S.T. JOHNSON CO.

Type FD68
Gas, Pressure and Air Atomizing Oil Burners

Installation, Operation, and Maintenance Instruction Manual

NOTICE: This manual is provided to supply general information on the installation, operation and maintenance of the FD68 burner system. The burner must be installed and operated by trained personnel, guided by generally accepted industry practice. Do not attempt to operate the burner without familiarizing yourself with these instructions and the manufacturer's instructions for all components in the system. Failure to do so can result in personal injury, loss of life and damage to property.

Specifications and procedures are subject to change without notice. Please consult factory for older unit specifications, or whenever the equipment supplied does not match descriptions in this manual.

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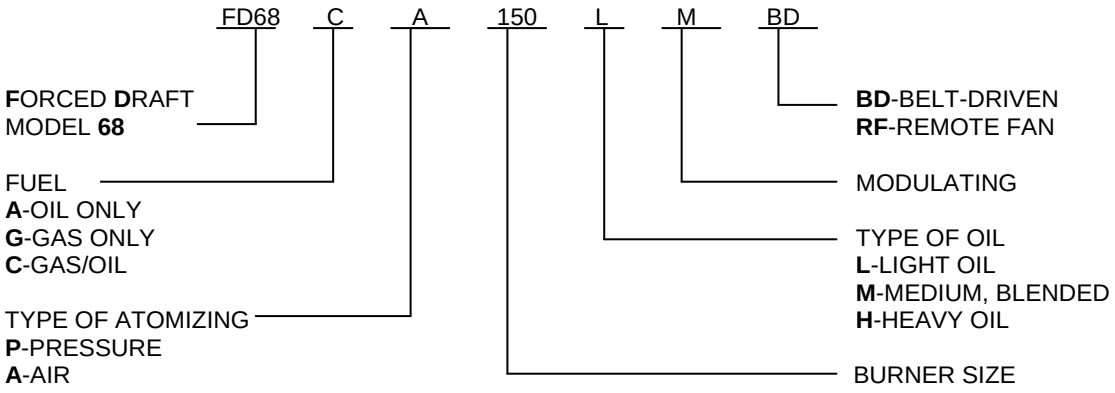
TABLE OF CONTENTS: **PAGE**

GENERAL INFORMATION

MODEL DESIGNATIONS



Model **-LM**: Designed for use with grade #2 oil or lighter. No provision for pre-heating oil is incorporated on the burner itself. Standard design includes an oil supply back pressure regulating valve for recirculating oil from the oil inlet on the burner. Pressure atomization is available up to size 300. Air atomization is available for all sizes.

Model **-MM**: Designed for use with blended fuel oils up through grade #5. A single oil pre-heater is incorporated into the burner design to raise the oil to atomizing temperature. Standard design includes an oil supply back pressure regulating valve for recirculating oil from the discharge of the oil heater. Pre and post firing nozzle purge system is available as an option.

Model **-HM**: Designed for use with the heaviest grades of fuel oil. Oil is heated to atomizing temperature with a single heater on sizes 50 - 125 and dual heaters on sizes 150 - 1000. Standard design includes a triple-pass oil manifold to continually keep all oil piping hot up to the nozzle, an oil supply back pressure regulating valve for recirculating the oil from the burner inlet, a relief valve for recirculating oil from the oil heater discharge, and a pre and post firing nozzle purge system.

ORDERING INFORMATION

The following information is required to process orders or quotations:

All systems:

Burner Model desired (see Page 1).
Burner capacity of boiler HP.
Type of boiler or furnace.
Furnace pressure to be fired against.
Electrical specifications.
Elevation (if greater than 2,000 ft.)
Insurance or local code requirements (if other than U.L.)
Control system programmer desired.
Control options desired.

Gas systems:

Type of gas.
Gas supply pressure at burner installation.

Oil systems:

Grade of oil to be burned.
If oil supply system is independent, or common with other burners.
If oil transfer pump, or pump and heater set is required.

GENERAL MODEL DESCRIPTION

A flange mounted windbox assembly, a firing head assembly, a stainless steel encased refractory burner tile, a gas/electric ignition system, modulating motor with a jackshaft and linkage assembly, a wiring junction box, a flame scanner, and an observation port.

Size 50 to 1000-SP packaged burners include an integral forced draft, axial-flow, backward-inclined, blower assembly hinge mounted to the windbox incorporating a triple-disc air shutter assembly with a jackshaft and linkage connected to the windbox jackshaft with a swivel linkage, an air proving switch, and a latch switch. All sizes also include a silencer on the blower inlet.

Burner models with a **-BD** suffix are constructed with an integral FD fan, as described above, but with a belt drive arrangement. These models are intended for use with 50Hz power sources only. Burner models with an -**RF** suffix are for use with a separate FD fan. They are designed for applications involving very high furnace pressures, 50Hz power sources, and/or high elevations.

A separate NEMA 1 control panel for remote mounting, incorporating a full-modulating flame safeguard programmer, a motor starter and overload relay for the blower motor, on-off switch, a manual/auto firing rate selector switch, a manual firing rate limiting potentiometer, and (4) indicating lights for: "POWER ON", "IGNITION", "FUEL" AND "SAFETY". Numerous other control features are available as options.

GAS FIRED SYSTEMS:

Standard gas train components include a gas butterfly control valve mounted on the burner, automatic gas shut-off valves, pressure switches, pressure regulators, and manual gas cocks shipped loose. Gas train assemblies are available to meet any local or national codes required. Optional factory pre-piped gas trains are available as an option.

Standard systems are designed for use with natural gas and/or propane gas. Applications involving the use of other fuel gases are reviewed on an individual basis after receiving details regarding the fuel analysis.

PRESSURE ATOMIZED OIL FIRED SYSTEMS:

An oil supply pump on a separate mounting base is provided to supply oil to the burner system at 300 psig. The burner mounted oil pipe train includes a solenoid shut-off valve, oil supply pressure gauge, return flow oil nozzle, oil return solenoid valve, oil return pressure gauge, and a return flow metering valve. The control system also includes an oil pump motor starter & overload relay.

AIR ATOMIZED OIL FIRED SYSTEMS:

Three different models are available for use with #2 oil, blended medium grade oil, and #6 oil. The model designations for these fuels are -LM, -MM, -HM respectively.

An oil supply pump on a separate mounting base is provided to supply oil to the burner system. The burner mounted oil pipe train includes a solenoid shut-off valve, oil supply pressure gauge, oil nozzle pressure gauge, oil metering valve, oil nozzle, and an oil back pressure regulating/relief valve.

A compressor set on a separate mounting base is provided to supply atomizing air to the system. The burner mounted atomizing air train includes an atomizing air pressure switch and an air pressure gauge.

Systems designed to fire with #4 oil also include one electric oil heater. A post-firing nozzle purge system is available as an option. Systems designed to fire with #6 oil include either one or two electric oil heaters, depending on the burner size, a post-firing nozzle purge system, and a oil recirculating system to maintain heated oil piping up to the oil nozzle at all times.

INSTALLATION INSTRUCTIONS

BURNER ASSEMBLY

If unsure of component identification refer to the component I.D. drawings included in the installation/operation manual furnished for each specific job:

The burner system is shipped with the refractory tile separate from the burner assembly to prevent damage in transit. The refractory tile should be bolted to the windbox mounting flange prior to mounting the assembly to the furnace mounting plate.

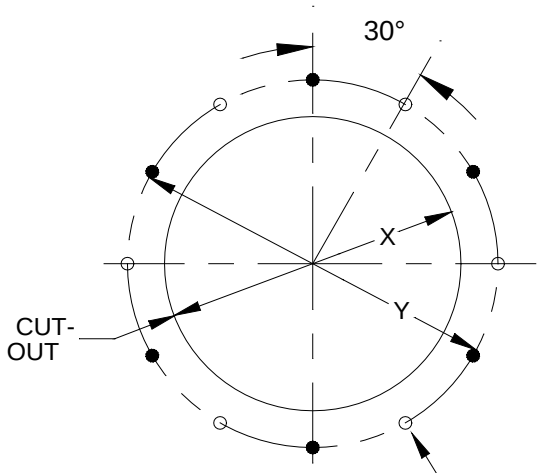
The firing head assembly can be installed inside the windbox after the burner has been mounted on the furnace. The adjustable firing head mounting brackets have been factory set for proper positioning of the head relative to the refractory burner throat. Because the refractory throat may not be positioned exactly the same at the installation as it was in the factory, a slight adjustment to the mounting brackets may be necessary to position the head concentric with the ID of the throat.

WARNING:
Both the windbox and the swing-away FD fan assembly have provision for installing a lifting lug, however the entire burner assembly should only be lifted using a lifting lug on the windbox. The weight of the burner should not be supported by using a lifting lug on the swing-away blower assembly. A lifting lug should only be used on the blower assembly should it become necessary to remove the blower assembly from the windbox.

BURNER MOUNTING DIMENSIONS

Burner Size	X	Y	Z
50-125	18	21 ¼	6
150-250	21	25 ¼	6
300	22	30 ¼	6
400	24	30 ¼	6
500-625	25	35 ¼	6
800	25	39 ½	12
1000	30	39 ½	12

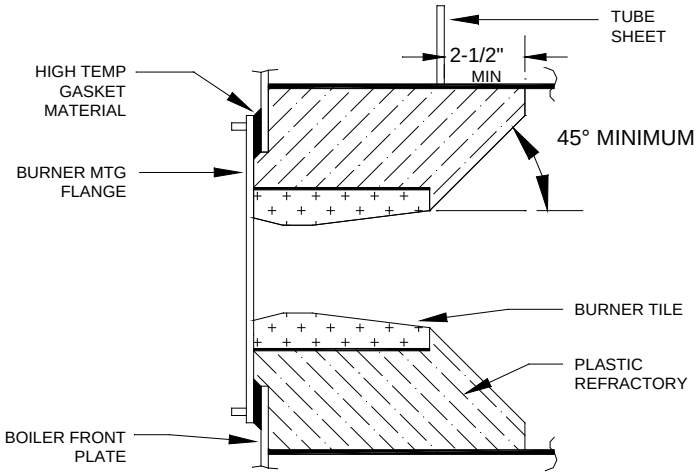
All dimensions in inches.



(Z) 1/2" MTG STUDS
(SOLID LOCATIONS for SIZE 800 & UP ONLY)

REFRACTORY INSTALLATION

Plastic refractory must be “rammed" into the area between the O.D. of the burner tile and the I.D. of the furnace. This refractory must extend a minimum of 2-1/2" beyond the tube sheet of water wall of the boiler. Refractory which extends beyond the end of the burner tile should be formed from the I.D. of the tile at a minimum angle of 45 degrees.



REFRACTORY TILE CURING INSTRUCTIONS

A gradual refractory heat up schedule must be followed to ensure proper curing of the burner tile and any plastic refractory used during installation. Improperly cured refractory can blister, crack, or explode due to too rapid heating and excessive vaporization of moisture in the material. Excessive steam issuing from the refractory indicates that temperature is increasing too rapidly. Hold temperature until steaming subsides.

The following schedule does not supersede the manufacturer’s schedule, but should be viewed as a minimum requirement. Always follow the plastic refractory manufacturer’s instructions for proper curing and longest refractory service life.

1. Initially fire the burner at low fire for 30 minutes.
2. Shutdown for 30 minutes.
3. Repeat steps 1 and 2 for 6 to 8 hours. This will incrementally, but gradually raise the refractory to proper curing temperature. Do not take the firing rate past minimum until the refractory is fully cured.

Fine surface cracks are normal in a properly cured refractory and do not indicate defect or failure. Large penetrating cracks or missing pieces indicate the refractory was improperly installed or cured too rapidly. All damaged refractory should be repair or replaced immediately to avoid damage to the burner.

SWING CYLINDER HINGE AND LATCH ADJUSTMENT

Jarring during shipment can cause misalignment of the swing-away blower assembly to the windbox, or of the latch lug to the latch lock. The blower assembly is aligned to the windbox with adjusting bolts on the hinges; the weight of the blower assembly must be supported should it become necessary to loosen the fastening bolts for readjustment.

The latch assembly can be readjusted in both the horizontal and vertical directions after loosening the mounting screws. The latch lug can also be adjusted to insure tight closure of the blower assembly to the windbox by loosening the jam nut behind the lug and threading the lug closer to, or farther away from the latch lock.

The position of the latch handle relative to the latch lug can be changed by pulling out on the handle while pushing in on the end of the latch shaft and rotating the handle to the desired position.

CONTROL PANEL & SAFETY CONTROLS INSTALLATION

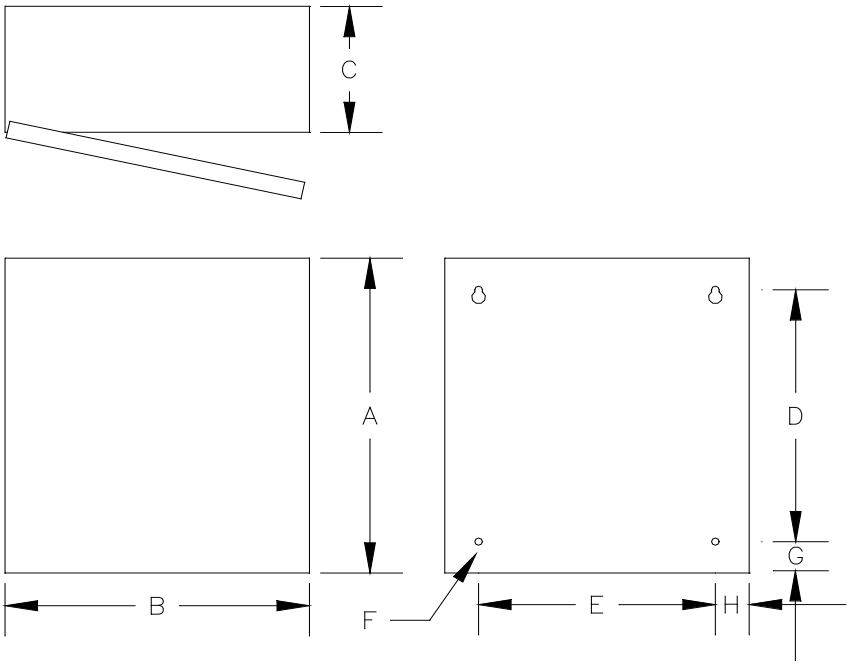
The control panel is furnished as a separate item and should be installed in a location other that immediately next to, or in line with the burner. It should be mounted on an adjacent wall or the side of the appliance. All wiring must comply with, and all branch circuits must be protected according to the national electrical code. Flame detector wiring between the burner and the control panel should be run in separate conduit from high voltage conductors.

WARNING: All safety controls that are indicated on the wiring schematic furnished with the burner must be installed and wired in the control system as shown. Any discrepancies, or changes, must be approved by the S.T. JOHNSON CO. prior to initial firing of the burner system.

All analog signal wiring should be run in separate conduit and shielded according to the wiring schematic supplied with the equipment.

STANDARD CONTROL PANEL MOUNTING DIMENSIONS

The installation dimensions for standard NEMA 1 control panel enclosures follow. Specifications for other than NEMA 1 enclosures, and/or the inclusion of optional control equipment, may result in different installation dimensions. If mounting dimensions are critical, check with the factory for information on specific jobs.



DESIGNATION	A	B	C	D	E	F	G	H
FD68 STD	21.375	21.375	7.25	19	14.875	.38	1.125	1.875
FD68 LARGE	27.5	21.5	7.25	25	14.75	.38	1.25	3.25
FD68 X-LARGE	27.5	21.5	12	25	14.75	.38	1.25	3.25

All dimensions in inches.

REQUIRED SAFETY LIMIT CONTROLS FOR ALL MODELS

All burner systems must be installed with a pressure or temperature operating control and high limit control. These controls must be installed on the appliance in a location where they can accurately sense the pressure of the vapor, or temperature of the liquid being heated. Contact the appliance manufacturer if unsure of the correct mounting location. The electrical wiring schematic furnished with the burner indicates where these controls need to be wired into the control system.

The operating control functions to limit the firing of the burner to those pressures, or temperatures, below the set point of the control. Its N.C. contacts break upon rise of the pressure, or temperature. Typical operating controls are:

Honeywell L404A for pressure Honeywell L4006A for temperature

The high limit control functions to shut off the burner system at a pressure, or temperature slightly above the set point of the operating control. The set point of the high limit control must be less than the maximum pressure, or temperature, or the appliance the burner is applied to. The N.C. contacts of this control break on a rise in pressure, or temperature, and must result in manual reset of the control to resume operation of the burner system. Typical high limit controls are:

Honeywell L404C for pressure Honeywell L6006E for temperature

WARNING:

If safety limit controls were not furnished with the burner system, nor with the appliance on which the burner is being installed, contact S.T. JOHNSON CO. or the appliance manufacturer to obtain the proper controls for installation prior to initial firing of the system.

All safety controls that are indicated on the wiring schematic furnished with the burner must be installed and wired in the control system as shown. Any discrepancies, or changes, must be approved by the S.T. JOHNSON CO. prior to initial firing of the burner system.

DO NOT attempt to fire any appliance, whether boiler or furnace without the necessary safety limit controls.

GENERAL STARTUP PROCEDURE

PRE-FIRING CHECKOUT

WARNING!

The initial firing, and/or adjustment of these combustion systems must be performed by authorized and properly trained personnel. Lack of extensive knowledge of these systems and/or the failure to explicitly follow these instructions, and the manufacturer's instructions provided for all components in the system, can result in personal injury or property damage.

Qualified personnel must follow the instructions before proceeding with the initial firing of this equipment.

Unqualified personnel must not proceed with initial firing; contact S.T. JOHNSON CO for recommendations for qualified personnel to initially fire the burner system.

This equipment must not be started up, or run at any time, without all guards, cover plates, and enclosures properly secured in place. Guards and cover plates must only be removed for maintenance and service.

The entire combustion system must be checked prior to attempting the initial operation. These checks must include, but are not limited to:

1. All piping must be checked against the provided piping drawings to insure proper installation. Tightness of all fittings should also be checked.

2. All wiring must be checked against the provided wiring drawings to insure completeness and accuracy. Check for loose connections or short circuits prior to applying power to the system.

3. The electrical power supply must be checked to insure the voltage coincides with the motor and control voltages listed on the equipment nameplates.

4. Check gas supply pressure to insure it is compatible with the pressure regulators installed on the gas train.

5. Check oil supply to verify the grade of oil corresponds to that specified on the burner nameplate. Also insure that transfer pumps, if used, do not supply oil to the burner pump at a pressure higher than the manufacturer's specification, generally 3 PSIG.

6. Check linkages to all fuel control valves and the air shutter to insure proper operation without binding or slippage.

7. Insure all pumps have been properly primed with oil and that the compressor, on air atomized systems, has been filled with the proper grade of compressor oil.

