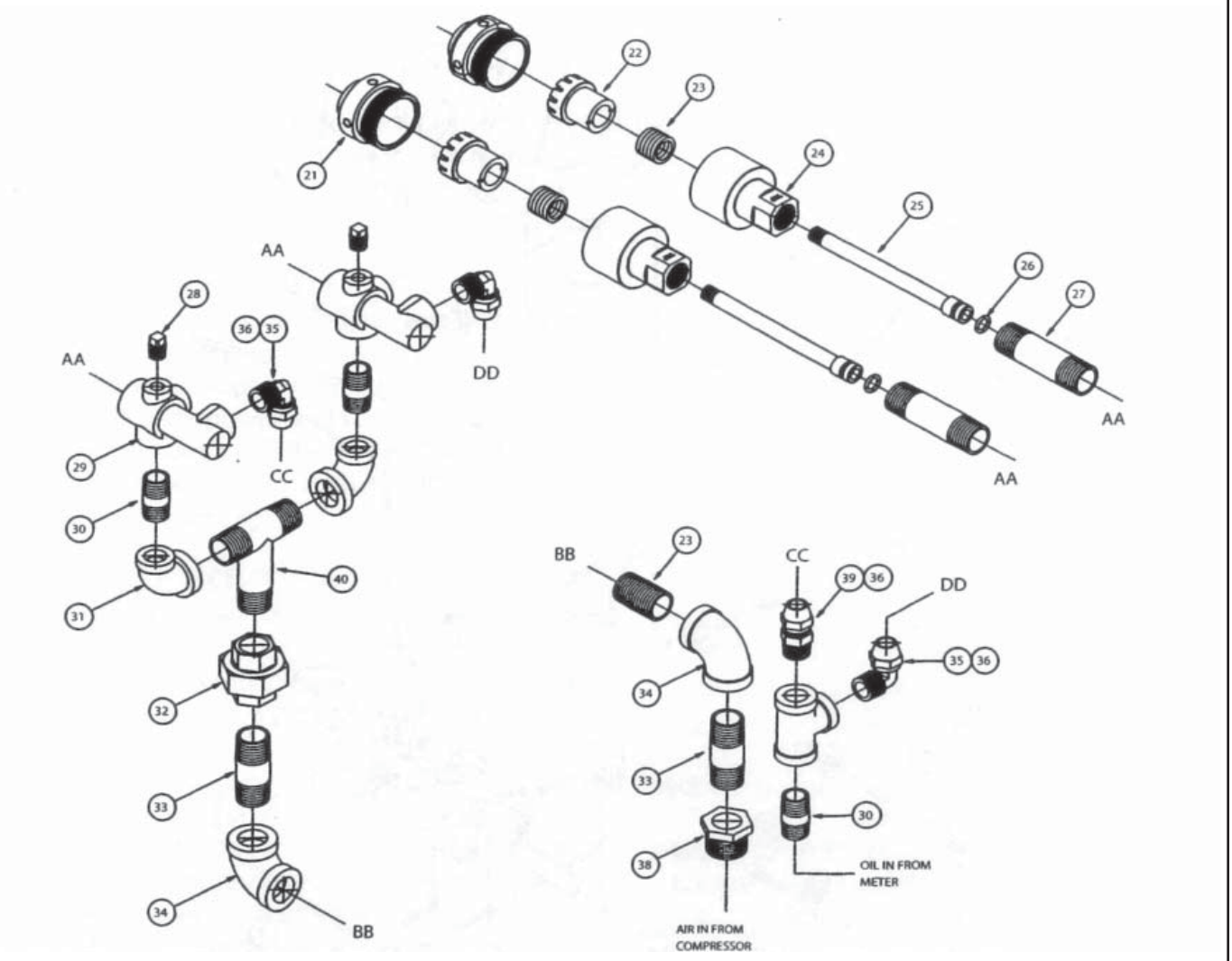
| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 12 | 1 | 82-153 | SPRING, ROLLER GUIDE, CAM |
| 13 | 1 | 313-14 | CAM ASSEMBLY - LEFT HAND |
| 14 | 16 | 860-299 | SCREW SET |
| 15 | 1 | 69-303 | ROLLER GUIDE ASSEMBLY |
| 16 | 1 | 2-13 | ARM, LINKAGE, 5/16" SHAFT, 17 HOLES |
| 17 | 1 | 8-1356 | BRACKET, LINKAGE ARM |
| 18 | 1 | 74-506 | SHAFT, LINKAGE ARM |
| 19 | 2 | 807-339 | BEARING, NYLON, 3/8" I.D. |
| 20 | 2 | 82-155 | SPRING |
| 21 | 1 | --- | SCREW |




