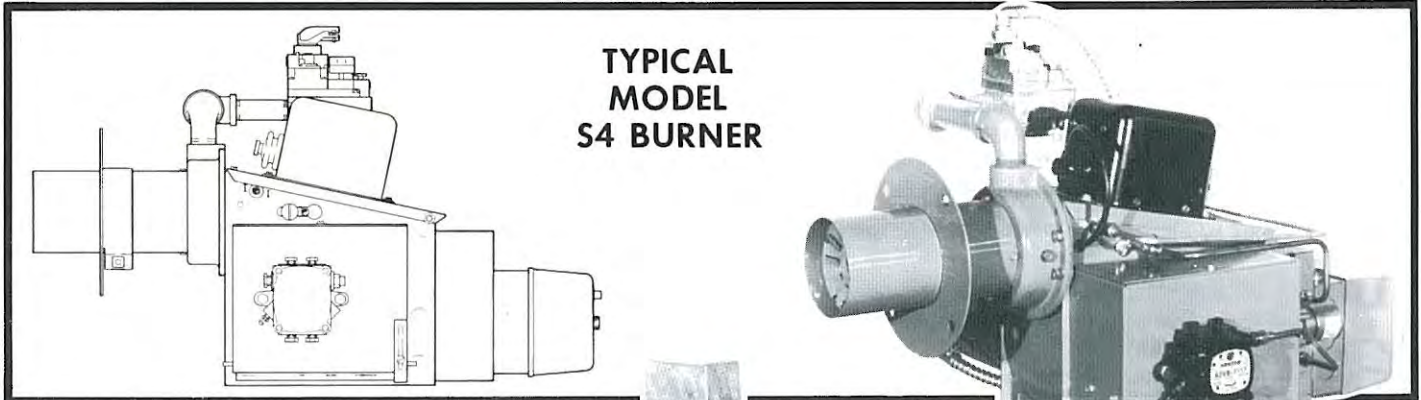


# MODEL S4

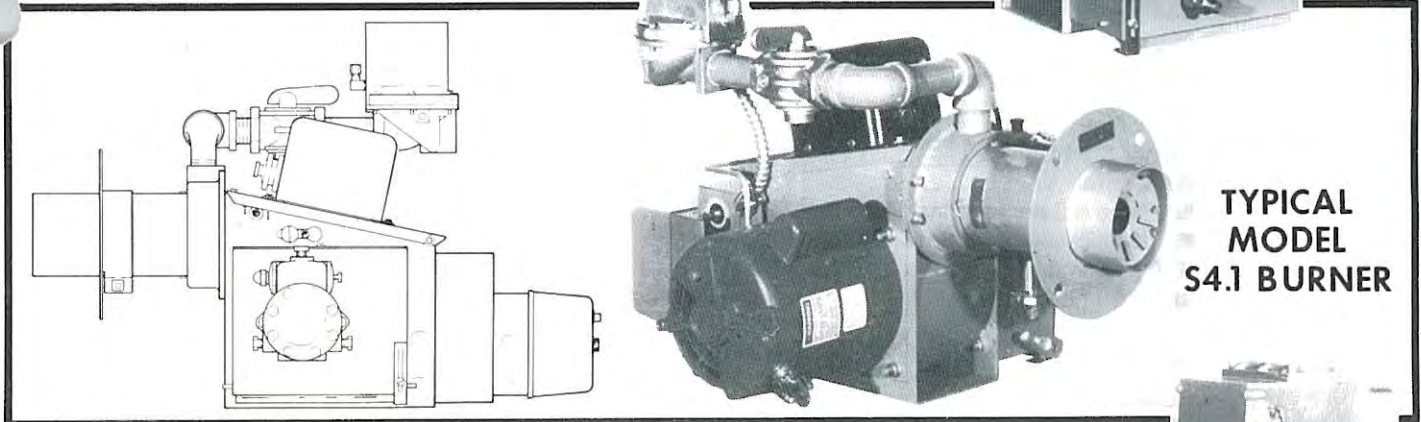
# Burner Instruction Manual

## FOR GAS AND PRESSURE ATOMIZING LIGHT OIL FUEL SYSTEMS

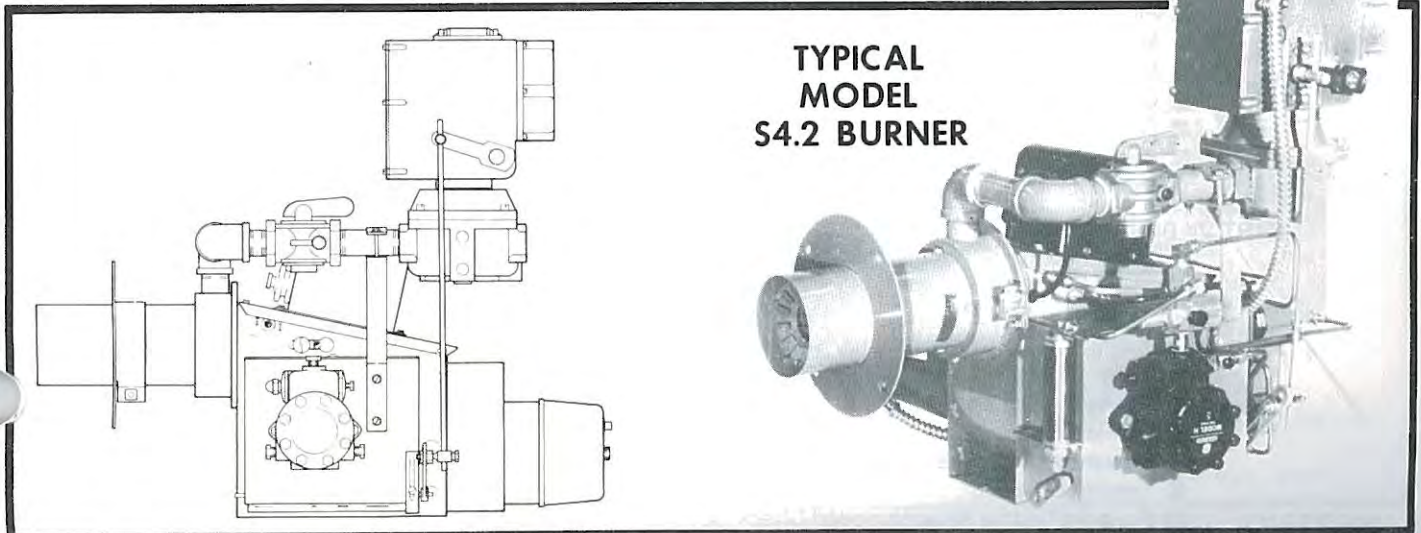
**NOTE:** YOUR BURNER MAY HAVE A LETTER PREFIX OR SUFFIX ADDED TO THE MODEL DESIGNATION; HOWEVER, THIS IS FOR IDENTIFICATION PURPOSES ONLY AND DOES NOT AFFECT THE INSTRUCTIONS IN THIS MANUAL



TYPICAL  
MODEL  
S4 BURNER



TYPICAL  
MODEL  
S4.1 BURNER



TYPICAL  
MODEL  
S4.2 BURNER

S4 Burners are UL Listed



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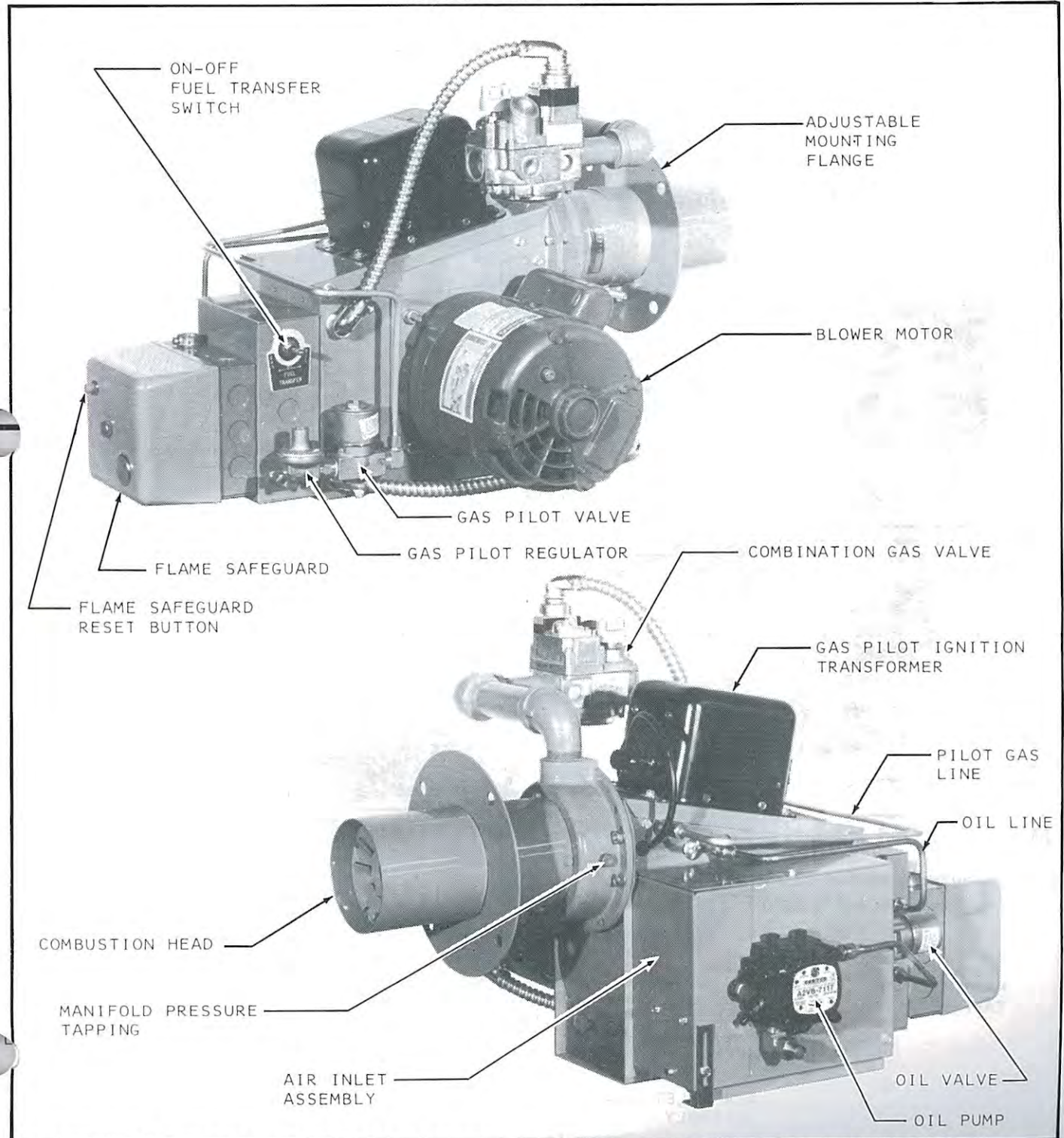
# PART I

## BURNER FAMILIARIZATION AND PRELIMINARY INSPECTION

BURNER FAMILIARIZATION - Study the following burner illustrations and determine the one which matches your unit. Take special note of the PART NAMES as shown in the call-outs. Fuel Systems are described in detail in Part III.

### Burner Identification

### Figure 1

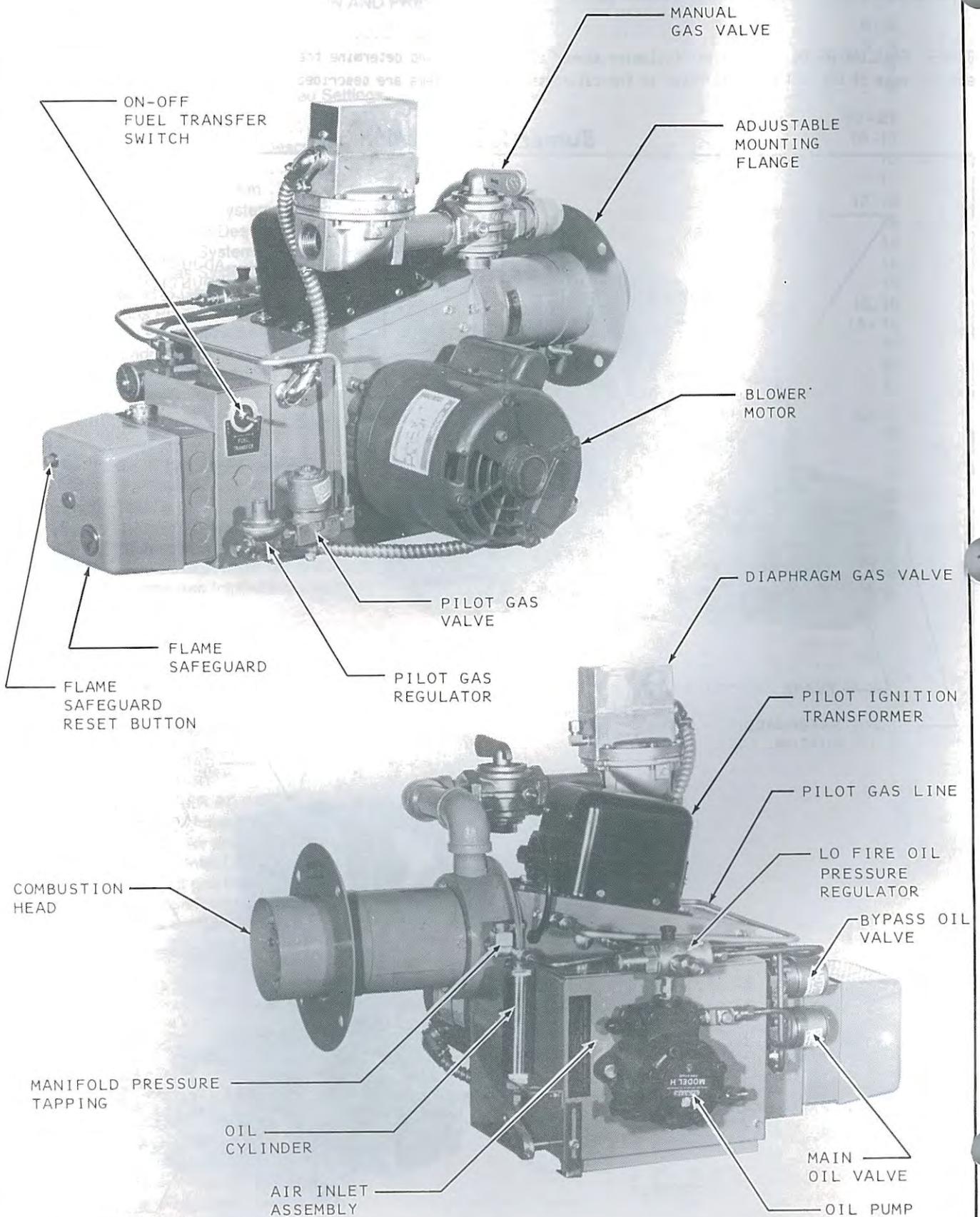


**TYPICAL MODEL S4 WITH STANDARD EQUIPMENT and B-F1 FUEL SYSTEM**



**Figure 2**

**Burner Identification**



**TYPICAL MODEL S4 WITH STANDARD EQUIPMENT and B-F4B FUEL SYSTEM**



# PART II

## INTRODUCTION

### WARNINGS

If you smell gas:

1. Open windows.
2. Don't touch electrical switches.
3. Extinguish any open flame.
4. EVACUATE people from building.
5. Immediately call the gas supplier.

The use and storage of gasoline or other flammable liquids and vapors in open containers in the vicinity of this appliance is hazardous.

In accordance with OSHA standard 1910.147, all equipment, machines and processes shall be locked out prior to servicing.

If not installed, vented, operated and maintained in accordance with the manufacturer's instructions, this product could expose you to substances in fuel or from fuel combustion which can cause death or serious illness and which are known to the State of California to cause cancer, birth defects or other reproductive harm.

Improper servicing of this equipment may create a potential hazard to equipment and operators.

**SERVICING MUST BE DONE ONLY BY FULLY TRAINED AND QUALIFIED PERSONNEL.**

Before disconnecting or opening up a fuel line and before cleaning or replacing parts of any kind.

- Turn **OFF** the main manual fuel shutoff valves including pilot gas cock, if applicable. If a multiple fuel burner, shut **OFF** all fuels.
- Turn **OFF** all electrical disconnects to the burner and any other equipment or systems electrically interlocked with the burner.

Do **NOT** use TEFLON TAPE or compounds with TEFLON content as an oil or gas pipe sealant. TEFLON can cause valves to fail creating a **SAFETY HAZARD**. Warranties are nullified and liability rests solely with the installer when evidence of TEFLON is found.

Rectorseal No. 2 pipe thread compound is used for factory assembly of oil and gas piping.

This manual has been prepared to assist in the installation, operation and maintenance of your burner. It is good practice to know as much as possible about a piece of equipment before trying to install or operate it. Read the contents carefully before proceeding.

#### NOTE

Installation requirements and instructions should always be covered in appropriate engineering drawings and specifications which detail the applicable building codes, etc. Information contained herein is to be used as a guide **ONLY** and not as the final authority.

