D/LND SERIES

Installation, Operation, and Service Manual

INDUSTRIAL COMBUSTION

⚠ WARNING

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

IC-790
10/10

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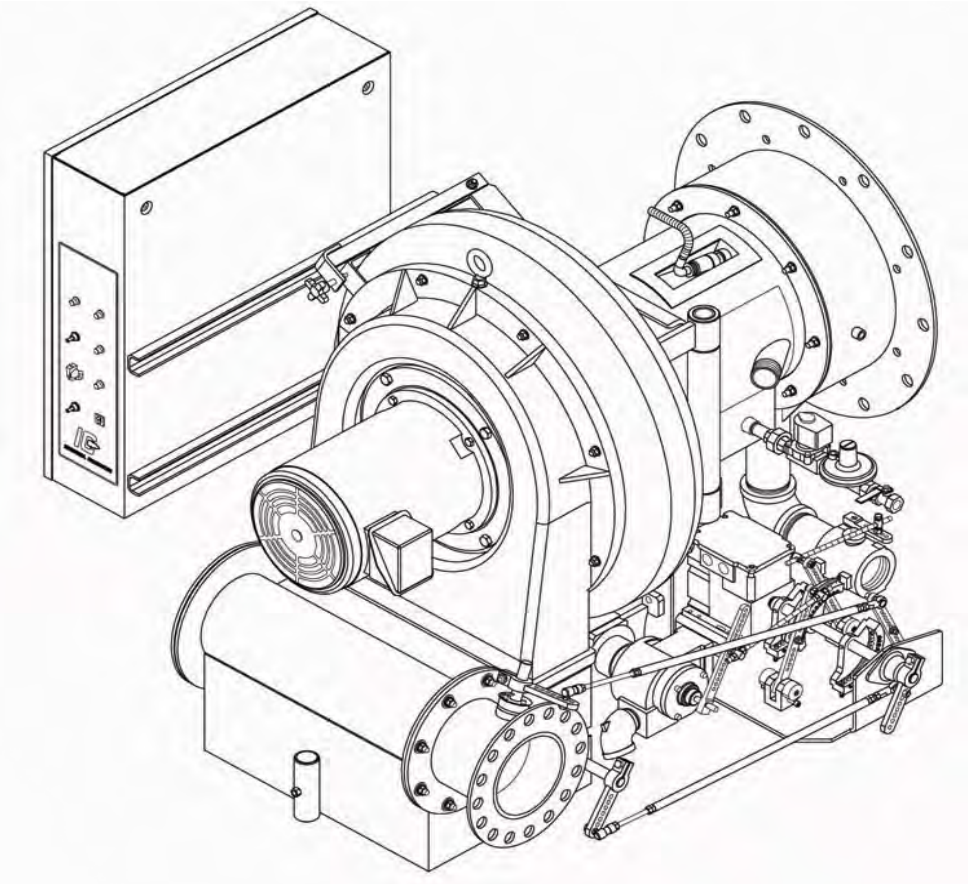

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Industrial Combustion

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PREFACE

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

⚠ Warning

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

⚠ Caution

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

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

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

Model Standards	**Fuel-Air Atomization**
DG	Gas
DL	#2 Oil
DLG	#2 Oil and Gas
DM	#2-5 Oil
DMG	#2-5 Oil and Gas
DE	#2-6 Oil
DEG	#2-6 Oil and Gas

S-Models for up to 1.5" W.C. furnace pressure.
P-Models for up to 4.0" W.C. furnace pressure.

Example: The model number on the nameplate is DLG-252, No. 2 oil and gas burner with input rated at 25,200 MBtu per hour, against furnace pressures up to 4" W.C. at 60hz.

NOTE: Firing at higher furnace pressures de-rates the burner by approximately 5% per one half inch of additional pressure. Consult with the factory.

The installation of a burner shall be in accordance with the regulations of authorities having jurisdiction. The equipment must be installed in accordance with applicable local, state, or provincial installation requirements including the National Electrical Code (NEC) and Associated Insurance Underwriters. Where applicable, the Canadian Gas Association (CGA) B149 and Canadian Standard Association (CSA) B140 and B139 (for oil burners) codes shall prevail. OIl and gas burning equip-

ment shall be connected to flues having sufficient draft at all times to assure safe and proper operation of the burner.

The D Series burners are designed to burn either gas or light oil No. 1 or 2 as defined by ASTM D396-1978 specifications, and heavy oils.

Do not use gasoline, crankcase oil, or any oil containing gasoline.

Burner Size	**Max. Burner Gas Input MBTU/hr.**	
	60hz	50hz
42 (S or P)	4,200	3,360
54 (S or P)	5,400	4,200
63 (S or P)	6,300	5,250
84 (S or P)	8,400	6,300
105 (S or P)	10,500	8,400
145 (S or P)	14,500	10,500
175 (S or P)	17,500	14,700
210 (S or P)	21,000	16,800
252 (S or P)	25,200	21,000
300 (S or P)	30,000	25,200
315 (P)	31,500	30,000
336 (P)	33,600	31,500
378 (P)	37,800	33,600
420 (P)	42,000	37,800

Gas input based on natural gass at 1,000 Btu/cu. ft. and 0.60 specific gravity.

Burner Size	Max. Burner Oil Input U.S.G.P.H.	
	60hz	50hz
42 (S or P)	30	24
54 (S or P)	39	30
63 (S or P)	47	38
84 (S or P)	60	53
105 (S or P)	75	60
145 (S or P)	107	90
175 (S or P)	125	105
210 (S or P)	150	120
252 (S or P)	180	150
300 (S or P)	215	180
315 (P)	225	215
336 (P)	240	225
378 (P)	270	240
420 (P)	300	270

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

D/LND Series

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CHAPTER 1 Introduction

1.1 — Overview

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

⚠ Caution

Only factory authorized burner service personnel should start-up, adjust, or service this equipment.

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

1.2 — Description

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

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

INDUSTRIAL COMBUSTION

1.3 — Operating Controls

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

Component	Details
On-Off Burner Switch	For gas or oil only.
Fuel Selector Switch	Gas-Off-Oil For combination gas-oil burners only. a) Gas Position: Selects gas as the firing fuel. b) Off Position: Burner off. c) Oil Position: Selects oil as the firing fuel. **NOTE:** When changing from oil to gas fuel, allow the programmer to complete post-purge and shutdown before moving the selector switch to the gas position. This will allow the interlock circuit to de-energize at either the oil-air pump or the compressor.
Control Circuit Breaker	Supplementary low overcurrent protection only. No larger than 15 amps.
Auto-Manual Modulation Selector Switch	a) Auto Position: Selects boiler modulation control. b) Manual Position: Selects 135 ohm potentiometer for manual modulating control.
Manual Modulating Control 135 ohm	Increases or decreases the burner firing rate manually.
Signal Lamps	a) Power On (white): Illuminates when the control circuit is energized (powered). b) Ignition (amber): Illuminates when the ignition transformer is powered, and gas pilot valve is energized (open). c) Main Fuel (green): Illuminates when the main fuel valve or valves (gas or oil) are energized (open). d) Flame Failure (red): Illuminates when the flame safeguard system fails to detect pilot or main flame.

1.4 — Flame Safeguard Controls

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

⚠ Warning

Read the flame safeguard manual and fully understand its contents before attempting to operate this equipment. Failure to follow this instruction may result in serious personal injury or death.

1.5 — Combustion Air Handling System

The combustion air handling system consists of three major components:

Component	Details
Damper Assembly	A rotary damper regulates the combustion air volume and is positioned by a modulating motor. The damper is normally almost closed in the low fire position and opens as the burner drives toward a high fire position.
Motor Driven Impeller	The diameter of the impeller determines available air pressure and the width determines air capacity in cubic feet per minute. Alternate motor-impeller combinations are available for 50 cycle or 60 cycle power and for firing against either moderate or high furnace pressure. At altitudes up to 2,000 ft. above sea level, model “S” impellers are recommended for up to 1.5” W.C. furnace pressure. Model “P” impellers are recommended for furnace pressures from 1.5” to 4.0” W.C. For higher altitudes and higher furnace pressure, motor and impeller combinations are determined at the factory.
Stator Cone	The stator cone in the air housing transforms the rotating air velocity pressure to static pressure prior to air entry into the blast tube.

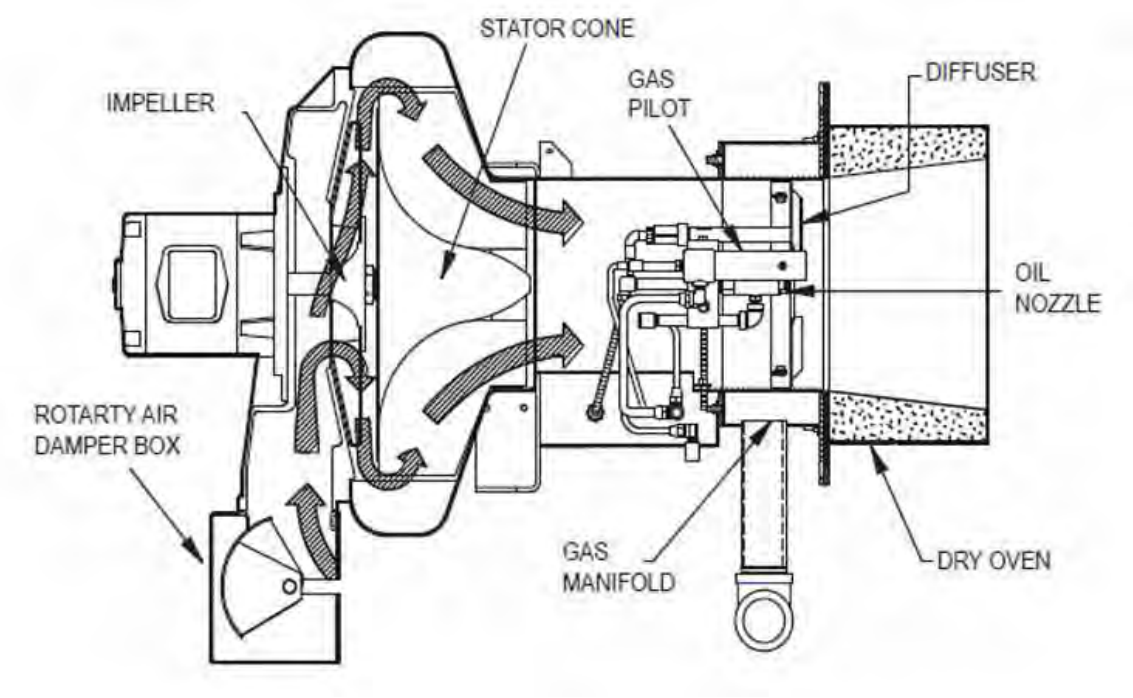


FIGURE 1-1. Damper, Impeller, and Stator Cone

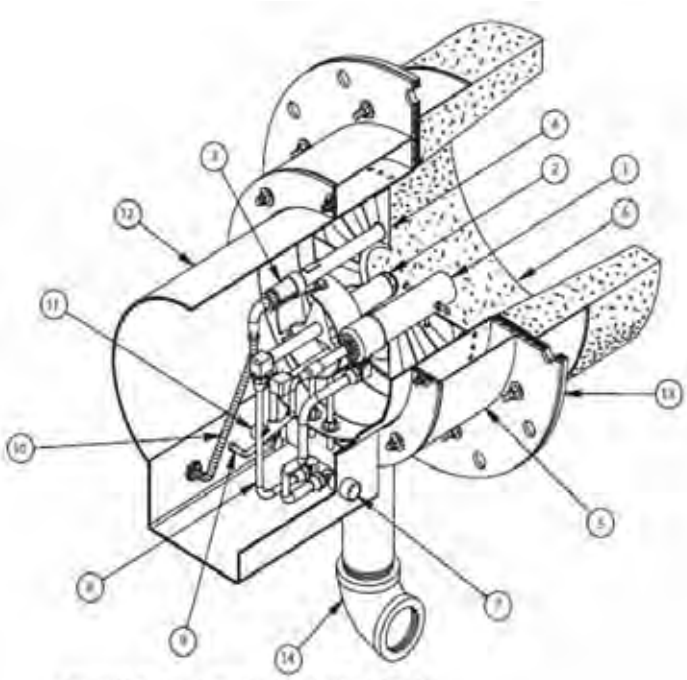
1.6 — Firing Rate Controls

Regardless of the fuel used, burner input is fully modulated between low fire and high fire on boiler demand. The firing rate is controlled by the potentiometer-regulated modulating motor. The combustion air control damper, oil

metering pump, and/or gas volume butterfly valve are controlled through variable rate rod and lever linkages. The modulating motor rotates 90º from low to high position. Flow rate through each component is adjusted by positioning the control rods on the levers and the angular position of levers on shafts. The lever on the modulating motor shafts actuate the high fire position proving switch.

1.7 — Firing Head

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



1- GAS PILOT ASSEMBLY WITH ELECTRIC SPARK IGNITOR
2- AIR ATOMIZING OIL NOZZLE (SINGLE OR DUAL)
3- FLAME SCANNER
4- AIR DIFFUSER
5- GAS PORTS IN SURROUNDING MANIFOLD
6- REFRACTORY OVEN
7- GAS PILOT INLET CONNECTION
8- ATOMIZING AIR LINE
9- ELECTRODE LEAD
10- SCANNER LEAD
11- FUEL OIL INLET
12- BLAST TUBE
13- DRY OVEN GASKET
14- GAS INLET

FIGURE 1-2. Firing Head Assembly

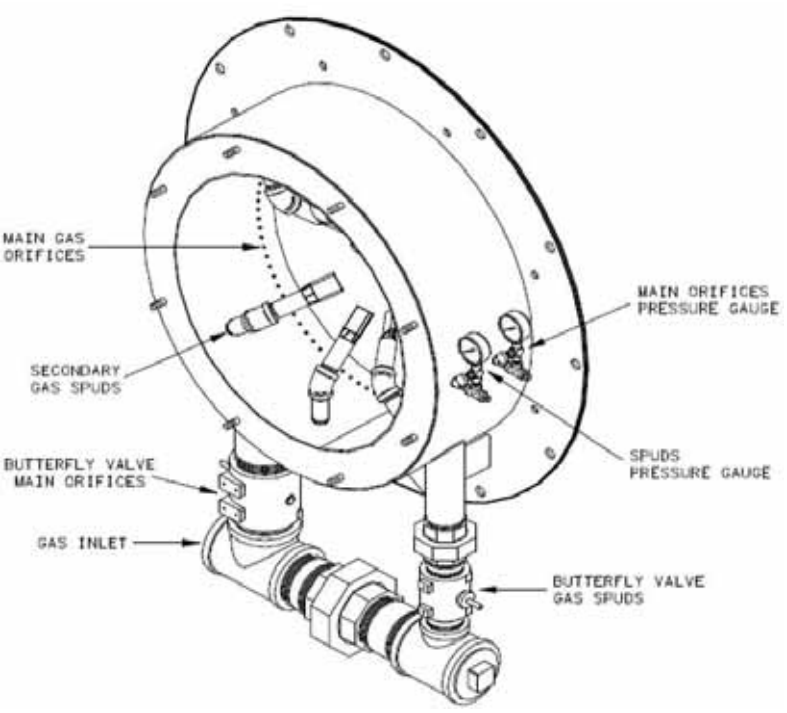


FIGURE 1-3. Dual Gas Manifold

1.8 — Oil System Air Atomizing

D Model burners use compressed air for atomization. Atomizing air is independent of combustion air. Either of two air/oil systems are used, depending on burner size and fuel. ONe system uses an integral air compressor/oil metering unit mounted on the burner and is driven by a separate motor. The other system is supplied with a separate compressor module for mounting near the burner.

1.8.1 — 3-Way Solenoid Valve

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

1.8.2 — Nozzle Assembly

The nozzle assembly consists of four main parts:

- Body
- Compression Spring
- Swirler
- Tip

The swirler is held against the nozzle tip by the compression spring.

The nozzle body has inlet ports for air and oil lines. Metered fuel oil enters the nozzle body and flows through a tube to the swirler. Oil is forced from the core of the swirler to the side ports where it meets with atomizing air.

Atomizing air enters and passes through the nozzle body to grooves in the swirler, where it mixes with fuel oil. Air/oil passes through grooves and out of the nozzle orifice in a cone of atomized oil. Proper velocity and angle of the fine spray ensures good mixing with the combustion air, providing quiet starts and excellent combustion efficiency. During pre- and post-purge, the nozzle tip is purged with air. This prevents afterdrip or baked-on residue.

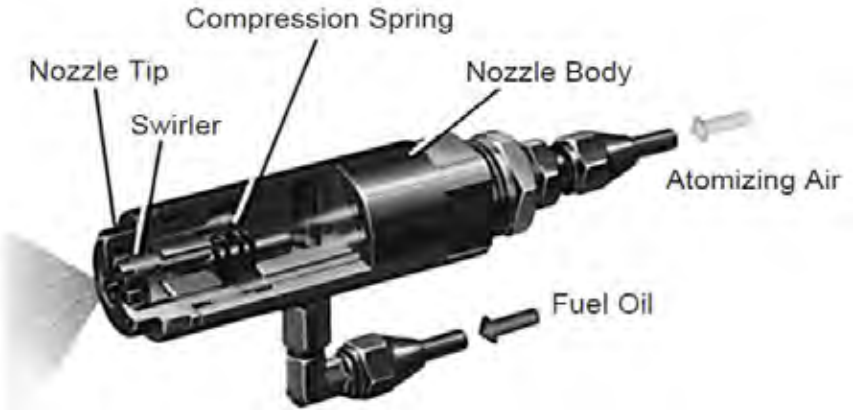


FIGURE 1-4. **Nozzle Assembly**

1.8.3 — Burner Mounted Trim Heater

This provides heat for No. 4, 5, and 6 fuel oil and is located between the metering pump and the 3-way valve. This heater should not be used as a continuous run line heater. The heater has an adjustable thermostat and a cold oil lockout switch which prevents the burner from starting until proper atomizing temperature is attained.

1.8.4 — Oil Strainer

Prevents foreign matter from entering the burner oil system.

1.8.5 — Atomizing Air Proving Switch

Pressure actuated switch contacts close when sufficient atomizing air pressure is present. The oil valve will not open unless switch contacts are closed.

1.8.6 — Air/Lube Oil Tank

Burner mounted tank stores compressed air for oil atomization and oil for compressor lubrication. Contains wire mesh filter to separate lube oil from compressed air.

1.8.7 — Integral Air/Oil Unit

Model designation DL, DLG, DM, DMG No. 2 through No. 5 oil with air atomization (Model D42 to 145). These models utilize an integral air compressor/oil metering unit which is separately driven at 1725 rpm and mounted on the burner.

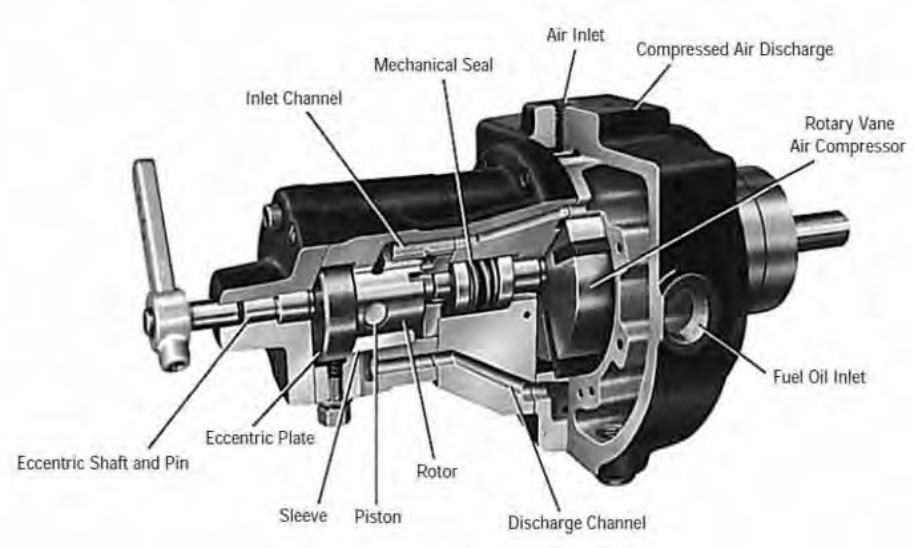


FIGURE 1-5. Integral Air/Oil Unit

1.8.9 — Air Compressor

Air is drawn into the vane-type, rotary compressor section of the air/oil unit through an air cleaner. The compressed air flows to an air-lube oil tank which serves the multiple purpose of lube oil mist recovery, lube oil sump, and air storage. The compressor is cooled and lubricated continuously by oil under pressure from the bottom of the tank. Oil vapor is extracted from the compressor air by a mist eliminator in the upper section of the tank. Atomizing air flows to the nozzle at a constant volume, but air pressure increases as the firing rate increases. Atomizing air is regulated by an adjusting valve in the return air line on integral metering units or in the air inlet on air compressor module burners.

