KEWANEE
INSTALLATION, OPERATING AND MAINTENANCE MANUAL FOR PHOENX LE FLUE GAS RECIRCULATION BURNER

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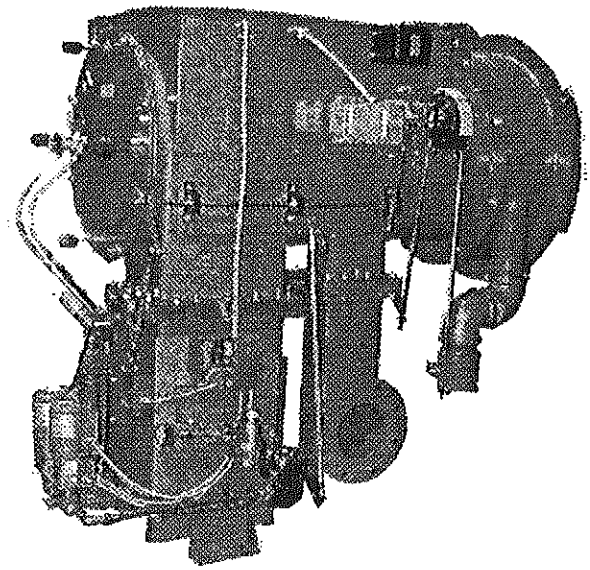

BURNER MODEL : _____ **BURNER SERIAL NO. :** _____

This manual details the principles of operation, installation, start-up and maintenance of the Kewanee natural gas and combination natural gas/No. 2 fuel oil fired Flue Gas Recirculation (FGR) burner and associated FGR controls and systems when the systems are factory mounted on a Kewanee Scotch or Firebox boiler.

This document is a section of a larger, complete burner/boiler system manual that was provided with your system. Before proceeding, thoroughly review and understand all of the other burner/boiler system manuals. The appendix of this manual contains general drawings of the system which must be fully understood before proceeding.

KEWANEE®

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PREFACE

The equipment shall be installed in accordance with those installation regulations in force in the area where the installation is to be made. These regulations shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made.

All wiring on boilers installed in the USA shall be made in accordance with the National Electrical Code and/or local regulations.

The following defined terms are used throughout this manual to bring attention to the presence of hazards of various risk levels or to note important information concerning the operating life of the product.

DANGER

INDICATES AN IMMENENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN DEATH, SERIOUS INJURY OR SUBSTANTIAL PROPERTY DAMAGE.

WARNING

INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN DEATH, SERIOUS INJURY OR SUBSTANTIAL PROPERTY DAMAGE.

CAUTION

INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN MODERATE OR MINOR INJURY, OR PROPERTY DAMAGE.

NOTICE

INDICATES SPECIAL INSTRUCTIONS ON INSTALLATION, OPERATION OR MAINTENANCE WHICH ARE IMPORTANT BUT NOT NECESSARILY RELATED TO PERSONAL INJURY HAZARDS.

BURNER/BOILER SYSTEM, AS USED THROUGHOUT THIS MANUAL, SHALL MEAN ALL MECHANICAL AND/OR ELECTRICAL EQUIPMENT INCLUDING THE BOILER, BURNER, PUMPS, COMPRESSORS, FEED WATER SYSTEMS, DEAERATOR SYSTEMS AND ALL ASSOCIATED PIPING, ELECTRICAL AND CONTROL SYSTEMS USED AND MAINTAINED IN THE BOILER ROOM.

WARNING

1. **INSTALLATION, START-UP, OPERATION AND/OR MAINTENANCE (SERVICE) OF THIS BURNER/BOILER SYSTEM MUST BE UNDERTAKEN ONLY BY TRAINED AND SKILLED PERSONNEL.**
2. **FAILURE TO FOLLOW ALL INSTRUCTIONS COULD CAUSE PERSONAL INJURY OR DEATH. READ ALL INSTRUCTIONS, INCLUDING THOSE IN ALL OTHER BOILER/BURNER SYSTEM MANUALS (MODULES) WHICH WERE PROVIDED WITH THE EQUIPMENT BEFORE INSTALLING, OPERATING OR SERVICING.**
3. **POST ALL INSTRUCTIONS AND MANUALS NEAR THE BOILER FOR REFERENCE BY SERVICE PERSONNEL.**
4. **KEEP BOILER AREA CLEAR AND FREE FROM COMBUSTIBLE MATERIALS, GASOLINE AND OTHER FLAMMABLE VAPORS AND LIQUIDS.**
5. **PROVIDE POSITIVE ASSURANCE THAT ADEQUATE COMBUSTION AND VENTILATION AIR IS PROVIDED FROM THE OUTDOORS TO THE BURNER/BOILER SYSTEM AND THE BOILER ROOM.**
6. **DO NOT PLACE ANY OBSTRUCTIONS IN THE BOILER ROOM THAT WILL HINDER THE FLOW OF COMBUSTION AND VENTILATING AIR.**
7. **INSULATE ALL STEAM AND HOT WATER PIPING, FITTINGS AND CONNECTIONS AND ALL OTHER HOT COMPONENTS AND EQUIPMENT FROM PERSONNEL CONTACT.**

DANGER

1. **IF YOU SMELL GAS OR FUEL OIL VAPORS, DO NOT TRY TO OPERATE THE BURNER/BOILER SYSTEM. DO NOT TOUCH ANY ELECTRICAL SWITCH OR USE ANY PHONE IN THE BUILDING. IMMEDIATELY CALL THE GAS OR OIL SUPPLIER FROM A REMOTELY LOCATED PHONE. FOLLOW THE GAS OR OIL SUPPLIERS INSTRUCTIONS OR IF THE SUPPLIER IS UNAVAILABLE, CONTACT THE FIRE DEPARTMENT.**

2. BURNER/BOILER SYSTEMS PRODUCE STEAM OR HOT WATER IN A PRESSURIZED VESSEL BY MIXING EXTREMELY FLAMMABLE GASEOUS, LIQUID OR SOLID FUELS WITH AIR TO PRODUCE COMBUSTION AND VERY HOT PRODUCTS OF COMBUSTION. EXPLOSIONS, FIRES, SEVERE PERSONAL INJURY, DEATH AND/OR PROPERTY DAMAGE WILL RESULT FROM IMPROPER, CARELESS OR INADEQUATE INSTALLATION, OPERATION OR MAINTENANCE OF FUEL BURNING AND BOILER EQUIPMENT.

3. ASSURE ALL PIPES, FITTINGS, ELECTRICAL CONTROLS AND ALL OTHER ASSOCIATED BURNER/BOILER EQUIPMENT IS OF PROPER DESIGN AND CONSTRUCTION FOR THE INTENDED USE AND PROVIDES ADEQUATE PROTECTION FROM ELECTRICAL SHOCK AND HARMFUL PHYSICAL CONTACT TO PERSONNEL.

4. A POSITIVELY LEAK TIGHT FUEL DELIVERY CONDUIT AND CONTROL SYSTEM MUST BE MAINTAINED AT ALL TIMES.

5. PRODUCTS OF COMBUSTION MUST BE TRANSPORTED FROM THE BOILER/BURNER SYSTEM TO THE OUTDOORS IN AN APPROVED, LEAK TIGHT, INSULATED VENTING SYSTEM. THE BOILER ROOM MUST BE POSITIVELY VENTILATED TO PREVENT A CONCENTRATION OF PRODUCTS OF COMBUSTION AND A REDUCTION IN THE AMOUNT OF OXYGEN IN THE AIR.

6. BURNER/BOILER MATERIALS OF CONSTRUCTION, PRODUCTS OF COMBUSTION AND FUELS CONTAIN ALUMINA, SILICA, HEAVY METALS, CARBON MONOXIDE, NITROGEN OXIDES, ALDEHYDES, CARBON DIOXIDE, PARTICULATES AND/OR OTHER TOXIC OR HARMFUL SUBSTANCES WHICH CAN CAUSE DEATH OR SERIOUS ILLNESS AND WHICH ARE KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS AND OTHER REPRODUCTIVE HARM. ALWAYS USE PROPER SAFETY CLOTHING, RESPIRATORS AND EQUIPMENT WHEN SERVICING OR WORKING NEARBY THE EQUIPMENT.

SECTION I
PRINCIPLES OF OPERATION

A. COMBUSTION - NATURAL GAS

The Kewanee FGR burner uses a combination of a uniform mixing, a high swirl flame pattern and a flue gas recirculation system to produce low concentrations of nitrogen oxides (NOx) and carbon monoxide (CO) in the boiler exhaust when the burner is fired on natural gas. A forced draft FGR system is utilized.

NOTICE

THE KEWANEE FGR BURNER IS ALSO OFFERED WITHOUT THE FGR SYSTEM TO FACILITATE EASY FUTURE UPGRADE OF THE BURNER/BOILER SYSTEM TO ACHIEVE LOW CONCENTRATIONS OF NOx EMISSIONS. NO CLAIM OF LOW NOx EMISSIONS IS MADE WITHOUT THE FACTORY APPROVED AND SUPPLIED FGR SYSTEM INSTALLED AND OPERATING PROPERLY.

In the Kewanee forced FGR system, a small quantity of boiler exhaust gases are drawn from the boiler vent stack by a separate FGR fan and forced through FGR piping to the front of the boiler and into the burner air plenum assembly on a tangent to the horizontal centerline of the air plenum. There these exhaust gases are mixed with combustion air, which was provided by a combustion air fan and introduces into the air plenum upstream of the FGR adapter assembly also on a tangent to the horizontal centerline of the air plenum. Having both the combustion air and FGR streams introduced tangentially serves to create a high swirl to the combustion air and FGR streams and, thereby, creates uniform mixing of the streams by means of an intense fluid shearing action. The uniform combustion air/FGR mixture swirls down the air plenum and into the gas head and is then forced through a natural gas diffuser (Figure 1A or 1B) which in turn increases the velocity of the mixture and intensifies the swirl.

Natural gas, which is conveyed through gas train piping consisting of a pressure regulator, multiple safety shut off valves and a butterfly valve is injected into the burner gas head by means of a tangential gas inlet pipe. The gas head consists of an outer steel wrapper, an inner steel cylinder with tappings for gas nozzles, a front mounting flange, a rear plate with studs and a gas inlet pipe.

Natural gas enters the gas head and is imparted with a swirling motion by means of the tangential gas inlet pipe. The gas swirls within the gas head annulus and enters the natural gas nozzles . The natural gas is injected at high velocity through the nozzles and into the swirling combustion air/FGR stream. The natural gas, combustion air and FGR are then uniformly mixed by the fluid shearing action of the swirling flow and the jet penetration of the high velocity natural gas. Combustion is then initiated inside the burner combustion zone.

The combustion zone is a highly turbulent, swirling flow which clings to the circumference of the burner refractory plug and the boiler furnace tube. Due to the high velocity flow of hot combustion gas at the furnace tube wall, the convective heat transfer through the wall of the tube is dramatically increased. Additionally, the high swirl combustion zone produces a compact flame front.

On the 300 through 800 HP burners there is axial air which is taken from the horizontal combustion air duct on the high pressure side of the combustion air damper. This air travels through a butterfly valve and hose assembly, down the center pipe of the gas tray assembly(figure 1B) and through the center of the diffuser.

B. COMBUSTION - NO. 2 FUEL OIL (If Equipped)

The Kewanee FGR burner uses unique combustion air diffusers for natural gas or No. 2 fuel oil firing. Natural gas and No. 2 oil have radically divergent mechanisms of combustion which necessitate different combustion air mixing methods for optimum burner performance. Unique fuel specific diffusers allow the burner to operate with low excess air and minimal CO/smoke emissions throughout the burner firing range on both fuels. This level of performance cannot be realized with the inherent compromises which are necessary to fire both natural gas and No. 2 fuel oil with the same burner.

WARNING

THE KEWANEE FGR BURNER IS DESIGNED AND BUILT TO OPERATE WITH FLUE GAS RECIRCULATION ONLY WHEN THE BURNER IS FIRING NATURAL GAS. THE FGR SYSTEM SHOULD NEVER BE OPERATED WHEN FIRING FUEL OIL.

As with natural gas firing, combustion air is delivered into the burner air plenum from a combustion air blower and through a tangentially aligned air transition assembly. The combustion air swirls down the air plenum, into the gas head and through the No. 2 fuel oil diffuser (figure 2A & 2B). Combustion air is forced through the small diameter cone of the diffuser.

This cone is located on the horizontal centerline of the burner and boiler furnace tube, thus the combustion air creates a high velocity jet in the center of the boiler furnace tube.

An air atomized oil nozzle assembly is located coaxially to the No. 2 oil diffuser cone. The oil assembly consists of a front plate, which mates to the flange of the air plenum, an air atomized oil nozzle, piping to deliver air and oil to the

nozzle, braided flexible connectors with unions, mounting and centering hardware and a safety switch to help prevent firing the burner on natural gas with the No. 2 oil diffuser.

WARNING

ALWAYS POSITIVELY ASSURE THE PROPER DIFFUSER FOR THE DESIRED FUEL IS MOUNTED, SECURED AND LEAK TIGHT BEFORE ATTEMPTING TO FIRE THE BURNER.

The oil nozzle is positioned coaxially to the diffuser cone with the forward tip of the nozzle extending slightly forward of the diffuser cone. This positioning helps prevent any oil from dripping on the diffuser and causing carbon build up. Atomized No. 2 oil is injected into the center of the combustion air jet. The combustion air, and oil form a high momentum, high pressure flame which is centered in the boiler furnace tube. As the flame travels down the furnace tube a low pressure zone is created at the boiler wall. The tips of the flame are drawn into this low pressure region and reverse flow inside the tube. As the hot combustion gases travel back toward the burner, the high velocity center flame retains the gases. Thus a recirculation zone is created inside the boiler furnace tube. This recirculation zone serves to ensure low soot formation, high heat transfer and low excess air requirements.

C. SEQUENCE OF OPERATION

WARNING

THE FOLLOWING SEQUENCE OF OPERATION IS GENERAL AND PROVIDED FOR ILLUSTRATION PURPOSES ONLY. EACH BOILER CONTROL SYSTEM IS UNIQUE AND MUST BE FULLY UNDERSTOOD BEFORE ATTEMPTING INSTALLATION, START-UP AND/OR OPERATION. CONSULT FACTORY SUPPLIED WIRING DIAGRAM FOR SPECIFIC CONTROLS PROVIDED ON YOUR BURNER/BOILER SYSTEM. CAREFULLY READ AND FULLY UNDERSTAND THE BURNER/BOILER CONTROLLER AND SAFETY CONTROLS MANUALS BEFORE PROCEEDING.