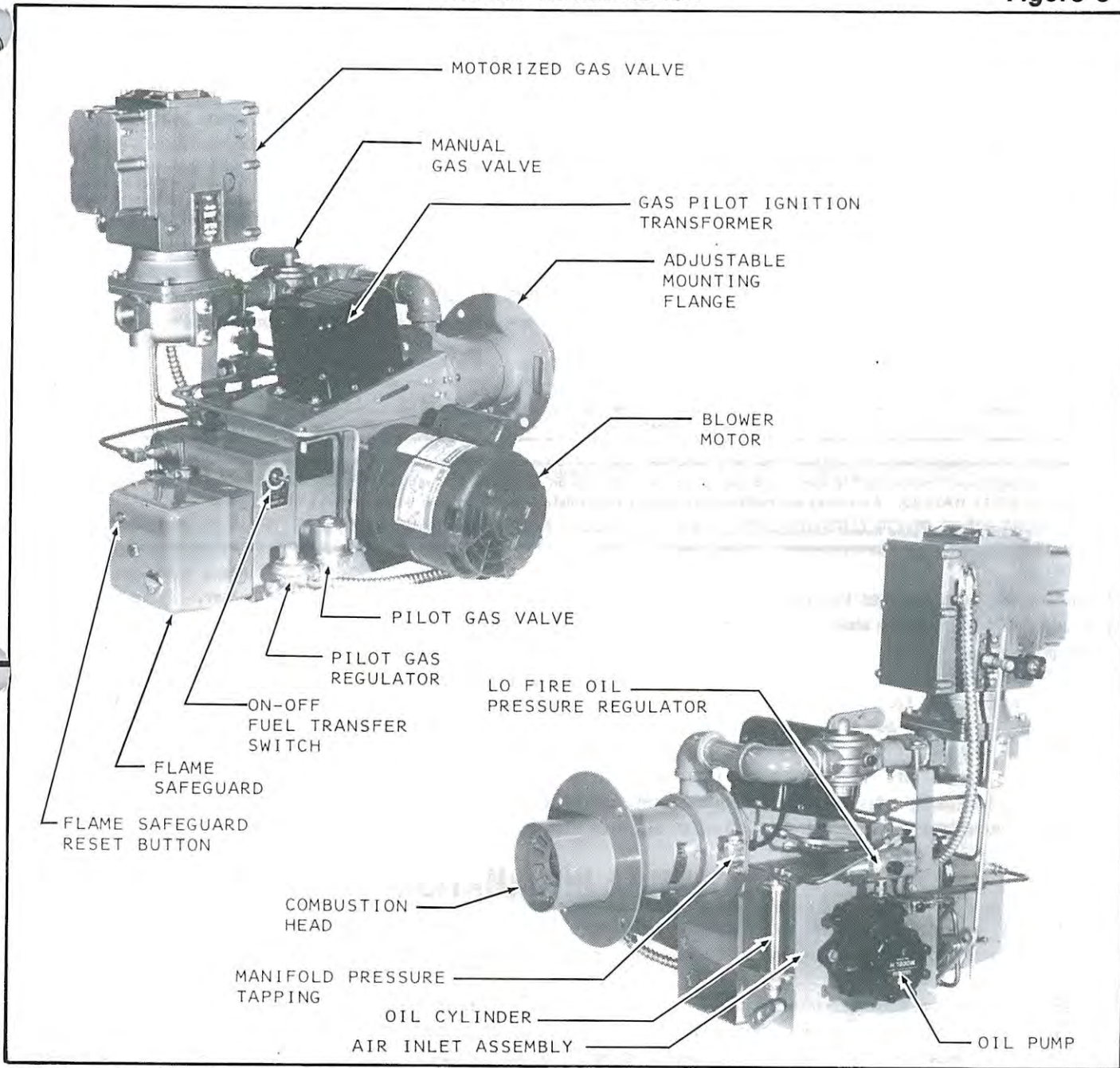
## GENERAL INFORMATION

- Starting a burner is an event which normally culminates the efforts of several different contractors, manufacturers, utility and engineering concerns, sales and factory representatives, and others.
- In order for the burner to operate safely and meet its design capabilities, the interfacing fuel, air, electrical, exhaust and heating control systems must be properly sized, selected, installed and tested. Additionally, all conditions must be such that the heat generated by the burner can be safely used without endangering personnel or equipment.
- It shall be the policy that no responsibility is assumed by the company nor any of its employees for any liability or damages caused by an inoperable, inadequate or unsafe burner condition which is the result, either directly or indirectly, of any of the improper or inadequate conditions described above. To insure that a safe and satisfactory installation has been made, a pre-start inspection is necessary. This inspection must be performed by an individual who is thoroughly familiar with all aspects of proper boiler/burner installation and how it interfaces with overall plant operation.
- Part I of this bulletin sets forth major inspection items that must be considered.

#### NOTE

This inspection should be performed before the burner start-up specialist is called in. An incomplete or inadequate installation may require additional time and effort by start-up personnel and cause an untimely and costly delay.





**TYPICAL MODEL S4 WITH STANDARD EQUIPMENT and H-F4H FUEL SYSTEM**

**PRELIMINARY INSPECTION** - The burner should be visually checked for damage and loose components as these conditions can occur during shipment, through improper handling, by tampering or through improper care and storage at the job site.

**CHECK FOR:**

- Obvious damage to housing, air inlet, and components mounted thereon.
- Tightness of fasteners, tube fittings, plugs, etc.
- Tightness of electrical terminals and connections.
- Tightness of adjustment mechanisms such as ball-joint swivel connectors and control arms.
- Accumulations of oil, dust, dirt, water or other foreign matter on, in, or near the burner.



The results of this inspection will often times identify corrections that must be made prior to start-up as well as point out potential or long range problems that may occur if corrections are not made.

Burner start-up is a serious matter and should not be viewed as a time for "crowd gathering" by unconcerned, uninformed or unauthorized personnel. The number of persons present should be held to an absolute minimum. Instruction of operating and other concerned personnel should be done after the burner has been successfully fired and adjusted by a qualified service agency or factory start-up specialist.

FUEL. The S4 burner will fire natural gas, LP gas and/or No. 2 (or lighter) fuel oil. Minimum gas pressure to the inlet of the combination gas control or to the main manual gas shutoff cock is listed on the burner material list. Maximum inlet gas pressure is 14 inches of water column with combination gas valve.

FIRING SYSTEM. The burner operates ON-OFF with fixed register air control, low fire start on oil, or low fire start gas and oil.

BURNER MOTOR. The burner uses a capacitor start, 1/4 or 1/3 HP, 115 volts, 60 cycle, single phase, 3450 rpm motor with built-in manual reset overload protection.

BLOWER WHEEL. Squirrel cage type. The tips of the forward curved blades point in the direction of rotation.

OIL PUMP. The pump is either a single-stage or two stage with built-in filter and is directly driven by the burner motor through a flexible coupling. A two-pipe system is used. The maximum operating oil pressure is 130 psi for single stage and 300 psi for two stage pumps.

OIL SOLENOID VALVE. Normally closed, 120 volts, 300 psi maximum operating pressure.

COMBINATION GAS CONTROL. This device incorporates the manual shutoff cock, main gas pressure regulator, and automatic main gas valve into a single unit. The three position gas cock is marked OFF, PILOT, and ON. The coil operating the normally closed automatic main gas valve is 120 volts. The pressure regulator is factory set at 3.5 inches of water column. Pilot pressure and main outlet pressure are independently adjustable.

GAS TRAIN. In lieu of the Combination Gas Control, the manual main shutoff cock, manual pilot shutoff cock, pilot gas pressure regulator, main gas pressure regulator, and automatic main gas valve may be supplied as separate components or in different combinations.

GAS SOLENOID VALVE(S). Normally closed, 120 volt, 10 psi maximum operating pressure.

GAS PILOT REGULATOR. Output range 1 - 3.5 inches water column. Maximum inlet 14 inches water column.

BURNER COMBUSTION HEAD AND DRAWER ASSEMBLY. Includes gas manifold, gas orifices, single simplex oil nozzle and diffuser.

IGNITION - GAS OR OIL. The intermittent or interrupted gas pilots are ignited by an interrupted spark from a 6,000 volt shielded transformer with the end point grounded.

**NOTE**

The intermittent pilot increases the burner input by approximately 10,000 Btu per hour.

AIR FLOW SAFETY SWITCH. Sail type mercury switch that closes only when adequate combustion air is delivered to the firing head. Loss of combustion air causes fuel valve(s) to close immediately.

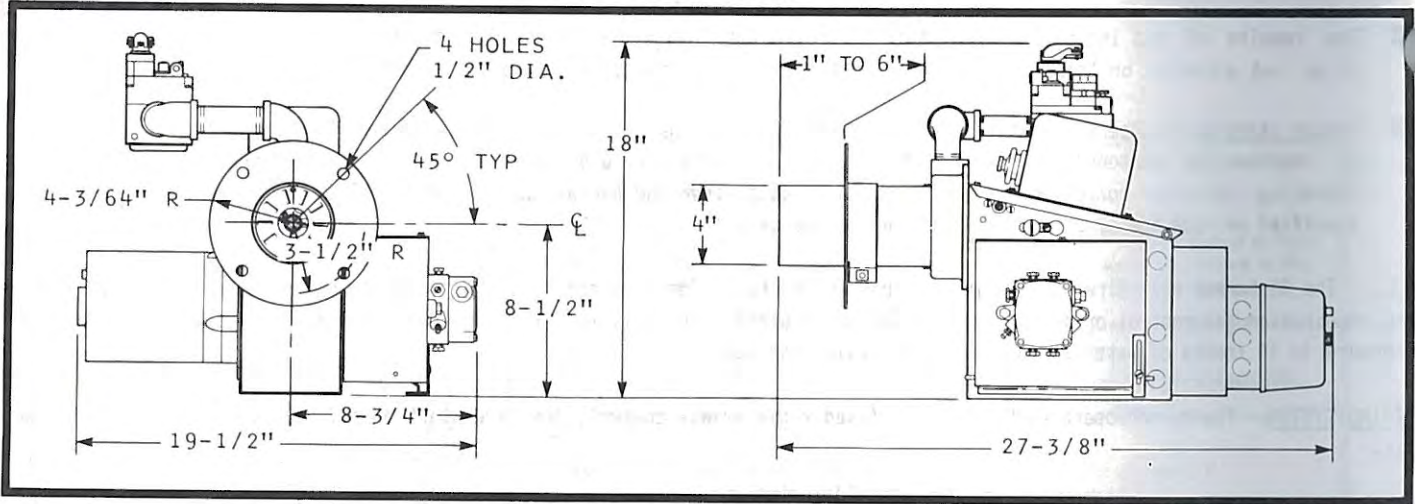
LIMIT AND OPERATING CONTROLS. Not included with burner. Must be 115 volts unless provision for low voltage (24 V) is provided. Refer to supplemental drawing for information regarding optional provisions for low voltage limit and operating controls.

PRE-PURGE. Pre-purge timing of 30-60-90 seconds are available std. on all gas-oil units and as an option on gas units under 400 MBH.

