S.T. JOHNSON CO.

Type DHF
Gas and Pressure Atomizing Oil Burners

Installation, Operation, and Maintenance Instruction Manual

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S.T. JOHNSON CO.

WARNING:

READ THESE INSTRUCTIONS AND SAVE FOR REFERENCE

This manual is provided to supply general information on the installation, operation and maintenance of the DHF burner system. The burner and burner management system must be installed and operated by qualified, meaning authorized and factory-trained, personnel. Lack of extensive knowledge of these systems and/or the failure to explicitly follow each manufacturer's instructions provided for all components in this system, can result in damage to property, personal injury or death.

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

DO NOT TAMPER WITH THE UNIT OR CONTROLS – CALL YOUR SERVICE PERSON AT LEAST ONCE A YEAR.

Qualified personnel must seek out and follow all manufacturers' instructions before proceeding with the initial firing of this equipment. Unqualified personnel must not proceed with initial firing; contact S.T. JOHNSON COMPANY for recommendations for qualified personnel to initially fire the burner system. Failure to do so can result in damage to property, personal injury or death.

Whenever there is a safety shutdown, the burner should not be restarted until a trained operator determines the cause of the shutdown and takes the necessary corrective action to ensure that conditions are within specified operating limits prior to restarting. Failure to do so can result in damage to property, personal injury or death.

Please consult factory for older unit specifications, or whenever the equipment supplied does not match descriptions in this manual.

THESE INSTRUCTIONS SHALL REMAIN WITH THE EQUIPMENT IN LEGIBLE CONDITION FOR SERVICING.

Canadian installations:
For recommended installation practice, see CSA B139, Installation Code for Oil-Burning Equipment.
The equipment shall be installed in accordance with the Provincial Installation Requirements, or in their absence, the CGA B149.1, Natural Gas and Propane Installation Code shall prevail.

FOR QUALIFIED SERVICE PLEASE CALL:

S.T. JOHNSON CO.

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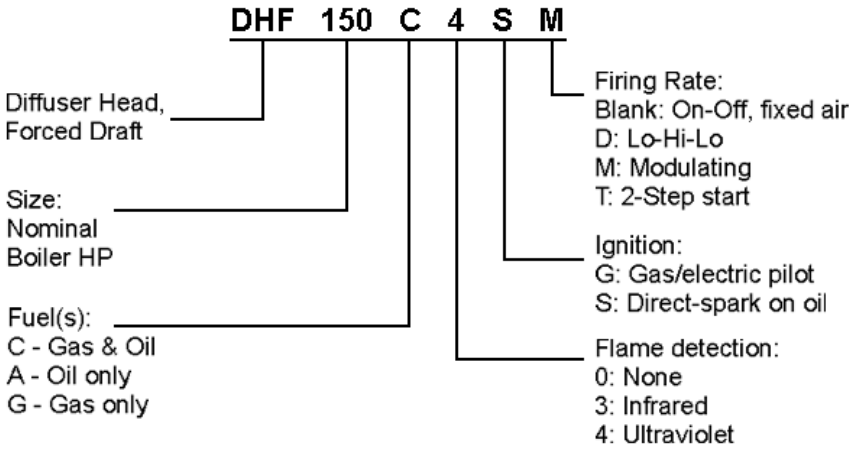
S.T. JOHNSON CO.

GENERAL INFORMATION FOR ALL SERIES DHF BURNERS

MODEL DESIGNATIONS



FIRING RATE CONTROL DESCRIPTION

ON-OFF ( )

One constant firing rate with a fixed position air shutter.

Available in Sizes 20 to 60 (Sizes 20 to 80 oil only versions).

2-STEP FIRING (T)

Provides for On-Off operation with a fixed air shutter on oil fired systems. Upon a call for heat, oil is directly spark ignited at an intermediate firing rate. Upon proof of flame the 2nd stage oil valve is energized providing high fire oil delivery.

Available on Sizes 20 to 60.

LO-HI-LO FIRING (D)

On Sizes 20 to 50, UL gas only systems, fuel flow is controlled with a HI-LO-OFF gas valve actuator with the air damper position controlled via a linkage connected to the gas valve actuator. All other systems are controlled with a 2-position actuator mounted on the burner. Gas flow and airflow are controlled via linkage from the actuator to the gas butterfly valve and the air damper. The oil flow is staged with two solenoid valves; the 2nd stage valve is energized via a limit switch in the 2-position actuator.

Available on Sizes 20 to 100.

MODULATING FIRING (M)

Provides for full modulation of air and fuel flow. Gas flow is controlled via a butterfly valve and oil flow is controlled with a return flow metering valve.

Available on all sizes.

ORDERING REQUIREMENTS

The following information is required to process orders or quotations

ALL SYSTEMS

Burner model desired (see PAGE 1).

Burner capacity or boiler horsepower.

Type of boiler or furnace.

Boiler make and model.

Furnace dimensions.

Furnace pressure.

Furnace pressure to be fired against.

Electrical specifications.

Elevation (if greater than 2000 ft.)

Insurance or local code requirements.

Control system programmer desired.

Control system options desired.

GAS SYSTEMS

Type of gas & supply pressure at gas train inlet.

OIL SYSTEMS

Grade of oil to be burned, not heavier than No. 2.

If an oil transfer pump set will be required.

LOW NOx SYSTEMS

Permitted emissions levels.

Stack temperature

STANDARD COMPONENTS & FIRING SEQUENCES

Please refer to the Project Bill of Materials (BOM) for specific component details and the Manufacturer's instructions provided in the manual furnished with the burner for additional information.

GAS ONLY - U.L.

BURNER COMPONENTS	BURNER SIZE 20	30	40	50	60	80	100	125	150	200
Fabricated Steel Scroll Case	S	S	S	S	S	S	S	S	S	S
Stainless Steel Blast Tube	S	S	S	S	S	S	S	S	S	S
1-Phase Blower Motor	S	S	S	S	S	A	A	A	A	N/A
3-Phase Blower Motor	A	A	A	A	A	A	A	A	A	S
Blower Air Pressure Switch	S	S	S	S	S	S	S	S	S	S
Gas Pilot & Igniter	S	S	S	S	S	S	S	S	S	S
Pilot Gas Cock & Regulator	S	S	S	S	S	S	S	S	S	S
Ignition Transformer	S	S	S	S	S	S	S	S	S	N/A
Base Mtd F.S. Primary Control	S	S	S	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Burner Mtd Control Panel	A	A	A	S	S	S	S	S	S	S
Remote Mtd Control Panel	A	A	A	A	A	A	A	A	A	A
FIRING SEQUENCE OPTIONS										
On-Off, Fixed Air Shutter 30-Sec, Open Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
On-Off Firing, Low-Fire-Start 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Lo-Hi-Lo Firing, LFS & PLFS 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Lo-Hi-Lo Firing, LFS & PLFS 30-Sec, Open Damper Prepurge	A	A	A	A	A	A	A	N/A	N/A	N/A
Modulated Firing, PLFS 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Modulated Firing, PLFS 30-Sec, Open Damper Prepurge	A	A	A	A	A	A	A	A	A	A

S = STANDARD **A** = AVAILABLE **N/A** = NOT AVAILABLE

Required UL Gas Train Components Must Be Selected From Catalog Section 9100.

See Catalog Page 4 For Additional Components Furnished For FM & IRI Codes.

GAS ONLY ADDITIONAL COMPONENTS - F.M.

Note: F.M. code requirements generally do not apply to gas burners rated at less than 2500 mbtu/hr. Standard UL listed burners & gas trains will be furnished unless otherwise instructed.

Gas only systems furnished to meet F.M. requirements will be furnished with the following additional features/components:

- Non-recycling flame safeguard programming controls
- Proof of open damper position during pre-purge
- Proof of low fire start

Required FM gas train components must be selected from catalog section 9100.

OIL ONLY U.L.

BURNER COMPONENTS	BURNER SIZE 20	30	40	50	60	80	100	125	150	200
Fabricated Steel Scroll Case	S	S	S	S	S	S	S	S	S	S
Stainless Steel Blast Tube	S	S	S	S	S	S	S	S	S	S
1-Phase Blower Motor	S	S	S	S	S	A	A	A	A	N/A
3-Phase Blower Motor	A	A	A	A	A	A	A	A	A	S
Blower Air Pressure Switch	S	S	S	S	S	S	S	S	S	S
Direct Spark Ignition	S	S	S	S	S	S	S	S	S	S
Gas Pilot & Ignitor	A	A	A	A	A	A	A	A	A	A
Ignition Transformer	S	S	S	S	S	S	S	S	S	S
Removable Oil Drawer Asbly	S	S	S	S	S	S	S	S	S	S
Integral Oil Pump	S	S	S	S	S	S	S	N/A	N/A	N/A
Separate Oil Pump/Motor	A	A	A	A	A	A	A	S	S	S
Low Oil Pressure Switch	A	A	A	A	A	A	A	S	S	S
2nd Oil Safety Shut-Off Valve	S	S	S	S	S	S	S	S	S	S
Base Mtd Primary F.S. Control	S	S	S	A	A	A	N/A	N/A	N/A	N/A
Burner Mtd Control Panel	A	A	A	S	S	S	S	S	S	S
Remote Mtd Control Panel	A	A	A	A	A	A	A	A	A	A
FIRING SEQUENCE OPTIONS										
On-Off, Fixed Air 30-Sec, Open Damper Prepurge	A	A	A	A	A	N/A	N/A	N/A	N/A	N/A
2-Stage Firing, Fixed Air 30-Sec, Open Damper Prepurge	A	A	A	A	A	N/A	N/A	N/A	N/A	N/A
Lo-Hi-Lo Firing, Lfs & Plfs 90-Sec, Closed Damper Prepurge	A	A	A	A	A	N/A	N/A	N/A	N/A	N/A
Lo-Hi-Lo Firing, Lfs & Plfs 30-Sec, Open Damper Prepurge	A	A	A	A	A	A	A	N/A	N/A	N/A
Modulated Firing, Plfs 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Modulated Firing, Plfs 30-Sec, Open Damper Prepurge	A	A	A	A	A	A	A	A	A	A

S = Standard **A** = Available **N/A** = Not Available

Required UL gas train components must be selected from catalog section 9100. See catalog page 6 for additional components furnished for FM & IRI codes.

OIL ONLY ADDITIONAL COMPONENTS - F.M.

Note: FM code requirements generally do not apply to oil burners rated at less than 5000 mbtu/hr. Standard UL listed burners will be furnished unless otherwise instructed.