1. Normal Operation (Natural Gas/FGR)

On a call for heat, (drop in steam pressure/water temperature below set point) the contacts of a pressure/temperature switch close, energizing the operating interlock circuit of the burner programmer. Operating interlocks(Recycling limits) include the low water float switch(s) and the steam pressure/water temperature switch(s). If the preignition interlock contacts are closed, (gas valve and/or oil valve end switches) the combustion air blower motor and the modulation motor are energized and the modulation motor then drives to the high fire position (prepurge). Ten seconds after energizing the blower motor, the controller checks the electrical continuity of the running interlock circuit(Non-recycling limits). The Running interlock circuit is proven when the contacts of the combustion air blower starter, the combustion air flow proving switch, High and Low gas pressure switch, gas tray proving switch(if dual fuel), axial air proving switch, 2nd low water cut-off, and any additional running interlocks, are closed. Once the modulation motor reaches the high fire position, a purge airflow interlock switch closes and the prepurge timing of the controller begins. After a 30 second prepurge period, the modulation motor is energized and modulates to the low fire position closing the low fire start switch.

The pilot ignition sequence is then initiated. The pilot gas valve(s) are energized and opened, and power is supplied to the ignition transformer. The FGR pilot relay is energized and contacts open. Natural gas/air mix from the pilot burner is ignited by the pilot burner spark plug creating a small flame at the head of the burner. The flame scanner of the controller detects the presence of the pilot flame and the controller timing advances. After a period of 10 seconds (the pilot flame establishing period), the main gas valves are energized and opened. The normally open vent valve is energized and closed. The FGR main gas relay is energized and the contacts close and natural gas flows to the gas head of the burner. Natural gas travels through the natural gas nozzles, mixes with the combustion air and is ignited by the pilot flame. The main flame ignites and burns at the low fire setting with the pilot flame continuing to burn and the flame scanner detecting the presence of the main and pilot flames (the main flame establishing period).

After a period of 10 seconds from initiation of the main flame establishing period, the pilot gas valve(s), the ignition transformer and the FGR pilot relay are de-energized and contacts close. The main flame is monitored by the flame scanner.

For the FGR system to operate the "FGR Operation Switch" must be in the "On" Position which will illuminate the "Low N0x Energized" light. When the boiler water temperature is above 180° F, a low fire hold aquastat is energized which allows power to be delivered to the FGR blower motor starter, FGR system time delay relays, and the motorized FGR damper.

The FGR blower and "LOW NOx OPERATION" lights are then energized. Sixty seconds after the FGR blower is started, the contacts of the time delay relays close, operation of the FGR blower is held in by means of a FGR proving switch. The burner controller is released to automatic and burner modulation motor is allowed to modulate under the supervision of the boiler pressure/temperature slide wire control.

The burner continues to operate, modulate and maintain steam pressure/water temperature until the high boiler pressure/ temperature switch(s) opens, the burner/boiler

controller detects a fault or open interlock, or the call for heat ends.

2. Normal Operation (No. 2 Oil)

On a call for heat, (drop in steam pressure/water temperature below set point) the contacts of a pressure/temperature switch close, energizing the operating interlock circuit of the burner programmer. Operating interlocks include the low water float switch(s), the steam pressure/water temperature switch(s). If the preignition interlock contacts are closed, (gas valve and oil valve end switches) the combustion air blower motor, the atomizing air compressor motor, the fuel oil pump motor are energized. The modulation motor then drives to the high fire position. Ten seconds after energizing the blower motor, the controller checks the electrical continuity of running interlock circuit. The Running interlock circuit is proven when the contacts of the combustion air blower starter, the combustion air flow proving switch, Low Oil pressure switch, Oil tray proving switch, Low Atomizing Air switch and any additional running interlocks, are closed. Once the modulation motor reaches the high fire position, a purge airflow interlock switch closes and the prepurge timing of the controller begins. After a 30 second prepurge period, the modulation motor is energized and modulates to the low fire position closing the low fire start switch.

The pilot ignition sequence is then initiated. The pilot gas valve(s) are energized and opened, and power is supplied to the ignition transformer. FGR pilot relay is energized and contacts open. Natural gas/air mix from the pilot burner is ignited by the pilot burner spark plug creating a small flame at the head of the burner. The flame scanner of the controller detects the presence of the pilot flame and the controller timing advances. After a period of 10 seconds (the pilot flame establishing period), the main oil valve(s) are energized and opened and No. 2 fuel oil flows to the burner oil nozzle assembly. Oil travel through the oil nozzle assembly where it mixes with atomizing air, exits the tip of the oil nozzle, mixes with the combustion air and is ignited by the pilot flame. The main flame ignites and burns at the low fire setting with the pilot burner continuing to burn and the flame scanner detecting the presence of the main and pilot flames (the main flame establishing period).

After a period of 10 seconds from initiation of the main flame establishing period, the pilot gas valve(s) and the ignition transformer are de-energized. The main flame continues to be monitored and, after a period of 10 seconds, the burner modulation motor is allowed to modulate under the supervision of the boiler pressure/temperature control.

The burner continues to operate, modulate and maintain steam pressure/water temperature until the high boiler pressure/temperature switch(s) opens, the burner/boiler controller detects a fault or open interlock or the call for heat ends.

3. Safety Shutdown

a. High Steam Pressure/High Water Temperature Limit Switch(s)

In the event excessive steam pressure/water temperature is developed and detected by the limit switch, the limit switch will open interrupting the power to the fuel valves, incidental to opening the programmer running interlock circuit. The boiler generally contains one manual reset limit switch. The manual reset switch is generally set slightly above the operating control. Normal operation will resume when the boiler steam pressure/water temperature drops to a point where the operating control contacts close and/or the manual reset limit switch is reset.

b. Low Water

In the event that the boilers water level drops below the set point and is detected by the low water cutoff float switches, the float switch will open interrupting the power to the fuel valves, incidental to opening the programmer running interlock circuit. The boiler generally contains one automatic reset and one manual reset float switch. The manual reset float is generally set slightly below the automatic reset float switch. Normal operation will resume when the water level is raised to a point where the automatic reset float switch contacts close and/or the manual reset float switch is reset.

c. Cover Interlocks (Combination Natural Gas/Oil Only)

In the event that the wrong diffuser assembly for the desired fuel is installed or an attempt to remove the diffuser during operation is made, the contact switch will open, interrupting power to the fuel valves. Normal operation will resume when the correct diffuser assembly is installed and securely fastened. On the 100 - 250hp burner this will be accomplished by the use of microswitches and pins on each tray. On the 300 - 800 hp burner this will be accomplished by the use of air pressure on the Axial Air line which will run through the cover of the tray and flange of the air plenum back to a triple function differential air switch(for gas proving), or a dual function pressure switch (for oil tray proving) .

d. Combustion Air Switch

In the event that the combustion air blower pressure drops below the set point and is detected by the combustion air switch, the air switch will open interrupting power to the fuel valves. If combustion air pressure is below the set point during the prepurge cycle, the controller will lockout operation.

e. Low Fire End Switch

In the event that the modulation motor end switch contact is not closed at the end of the prepurge cycle, burner operation will be delayed. If problem is not corrected after 10 minutes, the programmer will lock out. Normal operation will resume when the modulation motor contacts are closed.

f. FGR Modulation Motor End Switch

In the event that the contacts of the FGR two position motor end switch is not closed during No. 2 oil firing burner operation with oil will be prevented. Normal operation will resume when the motor end switch is closed.

g. Low Fire Hold Aquastat

In the event the boiler water temperature is below the set point of the low fire hold aquastat, the modulation motor will remain in the low fire position. Normal operation will resume when the boiler water temperature rises above the set point of the low fire hold aquastat.

h. Low and High Gas Pressure Switches

In the event the natural gas pressure drops below the set point of the low gas pressure switch or the natural gas pressure rises above the set point of the high gas pressure when firing natural gas, the pressure switch contacts will open interrupting power to the gas valves incidental to opening the programmer running interlock circuit. If pressure drops below or above the set point during prepurge or trial for ignition, burner operation will be interrupted. Normal operation will resume when the switches are manually reset.

i. Low Oil Pressure and Low Atomizing Air Compressor Pressure Switches

In the event oil pressure or compressor air pressure drops below the set points, the switches will open interrupting power to the oil valves. If the pressure drops below the set point during the prepurge or trial for ignition, burner operation will lock out. Normal operation will resume when the pressure switch contacts are closed or the oil pressure and/or compressor air pressure rises above the set points.

j. Purge Airflow Interlock Switch

In the event that the modulation motor end switch contacts are not closed during the prepurge cycle, the burner operation will be delayed for 10 minutes. If problem is not corrected after 10 minutes, the programmer will lock out. Normal operation will resume when the modulation motor end switch is closed.

k. FGR Proving Switch

In the event that the FGR blower pressure drops below the set point, the FGR proving switch contact will open interrupting power to the "Low NOx Operation" control light. If the FGR proving switch contacts are open and the controller is in run cycle, FGR blower operation will not be initiated when the FGR control switch is placed in the "on" position. Normal operation will resume when the FGR blower pressure rises above the set point or the contacts are closed and when the prepurge cycle is initiated.

l. Gas and Oil Valve End Switch

In the event that the contacts of the gas and oil valve end switch are not closed during initiation of the prepurge cycle, burner operation will be locked out (preignition interlock). Normal operation will resume when the contacts of the gas and oil valve end switch are closed. Both the gas and oil valve end switches need to be closed to fire either fuel on a dual fuel unit.

m. Axial Air Pressure Switch

In the event that the pressure in the Axial air line is less than 2"wc above the Air Plenum pressure the Axial air pressure switch will open, interrupting power to the fuel valve. This switch insures there is always a flow of air through the front of the diffuser which keeps it cool and adds secondary combustion air.

Note: On the 300 - 800 HP burners a single differential pressure switch will perform the function of the Axial Air Switch, the Combustion Air Switch and the Gas Cover Interlock Switch.
On Dual fuel units, there a single pressure switch will perform the function of the Oil Cover Interlock and the Combustion Air Switch when firing oil. The pressure for this switch comes from the axial air line which is attached to a dummy fitting on the oil tray cover.

SECTION II

INSTALLATION INSTRUCTIONS

WARNING

INSTALLATION OF THE KEWANEE FGR BURNER/BOILER SYSTEM MUST BE UNDERTAKEN BY TRAINED, SKILLED AND LICENSED PERSONNEL.

THE FOLLOWING SECTION DOES NOT INCLUDE EVERY POSSIBLE INSTALLATION CIRCUMSTANCE WHICH MAY BE ENCOUNTERED. THESE INSTRUCTIONS ARE GENERAL AND SHOULD BE USED AS A GUIDE ONLY. SPECIFIC SITUATIONS MAY REQUIRE DEVIATIONS BASED ON SOUND ENGINEERING JUDGMENT AND EXPERIENCE. CONSULT KEWANEE BEFORE DEVIATING FROM THESE INSTRUCTIONS, IF PROBLEMS OR QUESTIONS OCCUR.

INSTALLATION OF THE KEWANEE FGR BURNER REQUIRES THAT HEAVY COMPONENTS BE LIFTED IN THE AIR. ALWAYS USE APPROVED AND INSPECTED LIFTING DEVICES CAPABLE OF SAFELY LIFTING THE WEIGHT OF EACH COMPONENT. ALWAYS SAFEGUARD PERSONNEL FROM FALLING COMPONENTS IN CASE OF LIFTING DEVICE FAILURE OR SUDDEN MOVEMENT.

THE KEWANEE FGR BURNER/BOILER IS NOT DESIGNED TO OPERATE WITH OTHER BURNER/BOILER SYSTEMS WHICH SHARE A COMMON VENT STACK. ALWAYS USE SEPARATE VENT STACKS WITH NO INTERCONNECTIONS TO OTHER VENTED EQUIPMENT.

THE KEWANEE FGR BURNER/BOILER SYSTEM IS A FULLY PACKAGED AND COMPLETE EQUIPMENT SYSTEM. EACH BURNER/BOILER IS THOROUGHLY FACTORY FIRETESTED PRIOR TO SHIPMENT TO ASSURE OPERATION OF CONTROLS AND COMPONENTS. HOWEVER, SEVERAL BURNER/BOILER SYSTEMS HAVE BEEN DISASSEMBLED IN ORDER TO FACILITATE INSTALLATION AND TRANSPORTATION.

CAUTION

THE BURNER/BOILER SYSTEM INCLUDES COMPONENTS WHICH MAY HAVE SHARP EDGES, "PINCH POINTS" OR HAZARDOUS DESIGN FEATURES WHICH COULD INJURE PERSONNEL. ALWAYS USE SAFE EQUIPMENT, CLOTHING AND PROCEDURES TO PREVENT CUTS, BRUISES AND OTHER INJURIES WHEN WORKING NEAR THE BURNER/BOILER SYSTEM.

NOTICE

THIS MANUAL SECTION CONTAINS INSTALLATION INSTRUCTIONS FOR THE BURNER AND FGR SYSTEMS ONLY. CONSULT OTHER SECTIONS OF THE COMPLETE BURNER/BOILER SYSTEM MANUAL AND THE CONTROLS/EQUIPMENT MANUFACTURER'S MANUALS FOR INSTRUCTIONS ON INSTALLING THE BOILER, CONNECTING THE FUEL DELIVERY, FEEDWATER, BLOWDOWN, SUPPLY AND RETURN PIPING, VENTING AND ELECTRICAL SYSTEMS AND ALL OTHER ASSOCIATED INSTALLATION PROCEDURES.

THE BURNER/BOILER SYSTEM INSTALLATION MUST CONFORM TO THE REQUIRMENTS OF THE AUTHORITY HAVING JURISDICTION, OR IN THE ABSENCE OF SUCH REQUIRMENTS TO THE APPLICABLE UNDERWRITERS LABORATORY, FACTORY MUTUAL, INDUSTRIAL RISK INSURERS, AMERICAN SOCIETY OF MECHANICAL ENGINEERS, THE NATIONAL FUEL GAS CODE AND/OR THE NATIONAL ELECTRIC CODE. OTHER CODES MAY ALSO BE APPLICABLE.

A. INSPECTION

Inspect the entire shipment carefully for any signs of damage. All equipment is carefully manufactured, inspected and packed. Our responsibility ceases upon delivery of the burner/boiler system to the carrier in good condition. Any claims for damage or shortage in shipment must be filed immediately against the carrier by the consignee. No claims for variances or shortages will be allowed by the equipment manufacturer unless presented within sixty (60) days after receipt of the equipment.

B. COMBUSTION AIR BLOWER ASSEMBLY

The combustion air blower was disassembled from the burner's air transition assembly and shipped separately. Position the blower such that the blower's outlet flange is evenly mated to companion flange of the air transition assembly. Mark the location of the blower base and all the holes drilled in the blower base on the floor.

Move the blower and securely anchor threaded 1-1/2 inch long studs into the floor corresponding to the location of holes drilled in the blower stand.

NOTICE

IF THE BOILER IS RAISED ON A SEPARATE PAD ABOVE FLOOR LEVEL, THE BLOWER MUST ALSO BE RAISED THAT DISTANCE.

ALL ROUND FLANGES USED IN THE AIR AND FGR SYSTEMS ARE BUILT USING ANSI CLASS 125/150 DIMENSIONS FOR OUTSIDE DIAMETER, BOLT CIRCLE DIAMETER AND NUMBER OF HOLES.