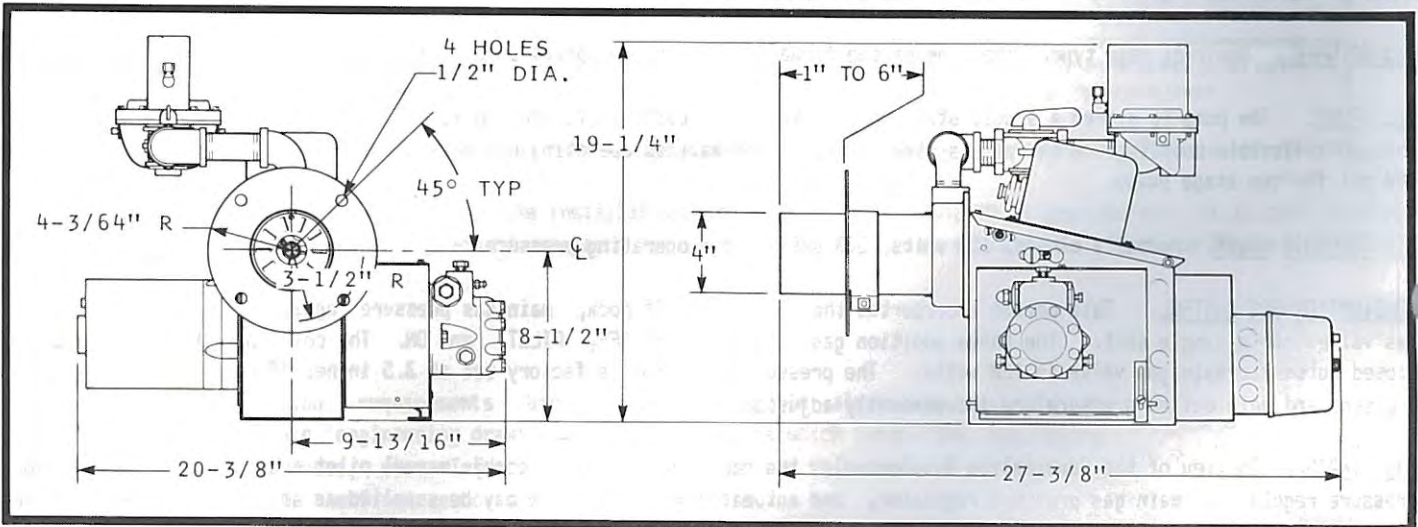


Figure 4

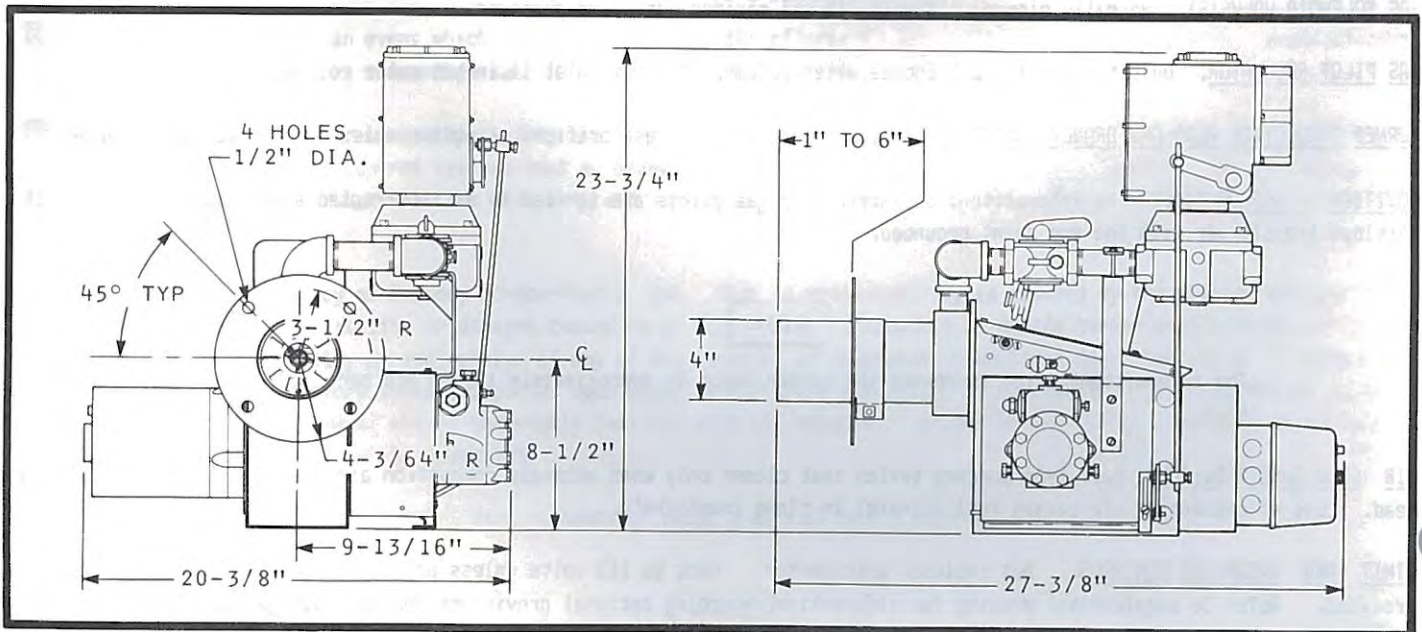
Dimensions



MODEL S4 BURNER



MODEL S4.1 BURNER



MODEL S4.2 BURNER



## S4 TABLE OF SUGGESTED SETTINGS

Figure 5

Burner Model	Firing Rate MBH/GPH	GAS ORIFICE DATA				OIL NOZZLE DATA			Start Up Air Louver Setting	Pilot Gas Pressure (iwc)
		Natural Gas		LP Gas		Oil System	Nozzle Size	Nozzle Press. (PSI)		
		Size Prim-Sec.	Manifold Press. (iwc)	Size Prim-Sec.	Manifold Press. (iwc)					
S4 & S4.1	210/1.5	#20-NA	3.3	1/8-NA	3.3	F1	1.5	100	3/16	2.5
	225/1.6	#18-NA	3.0	#29-NA	3.0	F1	1.5	114	1/4	2.5
	250/1.8	#15-NA	3.0	#27-NA	3.0	F1	1.75	105	3/8	2.5
	275/2.0	#12-NA	3.0	#25-NA	3.0	F1	2.0	100	7/16	2.5
	300/2.1	#9-NA	3.0	#23-NA	3.0	F1	2.0	110	1/2	3.0
	325/2.3	#5-NA	3.0	#20-NA	3.0	F1	2.25	105	9/16	3.0
	350/2.5	#4-NA	3.0	#19-NA	3.0	F1	2.50	100	5/8	3.0
	375/2.7	#3-NA	3.0	#18-NA	3.0	F1	2.50	115	1/4	3.5
	400/2.9	#3-NA	3.2	#18-NA	3.2	F1	2.75	110	5/16	3.5
	425/3.0	7/32-NA	3.2	#17-NA	3.2	F1	3.00	100	3/8	3.5
450/3.2	#1-NA	3.2	#15-NA	3.2	F1	3.00	114	1/2	3.5	
500/3.6	A-NA	3.5	#13-NA	3.5	F1	3.50	105	3/4	3.5	
S4.2	400/2.9	.098-1/4	2.4	.098-1/4	1.0	F1	2.75	110	5/16	3.5
	450/3.2	.098-1/4	3.0	.098-1/4	1.2	F1	3.00	114	1/2	3.5
	500/3.6	.098-1/4	3.7	.098-1/4	1.5	F1	3.5	105	3/4	3.5
	550/3.9	.098-1/4	4.5	.098-1/4	1.8	F1	4.0	95	1.0	3.5
S4.2	400/2.9	.098-1/4	2.4	.098-1/4	1.0	F4B	1.65	305	5/16	3.5
	450/3.2	.098-1/4	3.0	.098-1/4	1.2	F4B	2.0	255	1/2	3.5
	500/3.6	.098-1/4	3.7	.098-1/4	1.5	F4B	2.25	255	3/4	3.5
	550/3.9	.098-1/4	4.5	.098-1/4	1.8	F4B	2.25	300	1.0	3.5
	600/4.3	.098-1/4	5.4	.098-1/4	2.2	F4B	2.50	295	1 1/8	3.5
	630/4.5	.098-1/4	6.0	.098-1/4	2.5	F4B	2.75	270	1 5/16	3.5
S4.2	560/4.0	.098-5/16	2.5	.098-5/16	1.0	F4H	2.5	255	5/16	3.5
	600/4.3	.098-5/16	2.8	.098-5/16	1.1	F4H	2.5	295	5/16	3.5
	650/4.6	.098-5/16	3.3	.098-5/16	1.3	F4H	2.75	280	3/8	3.5
	700/5.0	.098-5/16	3.8	.098-5/16	1.5	F4H	3.0	280	3/8	3.5
	750/5.4	.098-5/16	4.4	.098-5/16	1.7	F4H	3.25	275	1/2	3.5
	780/5.5	.098-5/16	4.8	.098-5/16	1.9	F4H	3.25	285	1/2	3.5

**NOTES**

1. Maximum capacities and air louver settings are based on 2000 ft. altitude and -.05" wc overfire draft. GPH rate based on #2 oil of 140,000 BTU/gal.
2. Burner models are suffixed with G or GO for gas-gas/oil, 02 or 03 for 1/4 or 1/3 hp motors, flame safeguard model, and gas and/or oil systems. Example: S4-GO-02-UVMS-B-F1.
3. Pilot gas pressure measured at inlet to pilot solenoid valve.
4. F1 and F4B air louver settings are for high fire, F4H settings are for low fire.
5. Dimensions and pressures given in above table are for reference only. Actual settings must be determined at time of burner start-up by fully trained and qualified personnel.
6. Secondary orifice sizes are open tube - size listed is tube O.D.

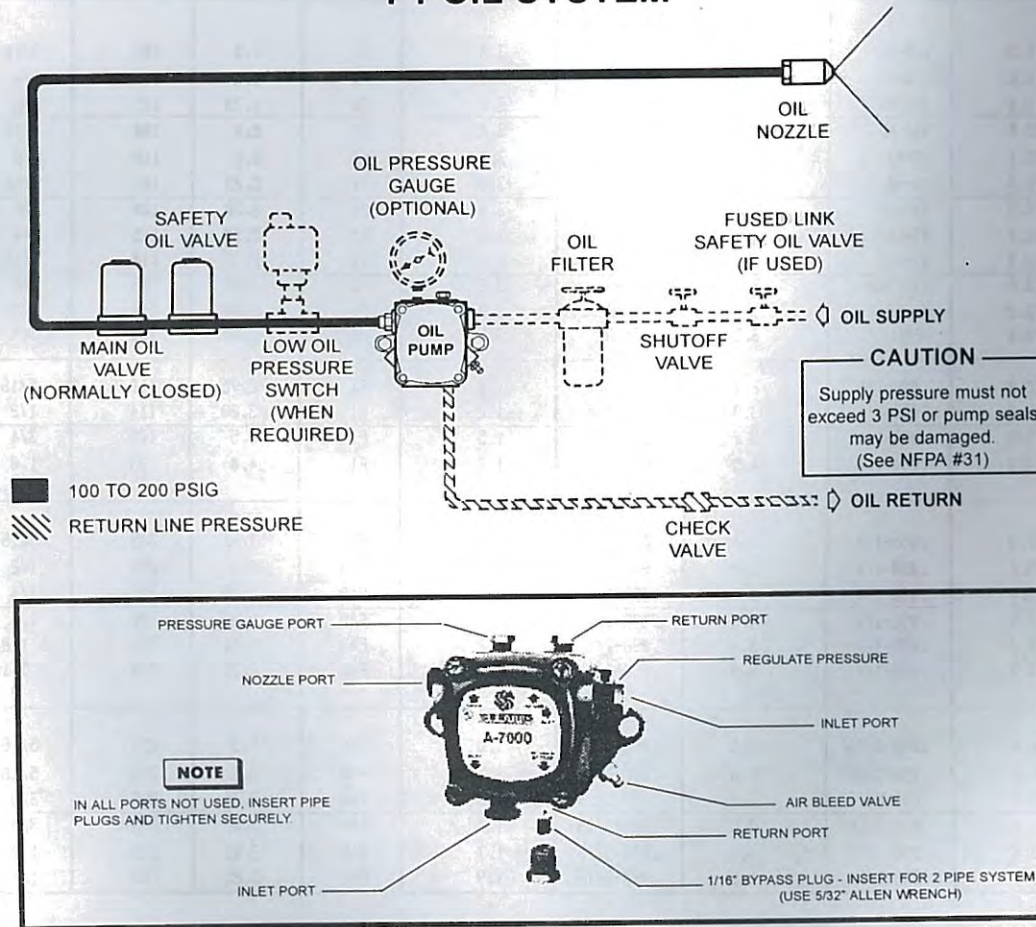
ABBREVIATIONS: iwc = Inches Water Column, O.T. = Open Tube, NA = Not Applicable



# PART III FUEL SYSTEMS

## BURNER OIL SYSTEM DESCRIPTION

### F1 OIL SYSTEM



#### APPLICATION

The F1 Oil System is used for On-Off firing of No. 2 fuel oil. It is commonly used on burners up to 4.0 GPH capacity and is used in conjunction with the "B" gas system for combustion gas-oil burners.

#### DESCRIPTION

The F1 System uses a simplex type nozzle and an oil solenoid valve to control flow. Pressure is generated by an oil pump connected to the burner motor through a flexible coupling. Pump pressure is adjusted and maintained by the pump's integral pressure regulating valve. Combustion air available to the burner is fixed in an open (high fire) position.

#### OPERATING SEQUENCE

The burner motor and oil pump start on a call for heat by the operating control and the pre-purge cycle begins.

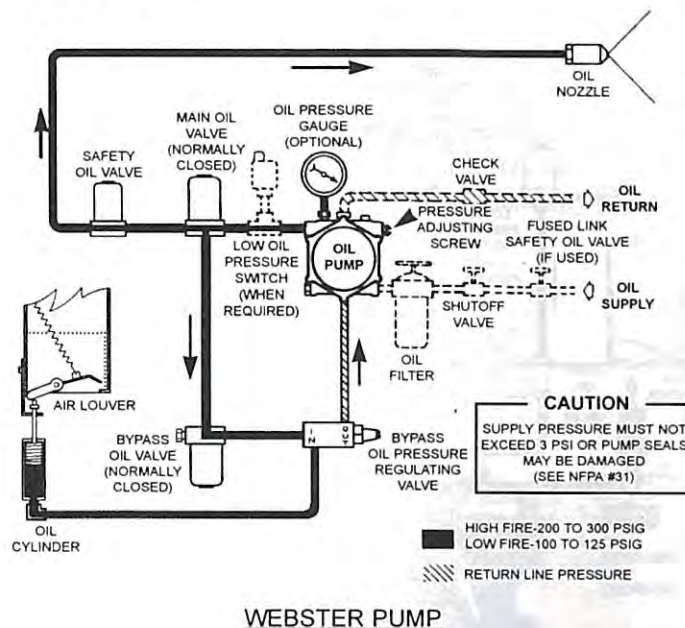
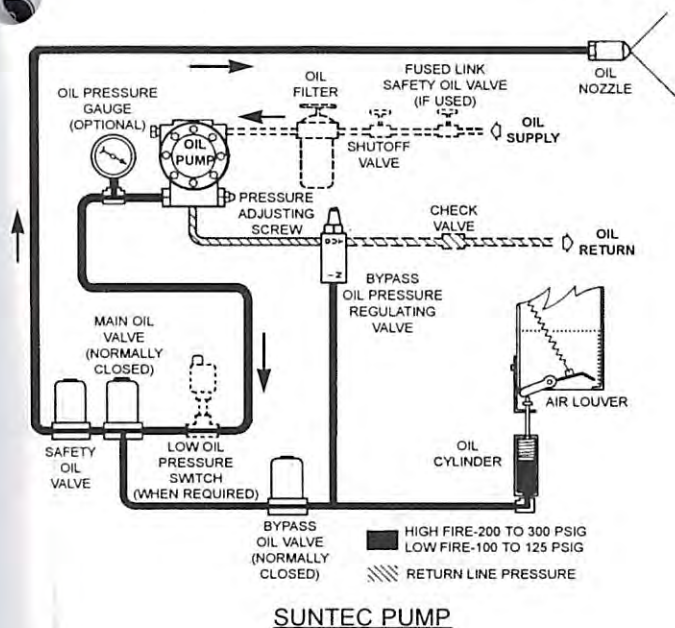
Oil is returned to the tank through the oil pump return line.

At the end of the pre-purge, the pilot ignition transformer and pilot solenoid valve are energized. A five second pilot stabilization period is provided before the main and safety oil valves open and the burner ignites. The pilot flame must be proven before the main fuel valve can be energized. The pilot ignition transformer and solenoid valve are de-energized 10 seconds after the main and safety valves are energized.

When the operating control is satisfied, the oil solenoid valves close and the burner motor is switched off, causing the burner to shut down and await the next call for heat.



## F4B OIL SYSTEM



"F4B" OIL SYSTEM SCHEMATIC  
(Shown In Low Fire Position)

### APPLICATION

The F4B Oil System is used for On-Off Low Fire Start control in firing No. 2 fuel oil. It is used on burners with 3 to 4.5 GPH capacity and is used in conjunction with the "B" gas system for combination gas-oil burners.

### DESCRIPTION

The F4B System uses a simplex type nozzle and an oil valving arrangement to provide a low fire and a high fire oil pressure to the nozzle and simultaneously control the combustion air available to the burner through the action of an oil cylinder assembly. The burner air inlet louver is spring loaded in the full open (high fire) position. Pressure is generated by an oil pump connected to the burner motor through a flexible coupling. Pump pressure is adjusted and maintained by the pump's integral pressure regulating valve. Low fire oil pressure is adjusted and maintained by the bypass oil pressure regulating valve.

### OPERATING SEQUENCE

The burner motor and oil pump start on a call for heat by the operating control and the pre-purge cycle begins. The main, safety and bypass oil solenoid valves remain closed. The oil cylinder piston remains in the retracted

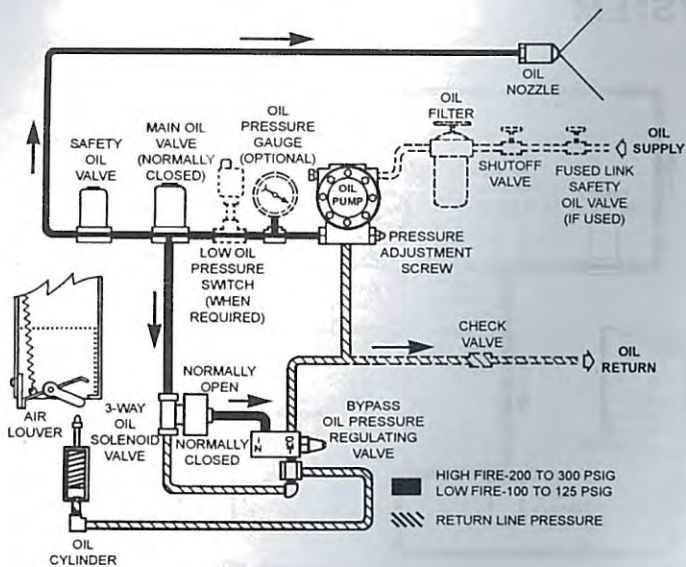
position allowing high fire combustion air through the louver. Oil is returned to the tank through the oil pump's return line.

At the end of pre-purge, the pilot ignition transformer, pilot solenoid valve, and bypass oil valve are energized. When the bypass oil valve opens the oil pressure drops to the low fire setting of the bypass regulator and the oil cylinder piston extends driving the air louver closed to the low fire air setting. The pilot lights and must be proven before the main and safety fuel valves can be energized. A 5 second pilot stabilization period is provided before the main and safety valves are opened and the burner ignites. Ten seconds after the main and safety oil valves open the pilot ignition transformer, pilot solenoid valve, and bypass oil valve are de-energized.

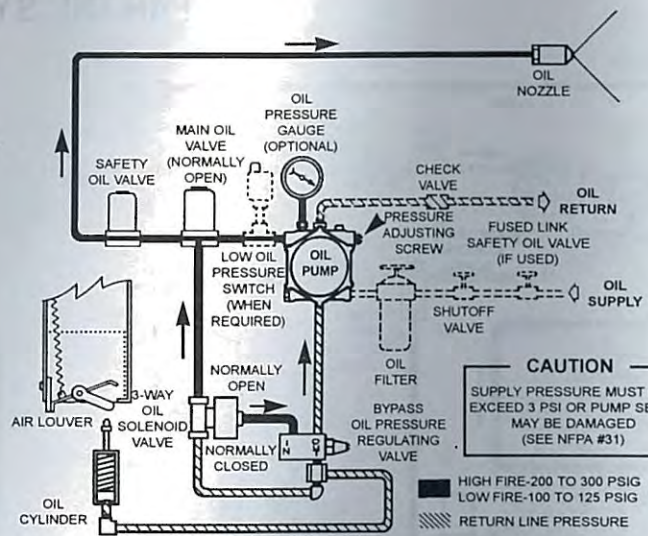
When the bypass oil solenoid valve closes it stops the flow through the bypass pressure regulating valve thus raising the nozzle pressure to the high fire setting of the pump's integral pressure regulating valve. When the bypass oil solenoid valve closes, the cylinder piston retracts allowing the air louver spring to pull the louver to the full open position and the burner goes to high fire.



## F4H OIL SYSTEM



SUNTEC PUMP



WEBSTER PUMP

"F4H" OIL SYSTEM SCHEMATIC  
(Shown in Low Fire Position)

### APPLICATION

The F4H Oil System is used for On-Off or High-Low, Low Fire Start Control in firing No. 2 fuel oil. It is commonly used on burners with 4 to 5.5 GPH capacity and is used in conjunction with the "H" or "H4" gas systems for combustion Gas-Oil models.

### DESCRIPTION

The F4H system uses a simplex type nozzle and an oil valving arrangement to provide a low fire and a high fire oil pressure to the nozzle and simultaneously control the combustion air available to the burner through the action of an oil cylinder assembly. The burner air inlet louver is spring loaded in the closed (low fire) position. Pressure is generated by an oil pump connected to the burner motor through a flexible coupling. Pump pressure is adjusted and maintained by the pump's integral pressure regulating valve. Low fire oil pressure is adjusted and maintained by the bypass oil pressure regulating valve.

### OPERATING SEQUENCES

The burner motor and pump start on a call for heat by the operating control and the pre-purge cycle begins. The "C" port of the 3-way oil solenoid valve is open allowing oil to flow through the bypass pressure regulating valve and return to the tank. The oil cylinder pis-

ton remains in the retracted position allowing low fire combustion air through the louver.

At the end of the pre-purge, the pilot ignition transformer and pilot solenoid valve are energized. A 5 second pilot stabilization period is provided.