1.8.10 — Oil Metering

Fuel oil under nominal pressure in the circulating loop, flows to the adjustable positive displacement, volumetric metering unit. Oil metering is accomplished by changing the piston stroke by means of an eccentric shaft and pin assembly. The pistons reciprocate in a rotor assembly, turning in a hardened steel sleeve having oil inlet and discharge slots. During each revolution the pistons go through the following cycle:

1. Inlet Cycle. The piston is at the bottom dead center position. At this position the cavity between the top of the piston and the outside diameter of the rotor fills with oil.
2. Discharge Cycle (180º from inlet cycle). The piston is at the top dead center position. At this position, the oil is forced out of the discharge port to the nozzle. The piston stroke length is determined by the position of the eccentric shaft and plate. The piston adjustment plate is positioned by an adjustable eccentric shaft. The eccentric shaft is positioned by the modulator through adjustable linkage. Counterclockwise rotation of the eccentric shaft increases the piston stroke (more oil delivered to the nozzle); clockwise rotation decreases the amount of oil delivered. When the eccentric shaft is stationary, at any position, the stroke of the pistons remains constant, delivering a constant volume of oil regardless of viscosity.

1.8.11 — Separate Compressor Module

All Models DE and DEG (also DL, DMG, DM, DMG 175-420) burners have a burner mounted oil metering unit and a separate compressor module. The system functions as follows:

1. **Air Compressor Module.** Air is supplied by a positive displacement rotary vane compressor. This provides a constant volume of atomizing air regardless of pressure. The compressor module includes motor, air-oil reservoir tank, air filter, and lube oil cooling coil. Air enters the compressor through the filter. The air flows from the compressor into the air-oil separating and reservoir tank. Filtering material and baffles separate the lube oil from the compressed air. The tank air pressure forces lubricating oil from the tank to the compressor to lubricate bearings and vanes. A sight glass indicates the level of lubricating oil in the air/oil reservoir. Lubricating oil must be visible in the gauge glass at all times. Air compression heat is absorbed in part by the flow of lube oil, creating a hot oil mist. The air/oil mist is cooled by a coil assembly. Lube oil is also cooled before entering the compressor.
2. **Oil Metering.** The oil metering unit is cored with channels through the housing. Fuel oil circulates through these channels keeping the metering unit warm to prevent heavy oils from congealing when the burner is idle. The operation of the oil metering unit is the same as the integral air/oil unit.
3. **Operation.** Fuel is delivered to the positive displacement metering pump at 10 to 15 psi. Metered oil is delivered to the common port of a 3-way solenoid valve for transfer to the burner nozzle through the normally closed port or back to the storage tank through the normally open port. During pre- and post-purge, metered oil is returned to the tank. During normal firing, all metered oil is delivered to the nozzle. Heavy oil burners have a supplementary nozzle line heater between the metering and the 3-way valve. Air enters a rotary vane compressor through an air cleaner where it is compressed to atomizing pressure. Air flows from the compressor to an air/oil tank which serves the multiple purpose of dampening air pulsation, lube oil mist recovery, lube oil and atomizing air storage. The compressor rotor is cooled and lubricated continuously by oil under pressure from the air/oil tank. Oil vapor is extracted by a mist eliminator in the upper section of the tank. Atomizing air from the upper tank section is delivered to the nozzle at a constant volume. Air pressure increases as the burner firing rate increases. Atomizing pressure may be adjusted by the needle valve located on the air-oil pump. The valve allows air to be bled from the tank to the compressor inlet. Delivery rate of the fuel oil metering pump is controlled by the modulating motor through adjustable linkage.

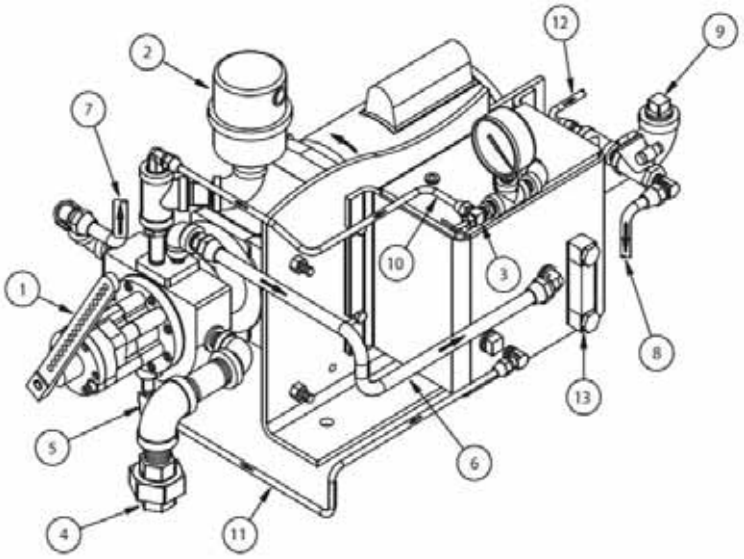


FIGURE 1-6. Integral Oil-Air Metering System and Tank

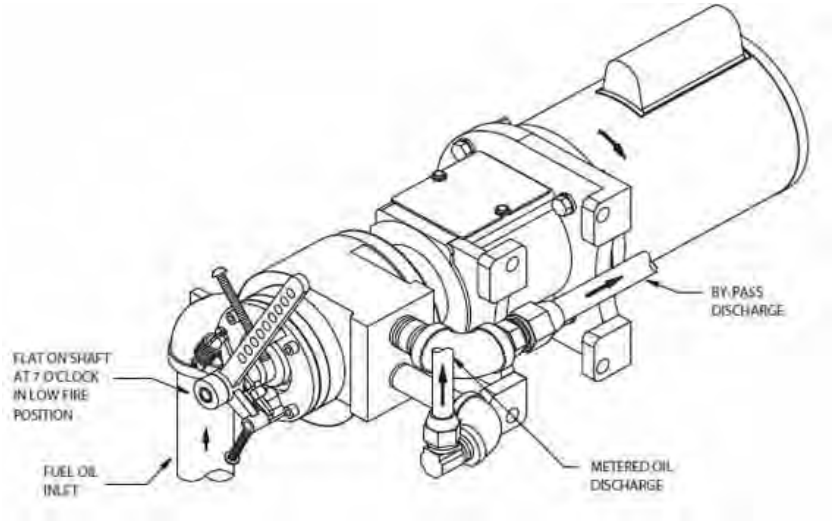


FIGURE 1-7. Fuel Oil Metering System (Used With Separate Compressor)

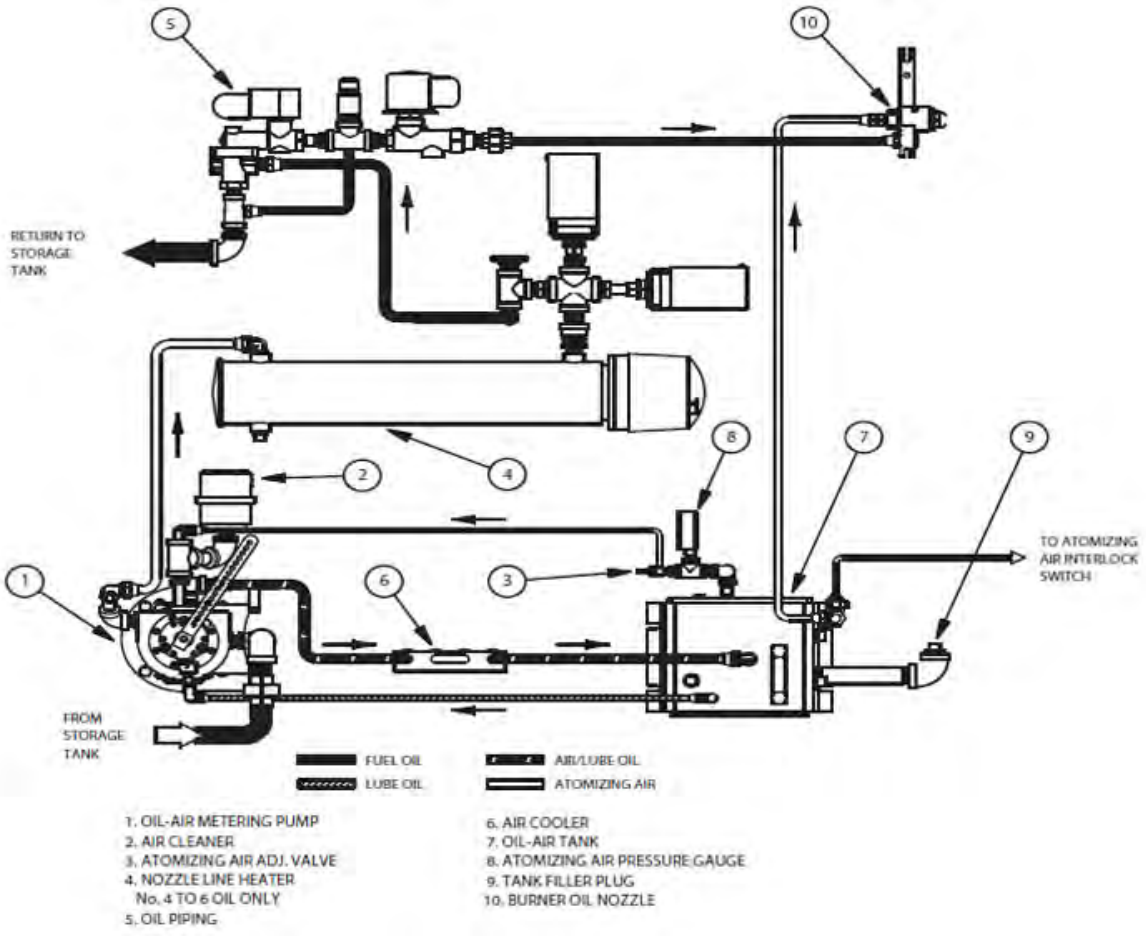


FIGURE 1-8. Integral Compressor Oil-Air Metering System

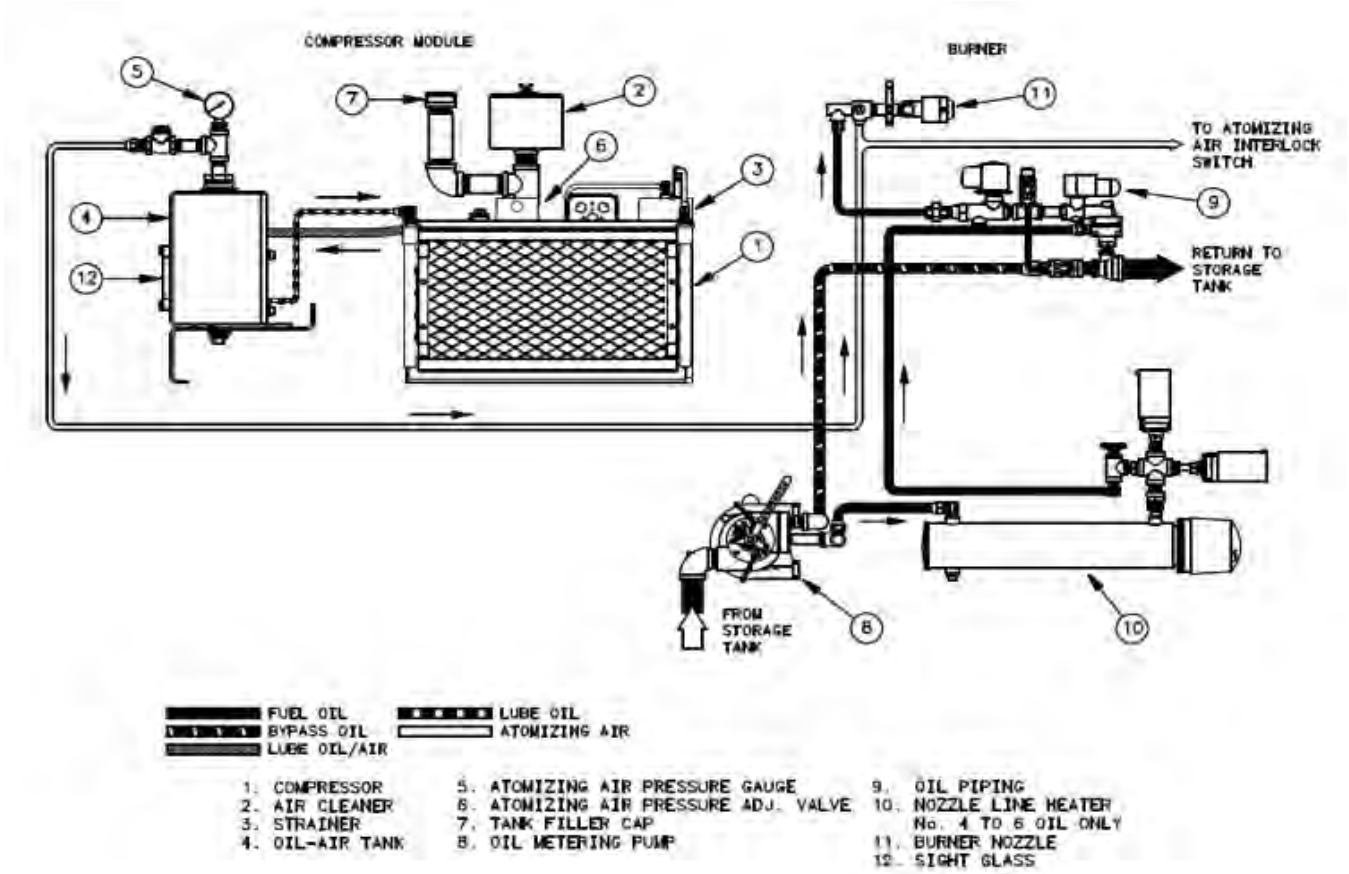


FIGURE 1-9. Compressor Module and Burner Oil Flow

1.9 — Gas System

Gas is introduced into the combustion zone from a circular manifold through multiple ports in the manifold. Firing rate is determined by the size and number of ports, by manifold pressure and by combustion zone pressure. The firing rate is regulated by a rotary, butterfly type throttling valve at the manifold inlet. The valve is actuated by an adjustable linkage from the modulating motor. Depending upon specific requirements, one or two safety shutoff, motorized main gas valves are provided for installation in the gas train upstream of the butterfly valve. Safety shutoff gas valves are wired into the programming control to automatically open and close at the proper time in the operating sequence.

1.9.1 — Main Gas Train Components

Depending on the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items:

Component	Description
Gas Volume Valve	The butterfly type valve is positioned by linkage from the modulating motor and controls the rate of flow of gas.
Main Gas Valves	Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard UL burners include: • Models D42: One motorized gas valve and one solenoid valve. • Models D54-105: One motorized gas valve w/closure interlock and one solenoid valve. • Models D145-420: Two motorized gas valves and one w/closure interlock.
Main Gas Regulator	Regulates gas train pressure to specified pressure required at the inlet to the gas train. Input is set by main gas pressure regulator adjustment.
Main Gas Cocks	For manual shutoff of the gas supply upstream of the pressure regulator. A second shutoff cock downstream of the main gas valve(s) provides a means of testing for leakage through the gas valve(s).
High Gas Pressure Switch	A pressure actuated switch that remains closed when gas pressure is below a pre-selected setting. Should the pressure rise above the setting, the switch contacts will open causing main gas valve(s) to close. This switch requires manual reset after being tripped.
Low Gas Pressure Switch	A pressure actuated switch that remains closed when gas pressure is above a pre-selected setting. Should the pressure drop below this setting, the switch contacts will open, causing main gas valve(s) to close. This switch requires manual reset after being tripped.

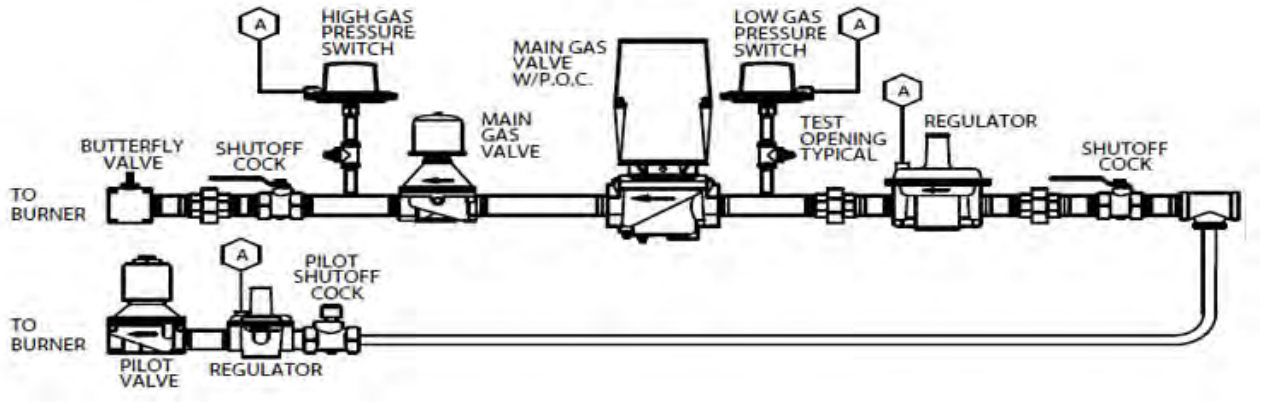


FIGURE 1-10. Gas Train Components

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1.9.2 — Pilot Gas Train Components

Component	Description
Gas Pilot Valve	A solenoid valve that opens during the ignition period to admit fuel to the pilot. It closes after main flame is established.
Gas Pressure Regulator	Reduces gas pressure to that required by the pilot.
Gas Pilot Shutoff Cock	For manually closing the pilot gas supply.

1.9.3 — Operation

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

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

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

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

CHAPTER 2 Introduction

2.1 — Application

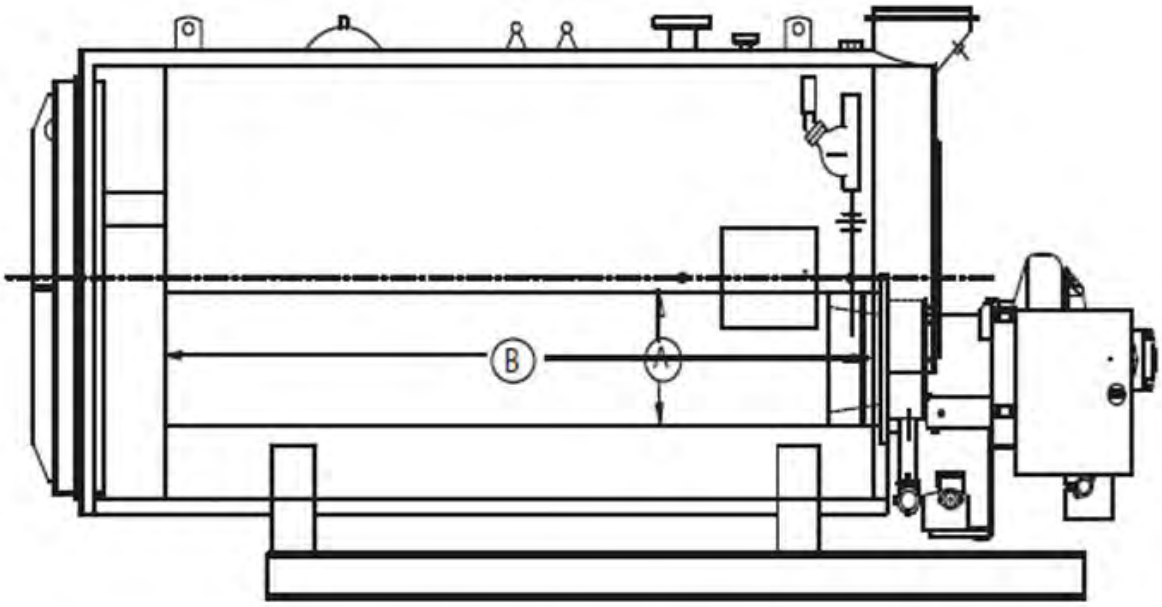
Electrical power available is usually 208 volt, 3-phase, 60 cycle, 230/460 volt, 3-phase, 60 cycle or 380 volt, 3-phase, 50 cycle. The control circuit is 115 volt, single phase, 60 cycle or 115 volt, single phase, 50 cycle. Refer to the electrical schematic diagram shipped with the burner. Power connections are made at the control panel. Wiring from the panel to burner mounted components is installed at the factory. Wiring from the burner panel to boiler controls, low water controls, remote compressor motor, and remotely located fuel valves is furnished by the installer.

Automatic over-fire draft control or barometric draft regulators are not usually required except where the system has a tall chimney. The exact height of a chimney requiring draft control is indeterminate, but draft regulation is seldom needed for chimneys less than fifty feet high, especially with Scotch Marine or sealed firebox boilers. Fuel requirements for burners of all sizes are listed in the specifications. Fuel oil piping and gas piping instructions are described in this chapter.