570-062

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 040-00446 | MANIFOLD ASSEMBLY |
| 2 | 1 | 313-14 | CAM ASSEMBLY - LEFT HAND |
| 3 | 1 | 476-84 | CAM FOLLOWER ASSEMBLY |
| 4 | 1 | 10-343 | BUSHING ASSEMBLY |
| 5 | 1 | 085-0939 | BURNER SUPPORT |
| 6 | 1 | 807-344 | BEARING, FLANGED 2PT, 3/4" SHAFT |
| 7 | 1 | 940-1195 | 4" FULL PORT VALVE |
| 8 | 1 | 002-00014 | LINKAGE ARM |
| 9 | 16 | 847-00260 | GUIDE, CAM SPRINGS |
| 10 | 2 | 71-24 | SCREW, SPRING FASTENER |
| 11 | 1 | 860-301 | SCREW LOCKING SET KIT (16 PER KIT) |
| 12 | 1 | 82-153 | SPRING, ROLLER GUIDE, CAM |

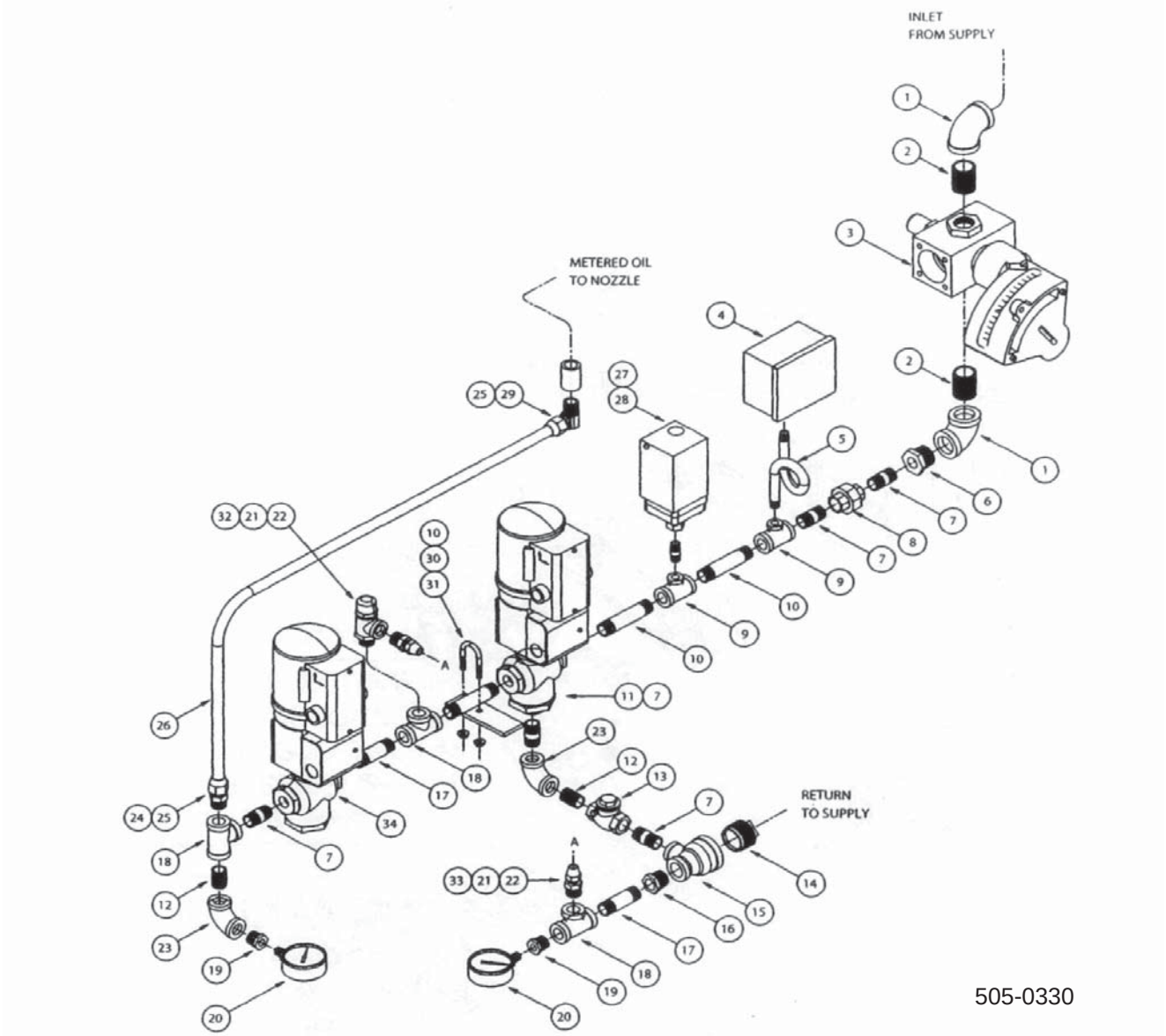
| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 13 | 1 | 313-14 | CAM ASSEMBLY - LEFT HAND |
| 14 | 16 | 860-299 | SCREW SET |
| 15 | 1 | 69-303 | ROLLER GUIDE ASSEMBLY |
| 16 | 1 | 2-13 | ARM, LINKAGE, 5/16" SHAFT, 17 HOLES |
| 17 | 1 | 8-1356 | BRACKET, LINKAGE ARM |
| 18 | 1 | 74-506 | SHAFT, LINKAGE ARM |
| 19 | 2 | 807-339 | BEARING, NYLON, 3/8" I.D. |
| 20 | 2 | 82-155 | SPRING |
| 21 | 1 | --- | SCREW |
| 22 | 1 | 67-489 | LINKAGE ROD ASSEMBLY |
| 23 | 1 | 074-621 | EXTENSION |