The pilot must be proven before the main and safety fuel valves can be energized. At the end of the 5 seconds, the main and safety oil solenoid valves open supplying oil to the nozzle at the low fire pressure setting of the bypass pressure regulating valve. The air inlet louver remains closed and the burner ignites at the low fire rate.

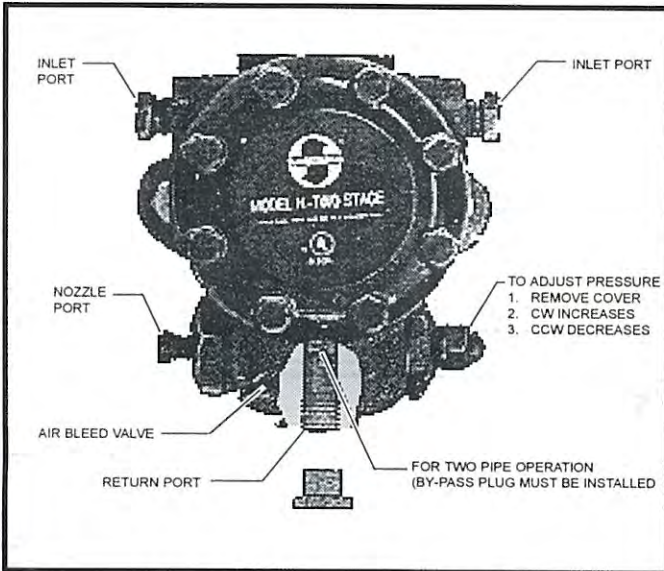
Five seconds after the main and safety oil valves are energized the 3-way solenoid valve is energized and the "C" port closes stopping the flow through the bypass pressure regulating valve thus raising the nozzle pressure to the high fire setting of the pump's integral pressure regulating valve. Simultaneously, when the "C" port closes the "B" port opens causing the oil cylinder piston to extend and drive the air louver to the full open position and the burner goes to high fire. Ten seconds after the main and safety oil valves are energized, the pilot ignition transformer and pilot solenoid valve are de-energized.



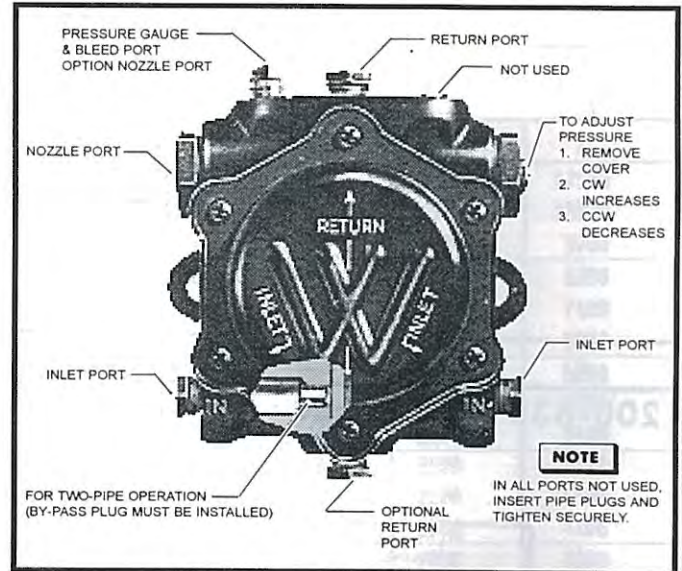
## HIGH-LOW OPERATIONS

On High-Low Control Systems, the High Fire Controller, when satisfied, opens the "C" port and closes the "B" port of the 3-way oil solenoid valve allowing flow through the bypass pressure regulating valve causing the nozzle pressure to drop to the low fire setting. Simultaneously, when the "B" port closes this allows

the oil cylinder piston to retract and the air louver spring pulls the louver to the closed (low fire) position. If low fire cannot maintain pressure or temperature in the boiler, the high fire controller will re-energize the 3-way oil solenoid valve and the burner will sequentially return to high fire.



SUNTEC OIL PUMP DETAILS

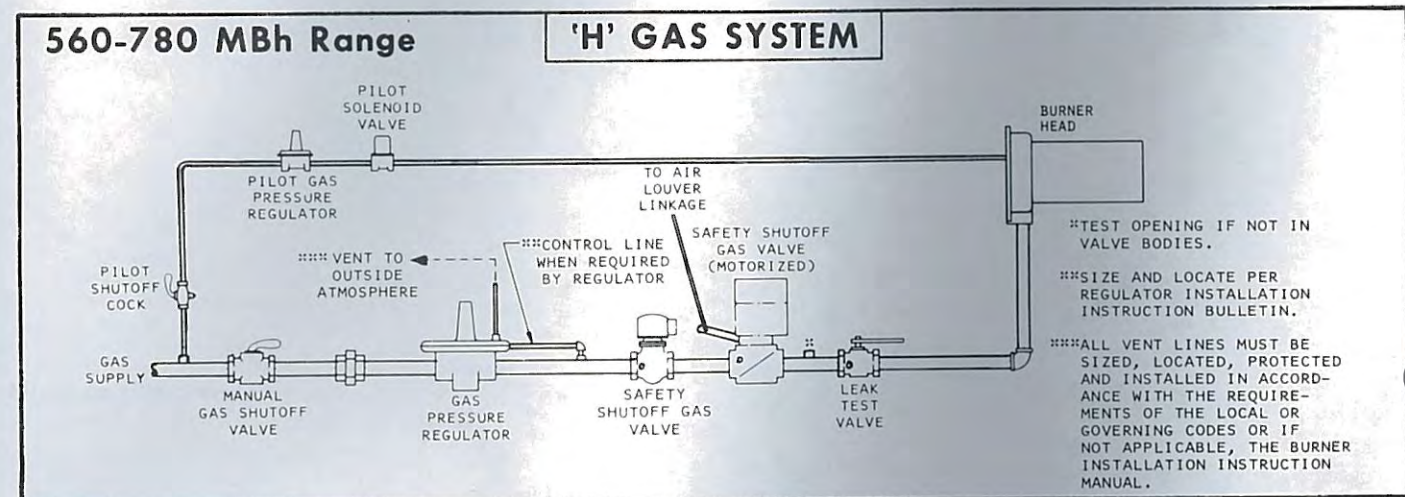
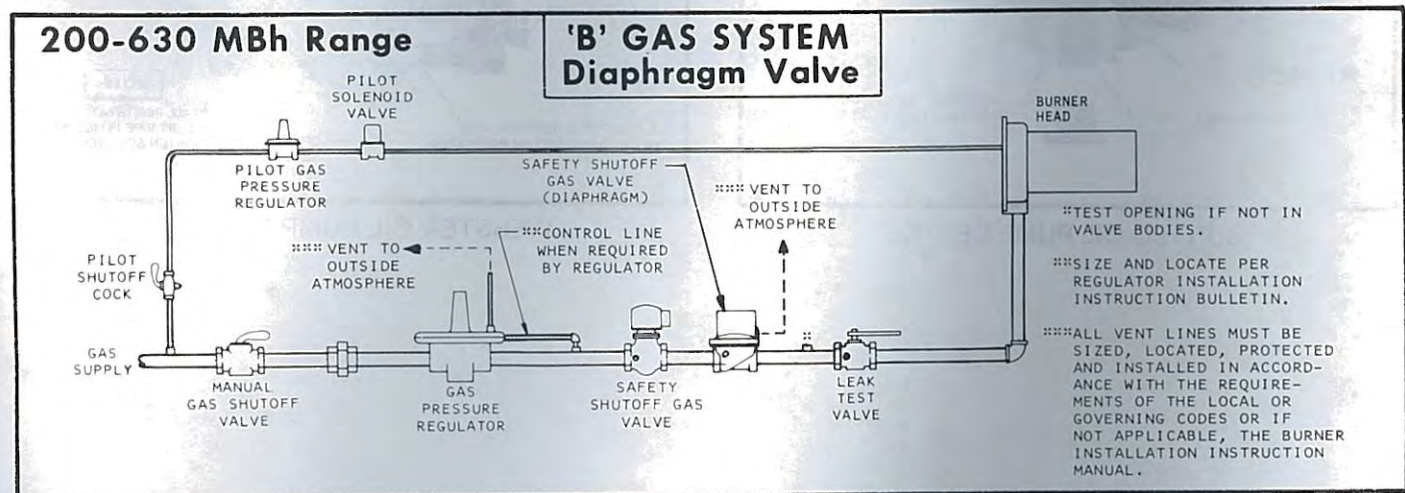
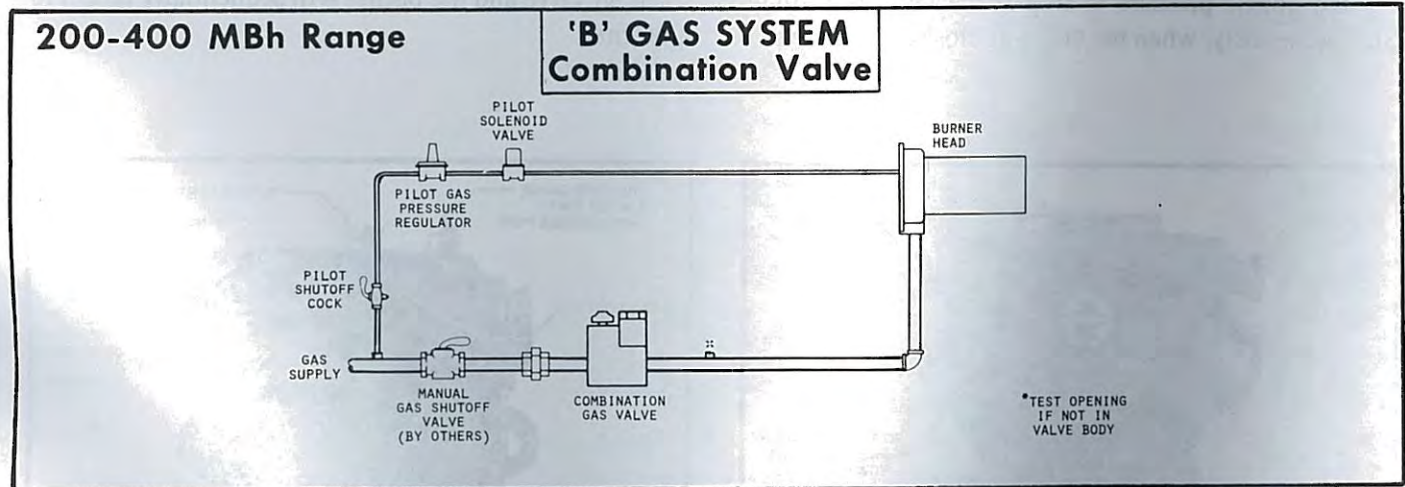


WEBSTER OIL PUMP DETAILS



**GAS SYSTEM DESCRIPTION.** The S4 burners are equipped with UL approved gas trains as standard equipment. Other Agency approved gas trains may be supplied when specified.

The following schematics depict the three UL approved systems used on burners with inputs of 200 through 780 MBH.





**GAS PIPING INFORMATION.** Gas piping should be sized to provide at least the required minimum pressure at the inlet to the gas train. Consult your local utility on any questions regarding gas pressure, piping pressure drops allowable, and local piping requirements.

Gas piping should be installed in accordance with the American National Standard, ANSI Z223.1, and any other local codes which may apply. All gas piping should be tested after installation with air pressure or inert gas of at least three times the gas pressure that will be used. The piping ahead of the main manual shutoff shall include a full size dirt pocket or trap. (Figure 7)

### Gas Flow Capacity of Pipe - CFH

Figure 6

With Pressure Drop of 0.3" w.c. and Specific Gravity of 0.60									
Pipe Length In Feet	Pipe Size - Inches (IPS)								
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4
10	132	278	520	1050	1600	3050	4800	8500	17500
20	92	190	350	730	1100	2100	3300	5900	12000
30	73	152	285	590	890	1650	2700	4700	9700
40	63	130	245	500	760	1450	2300	4100	8300
50	56	115	215	440	670	1270	2000	3600	7400
60	50	105	195	400	610	1150	1850	3250	6800
70	46	96	180	370	560	1050	1700	3000	6200
80	43	90	170	350	530	990	1600	2800	5800
90	40	84	160	320	490	930	1500	2600	5400
100	38	79	150	305	460	870	1400	2500	5100
125	34	72	130	275	410	780	1250	2200	4500
150	31	64	120	250	380	710	1130	2000	4100
175	28	59	110	225	350	650	1050	1850	3800
200	26	55	100	210	320	610	980	1700	3500

**MULTIPLIERS USED WITH ABOVE TABLE**

Specific Gravity Other Than 0.60	
Specific Gravity	Multiplier
0.50	1.10
0.60	1.00
0.70	.926
0.80	.867
0.90	.817
1.00	.775

Pressure Drop Other Than 0.3" w.c.			
Press. Drop	Multiplier	Press. Drop	Multiplier
0.1	.577	1.0	1.83
0.2	.815	2.0	2.58
0.3	1.00	3.0	3.16
0.4	1.16	4.0	3.65
0.6	1.42	6.0	4.47
0.8	1.64	8.0	5.15

**WARNING**

Do NOT use teflon tape as an oil or gas sealant. Teflon tape can cause valves to fail, creating a safety hazard. Warranties are nullified and liability rests solely with the installer when teflon tape is used. Use a pipe joint compound rather than teflon tape.

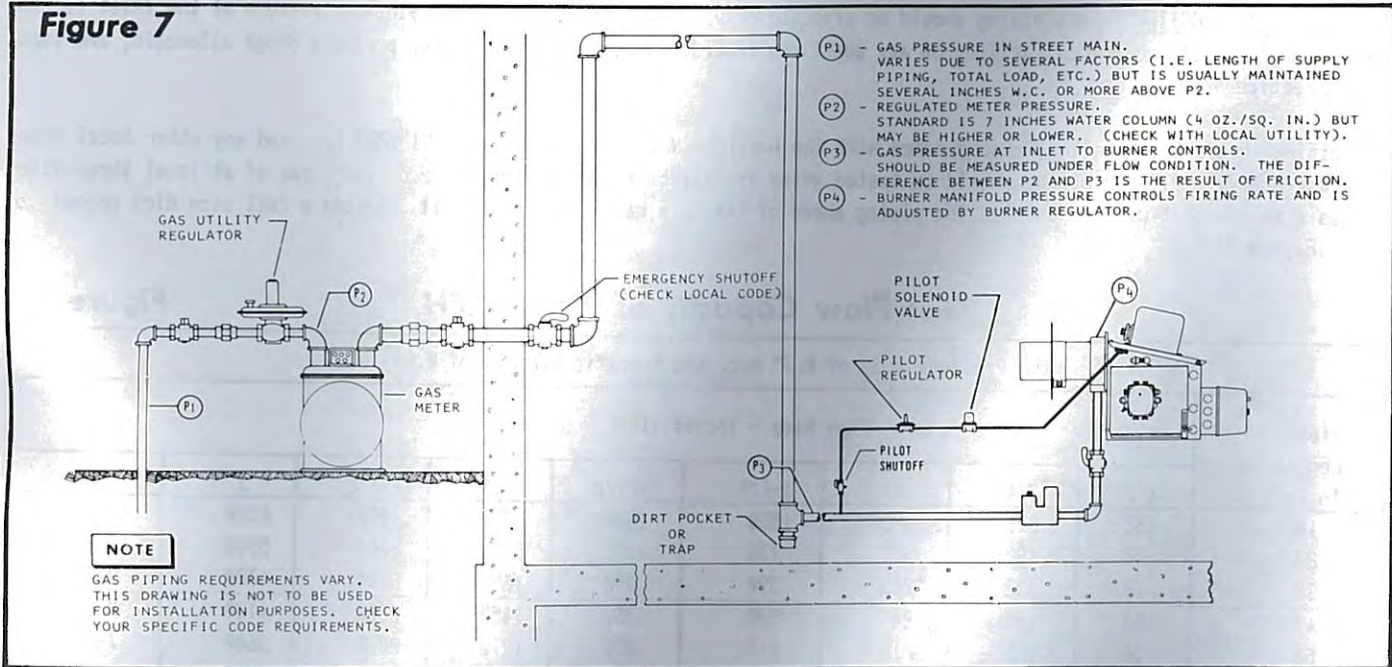
**SELECTION OF OIL.** The burner is designed for use with No. 1 or No. 2 fuel oils which can be burned without any pre-heating equipment.

**OIL TANK LOCATION.** The Rules of the National Board of Fire Underwriters (Pamphlet No. 31) and local codes and regulations should be followed in locating and installing Oil Storage Tanks and Burners.