2.2 — Combustion Chamber Construction

The combustion chamber dimensions should be proportioned to the heating load of the boiler (see Figures 2-1 and 2-2).

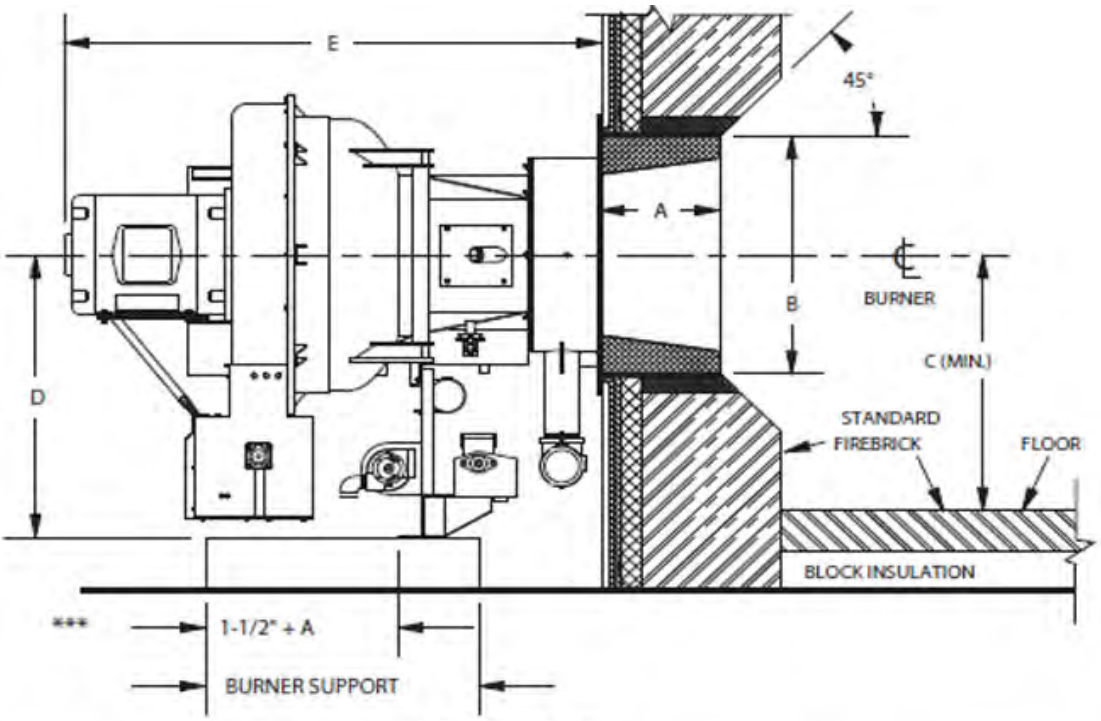
INDUSTRIAL COMBUSTION



RECOMMENDED COMBUSTION CHAMBER DIMENSIONS - SCOTCH MARINE BOILERS

BURNER MODEL	BOILER H.P.	"A" DIAMETER O.D.	"B" LENGTH
D42	100	24	120
D54	125	30	110
D63	150	30	133
D84	200	34	115
D105	250	34	144
D145S	300	38	158
D145P	350	38	185
D175	400	42	155
D210	500	42	195
D252	600	46	194
D300	700	48	204
D315	50	50	201
D336	800	50	230

FIGURE 2-1. Recommended Scotch Marine Chamber Dimensions



(ALL DIMENSIONS IN INCHES)

BURNER SIZE		DIM. A LGTH. OVEN REFRACTORY	DIM. B O.D. OVEN REFRACTORY	DIM. C ℄ BURNER TO FLOOR	DIM. D ℄ BURNER TO SUPPORT	DIM. E BURNER LENGTH	COMBUSTION CHAMBER	
D	LND						MIN. WIDTH	MIN. LENGTH
	42 P	9	15-7/8	14	23-3/4	43-3/4	28	55
42 S/P	54 P	9	15-7/8	14	23-3/4	43-3/4	28	56
54 S/P	63 P	9	15-7/8	15	23-3/4	43-3/4	32	60
63 S/P	84 S	9	15-7/8	16	23-3/4	43-3/4	34	65
84 S/P	105 S	10	19	19	25-3/8	45-5/8	38	74
105 S/P	145 S	10	19	23	25-3/8	45-5/8	46	84
125 S/P	145 P	10	19	24	25-3/8	47	50	90
145 S/P	175 P	12	22	25	30-1/8	56-7/8	55	100
175 S/P	210 P	12	27-1/2	27	31-7/8	60	60	108
210 S/P	252 P	12	27-1/2	30	35-7/8	64-1/8	70	120
252 S/P	300 P	15	31-1/2	30	37-3/8	67	84	132
300 S/P	315 P	15	31-1/2	32	37-3/8	67	84	144
315 P	336 P	15	31-1/2	34	37-3/8	69-3/8	84	147
336 P	378 P	18	34-5/8	34	38-7/8	68-1/2	86	152
378 P	420 P	18	34-5/8	36	39-7/8	73-7/8	92	160
420 P		18	34-5/8	38	39-7/8	73-7/8	96	170

* For Installation of Furnished Refractory, See Fig. 2 & 3.
** Floor can be Lowered or Pitted to Obtain Dimension C.
*** For Support of Burner During Installation or Removal.

RECOMMENDED COMBUSTION CHAMBER DIMENSIONS FOR FIREBOX AND WATERTUBE BOILERS

FIGURE 2-2. Recommended Firebox & Watertube Boiler Chamber Dimensions

INDUSTRIAL COMBUSTION

2.3 — Installation

Locate the burner properly. The burner is designed for operation with the blast tube level. Do not tilt the burner up or excessively downward. Installation of the refractory oven or combustion cone, shipped with the burner, is shown in Figures 2-3 and 2-4.

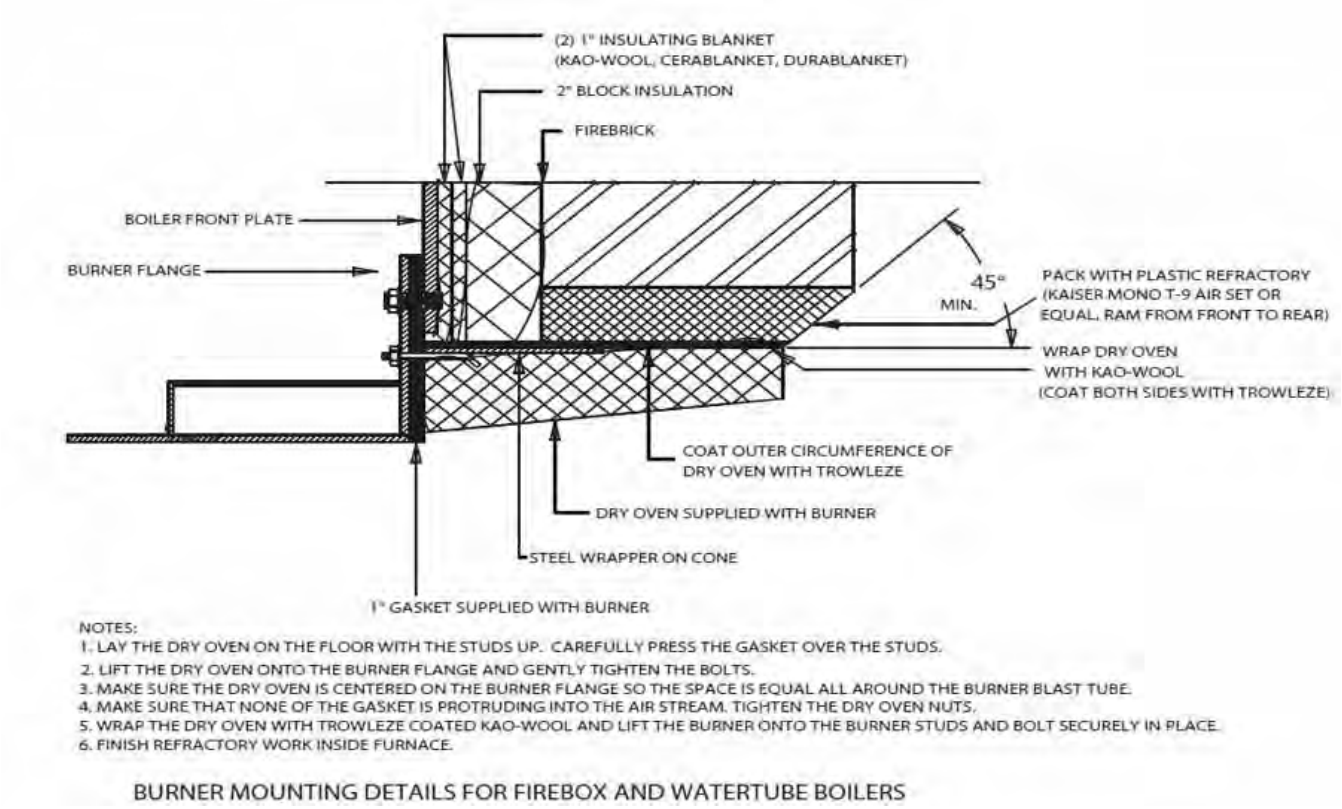


FIGURE 2-3. Firebox and Watertube Burner Mounting Details

Securely support the burner pedestal on the floor or foundation Allow enough clearance at the rear of the burner to allow the housing to swing open for service and maintenance. Figure 2-2 shows an installation with typical burner support. Many boilers, including some Scotch Marine types, do not have sufficiently rigid front plates and require additional support under the burner base. Bases under the support leg must be long enough to support the burner when being inserted or withdrawn from the boiler. Boilers operating with the combustion pressure above atmospheric pressure must be sealed to prevent escape of combustion products into the boiler room. The burner mounting flange is designed to provide for a seal. The face of the boiler and burner flange must be sealed with the gasket provided with the burner. Carefully place the gasket over the dry oven bolts before it is mounted onto the burner flange. The I.D. of the dry oven is slightly larger than the blast tube I.D. Make sure the dry oven and burner blast tube are concentric. Due to bolt hole tolerances, the dry oven may have to be shifted to accomplish this. After the dry oven nuts are properly tightened, the burner and dry oven assembly can then be mounted into the boiler. For maximum safety, it is recommended that boilers not operating under pressure should also be sealed.

⚠ Caution

It is important that you provide support for the housing when in the open position to prevent damage to the hinges and subsequent components.

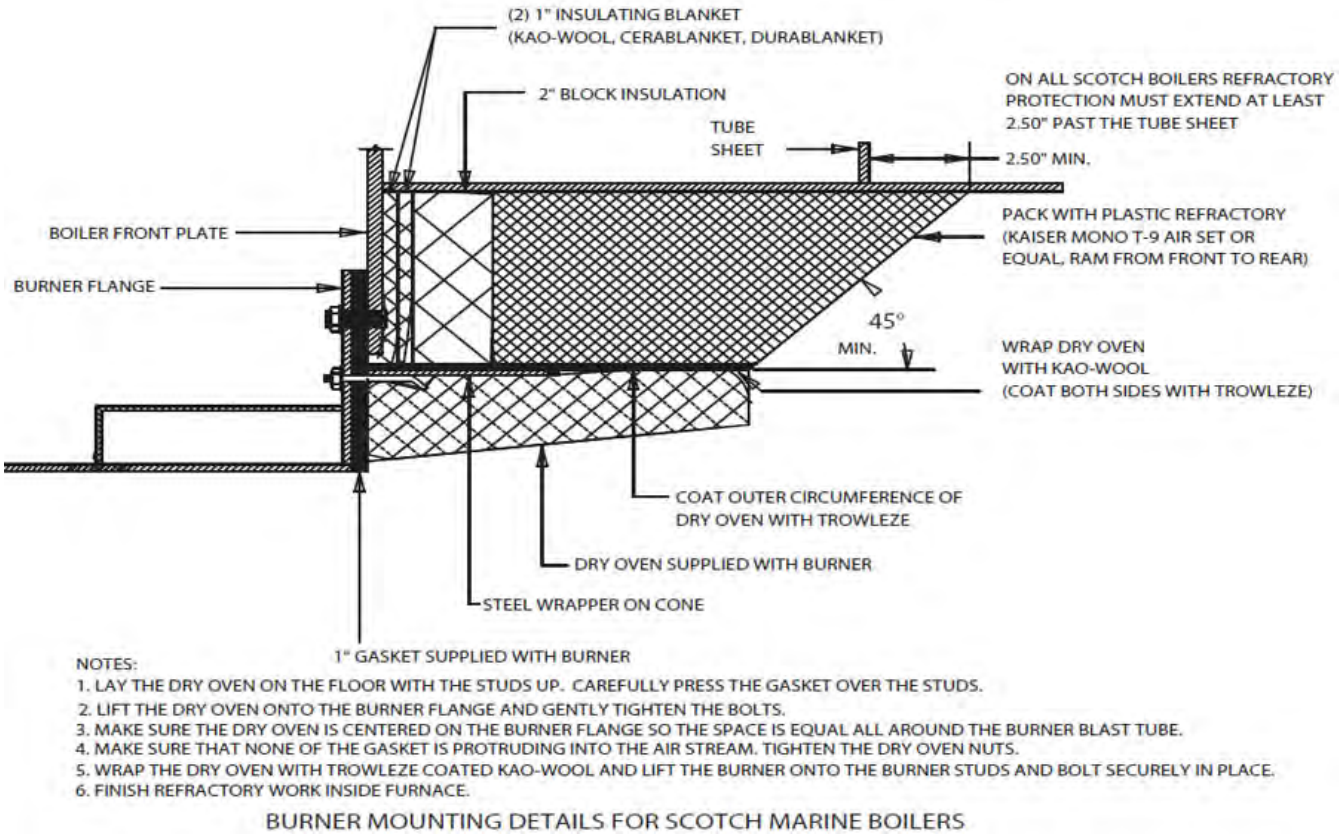


FIGURE 2-4. Scotch Marine Burner Mounting Details

2.4 — Packing Plastic Refractory Around Oven

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

2.5 — Separate Compressor Module

For oil burners supplied with the separate compressor module, piping to the burner is installed as shown in Figure 2-5. Earlier models have the oil cooler finned coil located below the damper. The earliest units used a coil in

the blast tube, but piping to the compressor and tank is essentially similar. Copper tubing for the installation is not supplied with the burner.

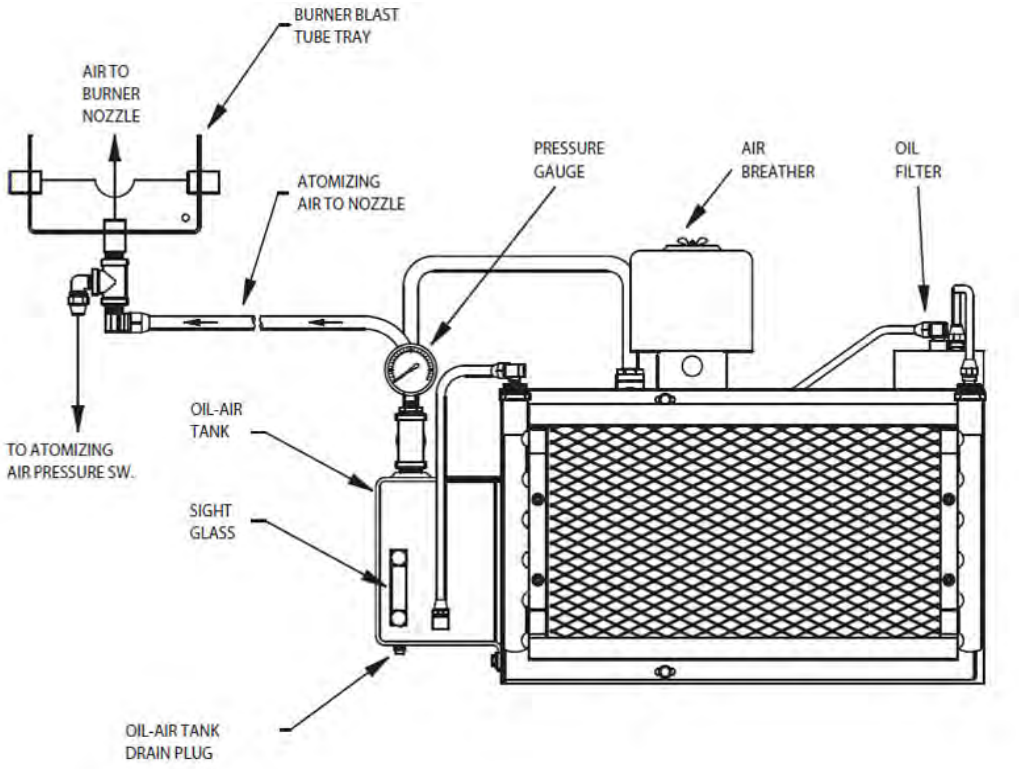


FIGURE 2-5. Separate Compressor Module

2.6 — Typical Oil Supply Loop

Refer to Figure 2-6. Continuous oil circulation must be supplied to the burner at a rate of 50% greater than the high fire burning rate. The oil circulating pump should be located as close as possible to the storage tank to keep suction lines short and minimize suction loss. Pipe line sizes indicated on the following oil piping schematics are of ample size to reduce pressure losses. If heating of the fuel oil is required, the lines must be large enough to prevent restriction of flow through any cold spots in the system. Note that the supply line is approximately 20 inches or higher above the burner metering pump inlet to help eliminate air problems. Above that is an adjustable, spring-loaded back pressure valve that sets approximately 10 to 15 PSI on the circulating loop. The return line to the tank is connected at the discharge port of the back pressure valve. Since air rises to the highest point, it will rise from the supply entrance and pass through the back pressure valve to the return line and on to the tank. Metered oil is pumped (by the metering pump) to the common port of a 3-way valve. With the 3-way valve de-energized, the metered oil returns to the tank through the back pressure valve and return line. When the 3-way valve is energized, metered oil is passed on to the burner oil nozzle and atomized by air from the compressor. The proper strainers, check valves, vacuum and pressure gauges, etc. should be installed as indicated. All lines should be pressure tested after installation.

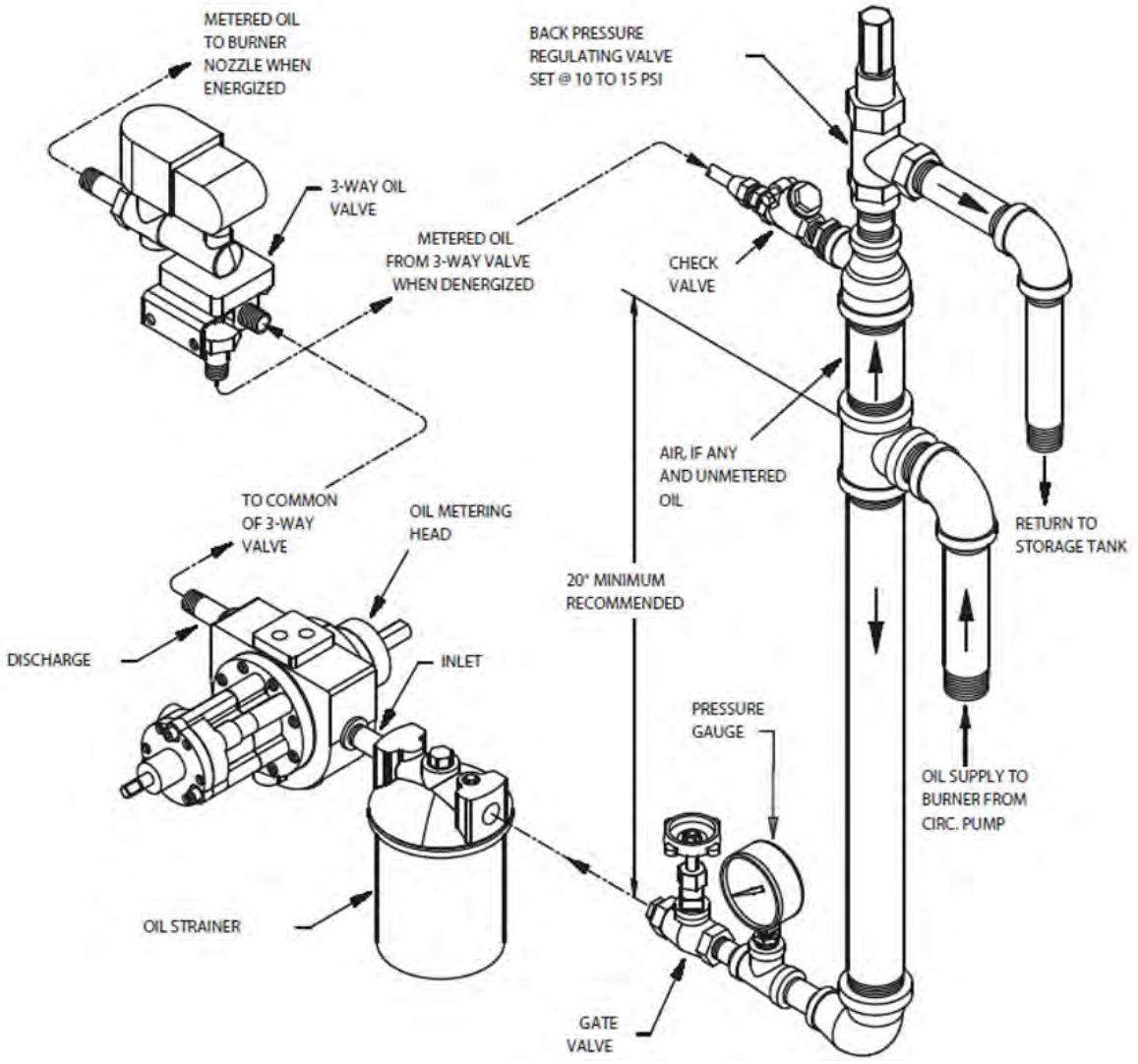


FIGURE 2-6. Typical Oil Supply Loop

2.7 — Oil Circulating Loop Operation

No. 2 Oil: Refer to Figures 2-7 to 2-9 at the end of this chapter.