021-0583

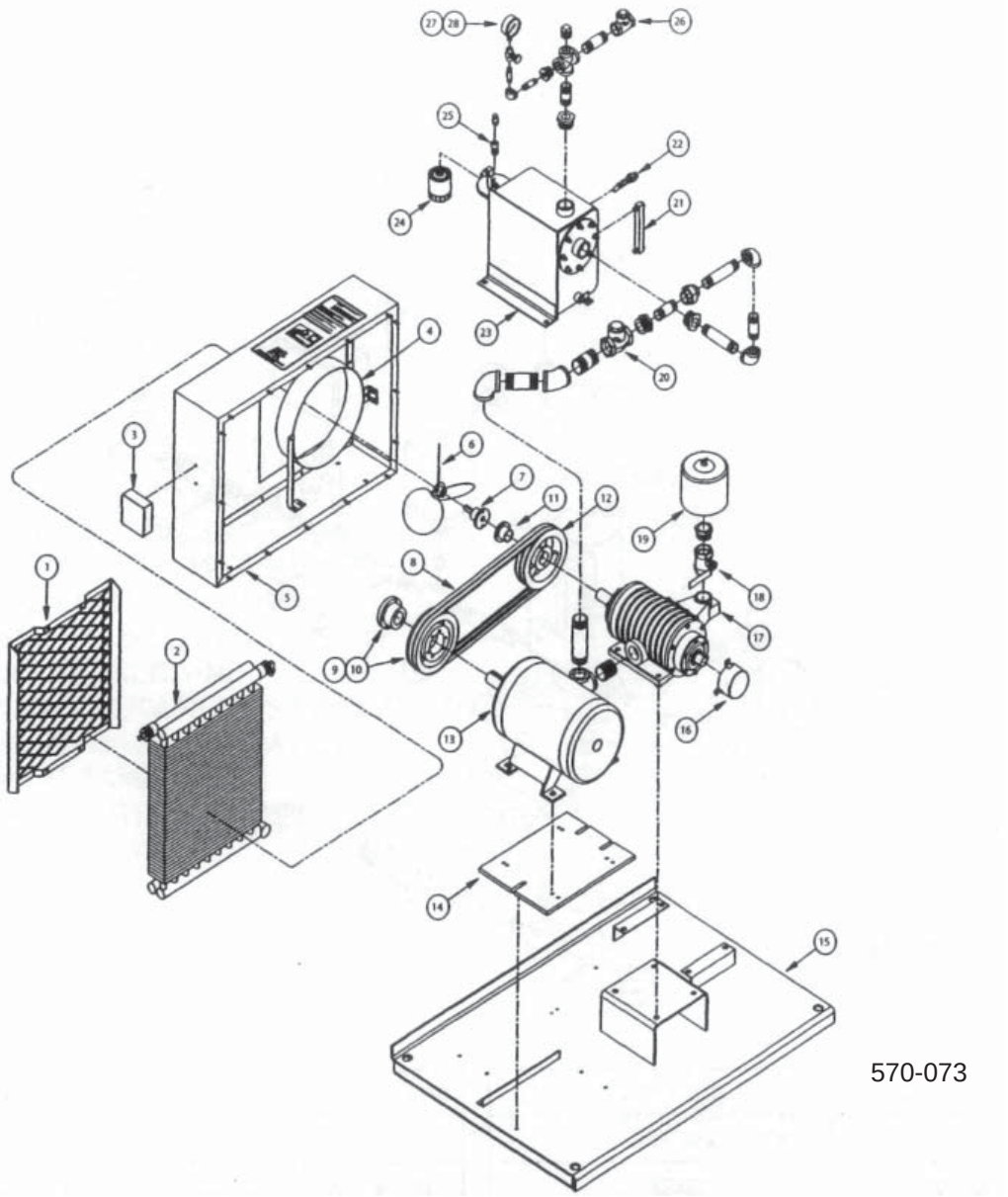
| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 21 | 2 | B-048-0203 | TIP, NOZZLE (REF. 528-00050) |
| 22 | 2 | B-109-0051 | SWIRLER (REF. 528-00050) |
| 23 | 2 | 082-00121 | SPRING |
| 24 | 2 | A-277-0107 | BODY, NOZZLE |
| 25 | 2 | A-090-0559 | TUBE, SLEEVE ASSEMBLY |
| 26 | 2 | 853-00613 | O-RING |
| 27 | 2 | 857-00169 | NIPPLE, 3/4" X 3-1/2" LG. |
| 28 | 2 | 858-00101 | PLUG, 1/4" PIPE |
| 29 | 2 | B-106-0101 | MANIFOLD, AIR/OIL INLET |
| 30 | 3 | 857-00153 | NIPPLE, 1/2" X 1-1/2"LG |