Oil only systems furnished to meet FM requirements will be furnished with the following additional features/components:

- Non-recycling flame safeguard programming controls
- Proof of open damper position during pre-purge
- Proof of low fire start
- Low oil pressure switch

OIL ONLY ADDITIONAL COMPONENTS - I.R.I.

Oil only systems furnished to meet IRI requirements will be furnished with the following additional features/components:

- Non-recycling flame safeguard programming controls
- Proof of open damper position during pre-purge
- Proof of low fire start
- Low oil pressure switch
- Audible alarm on safety shut-down

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GAS & OIL U.L.

BURNER COMPONENTS	BURNER SIZE 20	30	40	50	60	80	100	125	150	200
Fabricated Steel Scroll Case	S	S	S	S	S	S	S	S	S	S
Stainless Steel Blast Tube	S	S	S	S	S	S	S	S	S	S
1-Phase Blower Motor	S	S	S	S	S	A	A	A	A	N/A
3-Phase Blower Motor	A	A	A	A	A	A	A	A	A	S
Blower Air Pressure Switch	S	S	S	S	S	S	S	S	S	S
Direct Spark Ignition	A	A	A	A	A	A	A	A	A	A
Gas Pilot (Both Fuels)	S	S	S	S	S	S	S	S	S	S
Ignition Transformer	S	S	S	S	S	S	S	S	S	S
Removable Oil Drawer Asbly	S	S	S	S	S	S	S	S	S	S
Integral Oil Pump	S	S	S	S	S	S	S	N/A	N/A	N/A
Separate Oil Pump/Motor	A	A	A	A	A	A	A	S	S	S
Low Oil Pressure Switch	A	A	A	A	A	A	A	S	S	S
2nd Oil Safety Shut-Off Valve	S	S	S	S	S	S	S	S	S	S
Base Mtd Primary F.S. Control	S	S	S	A	A	A	N/A	N/A	N/A	N/A
Burner Mtd Control Panel	A	A	A	S	S	S	S	S	S	S
Remote Mtd Control Panel	A	A	A	A	A	A	A	A	A	A
FIRING SEQUENCE OPTIONS										
On-Off, Fixed Air 30-Sec, Open Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
On-Off, Lfs & Plfs 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Lo-Hi-Lo Firing, Lfs & Plfs 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Lo-Hi-Lo Firing, Lfs & Plfs 30-Sec, Open Damper Prepurge	A	A	A	A	A	A	A	N/A	N/A	N/A
Modulated Firing, Plfs 90-Sec, Closed Damper Prepurge	A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A
Modulated Firing, Plfs 30-Sec, Open Damper Prepurge	A	A	A	A	A	A	A	A	A	A

S = Standard **A** = Available **N/A** = Not Available
LFS - Low Fire Start
PLFS - Proof Of Low Fire Start

Required UL gas train components must be selected from catalog section 9100. See catalog page 8 for additional components furnished for FM & IRI codes.

GAS/OIL ADDITIONAL COMPONENTS - F.M.

Note: FM code requirements generally do not apply to gas burners rated at less than 2500 mbtu/hr, or oil burners rated at less than 5000 mbtu/hr. Standard UL listed burners in sizes 20 - 50 will be furnished unless otherwise instructed.

Gas/oil systems furnished to meet FM requirements will be furnished with the following additional features/components:

- Non-recycling flame safeguard programming controls
- Proof of open damper position during pre-purge
- Proof of low fire start
- Low oil pressure switch

GAS/OIL ADDITIONAL COMPONENTS - I.R.I.

Gas/oil systems furnished to meet IRI requirements will be furnished with the following additional features/components:

- Non-recycling flame safeguard programming controls
- Proof of open damper position during pre-purge
- Proof of low fire start
- Low oil pressure switch
- Audible alarm on safety shut-down

INSTALLATION REQUIREMENTS

WARNING!

Installation, start-up, 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.

Please refer to the fuel supply tank manufacturer's instructions for information regarding installation of the supply tank and fuel line.

The installer shall identify the Main Electrical Power disconnect, and the manual shut-off valve on the Gas Supply drop-line to the burner.

SAFETY 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 how these controls should 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. The normally-closed 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, of the appliance. The normally-closed contacts of the 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

BURNER ASSEMBLY & COMPONENTS

All burner systems are shipped with installation, operating and maintenance manuals that include a detailed parts list and manufacturers literature to aid in identifying components during installation and service.

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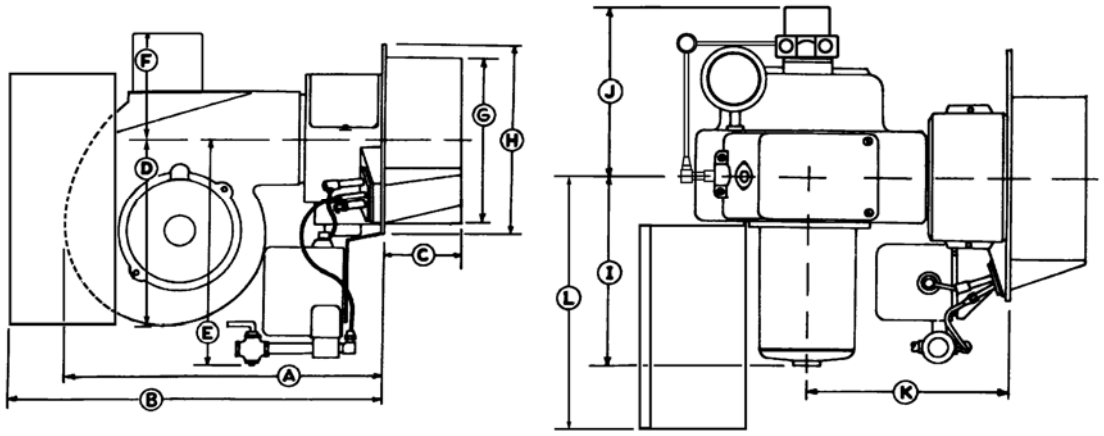
BURNER MOUNTING DIMENSIONS

STRAIGHT GAS & COMBINATION GAS/OIL BURNERS

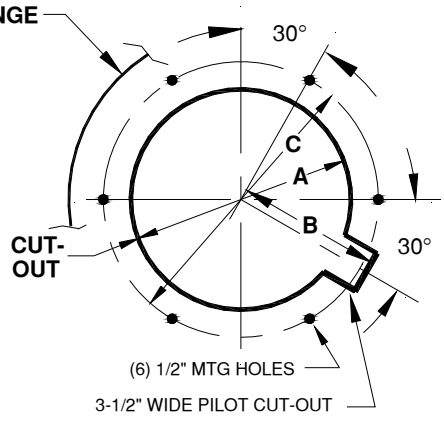


DIMENSIONS IN INCHES

Size	A	B	C	D	E	F	G	H	I	J	K	L*
20	16 7/8	23	4 3/8	8	9 ¾	7	6 ¾	12 ½	11 ¼	9	17 7/8	16 ½
30-40	17	23	4 3/8	10 ¾	11	7 3/8	9 1/8	15 ½	13	10 7/8	12 3/8	16 ½
50-100	23	29	4 3/8	15 1/8	12 ½	8	11 1/8	17 ½	15 ½	12 1/8	14 3/8	17 ½
125-250	30 5/8	33 ¾	4 3/8	17 ½	15 ½	8 ¾	14	20	14 ¾	10 7/8	19 3/8	18 ½

*The control panel is optional on many models, but it is shown here for maximum allowance.

BURNER SIZE	A	B	C	D
20	7-1/2"	5-5/8"	9"	12-1/2"
30 - 40	10-1/4"	7"	11"	15-1/2"
50 - 100	12-1/4"	8"	14"	17-1/2"
125 - 200	15"	9-3/8"	16-1/2"	20"



NOTES: The overall burner dimensions may vary depending on local code a
All dimensions are subject to change without notice.

Dimension "B" pilot cutout is not applicable for the following models:

DHF-G4GM Sizes 50-250 with standard internal gas pilot ignition
DHF-C4GM Sizes 50-250 with standard internal gas pilot ignition

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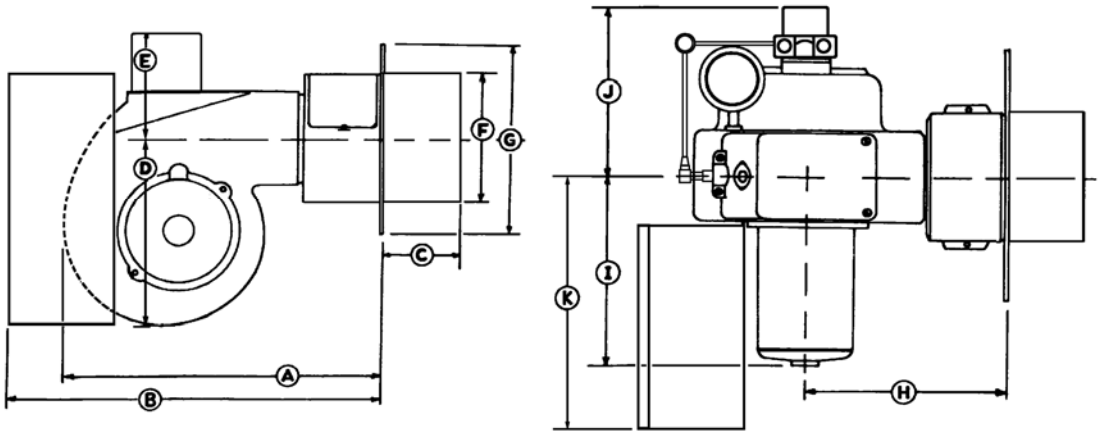
STRAIGHT OIL BURNERS

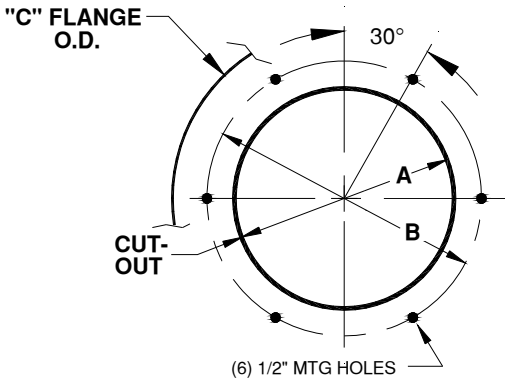


DIMENSIONS IN INCHES

Size	A	B	C	D	E	F	G	H	I	J	K *
20	16 7/8	23	4 3/8	8	7	5	10 ½	17 7/8	11 ¼	9	16 ½
30-40	17	23	4 3/8	10 ¾	7 3/8	7 3/8	12 ½	12 3/8	13	10 7/8	16 ½
50-100	23	29	4 3/8	15 1/8	8	9 1/8	15 ½	14 3/8	15 ½	12 1/8	17 ½
125-250	30 5/8	33 ¾	4 3/8	17 ½	8 ¾	10 1/2	18	19 3/8	14 ¾	10 7/8	18 ½

*The control panel is optional on many models, but it is shown here for maximum allowance.