8. Check for proper rotation of all motors by momentarily closing the motor starter contacts.

9. Referring to the manufacturer's instructions included in the operating manual furnished, check for the proper setting and operation of all safety related controls; this could include but is not limited to:

- Boiler operating and high pressure limit controls
- Boiler pressure safety relief valves
- Boiler low water cutouts
- Burner gas pressure switches
- Burner blower air pressure switch
- Burner atomizing air pressure switch
- Burner oil pressure switch
- Low & high oil temperature switch (-MM, -HM models)

COMBUSTION AIR ADJUSTMENT

INTEGRAL FAN BURNERS

Burners with an integral, swing-away, blower assembly should have the air shutter completely closed at low fire for proper pilot performance and maximum turndown of the main flame. On applications involving a positive furnace pressure the air shutter should be adjusted for full opening at high fire to obtain the maximum catalog capacity. On applications involving a negative furnace pressure the opening of the air shutter should be limited to a point where the fan motor will not draw more current than 115% of the nameplate amperage.

To insure complete closure of the air shutter at low fire the linkage between the main jackshaft and the air jackshaft should be adjusted to provide a slight amount of over-travel of the linkage into the overtravel or swivel assembly when the air shutter is closed.

On applications where a very high draft, or a changing draft, such as boiler conversions with high stacks or where multiple boilers utilize a common stack, serious consideration must be given to control the draft through the combustion chamber/burner. Uncontrolled draft can cause low efficiency, noisy combustion and instability.

REMOTE FAN BURNERS

Remote fan burners (-RF model designation) can be furnished with a multi-blade air damper on the inlet of the burner, or with an inlet vortex damper on the remote fan. Remote fans and associated air ducting must be sized to provide the following differential windbox air pressures (over & above the furnace pressure):

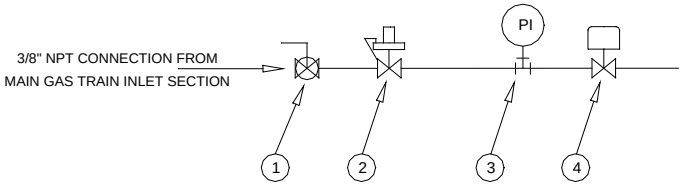
BURNER SIZE	CAPACITY (MBH)	DIFFUSER LOSS (Inches w.c.)	DAMPER LOSS (Inches w.c.)	TOTAL LOSS (Inches w.c.)
50	2,100	0.6	0.1	0.7
75	3,570	1.5	0.3	1.8
100	4,620	2.5	0.5	3.0
125	5,600	3.6	0.7	4.3
150	7,350	2.5	0.3	2.8
200	10,050	4.7	0.5	5.2
250	11,200	5.8	0.6	6.4
300	14,280	6.1	0.4	6.5
400	20,160	6.2	0.7	6.9
500	24,150	7.3	0.4	7.7
625	31,500	10.0	0.7	10.7
625	33,600	11.7	0.8	12.5
1000	42,000	12.5	0.7	13.2

IGNITION SYSTEM ADJUSTMENT PROCEDURE

Note: The "TEST/RUN" switch on the flame safeguard programmer may be used to provide additional time for adjustment; refer to the programmer instructions furnished with the burner.

STANDARD GAS-ELECTRIC PILOT SYSTEMS

Standard piloting arrangements are designed for use with natural gas or propane and include a pilot solenoid valve, pressure gauge, ball valve, ignition transformer and regulator rated for 10 PSIG max inlet pressure. The regulator should be adjusted to provide an outlet pressure of 3 to 6" w.c. The internal orifice in the pilot assembly may be drilled out to 1/8" maximum in applications where a larger pilot flame may be desired.

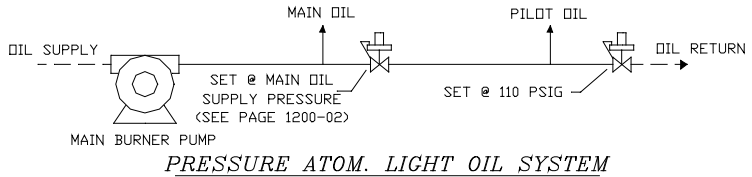


COMPONENT IDENTIFICATION

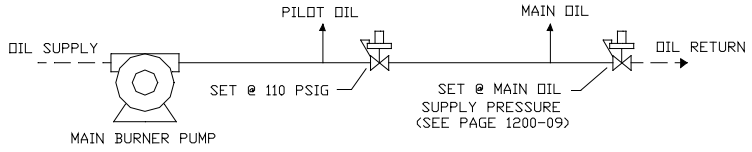
1. 3/8" BALL VALVE
2. 3/8" MAXITROL 325-3 REGULATOR
3. 0 - 35"W.C. PRESSURE GAUGE
4. 1/4" ASCO 8262G13 SHUTOFF VALVE

OPTIONAL DIESEL/ELECTRIC IGNITION SYSTEMS

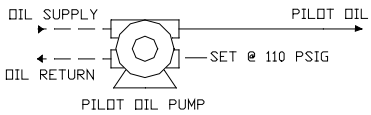
Diesel oil pilot systems are designed to operate with 100 to 110 PSIG oil pressure on the pilot nozzle. The exact piping configuration and adjustment procedure differs according to the burner model. Heavy oil burners include a separate pilot oil pump and a time delay relay in the control system to interrupt the pilot pump after establishment of the main flame. Standard arrangements for pressure or air atomized light oil burners utilize the main oil pump for the pilot, however a separate pilot oil pump can be furnished as an option.



PRESSURE ATOM. LIGHT OIL SYSTEM



AIR ATOM. LIGHT OIL SYSTEM

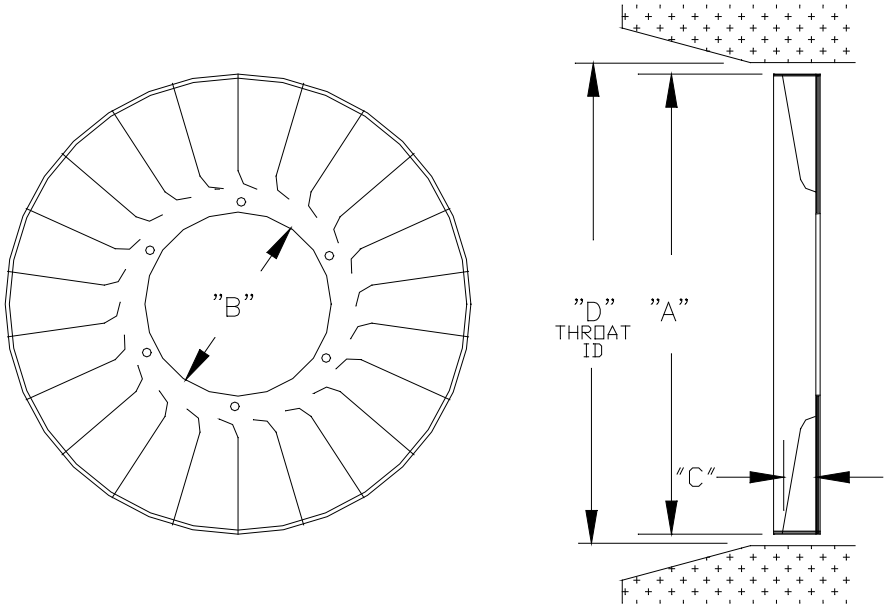


AIR ATOM. HEAVY OIL SYSTEM

FIRING HEAD ADJUSTMENT PROCEDURE

AIR DIFFUSER SPECIFICATIONS

The air diffuser is a critical component in the burner design. A damaged or deteriorated air diffuser will adversely affect combustion performance. The following dimensional information is furnished as a maintenance guide especially for checking for proper louver openings. Although these dimensions are the factory standard, certain special applications may have required opening the outside of the diffuser louvers further.

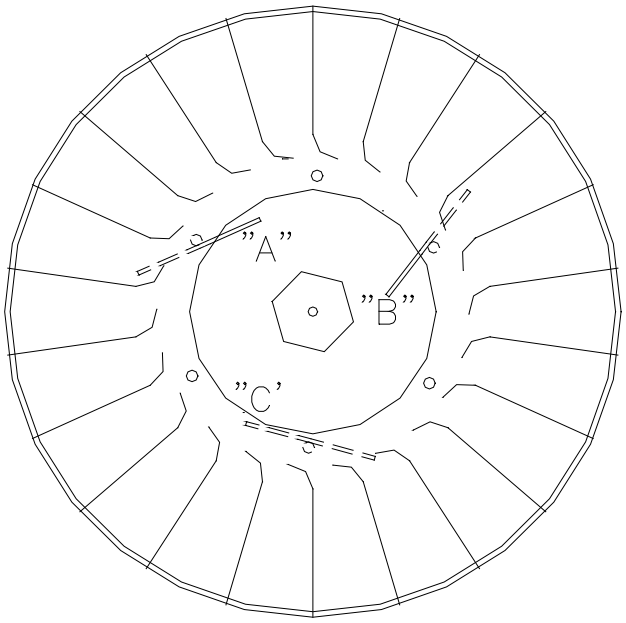


Burner Size	A	B	C	D
50, 75, 100	9.69"/246mm	4"/102mm	.31"/7.9mm	9.81"/249mm
125	9.69"/246mm	5"/127mm	.56"/14.3mm	9.81"/249mm
150, 200	12.63"/321mm	5.63"/143mm	.38"/9.5mm	12.75"/324mm
250	12.63"/321mm	6"/152mm	.50"/13mm	12.75"/324mm
300	13.63"/346mm	6.25"/159mm	.38"/9.5mm	13.75"/349mm
400	15.63"/397mm	6.25"/159mm	.50"/13mm	15.75"/400mm
500	16.38"/416mm	7.5"/191mm	.50"/13mm	16.50"/419mm
625, 800	17.38"/441mm	7.88"/454mm	.50"/13mm	17.50"/445mm
900, 1000	20.31"/517mm	9.25"/235mm	.50"/13mm	20.50"/521mm

AIR ROTATION BLADE SETTINGS

The air rotation blades serve to control the amount of, and swirl of, the combustion air flowing through the center of the air diffuser. This air has a rotation opposite to that of the air flowing through the outer diffuser louvers. The rate of fuel/air mixing and flame geometry can also be changed by the rotation blade setting especially when firing oil. Closing the blades more will result in a higher degree of swirl to the flame carrying the fuel/air mixture further out toward the furnace walls.

Oil only burners, especially those firing heavy oil, typically should have the rotation blades open further as indicated by position "B" below. Burners designed to fire on gas, or gas/oil, would typically have the blades set in the normal position "A". The closed position "C" is almost never recommended



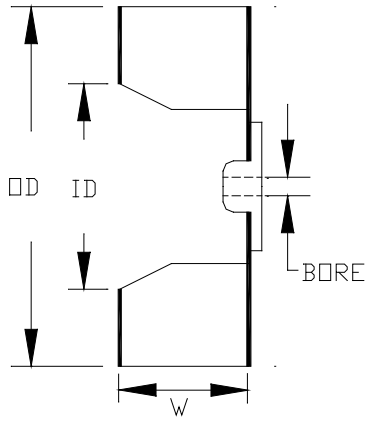
Positioning the blades so the stem is on the outward side will result in lower emissions on those installations where NOx control is incorporated.

Gas systems designed with gas spuds located behind the air diffuser can incur combustion behind the diffuser on initial light-off if the blades are open further than position "A" and the system is adjusted for maximum turndown. This condition should be checked for after initial commissioning and the blades closed further if the problem exists.

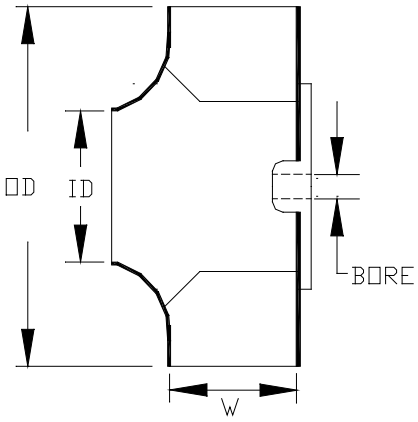
After initial setup the air rotation blades should only need to be checked, or re-set, if and when the air diffuser is replaced.

FAN WHEEL SPECIFICATIONS FOR 60HZ INSTALLATIONS

The following fan wheel dimensions are those for burners fabricated for 60Hz installations utilizing standard ODP motors. Burners built with special motors may have a different hub size.



SIZE 50 - 100



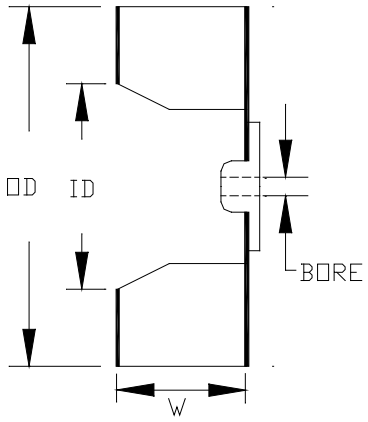
SIZE 125 - 1040

All dimensions are expressed as (Inches/mm).

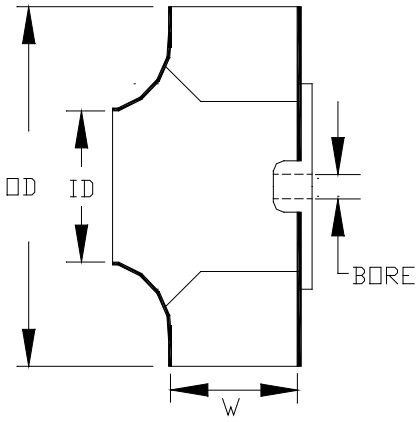
Burner Size	W	OD	ID	Bore
50	2.06 / 52	8.63 / 219	5.00 / 127	0.63 / 16
75	2.50 / 63	10.50 / 267	6.00 / 152	0.63 / 16
100	2.91 / 74	12.25 / 311	7.00 / 178	0.63 / 16
125-150	4.81 / 122	12.25 / 311	7.19 / 183	0.63 / 16
200	5.53 / 140	14.00 / 356	8.19 / 208	1.13 / 29
250-300	6.22 / 158	15.63 / 397	9.19 / 233	1.13 / 29
400	6.84 / 174	17.38 / 441	10.19 / 259	1.38 / 35
500	7.56 / 192	19.13 / 486	11.19 / 284	1.63 / 41
625	8.28 / 210	20.88 / 530	12.19 / 310	1.63 / 41
800	8.28 / 210	19.13 / 486	13.00 / 330	1.63 / 41
1000	8.28 / 210	20.88 / 530	14.50 / 368	1.63 / 41
1000-SP	7.50 / 190	22.63 / 575	15.5 / 394	1.88 / 48

FAN WHEEL SPECIFICATIONS FOR 50HZ INSTALLATIONS

The following fan wheel dimensions are those for burners fabricated for 50Hz installations utilizing standard ODP motors. Burners built with special motors may have a different hub size.



SIZE 50 - 100



SIZE 125 - 1040

All dimensions are expressed as (Inches/mm).

Burner Size	W	OD	ID	Bore
100	2.91 / 74	12.25 / 311	7.00 / 178	0.63 / 16
125-150	4.81 / 122	12.25 / 311	7.19 / 183	0.63 / 16
200	5.53 / 140	14.00 / 356	8.19 / 208	1.13 / 29
250-300	6.22 / 158	15.63 / 397	9.19 / 233	1.13 / 29
300-SP	6.84 / 174	17.38 / 441	10.19 / 259	1.38 / 35
400	6.84 / 174	17.38 / 441	10.19 / 259	1.38 / 35
400-SP	7.56 / 192	19.13 / 486	11.19 / 284	1.38 / 35
500	7.56 / 192	19.13 / 486	11.19 / 284	1.63 / 41
500-SP	8.28 / 210	20.88 / 530	12.19 / 310	1.63 / 41
625	8.28 / 210	20.88 / 530	12.19 / 310	1.63 / 41
800	8.28 / 210	19.13 / 486	13.00 / 330	1.63 / 41
1000	8.28 / 210	20.88 / 530	14.50 / 368	1.63 / 41
1000-SP	7.50 / 190	22.63 / 575	15.5 / 394	1.88 / 48

MAINTENANCE RECOMMENDATIONS FOR ALL BURNERS

ROUTINE (OPERATIONAL) BURNER CHECKS

1. Check visual appearance of flame (no impingement on furnace, etc)
2. Check for gas or oil leaks in fuel piping system
3. Check for abnormal bearing noise from motors
4. Inspect for loose or bent control linkage
5. Inspect for deteriorating refractory (broken pieces in furnace)

ROUTINE (OPERATIONAL) SAFETY CONTROL CHECKS

Note: The following procedures will result in a burner shut-down for a short period; if the burner does not shut down during any of the following steps, the control being tested must be replaced before placing the equipment back into service. Refer to the manufacturer's literature for check-out instructions for each specific control.

1. Manually shut off the source of fuel; the burner system should shut down within 4 seconds. If not the flame detector and/or the amplifier portion of the primary safety control must be replaced.
2. Reduce the set point of the operating limit control below the existing pressure, or temperature, condition. The burner should shut down immediately.
3. Reduce the set point of the high limit control below the existing pressure, or temperature, condition. The burner should shut down immediately requiring a manual reset to restart.
4. Reduce the set point of the low pressure switch for the fuel being used, either gas or oil, to a point below the operating pressure. The burner should shut down requiring a manual reset.

NON-OPERATIONAL CHECKS

1. Check for cleanliness of flame scanner lens.
2. Check for deterioration of pilot, ignition electrode & firing head components.
3. Check for dirt build-up on ignition electrode insulator and ignition cable.
4. Check for dirt build-up on fan blades.
5. Check for proper and safe operation of flame safeguard programmer according to the manufacturer's instructions provided in the manual furnished with the burner.
6. Leak test all fuel safety shut-off valves according to the manufacturer's instructions provided in the operating manual furnished with the burner.

LUBRICATION

Fan motors should be lubricated every 6 months under normal operating conditions, or more often with high ambient temperatures. For motors up through 10 HP use #2 consistency, lithium based, grease. For 15 HP and larger motors use #2 consistency, polyurea grease.

REPLACEMENT PARTS

When ordering parts, or requesting information on equipment, always include the nameplate data including shop order number.

SPECIAL MAINTENANCE RECOMMENDATIONS FOR BELT-DRIVE (50 Hz) BURNERS

SPROCKET & BELT ADJUSTMENTS FOR BELT DRIVE MODELS

The "HPT" style drives do not require as much belt tension as standard "V-BELT" type drives but sprocket alignment is very important to insure long belt life. A straight edge should be used to insure correct alignment of the sprockets.

The motor can be re-positioned on the adjustable motor mounting base to insure correct alignment of the motor shaft with the fan shaft in the vertical plane. If necessary, loosen the bolts holding the motor to the adjustable base and position on the motor to obtain proper shaft alignment in the vertical plane.