No. 4 & 5 Oil: Refer to Figures 2-10 to 2-12 at the end of this chapter. See Section 2.9 for heater operation.

No. 6 Oil: Refer to Figures 2-13 & 2-14 at the end of this chapter. See Section 2.9 for heater operation.

Multiple Burners Piping Loop: See Figure 2-15 at the end of this chapter for example of multiple burners piping installation.

INDUSTRIAL COMBUSTION

An oil circulating pump provides continuous oil circulation to the circulation loop. A back pressure valve holds 10 to 15 PSI on the loop system. With the oil supply line connected only to the oil metering pump inlet, all oil must pass through the pump. During pre-purge, unmetered oil flows through a bypass section of the oil metering pump. Metered oil passes through the metering section to a de-energized 3-way oil valve (common port). Both unmetered and metered oil must pass through the back pressure valve and return to an oil storage tank. The oil metering pump will only meter oil. It will not serve as a circulating pump. At trial for main flame (main fuel), the 3-way oil valve is energized admitting metered oil to the nozzle for atomization and fast smooth ignition. Unmetered oil continues to flow through the bypass section of the oil metering pump and returns to an oil storage tank.

2.8 — Circulating Oil Pump

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

2.9 — Oil Loop Heater

This heater should heat the fuel oil for proper burning at full firing rate. The proper oil temperature is that which gives the best results with the particular oil being fired. This may vary widely with different fuels in different firing systems. Residual oil viscosity can vary widely within grade limits and is not always within the specified limits of the grade. Fuel viscosity requirements for air atomizing burners are not critical. Under typical circumstances, a viscosity of 100 SSU might be optimum, but good results may be obtained up to 150 SSU. There is no advantage to less than 100 SSU.

Where the burning characteristics of the fuel are unknown, the following may be considered as typical:

No. 4	80º - 125º F
No. 5L	115º - 160º F
No. 5H	145º - 180º F
No. 6	180º - 220º F

2.10 — Burner Mounted Trim Heater

An auxiliary trim heater is in line between the metering pump and 3-way oil valve. The auxiliary trim heater is used for topping off oil temperature prior delivery to the nozzle.

2.11 — Back Pressure Valve

A back pressure valve, similar to Watson McDaniel type “R,” needs to be installed on the return line as shown in Figure 2-6. This valve must be installed in an upright vertical position. Before installing the valve, be sure to

blow out the pipe line, removing all dirt, pipe scale, and sediment. This type of valve is actuated by the system pressure which enters the body beneath the main valve. Valve loading is provided by a spring that can be adjusted to the desired set pressure.

To adjust the set pressure, remove the top cap, loosen the brass locknut and adjust the pressure with the steel setscrew. By increasing the compression on the spring, screwing down the screw, you increase the set pressure within the limits of the spring range. Reversing the setscrew lowers the set pressure.

Adjust to 10-15 PSI for No. 2 oil systems and 15-20 PSI for heavy oils. When the desired pressure is reached, tighten the locknut and replace the to cap and gasket.

2.12 — Gas Piping

Refer to Figures 2-16 to 2-19 for typical gas piping schematics.

Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet. All piping must be in strict accordance with applicable codes, ordinances, and regulations of the supplying utility. In the absence of other codes, piping should be in accordance with the following prevailing standards:

- National Fuel Gas Code NFPA No. 54
- ANSI No. Z 223.1

For Canada:

- Canadian Gas Association (CGA) B149
- Canadian Standards Association (CSA) B140

Gas train components upstream of the butterfly valve are shipped loose. These components should be mounted by the installer as close to the butterfly valve as practical. Normally, the control train is ordered to suit a particular code or insurance regulation, such as Underwriters Laboratories, Inc., CGA, Factory Mutual, or Industrial Risk Insurance.

Arrange gas piping at the burner so that the burner is accessible for servicing without disassembly.

The gas pilot supply line must be connected upstream of the main gas regulator. If a reducing bushing is required between the house piping and the burner piping, it should be close to the burner shutoff valve.

The gas piping must be internally clean and free of foreign material. Before using in service, a leak test must be performed.

2.13 — Installation Checklist

All burners are carefully assembled and tested at the factory, but before being placed in service, all connectors should again be checked for looseness caused during shipment.

Check:

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

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

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

Before burner operation, be sure all motors are rotating in the correct direction.

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

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

⚠ Caution

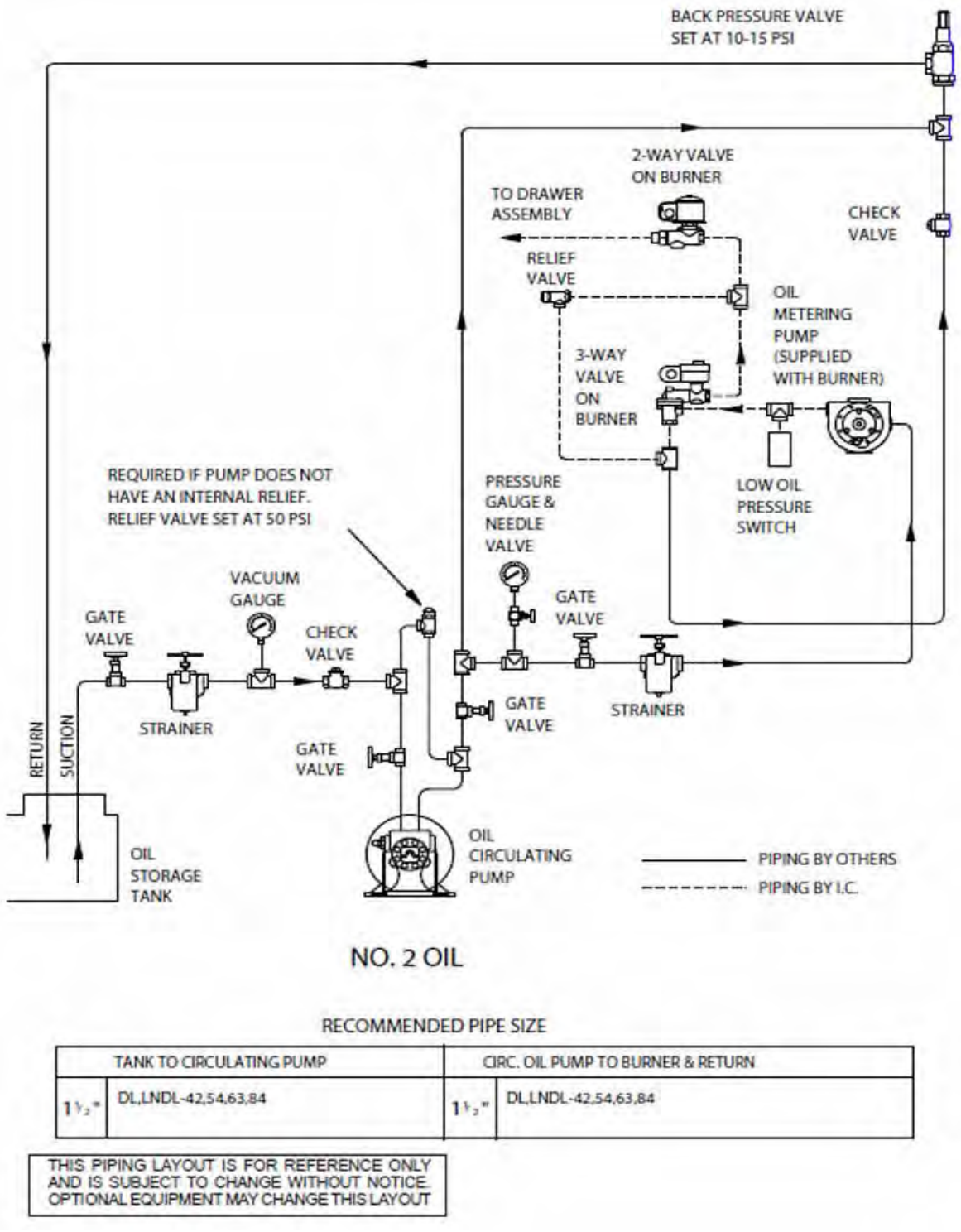
Before opening the gas shutoff valves, read the regulator instructions carefully. Open the shutoff valve slowly to allow inlet pressure to build up slowly in the regulator until it is fully pressurized. Opening the shutoff valve quickly will damage the regulator. Do not exceed the regulator pressure ratings.

⚠ Caution

Lubricating oil is drained from the air-oil tank before shipment. Before attempting to start the burner, add oil to the recommended level.

⚠ Caution

The burner refractory cone is air-cured only. Heat-curing must be initiated at initial startup. Run the burner at low fire for a period of 6 to 8 hours before starting to gradually increase the firing rate. Failure to do so will result in damage and cracks in the refractory.



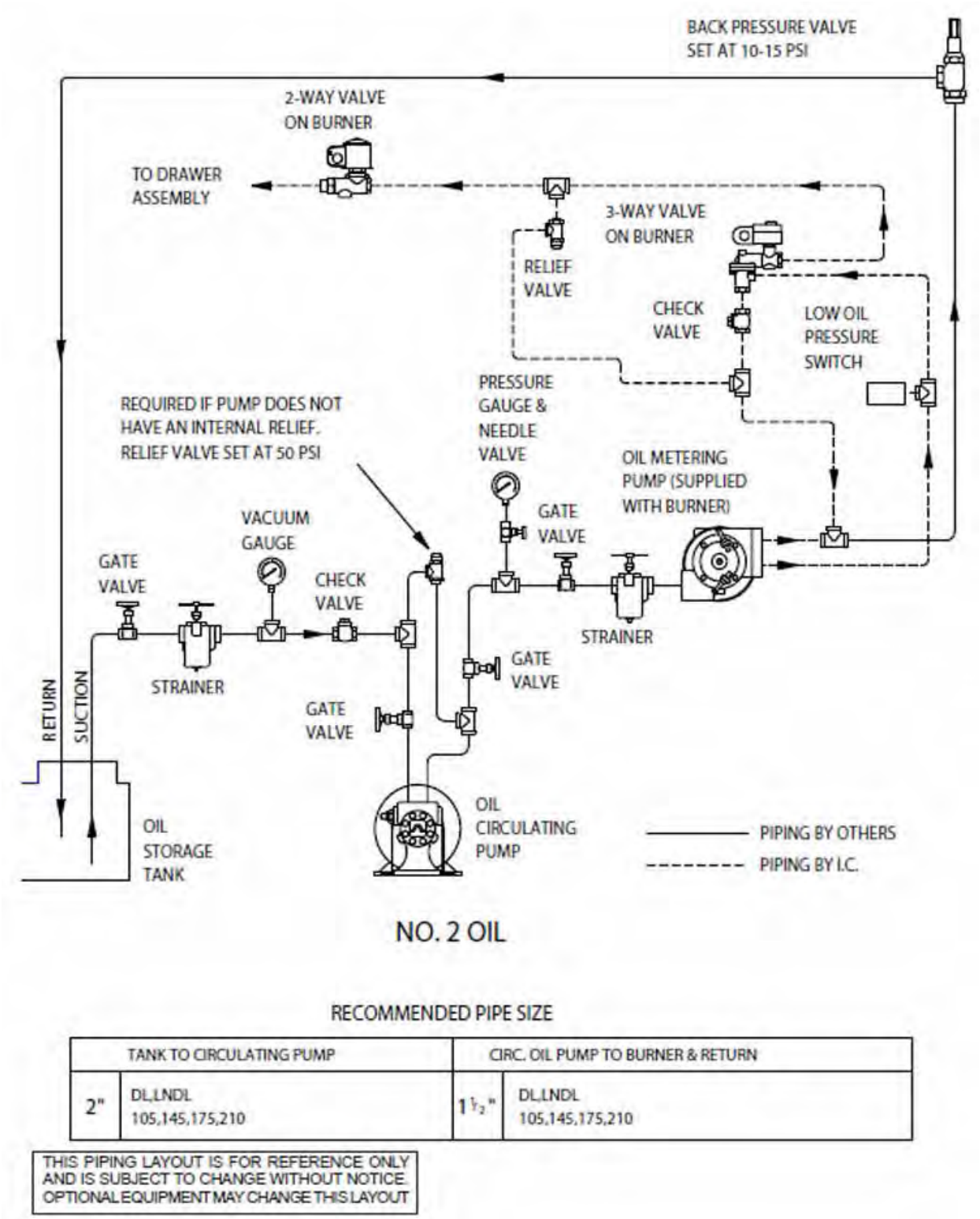
NO. 2 OIL

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
1½"	DL,LNDL-42,54,63,84	1½"	DL,LNDL-42,54,63,84

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT

FIGURE 2-7. Recommended Pipe Size

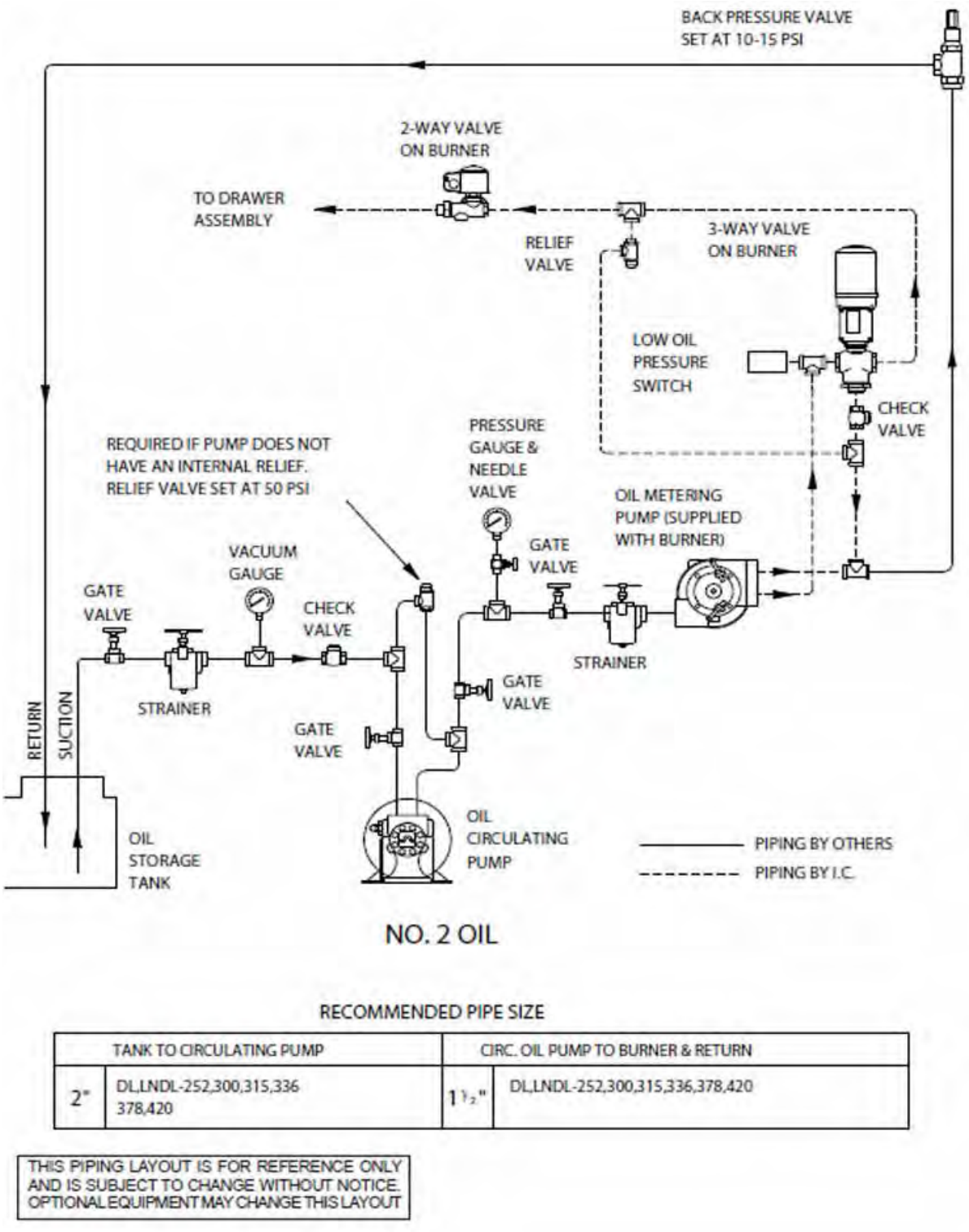


RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	DL,LNDL 105,145,175,210	1 ½"	DL,LNDL 105,145,175,210

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT

FIGURE 2-8. Recommended Pipe Size



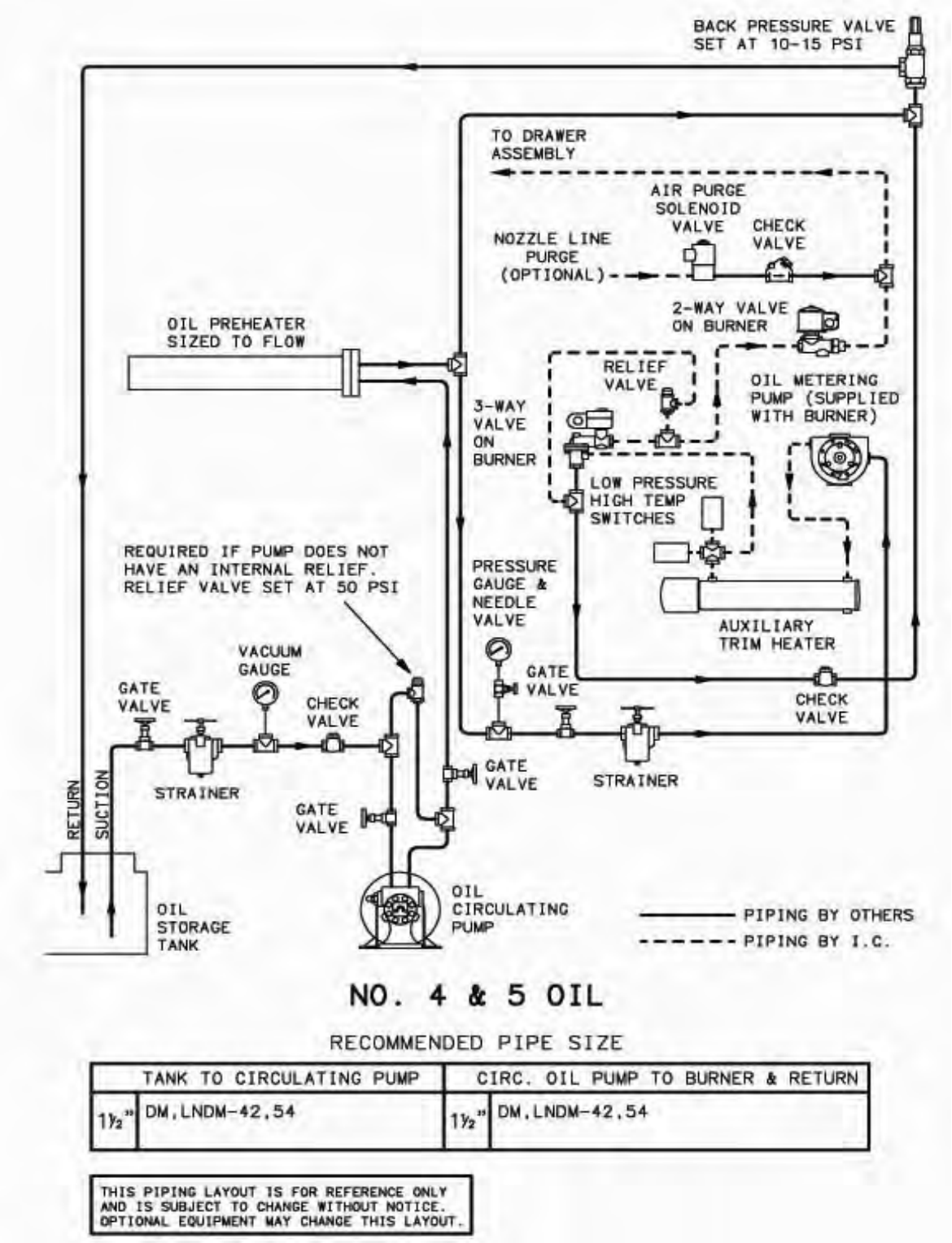
NO. 2 OIL

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	DL,LNDL-252,300,315,336 378,420	1½"	DL,LNDL-252,300,315,336,378,420

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT

FIGURE 2-9. Recommended Pipe Size



NO. 4 & 5 OIL

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
1½"	DM,LNDM-42,54	1½"	DM,LNDM-42,54

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT.