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 31 | 2 | 847-00548 | ELBOW, 3/4" X 1/2" REDUCING |
| 32 | 1 | 858-00217 | UNION, 3/4" PIPE |
| 33 | 2 | 857-00167 | NIPPLE, 3/4" X 2-1/2" LG. |
| 34 | 2 | 859-00081 | ELBOW, 3/4" X 90° PIPE |
| 35 | 3 | 845-00313 | F.F., 1/2"ODC. X 1/2" MPT. X 90° |
| 36 | 4 | 845-00224 | NUT, 1/2" FLARE |
| 37 | 1 | 857-00163 | NIPPLE, 3/4" CLOSE |
| 38 | 1 | 847-00426 | BUSHING, REDUCING 1" TO 3/4" |
| 39 | 1 | 845-00312 | F.F., 1/2" ODC. X 1/2" MPT. X STR. |
| 40 | 1 | A-085-0894 | NOZZLE SUPPORT ASSEMBLY |




| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 2 | 859-00082 | ELBOW, 1" X 90° PIPE |
| 2 | 2 | 857-00175 | NIPPLE, 1" X CLOSE |
| 3 | 1 | 940-01516 | VALVE, MAXON FLOW CONTROL |
| 4 | 1 | 817-00110 | SWITCH, HIGH OIL PRESSURE |
| 5 | 1 | 900-00290 | SIPHON, 1/4" PIPE |
| 6 | 1 | 847-00056 | BUSHING, 1" X 1/2" REDUCER |
| 7 | 5 | 857-00153 | NIPPLE, 1/2" X 1-1/2" LG. |
| 8 | 1 | 858-00216 | UNION, 1/2" PIPE |
| 9 | 2 | 847-00260 | TEE, 1/2" X 1/2" X 1/4" REDUCING |
| 10 | 3 | 857-00157 | NIPPLE, 1/2" X 3-1/2" LG. |
| 11 | 1 | 940-01233 | VALVE, 1/2" MOTORIZED 3-WAY OIL |
| 12 | 2 | 857-00151 | NIPPLE, 1/2" CLOSE |
| 13 | 1 | 940-01169 | VALVE, 1/2" HORIZONTAL CHECK |
| 14 | 1 | 919-00182 | PLUG, 1-1/4" PLASTIC PIPE |
| 15 | 1 | 847-00794 | TEE, 1-1/4" X 3/4" X 1/2" REDUCING |
| 16 | 1 | 847-00152 | BUSHING, 3/4" X 1/2" REDUCER |
| 17 | 2 | 857-00155 | NIPPLE, 1/2" X 2-1/2" LG. |