The motor mounting base can be adjusted to insure that the center line of the motor shaft and the center line of the fan shaft are parallel. If necessary, loosen the (4) locking bolts on the side of the adjustable base and change the height of either the front or the back of the mounting plate using the adjusting bolts located on top of the base.

After properly aligning the shafts, the height adjusting bolts on top of the adjustable base can be used to obtain the proper tension on the drive belt. When adjusting belt tension all (4) height adjusting bolts should be changed by the same amount in order to maintain proper shaft alignment. Exact belt tension can be determined by applying a perpendicular force to the center of the belt width, and the center of the belt span, with a spring scale. The following belt deflections should occur when a force of 5kg is applied:

BURNER SIZE	50 - 125	150 -250	300 -400	500 - 700	1025 - 1040
Deflection:	5 mm	6 mm	8 mm	10 mm	12mm

Note: Burner size 1040 furnished with a TEFC motor should have a deflection of 12mm when a force of 7.3 kg is applied.

FAN SHAFT BEARINGS

Fan shaft bearings should be lubricated with the same grease, and at the same interval as recommended for the fan motor.

The inner race of the fan shaft bearings is locked to the shaft with set screws; tightness of this set screw should be checked at regular maintenance intervals to insure the bearing race does not rotate on the fan shaft.

REPLACEMENT PARTS

When ordering parts, or requesting information on equipment, always include the nameplate data including shop order number.

OPTIONAL AIR FILTER ASSEMBLIES

FD68 air filter assemblies utilize a reticulated flexible polyester urethane foam filter media which have a three dimensional structure of skeletal strands to provide exceptional filtering characteristics at very low resistance to airflow. The media has the following specifications:

TEMPERATURE LIMITATIONS:	-40F to 250F (-4C to 120C)
DUST HOLDING CAPACITY:	.18lb/ Sq Ft (7.9gm/Sq M)
AIR PRESSURE DROP(CLEAN):	0.1" w.c. (.004 mm Aq)

WARNING:
The air filter media should not be exposed to prolonged periods of direct sunlight, strong acids, caustics, or chlorine. Exposure to aromatic hydrocarbons will cause swelling of the material, however, the original dimensions can be restored by removal of the hydrocarbons via cleaning.

MAINTENANCE RECOMMENDATIONS:

Normal cleaning procedures will simply involve vacuuming from the outside of the material or reverse flushing with water.

Oil and entrapped particulate can be removed by immersing in hot water and detergent.

REPLACEMENT FILTERS:

When ordering parts, or requesting information on equipment, always include the nameplate data including shop order number.

TROUBLESHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE
Call for heat but burner will not start.	• High limit control "LOCKED OUT". • Low water cut-out "LOCKED OUT". • Flame safeguard programmer "LOCKED OUT". • Blower motor overload relay tripped. • Blower motor circuit protection tripped. • Blower motor defective. • Blower air pressure switch not making. • Fuel pressure switch not making.
Burner starts but will not complete the prepurge cycle.	• Aux contact on blower starter is open. • Aux contact on pump or compressor starter is open. • Defective flame safeguard programmer module.
Purge complete but ignition is unsuccessful.	• Low fire start switch in mod motor not making.
Ignition is attempted but unsuccessful.	• Pilot gas cock is closed. • Pilot gas pressure is insufficient. • Ignition transformer is defective. • Pilot solenoid valve is defective. • Incorrect flame scanner sighting. • Flame scanner is defective.
Pilot established but main flame ignition is unsuccessful.	• Main fuel valve is closed. • High fuel pressure switch is tripping when main fuel valve opens. • Main gas control valve completely closed @ low fire.
Main flame established but burner shuts down when modulating to high fire.	• Improper fuel-air ratio @ low fire. • Improper fuel-air ratio @ mid-firing range. • Insufficient gas pressure from regulator. • Low fuel pressure switch set too high. • High limit control set too low or defective.
Burner remains @ low fire with increasing load demand.	• Modulating controller set too low or defective. • Modulating motor is defective. • Control system in "MANUAL, LOW FIRE" mode.
Lack of flame retention when firing on oil.	• Oil nozzle needs cleaning. • Improper atomizing air pressure. • Heavy oil temperature too high.
Creation of soot in furnace when firing on oil.	• Oil nozzle needs cleaning. • Fuel-air ratio is set too fuel rich. • Atomizing air pressure too low. • Spray angle of nozzle not correct for furnace.
Oil pressure is uncontrollably high @ light-off	• Cold oil is plugging oil nozzle. Check for proper operation of the nozzle purge solenoid and check valves.

GAS SYSTEMS STARTUP

GAS TRAIN INSTALLATION

SELECTION & SIZING

Gas trains are selected according to local code & insurance requirements. Components are sized according to available gas supply pressure, burner capacity, and furnace pressure. As a guide standard sizes are listed in the catalog bulletin along with the required outlet pressure of the main pressure regulator. Installation manuals for each job include drawings of the gas train furnished with the burner system.

LOCATION

Gas trains should be located as close to the burner assembly as possible, preferably on the left side of the burner to facilitate easy connection to the gas control valve. Temperature limitations of all the components should be taken into account when mounting directly on the heating appliance. (Refer to the specifications and installation instructions furnished with the operating manual).

FIELD PIPING

The piping should contain as few direction changes as possible between the main pressure regulator and the burner inlet to minimize the pressure drop. Proper sizing of components often results in a main pressure regulator with a smaller pipe size than the shut-off valves; this transition in pipe size should be made with a "bell type" reducer at least 4 pipe diameters downstream of the regulator outlet. Gas shut-off valves and regulators are all uni-directional and must be installed accordingly. Gas train assembly drawings are provided in the installation & operating manual with each system.

VENT CONNECTIONS

Gas train assemblies to meet IRI code, and all gas trains for capacities greater than 12500 MBTU/HR, include a N.O. vent valve for installation between the (2) shut-off valves. This valve should be installed in a horizontal run of piping with the solenoid coil on the top. The pipe size of the vent line must be no smaller than the valve furnished with the burner system. Vent connections from all pressure regulators and pressure switches should also be vented to the outside of the building using 1/4" OD tubing as a minimum and may be manifolded together but the size of the common vent line must be at least equal in area to the largest vent plus 50% of the area of the remaining vent lines. The vent line from the N.O. vent valve must be run separately.

WARNING:
All piping and gas train components must be leak tested prior to the initial start up of the burner system. The manual gas cock installed downstream of the shut-off valves is provided for this testing. Gas shut-off valves should be leak tested periodically to insure there is no leakage through the valve seats. It is recommended this leak testing be performed monthly.

MAIN GAS ADJUSTMENT

WARNING: Before proceeding with the main fuel/air adjustment, all appropriate PREFIRING CHECKOUTS must be performed. Also insure that all linkages move smoothly without binding and are properly set to provide for the minimum positions of both the air shutter and fuel valve at low fire. Make sure all connectors are tight.

A pilot turndown test must be performed according to the flame safeguard manufacturer's instructions provided with this burner system. This test must ensure that the main burner flame can be smoothly ignited with the smallest flame that can be detected by the flame detector. The orientation of the flame detector can be changed if necessary by readjusting its swivel mount. A spark pickup test should also be conducted to ensure that UV radiation from the ignition spark is not being detected whenever a UV flame detector is in use. Please refer the manufacturer's instructions.

The use of the "test/run" switch on the flame safeguard programmer, and the manual firing rate potentiometer, is recommended to facilitate main fuel/air adjustment. Before attempting main fuel/air adjustment insure that the system is in the low-fire, manual mode.

Flue gas constituents should be analyzed at all firing rates to optimize the levels of O2 & CO2 and insure that the level of CO is not excessive. The exact percentage of these constituents can vary according to the application but O2 levels will typically be 6-8% @ low fire and gradually decrease to 3-4% @ high fire. The required low fire adjustment is often affected by the combustion chamber size, with smaller chambers requiring more air to achieve proper flame geometry. If precise fuel/air ratios are required, or if acceptable levels are difficult to achieve due to application variables, a gas control valve with an adjustable characteristic cam must be considered.

If an adjustable characteristic cam is not used, the fuel/air ratio is determined merely by the low and high fire setting of the gas butterfly valve and the position of the valve crankarm relative to the position of the jackshaft crankarm. The effect of changing these relative positions is shown under GAS VALVE LINKAGE ADJUSTMENT.

Manifold gas pressure should be measured and recorders using a manometer connected to the test port located between the gas control valve and the burner inlet. The gas pressure at minimum fire will be negligible and difficult to read; for this reason the fuel/air adjustment is best accomplished by sight and flue product analysis. High fire manifold pressures to achieve the nominal burner capacity (i.e. 250HP for size 250), and the maximum cataloged capacities are listed under GAS PRESSURE SETTINGS in the proceeding section.

Burners designed to burn fuel other than natural gas will typically be constructed with different gas jet porting and will require manifold pressures similar to those previously listed for natural gas. All burners with special configurations will have the proper high fire manifold pressure stamped on the burner nameplate.

Gas combustion in a confined combustion chamber with a small cross-sectional area can result in combustion harmonics especially if the length to diameter ratio of the chamber is large. Model FD68 burners are designed to eliminate this problem for most applications, however if this problem occurs the following corrective steps should be attempted in the order listed:

1. An adjustable characteristic gas valve cam should be used.
2. The fuel/air ratio must be changed to compensate.
3. The jackshaft and valve crank positions must be changed.
4. The position of the air rotation blades on the firing head must be changed.
5. The position of the air band around the gas jet plenum should be changed.
6. Some of the inner gas jets should be plugged and the manifold pressure increased.

GAS PRESSURE SETTINGS: SIZE 50 TO 625

The following tables should be used as a guide to setting the high fire gas manifold pressure for sea level operation. The pressures listed for the nominal burner capacity are those required when firing against the furnace pressure listed. The maximum capacities & manifold pressures listed are for firing against a balanced furnace pressure. Manifold pressures for firing into higher furnace pressures can be closely estimated by adding 60 to 65% of the additional furnace pressure to the manifold pressure listed.

Final fuel/air adjustments should be made by flue gas analysis.

NATURAL GAS MANIFOLD PRESSURE:

TABLE A: STANDARD MODELS OPERATING @ 60 HZ

BURNER SIZE	50	75	100	125	150	200	250	300	400	500	625
Nominal MBTU/Hr	2,100	3,150	4,200	5,250	6,300	8,400	10,500	12,600	16,800	21,000	26,250
Manifold Pressure Inches w.c.	2.7	4.5	6.8	8.0	7.8	8.5	11.1	7.7	8.7	10.9	12.8
Furnace Pressure Inches w.c.	.75	.75	1.0	1.0	1.5	2.0	2.0	3.0	4.0	4.0	4.0
Maximum MBTU/Hr	2,500	3,750	5,100	5,600	7,500	10,050	11,200	15,000	20,250	25,200	31,500
Manifold Pressure Inches w.c.	3.0	5.1	7.5	8.4	9.2	10.4	11.3	7.6	9.0	11.3	15.0

TABLE B: STANDARD MODELS OPERATING @ 50 HZ

BURNER SIZE	50	75	100	125	150	200	250	300	400	500	625
Nominal kcal/Hr	240	506	730	890	945	1,540	1,835	2,730	3,935	4,640	6,435
Manifold Pressure mmAq	45	68	107	116	89	130	155	135	170	188	285
Furnace Pressure mmAq	50	50	50	50	50	50	50	50	50	50	50
Maximum kcal/Hr	515	650	1,055	1,160	1,555	2,085	2,320	3,110	4,200	5,225	6,535
Manifold Pressure mmAq	52	63	158	146	160	182	197	133	160	200	262

TABLE C: BELT-DRIVE MODELS (-BD) OPERATING @ 50 HZ

BURNER SIZE	100	125	150	200	250	300	350	400	500	600	700
Nominal kcal/Hr	1,045	1,230	1,500	2,100	2,700	3,440	4,200	4,870	5,820	7,225	8,000
Manifold Pressure mmAq	205	215	130	175	310	230	210	260	315	365	440
Furnace Pressure mmAq	50	50	50	50	50	50	50	50	50	50	50
Maximum kcal/Hr	1,275	1,400	1,875	2,510	3,050	3,750	4,510	5,150	6,250	7,800	8,450
Manifold Pressure mmAq	190	213	156	205	350	237	208	257	328	390	455

GAS PRESSURE SETTINGS: SIZE 800 to 1200

The following tables should be used as a guide to setting the high fire gas manifold pressure for sea level operation. The manifold pressures and capacities listed are the maximum obtainable for the corresponding furnace pressure. Manifold pressures for firing into higher furnace pressures can be closely estimated by adding 60-65% of the additional furnace pressure to the manifold pressure listed.

Final fuel/air adjustments should be made by flue gas analysis.

NAT GAS MANIFOLD PRESSURE @ 0.0" FURNACE PRESSURE

		Hi-Vee Gas Spuds				Whistlejet Spuds			
Nom. Boiler HP		**550**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**
Nominal MBTU/Hr		23,100	25,200	29,400	33,600	37,800	42,000	46,200	50,400
Outer Spud Orifice		0.25	0.25	0.25	0.30				
Manifold Pressure Requirements compared to furnace pressure	0.0" w.c.	11.8	14.1	19.1	15.1	10.5	13.0	15.7	18.7
	1.0" w.c.	12.5	14.8	19.8	15.8	11.2	13.7	16.4	19.4
	2.0" w.c.	13.1	15.4	20.4	16.4	11.8	14.3	17.0	20.0
	3.0" w.c.	13.8	16.1	21.1	17.1	12.5	15.0	17.7	20.7
	4.0" w.c.	14.4	16.7	21.7	17.7	13.1	15.6	18.3	21.3

SIZE 1000 NAT GAS MANIFOLD PRESSURE SETTINGS WITH VARIOUS FURNACE PRESSURE

TABLE A: STANDARD MODELS OPERATING @ 60 HZ

Furnace Pressure Inches w.c.	0.0	1.0	2.0	3.0	4.0	5.0	7.0
Max Capacity MBTU/Hr	42,000	39,350	37,255	35,700	33,900	32,200	29,800
Manifold Pressure Inches w.c.	13.0	13.6	14.2	14.9	15.5	16.2	17.4

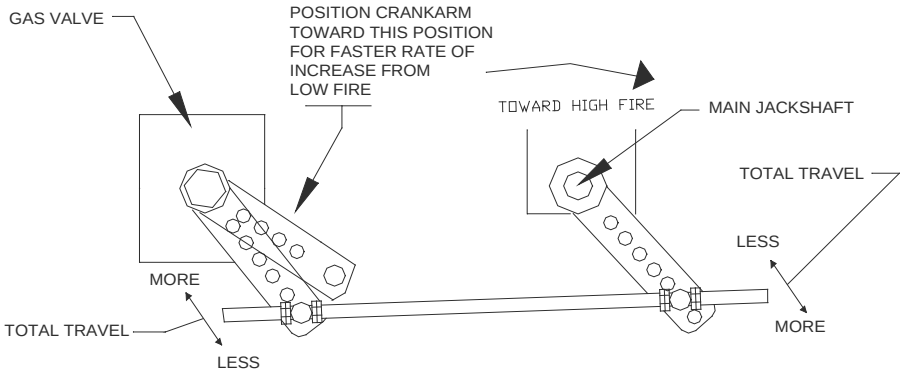
TABLE B: STANDARD MODELS OPERATING @ 50 HZ

Furnace Pressure mmAq	0	25	50	75	100	125
Max Capacity x1000 kcal/Hr	8715	7875	7430	6850	6475	6140
Manifold Pressure mmAq	13.0	13.6	14.2	14.9	15.5	16.2

Burners ordered specifically for firing with a fuel gas other than natural gas can be furnished with special orifices in the gas spuds which will result in manifold pressures different from those listed above.

GAS VALVE LINKAGE ADJUSTMENT

The following changes can be made to increase or decrease the rate of gas valve travel at low or high fire:

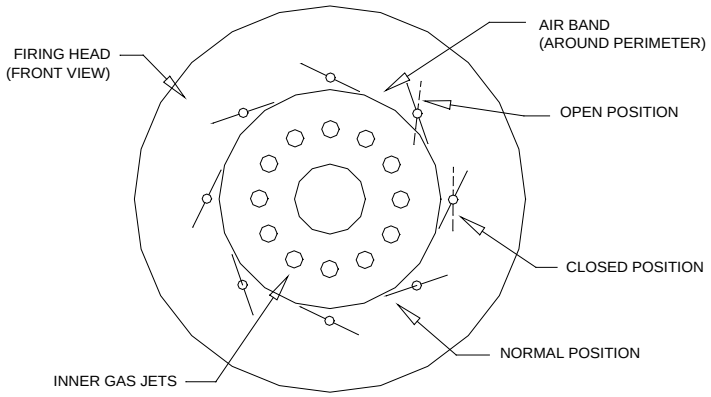


SIZE 50 - 250 SHOWN @ LOW FIRE

(JACKSHAFT ON LARGER SIZES
ROTATES IN OPPOSITE DIRECTION)

AIR ROTATION BLADE & AIR BAND SETTINGS

The air rotation blades may be changed as shown. It must be kept in mind that combination gas/oil burners will probably require a normal to open setting of these blades for oil firing. The air band (if supplied) may also be repositioned to change the amount of air introduced to the gas jet plenum.



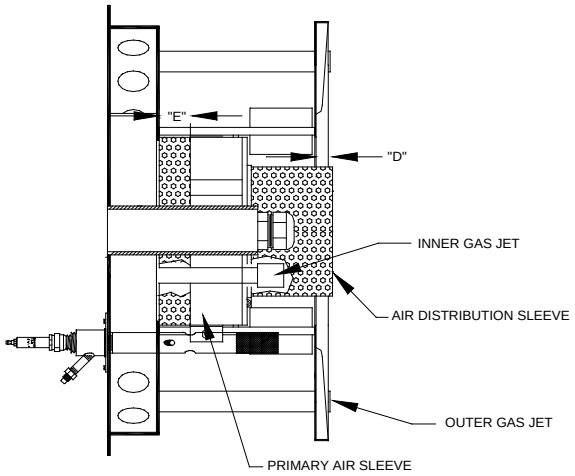
SIZE 1000 GAS FIRING HEAD CONFIGURATION

AIR ROTATION BLADE SETTINGS

The air rotation blades are factory set so that a straight edge place on the blades will be tangent with the primary sleeve on the firing head. Rotating the blades further open will result in more air being delivered into the center of the flame. Closing the blades will force more air toward the outside of the flame and will result in more rotation to the flame. Oil fired systems will generally require the blades to be open at least as far as the factory setting. The shaft of the blades should be facing toward the center of the firing head for lowest emissions.

PRIMARY AIR SLEEVE

The percentage of laminar air flow through the center of the air diffuser can be controlled with the setting of the primary air sleeve. The primary air opening "E" is factory set at the maximum opening. In general the primary air opening should be set for its maximum value particularly on oil fired systems.