FIGURE 2-10. Recommended Pipe Size

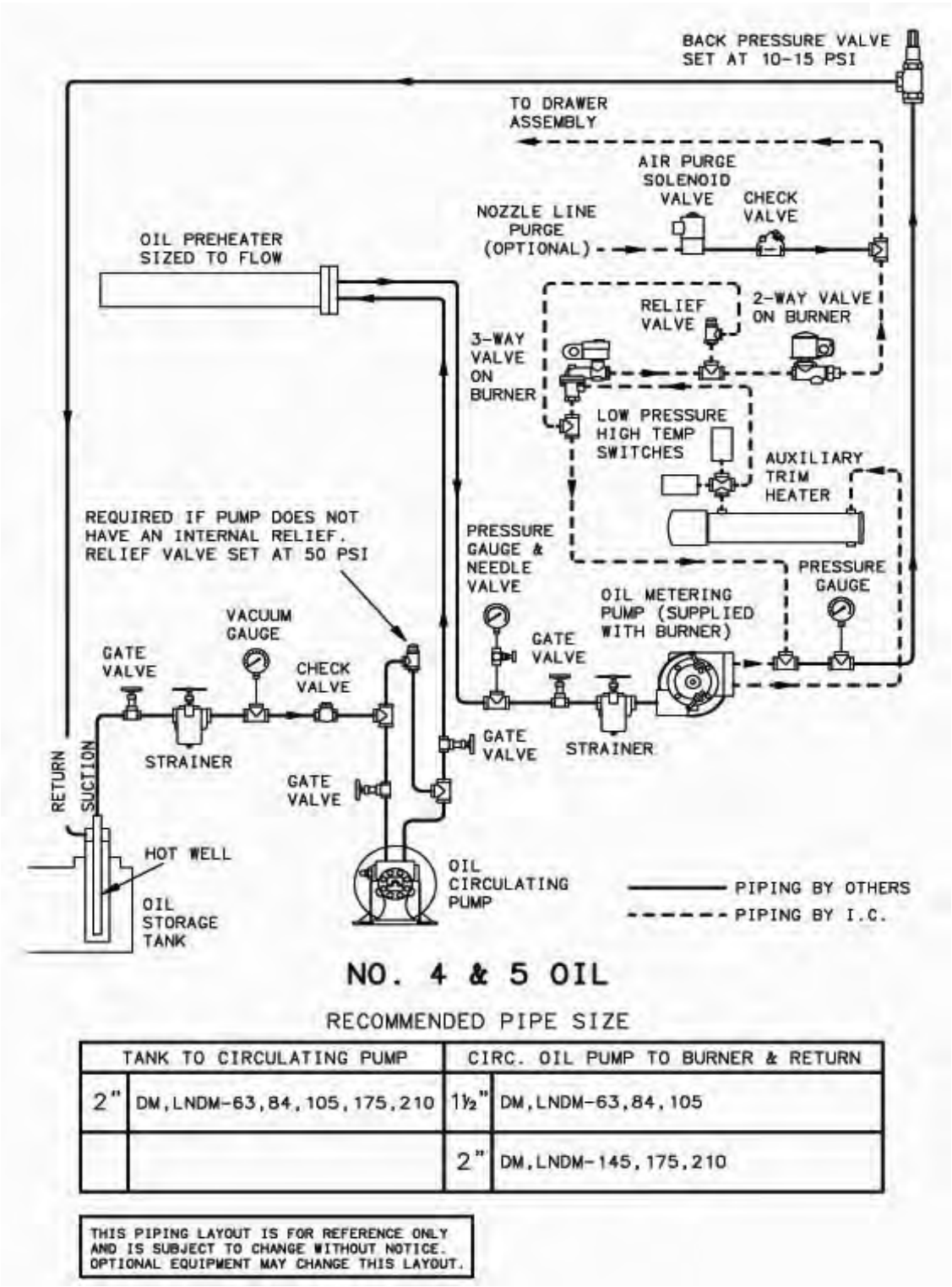
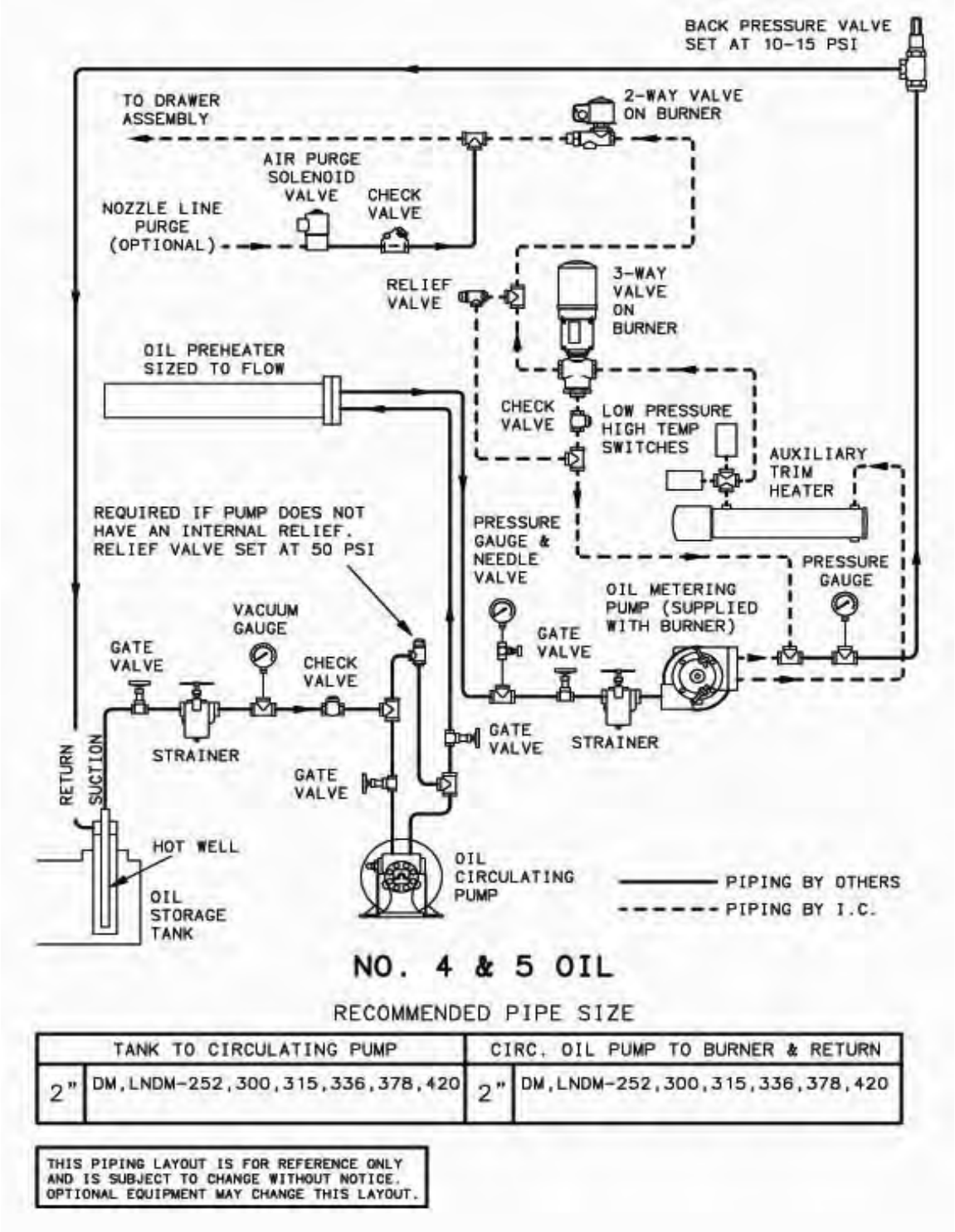


FIGURE 2-11. Recommended Pipe Size



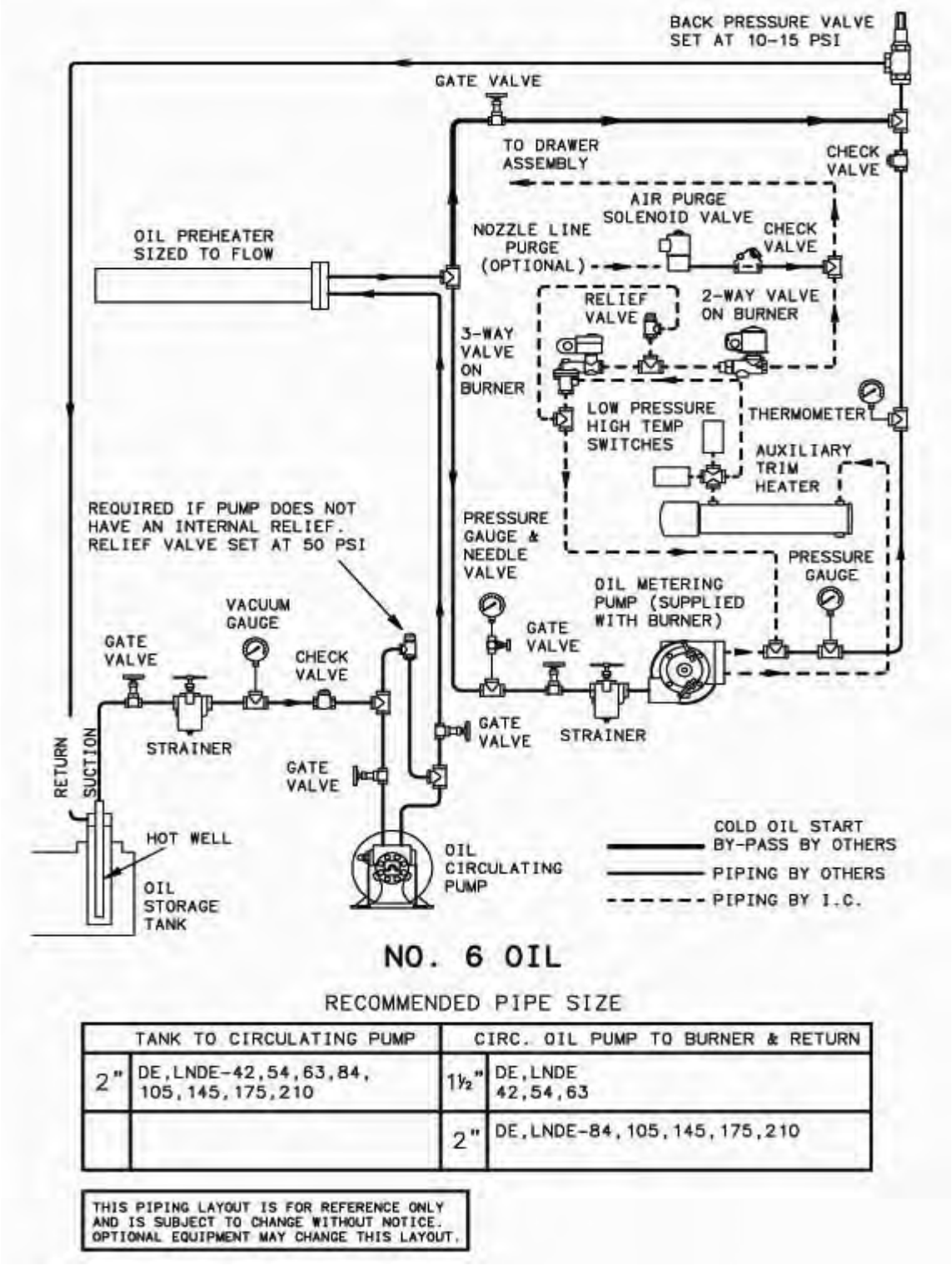
NO. 4 & 5 OIL

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	DM,LNDM-252,300,315,336,378,420	2"	DM,LNDM-252,300,315,336,378,420

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT.

FIGURE 2-12. Recommended Pipe Size



NO. 6 OIL

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	DE,LNDE-42,54,63,84, 105,145,175,210	1½"	DE,LNDE 42,54,63
		2"	DE,LNDE-84,105,145,175,210

THIS PIPING LAYOUT IS FOR REFERENCE ONLY AND IS SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT.