BURNER SIZE	A	B	C
20	6"	9"	10-1/2"
30 - 40	8"	11"	12-1/2"
50 - 100	10"	14"	15-1/2"
125 - 200	12"	16-1/2"	18"



NOTES: The overall burner dimensions may vary depending on local code and insurance requirements.
All dimensions are subject to change without notice.

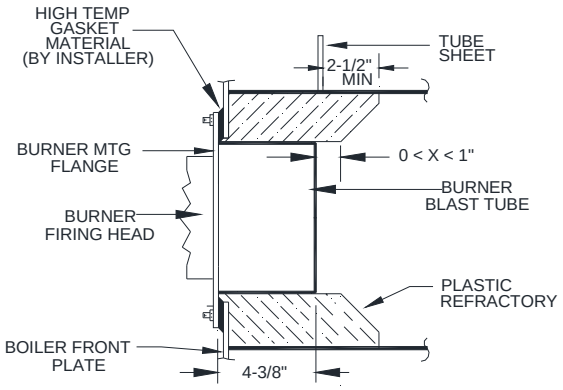
REFRACTORY INSTALLATION ON BOILERS

Plastic refractory must be “rammed” into the area between the outer diameter of the blast tube and the inner diameter of the furnace. This refractory must extend a minimum of 2½ inches beyond the tube sheet or water wall of the boiler.

Refractory extending beyond the end of the blast tube should be tapered from a point no further than 1 inch from the end of the blast tube.

The axial centerline of the burner shall match axial the centerline of the furnace for proper alignment and leveling.

Please refer to the Burner Mounting Dimensions for details on the cutout and bolt circle dimensions.



CONTROL PANEL & LIMIT CONTROLS

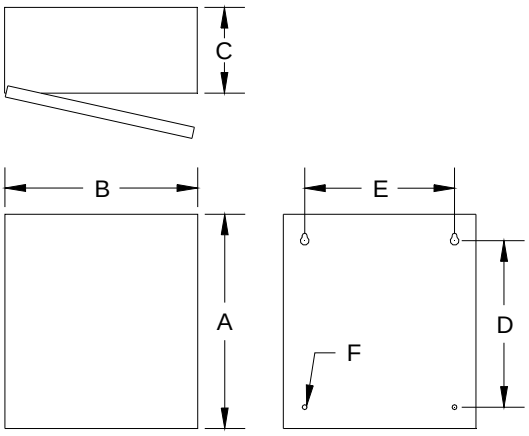
The control panel is furnished mounted on the burner assembly as a standard. If the optional remote panel is specified, it should be installed in a location other than immediately next to, or in line with the burner. It should be mounted on an adjacent wall or on the side of the appliance.

All wiring must comply with, and all branch circuits must be protected according to the National Electrical Code or the Canadian Electrical Code, Part I, as applicable. Flame detector wiring between the burner and the control panel should be run in separate conduit from high voltage conductors.

All safety controls indicated on the wiring schematic furnished with the burner must be installed and wired in the control system as shown. Any discrepancies or wiring changes must be approved by S.T. JOHNSON CO. prior to initial firing of the burner system. Complete details for the flame safeguard control components are available in the manufacturer’s instructions provided in the Manual furnished with the burner, which includes information regarding installation, wiring, adjustment, operation, system start, and shutdown of the electrical controls.

The installation of all burner systems must include an operating limit control and a manual reset high limit control as described on Page 9. If these safety controls were not furnished with the burner system, or 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.

REMOTE PANEL MOUNTING DIMENSIONS



DIMENSIONS IN INCHES

Panel	A	B	C	D	E	F
Small	16	14	7 ¼	14 ½	11 ½	¼
Large	21 ½	21 ½	7 ¼	20	14 ½	3/8

NOTE: Standard DHF burners will have a base mounted control or a burner mounted panel. Remote mounted panels are optional

FRESH AIR SUPPLY

An adequate supply of air into the furnace or boiler room, for satisfactory combustion and ventilation must be provided for all indoor installations. Fans exhausting air from the room should be avoided.

NOTE: For recommended practice, see NFPA 31, Installation of Oil-Burning Equipment, NFPA 54, National Fuel Gas Code, International Fuel Gas Code or CSA B139, Installation code for oil-burning equipment, and CSA B149.1, Natural gas and propane installation code, as appropriate.

EXHAUST

In general, Series DHF burners do not require the use of an induced draft (ID) fan in the stack. In fact, the use of an ID fan can cause unstable or highly negative pressure conditions in the combustion chamber, especially at minimum fire. A high negative pressure (draft) in the combustion chamber can make air damper adjustments very difficult and can be detrimental to flame retention, and combustion pulsation may result. The recommended overfire or appliance outlet pressure (draft) is + 0.75 ”wc.

EQUIPMENT SHALL BE CONNECTED TO FLUES HAVING SUITABLE PRESSURE (DRAFT) AT ALL TIMES TO ASSURE SAFE AND PROPER OPERATION OF THE BURNER.

Installations involving high exhaust stacks, and/or multiple appliances vented to a common stack, should include automatic draft controls for each combustion chamber to eliminate high, or varying, drafts. Please refer to the draft control manufacturers literature for additional information.

GAS IGNITION SYSTEM REQUIREMENTS

Gas Pilot Pressure Requirements:
Gas pilots require a supply pressure of 4" w.c. minimum, not exceeding 10 psig at the gas pressure regulator inlet. Flow requirement ranges from 30 to 40 CFH natural gas (12 to 16 CFH LP gas) depending on individual adjustment.

A pilot gas pressure regulator is provided with an adjustment range of 4 to 12" w.c. Outlet pressure is normally set between 3 to 6" w.c.

Intermittent Pilot Systems:
Standard gas only models in Sizes 20 to 50, and 60 under 2,501 MBH, incorporate an intermittent pilot which remains firing anytime the main flame is firing. Interrupted pilot systems are available for these burners as an option.

Interrupted Pilot Systems:
Gas only models in with a capacity greater than 2,500 MBH, and all sizes of gas/oil models incorporate an interrupted gas pilot.

WARNING!

Do not attempt to startup and commission the burner without first conducting **Normal Pilot Flame** and **Minimum Pilot** operational tests.

All tests must be conducted by a trained and qualified burner technician according to published instructions for the supplied flame safeguard control. Lost or misplaced instructions can be obtained by contacting S.T. Johnson Company.

PRE-FIRING CHECKOUT

WARNING!

Installation, start-up, 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 the components in the systems can result in personal injury or property damage.

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

DO NOT ATTEMPT TO START THE BURNER WHEN EXCESS OIL HAS ACCUMULATED, OR WHEN THE FURNACE OR BOILER IS FULL OF VAPOR.

PRE-STARTUP CHECKOUT

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 ensure 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 damper to insure proper operation without binding or slippage.

7. Insure all pumps have been properly primed with 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 limit controls
    - Boiler pressure safety relief valves(s)
    - Boiler low water cut-out(s)
    - Burner fuel pressure switches
    - Burner blower air pressure switch

10. Conduct Normal Pilot Flame and Minimum Pilot operational tests.

GAS TRAIN INSTALLATION

SELECTION & SIZING

Gas trains are selected according to local code and insurance requirements as listed in Catalog Section 9000. Components are sized according to available gas supply pressure, burner capacity, and furnace pressure. As a guide standard sized are listed in the catalog bulletin along with the required outlet pressure of the main pressure regulator.

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 to the heating appliance. (Refer to the specifications and installation instructions furnished with the operating manual).

FIELD PIPING

The piping should have as few directional 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 components are shipped loose for field piping, unless ordered “pre-piped” from the factory. Gas train assembly drawings are provided in the installation and operating manual with each system.

VENT CONNECTIONS

Gas train assemblies to meet I.R.I. code, and all gas trains for capacities greater than 12,500 MBTU/Hr, include a normally-open vent valve for installation between the two 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 ¼ inch OD tubing as a minimum. All vent lines 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.

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 that leak testing be performed monthly.

Always keep the fuel gas main manual supply valve shut off if the burner is shut down for an extended period of time.

MAIN GAS ADJUSTMENT

ALL SYSTEMS

Before proceeding with the main fuel/air adjustment, all appropriate “pre-firing” checkouts (see previous Section) must be performed. Also insure that all linkages are properly set to provide for the minimum positions of both the air shutter and fuel control valve at low fire.

A pilot turndown test must be performed according to the flame safeguard manufacturers instructions provided with this burner system. This test must insure that the main burner flame can be smoothly ignited with the smallest pilot flame that can be detected by the flame detector.

The use of the "TEST/RUN" switch on the flame safeguard programmer, and the manual firing rate potentiometer furnished with modulating systems, is recommended to facilitate main fuel/air adjustment.

Flue gas constituents should be analyzed at all firing rates to optimize the levels of O_2 and CO_2 and insure that the level of CO is not excessive. The exact percentage of these constituents can vary according to the application but O_2 levels will typically be 6 to 7% at low fire and gradually decrease to 3 to 4% at high fire. The required low fire adjustment is often affected by the combustion chamber size, with very small chambers requiring more air to achieve proper flame geometry and avoid flame impingement.

Manifold gas pressure should be read, and recorded, using a manometer connected to the test port located on the left side of the burner mounting flange. 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 maximum burner capacity are listed on Page 18.

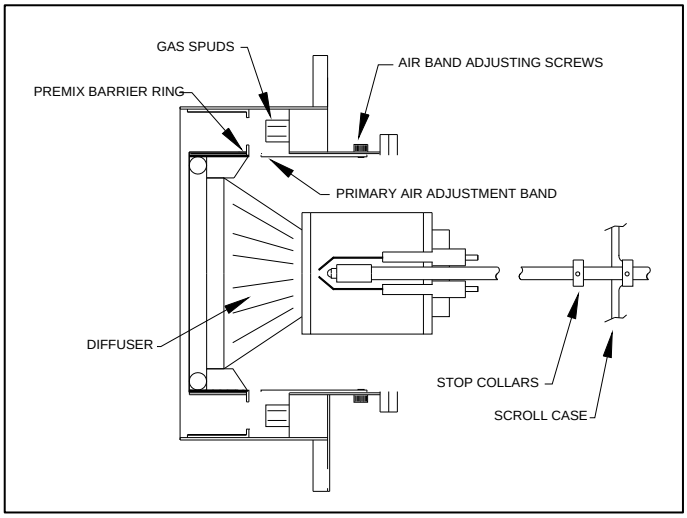
Burners designed to fire fuel other than natural gas will typically be constructed with different gas jet orifices and will require manifold pressures similar to those listed on Page 18 for natural gas. All burners with special configurations will have the proper high fire manifold pressure stamped on the burner nameplate.