AIR DISTRIBUTION SLEEVE

The air distribution sleeve is only furnished with gas only, LE-series firing heads. It controls the flow of air through the center of the diffuser. The dimension "D" is factory set at 5/8" but this dimension can be increased if lower NOx levels are required. The sleeve will result in a slower mixing flame when firing with oil and can be removed if a faster mixing oil fire, with more rotation, is required when firing in relatively small combustion chambers.

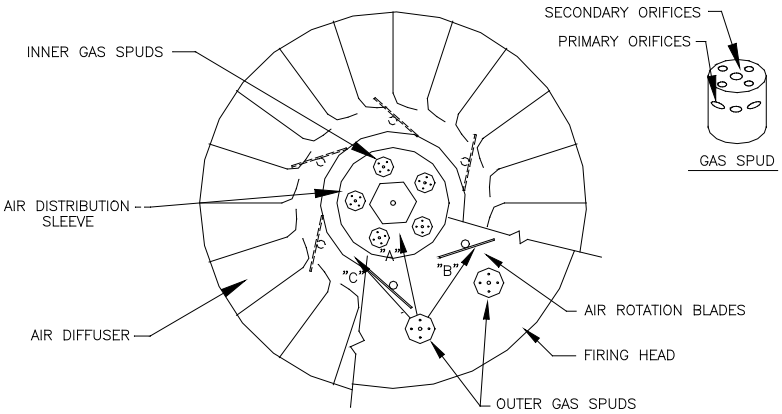
LE94 FIRING HEAD CONFIGURATION

The Series LE firing head design incorporates several features which enable field adjustment to change the rate of fuel/air mixing, flame geometry, and emission levels. Most installations will not require any changes from the factory settings as described below. In general NOx levels will decrease as more fuel is added to the outside of the flame. More gas can be directed to the outside of the flame until an unstable non-combustible, mixture is obtained in the center of the flame. Instability is usually only a limiting factor when firing into small diameter firetube boilers.

GAS SPUD ROTATION

The flame geometry and emission levels are affected by the direction at which the primary fuel gas is injected into the combustion air stream. The direction of the gas flow from the primary gas orifices of the outer spuds can be changed by rotating the spuds. The center orifice is factory set in position "A", directed toward the center of the firing head. Rotating in the direction of position "B" will result in more fuel being delivered to the outside of

the flame. Rotating toward position "C", against the flow of air through the diffuser louvers, will also result in faster mixing but generally is not recommended because of the generation of higher levels of CO and NOx.



FRONT VIEW

PRIMARY/SECONDARY GAS SPUD ORIFICES

For natural gas, two of the three primary gas orifices are plugged at the factory. If more fuel is desired in the center of the flame, one or both of the primary orifice plugs can be removed. The center secondary orifice, on the face of the spud, may also be plugged resulting in less fuel being delivered to the outside of the flame. Lower NOx emissions are generally achieved with two of the primary orifices open, and all five of the secondary orifices open. Orifice configuration will vary for fuels other than natural gas.

OIL SYSTEM STARTUP: PRESSURE ATOMIZED MODEL P-LM

Refer to general pre-firing checkout of the burner & controls.

Refer to all preceding sections including combustion air and IGNITION SYSTEM adjustments.

Refer to all manufactures' components instruction manuals.

INITIAL MAIN BURNER ADJUSTMENT

Please refer to each manufacturer's manual for system components prior to making any adjustments to the burner.

Prime the suction line to the pump by filling the suction line strainer with oil prior to checking for proper rotation of the pump. If supply pressure is not developed shortly after starting the pump, check for improper or loose connections in the suction line, or improper pump rotation. Prolonged operation without a proper prime will cause damage to the pump.

Modulating pressure atomizing systems utilize a return-flow nozzle with a constant oil supply pressure and a variable return flow pressure. The return flow pressure is determined by the position of the oil metering valve located in the oil return line on the left front of the burner. Refer to OIL SYSTEM SETTINGS for nominal supply and return pressures and valve settings, OIL PIPING SCHEMATIC, and METERING VALVE SETTINGS for linkage adjustments. The settings listed should be used as a guide for initial firing with final adjustments made according to the results of a flue gas analysis. Typical O2 readings are 3 - 4 % @ high fire and 6 - 8 % @ low fire. A smoke reading should also be taken to insure proper adjustment and good atomization or the oil.

The presence of white smoke indicates too little oil which normally can be eliminated by changing the position of the metering valve to a lower number on the index plate. Black smoke indicates too much oil and the need to change the metering valve to a higher numbered setting. If either of these conditions exists at one end of the firing range, but not the other, the rate of travel of the metering valve will have to be changed by changing the position of the valve crank arm relative to the position of the crank arm on the jackshaft.

Check for a dirty or clogged oil nozzle when experiencing difficulty obtaining proper combustion or recommended return oil pressures. If proper supply pressure cannot be obtained, check for restrictions in the oil suction line, especially the oil strainer.

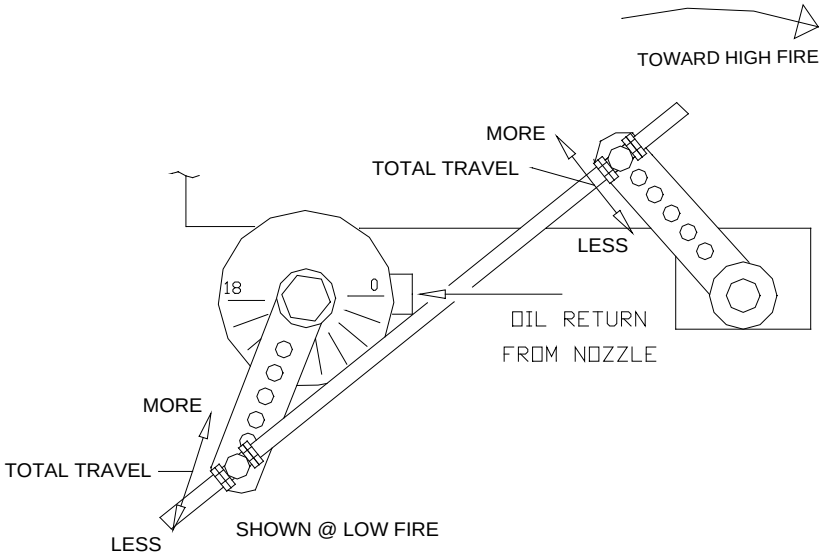
After making final adjustments check tightness of all linkage connections and ensure there is no binding of linkages during travel between maximum and minimum positions. Record all pressures and valve settings for future reference.

CAUTION: The system must be checked for smooth and reliable ignition of the main flame after main burner adjustments are made. All safety related controls must also be checked for proper, and safe operation.

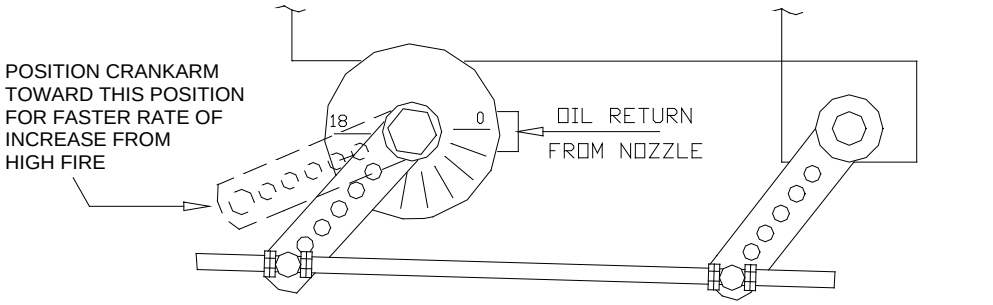
METERING VALVE LINKAGE SETTINGS

Typical linkage and crankarm arrangements for the oil metering valve are shown below for the different sizes of pressure atomized oil burners

The alternate positions of the crankarm, and the different locations of the linkage swivels, are shown as an aid to properly set the rate of fuel increase to match the rate of air increase when the burner modulates between low & high fire. The alternate positions apply to all burner sizes.



SIZE 50 - 250



SIZE 300 & UP

MODEL P-LM OIL SYSTEM SETTINGS: 60 Hz OPERATION

BURNER SIZE	DELAVAN VARIFLO NOZZLE QTY (4)	METERING VALVE SIZE	VALVE POSITION		SUPPLY PRESSURE PSIG	RETURN PRESSURE PSIG		FIRING RATE GPH	
			HIGH	LOW		HIGH	LOW	HIGH	LOW
50	2.5 x 60	S3-5	0	6	275	130	65	15	8
75	3.5 x 60	S3-5	0	9	260	130	70	23	9
100	4.5 x 60	S3-5	0	7.5	275	138	70	30	10
125	5.5 x 60	S3-7	0	6	275	130	65	38	12
150	7.0 x 80	S3-9	0	8	260	135	65	45	15
200	9.0 x 80	S3-9	0	9	275	118	65	60	20
250	10.0 x 80	S3-11	0	8	300	161	70	75	24
300	12.0 x 80	S3-13	0	8	300	155	90	90	30

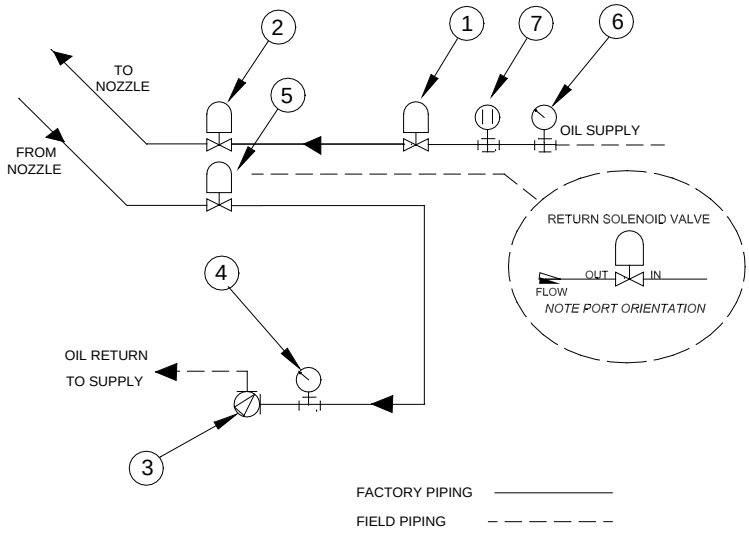
Maximum capacity listed is @ sea level firing against furnace pressures no greater than:+0.75"wc for sizes 50 & 75, +1.0"wc for sizes 100 & 125, +1.5"wc for size 150, +2.0 "wc for sizes 200 & 250, +3.0"wc for size 300.

Metering valve settings and return flow pressures are those recommended for initial adjustment. Final settings are to be made according to operating conditions and flue gas analysis.

OIL PUMP SPECIFICATIONS: 60 Hz OPERATION

BURNER SIZE	PUMP SIZE	HP	RPM	GPH
50-150	V024D	3/4	1725	110
200-250	V026D	1	1725	155
300	V024D	1.5	3450	240

OIL PIPING SCHEMATIC: 60 HZ OPERATION



COMPONENTS

1 & 2	SOLENOID VALVE
3	OIL METERING VALVE
4	OIL RETURN PRESSURE GAUGE
5	OIL RETURN SOLENOID VALVE
6	OIL SUPPLY PRESSURE GAUGE
7	OIL PRESSURE SWITCH (OPTIONAL)

MODEL P-LM OIL SYSTEM SETTINGS: 50 Hz OPERATION

BURNER SIZE	DELAVAN VARIFLO NOZZLE QTY (4)	METERING VALVE SIZE	VALVE POSITION		SUPPLY PRESSURE PSIG	RETURN PRESSURE PSIG		FIRING RATE kg/Hr	
			HIGH	LOW		HIGH	LOW	HIGH	LOW
100	3.5 x 60	S3-5	0	9	260(267)	130	70	79	26
125	4.5 x 60	S3-7	0	7	275(292)	138	70	98	32
150	5.5 x 80	S3-7	0	6	275(292)	130	65	124	38
200	7.0 x 80	S3-9	0	8	260(262)	135	65	146	49
250	9.0 x 80	S3-9	0	9	275(278)	118	65	195	64
300	10.0 x 80	S3-11	0	8	295(300)	161	70	244	81
300-SP	12.0 x 80	S3-11	0	8	293(300)	155	90	293	97

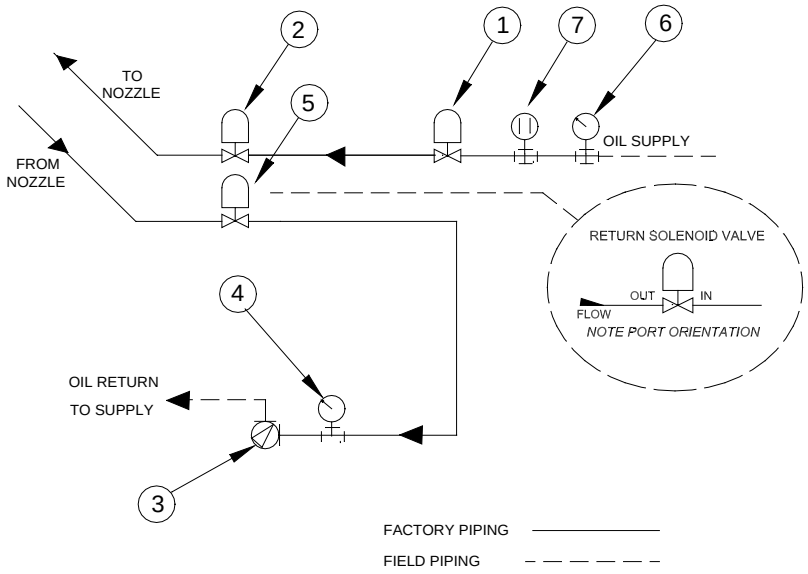
Maximum capacity listed is @ sea level firing against furnace pressures no greater than:+20mm Aq for sizes 50 & 75, +25mm Aq for sizes 100 & 125, +38mm Aq for size 150, +50mm Aq for sizes 200 & 250, +75mm Aq for size 300.

Metering valve settings and return flow pressures are those recommended for initial adjustment. Final settings are to be made according to operating conditions and flue gas analysis. The oil supply pressure listed in parenthesis is the pump pressure; the lower pressure is the actual pressure @ the oil nozzles.

OIL PUMP SPECIFICATIONS: 50Hz OPERATION

BURNER SIZE	PUMP SIZE	HP	RPM	LPH
100-200	V024D	3/4	1425	360
250-300	V026D	1	1425	470
300-SP	V024D	1	2850	725

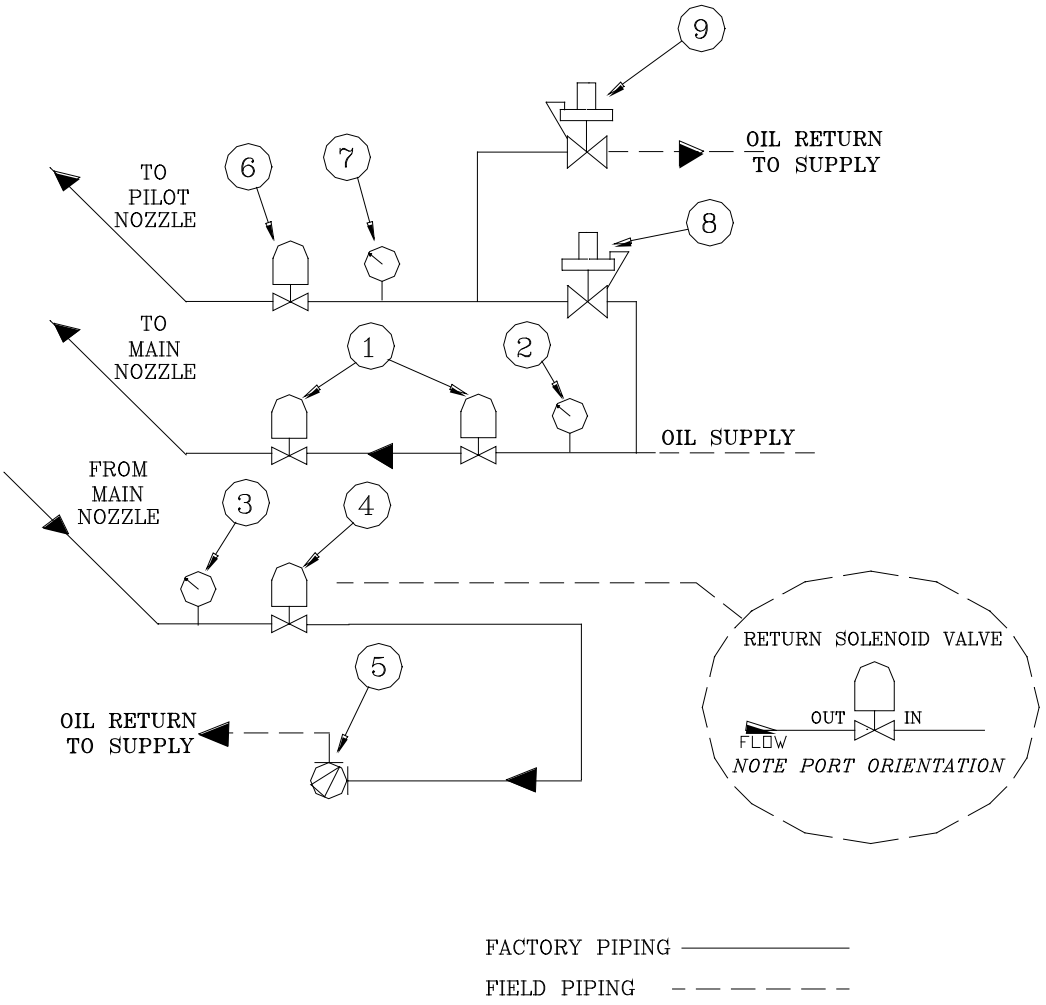
OIL PIPING SCHEMATIC: 50 HZ OPERATION



COMPONENTS

1 & 2	SOLENOID VALVE
3	OIL METERING VALVE
4	OIL RETURN PRESSURE GAUGE
5	OIL RETURN SOLENOID VALVE
6	OIL SUPPLY PRESSURE GAUGE
7	OIL PRESSURE SWITCH (OPTIONAL)

OIL PIPING SCHEMATIC: OPTIONAL DIESEL/ELECTRIC PILOT SCHEMATIC



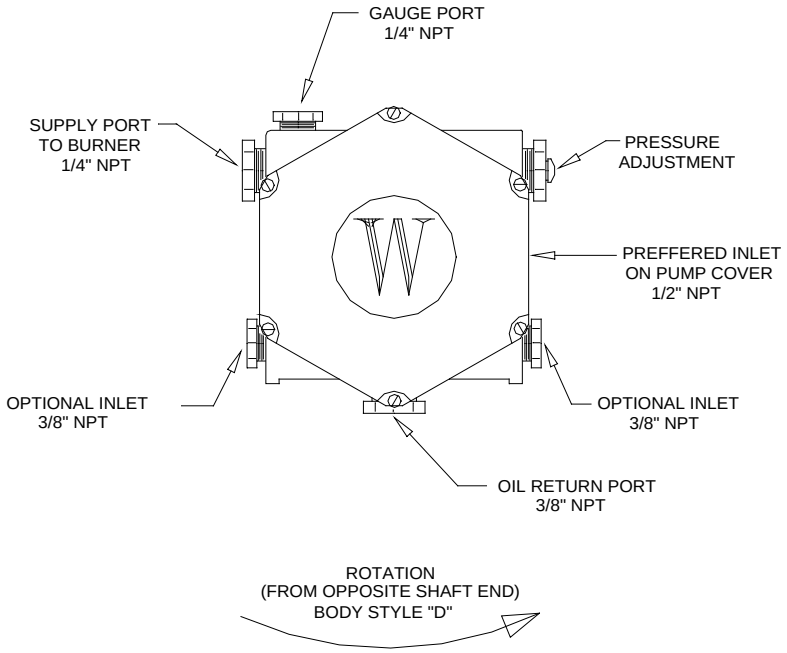
COMPONENTS

1. OIL SOLENOID VALVES (2)
2. MAIN OIL SUPPLY PRESSURE GAUGE
3. MAIN OIL RETURN PRESSURE GAUGE
4. PILOT SOLENOID VALVE
5. OIL METERING VALVE
6. PILOT OIL SOLENOID VALVE
7. PILOT OIL PRESSURE GAUGE
8. MAIN OIL BACKPRESSURE REGULATOR
9. PILOT OIL BACKPRESSURE REGULATOR

REMOTE OIL PUMP INSTALLATION

All FD68 pressure atomizing oil burners are furnished with a separate pump set mounted on a steel base for remote mounting. The pump requires a two-pipe system. Pump warranty will be voided if a one-pipe system is utilized.