FIGURE 2-13. Recommended Pipe Size

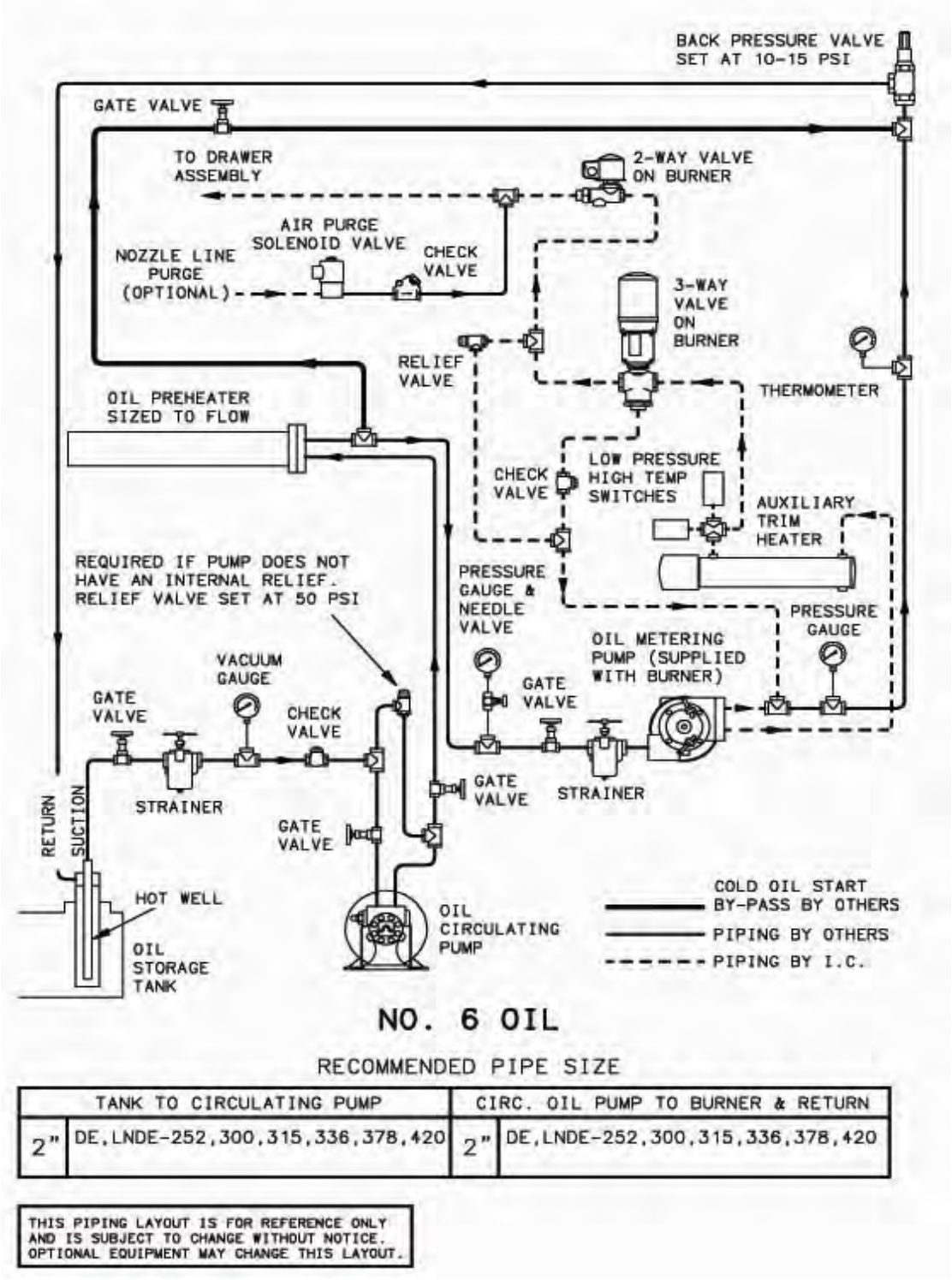


FIGURE 2-14. Recommended Pipe Size

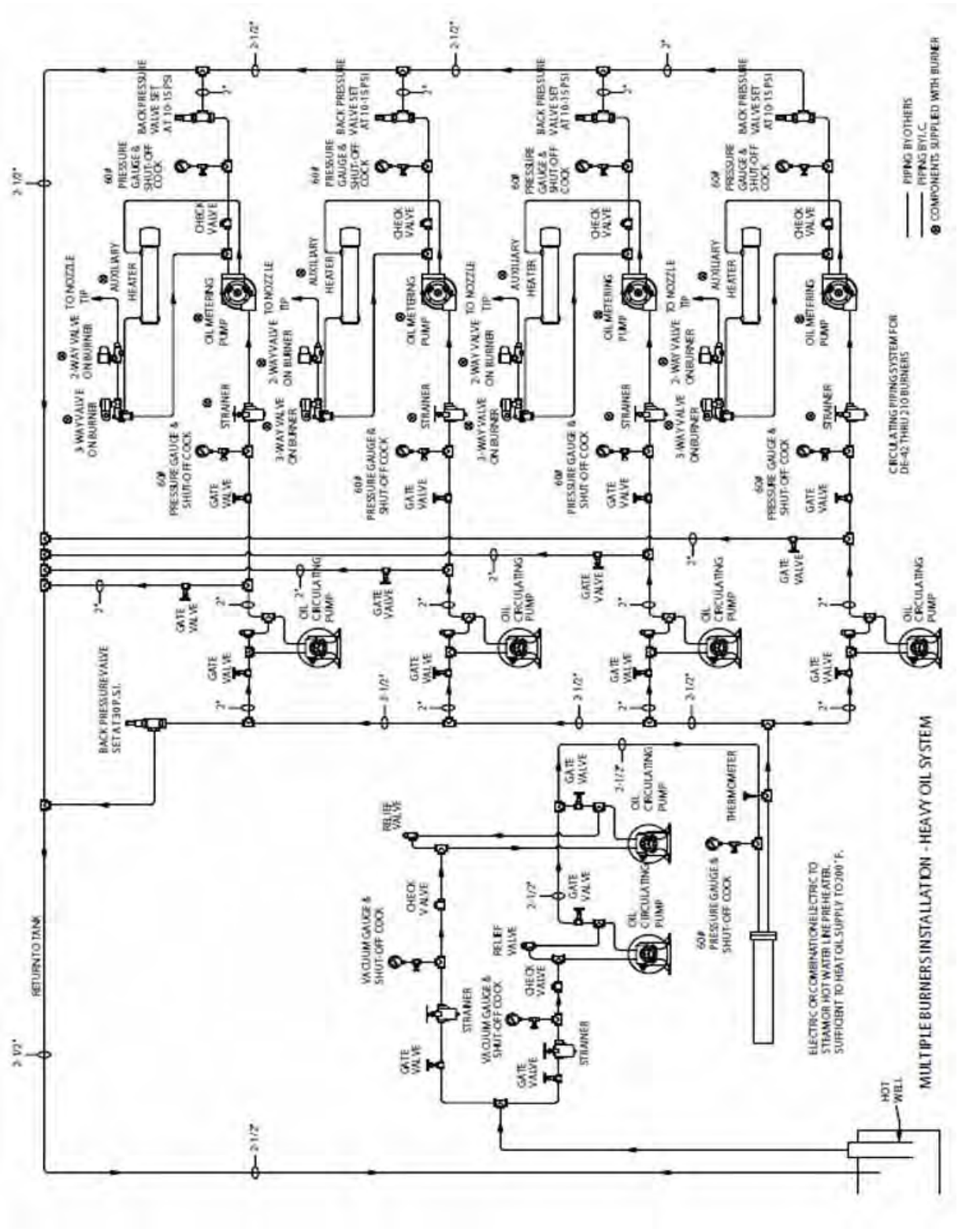


FIGURE 2-15. Multiple Boilers Installation-Heavy Oil

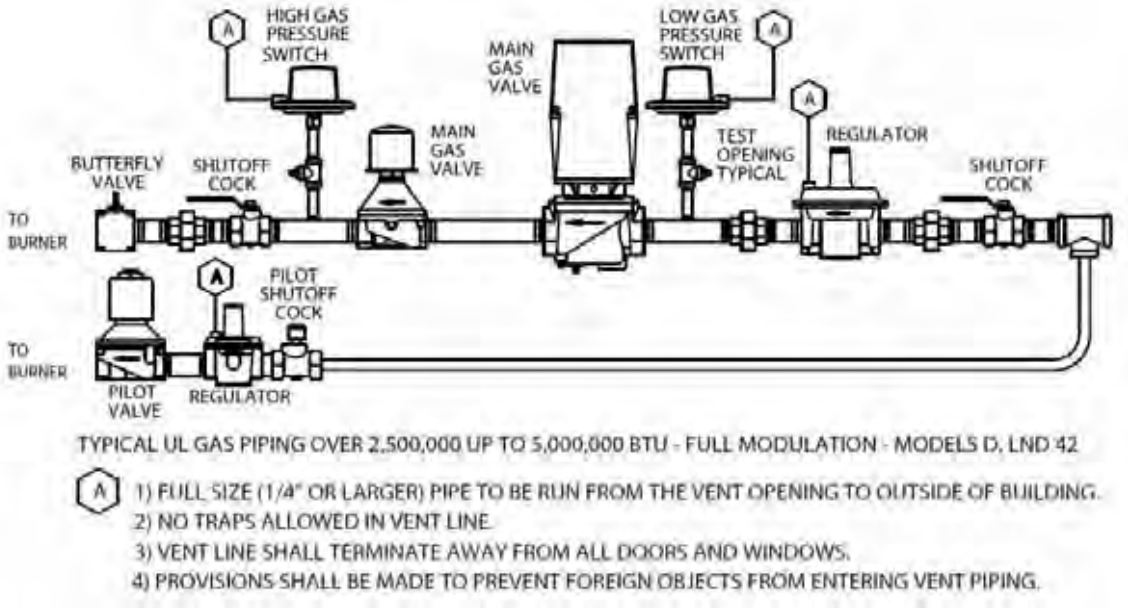


FIGURE 2-16. Typical UL Gas Piping

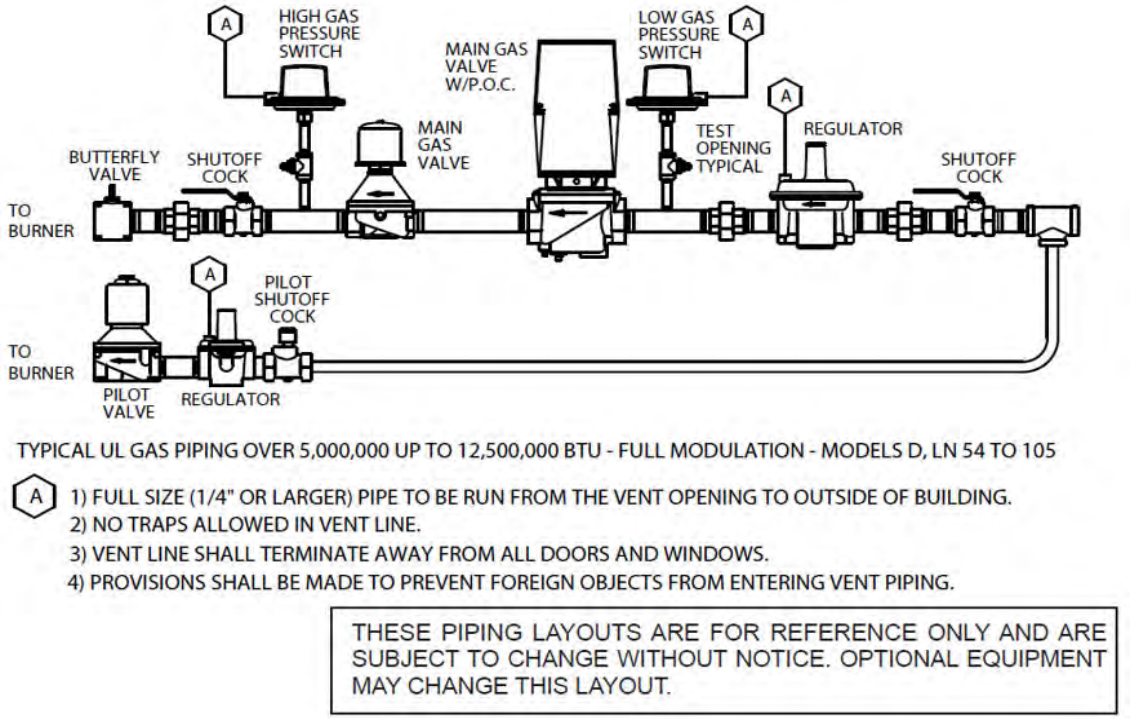
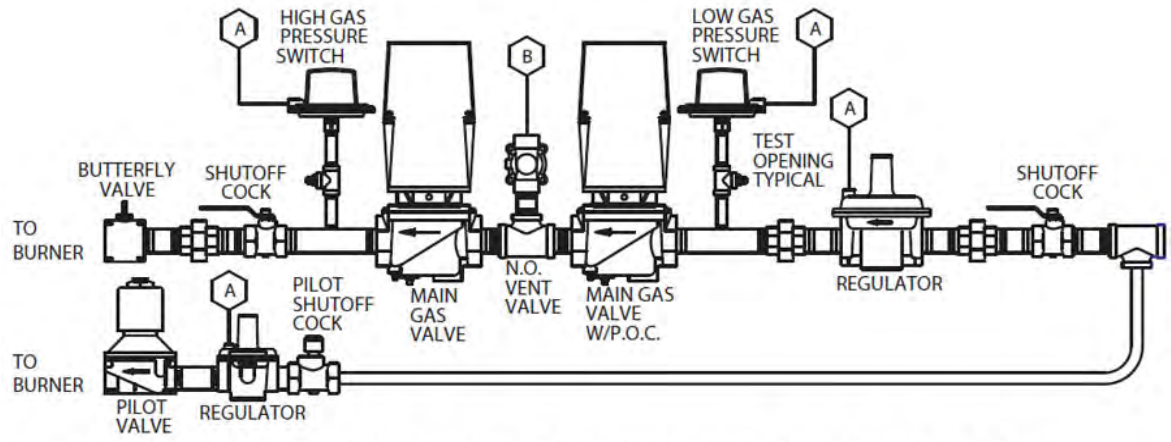


FIGURE 2-17. Typical UL Gas Piping

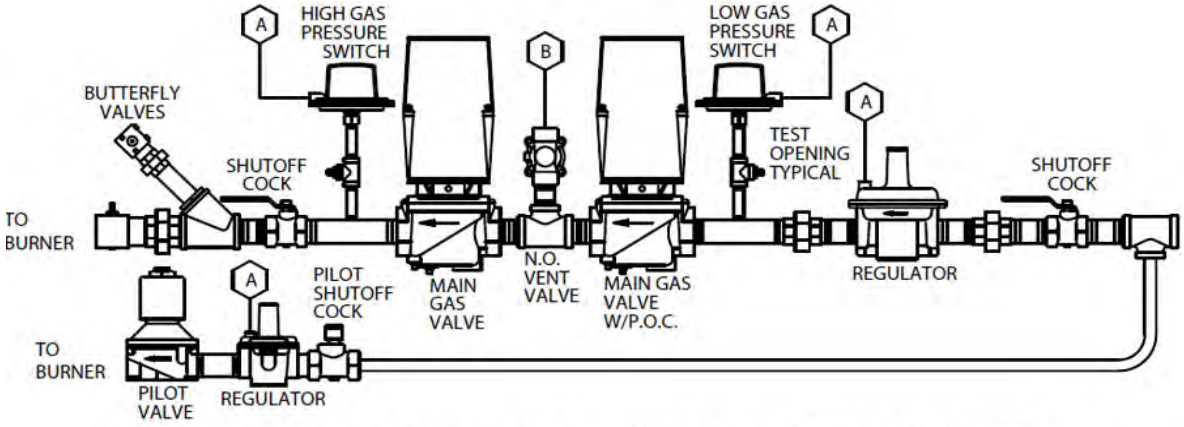


TYPICAL UL GAS PIPING OVER 12,500,000 BTU - FULL MODULATION - MODELS D, LN 378 & 420

A
1) FULL SIZE (1/4" OR LARGER) PIPE TO BE RUN FROM THE VENT OPENING TO OUTSIDE OF BUILDING.
2) NO TRAPS ALLOWED IN VENT LINE.
3) VENT LINE SHALL TERMINATE AWAY FROM ALL DOORS AND WINDOWS.
4) PROVISIONS SHALL BE MADE TO PREVENT FOREIGN OBJECTS FROM ENTERING VENT PIPING.

B
1) NORMALLY OPEN VENT VALVE LINE SHALL BE HALF OF THE MAIN GAS TRAIN PIPING SIZE (3/4" MIN.).

FIGURE 2-18. Typical UL Gas Piping



TYPICAL UL GAS PIPING OVER 12,500,000 BTU - FULL MODULATION - MODELS D, LN 378 & 420

A
1) FULL SIZE (1/4" OR LARGER) PIPE TO BE RUN FROM THE VENT OPENING TO OUTSIDE OF BUILDING.
2) NO TRAPS ALLOWED IN VENT LINE.
3) VENT LINE SHALL TERMINATE AWAY FROM ALL DOORS AND WINDOWS.
4) PROVISIONS SHALL BE MADE TO PREVENT FOREIGN OBJECTS FROM ENTERING VENT PIPING.

B
1) NORMALLY OPEN VENT VALVE LINE SHALL BE HALF OF THE MAIN GAS TRAIN PIPING SIZE (3/4" MIN.).

THESE PIPING LAYOUTS ARE FOR REFERENCE ONLY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. OPTIONAL EQUIPMENT MAY CHANGE THIS LAYOUT.

FIGURE 2-19. Typical UL Gas Piping

CHAPTER 3 Operation

3.1 — Preparations for Starting

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

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

Component	Description
Burner	Check the electrical power supply to the burner in accordance with the nameplate voltage on all motors and the control circuit. Check the direction or rotation of the motors. Open the housing to check the electrode setting (refer to Chapter 5). Check the gas pilot pressure at the pilot gas regulator. The normal setting is 3” to 5” W.C. For protection in shipment, the flame safeguard control chassis is shipped unmounted. Check all screw connections before attaching the flame safeguard chassis to the base. Screws must be secure to assure low resistance connections. The relay chassis is mounted on the sub-base with a screw which, when tightened, completes the connection between the sub-base and chassis contacts. Press the manual reset button to be sure safety switch contacts are closed. Check the control linkage for proper movement of the air volume damper and fuel metering components. This can be done by loosening the linkage at the actuator level and manipulating it by hand. Check the air shutter and adjust the low fire setting.

Component	Description
Boiler	Check the boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control slightly above the desired temperature. Set modulating controls at the desired temperature or pressure.
Firing Preparations for Oil Burners	Prior to initial firing, oil flow pressure and temperature should be verified. Inspect the compressor lube oil sump level. Add oil to bring the oil level to the midpoint or slightly higher in the reservoir sight glass. Make certain that the drive belts or couplings are aligned and properly adjusted. To verify air flow and pressure, momentarily flip the switch "ON" and immediately turn it "OFF." The programmer will continue through its cycle, however, without ignition or energizing the fuel valves. Observe the air pressure gauge. With the compressor running and no oil flow, the pressure should be approximately 10 PSI. The schematic flow diagrams in Chapter 1 indicate the flow of fuel and atomizing air. If the burner is a duel fuel model, make certain that the main gas shut off cock is closed and the fuel selector switch is set to "OIL."

3.1.1 — Oil Flow

Light Oil: Refer to the piping diagrams. Open all valves in the oil suction and return lines. The burner oil metering units are not capable of creating suction. Fuel oil must be supplied to the metering unit at a nominal 10 to 15 PSI pressure by a circulating supply pump.

Heavy Oil: Refer to the piping diagrams for burners using heavy oil. Note the bypass valve between the supply and return lines. At initial system startup or after prolonged shutdown, start the system as follows:

1. A vacuum (or compound pressure-vacuum) gauge should be installed in the oil suction line, and its reading noted. This gauge indicates the tightness of the suction system.
2. Open valve No. 1 in the bypass line and close valve No. 2 in the supply line to the metering pump.
3. Turn on the pre-heater and the circulating pump. Oil will circulate from the tank through the circulating pump and pre-heater, returning to the tank through the bypass and return lines. Observe the oil supply pressure gauge for indication that oil flow is established. If no pressure shows after a few moments, and the vacuum gauge shows little or no suction, stop the circulating pump and re-prime. heavy oil in the storage tank (hot well) must be warm enough to permit flow.
4. As the system becomes warm, the pressure required for circulation will gradually drop. When the return is warm, open No. 2 valve and throttle the flow in the bypass line with valve No. 1. This will cause the oil to flow through the back pressure valve to the tank via the return line. The pressure in this loop around the burner should not exceed 25 PSI. When the loop around the burner becomes warm, gradually close valve No. 1 in the bypass line. All supply oil will then flow through the burner loop.

3.1.2 — Oil Pressure

The system pressure is regulated by the back pressure valve. This should be set between 10 to 15 PSI (DL & DM Models) or 12 to 20 PSI (DE Models) at the burner inlet after the temperature stabilizes.

3.1.3 — Oil Temperature

Heavy oil flow and burning characteristics are dependent on oil viscosity, which in turn requires temperature regulation. A loop heater in the supply line between the circulating pump and the burner heats the oil. The loop

heater should be adjusted to give the designed operating temperature. Where the burning characteristics of the fuel are unknown, the following may be considered as typical:

No. 4	80º - 125º F
No. 5L	115º - 160º F
No. 5H	145º - 180º F
No. 6	180º - 220º F

3.1.4 — Air-Oil Tank (Lube Oil)

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

For a normal environment use SAE30 oil. For a 32º F and below environment sue SAE 10 oil. Change the oil every 2000 hours of operation.

3.1.5 — Firing Preparations for Gas Burners

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

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

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

3.2 — Electrical Interference Test

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

3.2.1 — Gas Fired

1. Close the pilot and the main line manual gas valves.
2. Start the burner and at the time of the pilot trial with just the electrical ignition system energized, the flame relay should not pull in (be energized).
3. Upon completion of a successful test, proceed with startup procedures.

3.2.2 — Oil Fired

1. disconnect the electrical power to the burner.
2. Disconnect the electric oil safety shutoff valve.
3. Reconnect electric power to the burner.

4. Close the pilot line manual gas valve (if used).
5. Start the burner and at the time of the pilot trial, with just the electrical ignition system energized, the flame relay should not pull in.
6. Upon completion of a successful test, disconnect the power supply.
7. Reconnect the oil safety shutoff valve and turn on the manual pilot gas valve.
8. Reconnect the power supply and proceed with startup procedures.

3.3 — Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. A normal setting is 3" to 6" W.C. when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame.

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

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

⚠ Warning

Read the flame safeguard manual and fully understand its contents before attempting to operate this equipment. Failure to do so may result in serious personal injury or death.

⚠ Warning

Should a starting failure occur for any reason, combustible fumes may fill the combustion chamber. Never attempt to re-light the burner under these conditions without first purging the chamber.

⚠ Warning

Keep fingers away from the combustion air intake below the damper. The damper is actuated with sufficient force to cause severe injury. Repeat the procedure until the high fire rate is reached. Always make high and intermediate rate adjustments when the burner has reached the low fire position. DO NOT disturb the low fire setting.

3.4 — Startup Sequence

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

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

Refer to the manufacturer's literature on programming controls and burner wiring diagrams for detailed information.

1. Begin starting sequence, with burner switch off, and with all manual valves closed. Switch main power on.
2. When firing oil, open the manual oil valves.
3. When firing on gas, open the main manual gas valve.
4. When firing on gas, manually reset the high and low gas pressure switches.
5. Place the gas/oil selector switch in position for the fuel to be used. With all limit and operating controls calling for heat, the burner will follow the Flame Safeguard Sequence.
6. When the burner motor starts, open the gas cock.
7. If firing on gas, when the main fuel lamp lights indicating pilot flame proven, slowly open the second shutoff cock downstream of the main gas valve(s).
8. Refer to the manufacturer's literature on primary control sequence of operations.

3.5 — Automatic Shutdown

When the limit or operating controls open:

- Fuel valves close. The main fuel lamp goes off. Flame safeguard timer starts.
- The flame safeguard timer and burner motor stop. The burner is ready for startup on the next call for heat.

3.6 — Manual Shutdown

1. Turn the gas/oil selector switch "OFF." The burner shuts down in Automatic Shutdown.
2. When the burner motor stops, close all manual valves.

3.7 — Safety Shutdown

1. If at any time during the operating cycle a flame failure occurs, the burner shuts down as in Automatic Shutdown, with an additional post-purge, and the flame failure lamp is energized.
   - The lockout switch on the flame safeguard control must be manually reset before the burner will fire again.
2. If a low water condition occurs, the burner shuts down as in Automatic Shutdown.
3. If a high or low gas pressure condition occurs while firing on gas, the burner shuts down as in Automatic Shutdown.
   - The condition must be corrected and the respective gas pressure switch manually reset before the burner will fire again on gas.

INDUSTRIAL COMBUSTION

3.8 — Startup and Operating

3.8.1 — Gas Burners

1. Close the main and pilot gas cocks. Make sure the “ON-OFF” switch is in the “OFF” position and the fuel selector switch is on “GAS.”
2. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.
3. Set the “MANUAL-AUTO” switch to “MANUAL.”
4. Set the manual potentiometer in the low fire position.
5. Open the gas pilot cock.
6. Set the “ON-OFF” switch to “ON.” The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot solenoid are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done.
7. On initial startup it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequence. Then determine that the main gas valve opens. When this is confirmed, turn the burner switch “OFF” and allow the programmer to finish its cycle. Check to see that the gas valve has closed tightly. If ignition does not occur, turn the burner switch “OFF” and allow the programmer to recycle for a new ignition trial.
8. Turn the burner “ON” and after pilot ignition when the flame relay pulls in, the slow opening, motorized, main gas valve is energized. Slowly open the downstream manual shutoff gas cock. The main flame should ignite at this time. The gas valve and air damper continue advancing until high fire is reached.
9. Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting the butterfly valve and air linkage. When low fire is adjusted, shut down the burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of an emergency, open the main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.
10. Turn the potentiometer switch to the high fire position. Check high fire at this point using combustion instruments.
11. Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings.

High fire combustion analysis typically is 9% to 10.5% CO_2. When conditions covered above are assured, refer to Sections 3.9 and 3.10.

3.8.2 — Oil Burners

1. Set the fuel selector to “OIL.” On initial startup of a combination burner, it is recommended that oil firing be adjusted before gas firing. The gas low firing rate is set to match oil low fire rate.
2. Be sure the “ON-OFF” switch is in the “OFF” position and the fuel selector switch is on “OIL.” Actuate the manual reset button of the flame safeguard control to close the safety switch contacts. Be sure the “MANUAL-AUTO” switch is in the “MANUAL” position. Set the manual modulating control potentiometer to the “LO” fire position. Open the pilot gas valve (if used).
3. Set the “ON-OFF” switch to “ON.” The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done. Refer to Chapter 4, Sections 4.3 and 4.4.

4. Observe the primary atomizing air pressure gauge on the air/oil tank. The gauge reading should be approximately 10 psi during pre-purge.
5. When the pilot flame is proven, the programmer will proceed to the main flame position. Allow the burner to operate in low fire, to warm the boiler before moving to high fire.

Typically, for No. 2 through No. 4 oil, CO_2 is 8% to 11% and No. 5 and No. 6 oil is 8% to 13% at low fire.

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

Typically, for No. 2 through No. 4 oil, CO_2 is 10% to 13% and No. 5 and No. 6 oil is 11% to 15% at high fire.

7. When conditions covered above are assured, refer to sections 3.9 and 3.10.

3.9 — Normal Operation

Normal operation must be with the “MANUAL-AUTO” switch selector on “AUTO.”

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

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

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

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

3.10 — Shutdown

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

1. The fuel valve(s) de-energize and flame extinguishes. The blower motor continues running during post-purge.
2. At the end of the post-purge, the blower motor is de-energized. The programmer returns to its starting position and stops. the unit is ready to restart.

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

Safety shutdown caused by ignition or flame failure will actuate a red indicator light and energize an audible alarm (if so equipped). If the programmer has a non-recycling interlock circuit, any interruption in this circuit dur-

ing the pre-purge or firing cycle will cause a safety shutdown. This type of shutdown requires manual reset of the programming control and must be corrected before operation can be resumed.

⚠ Warning

An ultraviolet flame sensor electrical spark interference test must be performed after final adjustment. See Section 3.2 for additional information.

CHAPTER 4 Adjustments

4.1 — Overview

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

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

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

4.2 — Combustion Adjustment on Gas and Oil

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

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

4.2.1 — Stack Temperature

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

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

INDUSTRIAL COMBUSTION

4.2.2 — Smoke Measurement

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

Smoky combustion can result from:

- improper air delivery
- insufficient draft
- improper fuel viscosity
- improper fuel-air ratio
- excessive air leaks in the combustion chamber
- improper fuel oil temperature

4.2.3 — Gas Adjustments

Low fire combustion analysis typically is 7% to 9% CO_2 and less than .04% CO (400 ppm). A high fire reading typically is 9% to 10.5% CO_2 and less than .04% CO.