Some localities require that the tank be located below the burner level. If any part of the tank is above the level of the burner, an anti-syphon device must be used to prevent flow of oil in case of a break in the oil line. The illustration shows a typical installation of an outside tank which should be covered with not less than 24" of earth. A concrete anchor base is advisable to prevent shifting of buried tank during wet weather. (Figure 8)



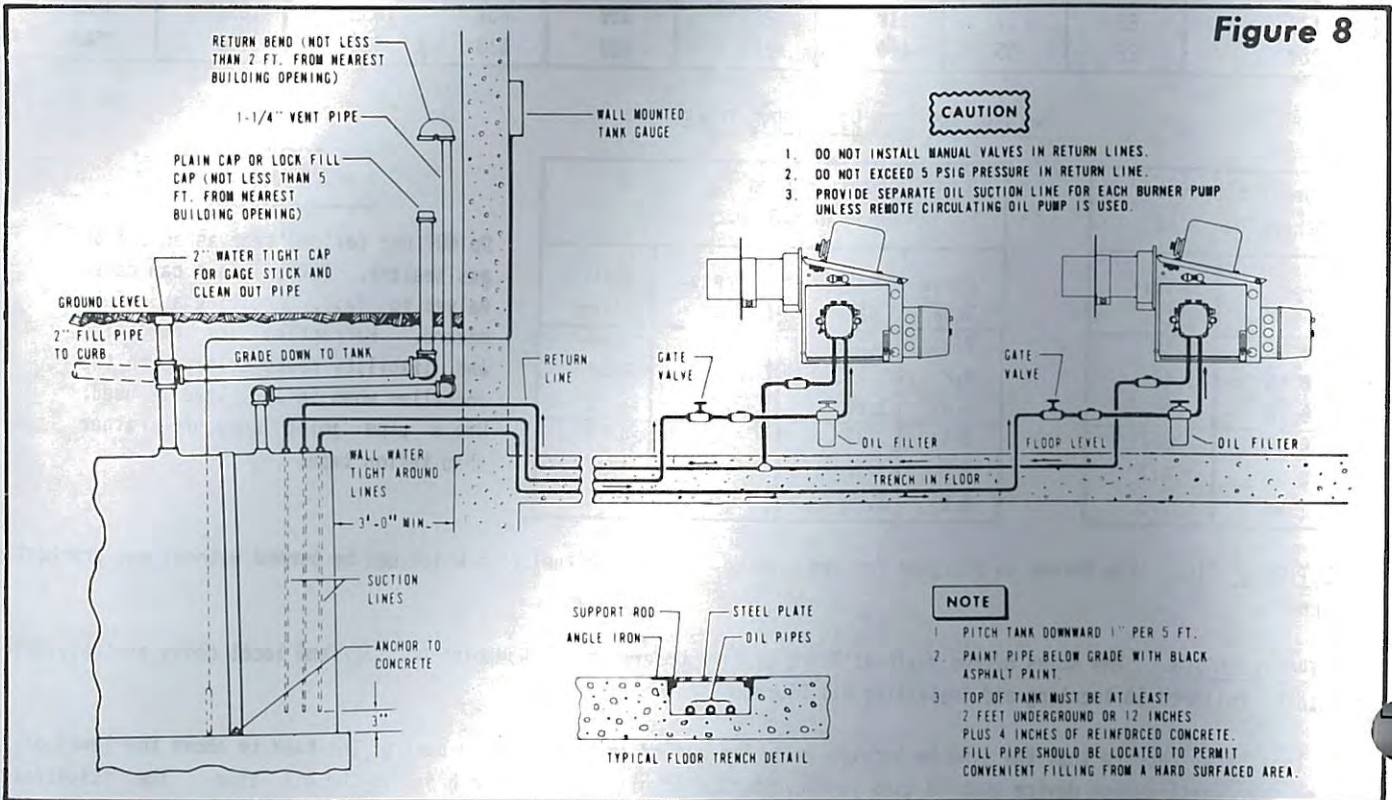
**Figure 7**



**TYPICAL GAS PIPING INSTALLATION**

**OIL PIPING INFORMATION.** Connections to buried tanks must be made with swing joints or copper tubing to prevent the pipes from breaking in case the tanks settle. If local requirements stipulate that iron pipe be used, swing joints made up with

**Figure 8**



**TYPICAL OIL PIPING INSTALLATION**



elbows and nipples several inches long should be used on both the suction and return lines as close to the tank as possible. The swing joints should be made up so that they will tighten as the tank settles. Non-hardening pipe joint compounds should be used on all threaded joints.

**NOTICE**

For a two-pipe system, the 1/16" by-pass plug must be inserted in the 1/4" return and by-pass port. The two-pipe system is required to prevent the pump from running dry when firing on natural gas. See oil pump manufacturer's bulletin.

LIFT VERSUS MAXIMUM LENGTH OF OIL SUPPLY AND RETURN LINES

Lift "L"	3/8" O.D. Tubing
0'	65'
1'	60'
2'	54'
3'	50'
4'	45'
5'	40'
6'	35'
7'	30'
8'	25'
9'	20'
10'	16'

**Figure 9**

**NOTE**

Maximum line lengths are calculated for fuel oil, viscosity 57 SSU.

Copper tubing should be used in preference to iron pipe as it requires less work, is neater, has less possibility of leaks, and does not scale off on the inside. Flare type fittings are recommended, as the soldered type may melt in case of fire.

The lines from the tank to the burner should not be smaller than 1/2" O.D. copper tubing; and, where the tanks are a considerable distance from the burner, they should be larger to reduce the friction loss. Install tank slip fittings (Chase No. 329 or equal) in the top of tank for both the suction and return line connections. Push both the suction and return lines down through the fittings until they touch the bottom of the tank and then pull them up three inches and lock in position with compression nuts so either line may be used as a suction line.

**NOTE**

Maximum pressure allowable on suction side of pump is 3 psig.

**OIL SHUTOFF VALVE.** A hand shutoff valve should be provided in the suction line near the burner and also at the tank or near the wall where the suction line comes through from an outside tank.

**NOTE**

Hand valves must not be installed on discharge side of pump or return line without a bypass relief to tank.



CHECK VALVE & STRAINER. If the top of the tank is below the burner level, use a check valve in the suction line on the burner side of the hand valve nearest the tank. An oil strainer is recommended for all installations.

**NOTE**

Select a check valve of the spring-loaded, soft-seated type suitable for #2 Oil, which will seat tightly with a low head.

OIL SUCTION LINE. Suction piping should be pitched back to the tank slightly whenever possible and particular care should be taken not to create an air trap in the line. There is always a slight amount of air in suspension in oil and if traps are present, they will gradually fill with air and the pump will lose its prime. Removal of air is generally very difficult.

Always provide a tee and plug in the suction line at the highest possible point to aid in priming the pump and in expelling air.

**NOTICE**

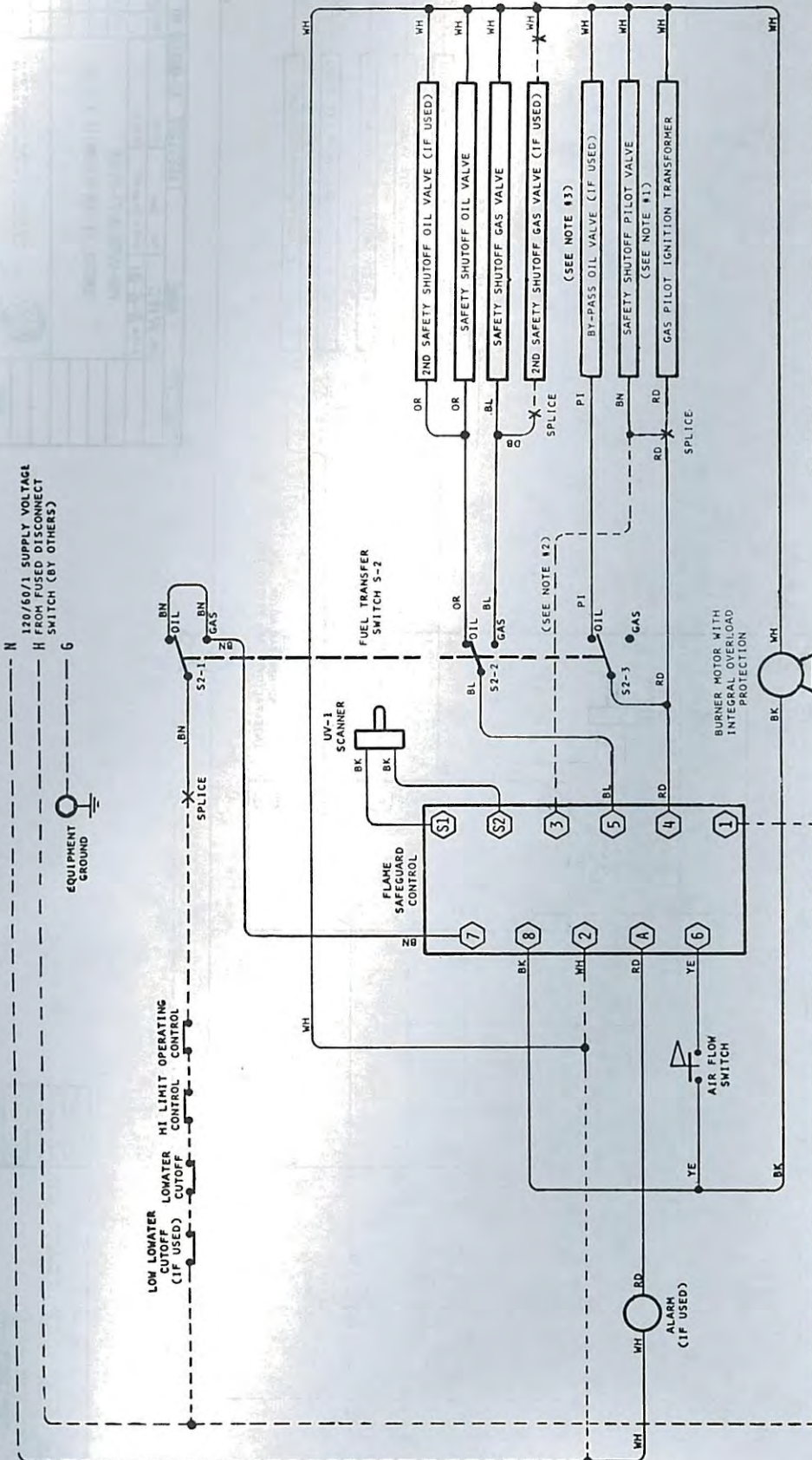
A foot valve at the end of the suction line in the tank is not recommended due to the high pressure drop associated with these valves.

**NOTICE**

On multiple burner installations where a circulating oil pump set is used, either oil flow switches, pressure switches or some other means of proving oil flow should be provided. This reduces the possibility of burner-boiler damage due to low or erratic oil pressure at the burner caused by inadequate oil supply.



# WIRING DIAGRAM FOR B-FI-F4B FUEL SYSTEMS



FIELD WIRING DIA. NO.	NONE	OPERATING SEQUENCE	33-001144-40
DR.	KX	CK.	267
DATE	10-12-83	DATE	10-12-83
TEST		DATE	
REV.		ECN.	
CK.			
F60-UW3-B-FI-PG-FB CONTROL SYSTEM SCHEMATIC WIRING			
NONE			
COMPONENT DRAWINGS			
DIAGRAM NO. 31-000092-40			
01/296100			

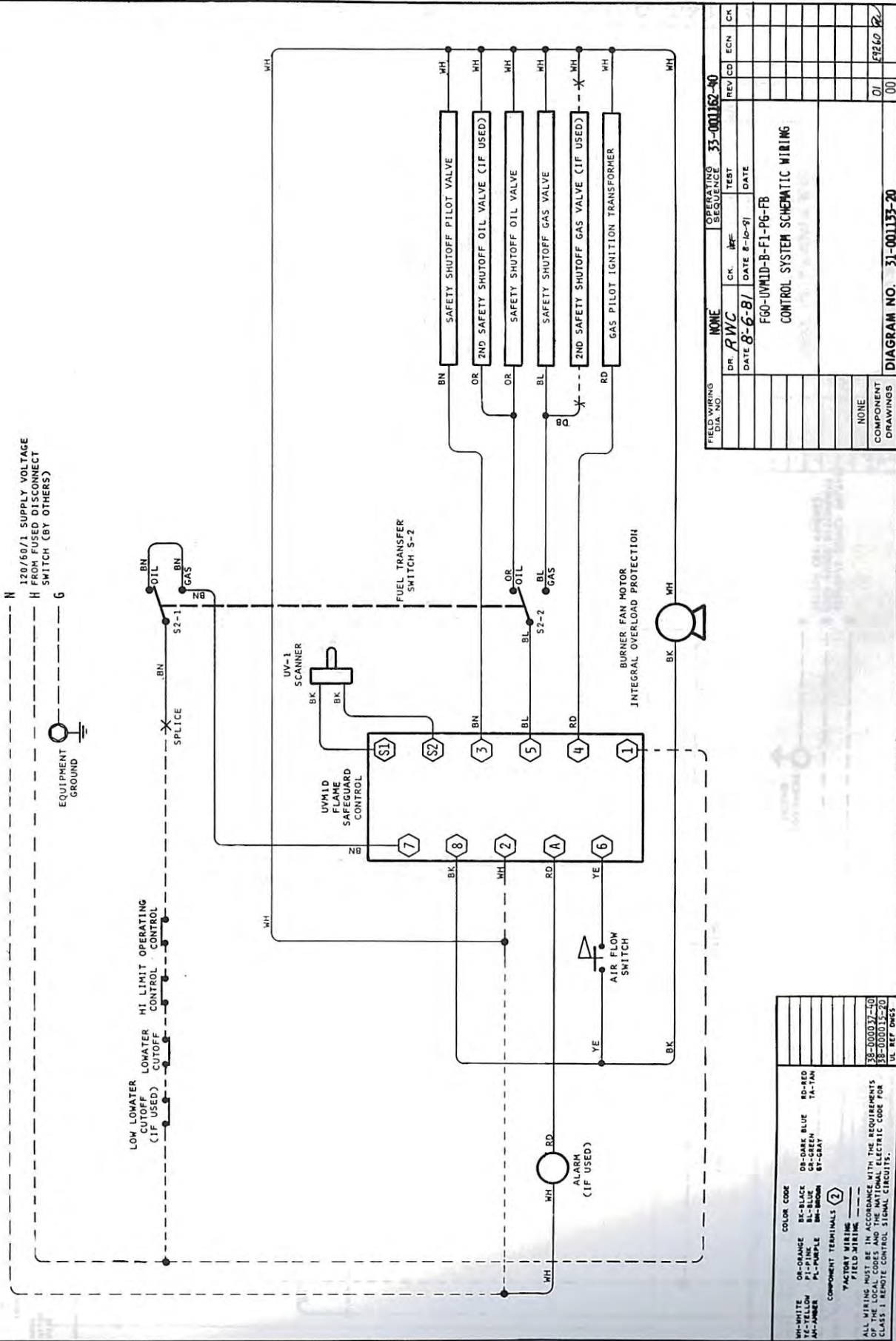
- NOTES:
- FOR INTERRUPTED PILOT USE ONLY UVM5 FLAME SAFEGUARD CONTROL AND CONNECT SAFETY SHUTOFF PILOT TO FLAME SAFEGUARD TERMINAL #4. INTERMITTENT PILOT MAY BE USED FOR UVM3 OR UVM3 FLAME SAFEGUARD CONTROL. DISCONNECT WIRE FROM SAFETY SHUTOFF PILOT VALVE THAT CONNECTS TO FLAME SAFEGUARD TERMINAL #4 AND CONNECT TO FLAME SAFEGUARD TERMINAL #3 AS SHOWN BY DASHED WIRING.
  - USED ON F4B OIL SYSTEMS ONLY.

OR-WHITE	OR-ORANGE	OR-DARK BLUE	RD-RED
OR-BLACK	BL-BLUE	TA-TAN	
OR-PURPLE	PI-PURPLE	GN-GREEN	
OR-BROWN	BR-BROWN	ST-GRAY	
COMPONENT TERMINALS (2)			
FACTORY WIRING			
FIELD WIRING			
ALL WIRING MUST BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE (NEC) AND THE NATIONAL FIRE ALARMING AND SIGNALING ASSOCIATION (NFPA) CLASS 1 REMOTE CONTROL SIGNAL CIRCUITS.			

## WIRING DIAGRAM FOR B-FI-F4B FUEL SYSTEMS



# WIRING DIAGRAM FOR B-F1 FUEL SYSTEM



FIELD WIRING DIA. NO.	NONE	OPERATING SEQUENCE	33-000132-40
DR.	RWC	CK.	WF
DATE	8-6-81	DATE	8-10-81
TEST		DATE	
FGO-UM10-B-F1-PG-PB CONTROL SYSTEM SCHEMATIC WIRING			
COMPONENT	NONE	REV	CD
DRAWINGS		DI	00
DIAGRAM NO.		31-001133-20	

WH-WHITE	BR-BROWN	DR-DARK BLUE	RD-RED
BL-BLACK	PK-PINK	OR-ORANGE	TA-TAN
YE-YELLOW	PL-PURPLE	GR-GRAY	BN-BROWN
AM-AMBER	BM-BROWN	BT-BLUE	BT-GRAY
FACTORY WIRING			
FIELD WIRING			
33-000132-40			
33-000133-20			
SEE REF. DESIG.			