The following drawing shows the available piping connections on the pump and the table indicates the recommended suction line sizing for various conditions. Contact the factory for installations involving suction lift greater than that listed in the table.



LIFT	Suction Pipe Size			
	Length: 25 ft	50 ft	75 ft	100 ft
5 ft	½"	½"	½"	½"
10 ft	½"	¾"	¾"	¾"
13 ft	¾"	¾"	1"	1"

The burner supply and oil return line sizes can be one pipe size smaller than the suction line size.

All pump installations must utilize a proper oil filter, such as a cartridge type, or 100 mesh basket strainer. Failure to install a proper suction filter may result in damage to the pump and void the warranty. The oil filter and suction line must be sized so as not to exceed 10" Hg vacuum (suction) at the oil pump suction port.

A fusible link valve and/or an overhead anti-siphon valve should be used as applicable by local code.

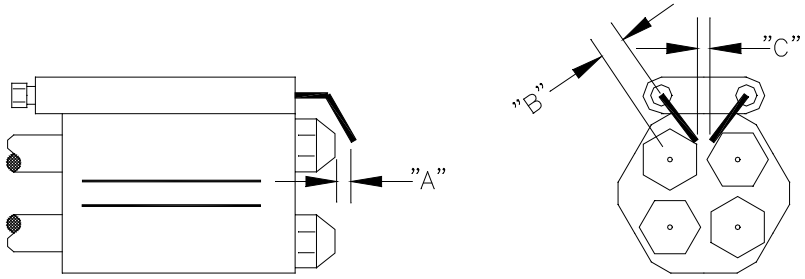
WARNING!
DO NOT use Teflon tape. Use of Teflon tape will void pump warranty.

DIRECT-SPARK IGNITION SYSTEM SETTINGS

Model FD68 pressure atomized light oil burners arranged for direct-spark ignition of the main flame have a dual-electrode ignition assembly fastened directly to the nozzle body. The nozzle body, nozzles, & ignition components can be easily removed from the firing head as one assembly for inspection, electrode setting or nozzle cleaning/replacement.

If it is necessary to remove the oil nozzles from the body it is recommended to first remove the ignition electrode assembly from the body to avoid disrupting the electrode setting and then re-fastening the ignition assembly to the body in the correct position after replacing the nozzles.

The correct electrode settings are as follows:



DIMENSIONS, mm (in)

BURNER SIZE	NOZZLE SPRAY ANGLE	A	B	C
50 - 125	60	4.8 - 6.4 (3/16 - 1/4)	7.9 - 9.5 (5/16 - 3/8)	4.0 -4.8 (5/32 - 3/16)
150 - 250	80	3.2 - 4.8 (1/8 - 3/16)	9.5 - 11.1 (3/8 - 7/16)	4.0 -4.8 (5/32 - 3/16)
300 - 300SP	80	3.2 - 4.8 (1/8 - 3/16)	9.5 - 11.1 (3/8 - 7/16)	4.0 -4.8 (5/32 - 3/16)

CAUTION:
It is imperative to insure that the low fire settings for the metering valve position, supply pressure, and return pressure shown in OIL SYSTEM SETTINGS are not exceeded for reliable and safe light-off.

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OIL SYSTEM STARTUP: AIR ATOMIZED OIL SYSTEMS MODELS A-LM, A-MM, A-HM

Refer to pre-firing check-out.

Refer to air shutter & pilot adjustment.

Refer to all manufactures' component instruction manuals.

Final air and oil adjustments should be made by analyzing the flue gas. Optimum CO2 readings will vary according to oil being burned, but O2 readings should be approximately 3-4% @ high fire and 5-7% @ low fire. These settings generally will result in a turndown ratio of 5:1; a larger turndown can be achieved with higher O2 readings @ low fire.

CAUTION: After adjustments are completed all safety related controls, including the flame safeguard programmer, temperature or pressure limit controls, and blower air & atomizing air pressure switches must be tested for proper operation by deliberately simulating component failure and/or changing the setting of the temperature and pressure limit controls to force safety shut-down of the burner system.

INITIAL MAIN BURNER ADJUSTMENTS

Refer to the PIPING DIAGRAM for -LM, -MM, or -HM burners respectively.

Preliminary settings should include:

Atomizing air pressure setting:	8 - 10 psig (at low fire).
Oil pressure switch setting	10 psig less than oil supply pressure.
Oil backpressure valve (A-HM burners):	10 - 12 psig (at low fire).
Low oil temp. switch (A-MM &-HM burners):	10 degrees less than proper atom. temp.
Oil heater thermostat (A-MM & -HM burners):	Set for proper oil atomizing temp.

Optimum atomizing temperature for the oil can very considerably but the following recommendations can be used as a guide to obtain the required 100 - 150 SSU viscosity at the nozzle:

Grade of Oil	Oil Atomizing Temperature (Degrees F)		
	Minimum	Typical	Max
#4	70 F	110 F	135 F
#5	130 F	150 F	175 F
#6	185 F	210 F	240 F

Improper atomization and high smoke readings will result if the oil temperature is too low and unstable, pulsating combustion will result from too high of an atomizing temperature. Model A-HM burners with (2) oil heaters should have the thermostats set at slightly different temperatures to avoid having both heaters cycle simultaneously causing wide swings in temperature.

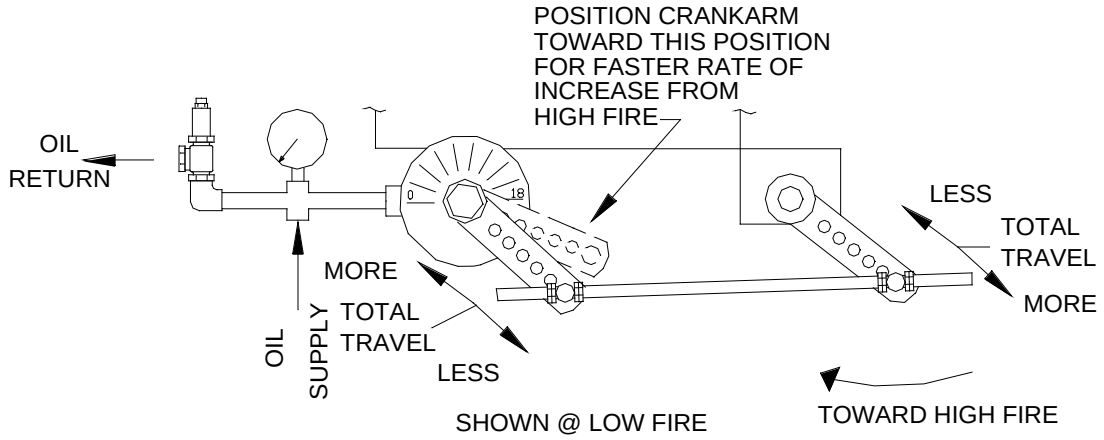
The oil delivery rate to the burner is determined by the oil metering valve position and the oil supply pressure to the inlet of the metering valve. Higher numbered positions on the metering valve and/or a higher supply pressure will result in a greater oil delivery rate.

The oil supply pressure is set by adjusting the backpressure regulating valve, which is located on the left-front of the burner assembly (right rear on sizes 800 and larger) between the oil supply and oil return connections. The optimum oil supply pressure setting will depend on the viscosity of oil at the burner inlet and other operating parameters such as furnace pressure, altitude, and desired firing rates.

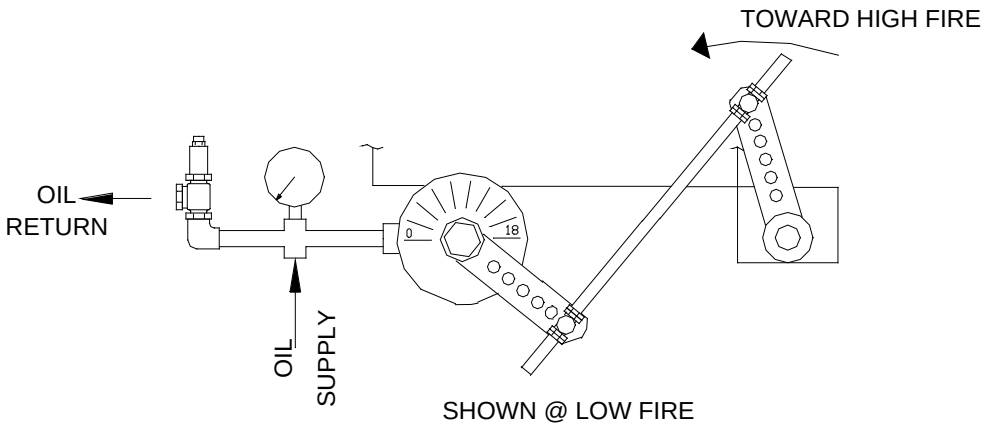
HAUCK FIXED GRADIENT OIL METERING VALVES

Oil metering valves are factory set to travel between the minimum and maximum positions indicated on the OIL SYSTEMS SETTING page for the respective burner model. The linkage to the metering valve can be adjusted to change the minimum or maximum firing rate, or to change the rate of increase of the oil flow from minimum to maximum.

Typical linkage and crank arm arrangements for the oil metering valve are shown below for the different sizes of air atomized oil burners when the optional adjustable characteristic cam is not used. The alternate positions of the crank arm, and the different locations of the linkage connectors, are shown as an aid to properly set the rate of fuel increase to match the rate of air increase when the burner modulates between low & high fire. The alternate positions apply to all burner sizes.



SIZE 50 – 250



SIZE 300 & UP

MAXON ADJUSTABLE GRADIENT OIL METERING VALVES

The linkage should be set to allow for full travel of the valve quadrant. The cover plate on the quadrant needs to be removed to allow access to the adjusting screws which are not factory set. Field adjustment of this valve is required. Turning the adjusting screws in (clockwise) will result in a higher fuel flow at that specific valve position.

Proper adjustment will result in each screw being slightly further in than the lower numbered screw adjacent to it. The highest numbered screw should not be in further than the face of the casting. If more fuel flow is needed with a maximum adjustment of the screw then the oil supply pressure should be increased.

Refer to the manufacturer's instruction manual for additional operating and maintenance procedures.

OPTIONAL ELECTRONIC METERING SYSTEM

Refer to OIL, AIR AND PUMP ARMATURE VOLTAGE SETTINGS for -LM, -MM, or -HM respectively.

Refer to the OIL PIPING DIAGRAM for -LM, -MM, or -HM with ELECTRONIC OIL METERING SYSTEM respectively.

The oil return line on the right side of the burner includes a backpressure regulating valve which should initially be set to provide 10 to 11 psig oil pressure at the nozzle pressure gauge in the low fire position during pre-purge. After final burner adjustment this pressure should be set to equal the low fire oil pressure.

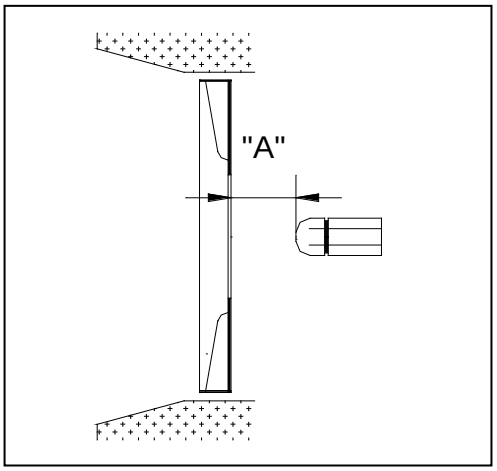
Initial temperature & pressure switch settings should be made as indicated for the oil metering valve system. All other adjustments should be made according to the ELECTRONIC OIL METERING SYSTEM INSTRUCTIONS in the proceeding section.

AIR ATOMIZING OIL NOZZLE SPECIFICATIONS

Note: The C169WA nozzle supplied with the burner is specially designed for S.T. Johnson Co. Other C169WA variants can cause smoke, sooting and carbon formation. To avoid costly problems, it is recommended that you purchase all replacement nozzles directly from S.T. Johnson, or your S.T. Johnson distributor.

NOZZLE POSITIONING

The position of the oil nozzle relative to the air diffuser is shown below.



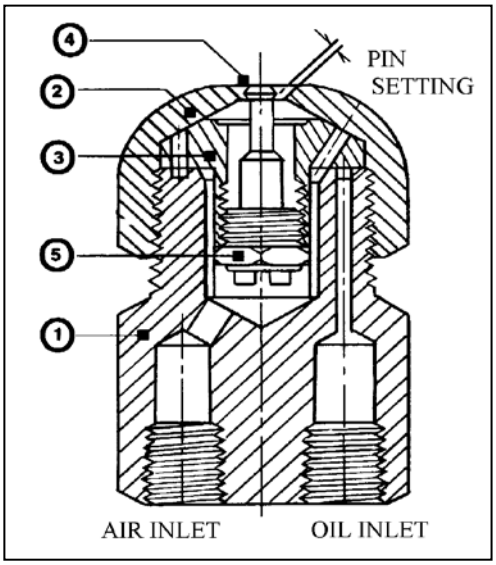
Burner Size	A
50 - 125	1.125” / 29mm
150 - 250	1.25” / 32mm
300 - 1000	1.5” / 38mm

NOZZLE PIN SETTING

Proper nozzle pin setting is critical to obtaining proper atomization. Correct settings for each nozzle size are shown below.

NOZZLE COMPONENTS

1. Body
2. Tip
3. Disc
4. Metering pin
5. Locknut



NOZZLE SIZE	PIN SETTING
30, 40	0.030” (0.762 mm)
50, 60, 80	0.040” (1.016 mm)
100	0.050” (1.270 mm)
125, 150, 200, 250,300, 350	0.062” (1.575 mm)

MODEL A-LM OIL SYSTEM SETTINGS

60 HZ OPERATION

BURNER SIZE			50	75	100	125	150	200	250	300	350	400	450	500	625
FIRING RATE	MAX	GPH*	18.2	26.6	36.4	40.0	53.5	72	80	107	119	144	155	180	224
	NOM	GPH*	15.0	22.5	30.0	37.5	45.0	60	75	90	105	120	135	150	188
	FURN. PRESS. "W.C.		0.75	0.75	1.0	1.0	1.5	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0
	MIN	GPH	7	7	8	9	9	12	15	18	18	24	24	30	37
NOZZLE SIZE		GPH	30	30	40	40	60	60	80	100	125	150	150	200	250
C169WA		ANGLE	50	50	50	50	70	70	70	70	70	70	70	70	70
NOZZLE PRESSURE,	AIR	MAX	20	22	21	22	20	23	20	22	17	20	24	21	23
		NOM	17	22	21	22	20	20	20	22	16	19	21	19	21
@ HIGH FIRE	OIL	MAX	22	28	28	32	28	36	30	33	25	31	37	28	29
		NOM	17	26	26	30	26	30	29	30	21	25	28	24	26
CONTROL VALVE SIZE			S3-5	S3-7	S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16
CONTROL VALVE SETTING	MAX		16	10	15	15	15	15	15	15	15	15	15	15	15
	MIN		10	4	4.5	4.5	3.5	3	3	3	3	3	3	3	3
OIL SUPPLY SETTING** PSI		MAX	55	50	54	62	60	74	56	59	58	50	58	56	71
		NOM	34	42	44	57	41	56	52	49	46	39	44	44	55
OIL PUMP SIZE			0LE	0LE	0LE	0LE	0LE	0LE	1LE	1LE	1LE	2LE	2LE	2LE	2LE
RATING (GPH)			78	78	78	78	78	78	144	144	144	276	276	276	276

*The max firing rate listed is the maximum recommended with a balanced, or negative, furnace pressure. The nominal firing rate listed is the maximum recommended when firing against the furnace pressure listed. Reduced firing rates will result in reduced air and oil supply pressure settings. Rates based on grade #2 fuel oil @ 140,000 BTU/GAL.

The nozzle pressures listed are those recommended for most applications. The same firing rates can be obtained by either raising or lowering both the air & oil pressures. The flame geometry will be affected by the nozzle pressure with slower mixing, wider flames resulting from lower pressures.

**Recommended oil supply pressure settings are typical for the maximum firing with grade #2 fuel oil @ 40 SSU. Final settings will vary according to the furnace pressure, desired firing rate, and oil viscosity; The optimum setting is determined by flue gas analysis.