4.2.4 — Fuel Oil Adjustments

Adjust for a “clean fire.” Typically for No. 2 through No. 4 oil, CO_2 is 8% to 11% at low fire and 10% to 13% at high fire. For No. 5 and No. 6 oil, CO_2 is 8% to 13% at low fire and 11% to 15% at high fire.

4.3 — Electrical Interference Test

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

4.3.1 — Gas Fired

1. Close the pilot and main line manual gas valves.
2. Start the burner and at the time of the pilot trial with just the electrical ignition system energized, the flame relay should not pull in (be energized).
3. Upon completion of a successful test, proceed with startup procedures.

4.3.2 — Oil Fired

1. Disconnect the electrical power to the burner.
2. Disconnect the electric oil safety shutoff valve.
3. Reconnect electric power.
4. Close the pilot line manual gas valve, if used.
5. Start the burner and at the time of the pilot trial, with just the electrical ignition system energized, the flame relay should not pull in.
6. Upon completion of a successful test, disconnect the power supply.
7. Reconnect the oil safety shutoff valve and turn on the manual pilot gas valve.
8. Reconnect the power supply and proceed with startup procedures.

4.4 — Gas System

4.4.1 — Gas Pressure

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

4.4.2 — Gas Flow

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

NOTE: When checking the input rate, make sure no other equipment is operating on the same meter.

4.4.3 — Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 3” to 6” W.C. when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame.

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

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

⚠ Warning

An ultra-violet flame sensor electrical spark interference test must be performed after final adjustment. See Section 4.3 for additional information.

4.4.4 — Main Gas Pressure Regulator

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

4.4.5 — Low Gas Pressure Switch

Turn the adjusting screw until indicator moves to a pressure setting slightly below the operating gas pressure. The control will break a circuit if pressure is below this set point. The control should be finally adjusted to prevent operation with low gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur. The switch must be manually reset after tripping. To reset, allow gas pressure to rise and press the manual reset button.

INDUSTRIAL COMBUSTION

4.4.6 — High Gas Pressure Switch

Turn the adjusting screw until the indicator moves to a pressure setting slightly above the maximum operating gas pressure. The control will break a circuit if pressure exceeds this value. The control should be adjusted to prevent operation with excessive gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur. This switch must be manually reset after tripping. To reset, allow the gas pressure to drop and press the manual reset button.

4.4.7 — Gas Combustion Adjustment

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

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

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

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

Recheck low fire and adjust if necessary.

Proper setting of the air/fuel ratios at all rates must be determined by combustion analysis. See Section 4.2 of additional information.

NOTE: Check for CO through the entire firing range.

4.4.8 — Secondary Valve Adjustment: Gas Models D 378 & 420

The secondary valve feeds gas to the inner spuds. A slot in the valve stem in relationship to the shut/open scale on the valve indicates the blade position. In the low fire starting position, the stem slot should be positioned at the left hand 1/4 mark and travel in a counterclockwise direction to the mid fire shut position. Continuing in a counterclockwise direction, the stem slot should stop at the right hand 1/4 mark. This is the high fire position. Both low and high fire positions are approximate. Adjustments to the valve should be made on the secondary valve linkage arm. To increase the travel, move the linkage arm closer to the pivot point. To decrease the travel, move the linkage arm away from the pivot point. The primary valve which feeds the outer spuds should be adjusted as normal.

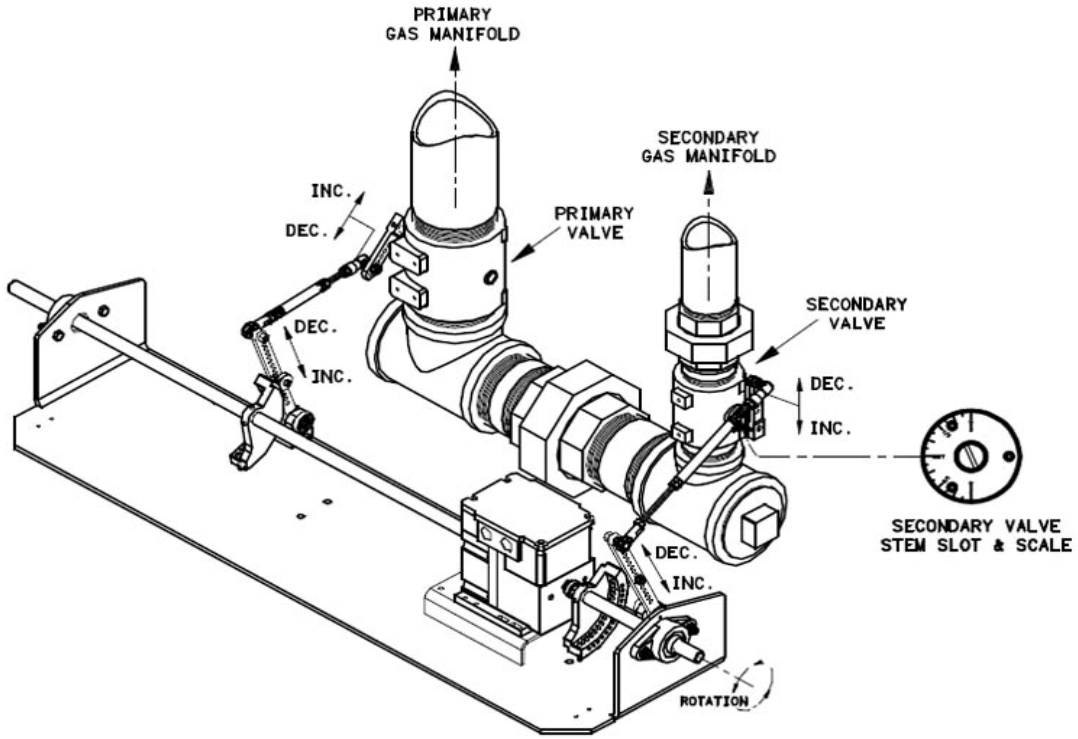


FIGURE 4-1. Gas Primary and Secondary Valve Arrangement: D 378-420

4.4.9 — Secondary Valve Adjustment: Dual Manifold

Each zone is controlled by a butterfly valve linked to a 14 point adjustment cam. The primary large butterfly valve controls the main gas orifices and the secondary small butterfly valve controls the pre-mix gas spuds.

Refer to the adjustment section to setup the burner. In the low fire position, the secondary valve controlling the pre-mix spuds is almost closed. After all adjustments are made throughout the modulating range, go back and relight the burner. Upon startup, check that the fire is not burning behind the diffuser. If this happens, close the secondary valve until this situation is corrected. Repeat several times.

4.5 — Oil System

4.5.1 — Oil Metering System

Fuel oil supply to the integral metering unit must be at 10 psi to 15 psi and up to 20 psi on separate metering units. The oil spray should ignite as soon as the oil solenoid valve opens. If the oil spray fails to ignite, move the metering unit adjustment lever a few degrees counterclockwise. This increases the amount of oil at low fire and makes ignition easier, it will also increase the oil on high fire, so this must be checked later. Once adjusted, the pump should operate with a minimum amount of adjustment. If a burner failure is caused by the oil metering pump, check the following:

1. See that the oil tanks are not empty.

2. That all oil valves between the burner and the tank are open.
3. That the suction line is not airbound.
4. That the low fire setting has not been disturbed.
5. That there is pressure at the integral metering unit, but not to exceed 15 psi (20 psi on a separate metering unit).
6. That the pump turns freely.
7. Check for a clogged strainer at the suction side of the circulating pump.
8. Check for a dirty burner strainer.
9. Check for a plugged or carboned nozzle. This will show up as excessive primary air pressure.
10. That the oil bypass valve is not bypassing the metered fuel oil.

Internal wear of the pump may take place due to the presence of dirt in the oil and in time, this will result in excessive clearances which reduces the pump capacity.

If the oil metering pump fails to deliver capacity or meters erratically, replace the oil and air pump as a unit and return the old pump for repair or exchange (where allowed).

4.5.2 — Atomizing Air Pressure

Atomizing air in the air/oil tank is regulated by adjusting the valve in the return air line on integral metering units or in the air inlet on air compressor module burners. The air pressure is indicated by the pressure gauge at the air/oil tank.

A minimum of 10 psi air pressure in low fire is suggested. As the firing rate increases, the air pressure also increases. Air pressure will be less with light oils. If any change in atomizing air pressure is made, check ignition several times for reliable light off. Adjustments should be set to obtain reliable ignition with best low and high fire combustion results.

If the required atomizing air pressure cannot be maintained, a lack of lubricating oil may be the cause or the intake filter may be dirty.

4.5.3 — Atomizing Air Proving Switch

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

4.5.4 — Low Oil Pressure Switch

The low oil pressure switch is adjusted at the minimum setting of 4 psi. Turning the knob clockwise will increase pressure, counterclockwise will decrease pressure.

4.5.5 — High Oil Temperature Switch

The temperature switch is set slightly below the maximum of 260º F. To adjust, remove cover and turn the screw located on top. Clockwise will increase temperature, counterclockwise will decrease temperature.

4.5.6 — Nozzle Line Heater

NOTE: Be sure the manifold is filled with oil prior to startup.

1. Remove the cover that encloses the thermostat and interlock switch. The pointer controls the thermostat setting. The knurled knob controls the cold oil interlock switch.
2. The thermostat pointer should be set at position 6 and then raised or lowered as required. Higher numbers indicate higher temperatures. Let the unit run before making further adjustments. The thermostat governing the nozzle line heater element is set lower than the thermostat governing the oil heater in the circulating loop.
3. The cold oil interlock switch is controlled by the small brass knurled knob under the pointer. This is set to prevent the burner from starting until proper oil temperature is attained. Set it below the oil thermostat setting. If the cold oil interlock is set higher than the oil temperature, the burner will not run.
4. Replace the cover.

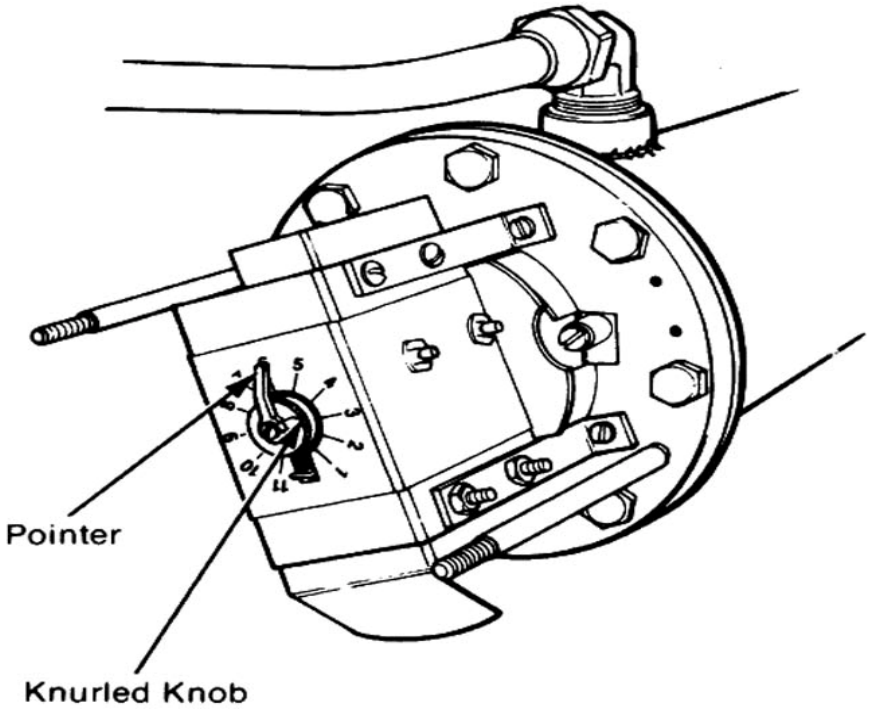


FIGURE 4-2. **Pointer and Knob**

4.6 — Linkage: Modulating Motor

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

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

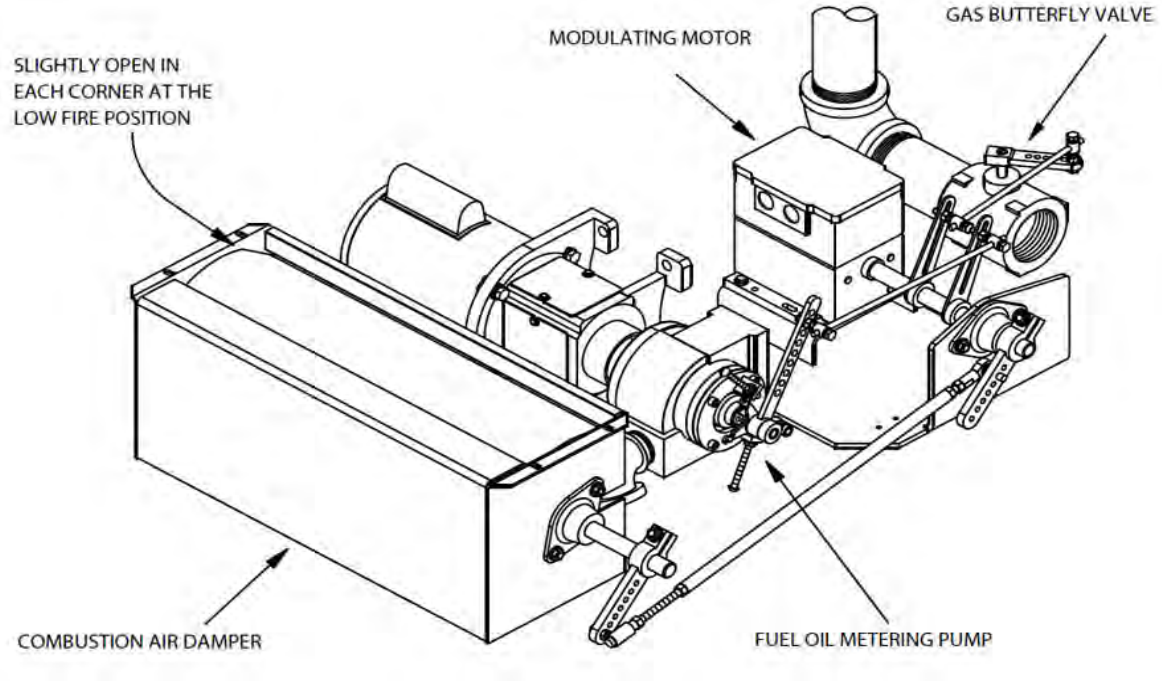


FIGURE 4-3. Low Fire Position

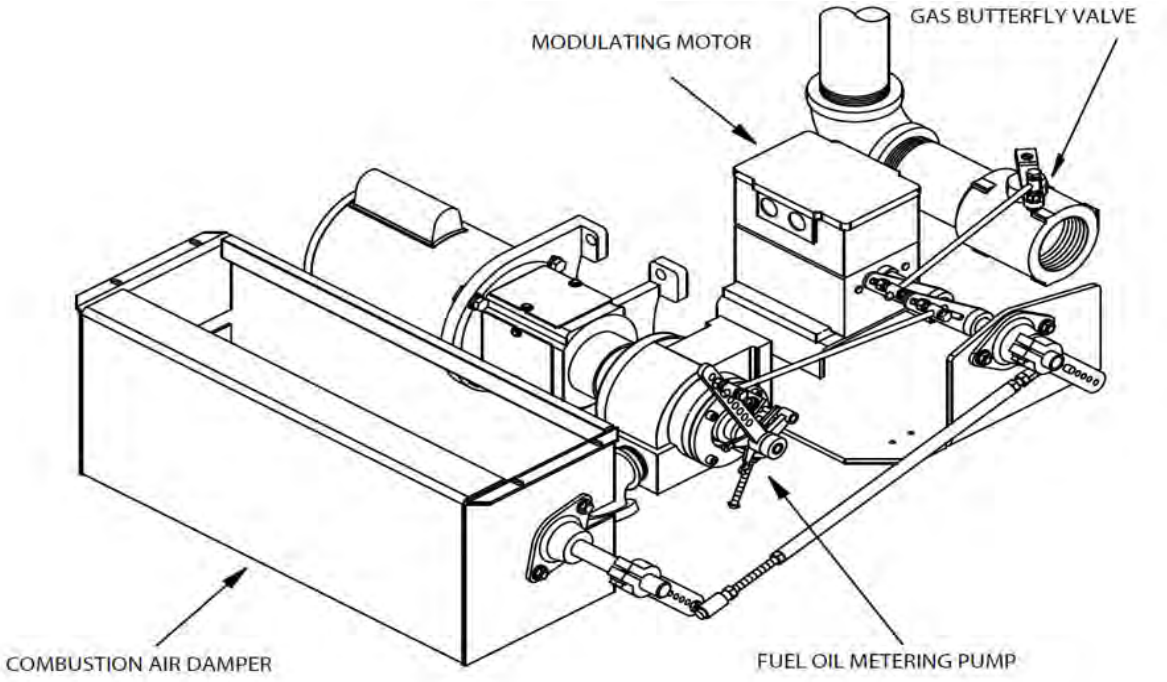


FIGURE 4-4. High Fire Position

The modulating motor will be stopped at the end of its stroke by an internal limit switch. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. The closer the rod comes to parallel

with the lever, the slower the rod moves. The angles of the driven levers on the jackshaft can be adjusted to vary the rate of change. The closer the rod to the hub of the lever, the less distance it will travel. Increasing the lever length on the damper, metering unit and valve(s) decreases flow rate.

4.7 — Cam Trim Adjustment

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

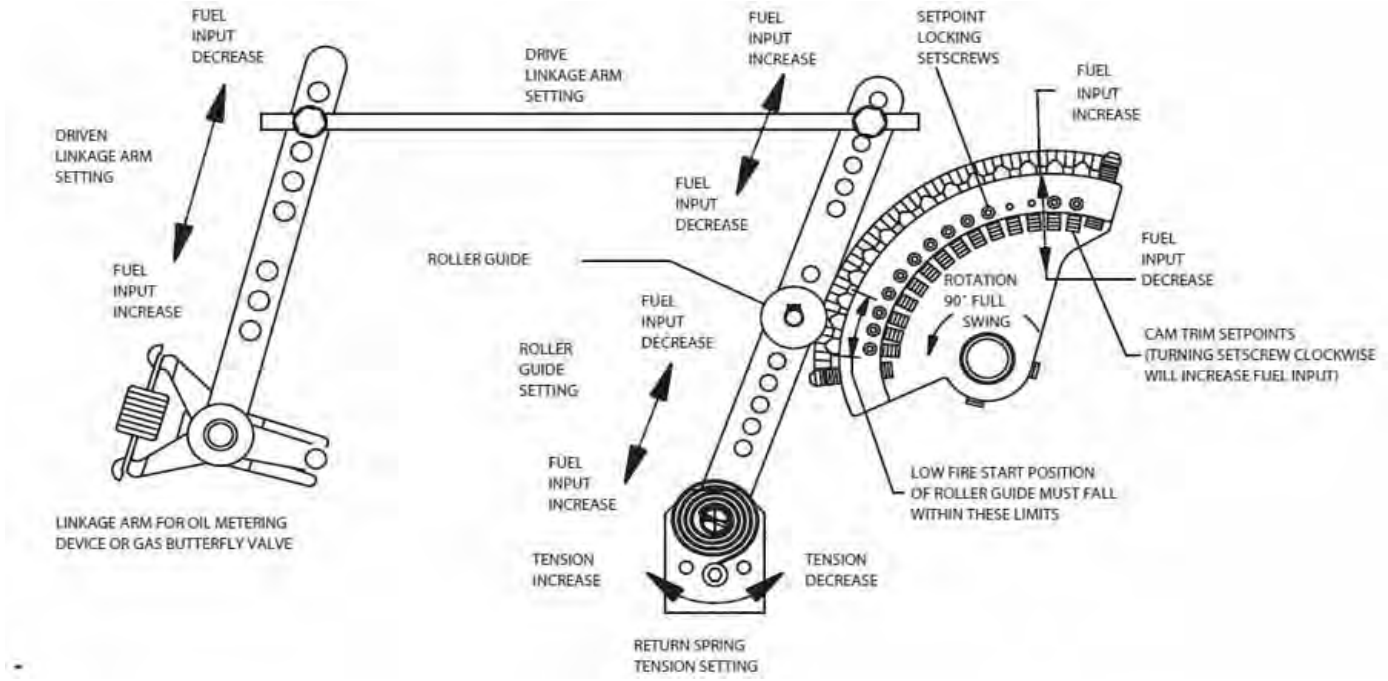


FIGURE 4-5. Cam Trim Adjustment

NOTE: It is essential that the cam spring, cam follower bearing wheel, and cam follower arm at the pivot point be greased sparingly every month to ensure smooth operation of the cam assembly. Regular automotive bearing grease should be used.