Position the blower so that the studs pass through the holes in the blower base and the blower outlet flange mates evenly with the companion flange on the air transition assembly. Install the provided gasket on the blower outlet flange and make sure it is centered properly. Securely bolt the blower outlet flange to the companion flange using 3/8 or 1/2 inch bolts, nuts and washers. Use all the bolt holes. Place lock washers, flat washers and nuts on the studs that penetrate the blower base. Securely fasten the nuts and washers.

Install silencer on the inlet of the blower(300-800 hp burner only). The opening should face down unless there is an interference, then it can be faced up or to the side.

C. FGR BLOWER ASSEMBLY (Figure 3)

Figure 3 is for a standard installation, consult factory drawing for your particular job.

The FGR blower and inlet piping is removed from the boiler prior to shipment and must be reassembled prior to start-up. The inlet and outlet piping need provisions to allow for thermal expansion due to high temp flue gas(300-400 F).This can be accomplished with expansion joints, Dresser coupling, etc. Support of the inlet piping is also necessary to take the weight off the fan housing and stack which could cause distortion.

Align the holes in the FGR blower outlet flange with the holes in the flange for the FGR outlet piping which is located under the boiler. Place a gasket capable of safely withstanding continuous operation at 600°F which duplicates the outside diameter, inside diameter and bolt hole number and diameter of the flange. Place bolts through the holes and use lock washers, flat washers and nuts on the bolts but do not tighten.

Position the boiler vent tee above the boiler vent flange located at the rear top of the boiler such that the smallest diameter section is perpendicular to the longitudinal centerline of the boiler shell. Place a gasket capable of safely withstanding continuous operation at 600°F which duplicates the outside diameter, inside diameter and bolt hole number and diameter of the boiler vent flange on the boiler vent flange. Align the gasket holes with the boiler vent flange holes.

Lower the FGR transition tee onto the gasket such that the holes in the vent flange, gasket and transition tee are aligned and the smallest diameter section of the tee is horizontal and approximately perpendicular to the longitudinal centerline of the boiler shell. Place bolts through the all holes of the boiler vent flange, gasket and transition tee flange using lock and flat washers and tighten bolts finger tight.

Position FGR inlet transition pipe assembly such that the flanges on the pipe assembly are aligned with the companion flange on the boiler vent tee and FGR blower inlet flange. A damper w/two position motor, expansion joints or dresser couplings will be installed in the inlet piping assembly. When installing the damper, insure that it is aligned properly and moves freely. Install the correct size gaskets capable of safely withstanding continuous operation at 600° F between the flanges where it is being installed, i.e. vent tee, FGR blower inlet flange, damper and expansion joint. Place 1/2 inch or 3/8 inch diameter bolts through the all the holes of the FGR transition pipe flanges and the boiler vent pipe flange and FGR blower inlet flange and gaskets, respectively, using lock and flat washers. Place nuts on the all bolts and securely tighten.

Mark holes in floor and install studs for mounting FGR blower to the floor. Secure FGR blower to the floor using lock, flat washers and nuts. Securely tighten bolts on the boiler vent, inlet and outlet piping.

D. INSULATION

WARNING

THE KEWANEE FGR BURNER/BOILER SYSTEM CONTAINS COMPONENTS THAT BECOME SUFFICIENTLY HOT DURING OPERATION TO CAUSE SEVERE INJURY. ALWAYS POSITIVELY ASSURE COMPONENTS ARE NOT HOT BEFORE TOUCHING OR WORKING NEARBY.

COMPONENTS MAY REMAIN HOT FOR LONG PERIODS AFTER THE SYSTEM IS SHUTDOWN. ALLOW SUFFICIENT TIME FOR THE COMPONENTS TO COOL AFTER SHUT DOWN BEFORE MAINTAINING OR OPERATING NEAR THE BURNER/BOILER SYSTEM.

THE BURNER/BOILER SYSTEM CONTAINS MOVING PARTS WHICH MUST HAVE FREE AND CLEAR MOVEMENT FOR THE SYSTEM TO OPERATE CORRECTLY. ALWAYS POSITIVELY ASSURE THAT ANY MOVING PARTS HAVE FREE MOVEMENT AND THAT ADDED COMPONENTS INCLUDING INSULATION DO NOT INTERFERE WITH OR RESTRICT PART MOVEMENT.

CAUTION

INSULATION MATERIALS SHOULD BE SEALED IN BY AN ABRASION RESISTANT, NONFLAMMABLE MATERIAL TO PREVENT DETERIORATION OF THE INSULATION DUE TO NORMAL WEAR AND INCIDENTAL CONTACT BY PERSONNEL OR EQUIPMENT. A RIGID METAL OR PLASTIC WRAPPER WHICH COMPLETELY SEALS IN THE INSULATION IS RECOMMENDED.

INHALATION OR EXPOSURE TO INSULATION MATERIALS MAY CAUSE SERIOUS INJURY AND/OR LONG TERM HEALTH HAZARDS. ALWAYS ASSURE PERSONNEL WORKING ON OR NEAR THE BOILER ARE ADEQUATELY PROTECTED FROM CONTACT AND/OR INHALATION.

The FGR burner/boiler system was shipped from the factory without thermal insulation on the FGR blower, the FGR piping assemblies, the boiler vent tee, the boiler vent, the burner FGR transition and other potential hot components.

Install fire proof, abrasion resistant thermal insulation (mineral wool, fiberglass etc. with outside metal wrapper) on all hot components which may come in contact with personnel during start-up, operation and/or maintenance. All hot surfaces should be insulated in such a way as to reduce the exposed surface temperature to below 120°F under all conditions.

In many instances, the FGR blower, due to its complex and bulky shape, may prove to be difficult to insulate adequately. Accordingly, protect against contact by personnel by installing a physical barrier such as posts anchored to the floor. This barrier should be of sufficient design as to prevent casual contact between personnel and the equipment.

E. ELECTRICAL

DANGER

ALWAYS POSITIVELY ASSURE ELECTRICAL POWER IS DISCONNECTED BEFORE ATTEMPTING WORK ON OR NEAR ELECTRICAL COMPONENTS OR SYSTEMS. ELECTRICAL SHOCKS WILL/CAN CAUSE DEATH OR SERIOUS INJURY.

NEVER WORK ON OR NEAR ELECTRICAL COMPONENTS WHEN THE POSSIBILITY OF WATER CONTACT EXISTS. ELECTRICAL SHOCKS WILL/CAN RESULT.

POWER MAY NEED TO BE DISCONNECTED AT MORE THAN ONE LOCATION ON ONE OR MORE VOLTAGE SUPPLIES.

ELECTRICAL WORK MUST BE PERFORMED BY LICENSED, SKILLED AND EXPERIENCED PERSONNEL.

ALWAYS FOLLOW THE ELECTRICAL DIAGRAMS PROVIDED WITH THE BURNER/BOILER SYSTEM. CONSULT MANUFACTURER IF PROBLEMS OR QUESTIONS ARISE.

ALWAYS POSITIVELY ASSURE ELECTRICAL WORK IS PERFORMED CORRECTLY ACCORDING TO THE AUTHORITY HAVING JURISDICTION BEFORE CONNECTING THE POWER SUPPLY.

Prior to system shipment, electrical connections for the combustion air blower, the FGR blower and FGR proving switch were disassembled. These electrical connections must be made for the burner/boiler system to operate safely and correctly.

NOTICE

THE FLEXIBLE CONDUITS FOR THE COMBUSTION AIR BLOWER, FGR BLOWER, FGR DAMPER MOTOR, AND FGR BLOWER AIR SWITCH WILL BE HANGING LOOSE ON THE BOILER WITH THE ELECTRICAL LEADS EXPOSED. NO JUNCTION BOXES ON THE BOILER OR BURNER NEED TO BE OPENED TO CONNECT THESE COMPONENTS.

Identify the appropriate electrical conduit (BX, Sealtite etc.) for the combustion air blower located at the front left side of the boiler. Verify that the anti-short insulator, located in the exposed end of the flexible electrical conduit is in place and in good condition.

Connect the electrical leads labeled T1, T2 and T3, to the electrical leads labeled likewise in the junction box located on the combustion air blower motor. Use permanent electrical connectors approved for this application. DO NOT USE WIRE NUTS. Secure the flexible conduit fitting to the combustion air blower motor junction box by means of a threaded conduit ring. Close and seal the junction box.

Identify the appropriate conduit (BX, Sealtite etc.) for the FGR blower located at the rear of the boiler. Verify that the anti-short insulator, located in the exposed end of the flexible electrical conduit is in place and in good condition.

Connect the electrical leads labeled T1, T2 and T3, to the electrical leads labeled likewise in the junction box located on the FGR blower motor. Use permanent connectors approved for this application. DO NOT USE WIRE NUTS. Secure the flexible conduit fitting to the FGR blower motor junction box by means of a threaded conduit ring. Close and seal the junction box.

Identify the appropriate conduit (BX, Sealtite etc.) for the FGR proving switch located at the right rear of the boiler mounted on the FGR blower stand. Verify that the anti-short insulator, located in the exposed end of the flexible conduit is in place and in good condition.

Connect the exposed leads from the flexible conduit to the terminals on the FGR proving switch label NO (normally open) and C (common). Use permanent connectors approved for this application. DO NOT USE WIRE NUTS. Secure the flexible conduit to the FGR proving switch casing box by means of threaded conduit ring. Close and seal the FGR proving switch.

F. FGR CONDENSATE DRAINS (If equipped)

During normal burner boiler system operation, a small quantity of flue gas condensate will form as the flue gases are recirculated from the boiler vent to the burner. System pipe tappings have been provided in the FGR blower, the FGR piping system and the burner FGR transition section to collect this condensate.

WARNING

FGR CONDENSATE IS ACIDIC AND HOT. PREVENT CONTACT WITH SKIN OR BREATHING VAPORS. INSULATE FGR CONDENSATE DRAIN PIPING WITH PROPER INSULATING SYSTEM.

CAUTION

CONSULT LOCAL AUTHORITIES CONCERNING SAFE AND APPROVED DISPOSAL OF FGR CONDENSATE. LOCAL CODES MAY PREVENT DIRECT DISPOSAL INTO PUBLIC DRAIN SYSTEMS.

Install a 1"NPT to 1/2"NPT reducing bushing in the 1" pipe tapping located at the bottom of the FGR blower scroll. Connect a 1/2"NPT corrosion resistant globe valve to the bushing. Connect 1/2" Schedule 40 pipe to the globe valve and route piping to a covered floor drain. End piping below floor level and protect against personnel contact with the piping and pipe termination.

Install a 1/2"NPT corrosion resistant globe valve to the 1/2"NPT bushing located on the pipe elbow of the FGR piping system which is closest to the burner. Connect 1/2" Schedule 40 pipe to the globe valve and route piping to a covered floor drain. End piping below floor level and protect against personnel contact with the piping and pipe termination.

Install a 1/2"NPT corrosion resistant globe valve to the 1/2"NPT coupling located on the bottom of the FGR transition duct. Connect 1/2" Schedule 40 pipe to the globe valve and route piping to a covered floor drain. End piping below floor level and protect against personnel contact with the piping and pipe termination.

WARNING

DO NOT CONNECT FGR CONDENSATE DRAINS INTO A COMMON PIPING SYSTEM. ALWAYS RUN SEPARATE PIPES TO THE DRAIN.

FGR CONDENSATE IS HIGHLY CORROSIVE TO METALS. USE OF CORROSION RESISTANT MATERIALS OF SUFFICIENT THICKNESS IS RECOMMENDED IN ALL CONDENSATE PIPING AND VALVES. INSPECT SYSTEM REGULARLY FOR SIGNS OF CORROSION AND PROMPTLY REPLACE ANY COMPONENTS WITH DEFECTS.

SECTION III

START-UP INSTRUCTIONS

All Kewanee FGR burner/boiler systems are thoroughly firetested prior to shipment to assure all components and systems associated with the burner are functioning correctly. However, each installation site has unique conditions. Burner setup and final adjustment must be conducted prior to putting the burner/boiler system into service.

WARNING

THE FOLLOWING START-UP INSTRUCTIONS ARE GENERAL AND PROVIDED FOR ILLUSTRATION PURPOSES ONLY. EACH BURNER/BOILER SYSTEM IS UNIQUE AND MUST BE FULLY UNDERSTOOD BEFORE ATTEMPTING START-UP. CONSULT FACTORY SUPPLIED WIRING DIAGRAM FOR SPECIFIC CONTROLS PROVIDED ON YOUR SYSTEM. CAREFULLY READ AND FULLY UNDERSTAND THE BURNER/BOILER CONTROLLER AND SAFETY CONTROLS MANUALS BEFORE PROCEEDING.

IF PROBLEMS OR QUESTIONS DEVELOP DURING THE START-UP PROCEDURE, CONSULT EQUIPMENT MANUFACTURER BEFORE DEVIATING FROM INSTRUCTIONS.

EACH BURNER/BOILER SYSTEM IS SUPPLIED WITH A FACTORY FIRETEST REPORT. THIS REPORT CONTAINS VALUABLE SPECIFICATIONS FOR ADJUSTING BURNER/BOILER CONTROLS. DO NOT ATTEMPT BURNER/BOILER START-UP WITHOUT THIS REPORT.

ADDITIONAL STEPS MAY BE REQUIRED TO COMPLETE THE BURNER/ BOILER START-UP PROCEDURE. CONSULT OTHER SECTIONS OF THE COMPLETE BURNER/BOILER SYSTEM MANUAL AND THE COMPONENT MANUFACTURERS MANUALS FOR ADDITIONAL PROCEDURES AND RECOMMENDATIONS.

A. PRE START-UP CHECKLIST

Confirm the natural gas, fuel oil, air, feedwater, steam, blowdown, FGR, vent, electrical connections and all other associated burner/boiler systems and components are complete, safe and installed correctly. All piping systems should be clean and free from debris or obstructions.

1. Confirm the natural gas, fuel oil, air and steam services are of adequate size and supplied at the proper pressure and temperature.
2. Confirm the electrical services are of the correct voltage, frequency and phase for each connection, and that the service line is adequate in size and design to safely carry the required amperage and voltage.
3. Confirm that the burner/boiler wiring is undamaged and the controls are wired exactly as shown in the provided system wiring diagram.
4. Confirm that all safety switches and controls are undamaged. These will require setting to the proper values are consistent with site specific conditions.
5. Confirm the boiler stack damper is fully open.
6. If the burner is 300hp or above, confirm the presence of a silencer. O_2 levels will be higher without a silencer.
7. Confirm the boiler is filled to the proper water level and the low water cutoff control(s) are operating properly.
8. Confirm the steam generated during start-up can be safely vented or consumed and that adequate, treated feedwater is available during operation.
9. Confirm all nuts, bolts and fasteners used on the burner/boiler are secure. Fuel, air and FGR linkage components must be secure and free from obstruction.
10. Confirm all agencies required for the burner/boiler system installation, start-up and operation have been notified of the start-up and prior approval has been given.
11. Confirm that provisions for adequate combustion air and ventilation air have been made prior to start-up. Combustion air and ventilation air must not be provided by means of open windows or doors. Permanent provision are required.
12. Confirm that the proper instrumentation is available, calibrated and warmed up.