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 18 | 3 | 859-00024 | TEE, 1/2" X 1/2" X 1/2" PIPE |
| 19 | 2 | 847-00419 | BUSHING, 1/2" X 1/4" REDUCER |
| 20 | 2 | 850-00003 | GAUGE, 0-60 PSI |
| 21 | 2 | 845-00046 | F.F., 3/8" ODC. X 3/8" MPT. X STR. |
| 22 | 2 | 845-00043 | NUT, 3/8" FLARE |
| 23 | 2 | 859-00080 | ELBOW, 1/2" X 90° |
| 24 | 1 | 845-00312 | F.F., 1/2" ODC. X 1/2" MPT. X STR. |
| 25 | 2 | 845-00224 | NUT, 1/2" FLARE |
| 26 | 1 | 939-00027 | TUBING, 1/2" ODC. |
| 27 | 1 | 857-00128 | NIPPLE, 1/4" X 1-1/4" LG. |
| 28 | 1 | 817-00687 | SWITCH, LOW OIL PRESSURE |
| 29 | 1 | 845-00313 | F.F., 1/2" ODC. X 1/2" MPT. X 90° |
| 30 | 1 | C-008-1830 | BRACKET, OIL PIPING SUPPORT |
| 31 | 1 | 007-00209 | U-BOLT, 1-1/8" DIA. |
| 32 | 1 | 940-01224 | VALVE, 1/2" RELIEF |
| 33 | 1 | 939-00070 | TUBING, 3/8" ODC. |
| 34 | 1 | 940-01190 | VALVE, 1/2" MOTORIZED 2-WAY |




| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 1 | 1 | 035-00440 | RADIATOR GUIDE ASSEMBLY |
| 2 | 1 | 017-00234 | RADIATOR ASSEMBLY |
| 3 | 1 | 848-00514 | ELECTRICAL JUNCTION BOX |
| 4 | 1 | 039-00446 | AIR FLOW DUCT ASSEMBLY |
| 5 | 1 | 035-00439 | BELT GUARD WELDMENT |
| 6 | 1 | 951-00174 | FAN BLADE |
| 7 | 1 | 074-00516 | FAN MOUNTING SHAFT |
| 8 | 1 | 809-00223 | V-BELT |
| 9 | 1 | 810-00073 | BUSHING |
| 10 | 1 | 921-00538 | SHEAVE |
| 11 | 1 | 810-00072 | BUSHING |
| 12 | 1 | 921-00537 | SHEAVE |
| 13 | 1 | 894-01380 | MOTOR, 15 HP, 3 PH 208 VOLT |
| 13 | 1 | 894-01381 | MOTOR, 15 HP, 3 PH 230/460 VOLT |
| 14 | 1 | 059-01284 | MOTOR MOUNTING PLATE |

| ITEM | REQD. | PART NO. | DESCRIPTION |
|---|---|---|---|
| 15 | 1 | 003-00377 | COMPRESSOR BASE |
| 16 | 1 | 035-00438 | COMPRESSOR SHAFT END GUARD |
| 17 | 1 | 505-00322 | AIR COMPRESSOR |
| 18 | 1 | 941-00127 | 1-1/2" NPT SHUTOFF VALVE |
| 19 | 1 | 923-00112 | AIR FILTER |
| 20 | 1 | 940-01281 | 1-1/2" NPT HORIZONTAL CHECK VALVE |
| 21 | 1 | 851-00180 | SIGHT GLASS |
| 22 | 1 | 832-00925 | LOW LUBE OIL SENSOR (OPTIONAL) |
| 23 | 1 | 195-00264 | OIL/AIR TANK ASSEMBLY |
| 24 | 1 | 843-00106 | OIL FILTER |
| 25 | 1 | 010-00315 | OIL FILTER MOUNTING BUSHING |
| 26 | 1 | 940-01279 | 1" NPT HORIZONTAL CHECK VALVE |
| 27 | 1 | 850-00003 | GAUGE, 0-60 PSI |
| 28 | 1 | 941-00587 | 1/4" NPT NEEDLE VALVE |