50 HZ DIRECT-DRIVE OPERATION (EXPORT)

BURNER SIZE			100	125	150	200	250	300	300SP	400	400SP	500	500SP	625	1000
FIRING RATE	**MAX**	**GPH***	27	32	41	57	64	85	95	115	127	139	168	180	240
		KGH*	88	*104*	*134*	*186*	*208*	*277*	*309*	*375*	*414*	*453*	*547*	*586*	*782*
	MIN	**GPH***	8	9	10	11	12	16	18	21	24	26	31	34	42
		KGH*	*26*	*29*	*33*	*36*	*39*	*52*	*59*	*68*	*78*	*85*	*100*	*111*	*137*
NOZZLE SIZE		**GPH**	40	40	40	60	60	100	125	125	150	150	200	250	250
		ANGLE	50	50	70	70	70	70	70	70	70	70	70	70	70
NOZZLE PRESSURE @ HIGH FIRE	**AIR**	**PSI**	15	20	20	19	21	23	20	17	20	22	20	21	23
		Kg/CM^2	1.05	1.41	1.41	1.34	1.48	1.62	1.41	1.20	1.41	1.55	1.41	1.48	1.62
	OIL	**PSI**	23	26	31	28	35	33	29	22	26	29	26	26	29
		Kg/CM^2	1.62	1.83	2.18	1.97	2.46	2.32	2.04	1.55	1.83	2.04	1.83	1.83	2.04
CONTROL VALVE SIZE			S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16	½-O
CONTROL VALVE SETTING	**MAX**		15	15	15	15	15	15	15	15	15	15	15	15	15
	MIN		4.5	4.5	3.5	3	3	3	3	3	3	3	3	3	3
OIL SUPPLY SETTING**	**PSI**		36	44	62	52	65	62	50	46	40	45	48	54	68
	Kg/CM2		2.53	3.09	4.36	3.66	4.57	4.36	3.52	3.23	2.81	3.16	3.37	3.80	4.78
OIL PUMP															
	SIZE		OLE	OLE	OLE	OLE	1LE	1LE	1LE	2LE	2LE	2LE	2LE	2LE	2LE
	RATINGLPH		238	238	238	238	431	431	431	840	840	840	840	840	840

*The high fire rate listed is the maximum recommended with +25 mm Aq furnace pressure. Higher positive furnace pressure will result in a reduced capacity and reduced air and oil supply pressure setting. Contact the factory for maximum firing rates firing against higher furnace pressures. Rates based on grade #2 fuel oil @ 10,300 KCAL/KG.

**Recommended oil supply pressure settings are nominal settings for typical grade #2 fuel oil. Final settings will vary according to the furnace pressure, desired firing rate, and oil viscosity. The optimum setting is determined by flue gas analysis.

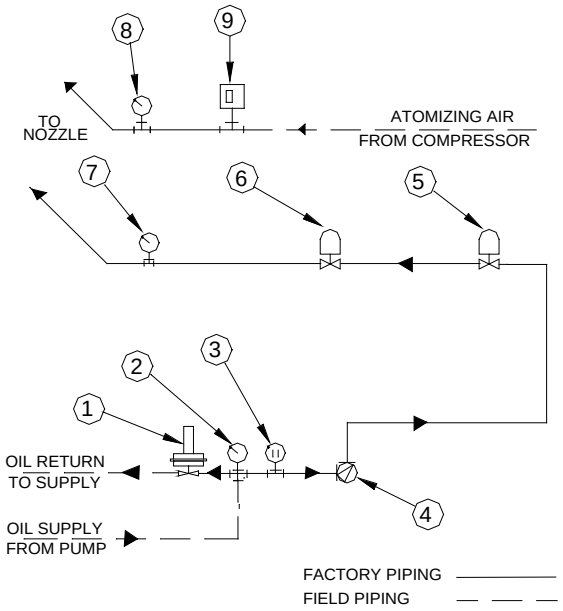
50 HZ BELT-DRIVE OPERATION (EXPORT)

BURNER SIZE			100	125	150	200	250	300	350	400	500	600	700
FIRING RATE *	**MAX**	**GPH**	36	40	54	72	79	107	120	144	180	200	224
		KGH	117	130	176	235	257	349	391	469	586	652	730
	NOM	**GPH**	30	37.5	45	60	75	90	105	120	150	180	210
		KGH	98	122	147	196	244	293	342	391	489	586	684
	FURN PRESS MM Aq		25	25	37	50	50	75	75	100	100	100	100
	MIN	**GPH**	8	9	10	11	13	17	17	22	28	31	34
		KGH	26	29	33	36	42	55	55	72	91	101	111
NOZZLE SIZE		**GPH**	40	40	60	60	80	100	125	150	200	250	250
		ANGLE	50	50	70	70	70	70	70	70	70	70	70
NOZZLE PRESSURE Kg/CM2 @ HIGH FIRE *	AIR	MAX	1.41	1.41	1.34	1.48	1.55	1.41	1.13	1.41	1.34	1.41	1.48
		NOM	1.41	1.41	1.27	1.41	1.62	1.48	1.05	1.27	1.27	1.34	1.41
	OIL	MAX	1.97	2.11	1.90	2.46	2.18	2.18	1.62	1.97	1.90	1.83	1.97
		NOM	1.76	1.97	1.69	2.11	2.18	2.04	1.41	1.62	1.69	1.69	1.90
CONTROL VALVE SIZE			S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16
CONTROL VALVE SETTING		**MAX**	15	15	15	15	15	15	15	15	15	15	15
		MIN	4.5	4.5	3.5	3	3	3	3	3	3	3	3
OIL SUPPLY SETTING**		**MAX**	3.20	4.31	3.48	5.26	3.93	4.06	3.95	3.24	3.88	4.28	5.04
		NOM	2.62	3.90	2.78	4.05	3.76	3.37	3.19	2.50	3.07	3.67	4.60
OIL PUMP													
	SIZE		009	009	009	009	009	009	009	009	009	015	015
	RATINGLPH		356	356	356	356	356	681	681	681	681	1135	1135

*The maximum (max) firing rate listed is the maximum recommended with a balanced, or negative furnace pressure. The nominal (nom) firing rate listed is the maximum recommended when firing against the furnace pressure listed. Higher positive furnace pressure will result in a reduced capacity and reduced air and oil pressure settings. Maximum firing rates are based on grade #2 oil @ 10,300 KCAL/KG. Nozzle pressures are based on an oil viscosity = 40 SSU @ the nozzle.

**Recommended oil supply pressure settings are typical settings for grade #2 oil. Final settings will vary according to the furnace pressure, desired firing rate and oil viscosity; The optimum setting is determined by flue gas analysis.

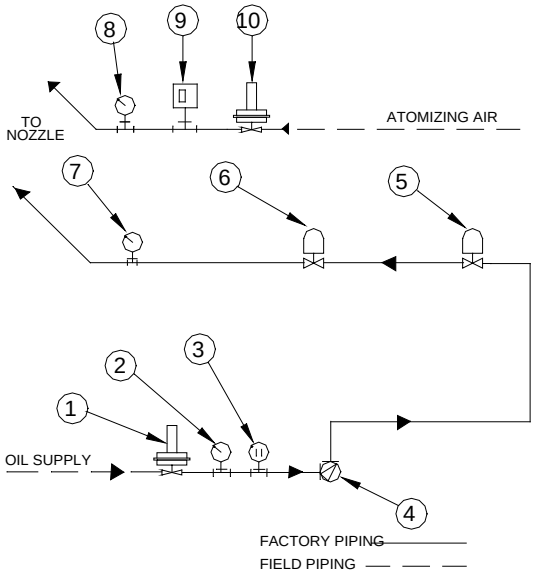
OIL PIPING SCHEMATIC: SYSTEMS WITH OIL METERING VALVE



COMPONENTS

1	SUPPLY PRESSURE REGULATING VALVE
2	OIL SUPPLY PRESSURE GAUGE
3	OIL PRESSURE SWITCH
4	OIL METERING VALVE
5 & 6	OIL SOLENOID VALVE
7	OIL NOZZLE PRESSURE GAUGE
8	ATOMIZING AIR PRESSURE GAUGE
9	ATOMIZING AIR PRESSURE SWITCH

OIL PIPING SCHEMATIC: SYSTEMS WITH CENTRAL OIL SUPPLY SYSTEM



COMPONENTS

1	SUPPLY PRESSURE REGULATING VALVE
2	OIL SUPPLY PRESSURE GAUGE
3	OIL PRESSURE SWITCH
4	OIL METERING VALVE
5 & 6	OIL SOLENOID VALVE
7	OIL NOZZLE PRESSURE GAUGE
8	ATOMIZING AIR PRESSURE GAUGE
9	ATOMIZING AIR PRESSURE SWITCH

MODEL A-MM (#4 OIL) OIL SYSTEM SETTINGS

60 HZ OPERATION

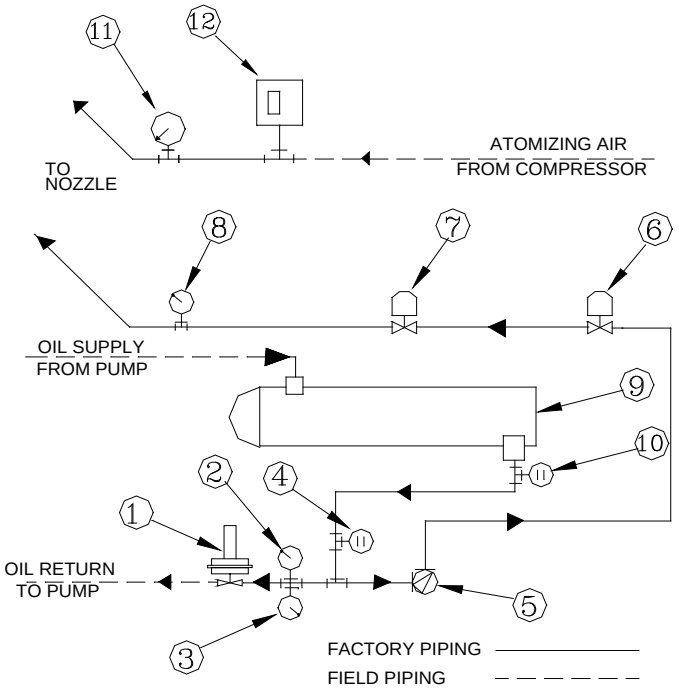
BURNER SIZE			50	75	100	125	150	200	250	300	350	400	450	500	625
FIRING	MAX	GPH*	17.6	25.7	35.1	38.6	51.6	69	77	103	114	139	149	174	216
RATE	NOM	GPH*	14.5	21.7	28.9	36.2	43.4	58	72	87	101	116	130	145	182
	FURN. PRESS. "W.C.		.75	.75	1.0	1.0	1.5	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0
	MIN	GPH	7	7	8	9	9	12	14	17	17	23	23	29	36
NOZZLE SIZE		GPH	30	30	40	40	60	60	80	100	125	150	150	200	250
C169WA		ANGLE	50	50	50	50	70	70	70	70	70	70	70	70	70
NOZZLE	AIR	MAX	20	22	21	22	20	23	20	22	17	20	24	21	23
PRESSURE,		NOM	17	22	21	22	20	20	20	22	16	19	21	19	21
@ HIGH	OIL	MAX	22	28	28	32	28	36	30	33	25	31	37	28	29
FIRE		NOM	17	26	26	30	26	30	29	30	21	25	28	24	26
CONTROL VALVE SIZE			S3-5	S3-7	S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16
CONTROL VALVE SETTING	MAX		16	10	15	15	15	15	15	15	15	15	15	15	15
	MIN		10	4	4.5	4.5	3.5	3	3	3	3	3	3	3	3
OIL SUPPLY SETTING**	MAX		48	62	54	62	49	75	55	56	56	46	48	54	72
PSI	NOM		33	48	43	56	40	58	52	47	46	36	40	44	58
OIL PUMP	SIZE		OLE	OLE	OLE	OLE	OLE	OLE	1LE	1LE	1LE	2LE	2LE	2LE	2LE
	RATING, GPH		78	78	78	78	78	78	144	144	144	276	276	276	276

*The max firing rate listed is the maximum recommended with a balanced, or negative, furnace pressure. The nominal firing rate listed is the maximum recommended when firing against the furnace pressure listed. Firing against higher furnace pressures will result in reduced capacity and lower air and oil supply pressure settings. Rates based on grade #4 fuel oil @ 145,000 BTU/GAL.

The nozzle pressures listed are based on an oil viscosity = 40 SSU @ the nozzle, and are those recommended for most applications. The same firing rates can be obtained by either raising or lowering both the air & oil pressures. The flame geometry will be affected by the nozzle pressure with slower mixing, wider flames resulting from lower pressures.

**Recommended oil supply pressure settings are typical for the maximum firing with grade #4 fuel oil @ 150 SSU pumping viscosity. Final settings will vary according to the furnace pressure, desired firing rate, and oil viscosity. The optimum setting is determined by flue gas analysis.

OIL PIPING SCHEMATIC: SYSTEMS WITH OIL METERING VALVE



COMPONENTS:

1	SUPPLY PRESSURE REGULATING VALVE
2	OIL SUPPLY PRESSURE GAUGE
3	OIL TEMPERATURE GAUGE
4	LOW OIL PRESSURE SWITCH
5	OIL METERING VALVE
6	OIL SOLENOID VALVE
7	2ND OIL SOLENOID VALVE
8	NOZZLE OIL PRESSURE GAUGE
9	ELECTRIC OIL HEATER
10	LOW OIL TEMPERATURE SWITCH
11	ATOMIZING AIR PRESSURE GAUGE
12	ATOMIZING AIR PRESSURE SWITCH

MODEL A-HM (#6 OIL) SYSTEM SETTINGS

60 Hz OPERATION

BURNER SIZE			50	75	100	125	150	200	250	300	350	400	450	500	625
FIRING RATE	MAX	GPH*	17	25	34	37	50	67	74	100	111	135	144	168	210
	NOM	GPH*	14	21	28	35	42	56	70	84	98	112	126	140	175
	FURN. PRESS. "W.C.		0.75	0.75	1.0	1.0	1.5	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0
	MIN	GPH	8	8	9	9	10	11	13	17	17	22	22	28	34
NOZZLE SIZE		GPH	30	30	40	40	60	60	80	125	125	150	200	200	250
C169WA		ANGLE	50	50	50	50	70	70	70	70	70	70	70	70	70
NOZZLE PRESSURE, PSIG @ HIGH FIRE	AIR	MAX	22	22	20	21	21	20	22	17	18	21	22	22	26
		NOM	20	22	20	20	21	18	22	15	17	18	18	21	23
	OIL	MAX	28	36	30	33	28	34	33	30	36	40	41	47	59
		NOM	23	30	27	30	25	29	32	24	30	31	33	39	46
CONTROL VALVE SIZE			S3-5	S3-7	S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16
CONTROL VALVE SETTING	MAX		16	10	15	15	15	15	15	15	15	15	15	15	15
	MIN		10	4	4.5	4.5	3.5	3	3	3	3	3	3	3	3
OIL SUPPLY SETTING** PSI	MAX		55	64	57	65	50	75	59	56	68	56	59	72	97
	NOM		41	44	45	59	41	57	55	42	55	42	47	56	72
OIL PUMP SIZE			4312	4312	4312	4312	4312	4312	4312	4312	4312	4312	4312	4313	4313
RATING (GPH)			95	95	95	95	95	95	95	180	180	180	180	300	300

*The max firing rate listed is the maximum recommended with a balanced, or negative, furnace pressure. The nominal firing rate listed is the maximum recommended when firing against the furnace pressure listed. Reduced firing rates will result in reduced air and oil supply pressure settings. Rates based on grade #6 fuel oil @ 150,000 BTU/GAL.

The nozzle pressures listed are those recommended for most applications, and are based on an oil viscosity of 150 SSU @ the nozzle. The same firing rates can be obtained by either raising or lowering both the air & oil pressures. The flame geometry will be affected by the nozzle pressure with slower mixing, wider flames resulting from lower pressures.

**Recommended oil supply pressure settings are typical for firing with a medium grade #6 fuel oil @ 140^{o}F delivery temperature to the burner. Final settings will vary according to the furnace pressure, desired firing rate, and oil viscosity. The optimum setting is determined by flue gas analysis.

50 Hz DIRECT-DRIVE OPERATION (EXPORT)

BURNER SIZE			100	125	150	200	250	300	300SP	400	400SP	500	500SP	625	1000
FIRING RATE *	MAX	GPH	25	30	39	54	60	80	90	108	119	130	157	170	205
		KGH	90	108	140	194	216	288	324	389	428	468	565	612	738
	MIN	GPH	8	9	10	11	12	16	18	21	24	26	31	34	42
		KGH	28	32	36	40	43	58	65	75	86	94	112	122	151
NOZZLE SIZE		GPH	40	40	40	60	60	100	125	125	150	150	200	250	250
		ANGLE	50	50	70	70	70	70	70	70	70	70	70	70	80
NOZZLE, PRESSURE @ HIGH FIRE *	AIR	PSI	15	17	20	16	16	19	17	16	18	16	22	19	25
		Kg/cm2	1.05	1.20	1.41	1.13	1.13	1.34	1.20	1.13	1.27	1.13	1.55	1.34	1.76
	OIL	PSI	20	24	32	24	26	27	25	24	26	24	33	29	38
		Kg/cm2	1.41	1.69	2.25	1.69	1.83	1.90	1.76	1.69	1.83	1.69	2.32	2.04	2.67
CONTROL VALVE SIZE			S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16	½"-O
CONTROL VALVE SETTING	MAX		15	15	15	15	15	15	15	15	15	15	15	15	MAX
	MIN		4.5	4.5	3.5	3	3	3	3	3	3	3	3	3	MIN
OIL SUPPLY		PSI	48	50	50	65	50	50	55	65	45	45	60	65	70
SETTING**		Kg/cm^2	3.38	3.52	3.52	4.57	3.52	3.52	3.87	4.57	3.16	3.16	4.22	4.57	4.92
OIL PUMPSIZE			4312	4312	4312	4312	4312	4312	4312	4312	4312	4312	4312	4313	4313
RATING		LPH	356	356	356	356	356	356	681	681	681	681	681	1135	1135

*The high fire rate listed is the maximum recommended with +25 mm Aq furnace pressure. Higher positive furnace pressure will result in a reduced capacity and reduced air and oil pressure settings. Maximum firing rates are based on 9,700 KCAL/KG. Nozzle pressures are based on an oil viscosity = 150 SSU @ the nozzle.

**Recommended oil supply pressure settings are nominal settings for medium viscosity #6 oil @ 60 C. pumping temperature. Final settings will vary according to the furnace pressure, desired firing rate, oil viscosity, and pumping temperature; The optimum setting is determined by flue gas analysis.