B. TOOL, SPECIAL EQUIPMENT AND INSTRUMENT REQUIREMENTS

The Kewanee FGR burner/boiler system is a complex system which requires specialized tools and equipment for proper start-up, operation and maintenance. The following equipment list is the minimum requirement for safe reliable setup and operation. Additional equipment may be necessary based on job site conditions. Always use the correct tool, equipment or instrument in a safe manner.

1. Common Hand Tools

Flat and Phillips head screwdrivers (sizes 1 through 3), adjustable wrenches up to 24", standard 1/2" drive socket set up to 1-1/2", pipe wrenches up to 3', complete set of standard nut drivers, box end wrench set up to 1-1/2", long and short handle Allen wrench set and a Torque wrench set.

2. **Special Equipment**

Multimeter with AC/DC voltage and resistance/continuity scales, Ammeter, electrical wire stripper and permanent connection fastening tool, permanent electrical connectors, DC micro amperage meter, 1/4" or 1/8" NPT shut-off cocks, accurate stop watch, high intensity flash light, bearing oiler and spark plug gapping tool.

3. **Instrumentation**

Accurate NOx, CO, and Oxygen analyzers, vent thermocouple readout or precision thermometer for boiler vent, surface temperature thermocouple readout and U-tube and incline manometers for windbox air pressure, pilot gas pressure, pilot air pressure and vent stack pressure.

NOTICE

ALTHOUGH THE MEASUREMENT OF CARBON DIOXIDE IN THE FLUE GAS IS SOMETIMES MORE CONVENIENT THAN MEASURING OXYGEN LEVELS, THE LOW EXCESS AIR REQUIRMENTS OF THE KEWANEE FGR BURNER REQUIRE THAT AN ACCURATE MEASUREMENT OF OXYGEN IN THE FLUE GAS BE PERFORMED.

DANGER

NEVER ALLOW THE ACCUMULATION OF NATURAL GAS OR FUEL OIL (LIQUID OR VAPOR) INSIDE THE BURNER OR BOILER. EXPLOSION, FIRE OR OTHER HAZARDOUS CONDITIONS WILL RESULT.

ALWAYS ASSURE THE BURNER HAS COMPLETED A PREPURGE CYCLE BEFORE ATTEMPTING ANOTHER PILOT IGNITION TRIAL OR MAIN FLAME IGNITION TRIAL. BYPASSING THE PREPURGE CYCLE WILL RESULT IN A NATURAL GAS CONCENTRATION IN THE BOILER THAT COULD RESULT IN AN EXPLOSION, FIRE AND/OR SERIOUS INJURY.

NEVER OPERATE THE BURNER/BOILER SYSTEM WITH AN UNSTABLE, NOISY AND/OR IRREGULAR FLAME OR, WITH JUMPERED, DISCONNECTED AND/OR INOPERATIVE CONTROLS. EXPLOSION, FIRE OR OTHER HAZARDOUS CONDITIONS WILL RESULT.

WARNING

THE CAM COMMAND FUEL/AIR TRIM SYSTEM IS A CRITICAL COMPONENT OF THE BURNER/BOILER SYSTEM. THE PRINCIPLES OF OPERATION AND OPERATING INSTRUCTION FOR THE CAM COMMAND ARE CONTAINED IN A SEPARATE MODULE OF THE COMPLETE KEWANEE MANUAL. READ AND COMPLETELY UNDERSTAND THE DESIGN AND OPERATION OF THE CAM COMMAND SYSTEM BEFORE ATTEMPTING START-UP, OPERATION AND/OR MAINTENANCE OF THE KEWANEE FGR BURNER/BOILER SYSTEM.

ALWAYS POSITIVELY ASSURE THE CAM COMMAND SYSTEM IS OPERATING SAFELY WITHOUT OBSTRUCTION AND IS IN A GOOD STATE OF REPAIR.

OPERATING THE BURNER OUTSIDE THE NORMAL EXCESS AIR RANGE CAN CAUSE HIGH LEVELS OF CO FORMATION, SOOTING OF THE BOILER SURFACES AND/OR UNSTABLE FLAMES. ALWAYS MAINTAIN THE PROPER EXCESS AIR LEVELS AND CONFIRM THROUGH FREQUENT MONITORING OF THE STACK GAS CONSTITUENTS.

FAILURE TO ALLOW PROPER BOILER WARM UP CAN CAUSE REFRACTORY FAILURE AND/OR SEVERE DAMAGE TO THE BOILER PRESSURE VESSEL. THE WARM UP TIME ON INITIAL BURNER/BOILER SYSTEM START-UP SHOULD BE NO LESS THAN TWO HOURS. WARM UP IS CONSIDERED COMPLETE AFTER THE INITIAL START-UP WHEN THE LOW WATER CUTOFF PIPING IS ABOVE 180°F.

C. PILOT DESCRIPTION (Figure 4)

The pilot is located on the top of the gas head of the burner (on the bottom of the 100,125,500HP). The pilot pipe protrudes through the gas head and refractory insert at a 45° angle downward.

Gas for the pilot is taken off the gas train and enters the pilot gas regulator and solenoid(s)on the burner. The gas the enters the pilot assembly from the rear and flows into the pilot gas injector tube. The pilot gas injector tube has a series of four(4) holes around the circumference and one(1) at the end.

Combustion air is taken off the combustion air duct below the dampers, through an adjustment valve and into the side of the piping assembly. This air is also used for the scanner purge.

A spark electrode is located down stream of the gas and air injection points on the pilot assembly and is gapped approx 1/8" from the pilot gas injector tube. The spark ignites the gas/air mixture and the flame is directed into the combustion chamber and in front of the scanner.

D. PILOT START-UP

1. Connect the instrumentation to the appropriate location on the burner/boiler system.
2. Confirm that all the natural gas and fuel oil manual shut off valves are in the closed position.
3. Position the fuel selector switch to the **GAS** position, the burner switch to the **OFF** position, the modulation switch in the **MAN** position and the FGR switch in the **OFF** position.

4. Open the pilot manual gas shut off valve(s) located upstream of the boiler gas train.
5. Confirm absence of leaks in the natural gas piping.
6. Open the manual gas shut off valve located on the natural gas train closest to the rear of the boiler leaving the shut off valve closest to the burner closed.
7. Move the burner switch to the **ON** position.
8. Reset all of the manual reset controls (high/low gas pressure, high boiler pressure or temperature control, water level control(s) and/or flame safeguard).
9. After blower motor starts, turn the burner switch to the **OFF** position.
10. Confirm proper combustion air blower rotation. The motor should rotate in the direction of the red arrow located on the combustion air blower housing. If rotation is incorrect, turn all power off to the boiler and reconfigure wiring. Repeat steps 7, 8 and 9 until combustion air blower rotation is correct.

WARNING

THE COMBUSTION AIR AND FGR BLOWER CONTAIN MOVING PARTS AT HIGH SPEED. CONTACT WITH THESE PARTS CAN CAUSE SEVERE INJURY. NEVER REMOVE ANY GUARDS OR ANY OTHER BOILER SAFETY DEVICES. PREVENT CONTACT WITH ANY MOVING PARTS.

11. Move the burner switch to the **ON** position.

CAUTION

THE LINKAGE IS DRIVEN BY A HIGH TORQUE MODULATION MOTOR WHICH IS CAPABLE OF CAUSING INJURY TO HANDS, FINGERS AND OTHER AREAS. AVOID CONTACT WITH LINKAGE COMPONENTS WHEN IN MOTION.

12. Watch the fuel and air linkage rotate and travel. Make sure linkage moves smoothly without binding from the beginning position (low fire) to the final position (high fire). The burner/boiler is now in the **PREPURGE CYCLE.**

CAUTION

IF THE LINKAGE BINDS, TURN THE BURNER SWITCH TO THE OFF POSITION. AFTER THE MODULATION MOTOR HAS RETURNED TO THE LOW FIRE POSITION, READJUST LINKAGE SO SMOOTH TRAVEL IS OBTAINED. THE LOW FIRE AND HIGH FIRE SETTINGS OF THE VALVES AND DAMPERS SHOULD REMAIN UNCHANGED. MARK VALVE/DAMPER LOCATION BEFORE ADJUSTING ANY LINKAGE COMPONENTS.

13. After the linkage has started to travel to low fire position place the run/test switch located on the programmer in the **TEST** position.
14. Watch and wait for the linkage to travel to the low fire position. Confirm the natural gas valve, air damper and FGR damper are NEAR the fully closed position by looking at the slots machined in the respective valve/damper shafts. The valves/dampers are fully closed when the slots are horizontal. The valves/damper shaft slots should be no more than 5° open. **On the 500 - 800hp burner the air damper has two blades, The inner blade is factory set to be open slightly more than the outer blade.** If the valves/dampers are misadjusted, turn the burner switch to the **OFF** position, readjust the linkage until the valves/dampers are near the horizontal position and repeat steps 11 through 14.
15. Place the run/test switch in the **RUN** position.

DANGER

THE MAIN GAS SAFETY VALVES SHOULD REMAIN CLOSED AT ALL TIMES EXCEPT DURING THE TRIAL FOR MAIN FLAME AND RUN CYCLES. IF THE MAIN GAS VALVES ARE OPEN AT ANY OTHER TIME THE BURNER/BOILER SYSTEM IS MISWIRED OR THE VALVES ARE DEFECTIVE. AN EXPLOSION, FIRE OR SERIOUS INJURY MAY RESULT.

16. Monitor flame signal with appropriate device (reference flame safeguard manual). The burner is now in the pilot ignition trial cycle. As soon as the pilot ignition trial begins, the flame scanner should detect the presence of flame in the boiler. When the presence of flame is detected, place the run/test switch in the **TEST** position. If the presence of flame is not detected within 10 seconds, the controller will stop the ignition sequence, display a pilot ignition failure fault and begin a post purge cycle.

NOTICE

ON INITIAL START-UP OR IF THE BURNER HAS BEEN IDLE FOR LONG PERIODS, THE PILOT GAS OR MAIN GAS LINES MAY CONTAIN AIR. IF THE LINES DO CONTAIN AIR, SEVERAL PILOT IGNITION OR MAIN FLAME IGNITION TRIALS MAY BE NECESSARY TO PURGE THE AIR AND ACHIEVE IGNITION.

IF THE PILOT OR MAIN FLAME DOES NOT LIGHT DURING THE FIRST TRIAL, RESET THE FLAME SAFEGUARD AFTER THE POST PURGE CYCLE AND REPEAT STEPS 12 THROUGH 16.

CONSULT THE TROUBLESHOOTING GUIDE CONTAINED IN LATTER SECTIONS OF THIS MANUAL IF AFTER CONFIRMING THE ABSENCE OF AIR IN THE PILOT GAS LINE, THE PILOT DOES NOT LIGHT OR THE SCANNER IS NOT DETECTING THE PRESENCE OF THE PILOT FLAME.

17. Observe the pilot flame from the rear boiler sight glass and the burner observation sight glass. The pilot flame should appear well defined without a lazy appearance and be of sufficient length to cover scanner tube end. The base of the pilot flame should be deep blue with the pilot flame tips flickering between blue and orange. The pilot flame should not be burning in the pilot pipe. If the pilot will not light or Scanner is not detecting a flame, place the burner switch to the **OFF** position and consult the troubleshooting guide. Repeat steps 11 through 17 until the correct pilot flame is achieved.

18. Place the run/test switch in the **Run** position (with the manual gas valve still closed) and confirm that the main gas valves open and snap shut. The controller display should show a main flame failure. If the Valves do not open or close completely, do not proceed any further until the cause is found and repaired.

E. NATURAL GAS START-UP

1. Following the start-up sequence for the pilot, the controller run/test switch should be in the **TEST** position with a reliable pilot flame burning in the boiler with the correct flame appearance and the flame scanner detecting the presence of the flame.

2. Place the controller run/test switch to the **RUN** position. The main flame ignition trial cycle will then begin. The appropriate indicating device will continue to indicate presence of flame and the main gas safety shutoff valves will open. Slowly open the manual gas valve closest to the burner which is located on the natural gas train. The main flame should ignite smoothly and the pilot flame extinguish after main flame trials. If the main flame fails to ignite, allow the completion of the post purge cycle, reset the controller and allow another main flame ignition trial (steps 11 through 17). If after three tries, the main flame still will not ignite, place the burner switch in the **OFF** position and consult the troubleshooting guide. If the main flame ignition is rough or excessively noisy, **IMMEDIATELY** place the burner switch in the **OFF** position and consult the troubleshooting guide. When the main flame lights for the first time, watch the flame through the observation port while the burner is turned off . The Flame should extinguish almost immediately. This indicated proper function of the safety shutoff valves. If it is not extinguished within a few seconds, shut off the manual gas valve. Check the operating and safety gas valves to determine whether they have closed properly.

3. Utilizing the manual potentiometer hold the burner in the low fire position. The burner is now at the low fire input. Observe the main flame from both the rear boiler sight glass and the burner observation sight glass. The flame should appear stable with a swirling blue core and blue/orange flame tips.

WARNING

IF ADJUSTMENTS ARE MADE TO THE LINKAGE, VALVES OR DAMPER POSITION, TURN THE BURNER SWITCH TO THE OFF POSITION FIRST. THIS IS TO PREVENT A DANGEROUS SITUATION FROM OCCURRING BECAUSE A LINKAGE SLIPPED WHILE IT HAD BEEN LOOSENED FOR ADJUSTMENT. ANY ADJUSTMENTS THAT ARE MADE TO THE FUEL REGULATOR, LINKAGE, VALVES OR DAMPER POSITION CAN AFFECT THE WHOLE RANGE OF THE BURNER MODULATION. CHECK THE ENTIRE FIRING RANGE WHEN ADJUSTMENTS OF THIS NATURE ARE MADE.

4. Take and record the fuel input, Oxygen (O2), Carbon Monoxide (CO) values and, natural gas pressure at the inlet to the gas train. Compare this to the data supplied in the firetest report. Adjustment for natural gas should start with the regulator located in the gas train. The inlet and outlet pressure readings of the regulator at the low and high fire rates should match the values on the firetest report. Should additional adjustments be required, use the right side of the adjustable cam to adjust fuel input. Changing linkage, valve and damper position should be a last resort when adjusting the burner. Make adjustments until the fuel input and O2 levels are consistent with the firetest report. Repeat pilot start-up procedure if the linkage is adjusted.

NOTICE

THE KEWANEE FGR BURNER IS DESIGNED TO OPERATE AT LOW EXCESS AIR (I.E. LOW O2) LEVELS. NORMAL OPERATING VALUES RANGE BETWEEN 2 AND 5 PERCENT OXYGEN CONCENTRATION AT THE VENT OUTLET THROUGHOUT THE TURNDOWN RANGE WHEN FIRING NATURAL GAS. NORMAL CO VALUES AT THE NORMAL O_2 RANGE ARE BETWEEN 5 AND 25 PPM. (SEE PERFORMANCE STANDARDS: CHART I).