PRIMARY AIR ADJUSTMENT BAND

Model DHF gas burners are designed with a primary air adjustment band. The amount of air permitted to mix immediately with the raw gas emerging from the gas spuds will have a decided effect on the quietness of combustion and flame stability. Moving the band forward will reduce the amount of air in the mixture injected through the ports in the premix barrier ring, while moving the band back will increase the air in this mixture. Decreasing the primary air will result in a longer, slower mixing flame; however moving the band too far forward (closed) can result in a loss of flame retention on the face of the burner.

Proper adjustment is made by pushing the band forward just until the flame starts to pant or pulsate, then pulling it back (open) to establish a soft, evenly distributed flame without a harsh, premix noise characteristic. Rarely is the band pulled all the way open, which can result in a noisy, fast mixing flame that will burn too close to the jets. This type of flame will typically generate more NOx, when burner emissions are of concern. Too much primary air may also cause premature deterioration of the premix barrier ring and burner nose piece.

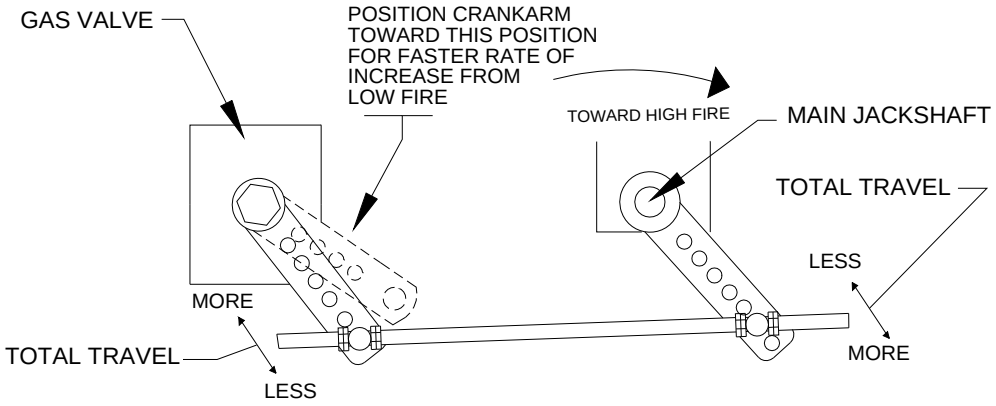
Once a satisfactory setting is obtained, the air adjustment band space should be checked for an even opening and the adjusting screws should be tightened in place. There should be no need to readjust unless the application requires the band to be set all the way forward when firing with oil on combination gas and oil systems.



MODULATING SYSTEMS

It is recommended to make fuel/air adjustments in the "MANUAL" firing rate mode utilizing the manual firing rate potentiometer to gradually increase the firing during adjustment. At high fire, gas flow is set according to the manifold pressure listed on PAGE 18.

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 crank arm relative to the position of the jackshaft crank arm. The effect of changing these relative positions is shown below:



LO-HI-LO SYSTEMS

Gas only versions of LO-HI-LO systems utilize a "HI-LO-OFF" actuator on the main gas shut-off valve for firing rate control. The position of the air damper is controlled via a linkage connected to this actuator. The low fire position of the air damper, and the percentage opening of the gas valve is set via an adjustment on the actuator. Refer to the manufacturer's instruction manual for the specific actuator furnished.

High fire gas flow is set according to the manifold pressure listed on PAGE 18. Adjustment of the linkage between the gas valve actuator and the air damper sets the proper airflow.

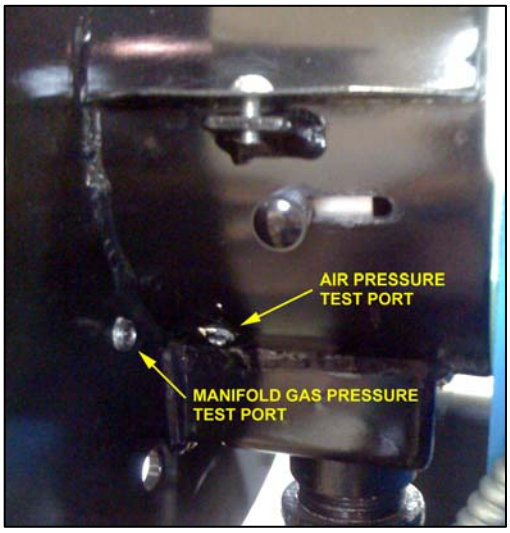
Combination gas and oil versions of LO-HI-LO systems utilize a separate 2-position actuator mounted on the burner for firing rate control. Airflow is controlled in the same manner as the gas only versions, but gas flow is controlled via a gas butterfly valve connected via a linkage to the actuator. Fuel/air ratios are adjusted by the setting of the linkages to the air damper and the gas butterfly valve.

ON-OFF, FIXED AIR SYSTEMS

Gas flow is controlled by setting the main gas pressure regulator to achieve the proper gas manifold pressure listed on PAGE 18. The air damper is adjusted to give the desired fuel/air ratio, and then it is locked into position.

GAS MANIFOLD PRESSURE ADJUSTMENT

Gas manifold pressure is measured with a manometer connected to the test port on the left side of the burner mounting flange. The manifold test port should not be confused with the air pressure test port located on the blast tube.



The following tables should be used as a guide to setting the high fire gas manifold pressure for sea level operation. The maximum capacities listed can be obtained firing against +0.75" w.c. furnace pressure or less. The manifold pressures listed do not take into account furnace pressure. Manifold pressures for firing into positive furnace pressures can be obtained by adding the furnace pressure to the manifold pressure listed.

NOTE: Burners operating with the air adjustment band completely back would require slightly higher manifold pressures than when operating with the air adjustment band completely forward.

TABLE A: GAS MANIFOLD PRESSURES FOR 60 Hz OPERATION

Burner Size	20	30	40	50	60	80	100	125	150	200	250
Gas Jet QTY	12	24	24	30	30	30	30	72	72	72	72
Orifice Size, Nat Gas	#18	9/64	#18	3/16	13/64	15/64	15/64	3/16	13/64	15/64	15/64
Orifice Size, LP Gas	1/8	7/64	1/8	#30	9/64	#16	#16	#30	9/64	#20	#20
Maximum MBTU/Hr	840	1260	1680	2100	2520	3360	4200	5250	6300	8400	10500
Manifold Pressure, in. w.c.	3.7	4.4	4.0	3.1	3.1	3.2	5.1	2.7	2.7	2.9	4.5

TABLE B: GAS MANIFOLD PRESSURES FOR 50 Hz OPERATION

Burner Size	20	30	40	50	60	80	100	125	150	200	250
Gas Jet QTY	12	24	24	30	30	30	30	72	72	72	72
Orifice Size, Nat Gas	5/32	#30	5/32	11/64	3/16	7/32	7/32	11/64	3/16	7/32	7/32
Orifice Size, LP Gas	#33	3/32	#33	#33	#30	9/64	9/64	1/8	#30	5/32	5/32
Maximum MBTU/Hr	700	1050	1400	1750	2100	2800	3500	4375	5250	7000	8750
Manifold Pressure, in. w.c.	3.7	4.4	4.0	3.1	3.1	3.2	5.1	2.7	2.7	2.9	4.5
Maximum KCAL/Hr x 1000	175	260	350	435	525	695	870	1090	1310	1745	2180
Manifold Pressure, mm Aq	94	112	102	79	79	81	130	69	69	74	114

OIL PUMP OPERATION & PIPING

WARNING!

All standard size 20 through 100 combination gas/oil burners include an integral oil pump driven by the forced draft fan motor. If it is necessary to operate the burner on gas, without having an adequate supply of oil to the oil pump, the oil pump drive coupling must be disconnected from the splined hub of the fan wheel. Access to the coupling is achieved by removing the top cover of the fan housing.

Failure to provide an adequate supply of oil to the pump, or failure to disconnect the pump coupling, while firing on gas, may cause permanent damage to the oil pump.

Fuel oil shall not be heavier than No. 2. DO NOT USE GASOLINE, CRANKCASE OIL, OR ANY OIL CONTAINING GASOLINE.

ALWAYS KEEP THE FUEL OIL SUPPLY VALVE SHUT OFF IF THE BURNER IS SHUT DOWN FOR AN EXTENDED PERIOD OF TIME.

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

OIL PIPING

Oil pumps are designed for use with a “two-pipe” system; an oil return line **MUST** be installed from the return port of the pump to the oil tank. DO NOT operate the pump without a return line properly installed.

On burner Sizes 20 to 100, a bypass plug is factory installed in the upper right-hand inlet port of the pump for operation in a "two-pipe" system; refer to the manufacturer’s literature included in the burner operating manual. In general, the size of the return line can be one pipe size smaller than the recommended supply line size.

FIELD PIPING REQUIREMENTS

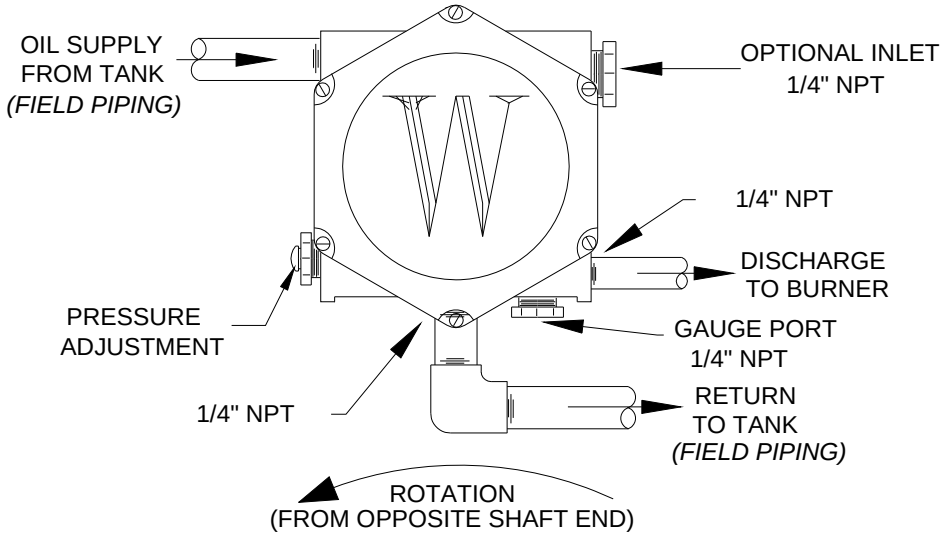
A filter **MUST** be installed in the oil supply line to protect the oil pump and safety valves from debris in the oil tank and supply piping. The filter must be cleaned according to the manufacturer’s instructions provided in the manual furnished with the burner.