ALL WIRING MUST BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE LOCAL CODES AND THE NATIONAL ELECTRIC CODE FOR CLASS 1 REMOTE CONTROL SIGNAL CIRCUITS.

WIRING DIAGRAM FOR B-F1 FUEL SYSTEM







## PART IV

# INSTALLATION INSTRUCTIONS

**GENERAL.** Check burner parts illustrated on preceding pages. The burner has been carefully checked at the factory, thus missing or damaged parts must be reported at once in order that appropriate action may be taken to replace them. Give burner model number and serial number when ordering parts.

The heat transfer surfaces of the furnace or boiler should be cleaned before the burner is mounted. Consult your local gas utility company regarding any special requirements in the preparation of the furnace or boiler.

**VENTING REQUIREMENTS.** Flue pipe, double acting barometric damper, draft hood, or vent should not be smaller than recommended by the furnace or boiler manufacturer, which size is typically represented by the dimension of the smoke outlet.

**COMBUSTION AIR SUPPLY.** The boiler room in which the burner is located must be provided with an adequate fresh air supply to assure proper combustion. The American National Standard ANSI Z223.1 specifies where directly connected with the outdoors, a permanent opening or openings having a total free area of not less than one square inch per 4000 BTU per hour total input rating of all appliances shall be required.

**WIRING.** The burner is prewired at the factory as far as practical. Refer to burner wiring diagram for complete wiring information and study thoroughly before making any connections. Make sure all screws on the flame safeguard base are tight as some may have been loosened during shipment.

Power to the burner must be 120 volts. All wiring must be done in accordance with National Electrical Code and local requirements. Burner electric power should be provided from a separate fused disconnect switch located in the Boiler Room.

**BURNER GASKET.** Cement rope gasket or sheet gasket to the burner mounting flange to prevent leakage of combustion gases from the boiler firebox.

**BURNER MOUNTING.** Attach burner to the boiler frontplate by firmly tightening nuts on the mounting studs or clamps so that a rigid installation is accomplished. Make sure burner is level before tightening clamps. Support the burner's weight by installing a 1/2" NPT pipe nipple from the floor to the support bracket located on the bottom of the housing.



COMBUSTION CHAMBER AND APPLICATIONS DATA

**NOTE**

Minimum Recommended Combustion Chamber Dimensions (inches)			
Input MBH	Rectangular Chamber		Round Chamber Inside Diameter
	Inside Width	Inside Length	
200-300	12	18	14
301-400	13	23	15
401-500	14	28	16
501-600	16	33	17
601-700	17	38	18
701-780	18	42	18

Combustion chamber dimensions may vary from table to fit job conditions. Floor area should not be less than 50 square inches per 100 MBH input. Larger floor areas are desirable as combustion chamber temperatures will be reduced giving longer refractory life. Combustion chamber length should not be less than 1-1/2 times the width. Combustion chamber height should equal chamber width or approximately twice the nozzle height of the burner from the floor. Recommended minimum distance from centerline of burner head to the floor is 6".

**FIREBOX BOILER WITH COMBUSTION CHAMBER IN BASE**

The illustration at left shows the burner installed in a conventional firebox boiler using a standard base and combustion chamber.

**FIREBOX BOILER FOR "FORCED DRAFT" FIRING**

The burner installation in a firebox type boiler designed for forced draft firing requires no refractory other than in the floor of the firebox and the burner frontplate. Special frontplates may be ordered with the burner to fit the boiler opening.

**INSTALLATION IN SCOTCH MARINE BOILER**

May be installed in Scotch Marine boilers of either 2 or 3 pass design. Refractory frontplate may be ordered with burner to adapt burner to boiler and provide protection to non-water backed surfaces.



# SUGGESTED INSTALLATION INSPECTION CHECKLIST

Check When Completed

## General

- Is burner installed in accordance with applicable installation drawings?
- If a refractory combustion chamber is part of the installation, is it completely dry, cured, and ready for firing at full boiler input?
- Has the proper electrical voltage been connected to the burner control cabinet as shown on the burner material list?
- Has the burner wiring been checked for completeness and accuracy?
- Are the boiler mounted limit controls such as low water cutoffs, high limit controls, operating controls, modulating controls, etc., properly installed and wired?
- Are the boiler controls the right type and range for the installation?
- Is the boiler water supply, including feed pumps, properly connected and is boiler filled with water?
- Is sufficient load connected to the boiler so that it can be fired continuously at full rating?
- If boiler load is not connected, can steam be wasted so that boiler can be fired continuously at full rating without endangering personnel or equipment?
- If the installation is a hot water boiler, have the circulating pumps been completely installed, wired and tested to assure proper operation so that the burner can be fired continuously at full rating?
- For new boiler installations, has the boiler been boiled out in accordance with the boiler manufacturer's instructions?
- Have the boiler breeching connections to the stack been completed and are they open and unobstructed?
- Is draft control equipment required and, if so, installed?
- Have adequate provisions for combustion air been installed?
- Have the persons listed below been notified of the burner start-up date?
  - Owner's Representative
  - Mechanical Contractor's Representative
  - Electrical Contractor's Representative
  - Service Organization's Representative
  - Boiler Manufacturer's Representative
  - Gas Utility Co. or Inspector
- Is all specified auxiliary equipment mounted and wired? This may include outdoor temperature controls, oil flow switches, space thermostats, water flow switches, motorized combustion air louvers, etc.?

## Gas Fire

- Gas piping into building, meter and service regulator has been installed, tested and ready for service?



- Are all gas train components installed and have they been properly selected, sized and assembled?
- Have properly sized vent lines been installed on all gas train components which require venting? This includes such items as pressure regulators, normally open vent valves, diaphragm valves, low and high gas pressure switches, etc.
- Have gas train piping and components been tested and proven gas tight?
- Have the gas lines been purged?
- Is the proper gas pressure available at the inlet to the controls which meets the requirement shown on the burner material list?

### Oil Fire

- Is the oil tank installed and filled with the proper type and grade of fuel oil as required by the burner material list? There must positively be no water in the tank!
- Is the proper oil pressure, temperature and viscosity available at the inlet to the controls which meets the requirements shown on the burner material list and/or oil system sheet?
- Have oil supply and return lines been properly sized to meet the maximum pumping capacity of the pump and has the system been purged and proven leak proof?
- Is the oil system piped for two-pipe operation as required and is the oil pump set-up for two-pipe operation?

**NOTE**

Some pumps require the use of an internal bypass plug for two-pipe operation.



## BURNER START-UP

### CAUTION

This manual has been prepared as a guide in burner start-up operations. It is written for the start-up specialist who is thoroughly qualified both by training and experience.

1. GENERAL - The following data is pertinent to the burner start-up and should be carefully studied before any attempt to operate the burner is made. This material is a part of the manual shipped with the burner.

- Burner Material List
- Burner Wiring Diagram and Operating Sequence
- Flame Safeguard Bulletin
- Gas System Bulletin (if applicable)
- Oil System Bulletin (if applicable)
- Miscellaneous Manufacturer's Data on Controls, Valves, Regulators, etc.

### NOTE

The above cited manual is ONE OF A KIND in that it contains material covering your SPECIFIC burner. To replace it, considerable time, special handling and significant costs are involved. Accordingly, it should be handled with care and kept in a location free of dust and moisture.

2. FLAME SAFEGUARD INSTALLATION - Assure flame safeguard is properly installed in its subbase.

### NOTE

The Burner Flame Safeguard is oftentimes packaged and shipped in a separate carton; however, the subbase is installed and pre-wired in the factory. See separate manufacturer's instructions for mounting the unit in the subbase.

3. IDENTIFICATION OF CONTROLS - Review the burner wiring diagram and operating sequence. Study these items and identify the various controls.

### NOTE

Do not proceed with start-up unless all applicable checklist items in Part IV and preliminary adjustment requirements in Part V have been satisfied.

If the burner is a combination gas-oil unit, it is recommended that the burner be fired on GAS first so the correct input rate in BTU's per hour may be determined by reading the gas meter.

### WARNING

Be certain combustion chamber, flues, and surrounding areas are free of GAS accumulations, OIL or OIL VAPOR and other combustibles such as paint thinners, cleaning solutions, etc. An explosimeter (Mine Safety Appliances Co. Model No. 2A or equivalent) should be used to make this determination.



4. GAS BURNERS - (See Paragraph 5 for oil burners)

4.1 REVIEW BURNER MATERIAL LIST IN THE INSTRUCTIONS MANUAL AND NOTE THE FOLLOWING INFORMATION:

- A. Firing rate (MBTU)
- B. Cubic feet of gas per hour (CFH)
- C. BTU per cubic foot (BTU/CF)
- D. Required gas pressure at control inlet (inches W.C.)
- E. Required gas pressure at orifices (inches W.C., taken at burner manifold)

The above information is pertinent to setting up the burner.

**CAUTION**

One of the most common oversights by an installer is failure to purge air, water, rust or other foreign matter from the Oil System. DAMAGE TO PUMPS AND OTHER COMPONENTS CAUSED BY RUST, WATER OR FOREIGN PARTICLES IS NOT COVERED BY WARRANTY.

A standard method for purging is to remove the system pressure gauge (or plug where gauge would normally be installed) and temporarily install a piece of copper tubing long enough to drain into a bucket or other container. With the pilot and main gas valves off, turn the burner on to gas and let the burner run during pre-purge. At the end of pre-purge, shut off the switch. There must be no sign of air, water, rust or other foreign matter in the flow. Repeat above steps until such matter is completely purged from the system.

If flow is not established within 1 minute, the pump should be primed through the suction line. Reinstall gauge or plug after purging is complete.

5. OIL BURNERS - (See Par. 4 for Gas Burners)

5.1 REVIEW BURNER MATERIAL LIST IN THE INSTRUCTIONS MANUAL AND NOTE THE FOLLOWING INFORMATION:

- (1) Oil Firing Rate (GPH)
- (2) Oil Pressure at Nozzle (PSIG)
- (3) Bypass Oil Pressure (PSIG) (If Applicable)

**NOTE**

The above information is pertinent to setting up the burner.

**WARNING**

During initial start-up, the operator must be on constant alert for emergency conditions such as fuel leaks, electrical malfunctions, etc. The location of all manual shutoff valves and switches should be clearly in mind so the burner can be quickly shut down if necessary. Should the burner fail to ignite, never manually manipulate the flame safeguard sequence which provides for purging of the combustion chamber.



# PART V

## BURNER ADJUSTMENTS

**FACTORY ADJUSTMENTS** - The burner is adjusted at the factory to meet "dry run" conditions. Adjustments and initial settings must be checked prior to initial light-off and settings must be verified by combustion tests.



Do not set fire visually on forced draft burners. Instruments are the only safe and reliable means to determine the proper adjustments.

**AIR AND FUEL ADJUSTMENT MECHANISMS** - Various adjustment mechanisms control the air and fuel available for combustion. These will vary by the type fuel to be burned and the method used to control the air fuel ratio.

Illustrations which follow show the items which are subject to adjustment. Determine the applicability of each illustration to your burner, then proceed to familiarize yourself with how the item functions. Where a setting is indicated, verify the setting or make preliminary adjustments as necessary to facilitate initial start-up.

### BURNER AIR AND FUEL ADJUSTMENTS

#### ADJUSTMENT OF AIR INLET LOUVER

APPLICABLE TO THESE FUEL SYSTEMS

B  
GAS

F1  
OIL

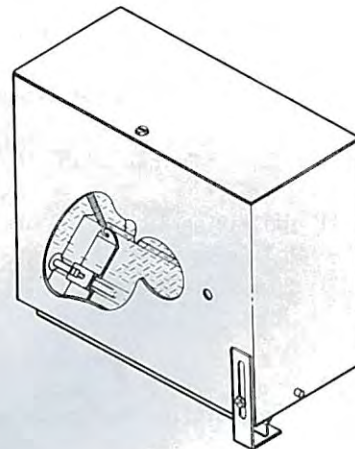
B-F1  
GAS-OIL

**DESCRIPTION**

These systems use an air louver which is spring loaded OPEN against an adjustment stop bracket. The system function when firing gas or oil is ON-OFF, FIXED AIR and FUEL.

**ADJUSTMENT PROCEDURE**

1. Loosen screw holding louver adjustment bracket and move to desired position then retighten.
2. For initial start-up, set the louver as per table of suggested setting for your burner firing rate.





APPLICABLE TO THESE FUEL SYSTEMS

F4B  
OIL

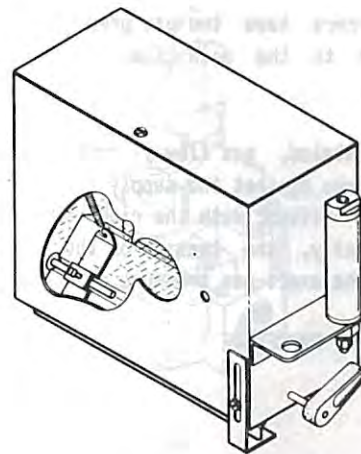
B-F4B  
GAS-OIL

#### DESCRIPTION

These systems use an air louver which is spring loaded OPEN against an adjustable stop bracket. When firing on oil, an oil cylinder and actuator arm arrangement move the louver to the CLOSED position for low-fire start. The system function when firing on gas is ON-OFF, FIXED AIR and FUEL. When firing on oil, ON-OFF, LOW FIRE START.

#### ADJUSTMENT PROCEDURE

1. Loosen screw holding louver adjustment bracket and move to desired position then retighten.
2. For initial start-up:
  - a. Set the louver as per table of suggested settings for your burner firing rate.
  - b. Set the low-fire adjustment arm so there is  $3/8$ " clearance between acorn nut on end of oil cylinder plunger and arm.
  - c. To decrease low fire air setting decrease the  $3/8$ " dimension in b. To increase the low fire setting increase the  $3/8$ " dimension.



APPLICABLE TO THESE FUEL SYSTEMS

H  
GAS

F4H  
OIL

H-F4H  
GAS-OIL

#### DESCRIPTION

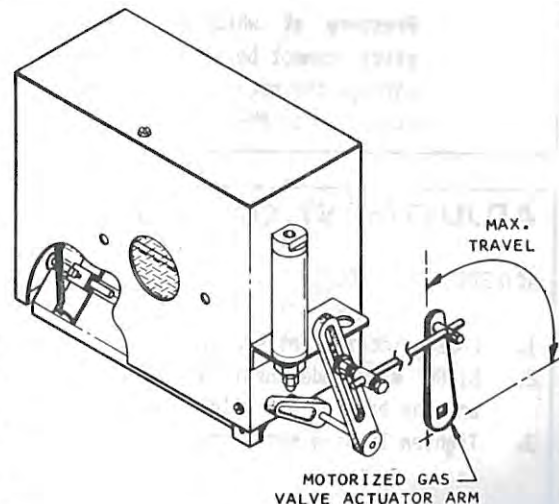
These systems use an air louver which is spring loaded CLOSED against an adjustable stop bracket. When firing on oil, an oil cylinder and actuator arm arrangement move the louver to the OPEN position for high fire. When firing on gas, a linkage arrangement to a motorized gas valve moves the louver OPEN. The system function is ON-OFF or HIGH-LOW, LOW FIRE START for both gas and oil.

#### ADJUSTMENT PROCEDURE

1. Loosen the screw holding louver adjustment bracket and move to desired position then retighten.
2. For initial start-up:
  - a. Set the louver as per table of suggested settings for the desired firing rate.
  - b. Set the louver actuator arm (under the oil cylinder) so there is  $3/8$ " clearance between acorn nut on end of oil cylinder plunger and arm.
  - c. To increase the high fire air setting, decrease the  $3/8$ " dimension in b. To decrease the high fire air setting, increase the  $3/8$ " dimension in b.
  - d. Adjust linkage arrangement to motorized gas valve so louver will open approximately  $1 1/4$ " when gas valve opens.

#### NOTE

Motorized gas valves and the linkage arrangement used will vary. Use good mechanical judgement to insure the linkage adjustments will open the louver as the gas valve opens.





## ADJUSTMENT OF PILOT GAS PRESSURE REGULATOR

### DESCRIPTION

Gas burners have two gas pressure regulators, one to regulate the pressure to the main flame and the other to regulate the gas pilot igniter.

Simply stated, gas flow is controlled by a spring of known load range which works against the supply gas pressure, therefore, each regulator must be fitted with the right spring for it to function properly. Additionally, the tension on the regulator spring must be adjusted to obtain the exact gas pressure required at the inlet to the pilot.

### ADJUSTMENT PROCEDURE

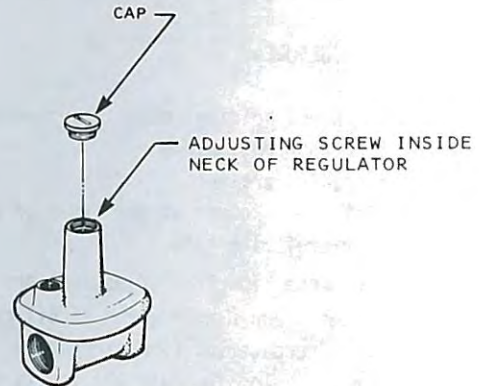
#### NOTE

See gas pressure regulator manufacturer's instructions for detailed procedures.