5. Allow the boiler to warm up at the low fire input. The warm up time on initial burner/boiler system start-up should be no less than two hours. Warm up is considered complete after the initial start-up when the low water cutoff piping is above 180°F.

6. Confirm the manual potentiometer is in the **MIN** position and the modulation switch is in the **MAN** position.

7. Modulate the burner to the high fire position in small gradual increments by very slowly rotating the manual potentiometer dial towards the **MAX** position. When the dial is rotated, the modulation motor will rotate the linkage and fuel valve(s) and dampers toward the high fire position. Closely monitor the oxygen concentration in the flue gas. During modulation, the boiler flame should remain stable without excessive noise. If instability or excessive noise results, **IMMEDIATELY** place the burner switch to the **OFF** position and consult the troubleshooting guide.

8. Take and record the fuel input, oxygen and carbon monoxide values, and the natural gas pressure at the inlet to the natural gas train at the high fire gas input. Compare this to the data supplied in the firetest report. Adjustment for natural gas should start with the regulator located in the gas train. The inlet and outlet pressure readings of the regulator at the low and high fire rates should match the values on the firetest report. Should additional adjustments be required, use the right side of the adjustable cam to adjust fuel input. Changing linkage, valve and damper position should be a last resort when adjusting the burner. Make adjustments until the fuel input and O2 levels are consistent with the firetest report. Repeat pilot start-up procedure if the linkage is adjusted.

9. Turn the manual potentiometer to the **MIN** position in slow gradual increments. The modulation motor will rotate to the low fire position.

10. Take and record the fuel input, O2 and CO concentrations again. Confirm that this data has not changed from the initial readings. If the data has changed repeat steps 4 through 10 until consistent repeatable readings are observed at low and high fire.

11. Modulate the boiler from low fire, by turning the manual potentiometer toward the **MAX** position until the input rate is approximately 25 percent of the maximum input.

12. Take and record the fuel input and, O2 and CO values at this input rate. Adjust the appropriate Allen screw on the CAM Command system so that the O2 level in the stack gas is in the normal operating range.

13. Repeat steps 11 and 12 for both 50 percent and 75 percent of the maximum fuel input.

14. Modulate the burner from high fire to low fire to high fire while observing the O2 values. Stop the modulation at any points where O2 values are outside the normal operating range and adjust the CAM Command system to maintain acceptable O2 values at every point throughout the input range.

15. Set, adjust and/or confirm all of the safety and control devices (switches, low water cutoff(s), valves, controller etc.) located in the burner/boiler system are set correctly and operating as designed per the manufacturer's instructions, the instruction in this manual, the firetest report and safe practice.

F. NO. 2 FUEL OIL START-UP (If Equipped)

1. Confirm the burner switch is in the **OFF** position and the burner/boiler system is sufficiently cool to allow service procedures without causing injury. Inspect the oil tray assemble to assure all of the components are undamaged.

WARNING

THE DIFFUSER PORTION OF THE BURNER TRAY ASSEMBLY MAY BE HOTTER THAN THE OTHER TRAY COMPONENTS.

ALWAYS USE EXTREME CARE IN REMOVING TRAY ASSEMBLIES. ABUSE, DROPPING OR OTHER IMPROPER HANDLING MAY CAUSE DAMAGE AND/OR DISTORTION OF THE TRAY COMPONENTS. BURNER INSTABILITY, AN EXCESSIVELY NOISY FLAME OR OTHER HAZARDOUS CONDITIONS MAY RESULT.

WHEN NOT IN USE, STORE TRAY ASSEMBLES IN A SECURE LOCATION WHERE THE ASSEMBLY IS COMPLETELY PROTECTED FROM CONTACT WHICH MAY CAUSE DAMAGE AND/OR DISTORTION OF THE ASSEMBLY COMPONENTS.

2. Install the oil tray assembly (Figure 2A or 2B). This is accomplished by removing the wing nuts which secure the gas tray assembly (Figure 1A or1B) to the burner air plenum, (disconnecting the Axial Air hose on 300 - 800 hp), and pulling back on the handles of the assembly. Place the gas tray assembly in a secure location. Carefully position the diffuser of the oil tray assembly inside the air plenum of the burner and push the tray assembly forward. The oil tray assembly is in position when the end plate of the tray assembly is against the flange of the air plenum, all of the mounting studs of the air plenum flange are through the end plate

of the tray assembly and the cover interlock is engaged. Securely fasten the end plate to the air plenum by reinstalling the wing nuts. Connect the Axial Air line to the dummy connection on the cover. Connect the flexible hydraulic conduits (i.e. the braided atomizing air and fuel oil lines) which are part of the oil tray assemble to the corresponding connections on the burner.

3. Check for correct rotation of air compressor and oil pump. Confirm the correct and safe operation of the pilot by repeating the pilot start-up procedure which is detailed in a previous section of this manual. The pilot should be operating with the run/test switch in the **TEST** position and the manual potentiometer in the **MIN** position.

4. Confirm that the oil metering valve is nearly closed (no more than 5 degrees of rotation from the fully closed position) and the oil metering valve linkage is securely fastened.

5. Place the controller run/test switch in the **RUN** position. The main flame ignition trial will then begin. The appropriate flame signal monitoring device will continue to indicate the presence of flame and the oil safety valve(s) will open. The main flame should ignite smoothly and the pilot flame extinguish. If the main flame fails to ignite, allow the completion of the post purge cycle, reset the controller and allow another main flame ignition trial. If after three tries the main flame still will not ignite, place the burner switch in the **OFF** position and consult the troubleshooting guide. If the main flame is rough of excessively noisy, **IMMEDIATELY** place the burner switch in the **OFF** position and consult the troubleshooting guide.

6. The burner is now at the low fire input. Observe the main flame from both the rear boiler sight glass and the burner observation sight glass. The flame should appear stable with a white/yellow flame jet which is centered in the furnace tube.

WARNING

IF ADJUSTMENTS ARE MADE TO THE LINKAGE, VALVES OR DAMPER POSITION, TURN THE BURNER SWITCH TO THE OFF POSITION FIRST. THIS IS TO PREVENT A DANGEROUS SITUATION FROM OCCURRING BECAUSE A LINKAGE SLIPPED WHILE IT HAD BEEN LOOSENED FOR ADJUSTMENT. ANY ADJUSTMENTS THAT ARE MADE TO THE FUEL REGULATOR, LINKAGE, VALVES OR DAMPER POSITION CAN AFFECT THE WHOLE RANGE OF THE BURNER MODULATION. CHECK THE ENTIRE FIRING RANGE WHEN ADJUSTMENTS OF THIS NATURE ARE MADE.

7. Take and record the fuel input, O2 value, smoke spot number, and the oil and atomizing air pressures. Compare these value to the data supplied in the firetest report If there is a discrepancy in the oil supply pressure reading, this should be the first adjustment to be made. If the supply pressure is correct, check and adjust if necessary, the atomizing air compressor pressure, oil metering valve, or oil valve linkage, until the fuel input and O2 level are consistent with the firetest report and the linkage travel maintains the factory set high fire oil valve position.

NOTICE

THE KEWANEE FGR BURNER IS DESIGNED TO OPERATE AT LOW EXCESS AIR (I.E. LOW O2) LEVELS. NORMAL OPERATING VALUES RANGE BETWEEN 2 AND 5 PERCENT OXYGEN CONCENTRATION AT THE VENT OUTLET THROUGHOUT THE TURNDOWN RANGE WHEN FIRING FUEL OIL. NORMAL SMOKE SPOT NUMBER AT THE NORMAL O2 LEVELS ARE ZERO TO A ONE.

8. Allow the boiler to warm up at the low fire input.

9. Confirm the manual potentiometer is in the **MIN** position and the modulation switch is in the **MAN** position.

10. Modulate the burner to the high fire position in small gradual increments, by very slowly rotating the manual potentiometer dial towards the **MAX** position. Closely monitor the O2 concentration in the flue gas. During modulation, the flame should remain stable without excessive noise. If instability or excessive noise results, **IMMEDIATELY** place the burner switch in the **OFF** position and consult the troubleshooting guide.

11. Take and record the fuel input, O2 value, the smoke spot number and the oil and atomizing air pressures. Compare these value to the data supplied in the firetest report If there is a discrepancy in the oil supply pressure reading, this should be the first adjustment to be made. If the supply pressure is correct, check and adjust if necessary the atomizing air compressor pressure, oil metering valve, oil valve linkage, until the fuel input and O2 level are consistent with the firetest report and the linkage travel maintains the factory set low fire oil valve position.

12. Turn the modulation motor to the **MIN** position in slow gradual increments. The modulation motor will rotate the low fire position.

13. Take and record the fuel input, O2 value and smoke spot number again. Confirm that this data has not changed from the initial oil readings. If the data has changed, repeat steps 7 through 13 until consistent repeatable readings are observed at high and low fire.

14. Modulate the boiler from low fire until the input rate is approximately 25 percent of the maximum input.

15. Take and record the fuel input, O2 value and smoke spot number at this rate. Adjust the oil metering valve and/or linkage travel so that the O2 level in the stack gas is in the normal operating range.

16. Repeat steps 14 and 15 at both 50 percent and 75 percent of maximum fuel input.

17. Modulate the burner from high fire to low fire to high fire while observing the O2 value. Stop the modulation if O2 is outside the normal range and readjust oil metering valve position and/or the oil valve linkage travel. Confirm that low fire and high fire oil metering valve location has not changed due to linkage readjustment.

18. Set, adjust and/or confirm all of the safety and control devices (switches, low water cutoff(s), valves, controller etc.) located in the burner/boiler system are set correctly and operating as designed per the manufacturers instructions, the instructions in this manual, (see Part I page 19) the firetest report and safe practice.

G. FGR SYSTEM START-UP

NOTICE

THE FGR SYSTEM OPERATES ONLY WHEN FIRING NATURAL GAS.

1. Confirm that all safety and control devices are operating properly, the pilot and main fuel(s) start-up procedures have been completed, the natural gas tray assembly is securely in place, the burner switch is in the **OFF** position, the modulation switch is in the **MAN** position, the manual potentiometer is in the **MIN** setting and the fuel selector switch is in the **GAS** position.

2. Check for correct rotation of the FGR blower and confirm that the FGR system is correctly piped and wired. Confirm that the motorized FGR damper is in the closed position when the FGR blower is not running. Connect the NOx analyzer to the boiler vent.

3. Place the FGR switch in the **ON** position.

4. Place the burner switch in the **ON** position. Allow the burner to cycle through the pre purge, trial for pilot and trial for main flame cycles. The burner is now at low fire.

5. Allow the boiler to warm up. When the boiler has sufficiently warmed up such that the low fire hold aquastat contacts close, the FGR blower and motorized FGR damper will be energized. Check if the damper has stroked to the factory set position and there is no binding.

6. Observe the burner operation as the FGR blower is energized. The flame should remain stable without excessive noise. If the burner becomes unstable or is excessively noisy, IMMEDIATELY turn the fuel burner to the **OFF** position and consult the troubleshooting guide.

7. Take and record the O2, CO and NOx values. O2 and CO should remain within the normal operating ranges with NOx between 20 and 25 ppm.

WARNING

EXCESS FLUE GAS RECIRCULATION MAY CAUSE BURNER INSTABILITY AND OTHER HAZARDOUS CONDITIONS. NEVER DECREASE NOx READINGS (BY INCREASING FLUE GAS RECIRCULATION) BELOW THOSE VALUES RECORDED IN THE FIRETEST REPORT WITHOUT PRIOR FACTORY CONSULTATION AND WRITTEN APPROVAL.

THE CAM COMMAND SYSTEM CONTAINS TWO ROWS OF ALLEN SCREWS, ONE FOR TRIMMING NATURAL GAS INPUT AND ONE FOR TRIMMING FGR FLOW. ALWAYS POSITIVELY ASSURE THAT THE PROPER ROW OF SCREWS IS BEING ADJUSTED.

8. If NOx readings are above or below the desired level, increase/decrease FGR into the burner by carefully adjusting the appropriate Allen screw on the CAM Command system. If burner instability results, **IMMEDIATELY** place the burner switch in the **OFF** position and consult the troubleshooting guide. Adjust the O2 level, if required, by adjusting the appropriate Allen screw of the CAM command system.

9. Modulate the burner to high fire in small gradual increments by slowly rotating the manual potentiometer dial to the **MAX** position. During modulation the flame should remain stable without excessive noise. If instability or excessive noise results, **IMMEDIATELY** place the burner switch to the **OFF** position and consult the troubleshooting guide.

10. Modulate the burner from high fire to low fire to high fire while observing the O2 and NOx values. Stop the modulation at any points where O2 and/or NOx are outside the normal operating range or desired level respectively. Adjust the appropriate Allen screw of the CAM Command system to maintain the proper O2 and NOx levels throughout the firing range.

11. Set, adjust and/or confirm all of the safety and control devices located in the burner boiler system are set correctly and operating as designed per the manufacturers instructions, the instructions in this manual and safe practice.(See Page 19, Pressure and Temperature control settings for FGR burner)

12. Confirm that the FGR condensate valves are opened enough to prevent accumulation of condensate in the FGR piping and blower yet does not allow substantial quantities of flue gases to be directed outside the FGR piping.

H. FINAL START-UP PROCEDURE

1. Reconfirm the proper operation of all safety and control devices and systems associated with the burner/boiler system.

2. Complete system boil out procedure as required.

3. Adjust the operating control (pressure or temperature) to maintain the desired value. Adjust the manual reset high limit so that burner operation is interrupted before unsafe burner/boiler or system operation results and the system requirements are met.

4. Place the modulation switch in the **AUTO** position. The burner will now modulate firing rate to maintain the pressure or temperature set on the modulating control.

5. Observe the burner operation for several hours. During this period, observe the full range of burner operation on all fuels with and without FGR. Multiple prepurge, trial for pilot ignition, trial for main flame, modulating (run) and post purge cycles must be observed.

6. Instruct equipment owner or operators in proper and safe burner/boiler system operation and maintenance.

7. Inform proper authorities (owner, plant supervisor, gas supplier, boiler inspector etc.) that the burner/boiler system has completed installation and start-up. The boiler is now ready to be put into service.

I. Pressure and Temperature Control Settings for the FGR burner

High Gas Pressure Switch - Record gas manifold pressure at high fire, set switch 15% above recorded pressure.

Low Gas Pressure Switch - Record gas pressure after the main regulator at high fire, set switch 15% below recorded pressure.

Combustion Air switch- Record Air pressure upstream of combustion air damper at high fire, set switch 15% below recorded pressure.

Fuel	100 - 250 hp	300 - 800 hp
Gas	Use procedure described under **Combustion Air switch** for setting switch	Combination Combustion air proving/ Axial air proving/ Gas cover interlock. Use procedure for **Axial air proving switch** for setting switch.
Oil	Use procedure described under **Combustion Air switch** for setting switch	Combination Combustion air proving/Oil cover interlock. Use procedure described under **Combustion Air switch** for setting switch.

FGR flow switch - Set to 14"wc

Low oil Pressure switch- Record oil supply pressure at high fire, set switch 10% below recorded pressure

Low Atomizing Air pressure Switch - Record Air pressure during purge, set switch 10% below recorded pressure.