An anti-siphon valve should be installed at the highest point in the suction line when the oil storage tank is located above the level of the burner. It is advisable to install a shut-off valve and a check valve in the supply line near the burner and a “foot valve” at the end of the suction line inside the oil tank.

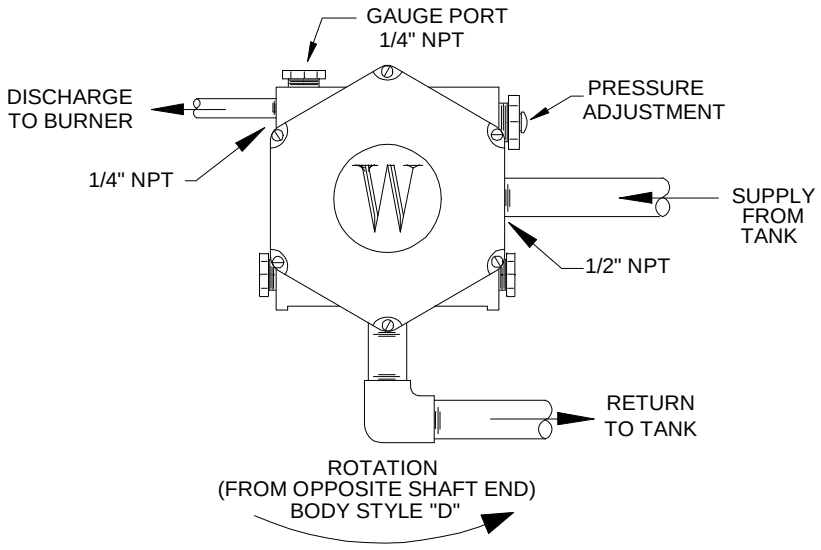
The following table can be used as a guide to supply line sizing:

Lift/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”

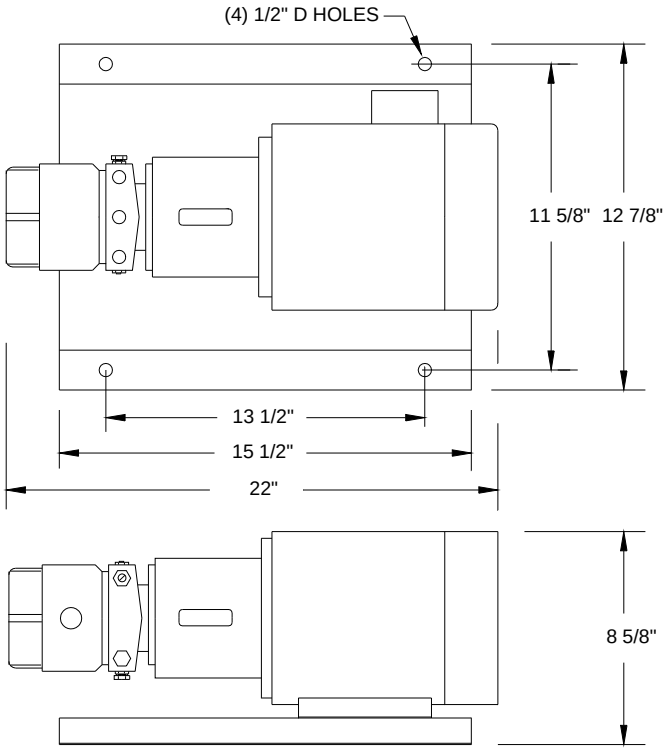
WEBSTER MODEL "R" INTEGRAL OIL PUMP CONNECTIONS: BURNER SIZES 20 – 100



WEBSTER "V-SERIES" REMOTE OIL PUMP CONNECTIONS: BURNER SIZES 125 – 250



REMOTE PUMP MOUNTING DIMENSIONS



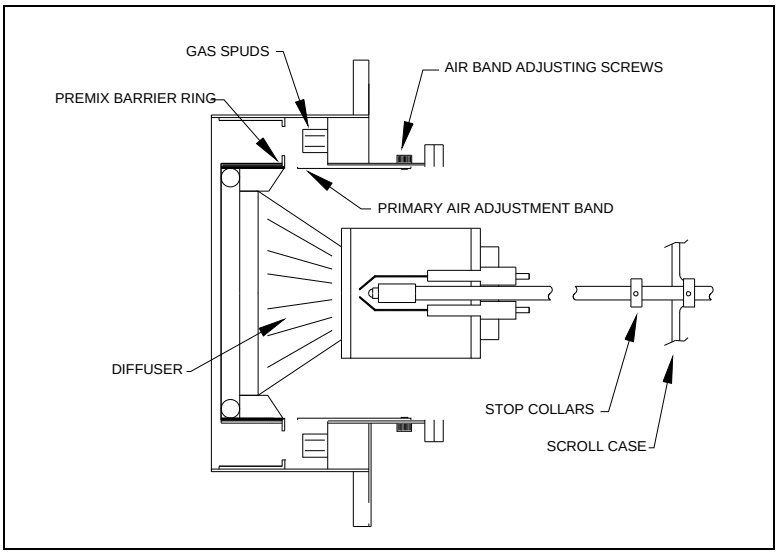
OIL SYSTEM ADJUSTMENTS

COMBUSTION AIR ADJUSTMENTS

Total airflow is controlled with the air damper on the inlet to the forced draft fan. Because the forced draft fan is designed to supply sufficient combustion air when firing against high furnace pressure, the total opening of the damper must be restricted on applications where the furnace pressure is balanced, or negative. The final setting of the air damper will be determined by analyzing the flue gas. Refer to the main burner adjustment instructions for the specific control system involved on PAGES 22 through 34.

Note: Best performance when firing oil with a combination gas & oil burner will be obtained with the primary air adjustment band set to the forward-most position (closed), especially on fire-tube boiler applications.

The diffuser positioning should be completely forward for most applications. The diffuser is completely forward when the oil drawer assembly is positioned with its outer stop collar up against the rear of the scroll case. This setting will result in a maximum amount of combustion air being driven through the diffuser louvers and into the atomized oil spray.



Primary Air Adjustment should be closed for best results when firing oil.

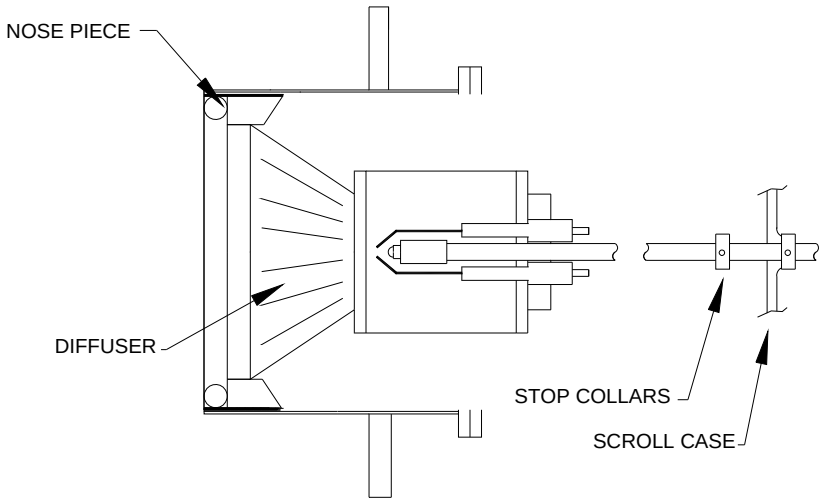
OIL FLOW ADJUSTMENTS

The oil supply pressure from the pump, and the nozzle size on all systems determines total oil flow. The firing rate of modulating systems is also determined by the setting of the return-flow oil metering valve. Refer to the main burner adjustment instructions on PAGES 22 through 34 for the proper oil supply pressure settings and nozzle sizes.

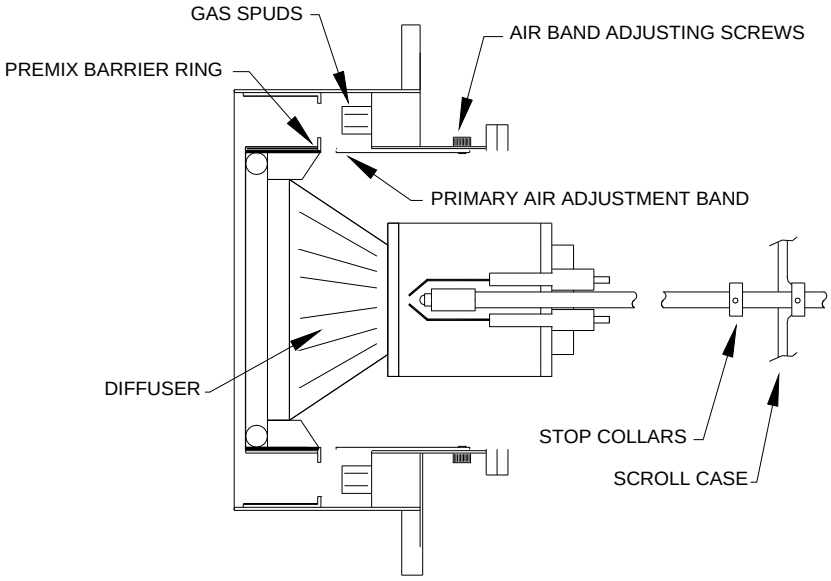
Applications involving the “downsizing” of burners should utilize smaller nozzles rather than lower supply pressures. The supply pressure fixed-firing-rate nozzles should never be less than 100 psig.

OIL FIRING HEAD ADJUSTMENTS

STRAIGHT OIL BURNERS



COMBINATION GAS & OIL BURNERS



OIL NOZZLE & ELECTRODE ADJUSTMENTS

The nozzle and electrode position relative to the air diffuser can be changed by loosening the set screw fastening the stabilizer to the oil drawer assembly and repositioning the stabilizer, sleeve and diffuser sub-assembly relative to the nozzle(s).