1. Remove cap or bonnet from regulator to gain access to adjustment screw or button.
2. Turn clockwise to increase and counter-clockwise to decrease outlet pressure.
3. For initial start-up, set pressure according to value in specification table for appropriate firing rate.
4. Reinstall cap or bonnet after adjustment.

#### NOTE

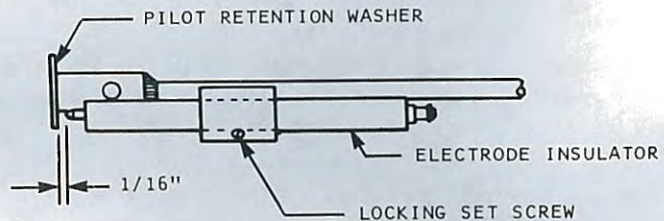
Pressure at which gas will be delivered to the pilot cannot be determined without gas flowing through the regulator. Be prepared to adjust the regulator as the pilot is tested.



## ADJUSTMENT OF GAS PILOT IGNITION ELECTRODE

### ADJUSTMENT PROCEDURE

1. Loosen locking set screw.
2. Slide electrode insulator until the gap between the electrode tip and the back of the pilot retention washer is  $1/16"$ .
3. Tighten locking set screw.





## ADJUSTMENT OF MAIN GAS PRESSURE REGULATOR

### DESCRIPTION:

Gas burners have two gas pressure regulators, one to regulate the pressure to the main flame and the other to regulate the gas pilot. The combination gas valves include the main gas pressure regulator and the main gas automatic shutoff valve.

### ADJUSTMENT PROCEDURE:

#### NOTE

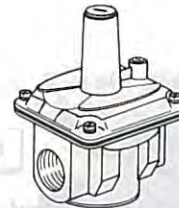
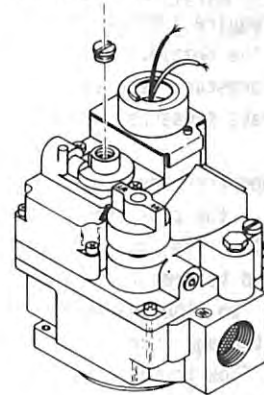
See manufacturer's instructions for detailed procedures.

1. Connect manometer to pressure tap in burner combustion head manifold.
2. Remove regulator adjustment screw cap.
3. With screwdriver, rotate adjustment screw "clockwise" to increase, or "counterclockwise" to decrease pressure.

#### NOTE

Pressure at which gas will be delivered to the burner cannot be determined without gas flowing through the regulator. Be prepared to adjust the regulator as the burner is test fired.

4. Replace regulator adjustment screw cap.
5. Disconnect manometer and plug pressure tap in burner manifold.



## ADJUSTMENT OF OIL BYPASS PRESSURE REGULATING VALVE

### DESCRIPTION

Oil burners which have low fire start fuel control systems must deliver oil to the nozzle at reduced pressure for low fire. This is normally accomplished by diverting a portion of the oil pump delivery through a bypass return line to the tank.

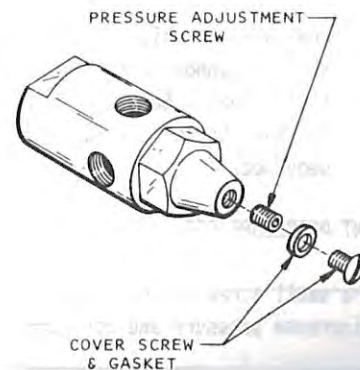
The amount of oil delivered to the nozzle versus that returned to the tank is controlled by a device which limits or meters flow, thus an oil bypass regulating valve or an oil metering valve is used for this purpose.

### ADJUSTMENT PROCEDURE

1. Using screwdriver, remove cover screw and gasket to gain access to the adjustment mechanism.
2. Use 1/8" Allen wrench to turn pressure adjusting screw clockwise to increase pressure and counter-clockwise to decrease.
3. For initial start-up: Set low fire pressure to 100 PSI.

#### NOTE

Pressure at which oil will be delivered to the nozzle cannot be determined until the burner is test fired. Be prepared to adjust the regulator as the burner is cycled through its firing sequence.





## ADJUSTMENT OF OIL SUPPLY PRESSURE REGULATOR

### DESCRIPTION

Oil burners require a close regulation of the pressure at which oil is delivered to the nozzle. Small GPH burners normally use an oil pump which has a pressure regulator built-in while larger capacity burners employ a separate pressure regulating valve.

Burner oil pumps are generally identified by the rate at which they can deliver (GPH), the pressure of the delivery (PSIG), and the speed of rotation (RPM). The pump is usually capable of delivering more fuel than is required to meet firing requirements; therefore, the amount of oil delivered to the nozzle must be controlled. This control is accomplished through use of an adjustable pressure regulating valve which reduces flow to the nozzle by causing more oil to be returned to the tank. Like most regulators, flow is controlled by an adjustable spring and each regulator has a pressure range over which it will reliably operate.

### ADJUSTMENT PROCEDURE FOR MODEL A

#### NOTE

See oil pump manufacturer's instructions for detailed procedures.

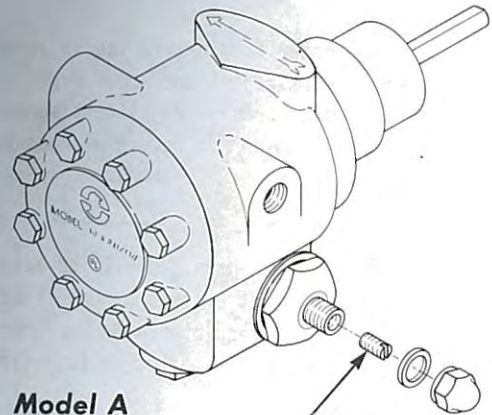
1. Using wrench, remove cover to gain access to the adjustment mechanism.
2. Use small screw driver to turn pressure adjusting screw clockwise to increase pressure and counter-clockwise to decrease.
3. For initial start-up: Set pressures as per table of suggested setting for the burner firing rate.

#### NOTE

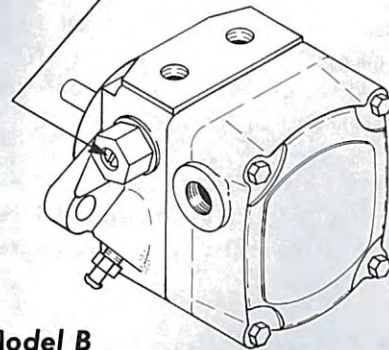
Pressure at which oil will be delivered to the nozzle cannot be determined until the burner is test fired. Be prepared to adjust the regulator as the burner is cycled through its firing sequence.

### ADJUSTMENT PROCEDURE FOR MODEL B

1. Use a small screw driver to turn pressure adjusting screw clockwise to increase pressure and counter-clockwise to decrease.



PRESSURE  
ADJUSTING  
SCREW



Model B

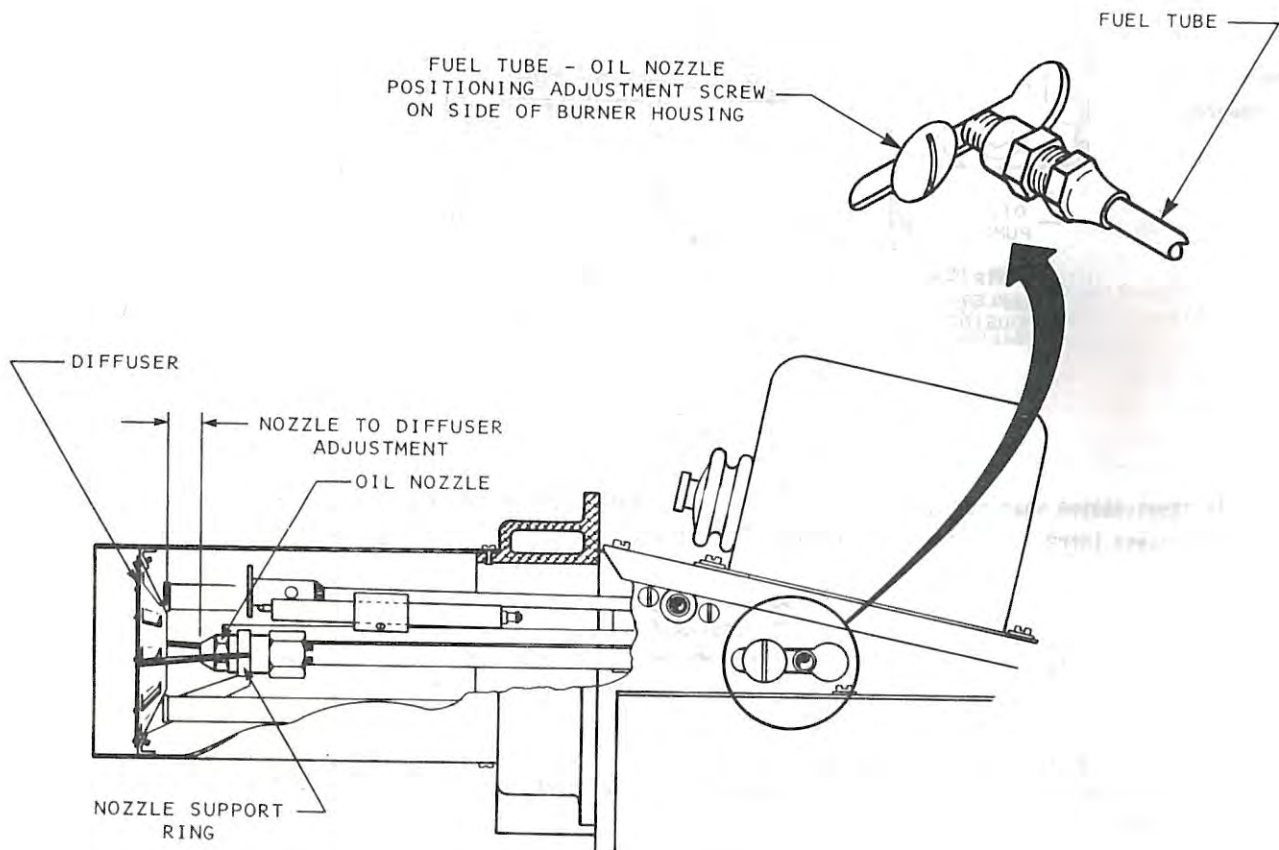


## ADJUSTMENT OF BURNER OIL NOZZLE POSITION

The adjustment of the oil nozzle to diffuser distance is preset at the factory for normal operating conditions and should not require adjustment. The distance between the nozzle and diffuser is dependent on the diffuser inside diameter and the nozzle spray angle. The smaller the diameter and the wider the spray angle the closer the nozzle must be to the diffuser. This setting affects the oil fire retention on the diffuser face and hence the flame stability.

### NOTE

Adjustment requirements cannot be finally established until after the burner is fired. Generally, the oil nozzle should be positioned as far to the rear (away from boiler) as possible without the oil spray impinging on the back side of the diffuser with the nozzle remaining inside the nozzle support ring.

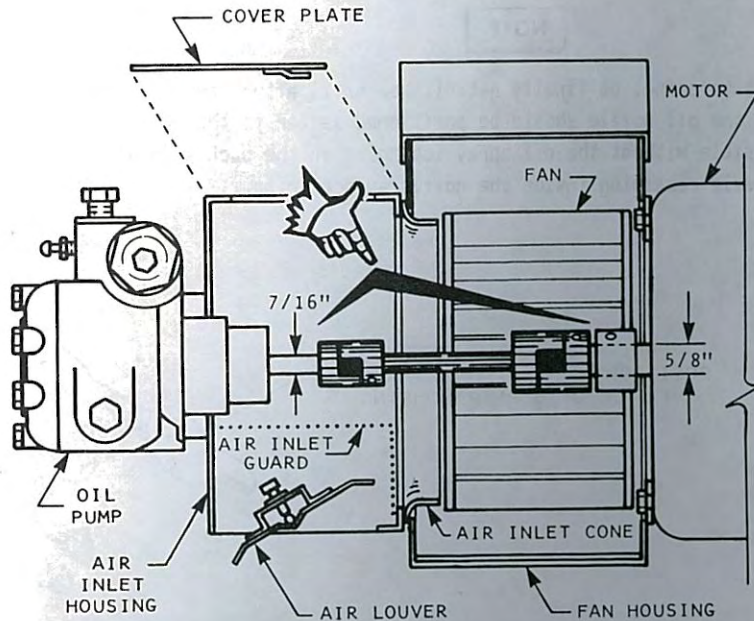




## OIL PUMP COUPLING ASSEMBLY

The oil pump is direct driven through a flexible coupling. The coupling is a vital part of the oil system and should be periodically inspected for wear, damage, and loose components. Details are shown below.

Figure 10



### NOTE

Combination gas-oil burners firing gas should not have the oil pump operating unless there is oil circulating through the pump.

### CAUTION

Serious damage to the pump will result if operated dry.

It is recommended that the coupling be removed for extended gas firing thus lessening the wear of the oil pump and reducing the starting torque of the blower motor.



# PART VI

## BURNER START-UP AND SERVICE

### CAUTION

Burner start-up, adjustment and service must be done by fully trained and qualified personnel.

A representative of the owner or the operator of the equipment should be present to receive instruction in care and adjustment of the unit. Upon completion of the initial start-up, he should sign the start-up form acknowledging that instruction has been received and a date established for start of free service period, if provided.

Proper combustion adjustments involve setting the fuel input rates and the combustion air to achieve maximum practical efficiencies on either fuel. It is recommended, but not mandatory, that the adjustments for gas burning be made first so the correct input rate in Btu's per hour may be determined by reading the gas meter. The gas input is adjusted by regulating the gas pressure on the burner manifold. This is accomplished by setting the spring of the gas pressure regulator while the burner is in operation.

The operator should become familiar with the location and purpose of all controls covering the burner's operation. Schematic wiring diagrams and identification photographs in this manual show the most important valves, instruments and electrical controls which regulate the burner operation.

### CAUTION

Examine the material list, wiring diagram and other information supplied with your burner. Determine the type combustion safeguard used and study the information contained in the Supplementary Data Section until thoroughly familiar with the control.

### Before Start-up

1. **VOLTAGE CHECK - 115 VOLT MOTOR & 120 VOLT CONTROLS** - With burner control switch OFF turn on burner power at disconnect switch or breaker. Check voltage with meter between terminals 1 and 2 on flame safeguard base. If voltage is not within +10%/-15% of 120 volts, contact local utility.
2. **CALL FOR HEAT** - Operating and limit controls must be calling for burner operation. These controls may include the low water cutoff, steam pressure or hot water temperature controls, end switch on automatic draft control, combustion air damper switch and other remote switches or controls, if used.
3. **PURGE GAS LINE** -

### CAUTION

Purging of gas lines must be done in accordance with American National Standard, ANSI Z223.1.

After making certain that all electrical switches are in OFF position and with the combination gas control or manual valve in the OFF position, the pilot supply tubing should be removed at the inlet to the pilot solenoid gas valve. Turn the pilot gas cock on and bleed the gas line until all air is purged from the line. Turn pilot gas cock off and reconnect the pilot gas supply line.

4. **LUBRICATION** - If blower motor is equipped with lubrication devices, add (2) drops of SAE20 lubricating oil to each bearing.
5. **AIR LOUVER** - Adjust air louver to position indicated in table for firing rate of your burner.



## Start-up

### CAUTION

The oil pump is directly coupled to the motor shaft. Oil must be available to circulate through the pump when the motor is energized to prevent the pump from running dry. Air bleeding is automatic with the installed two-pipe system. Do not proceed beyond Item 1 of the Startup Procedure until oil flow through the pump is established. Remove coupling if no oil available (See Figure 10).

1. With the operating control set to CALL FOR HEAT and the main gas control valve (or manual valve) and the pilot gas cock set to off, turn the fuel selector switch to GAS. Listen for ignition spark. Allow flame safeguard control to proceed to a safety lockout, thereby checking the control for flame failure.
2. Turn pilot gas cock on and then push in the reset button on the flame safeguard control. With pilot running, set pilot pressure in accordance with firing rate in table of suggested settings and visually inspect pilot flame and check the signal strength in accordance with the flame safeguard manufacturer's bulletin.
3. Turn gas control valve or manual valves ON. Visually inspect main gas flame and check signal strength. Set manifold gas pressure to that shown on material list or that shown for your firing rate in the table of suggested settings. Clock the firing rate of the burner with the gas utility company meter and adjust burner pressure regulator, if necessary, to obtain rated capacity.
4. Adjust combustion air inlet louver to obtain between 8 1/2% and 9 1/2% carbon dioxide (CO<sub>2</sub>) without forming carbon monoxide (CO).

### CAUTION

Do not adjust flame visually. Instruments are the only reliable means to determine proper air adjustment.