Axial Air proving Switch- Preset to 2" wc above Air plenum pressure. At the low fire position the axial air should be set to read slightly greater than 2" wc at the pressure port for the axial air proving switch. The damper should then swing open fast enough to maintain a pressure differential of 2"wc or greater throughout the range.

Low Temperature Hold Aquastat - Set at 180°F or above.

SECTION IV

OPERATION AND MAINTENANCE

WARNING

THE FOLLOWING OPERATING AND MAINTENANCE INSTRUCTIONS ARE GENERAL AND PROVIDED FOR ILLUSTRATION PURPOSES ONLY. EACH BURNER/BOILER SYSTEM IS UNIQUE AND MUST BE FULLY UNDERSTOOD BEFORE ATTEMPTING TO OPERATE THIS SYSTEM. CAREFULLY READ THIS AND ALL OTHER BURNER/BOILER SYSTEM MANUALS.

NEVER OPERATE THE BURNER/BOILER SYSTEM WITH DEFECTIVE, INOPERATIVE, JUMPERED CONTROLS OR COMPONENTS. ALWAYS FOLLOW THE OPERATING AND MAINTENANCE INSTRUCTIONS PROVIDED FROM THE COMPONENT MANUFACTURER.

NEVER OPERATE THE BURNER/BOILER SYSTEM WITHOUT FULLY READING AND UNDERSTANDING THE COMPLETE BURNER/BOILER SYSTEM MANUAL.

In order to maintain a safe, efficient and reliable burner/boiler system, constant and rigorous monitoring of the system is required. Only experienced and skilled operators should work on or near the system. Each operator must be knowledgeable of safe boiler operation and the specific design and operating details of each piece of equipment in the boiler room area.

The accumulation of dust, dirt and trash around the burner/boiler constitutes a safety and fire hazard and should never be allowed. Daily boiler room cleaning and housekeeping not only reduces the risks associated with operating the boiler system, but also maintains a professional appearance and pride in the boiler room personnel.

Always maintain all burner/boiler system documentation including manuals, drawings, and literature in a convenient single location, under the supervision of one person and in a neat and legible form. All manuals and instructions must be kept available to personnel working on and/or near the system.

A key function of the boiler room staff is to keep and maintain a neat, accurate boiler room log. All boilers must have a permanent log book which records the date, operator's name(s), maintenance work, inspections, tests, operating data and any other pertinent information. All activities associated with the operation of the boiler must be logged daily.

A. FUEL SWITCH-OVER

The Kewanee FGR burner/boiler system requires personnel to manually switch certain components of the burner when switch between natural gas and No. 2 fuel oil. These procedures are very straight forward, require minimal hand tools and can be accomplished in less than 5 minutes. However, read and completely understand these procedures as given in the preceding start-up instructions before attempting to switch between fuels.

B. FGR SYSTEM SHUT DOWN

WARNING

NEVER PLACE THE FGR SWITCH IN THE OFF POSITION WHEN THE BURNER IS ABOVE THE LOW FIRE POSITION.

The burner/boiler system is capable of operating without FGR. If the FGR is to be shutdown, first move the potentiometer to the low fire position. Place the auto/manual switch in the MAN position, this will drive the unit to low fire. Once the burner is at low fire, place the FGR switch in the OFF position. Wait for the FGR fan to slow down and the motorized damper to close. Place the auto/manual switch back in the AUTO position. The boiler will resume operation without FGR and Low NOx emissions.

C. DAILY PROCEDURES

1. Blow down the boiler using the bottom blowdowns.
2. Blow down the low water cutoff control by opening the valve located in the bottom piping. If multiple low water cutoffs are included in the system, blow down each one. Burner/boiler operation should cease if the water level in the low water cutoffs is below the setpoint. Never operate the system with inoperative or disabled low water cutoff(s).
3. Check fuel supply piping for leaks and or any other unsafe condition.
4. Take and record boiler stack temperature and flame appearance. Consult factory if nonconformance of any of the parameters appear.
5. Check linkage and valve/damper travel. All moving component should travel smoothly without obstruction.
6. Check combustion air blower and FGR blower for smooth, quiet operation. The blower should be vibration free without excessive noise.
7. Check FGR condensate is draining correctly.

D. WEEKLY PROCEDURES

1. Check and confirm proper operation of flame controller. Observe all functions of the controller.
2. Check and confirm proper operation of all safety and limit controls.
3. Remove and inspect the oil nozzle.
4. Check all alarms on the burner/boiler system.
5. Check for leaks in FGR system.
6. Take and record O2, CO, smoke spot number and NOx (if equipped with FGR). Have qualified service technician adjust if not within the normal operating range.
7. Refer to equipment manufacturers recommendations on lubrication intervals. Premature failure of bearings can occur from over greasing.

E. MONTHLY PROCEDURES

1. Check all moving parts associated with the burner/boiler system for wear. Lubricate and/or replace as necessary. Always use lubricant specified by the component or control manufacturer.
2. Check and clean all strainers and filters.
3. Check boiler safety valve operation (by hand).
4. Clean atomizing air compressor intake.
5. Check entire system for flue gas leaks.
6. Check atomizing air compressor motor, oil pump motor, combustion air and FGR blower lubrication.

F. ANNUAL PROCEDURES

1. Shut the burner/boiler system down and allow the boiler to cool.
2. Clean the boiler.
3. Open the boiler's water side and inspect. Arrange for annual authorized inspectors certification of the system.
4. Inspect the refractory insert and burner end head for any damage or wear. Repair/replace as needed.
5. Disassemble and closely inspect the entire FGR system (piping, FGR blower assembly and drain system). Replace any and all corroded, defective or questionable components.

SECTION V

TROUBLESHOOTING GUIDE

WARNING

THIS SECTION CONTAINS GENERAL INFORMATION CONCERNING THE CORRECTION OF COMMONLY NOTICED IMPROPER BURNER/BOILER SYSTEM OPERATION. DUE TO THE LARGE NUMBER AND VARIATION OF POSSIBLE PROBLEMS WHICH MAY BE ENCOUNTERED IN BURNER/BOILER SYSTEM INSTALLATION, START-UP AND OPERATION. THIS SECTION DOES NOT CONTAIN ALL POSSIBLE CAUSES AND SOLUTIONS FOR SYSTEM OPERATION PROBLEMS.

THE INFORMATION AND REMEDIES CONTAINED IN THIS DOCUMENT SHOULD ONLY BE USED BY TRAINED, SKILLED AND EXPERIENCED SERVICE PERSONNEL. A THOROUGH AND COMPLETE UNDERSTANDING OF ALL THE BURNER/BOILER SYSTEM COMPONENTS, PRINCIPLES OF OPERATION AND THE INFORMATION CONTAINED IN THE COMPLETE MANUAL IS REQUIRED BEFORE ATTEMPTING TO CORRECT SYSTEM PROBLEMS.

NEVER ALLOW UNSAFE OR IMPROPER SYSTEM OPERATION.

CAUTION

CONSULT FACTORY IF THE REMEDIES OUTLINED IN THIS SECTION FAIL TO RESOLVE THE PROBLEM OR, IF UNEXPECTED, UNKNOWN AND/OR DIFFICULT PROBLEMS OR QUESTIONS ARISE.

PROBLEM	POSSIBLE CAUSE	POSSIBLE REMEDY
BURNER WILL NOT START	NO CALL FOR HEAT	CHECK PLANT SYSTEM WIRING. CORRECT AS NEEDED.
	NO POWER	CORRECT POWER INTERRUPTION SOURCE (BREAKER, SWITCH) OR REWIRE AS NEEDED
	BLOWN FUSE	REPLACE FUSE
	PRESSURE OR TEMPERATURE LIMITS OPEN	CHECK OPERATING OR SAFETY LIMIT SETTING. CORRECT IF MISADJUSTED
	IMPROPER POWER SUPPLY	CHECK POWER VOLTAGE AND CORRECT/REWIRE AS NEEDED
	OPEN INTERLOCK CONTROL	CHECK INTERLOCK SETTINGS AND ADJUST/RESET AS NEEDED WRONG DIFFUSER
	LOW WATER	CHECK WATER LEVEL AND FILL BOILER TO PROPER WATER LEVEL CHECK FEEDWATER SYSTEM. OPEN VALVES OR ADJUST/ CORRECT TO MAINTAIN PROPER WATER LEVEL
	BLOWER STARTER NOT PULLING IN	CHECK POWER TO THE COIL. REWIRE AND/OR REPLACE AS NEEDED RESET/REPLACE OVERLOADS
PILOT WILL NOT LIGHT	NO NATURAL GAS SUPPLY TO PILOT GAS TRAIN OR PILOT BURNER	CHECK/OPEN APPROPRIATE MANUAL GAS VALVES CHECK/CLEAR OBSTRUCTION IN NATURAL GAS LINES CHECK/REPLACE PILOT GAS TUBING CHECK/REPLACE PILOT GAS VALVE(S)

PROBLEM	POSSIBLE CAUSE	POSSIBLE REMEDY
PILOT WILL NOT LIGHT (CONTINUED)	NO SPARK	CHECK/REPLACE IGNITION CABLE CHECK/TIGHTEN CABLE ENGAGEMENT TO PLUG AND TRANSFORMER REWIRE/REPLACE IGNITION TRANSFORMER CLEAN/REPLACE ELECTRODE CLEAN CARBON BUILD UP ON GAS INJECTOR TUBE. REGAP SPARK PLUG TO APPROXIMATELY 1/8 INCH
	INCORRECT FUEL/AIR MIXTURE TO PILOT BURNER	ADJUST PILOT GAS REGULATOR AND/OR COMBUSTION AIR FLOW TO THE PILOT ADJUST/CORRECT GAS PRESSURE AT INLET TO PILOT GAS TRAIN CORRECT COMBUSTION AIR BLOWER ROTATION REPAIR/REPLACE PILOT AIR TUBING
	OBSTRUCTED OR MIS- SIZED PILOT PORT IN THE BURNER REFRACTORY INSERT	CLEAR/RESIZE/REPLACE REFRACTORY INSERT
	AIR IN FUEL LINES	PURGE AIR FROM LINE
	IMPROPER COMBUSTION AIR DAMPER SETTING	READJUST AIR DAMPER
PILOT LIGHTS BUT FLAME SCANNER NOT DETECTING THE PRESENCE OF FLAME IN THE BURNER/BOILER	INOPERATIVE/DEFECTIVE FLAME SCANNER	REWIRE/REPLACE
	INOPERATIVE/DEFECTIVE FLAME AMPLIFIER	REPLACE
	OBSTRUCTED/MISALIGNED SCANNER PORT IN THE REFRACTORY INSERT	CLEAR OBSTRUCTION ALIGN REFRACTORY INSERT PORT

PROBLEM	POSSIBLE CAUSE	POSSIBLE REMEDY
PILOT LIGHTS BUT FLAME SCANNER NOT DETECTING THE PRESSENCE OF FLAME IN THE BURNER/BOILER (CONTINUED)	POOR PILOT FLAME	ADJUST PILOT FUEL/AIR MIXTURE INCREASE FUEL AND/OR FLOW TO PILOT
	INPROPER COMBUSTION AIR DAMPER SETTING	READJUST AIR DAMPER
PILOT BURNER LIGHTS BUT MAIN FLAME WILL NOT	PROGRAMMER IN TEST POSITION	PLACE SWITCH IN RUN POSITION
	POOR PILOT FLAME SIGNAL	SEE ABOVE
	IMPROPER FUEL AND AIR SETTING	READJUST VALVE SETTINGS AND/OR LINKAGE
	FUEL VALVES NOT OPENING	CHECK/REWIRE/REPLACE AS NEEDED
	MANUAL SHUT OFF VALVES CLOSED	OPEN APPROPRIATE VALVES
	GAS NOZZLES OR OIL NOZZLE OBSTRUCTED	CLEAN/REPLACE AS NEEDED
	AIR IN FUEL LINES	PURGE AIR FROM LINE
	OIL PUMP PRESSURE LOW	READJUST PUMP PRESSURE
BURNER WILL NOT MODULATE FROM LOW FIRE	MODULATING CONTROLLER SET TO LOW	READJUST CONTROLLER
	LOW FIRE HOLD AQUASTAT SET TO HIGH	READJUST AQUASTAT
	WRONG SWITCH SETTINGS	TURN MANUAL POTENTIOMETER TO MAX POSITION PLACE MODULATION CONTROL SWITCH IN AUTO POSITION
	CONTROLS MISWIRED	REWIRE CORRECTLY
	DEFECTIVE/MISWIRED MODULATION MOTOR	REPLACE/REWIRE MOTOR
BURNER LOCKS OUT WHILE IN SERVICE	UNRELIABLE PILOT	SEE APPROPRIATE SECTION OF THIS TROUBLE- SHOOTING GUIDE
	MAIN FLAME BLOW OUT	READJUST FUEL AND AIR RATIO THROUGHOUT TURNDOWN TO MAINTAIN PROPER RATIO AT ALL INPUTS

PROBLEM	POSSIBLE CAUSE	POSSIBLE REMEDY
BURNER LOCKS OUT WHILE IN SERVICE (CONTINUED)	ELECTRICAL POWER SPIKES	CHECK/CONTACT ELECTRICAL POWER SUPPLIER
	ELECTRICAL SHORT	CHECK/CORRECT AS NEEDED
	FLUCTUATING STACK DRAFT	CONTACT STACK CONTRACTOR. REDESIGN AS NEEDED
	POOR OR FLUCTUATING FLAME SIGNAL	SEE APPROPRIATE SECTION OF THIS TROUBLE-SHOOTING GUIDE
	EXCESSIVE HEAT IN THE BOILER ROOM	ASSURE PROPER VENTILATING AIR SUPPLY
	DEFECTIVE CONTROLLER	REPLACE
	SAFETY CONTROL(S) OPENING	CHECK/ADJUST AND/OR REPLACE CONTROL (AIR SWITCH, FGR SWITCH, HIGH/LOW GAS PRESSURE SWITCH, ETC.)
NOISY, UNSTABLE AND/OR POOR LOOKING FLAME	IMPROPER FUEL/AIR RATIO	READJUST FUEL VALVE AND/OR AIR DAMPER LOW FIRE SETTINGS AND LINKAGE
	IMPROPER PILOT FLAME	SEE OTHER SECTIONS OF THIS TROUBLESHOOTING GUIDE
	BLOWER MOTOR ROTATION INCORRECT	REWIRE CORRECTLY
	FGR INTRODUCTION DURING INITIAL TRIAL FOR MAIN FLAME	REWIRE CORRECTLY
	EXCESSIVE FGR INTRODUCTION	REDUCE FGR INTRODUCTION BY READJUSTING FGR DAMPER AND/OR LINKAGE
	OBSTRUCTED/DEFECTIVE GAS NOZZLES OR OIL NOZZLE	CHECK, CLEAN AND/OR REPLACE AS NEEDED
	IMPROPER BOILER VENTING	REDESIGN STACK VENTING
	DEFECTIVE COMBUSTION AIR OR FGR BLOWER	CHECK MOTOR RPM AND ASSURE WHEELS ARE TIGHT ON HUBS
	POOR FUEL QUALITY	CONTACT FUEL SUPPLIER