DELAVAN "VARIFLO" OIL NOZZLE POSITIONING

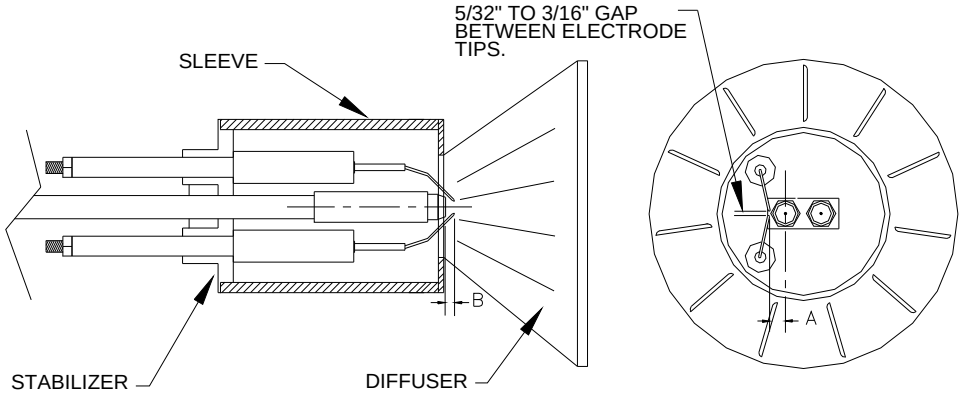
All systems utilizing "Delavan" oil nozzles should have the tip of the oil nozzle(s) positioned even with the rear of the Air Diffuser. Delavan nozzles are factory installed in 60° degree spray angles only. The nozzle(s) can be positioned further forward as long as the ignition electrodes are not within ¼" of the diffuser, or the nozzle(s) themselves. Positioning the nozzles too far back can result in oil impingement on the air diffuser.

MONARCH "PLP & BPS" OIL NOZZLE POSITIONING

All systems utilizing "Monarch" oil nozzles should have the tip of the oil nozzle(s) positioned even with or up to 5/16" in back of the rear of the Air Diffuser. Monarch nozzles are usually furnished in 60° degree spray angles. The nozzle(s) can be positioned forward as long as the ignition electrodes are not within ¼" of the diffuser, or the nozzle(s) themselves. Positioning the nozzles too far back can result in oil impingement on the air diffuser.

ELECTRODE POSITIONING

Electrode positioning is a function of the nozzle spray angle (dimensions listed for 45° and 80° degree nozzles are listed only in the remote chance the standard 60° nozzles are changed. The recommended distance from the centerline of the nozzle, "A", and the distance from the tip of the nozzle, "B", are listed in the table below. The spark gap between the electrodes should be 5/32" to 3/16" for all nozzles. No portion of the electrodes should be within ¼" of any burner component.



Spray Angle	Setting	
	A	B
45	¼" – 5/16"	¼" – 5/16"
60	5/16" – 3/8"	3/16" – ¼"
80	3/8" – 7/16"	1/8" – 3/16"

ON-OFF, FIXED-AIR OIL SYSTEMS

Refer to PAGE 14 for Pre-Firing Checkout of the burner and controls.

MAIN BURNER ADJUSTMENT

All of the manufacturer's manuals for the system components should be studied 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.

The oil piping schematic for these systems is shown on PAGE 26.

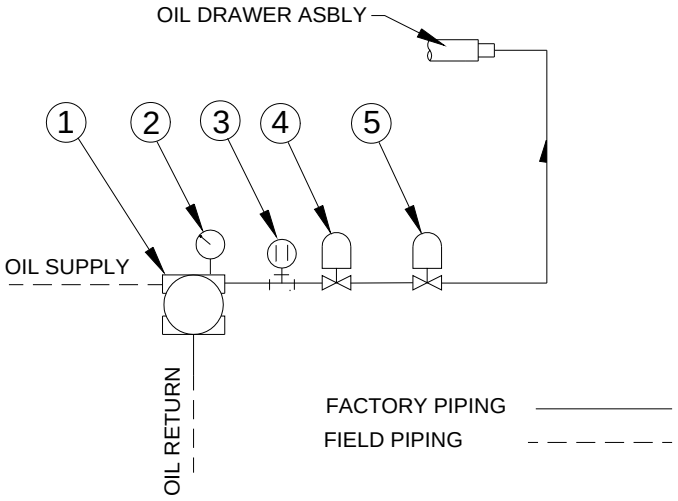
Fuel flow is adjusted by the setting of the oil pump pressure as listed in the chart below. If it is desired to operate at a reduced firing rate, the nozzle size should be reduced rather than reducing the pump pressure.

Airflow is adjusted by the setting the air damper to achieve the desired fuel/air ratio.

SPECIFICATIONS FOR ON-OFF, FIXED-AIR OIL SYSTEMS (60 Hz)

BURNER SIZE	NOZZLE SIZE (GPH)	PUMP MODEL	SUPPLY PRESSURE (PSIG)	FIRING RATE (GPH)
20	(1) 6.0	22R221	100	6.0
30	(1) 9.0	22R221	100	9.0
40	(1) 12.0	22R221	100	12.0
50	(2) 7.5	22R221	105	15.0
60	(2) 8.5	22R221	120	18.0
80	(1) 9.5	22R221	120	20.0

OIL PIPING SCHEMATIC FOR ON-OFF, FIXED-AIR OIL SYSTEMS



COMPONENTS:

1. OIL PUMP
2. OIL SUPPLY PRESSURE GAUGE
3. LOW OIL PRESSURE SWITCH (OPTIONAL)
4. OIL SAFETY SOLENOID VALVE
5. 2nd OIL SOLENOID VALVE

2-STEP START OIL SYSTEMS

Refer to PAGE 14 for Pre-Firing Checkout of the burner and controls.

MAIN BURNER ADJUSTMENT

All of the manufacturer's manuals for the system components should be studied 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.

The oil piping schematic for these systems is shown on PAGE 28. The first stage is powered by the pilot terminal of the primary flame safeguard control. Upon flame detection the second stage is powered by the main burner terminal of the control.

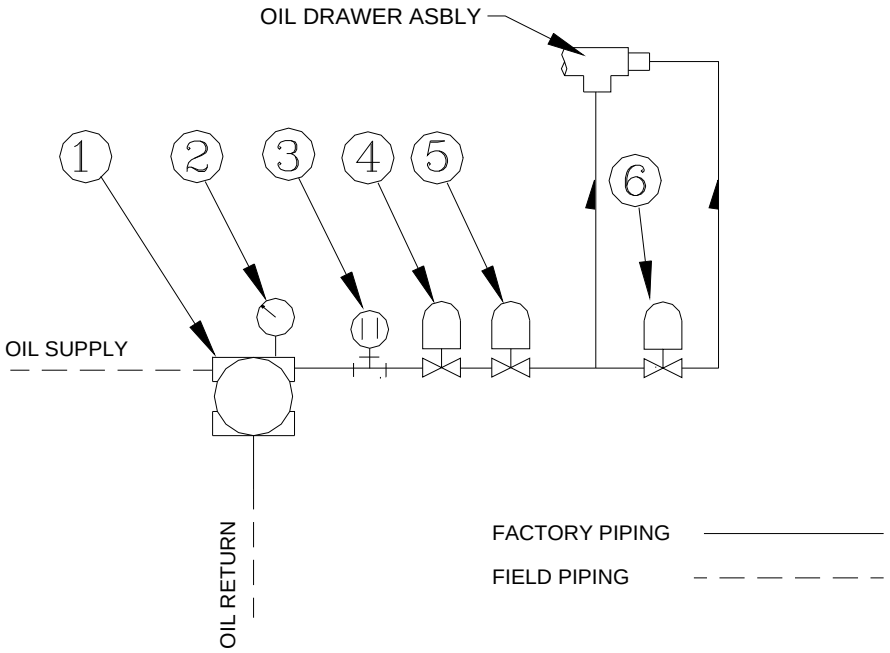
Fuel flow is adjusted by the setting of the oil pump pressure as listed in the chart below. If it is desired to operate at a reduced firing rate, the nozzle size should be reduced rather than reducing the pump pressure.

Airflow is adjusted by the setting the air damper to achieve the desired fuel/air ratio with BOTH oil stages energized.

SPECIFICATIONS FOR 2-STEP START OIL SYSTEMS (60 Hz)

BURNER SIZE	NOZZLE SIZE (GPH)	PUMP MODEL	SUPPLY PRESSURE (PSIG)	FIRING RATE (GPH)
20	(2) 3.0	22R221	100	6.0
30	(2) 4.5	22R221	100	9.0
40	(2) 5.5	22R221	100	12.0
50	(2) 7.5	22R221	105	15.0
60	(2) 8.5	22R221	120	18.0

OIL PIPING SCHEMATIC FOR 2-STEP START OIL SYSTEMS



COMPONENTS:

1. OIL PUMP
2. OIL SUPPLY PRESSURE GAUGE
3. LOW OIL PRESSURE SWITCH (OPTIONAL)
4. OIL SAFETY SOLENOID VALVE
5. 1ST STAGE OIL SOLENOID VALVE
6. 2ND STAGE OIL SOLENOID VALVE

LO-HI-LO OIL SYSTEMS

Refer to PAGE 14 for Pre-Firing Checkout of the burner and controls.

MAIN BURNER ADJUSTMENT

All of the manufacturer's manuals for the system components should be studied 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.

1st STAGE ADJUSTMENT

Reduce the set point of the LO-HI-LO controller, or disconnect it's wiring from the control circuit, to insure the burner will remain at the low fire position during adjustment. The fuel/air setting is accomplished by the low fire setting of the air shutter. The O_2 level should be 6 to 9% for the initial setting. Too much will result in high levels of CO and white smoke, while too little air will result in high levels of HC and black smoke. Final settings will be influenced by furnace dimensions, desired flame geometry, etc.

2nd STAGE ADJUSTMENT

Remove the cover on the 2-position actuator and reconnect the wiring to the LO-HI-LO controller, and/or increase it's set point, to force the burner to high fire. The 2nd stage oil valve will be energized through the auxiliary switch in the actuator. The point at which the 2nd stage is energized is adjustable anywhere from 5 to 70 degrees of actuator stroke. The exact setting for energizing the 2nd stage will be influenced by application variables such as furnace pressure, desired maximum firing rate, etc with 50 to 60 degrees of actuator stroke being the most common setting.

Energizing the 2nd stage too soon will result in black smoke upon energizing, while bringing the 2nd stage on too late will result in white smoke just prior to the introduction of the 2nd stage oil.