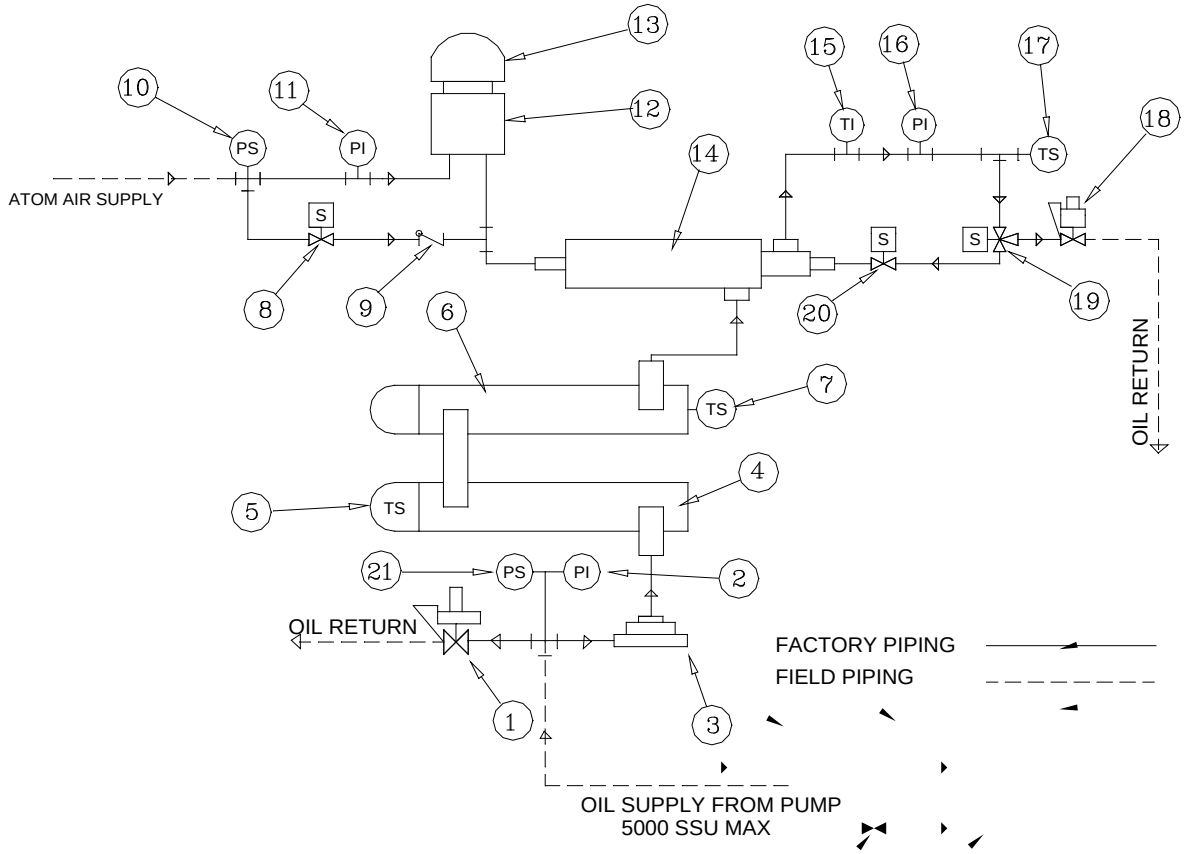
50 Hz BELT-DRIVE OPERATION (EXPORT)

BURNER SIZE			100	125	150	200	250	300	350	400	500	600	700
FIRING RATE *	**MAX**	**GPH**	34	37	50	67	74	100	113	135	168	188	210
		KGH	122	133	180	241	266	360	410	486	604	676	755
	NOM	**GPH**	28	35	42	56	70	84	98	112	140	158	175
		KGH	108	126	151	201	252	302	389	432	504	568	630
	FURN PRESS MM Aq		25	25	37	50	50	75	75	100	100	100	100
	MIN	**GPH**	8	9	10	11	13	17	17	22	28	31	34
		KGH	28	32	36	40	47	61	61	79	101	112	122
NOZZLE SIZE		**GPH**	40	40	60	60	80	100	125	150	200	250	250
		ANGLE	50	50	70	70	70	70	70	70	70	70	70
NOZZLE PRESSURE Kg/CM2 @ HIGH FIRE *	**AIR**	MAX	1.41	1.48	1.48	1.41	1.55	1.20	1.27	1.48	1.55	1.48	1.83
		NOM	1.41	1.41	1.48	1.27	1.55	1.05	1.13	1.27	1.48	1.34	1.62
	OIL	MAX	2.11	2.32	1.97	2.39	2.32	2.11	2.46	2.81	3.30	3.44	4.15
		NOM	1.90	2.11	1.76	2.04	2.25	1.69	1.97	2.18	2.74	2.00	3.23
CONTROL VALVE SIZE			S3-7	S3-7	S3-9	S3-9	S3-11	S3-13	S3-13	S3-16	S3-16	S3-16	S3-16
CONTROL VALVE SETTING		**MAX**	15	15	15	15	15	15	15	15	15	15	15
		MIN	4.5	4.5	3.5	3	3	3	3	3	3	3	3
OIL SUPPLY SETTING**		**MAX**	4.00	4.57	3.52	5.27	4.15	3.94	4.78	3.94	5.06	5.56	6.82
		NOM	3.16	4.15	2.88	4.01	3.87	2.95	3.73	2.95	3.94	3.48	5.06
OIL PUMP	**SIZE**		4312	4312	4312	4312	4312	4312	4312	4312	4312	4313	4313
	RATING LPH		356	356	356	356	356	681	681	681	681	1135	1135

*The maximum (max) firing rate listed is the maximum recommended with a balanced, or negative furnace pressure. The nominal (nom) firing rate listed is the maximum recommended when firing against the furnace pressure listed. Higher positive furnace pressure will result in a reduced capacity and reduced air and oil pressure settings. Maximum firing rates are based on grade #6 oil @ 9,700 KCAL/KG. Nozzle pressures are based on an oil viscosity = 150 SSU @ the nozzle.

**Recommended oil supply pressure settings are for medium viscosity #6 oil @ 60 C. pumping temperature. Final settings will vary according to the furnace pressure, desired firing rate, oil viscosity, and pumping temperature; The optimum setting is determined by flue gas analysis.

OIL PIPING SCHEMATIC: SYSTEMS WITH OIL METERING VALVE



COMPONENTS:

1. SUPPLY PRESSURE REGULATING VALVE
2. OIL SUPPLY PRESSURE GAUGE
3. OIL METERING VALVE
4. OIL HEATER #1
5. OIL HEATER THERMOSTAT #1
6. OIL HEATER #2 (BURNER SIZE 150-625)
7. OIL HEATER THERMOSTAT #2
8. N.O. NOZZLE PURGE SOLENOID VALVE
9. NOZZLE PURGE CHECK VALVE
10. ATOMIZING AIR PRESSURE SWITCH
11. ATOMIZING AIR PRESSURE GAUGE
12. OIL NOZZLE BODY
13. OIL NOZZLE TIP & SPINNER
14. TRIPLE-PASS OIL MANIFOLD
15. OIL TEMPERATURE GAUGE
16. OIL NOZZLE PRESSURE GAUGE
17. LOW OIL TEMPERATURE SWITCH
18. ANTI-SURGE VALVE
19. 3-WAY OIL SOLENOID VALVE
20. 2nd OIL VALVE
21. OIL PRESSURE SWITCH

AIR ATOMIZED BURNERS WITH ELECTRONIC OIL METERING SYSTEM (EMS)

MODEL A-LM #2 OIL EMS SETTINGS

BURNER SIZE			50	75	100	125	150	200	250	300	350	400	450	500	625
FIRING RATE	MAX	GPH*	18.2	26.6	36.4	40.0	53.5	72	80	107	119	144	155	180	224
	NOM	GPH*	15.0	22.5	30.0	37.5	45.0	60	75	90	105	120	135	150	188
	FURN. PRESS. "W.C.		.75	.75	1.0	1.0	1.5	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0
	MIN	GPH	7	7	8	9	9	12	15	18	18	24	24	30	37
NOZZLE SIZE		GPH	30	30	40	40	60	60	80	100	125	150	150	200	250
C169WA		ANGLE	50	50	50	50	70	70	70	70	70	70	70	70	70
NOZZLE PRESSURE, @ HIGH FIRE	AIR	MAX	20	22	21	22	20	23	20	22	17	20	24	21	23
		NOM	17	22	21	22	20	20	20	22	16	19	21	19	21
	OIL	MAX	22	28	28	32	28	36	30	33	25	31	37	28	29
		NOM	17	26	26	30	26	30	29	30	21	25	28	24	26
STD PUMP SETTINGS	SIZE		30LE	30LE	00LE	00LE	00LE	00LE	0LE	0LE	1LE	1LE	1LE	1LE	2LE
	Varm@MAX		65	93	73	80	79	ALT	83	ALT	60	73	78	ALT	63
	Varm@NOM		55	80	60	75	67	95	78	84	53	61	70	80	53

ALT PUMP SETTINGS	SIZE							0LE		1LE				2LE	
	Varm@MAX							68		58				53	
	Varm@NOM							55		49				45	

*The max firing rate listed is the maximum recommended with a balanced, or negative, furnace pressure. The nominal firing rate listed is the maximum recommended when firing against the furnace pressure listed. Reduced firing rates will result in reduced air and oil supply pressure settings. Rates based on grade #2 fuel oil @ 140,000 BTU/GAL.

The nozzle pressures listed are those recommended for most applications. The same firing rates can be obtained by either raising or lowering both the air & oil pressures. The flame geometry will be affected by the nozzle pressure with slower mixing, wider flames resulting from lower pressures.

The alternate pumps may be used on sizes 200, 300 & 500 for obtaining nominal capacity @ the Varm indicated. The alternate pumps must be used on sizes 300, 300 & 500 to obtain the maximum capacity @ the Varm indicated.

MODEL A-HM #6 OIL EMS SETTINGS

BURNER SIZE			50	75	100	125	150	200	250	300	400	500	625
FIRING RATE	MAX	GPH*	17.0	24.8	34.0	37.3	49.9	67.2	74.6	100	135	168	210
	NOM	GPH*	14.0	21.0	28.0	35.0	42.0	56.0	70.0	90.0	84.0	140	175
	FURN. PRESS. "W.C.		.75	.75	1.0	1.0	1.5	2.0	2.0	3.0	4.0	4.0	4.0
	MIN	GPH	7	7	7	9	9	11	13	17	22	28	34
NOZZLE SIZE		GPH	30	30	40	40	60	60	80	125	150	200	250
C169WA		ANGLE	50	50	50	50	70	70	70	70	70	70	70
NOZZLE PRESSURE,	AIR	MAX	22	22	20	21	21	20	22	17	21	22	26
		NOM	20	22	20	20	21	18	22	15	18	21	23
@ HIGH FIRE	OIL	MAX	28	36	30	33	28	34	33	30	40	47	59
		NOM	23	30	27	30	25	29	32	24	31	39	46
STD PUMP SETTINGS	SIZE		30LE	30LE	00LE	00LE	00LE	00LE	0LE	0LE	1LE	1LE	2LE
	Varm@MAX		62	90	53	64	81	ALT	72	ALT	73	ALT	63
	Varm@NOM		51	76	43	68	68	95	67	87	61	76	53
ALT PUMP SETTINGS	SIZE							0LE		1LE		2LE	
	Varm@MAX							65		58		52	
	Varm@NOM							54		49		43	

*The max firing rate listed is the maximum recommended with a balanced, or negative, furnace pressure. The nominal firing rate listed is the maximum recommended when firing against the furnace pressure listed. Reduced firing rates will result in reduced air and oil supply pressure settings. Rates based on grade #6 fuel oil @ 150,000 BTU/GAL.

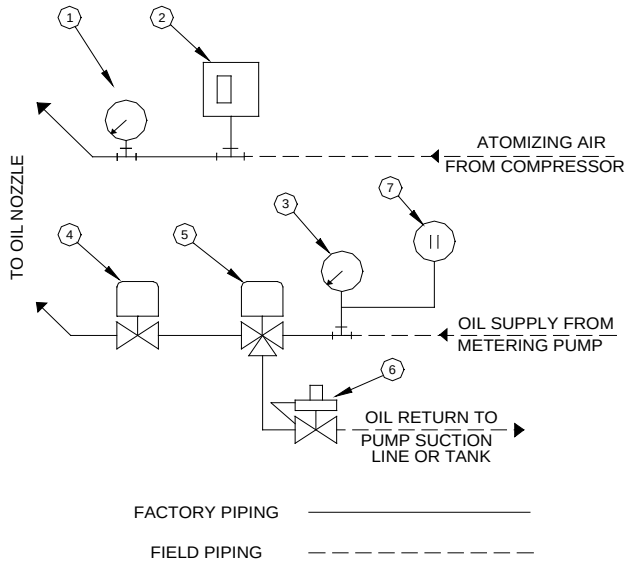
The nozzle pressures listed are those recommended for most applications. The same firing rates can be obtained by either raising or lowering both the air & oil pressures. The flame geometry will be affected by the nozzle pressure with slower mixing, wider flames resulting from lower pressures.

The alternate pumps may be used on sizes 200, 300 & 500 for obtaining nominal capacity @ the Varm indicated. The alternate pumps must be used on sizes 300, 300 & 500 to obtain the maximum capacity @ the Varm indicated.

Refer to catalog section 9400 for complete metering pump flow charts including recommended armature voltages for low fire settings.

ELECTRONIC OIL METERING SYSTEM PIPING SCHEMATIC

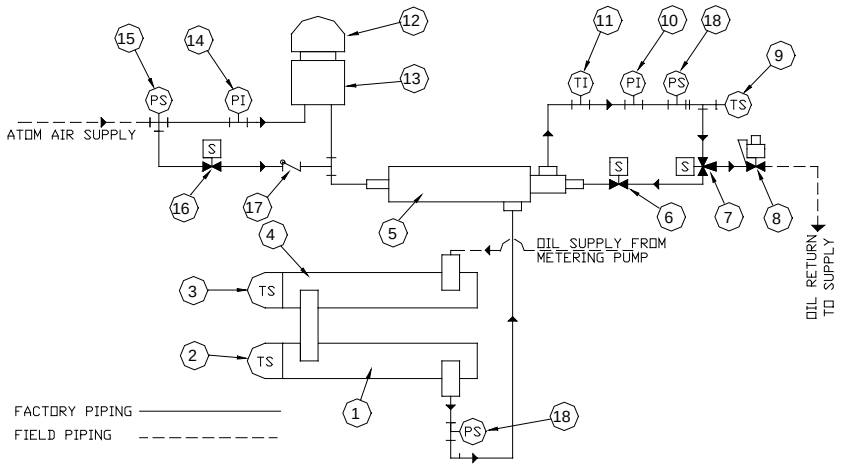
MODEL A-LM #2 OIL SYSTEMS



COMPONENTS:

1 ATOMIZING AIR PRESSURE GAUGE
2 ATOMIZING AIR PRESSURE SWITCH
3 NOZZLE OIL PRESSURE GAUGE
4 2-WAY OIL SOLENOID VALVE
5 3-WAY OIL SOLENOID VALVE
6 ANTI-SURGE VALVE
7 LOW OIL PRESSURE SWITCH

MODEL A-HM #6 OIL SYSTEMS



COMPONENTS:

1 OIL HEATER #1
2 OIL HEATER THERMOSTAT #1
3 OIL HEATER THERMOSTAT #2
4 OIL HEATER #2 (BURNER SIZE 150-625)
5 TRIPLE-PASS OIL MANIFOLD
6 2nd OIL VALVE
7 3-WAY OIL SOLENOID VALVE
8 ANTI-SURGE VALVE
9 LOW OIL TEMPERATURE SWITCH
10 OIL NOZZLE PRESSURE GAUGE
11 OIL TEMPERATURE GAUGE
12 OIL NOZZLE TIP & SPINNER
13 OIL NOZZLE BODY
14 ATOMIZING AIR PRESSURE GAUGE
15 ATOMIZING AIR PRESSURE SWITCH
16 N.O. NOZZLE PURGE SOLENOID VALVE
17 NOZZLE PURGE CHECK VALVE
18 LOW OIL PRESSURE SWITCH

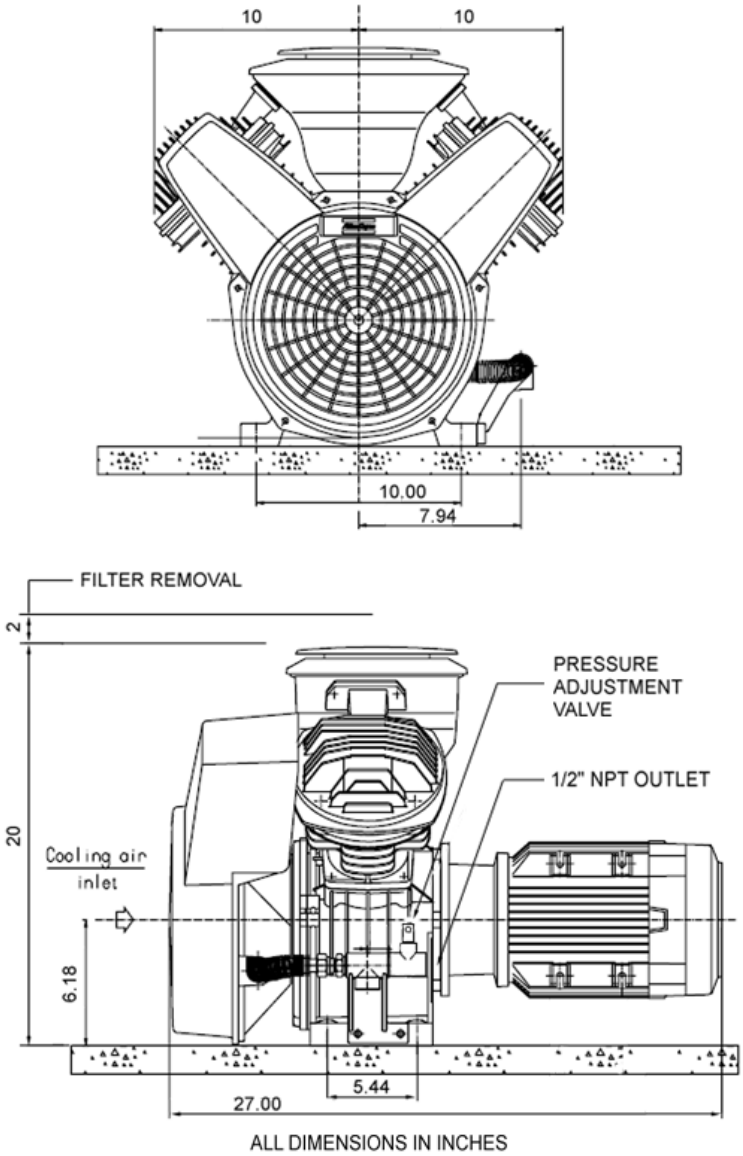
ATOMIZING AIR COMPRESSOR INSTALLATION & ADJUSTMENT PROCEDURE

INSTALLATION

All compressor sets furnished with series FD68 air atomized burners are mounted on steel bases for mounting separately from the burner. The base must be firmly anchored as close to the burner as possible to avoid excessive pressure drop in the atomizing air piping. Vibration isolators are not required, but may be used.

If remote mounting is necessary good piping design must be utilized to ensure sufficient atomizing air pressure at the burner nozzle.

DIMENSIONS: ATLAS COPCO MODELS LE2, -3, -5



PIPING

Compressors are not furnished with reservoir tanks as the output is closely matched to the air requirement of the burner. To eliminate the possibility of pressure fluctuations at the burner nozzle it is good practice to install a short run of oversized piping at the compressor outlet to act as a small accumulator.