PROBLEM	POSSIBLE CAUSE	POSSIBLE REMEDY
NOISY, UNSTABLE AND/OR POOR LOOKING FLAME (CONTINUED)	DEFECTIVE METERING VALVE	CHECK/REPAIR/REPLACE
	IMPROPER DIFFUSER SETTINGS	CONTACT FACTORY
	FGR CONDENSATE DRAIN VALVES DIVERTING TOO MUCH FGR	REDUCE VALVE OPENINGS
	ATOMIZING AIR COMPRESSOR NOT BYPASSING ENOUGH AIR	INCREASE AMOUNT OF AIR BYPASSED BY OPENING DRAIN VALVE FURTHER
	ATOMIZING AIR ACCUMULATOR (SURGE TANK) OBSTRUCTED	CLEAN/REPLACE AS NEEDED
	LOOSE LINKAGE	REPEAT START-UP PROCEDURE AND TIGHTEN LINKAGE
	DEFECTIVE REFRACTORY INSERT	REPAIR/REPLACE
	IMPROPERLY SIZED OR DEFECTIVE NATURAL GAS REGULATOR	REPLACE WITH CORRECTLY SIZE REGULATOR
	IMPROPER FUEL PIPING	REPIPE CORRECTLY
	TOO MUCH AXIAL AIR AT LOW FIRE	THE AXIAL AIR PRESSURE SHOULD READ 2" WC AFTER THE AXIAL AIR DAMPER WHEN AT LOW FIRE AND HAVE A 2" WC OR GREATER READING ABOVE AIR PLENUM PRESSURE THROUGHOUT THE RANGE

SECTION VI

CHARTS & FIGURES

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Performance Standards For the Low Emissions(LE) Burner

The following performance standards for excess oxygen (O_2), carbon dioxide(CO_2), carbon monoxide(CO) and smoke spots in the flue gases of boilers are recommended. (All % values given as a percentage by volume of dry flue gases)

Excess Oxygen (O_2) in the flue gas by fuel			
Fuel	O_2%		
	High fire	Mid fire	low fire
Natural Gas w/o FGR	3.0 +/- 0.5%	3.5 +/- 0.5 %	5.0 +/- 0.5%
Natural Gas w/FGR	3.0 +/- 0.5%	3.5 +/- 0.5 %	5.0 +/- 0.5%
#2 oil	3.0 +/- 0.5%	4.0 +/- 0.5 %	5.0 +/- 0.5%

Carbon Dioxide(CO_2) in flue gas by fuel			
Fuel	% CO_2 (Dry Basis)		
	High Fire	Mid fire	Low fire
Natural gas w/FGR	10.2 +/- 0.3%	10.0 +/- 0.3%	9.4 +/- 0.3%
Natural gas w/o FGR	10.2 +/- 0.3%	10.0 +/- 0.3%	9.4 +/- 0.3%
#2 oil	13.1 +/- 0.3%	12.5 +/- 0.3%	11.7 +/- 0.3%

Carbon Monoxide (CO) in the flue of gas fired burner should not exceed 50 PPM at any firing rate.

Smoke Spot (Bacharach Scale) in the flue gas by fuel Oil			
Fuel oil	Smoke Spot		
	High fire	Mid fire	Low fire
#2 oil	1	1	1