If problems are incurred obtaining proper combustion, check for dirty or clogged oil nozzles. If proper supply pressure cannot be obtained check for restrictions in the oil suction line, especially the oil strainer.

WARNING!

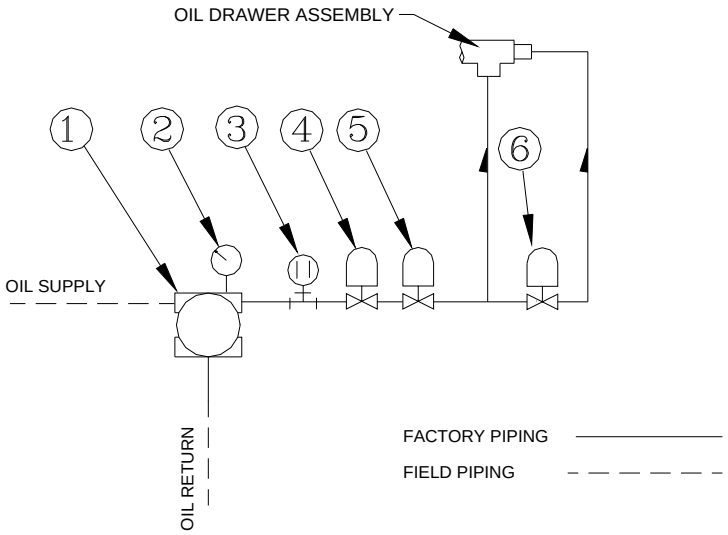
After making final adjustments check tightness of all linkage connections and insure there is no binding of linkages during travel between maximum and minimum positions. Record all pressures and valve settings for future reference.

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.

SPECIFICATIONS FOR LO-HI-LO OIL SYSTEMS (60 Hz)

BURNER SIZE	NOZZLE SIZE (GPH)	PUMP MODEL	SUPPLY PRESSURE (PSIG)	FIRING RATE (GPH)	
				HIGH	LOW
20	(2) 3.0	22R221	100	6.0	3.0
30	(2) 4.5	22R221	100	9.0	4.5
40	(2) 5.5	22R221	120	12.0	6.0
50	(2) 7.5	22R221	105	15.0	7.5
60	(2) 8.5	22R221	125	18.0	9.0
80	(2) 12.0	22R221	105	24.0	12.0
100	(2) 13.5	22R623	125	30.0	15.0

OIL PIPING SCHEMATIC FOR LO-HI-LO OIL SYSTEMS



COMPONENTS:

1. OIL PUMP
2. OIL SUPPLY PRESSURE GAUGE
3. LOW OIL PRESSURE SWITCH (OPTIONAL)
4. OIL SAFETY SOLENOID VALVE
5. 1ST STAGE OIL SOLENOID VALVE
6. 2ND STAGE OIL SOLENOID VALVE

MODULATING OIL SYSTEMS

Refer to PAGE 14 for Pre-Firing Checkout of the burner and controls.

MAIN BURNER ADJUSTMENT

All of the manufacturer's manuals for the system components should be studied 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 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 rear of the burner. Refer to PAGE 32 for nominal supply pressure, return pressures and valve settings, PAGE 33 for piping arrangement, and PAGE 34 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 O_2 readings are 3 to 4% at high fire and 6 to 9% at low fire. A smoke reading should also be taken to insure proper adjustment and good atomization of the oil.

The presence of white smoke indicated 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.

If problems are incurred obtaining proper combustion, check for dirty or clogged oil nozzles. If proper supply pressure cannot be obtained, check for restrictions in the oil suction line, especially the oil strainer.

WARNING!

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

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.

SPECIFICATIONS FOR MODULATING OIL SYSTEMS: 60 Hz OPERATION
USING DELAVAN VARIFLO NOZZLES (S.O.# 290131 & HIGHER)

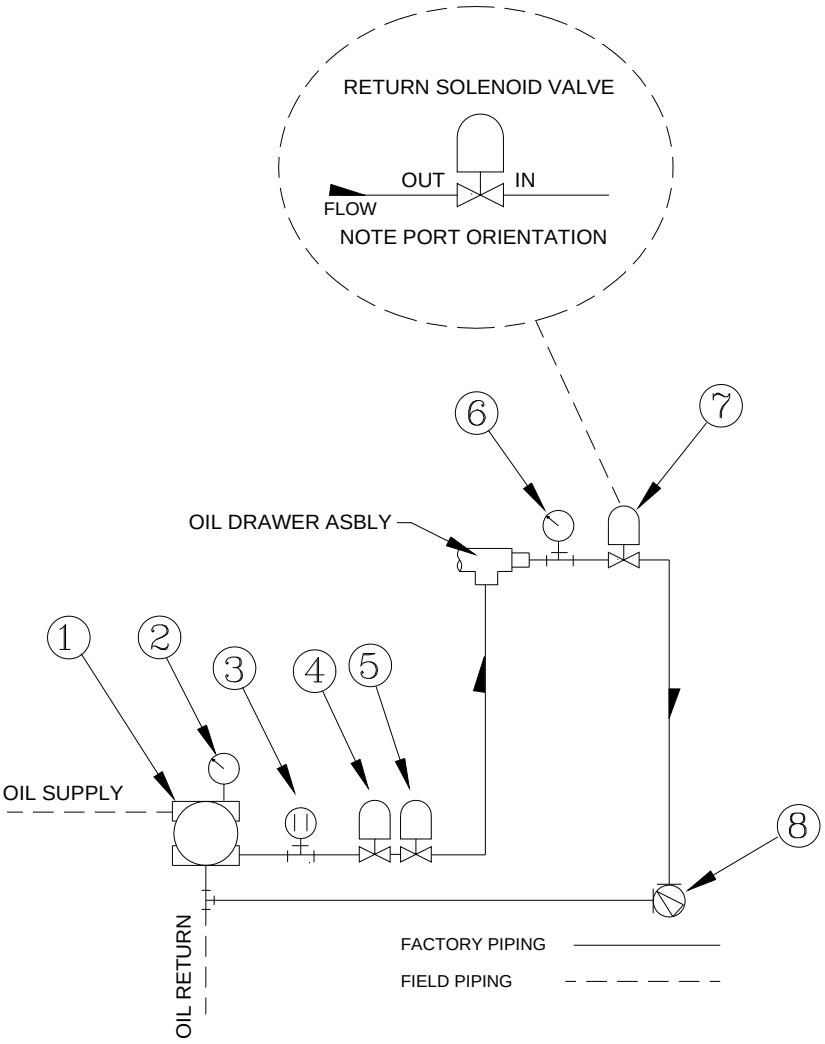
BURNER SIZE	NOZZLE SIZE	METERING VALVE	PUMP MODEL	SUPPLY PRESSURE (PSIG)	RETURN PRESSURE / VALVE POSITION [1]		FIRING RATE (GPH) [2]	
					HIGH	LOW	HIGH	LOW
20	(1) 3.5	S3-3	22R221	275	125 / 0	65 / 6	6	2
30	(1) 5.0	S3-3	22R221	300	138 / 0	75 / 11	9	3
40	(1) 7.0	S3-5	22R221	275	126 / 0	65 / 6	12	4
50	(2) 4.5	S3-5	22R221	275	138 / 0	70 / 7.5	15	5
60	(2) 5.0	S3-5	22R221	300	140 / 0	70 / 9	18	6
80	(2) 7.0	S3-7	22R623	275	130 / 0	70 / 6	24	8
100	(2) 9.0	S3-7	22R623	275	118 / 0	65 / 7	30	10
125	(2) 10.0	S3-9	V024	300	161 / 0	70 / 5.5	38	12
150	(2) 12.0	S3-9	V024	300	155 / 0	90 / 5.5	45	15
200	(2) 18.0	S3-11	V026	280	154 / 0	70 / 7	60	20
250	(2) 22.0	S3-11	V026	295	136 / 0	65 / 10.5	75	25

1 Optimum return flow pressures are influenced by combustion chamber static pressure, desired maximum capacity, altitude, and customer preference. The pressures listed are a guide for initial settings with the final settings being determined by analysis of the flue gas.

2 Maximum capacity at sea level and +0.75" w.c. combustion chamber static pressure.

NOTE: If a reduced maximum firing rate is desired on any given size burner it is recommended to use smaller nozzle(s) when possible, rather than reducing the operating pressures.

OIL PIPING SCHEMATIC FOR MODULATING OIL SYSTEMS



COMPONENTS

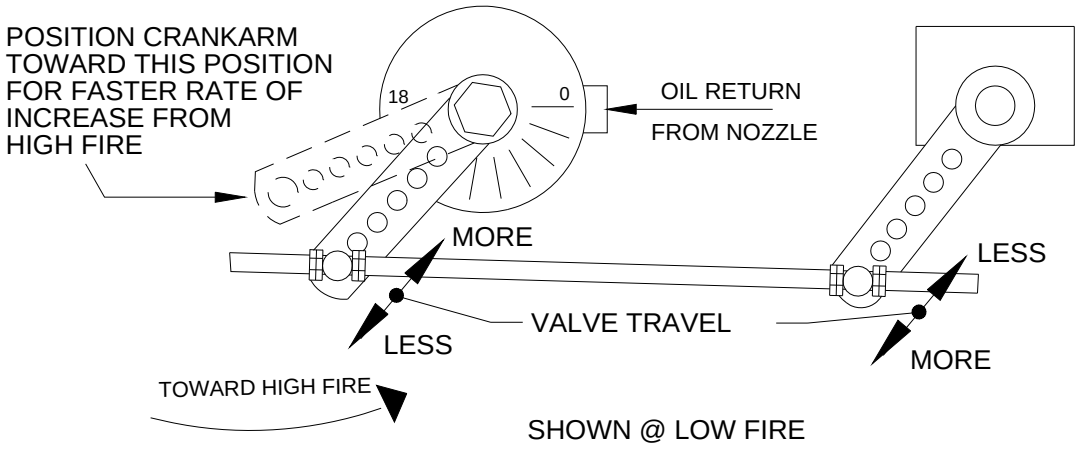
1. OIL PUMP
2. OIL SUPPLY PRESSURE GAUGE
3. LOW OIL PRESSURE SWITCH (OPTIONAL ON SIZES 20 - 100)
4. SUPPLY OIL SOLENOID VALVE
5. 2nd OIL SOLENOID VALVE
6. RETURN OIL PRESSURE GAUGE
7. RETURN OIL SOLENOID VALVE
8. OIL METERING VALVE

METERING VALVE LINKAGE SETTINGS

The typical linkage and crank arm arrangement for the oil metering valve is shown below for the series DHF return-flow oil systems.