5. Turn the fuel selector switch to OIL. The desired CO<sub>2</sub> should range between 11% and 12 1/2% with not more than a Bacharach No. 2 smoke. If air louver is readjusted, the CO<sub>2</sub> and CO from gas firing must be retested.

### NOTE

If the burner is equipped with an intermittent gas pilot it will have an input of approximately 10,000 BTU/Hour. When firing oil, the total BTU/Hour input to the furnace or boiler is the sum of the oil rate and the pilot rate.

### NOTE

Oil pump operational pressure shall not be less than 90 psig nor more than 125 psig for F1 oil systems. For F4B oil systems the oil pressure should be between 250 and 310 psig. If oil firing rate cannot be obtained within this pressure range, select a different size nozzle.

## Burner Safety Check

1. Start and stop burner several times on each fuel to insure proper operation.
2. Check operation of combustion safeguard control by simulating a flame failure on each fuel, making certain the burner locks out on safety within the proper time limit.



3. Check operation of the air flow switch on each fuel, making certain the respective fuel valve closes when the air flow mercury switch opens.
4. Set the high limit control 2 to 3 psi or 10 degrees F. to 15 degrees F. higher than the desired operating pressure or temperature. Set the operating control pressure or temperature higher than the high limit control for this test. Permit burner to run until desired HIGH LIMIT pressure or temperature is indicated and then adjust high limit control, if necessary, to shut off the burner at the desired high limit pressure or temperature.
5. Reset operating control to desired pressure or temperature. Permit burner to run until it is shut off by the operating control. Adjust operating control, if necessary until it causes burner to stop and start within desired range.
6. With the burner running, open the blow-down valve on the low water cutoff (if used). The burner should shut off immediately. The burner should restart automatically when the proper level of water in the low water cutoff is re-established.
7. Conduct minimum pilot test as described in manufacturers flame safeguard bulletin.
8. The following readings should be taken and recorded after final adjustments have been made.
  - a. Burner input (CFH Gas) (GPH Oil)
  - b. Percent CO<sub>2</sub> (Gas and Oil)
  - c. CO indication (Gas) and Smoke indication (Oil)
  - d. Stack Temperature (Gas and Oil)
  - e. Firebox Pressure (in. w.c.)
  - f. Fuel pressure (psi - Oil) (in. w.c. - Gas)
  - g. Voltage to burner
  - h. Flame signal strength

## **BURNER MAINTENANCE and TROUBLE SHOOTING**

Frequency of maintenance depends on the condition of the heating plant area. For dusty or adverse conditions, preventative maintenance should be performed once a month, or as often as necessary for proper burner operation. PREVENTATIVE AND YEARLY MAINTENANCE can be performed by building maintenance personnel. ALL SERVICE AND ADJUSTMENT OF THE BURNER SHOULD BE PERFORMED ONLY BY QUALIFIED BURNER SERVICE PERSONNEL.



Always turn electrical power and gas fuel supply OFF before undertaking any maintenance that does not require the burner to be in operation.

### **General Maintenance**

1. Make certain combustion chamber and flues are purged of any unburned fuel before attempting to start burner following an OFF period due to any burner problems.
2. Always follow the "Burner Operating Instructions" in turning the burner OFF or ON.
3. Make certain that all electrical connections are secure, including the flame safeguard relay mounting connections.
4. Never oil the flame safeguard relay.
5. Maintenance of flame safeguard control, oil pump, and other such burner components should be performed in accordance with instructions contained in the manufacturer's bulletin.



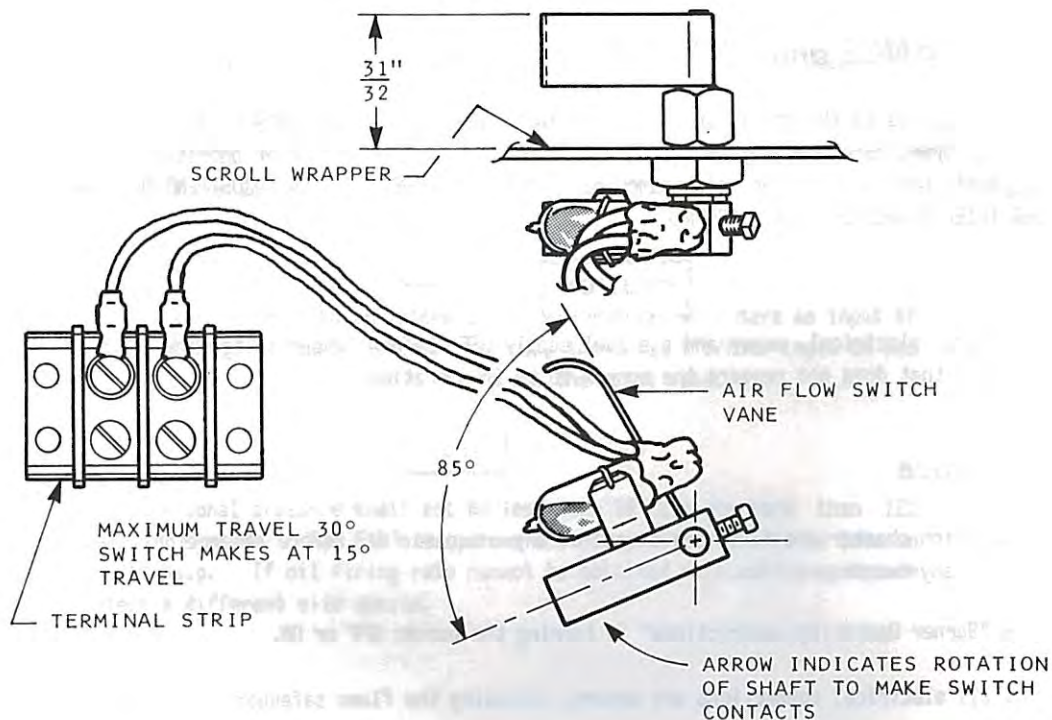
## Yearly Maintenance

Preferably before start of heating season.

1. Remove blower motor and blower wheel assembly and clean.
2. Remove drawer assembly and clean complete assembly, including nozzle.
3. Remove pilot assembly. Check spark gap of ignition electrode and clean complete assembly.
4. Remove scanner and clean lens.
5. Clean all inside surfaces of blower scroll.
6. Make repairs to combustion chamber, if necessary.
7. Check operation of all limit and operating controls.
8. Tighten all screws holding components and conductors.
9. Check combustion.

## Air Flow Switch Adjustment

Figure 11





## Preventive Maintenance

1. Visually inspect for dirt deposits on blower wheel.
2. Check that blower wheel is not loose on motor shaft.
3. Check that air flow switch is working properly (Figure 11).
4. Check the combustion chamber for loose bricks and cracks.
5. Oil both bearings of blower motor as directed by decal located on motor housing.
6. Always keep cover on control cabinet, except during servicing.
7. Check operation of flame safeguard as per starting instructions.
8. Check limit and operating controls.

Figure 12

## TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
Blower Motor does not operate when fuel selector switch is closed.	Power disconnected.	Check voltage between terminals 1 and 2 on subbase. If no voltage, check power supply.
	Operating control not calling for heat or high limit control open	Check voltage between terminals 2 and 7 on subbase. If no voltage, check for open operating and/or limit control.
	Lockout switch open due to flame failure.	Push in reset button on flame safeguard control.
	Overload tripped out on motor.	Reset. Check motor current for possible overload.
	Defective motor.	If voltage at motor terminals is correct, replace motor.
	Defective flame safeguard control.	Replace flame safeguard.
	Defective fuel transfer switch.	Check voltage between either switch terminal that has factory installed brown wire jumper and terminal 2 (ground). Replace switch.
	Oil pump shaft frozen.	Replace pump. Return damaged pump to approved service station or factory for repair. Check for water or dirt in oil tank.



Figure 12 (continued)

TRUBLE SHOOTING

Trouble	Probable Cause	Remedy
Motor runs but ignition spark does not occur.	Air flow switch fails to make.	Adjust switch and tighten set screw. Replace mercury bulb if broken. (See Figure 11).
	Ignition cable or electrode loose or grounded.	Check to insure that ignition cable is securely plugged into transformer and into electrode. Check cable and clean if necessary.
		Remove pilot assembly and check spark gap (1/16" from tip to nearest grounded surface). Check electrode insulator for cracks.
	Dirty contacts in main relay.	Check voltage to primary coil of ignition transformer during trial for ignition.
	Defective ignition transformer.	Replace transformer.
Defective flame safeguard.	Replace flame safeguard.	
Motor runs, ignition spark occurs, but gas pilot does not ignite.	No gas being supplied to pilot.	Check all manual gas valves leading to burner to insure that they are open or that separate manual pilot valve is open.
	Pilot gas valve does not open.	Check voltage to coil during trial for ignition. Check valve action by sound and feel. Replace coil or valve body as needed.
		If no voltage to coil, replace the flame safeguard control.
Insufficient gas flow to pilot.	Increase gas pressure to pilot. Check for crushed pilot gas supply line.	
Motor runs, gas pilot establishes, pilot flame signal too low.	Insufficient gas flow to pilot.	Increase gas pressure to pilot.
	Flame scanner lens dirty.	Clean.
	Sight tube dirty or plugged.	Clean.
	Sight tube misaligned.	Install in proper position.
	Defective scanner.	Replace scanner.
Defective flame safeguard.	Replace flame safeguard.	
Motor runs, gas pilot establishes, main gas flame does not ignite.	Manual valve not in proper position.	Turn to ON or open position.



Figure 12 (continued)

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
<p>Motor runs, gas pilot establishes, main gas flame does not ignite. (con't.)</p>	<p>Main gas valve does not open.</p>	<p>Check voltage to coil of main gas valve. Check valve action by sound and feel. Replace coil or valve body as needed.</p> <p>If no voltage to coil, replace the flame safeguard control.</p>
	<p>Excessive air to fuel ratio.</p>	<p>If gas flow rate is less than 50% of rated capacity, increase gas manifold pressure.</p> <p>Oversized blower wheel. Compare actual size with that shown on material list.</p>
	<p>Manifold gas pressure too low.</p>	<p>Adjust pressure regulator to valve shown on burner material list.</p> <p>Inlet pressure to combination gas control or main shutoff cock too low. If it is, consult your local gas utility company.</p>
	<p>Incorrect gas orifices.</p>	<p>See material list for proper size.</p>
	<p>Defective fuel transfer switch.</p>	<p>Check voltage between switch terminal connected to blue wire leading to main gas valve and terminal 2 (ground). Replace switch.</p>
	<p>Motor runs, gas pilot established, oil flame does not establish.</p>	<p>Oil tank empty.</p>
<p>Clogged strainer or nozzle.</p>		<p>Clean or replace.</p>
<p>Oil valve does not open.</p>		<p>Check voltage across coil. Check valve action by sound and feel. Replace coil or valve body as needed.</p> <p>If no voltage to coil, replace the flame safeguard control.</p>
<p>Broken or defective coupling between motor shaft and oil pump shaft.</p>		<p>Replace coupling.</p>
<p>Insufficient oil pressure. (To install gauge, refer to pump manufacturer's bulletin.)</p>		<p>If oil pressure is less than 90 psi, increase pump pressure by adjustment. If pressure adjustment is ineffective, check for blockage in fuel line, filter or strainer.</p>
<p>Defective fuel transfer switch.</p>		<p>Check voltage between switch terminal connected to orange wire leading to oil valve and terminal 2 (ground). Replace switch.</p>



Figure 12 (continued)

TRUBLE SHOOTING

Trouble	Probable Cause	Remedy
Oil Pump.		See Trouble Shooting Guide in pump manufacturer's bulletin.
Yellow flicks of oil burn while firing on gas.	Main oil valve leaking.	Remove and clean or replace.
Lockout on flame failure.	Interrupted fuel supply.	Establish fuel supply to burner.
	Improper combustion.	Adjust burner to obtain a clean flame.
	Weak flame signal.	Refer to flame safeguard control manufacturer's bulletin. Check flame signal strength, clean scanner with clean cloth and detergent.
Carbon Monoxide formation when firing gas.  <b>CAUTION</b> Check CO with reliable instrument. Be certain to check for CO before leaving burner location.	Flame impingement on a cold surface due to excessive firing rate.	Check gas flow rate. Adjust flow rate, if necessary.  Check gas orifice size versus burner material list.
	Flame impingement on cold surface due to undersized combustion chamber.	See Specification Table.
Excessive smoke formation when firing oil. (Carbon formation on combustion chamber surface)	Dirty or defective oil nozzle.	Clean or replace nozzle.
	Poor atomization due to low oil pressure.	Increase pressure to a minimum of 90 psi. If pressure adjustment is ineffective, check for blockage in fuel line.
	Flame impingement on a cold surface.	See carbon monoxide formation trouble noted above.
	Fuel oil of grade heavier than No. 2.	If API gravity is less than 30 degrees corrected to 60 degrees F., contact your fuel oil supplier. Fuel does not meet minimum requirement for No. 2 fuel oil.
	Flame too wide and impinging on sides of combustion chamber.	Decrease spray angle of nozzle.
		Check combustion chamber width.
Flame too long and impinging on rear of combustion chamber.	Increase spray angle of nozzle.	
	Check combustion chamber length.	
Yellow (oil) stain on smoke test filter paper.	Dirty or defective oil nozzle.	Clean or replace nozzle.
	Nozzle spray angle too narrow.	Increase spray angle of nozzle.
	CO2 level too low	Adjust to 10 1/2 - 12 1/2%.



## PERIODIC TESTING RECOMMENDED CHECK LIST

ITEM	FREQUENCY	ACCOMPLISHED	REMARKS
Check burner and boiler control linkage	Daily	Operator	Make visual inspection
Check fuel system for leaks	Daily	Operator	Make inspection visually and with leak detection instrumentation
Gauges, monitors and indicators	Daily	Operator	Make visual inspection and record readings in log
Oil pump inlet vacuum	Daily	Operator	Make visual inspection and record readings in log
Oil pressure at pump, burner, and/or regulating valve	Daily	Operator	Make visual inspection and record readings in log
Instrument and equipment settings	Daily	Operator	Make visual check against recommended specifications
Check burner flame	Daily	Operator	Visual inspection for changes
Firing rate control	Weekly Semiannually Annually	Operator Service technician Service technician	Verify factory settings Verify factory settings Check with combustion test
Stack temperature	Daily	Operator	Record in log
Flue, vent, stack or outlet dampers	Monthly	Operator	Make visual inspection of linkage, check for proper operation
Igniter	Weekly	Operator	Make visual inspection, check flame signal strength if meterfitted (see "Combustion safety controls")
Oil nozzle(s) and Strainers	Semiannually	Operator	Check for dirt and wear
Fuel Valves			
Pilot and main	Weekly	Operator	Open limit switch - make aural and visual check - check valve position indicators and check fuel meters if so fitted
Pilot and main gas or main oil	Annually	Service technician	Perform leakage tests - refer to instructions
Combustion safety controls			
Flame failure	Weekly	Operator	Close manual fuel supply for (1) pilot, (2) main fuel cock, and/or valve(s); check safety shutdown timing; log
Flame signal strength	Weekly	Operator	If flame signal meter installed, read and log; for both pilot and main flames, notify service organization if readings are very high, very low, or fluctuating; refer to instructions
Pilot turndown tests	As required/annually	Service technician	Required after any adjustments to flame scanner mount or pilot burner verify annually-refer to instructions
Refractory hold in	As required/annually	Service technician	See "Pilot turndown tests"



## PERIODIC TESTING RECOMMENDED CHECK LIST

ITEM	FREQUENCY	ACCOMPLISHED	REMARKS
Low-water fuel cutoff and alarm	Daily/Weekly Semiannually	Operator Operator	Refer to instructions Perform a slow drain test in accordance with ASME Boiler and Pressure Vessel Code Section VI
High limit safety control	Annually	Service Technician	Refer to instructions
Operating control	Annually	Service technician	Refer to instructions
Low draft, fan, air pressure, and damper position interlocks	Monthly	Operator	Refer to instructions
Atomizing air/steam interlock	Annually	Service technician	Refer to instructions
High and low gas pressure interlocks	Monthly	Operator	Refer to instructions
High and low oil pressure interlocks	Monthly	Operator	Refer to instructions
High and low oil temperature interlocks	Monthly	Operator	Refer to instructions
Fuel valve interlock switch	Annually	Service technician	Refer to instructions
Purge switch	Annually	Service technician	Refer to instructions
Burner position interlock	Annually	Service technician	Refer to instructions
Low fire start interlock	Annually	Service technician	Refer to instructions
Automatic changeover control (dual fuel)	At least annually	Service technician	Under supervision of gas utility
Safety valves	As required	Operator	In accordance with procedure in Section VI, ASME Boiler and Pressure Vessel Code, Recommended Rules for Care and Operation of Heating Boilers
Inspect burner components	Semiannually	Service technician	Refer to instructions
Clean burner fan	Annually or as required	Operator	Remove buildup on fan blades

### PART VII

## SUPPLEMENTARY DATA

This manual should be kept with other literature on your boiler room equipment as a complete reference source for maintenance and service.