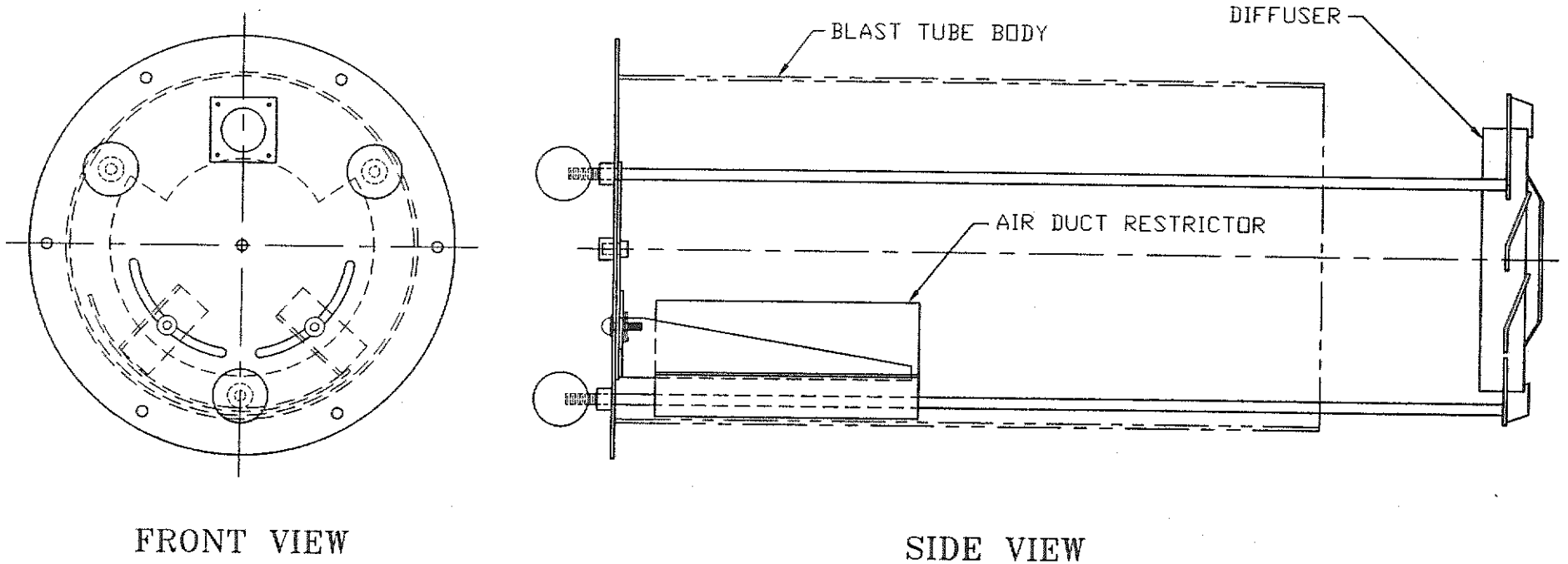


FIGURE 1A

GAS BURNER TRAY ASSEMBLY MODELS 100-250 FGR BURNER

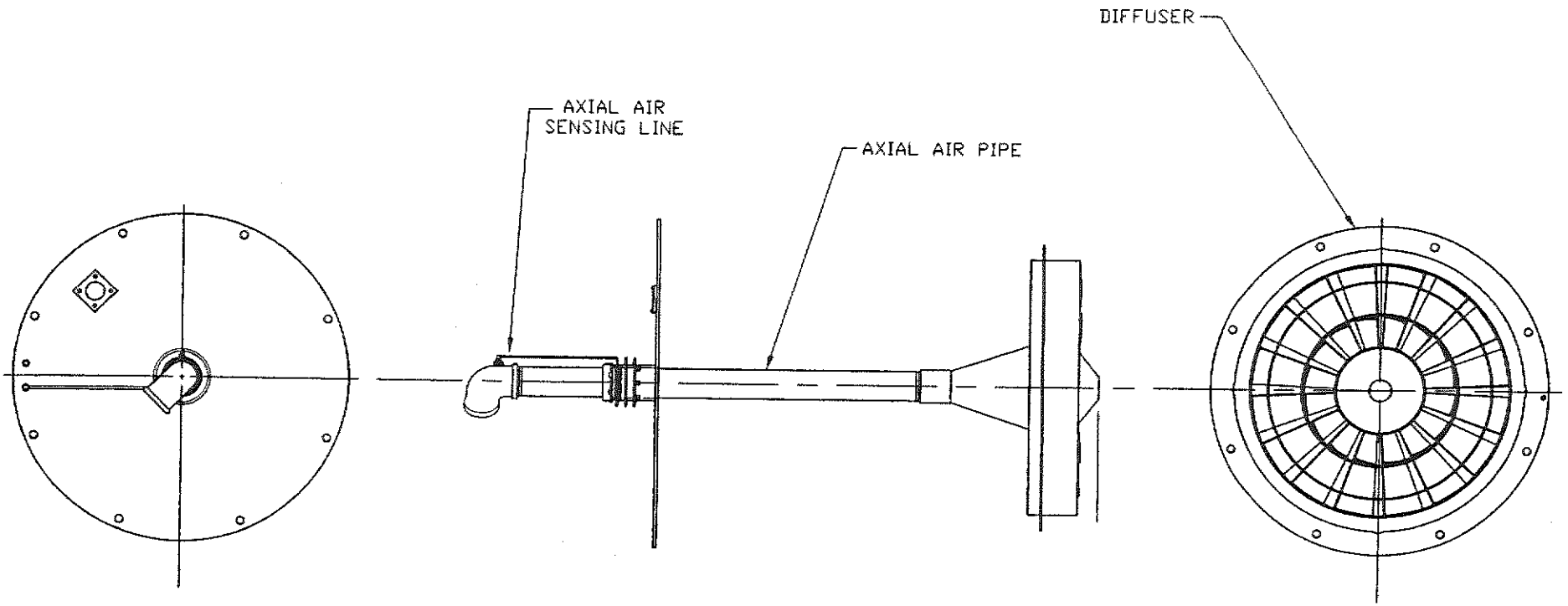


FIGURE 1B

GAS BURNER TRAY ASSEMBLY MODELS 300-800 FGR BURNER

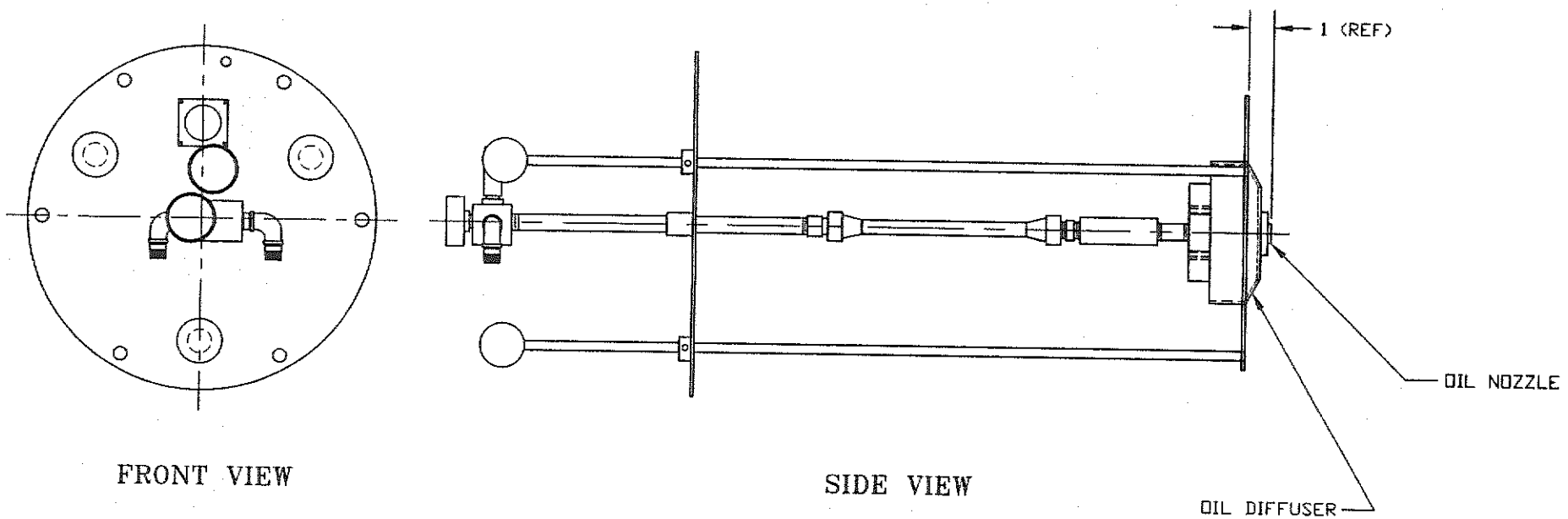


FIGURE 2A

BURNER TRAY ASSEMBLY, OIL MODELS 100-250 FGR BURNER

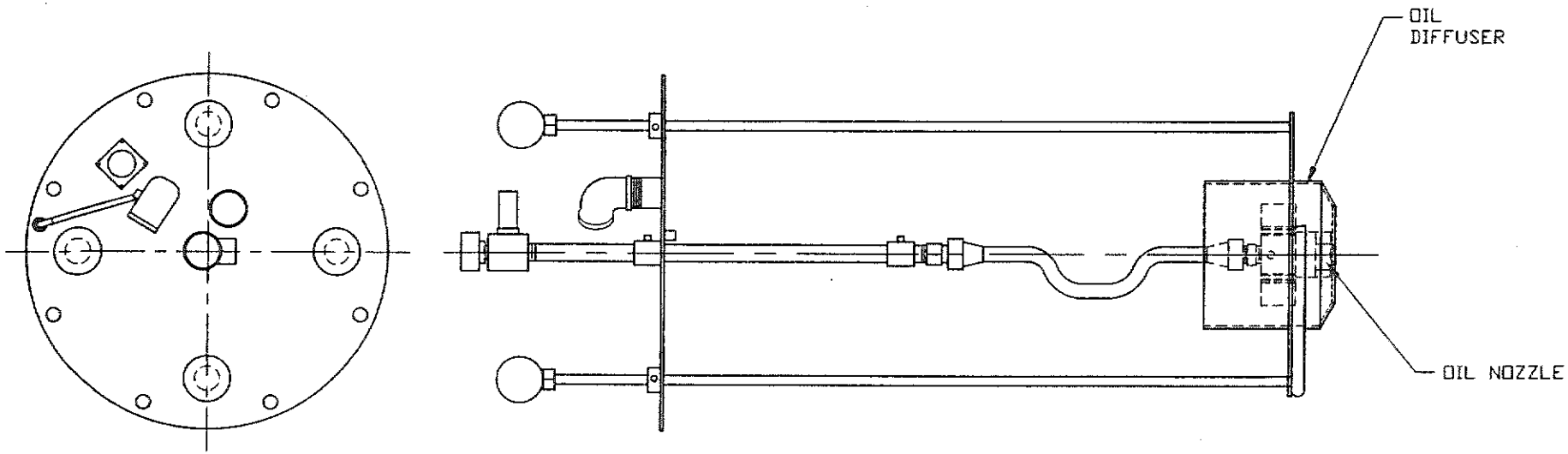


FIGURE 2B

BURNER TRAY ASSEMBLY, OIL MODELS 300-800 FGR BURNER

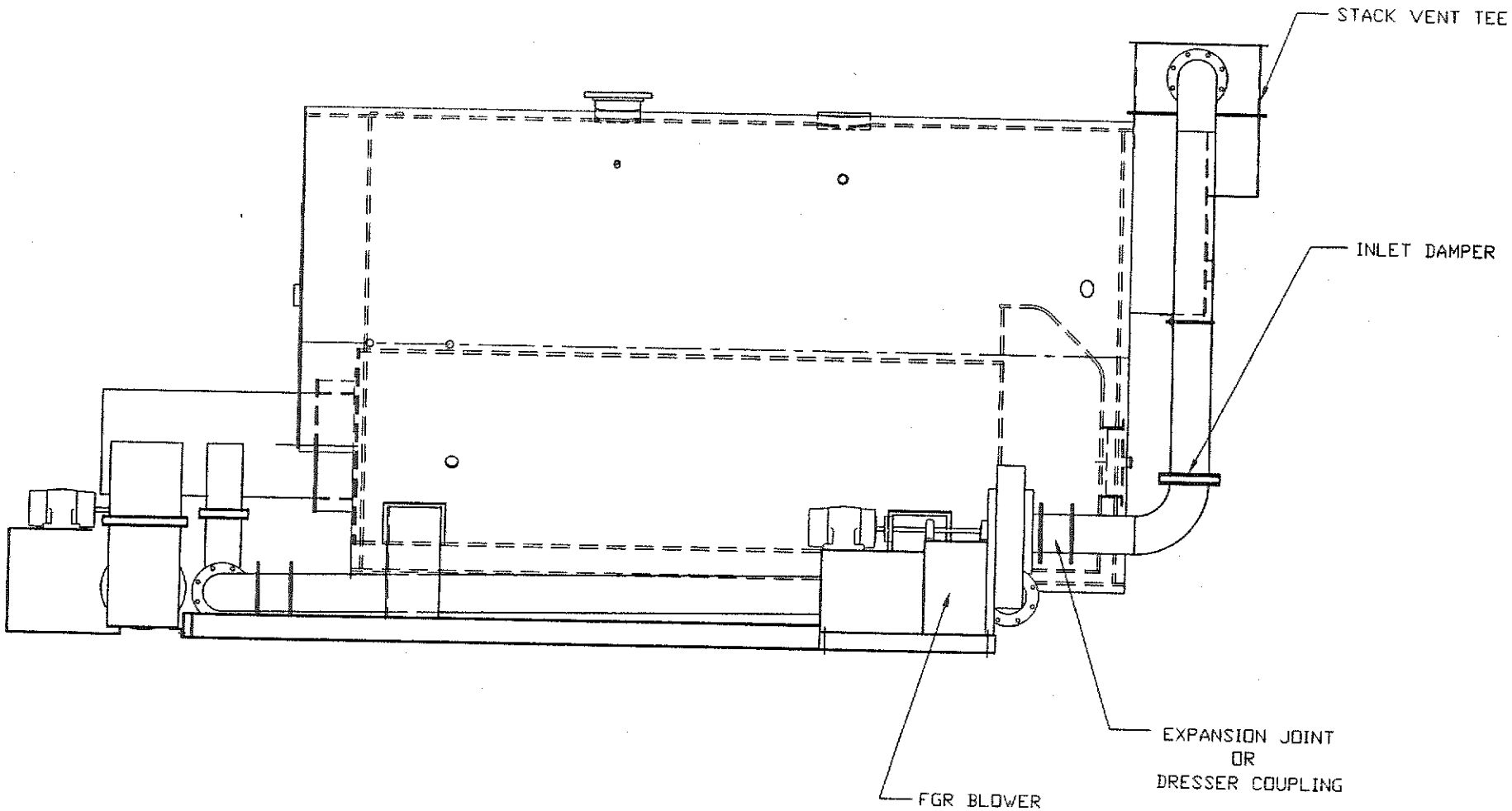


FIGURE 3

TYPICAL FGR FAN INLET PIPING

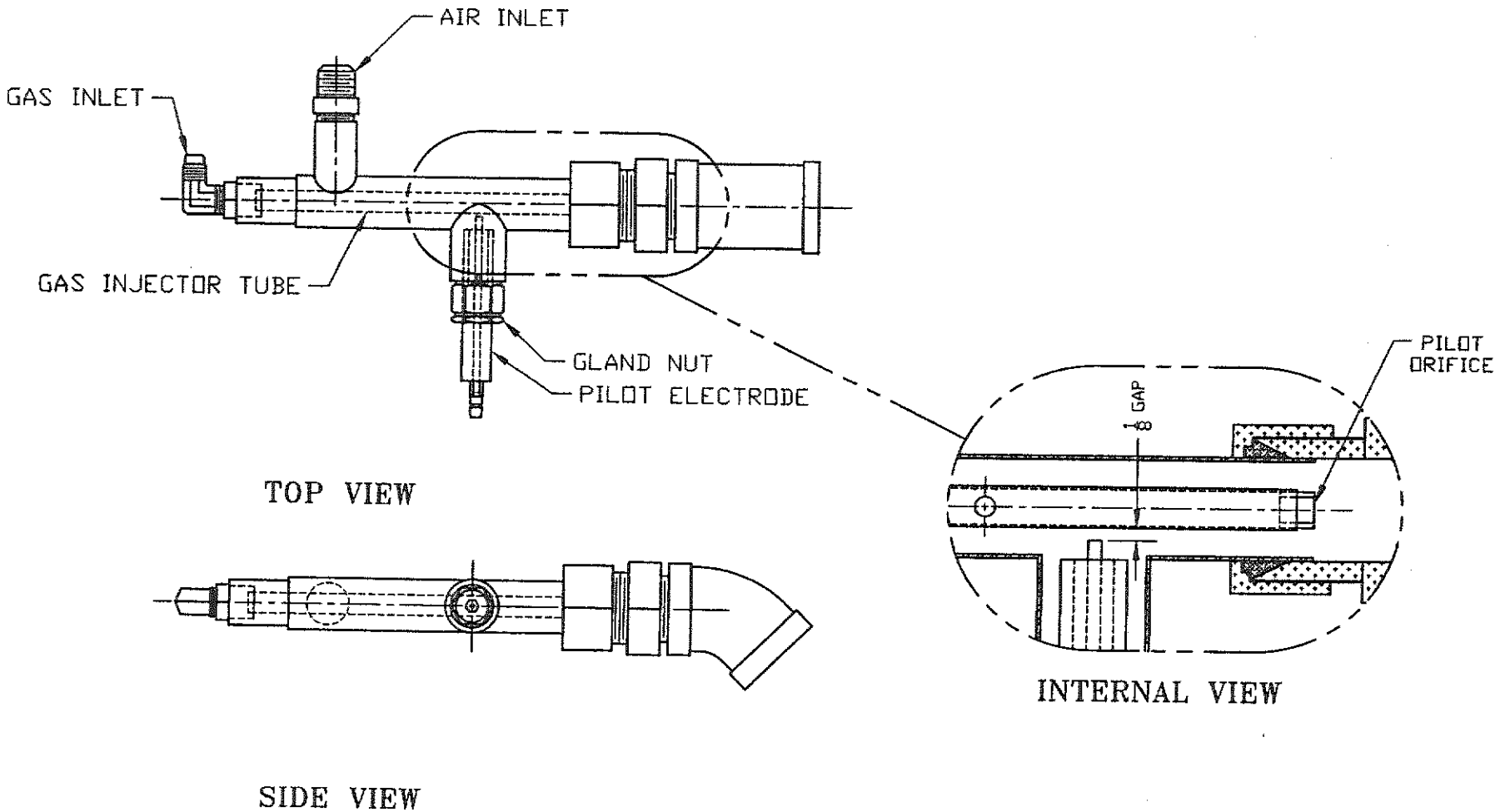


FIGURE 4

PILOT PIPING ASSEMBLY WITH ELECTRODE FGR BURNER

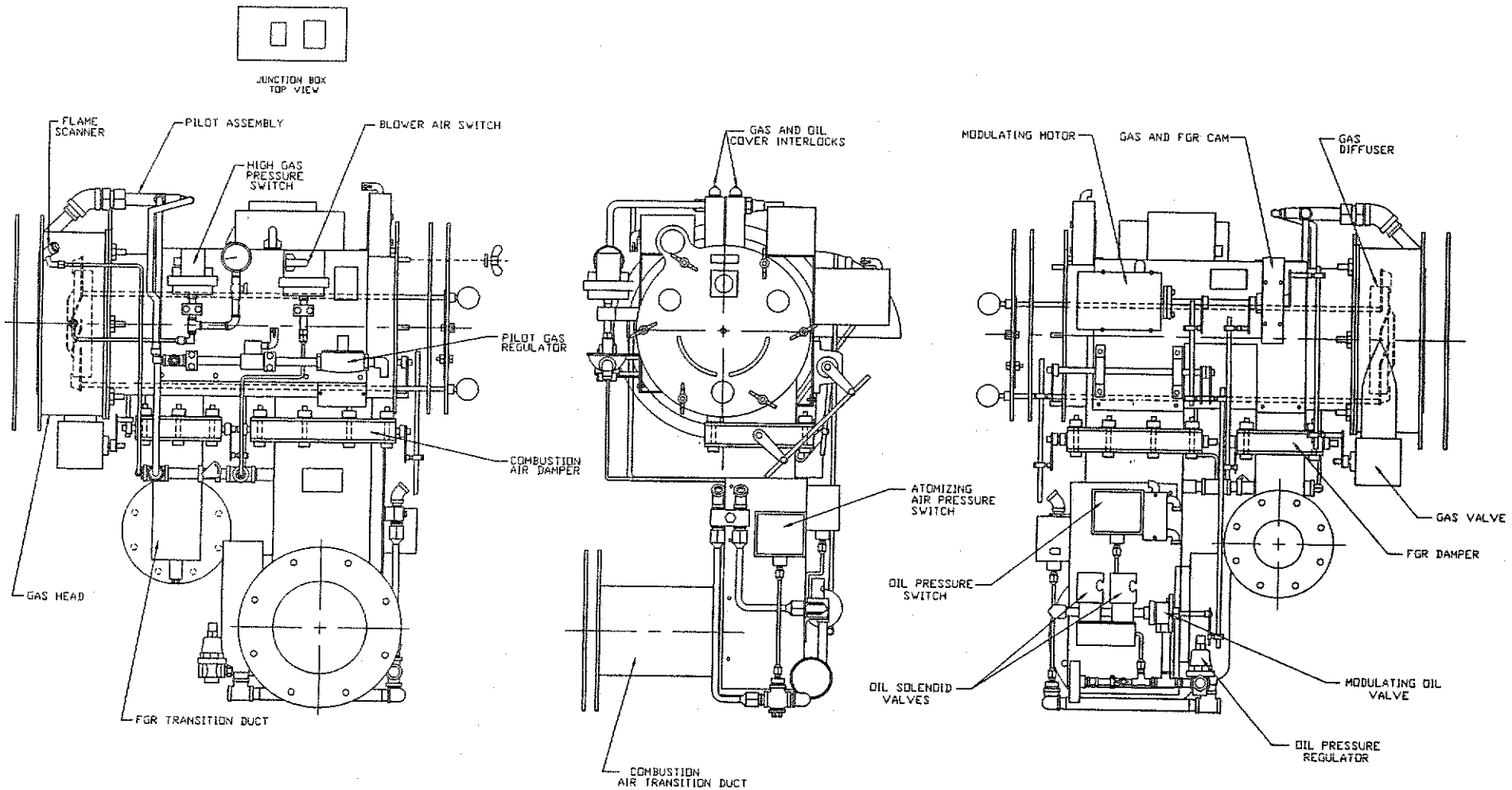
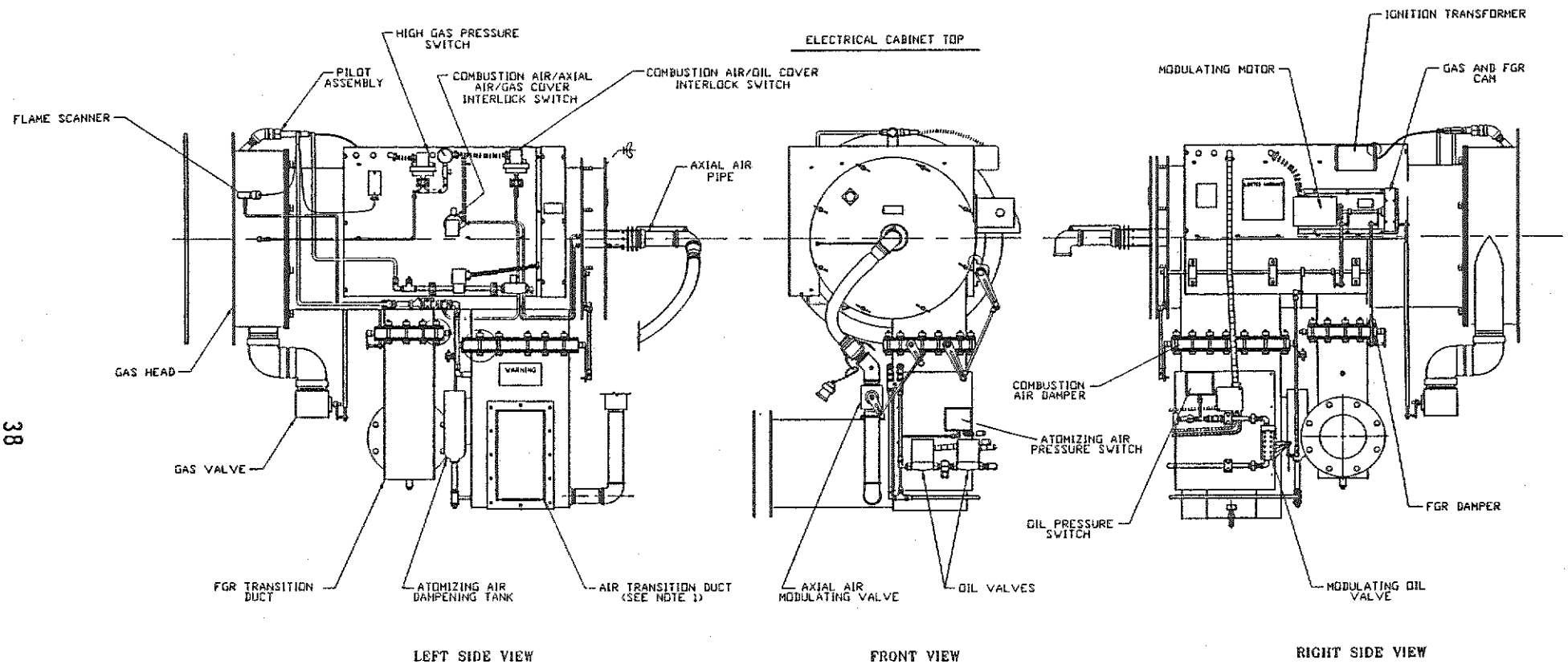


FIGURE 5

FGR BURNER ASSEMBLY - MODELS 100-250



NOTES:
1. 300-600 HP WILL HAVE ROUND OPENING ON AIR TRANSITION DUCT.

FIGURE 6

FGR BURNER ASSEMBLY
MODELS 300-800 w/GAS TRAY INSTALLED

NEED PARTS?
OEM Boiler Parts
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sales@oemboilerparts.com