START-UP

In general, compressors are shipped without oil in the crankcase. Follow the manufacturer's instructions for filling with the proper grade of oil prior to starting. Because most installations involve prolonged periods of operation it is recommended to use 500 SUS napthenic base compressor oil for lubrication. SAE 30, non-detergent, automotive grade oil can be substituted but it is not recommended for continuous operation.

ADJUSTMENT

Compressors are furnished with a bypass line and adjusting valve from the discharge to the inlet to enable adjustment of the air volume delivered to the burner nozzle. If adjustment is required refer to the burner adjusting instructions for proper setting of the atomizing air pressure.

In general, too little atomizing air pressure will result in poor atomization while too high a pressure can result in a pulsating flame and even combustion harmonics especially in restricted combustion chambers.

MAINTENANCE

Compressor oil level must be checked at least twice a week during periods of continuous operation. Compressors installed in areas of high ambient temperatures and/or little ventilation will run hotter and may consume some oil. Refer to the manufacturer's manual for complete recommendations.

OIL PUMP INSTALLATION

DIRECT-DRIVE OIL PUMP SET

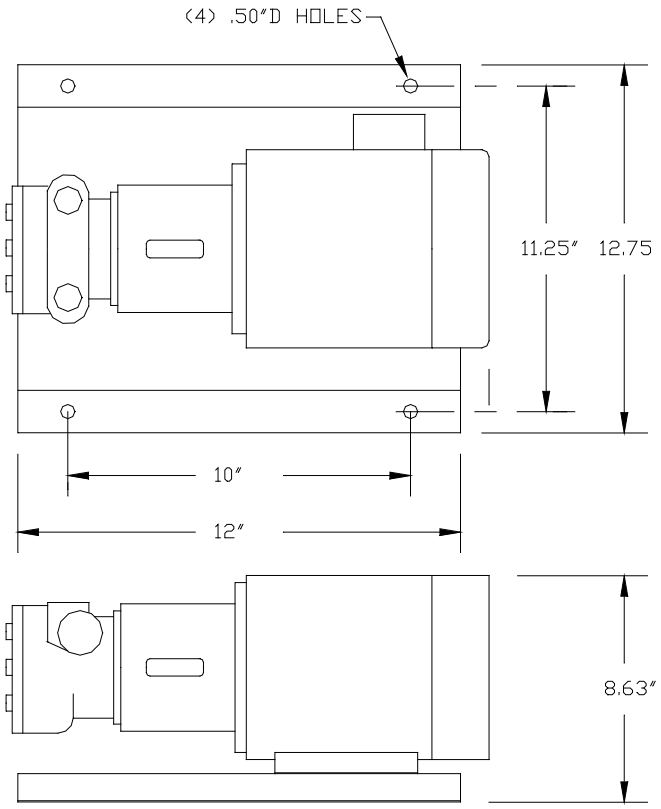
60Hz OPERATION

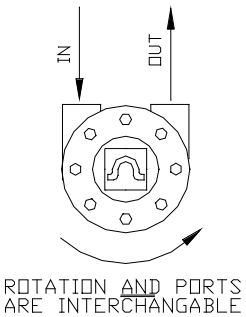
Standard direct-drive burner oil pumps furnished with series FD68 burners should be floor or boiler base mounted in close vicinity to the burner with no valving installed between the pump set and the burner inlet.

The following chart may be used as a suction line sizing guide considering a suction lift of 10 feet. The return line from the burner may be one pipe size smaller than the recommended suction line size.

BURNER SIZE	PUMP MODEL	MOTOR HP	PORT SIZE	GPH	SUCTION LINE LENGTH			
					25'	50'	75'	100'
50-200	0LE	1/3	½"	78	½"	½"	½"	½"
250-300	1LE	1/2	½"	144	½"	½"	¾"	¾"
400-800	2LE	3/4	½"	276	¾"	1"	1"	1"
1000	5LE	1	1"	360	¾"	1"	1"	1"

5LE RPM = 1150, ALL OTHERS RPM = 1725





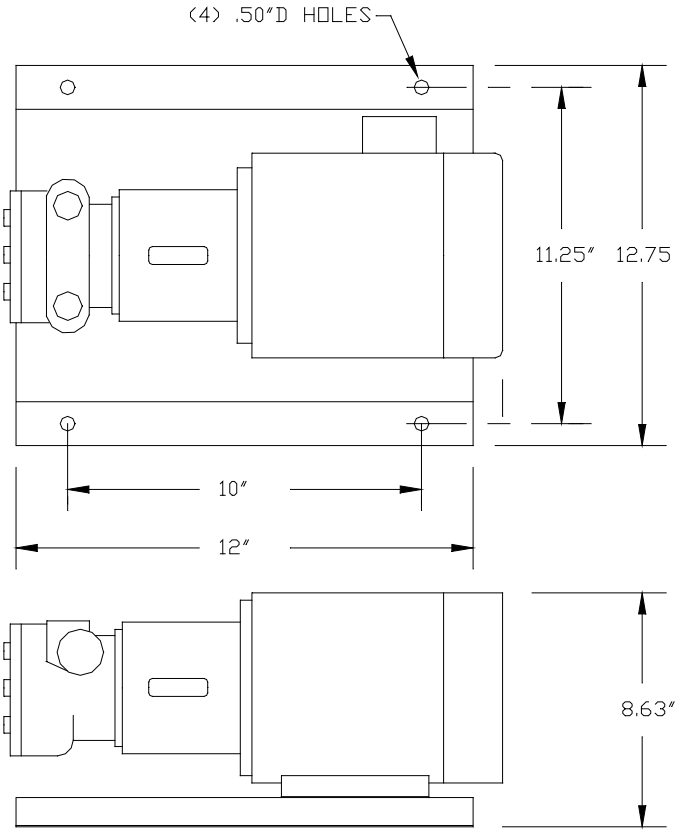
50Hz OPERATION

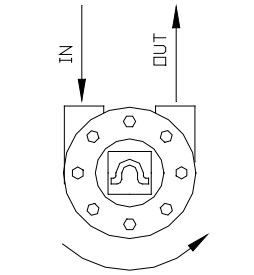
Standard direct-drive burner oil pumps furnished with series FD68 burners should be floor or boiler base mounted in close vicinity to the burner with no valving installed between the pump set and the burner inlet.

The following chart may be used as a suction line sizing guide considering a suction lift of 10 feet. The return line from the burner may be one pipe size smaller than the recommended suction line size.

BURNER SIZE	PUMP MODEL	MOTOR HP	PORT SIZE	LPH	SUCTION LINE LENGTH			
					25'	50'	75'	100'
50-200	0LE	1/3	½"	238	½"	½"	½"	½"
250-300SP	1LE	1/2	½"	431	½"	½"	¾"	¾"
400SP-1000	2LE	3/4	½"	908	¾"	1"	1"	1"

PUMP RPM = 1425 FOR ALL SIZES





ROTATION AND PORTS ARE INTERCHANGABLE

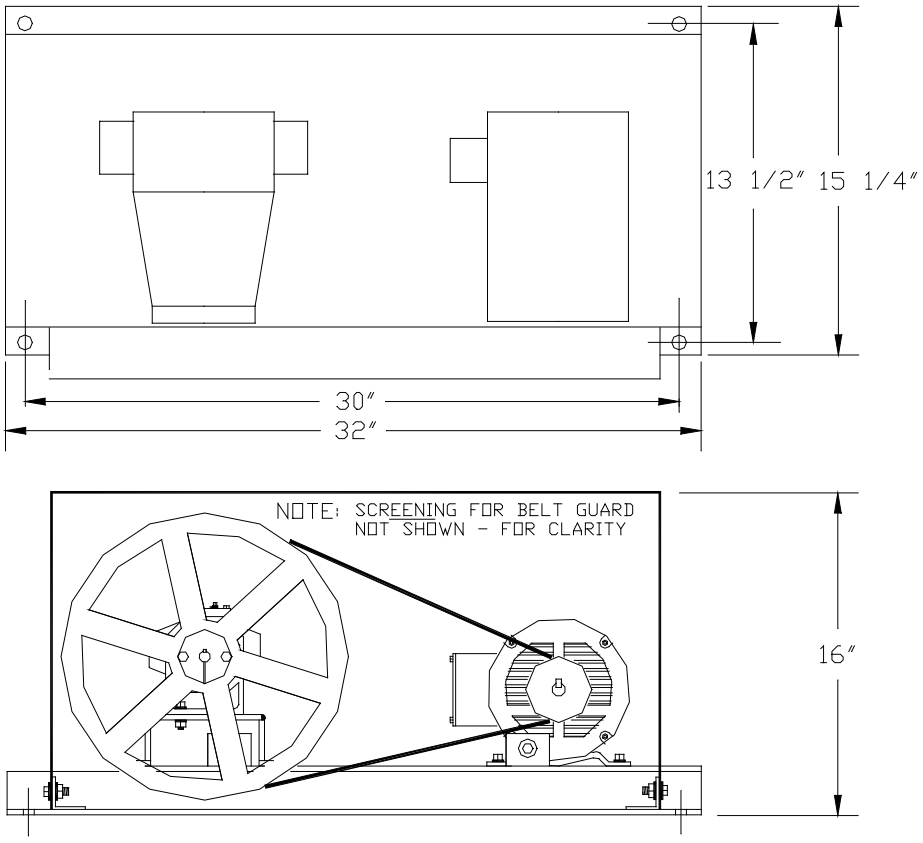
BELT-DRIVE HEAVY OIL PUMP INSTALLATION

Standard belt-drive burner oil pumps furnished with series FD68 burners should be floor or boiler base mounted in close vicinity to the burner with no valving installed between the pump set and the burner inlet.

The following chart may be used as a suction line sizing guide considering a suction lift of 10 feet & a viscosity of 2000 SSU. The return line from the burner may be one pipe size smaller than the recommended suction line size.

BURNER SIZE	PUMP MODEL	PUMP RPM	MOTOR HP	PORT SIZE	GPH	LPH	SUCTION LINE LENGTH			
							25'	50'	75'	100'
50-250	4312	300	3/4	1"	95	360	1 ¼"	1 ¼"	1 ¼"	1 ¼"
300-500	4312	600	3/4	1"	180	681	1 ¼"	1 ¼"	1 ¼"	1 ¼"
625-800	4313	600	1-1/2	1 ¼"	300	1136	1 ¼"	1 ¼"	1 ½"	1 ½"
1000	4313	800	2	1 ¼"	420	1590	1 ½"	1 ½"	2"	2"

MOTOR RPM = 1725 FOR ALL SIZES 60Hz & 1450 FOR ALL 50Hz SYSTEMS

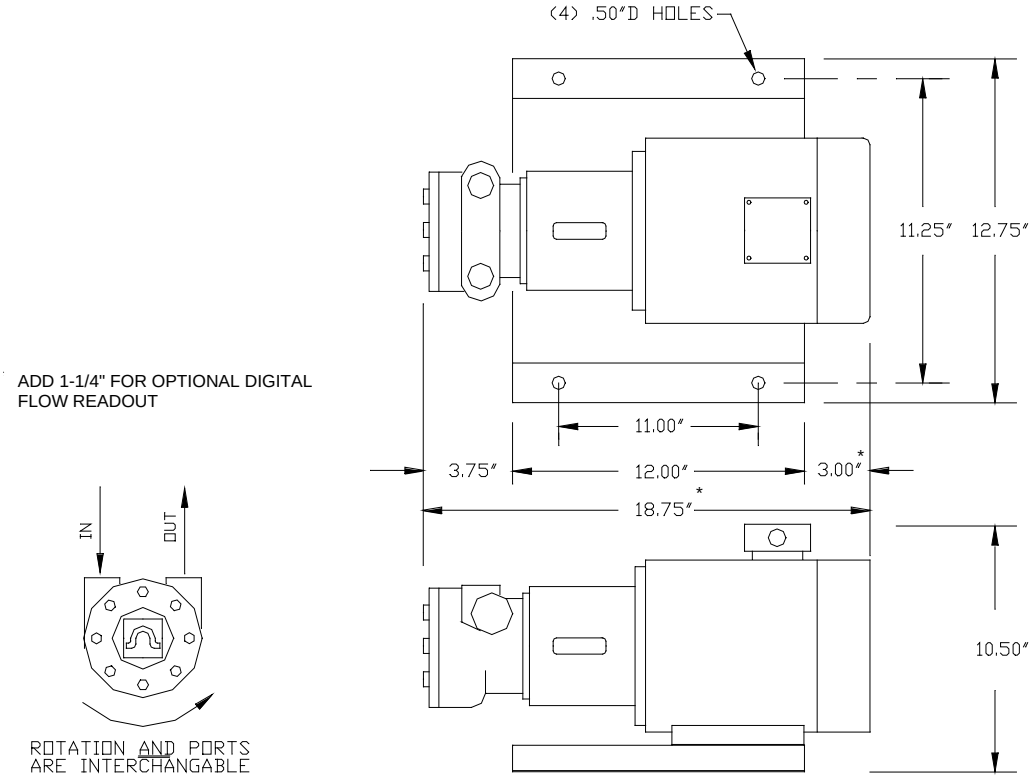


ELECTRONIC OIL METERING PUMP INSTALLATION

Variable speed oil metering pumps furnished with series FD68 burners should be floor or boiler base mounted in close vicinity to the burner with no valving installed between the pump set and the burner inlet.

The following chart may be used as a suction line sizing guide considering a suction lift of 10 feet. The return line from the burner may be one pipe size smaller than the recommended suction line size.

BURNER SIZE	STD PUMP MODEL	MOTOR HP	PORT SIZE	MAX GPH	SUCTION LINE LENGTH			
					25'	50'	75'	100'
50-75	30LE	1/3	½"	28	½"	½"	½"	½"
100-200	00LE	1/3	½"	60	½"	½"	½"	½"
250-300	0LE	1/3	½"	112	½"	½"	½"	½"
400-500	1LE	1/3	½"	180	½"	½"	¾"	¾"
625-800	2LE	1/2	½"	300	¾"	1"	1"	1"



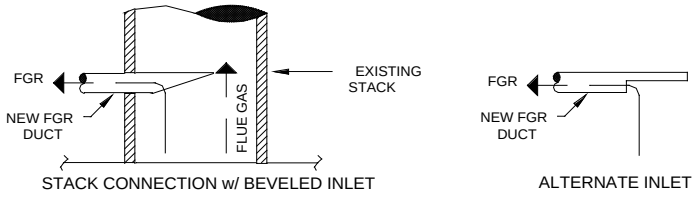
INDUCED FGR OPTION (LOW NOx OR FUTURE LOW NOx BURNERS ONLY)

WARNING! The induced FGR option should be used for FD68 burners designed for Low NOx operation. Application to standard models may result in serious damage and injury.

STACK CONNECTION:

The FGR connection to the stack should be in a location which will result in the straightest run of piping to the burner inlet, connection near the discharge of the stack must be avoided to eliminate the possibility of entraining air into the system. If a stack damper is used the connection should be between the boiler outlet and the damper. If an I.D. FAN is used the connection should be on the discharge of the fan.

The FGR piping should protrude into the stack with a beveled inlet to enhance the flow of flue gas into the piping with a minimum pressure drop.



FGR PIPING:

All FGR piping must be gas tight, insulated, non-corrosive stainless steel FGR ductwork of same, or larger, diameter as the burner FGR connection. All connections must be air tight seal welded, or flanged with gaskets. All bends and turns must be long-radius elbows. Sharp mitered turns may not be used.

FGR PIPE SIZING:

The required FGR pipe size is affected by the burner size, required NOx threshold, length of piping, and the expected number of direction changes. Recommendations will be made on an individual job basis.

FGR CONTROL VALVE:

An FGR control valve is furnished to shut off the recirculation during purging and ignition cycles and for the purpose of modulating the amount of recirculation during firing cycles. It can be mounted anywhere in the FGR piping but mounting close to the burner assembly reduces the length of wiring required from the burner to the valve actuator.

Systems incorporating a single-point positioning control system incorporate a Q181A aux potentiometer mounted on the burner modulating motor to control the position of the modulating motor on the FGR control valve. Systems incorporating a parallel positioning control system include a servomotor mounted on the FGR valve.

The Q181A aux potentiometer has an adjustable pick-up & span which needs to be adjusted after installation to provide for proper modulation of the FGR valve.

LIMITED WARRANTY

Innovative Combustion Technologies, Inc. d.b.a. S.T. Johnson Company, hereinafter called “Seller” of 925 Stanford Avenue, Oakland, CA hereby warrants the goods manufactured by seller to be free from defects in material and workmanship under normal use and service for 12 months from date of shipment. If within the warranty period any of the goods fail to conform, or are found to have been defective in material or workmanship when shipped, and within said period seller receives written notice thereof, such defective goods shall, at seller's option, either be repaired or replaced by seller, F.O.B. Oakland, California. As a condition to securing warranty repair or replacement, a Return Goods Authorization shall be obtained, and warranted equipment shall be returned to seller freight prepaid. If inspection by seller discloses defects not covered by this warranty, seller shall notify buyer/owner. Said equipment, at owner’s/buyer’s option, may be repaired or replaced and transported at the expense of owner/buyer.

EXCLUDED FROM THIS WARRANTY ARE DEFECTS IN WARRANTED EQUIPMENT CAUSED BY FREIGHT DAMAGE, FAULTY INSTALLATION, MISUSE OR NEGLIGENCE. Equipment that is repaired or replaced shall carry a warranty equal to the unexpired portion of the original warranty period. No credit will be given for returns except by prior approval of seller at Oakland, California. No special materials or equipment may be returned. No burner nozzle, burner block, or other parts directly exposed to flame, even for short periods, may be returned after use.

IN ALL EVENTS, SELLER SHALL NOT BE LIABLE FOR, AND WILL NOT REIMBURSE ANY LABOR, MATERIAL, OR OTHER REPAIR CHARGES INCURRED BY ANYONE OTHER THAN SELLER ON ANY WARRANTY EQUIPMENT. SELLER SHALL HAVE NO LIABILITY TO BUYER FOR ANY INDIRECT OR CONSEQUENTIAL DAMAGES ATTRIBUTABLE TO THE WARRANTED EQUIPMENT. SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR USE BY THE BUYER OR ITS CUSTOMERS.

WARNINGS The improper installation or application of the goods; their use with improper wiring, piping, or ventilation; improper system design or engineering; inadequate inspection or testing; the lack of regular careful maintenance of both the goods and any equipment in connection with which the goods are used; the employment of insufficient or unqualified personnel; the lack of careful supervision, proper warnings, operating instructions, and safety precautions; the exposure of the goods to excessive heat, moisture, dust, dirt, corrosion, or any other deleterious condition, each constitutes a hazard which can result in loss of life, serious personal injury, heavy property or business damage, and buyer /owner agrees with seller to itself take and require others to take all reasonable measures to avoid each such hazard.