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 and high fire. In general the fastest rate of increase of airflow is from minimum to the middle firing range with very little increase at the highest end of the linkage travel.

The position of the metering valve crank arm can be changed without changing the metering valve setting by loosening both the socket head screw on the crank arm collar and the hex head nut on the valve shaft and loosening the linkage connected to the crank arm.



Similar adjustments can be made to the air butterfly linkage and/or crank arm if it is desired to slow down the rate of air flow increase from minimum fire to the intermediate firing range.

MAINTENANCE RECOMMENDATIONS

ROUTINE (OPERATIONAL) BURNER CHECKS:

- Visual appearance of flame (no impingement on furnace, etc)
- Gas or oil leaks in fuel piping system
- Abnormal bearing noise from motors
- Abnormal vibration from fan wheel
- Loose or bent control linkage
- 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 provided in the operating manual for check-out instructions for each specific control.

- 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.
- Reduce the set point of the operating limit control below the existing pressure, or temperature, condition. The burner should shut down immediately.
- 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.
- 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.
- Reduce the set point of the low combustion air pressure switch. The burner should shut down immediately requiring a manual reset to restart.

NON-OPERATIONAL CHECKS:

- Cleanliness of flame scanner lens
- Deterioration of pilot, ignition electrode and firing head components
- Build-up on ignition electrode insulator and ignition cable
- Clean oil filter and oil nozzle screens according to the manufacturer's instructions provided in the manual furnished with the burner.
- Dirt build-up on fan blades
- Check for proper and safe operation of flame safeguard programmer according to the manufacturer's instructions provided in the manual furnished with the burner.
- 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.

SERVICE:
Contact your service person, or ST Johnson Company for a referral to authorized factory trained personnel, at least once a year.

TROUBLESHOOTING HINTS

SYMPTOM	PROBABLY CAUSE
Call for Heat but burner will not start	• High limit control “LOCKED OUT” • Low water cut-out “LOCKED OUT” • Burner Flame Safeguard programmer “LOCKED OUT” • Blower motor overload relay tripped • Blower motor circuit protection tripped • Blower motor defective
Burner starts but will not complete the pre-purge cycle	• Blower air pressure switch not making • Fuel pressure switch not making • Auxiliary contacts on motor starter open • Auxiliary contacts on oil pump starter open (if used) • Defective Flame Safeguard programmer module
Purge complete but ignition not attempted	• Low fire start switch not making (if used)
Ignition attempted but unsuccessful (Gas ignition systems)	• Pilot gas cock closed • Pilot gas pressure insufficient • Ignition transformer defective • Pilot solenoid valve defective • Ignition electrode insulator cracked or dirty • Ignition electrode gap improperly set • Incorrect flame scanner sighting • Flame scanner defective
Ignition attempted but unsuccessful (Direct-spark oil systems)	• Ignition electrode gap improperly set • Ignition electrode insulator cracked or dirty • Ignition electrode oil nozzle gap incorrect • Ignition transformer defective • Low fire oil pressure incorrectly set • Dirty or damaged oil nozzle(s)
Pilot established but main flame ignition is unsuccessful	• Main fuel valve closed • High fuel pressure switch tripped when main fuel valve opens • Main gas control valve completely closed at low fire • Improper fuel and air ratio at low fire
Main flame established but burner shuts down when modulating to high fire	• Improper fuel and air ratio at mid-firing range • Insufficient gas pressure from main regulator • Low fuel pressure switch set too high • High limit control set too low or defective
Burner remains at low fire with increasing load demand	• Modulating controller set too low or defective • Modulating motor defective • Control system in “Manual, Low Fire” mode
Lack of flame retention when firing on oil	• Dirty or damaged oil nozzle(s) • Fuel and air ratio is adjusted too rich
Creation of soot in furnace when firing on oil	• Dirty or damaged oil nozzles(s) • Fuel/air ratio is set too fuel rich • Spray angle of nozzle not correct for furnace • Air adj. Band set too far back for the application • Damaged air diffuser
Low fire oil pressure can’t be set low enough on modulating systems	• Oil leakage past Teflon seal on nozzle(s) • Oil leakage past the O-ring seal in the supply/return isolating fitting

SYMPTOM	PROBABLY CAUSE
Improper oil atomization	• Dirty or damaged oil nozzle(s) • Oil leakage past Teflon seal on nozzle(s) • Oil leakage past the O-ring seal in the supply/return isolation fitting
Improper fuel/air mixing and/or high CO firing on gas	• Gas orifices are damaged • Premix barrier ring is damaged • Gas leakage through damaged gas manifold • Fuel/air mixture is incorrect
High CO firing on oil	• Fuel/air mixture set too “lean”
High CO and HC firing on oil	• Fuel/air mixture is set too “rich”
Intermittent shut downs when firing on oil	• Oil coating on the flame scanner lens • Flame scanner not properly sighting flame • Flame scanner cell is “weak” • Flame amplifier is defective • Air infiltration in the oil
Proper oil supply pressure can’t be set high enough	• Clogged oil filter • "Weak" oil pump • Air in oil • Coupling splines may be worn
Oil supply pressure varies and oil pump “screams”	• Air in oil
Oil leaks into combustion chamber when burner is off	• The return flow solenoid valve is installed with the inlet port facing the burner. Reverse the valve.

DHF-LN (LOW NOx) BURNERS WITH FLUE GAS RECIRCULATION OPTION

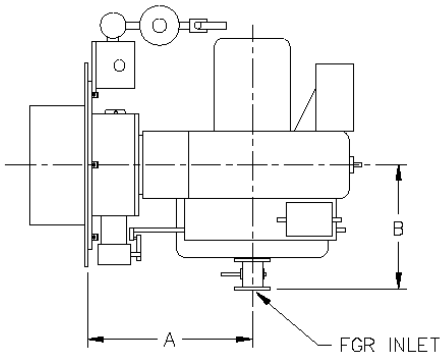
GENERAL DESCRIPTION

The level of NOx emissions generated by Series DHF burners can be reduced by inducing a small percentage of flue gas (FGR) through the forced draft fan. This option consists of a flanged FGR control valve mounted on the side of the burner scroll case. The FGR valve can be controlled by a separate modulating motor, directly from the burner jackshaft, or by a servo motor driven by a microprocessor-based parallel-positioning system.

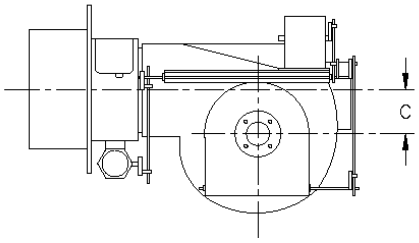
WARNING: FGR effectiveness and flame stability can be diminished when flue gases exceed 450° F. Boiler conditions that create high flue gas temperature levels must be corrected prior to implementing FGR.

DIMENSIONS

All burner mounting dimensions are the same as the standard Series DHF burners. The FGR valve can be mounted anywhere in the FGR piping, if it is not driven directly from the burner jackshaft. Approximate clearance dimensions for the FGR inlet with the FGR valve mounted directly on the inlet are as follows:



TOP VIEW



LEFT SIDE VIEW

DIMENSIONS IN INCHES

BURNER SIZE	20	30–40	50–60	80–100	125–250
VALVE SIZE	2	2	2	3	4
A	8 31/32	9 27/32	11 7/8	11 7/8	19 9/16
B	9 3/4	9 3/4	10 7/16	11 15/16	16
C	5 5/8	5 5/8	5 3/4	5 3/4	7 9/16

FGR PIPING

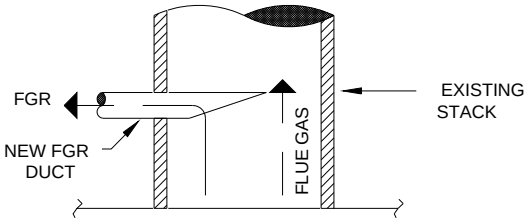
The weight of the FGR piping should not be supported by the burner, FGR valve, or boiler stack. All piping must be leak-tight to avoid entrainment of oxygen into the system.

FGR piping in any location where personnel access is possible must be insulated to prevent accidental contact with the hot surfaces.

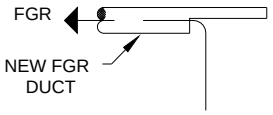
Condensation may not be allowed to accumulate within the burner housing. Provision for condensate draining must be considered, especially where long runs of piping are involved, ambient temperature is cold, or boiler stack temperature is low. Hot water boilers are particularly susceptible to condensate due to low stack temperatures.

The FGR piping connection to the stack should be in a location, which will result in the straightest run of piping to the burner. The connection should be made before any stack damper or economizer where possible.

The FGR piping should protrude into the center of the stack with a beveled end to minimize pressure loss into the piping.



STACK CONNECTION w/ BEVELED INLET



ALTERNATE INLET

BURNER SIZE	30 – 40	50 – 60	80 – 100	125 – 250
PIPING SIZE	2 1/2”	3”	3”	4”

Expansion and contraction of the piping system must be accounted for where long runs of straight pipe are encountered. The following expansion rates can be used as a guide to determine the total expansion of carbon steel pipe:

Gas Temperature °F	200	300	400	500
Inches per 10 ft	0.099	0.182	0.270	0.362

ADJUSTMENT

FGR may be introduced only after a good, stable flame has been established and combustion readings verified in accordance with prior section: MAIN GAS ADJUSTMENT. The introduction of FGR will result in a reduction of main flame stack O2 levels, so some readjusting of the fuel-air ratio curve may be warranted, if not necessary to meet emissions goals, and an acceptably safe level of excess air (3% stack O2 minimum).

TROUBLESHOOTING

In addition to the standard troubleshooting hints listed on PAGE 36 and 37 the following guide should be used with systems incorporating induced flue gas recirculation:

SYMPTOM	PROBABLE CAUSE
NOx level is too high	- Too much pressure drop in FGR piping. - Air is infiltrating the FGR system. - FGR control valve is not opening far enough. - Air adjustment band on burner is open too far. - Stack temperature exceeds 450F.
CO level is too high	- % of FGR recirculation is too high. - Air damper too far open for the desired firing rate. - Gas jet orifices are damaged. - Premix barrier ring is damaged. - Air adjustment band on burner is closed too far.
LOSS OF FLAME RETENTION	- Air adjustment band on burner is closed too far. - % FGR recirculation is too high. - Premix barrier ring is damaged. - Stack temperature exceeds 450F.