4.8 — Firing Rate Controls

Firing rate adjustments are made at the modulating motor linkages to the combustion air inlet damper, air-oil metering pump, and main gas butterfly valve. Settings are determined by the operating length of the levers and the angular position on the shafts. Increasing the lever lengths on damper, pump, or valve decreases the flow

rate. Driving and driven levers are approximately parallel, but the angles can be adjusted to vary the rate of change. The most rapid rod travel occurs when the lever is perpendicular to the rod. The closer the rod comes to being parallel with the lever, the slower the rod moves. Always allow the burner to return to low fire position before adjusting high or intermediate settings. Do not alter low fire settings. Normally, the air control damper will be approximately 1" open in low fire position. Excessive opening in low fire can cause pilot ignition problems. Air to the pilot is supplied under pressure to compensate for variations in furnace pressure, but the damper must be in low fire position for reliable ignition.

⚠ Warning

Keep fingers away from the air intake below the damper. The damper is actuated with sufficient force to cause serious injury.

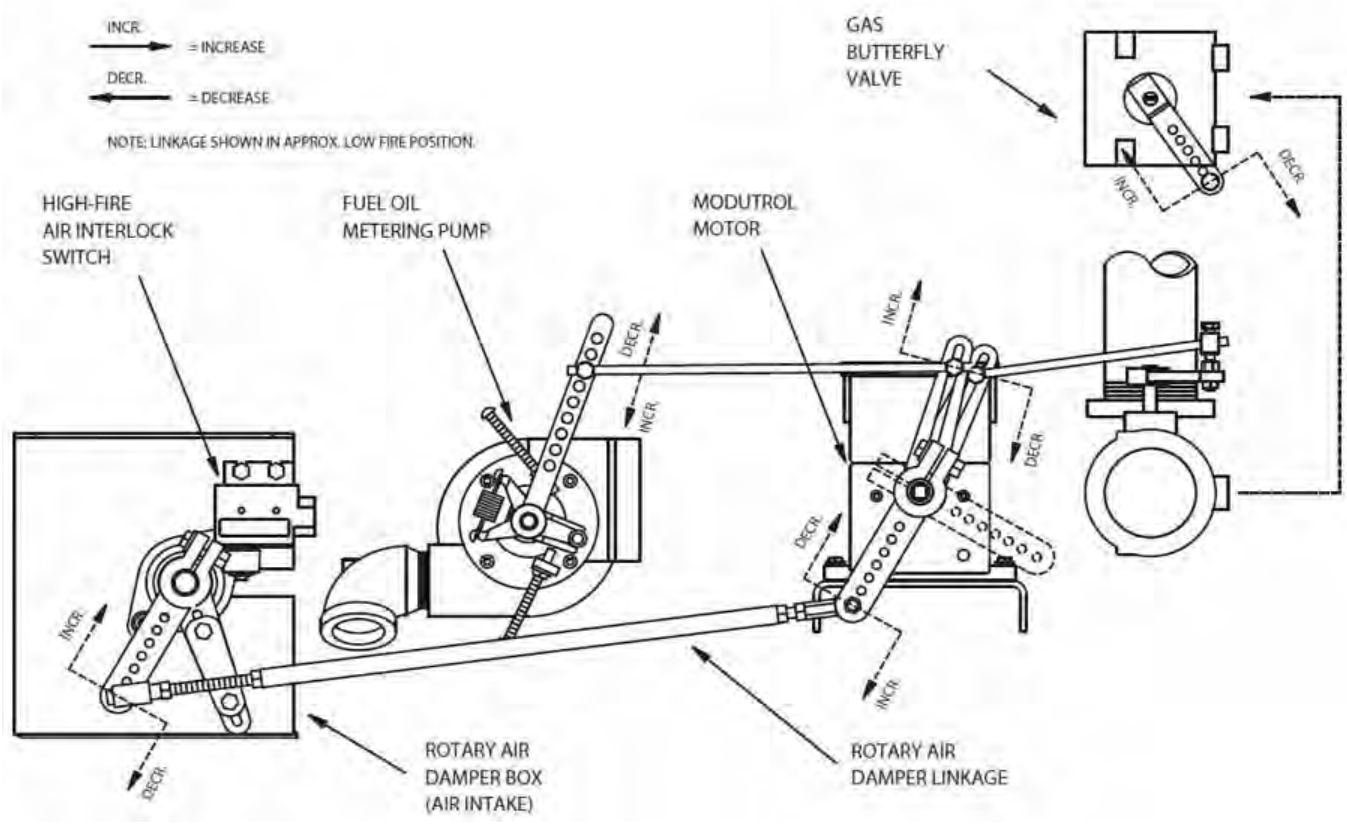


FIGURE 4-6. Firing Rate Control Adjustments

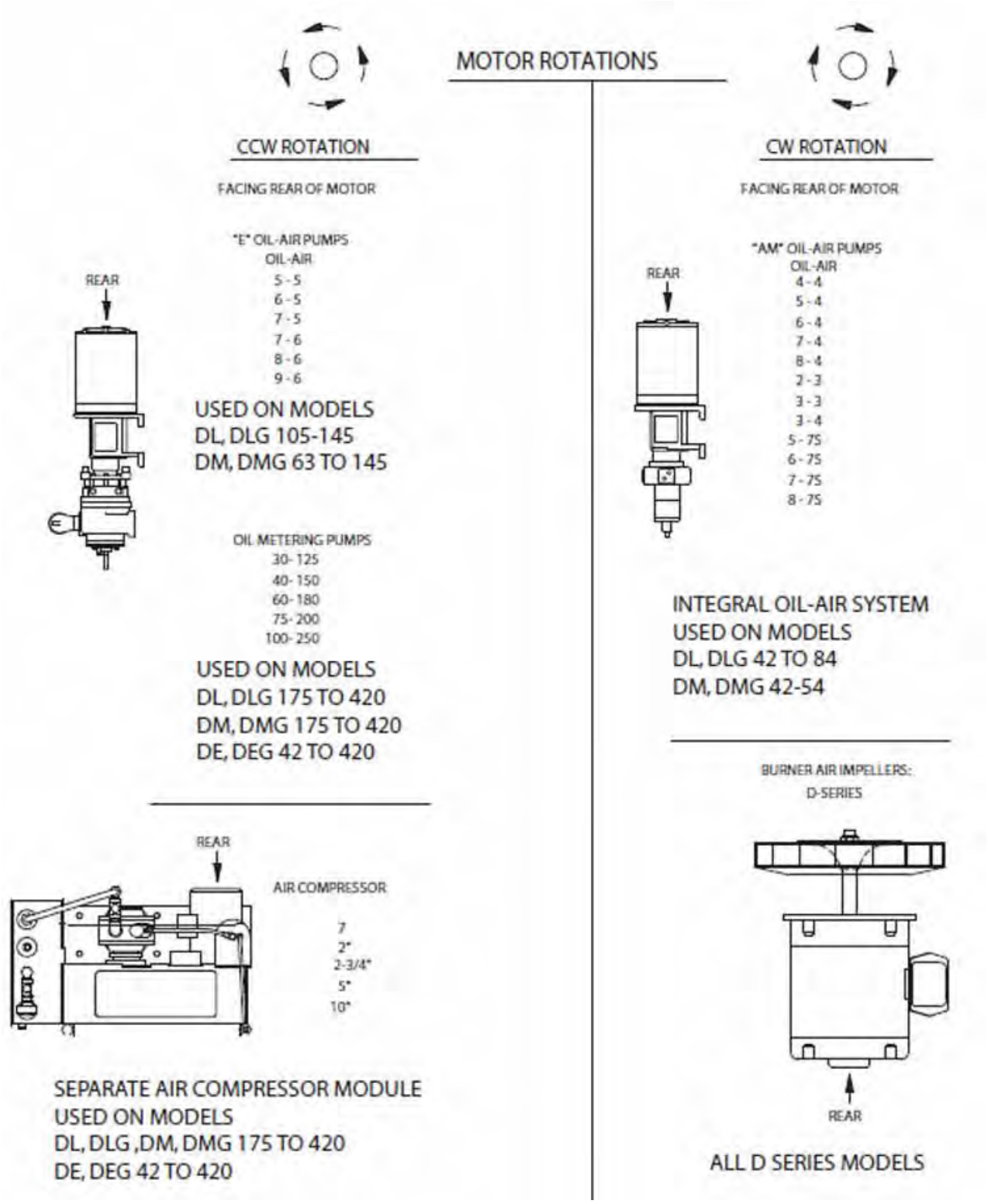


FIGURE 4-7. Motor Rotations

CHAPTER 5 Maintenance

⚠ Warning

Any cover plates, enclosures, or guards anchored to the burner, or any burner related equipment, must remain in position at all times. Only during maintenance and service shutdown can these cover plates, enclosures or guards be removed. They must be replaced, and securely anchored before testing, adjusting, or running the burner or burner related equipment.

⚠ Caution

It is important that support is provided for the hosing when in the open position to prevent damage to the hinges and subsequent components.

5.1 — Overview

A maintenance program avoids unnecessary downtime, costly repairs, and promotes safety. It is recommended that a record be maintained of daily, weekly, monthly, and yearly maintenance activities.

Electrical and mechanical devices require systematic and periodic inspection and maintenance. Any “automatic” features do not relieve the operator from responsibility, but rather free him from certain repetitive chores, providing time for upkeep and maintenance.

Unusual noise, improper gauge reading, leak, sign of overheating, etc., can indicate a developing malfunction, requiring corrective action.

5.2 — Control System

Most operating controls require very little maintenance beyond regular inspection. Examine electrical connections. Keep the controls clean. Remove any dust from the interior of the control. Covers should be left on controls

at all times. Keep the control cabinet doors closed. Dust and dirt can damage motor starters and relay contacts. Starter contacts are plated with silver and are not harmed by discoloration. Never use files or abrasive materials such as sandpaper on contact points.

5.2.1 — Programming Control

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

5.3 — Impeller and Stator Cone

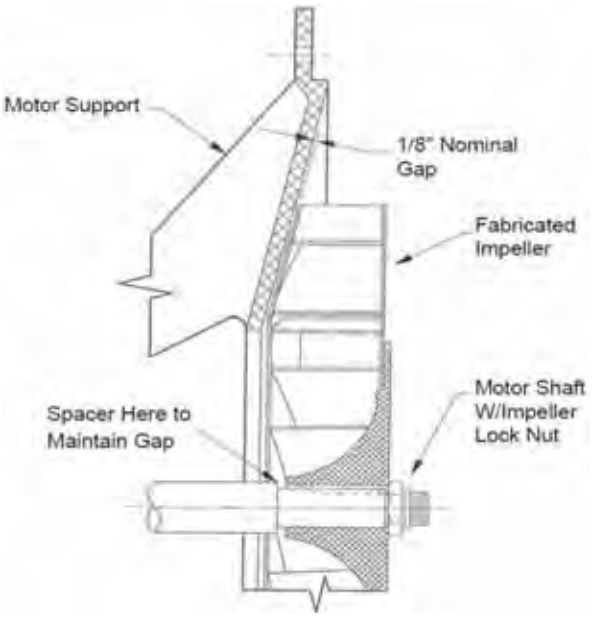


FIGURE 5-1. **Impeller and Stator Cone**

Proper clearance between the impeller and the inlet housing and between the impeller and stator cone is not critical and is set at 1/8" nominal. When installing or removing the impeller, it is mandatory to use an impact wrench.

NOTE: Under no circumstance should anything other than an impact wrench be used.

Inserting a bar through the impeller blade and using it as a lever will only damage the blade and also void the 5 year impeller warranty. If the impeller is changed to a different width, the stator cone position may require adjustment. This is provided for by means of slotted mounting holes in the blast tube. Loosen the three screws to reposition the cone.

5.4 — Firing Head Inspection

1. Disconnect the damper linkage.
2. Release the impeller housing latch and swing the housing open for access to the firing head.
3. Inspect the flame scanner lens to be sure it is clean and the support tube is in proper position to sight the flame through the hole in the diffuser.
4. Inspect the lead wire to the ignition electrode. It must be firmly attached and the insulation should be clean and free of cracks.

5. The oil nozzle should be inspected periodically depending on the grade of oil burned and the cleanliness of the environment.

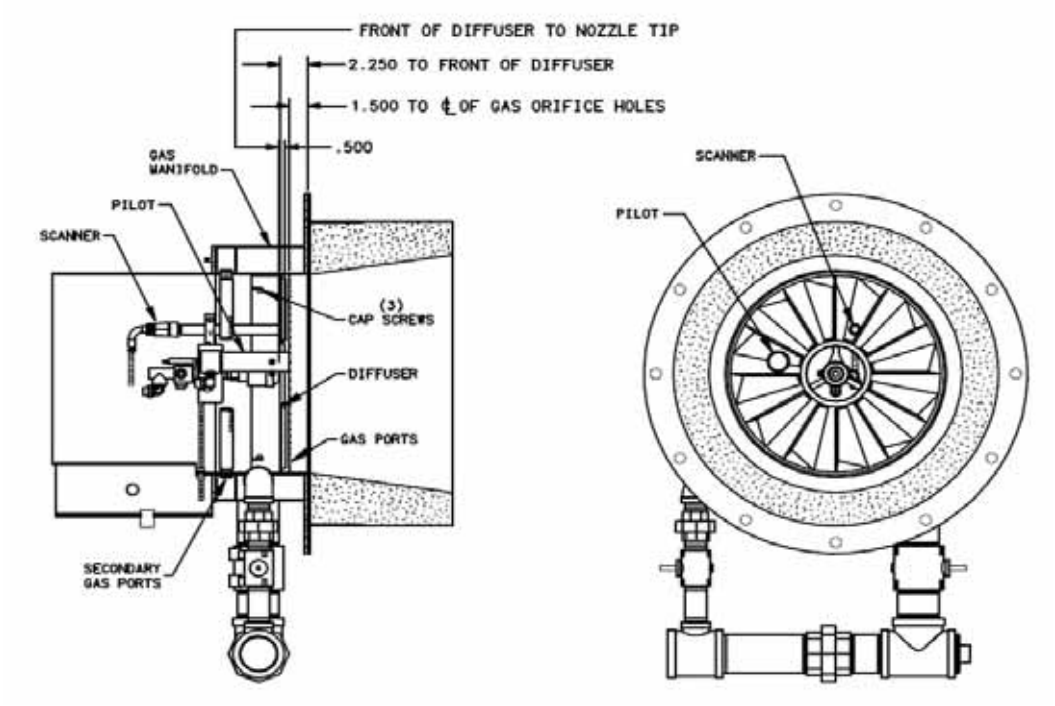


FIGURE 5-2. **Firing Head Assembly: Dual Manifold**

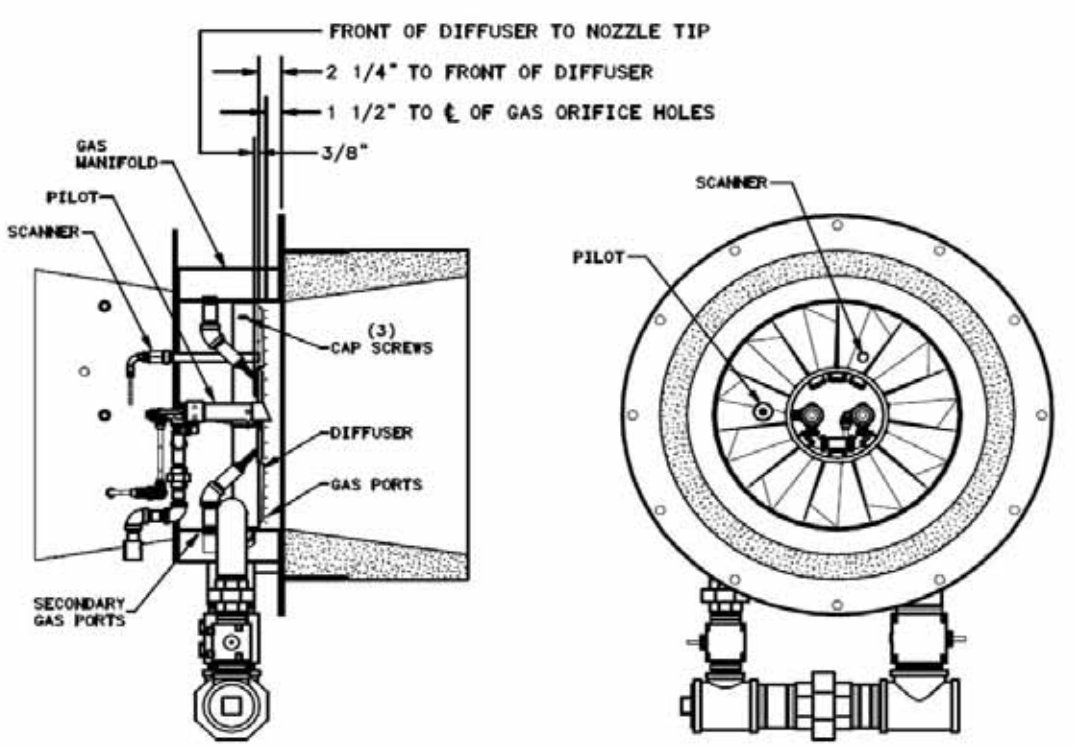


FIGURE 5-3. **Firing Head Assembly: D378 & 420**

5.5 — Pilot and Ignition Electrode

The ignition transformer requires little attention other than making sure the ignition wire is firmly attached to the transformer and the electrode.

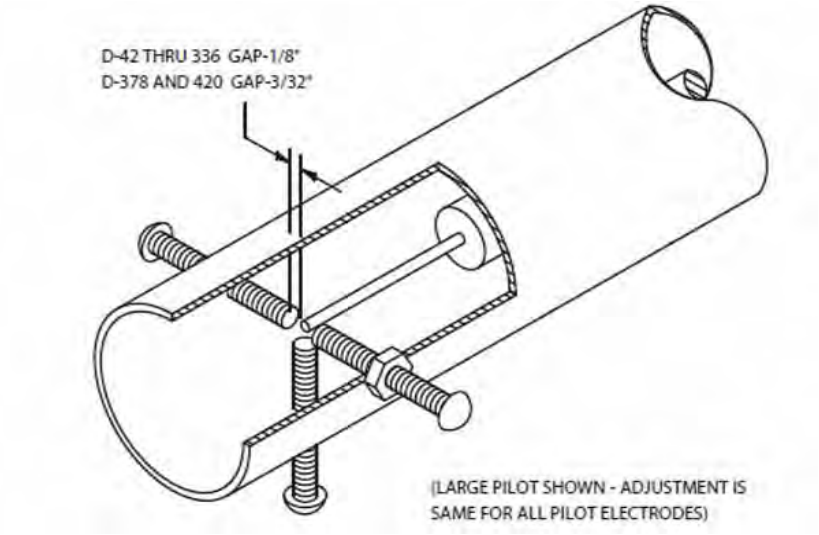


FIGURE 5-4. Ignition Pilot Electrode Setting

Be sure the wire insulation is in good condition and not grounded. Failure to keep the ignition electrode clean and properly set can cause faulty operation. The pilot assembly is supported by a socket in the diffuser and gas inlet tube. No adjustment is required except proper positioning of the electrode wire.

5.6 — Flame Scanner

The scanner must be clean. Even a small amount of contamination will reduce the flame signal. Wipe the scanner lens with a clean soft cloth.

5.7 — Oil Nozzle

Successful burner operation requires use of the proper style nozzle tip and keeping the orifice clean. Standard nozzle tips furnished on the burners are of a special emulsifying type which delivers a spray of extreme fineness and at an angle which insures proper mixing with the air stream. Unsatisfactory performance and loss of efficiency can result from the use of non-standard nozzle tips. If the burner flame becomes stringy or lazy, it is possible that the nozzle spring is not properly in place or the nozzle is clogged. This problem is usually indicated by an abnormally high reading on the atomizing air pressure gauge on the air-oil tank.

To remove the nozzle:

1. Disconnect the oil and air tubes from the nozzle assembly.
2. Loosen the three 1/4” screws holding the nozzle spider bracket to the support ring.
3. Withdraw the nozzle and bracket assembly.
4. Clean the nozzle tip by unscrewing the tip from the nozzle body. Use care not to distort the tube.

5. Hold the nozzle body in a vise or use two wrenches, one on the body and one on the tip.
6. Disassemble the nozzle tip.
7. Carefully clean all parts in solvent and reassemble the nozzle.

To insure proper atomizing, the tip must be screwed in tightly with the swirler seating spring pressing the swirler tight against the nozzle tip. Turn the swirler a few times to be sure it fits snugly in the nozzle and the spring is pressing the two parts firmly together. When reinstalling, be surer the nozzle is centered with the proper distance from the diffuser (see Figures 5-2 and 5-3).

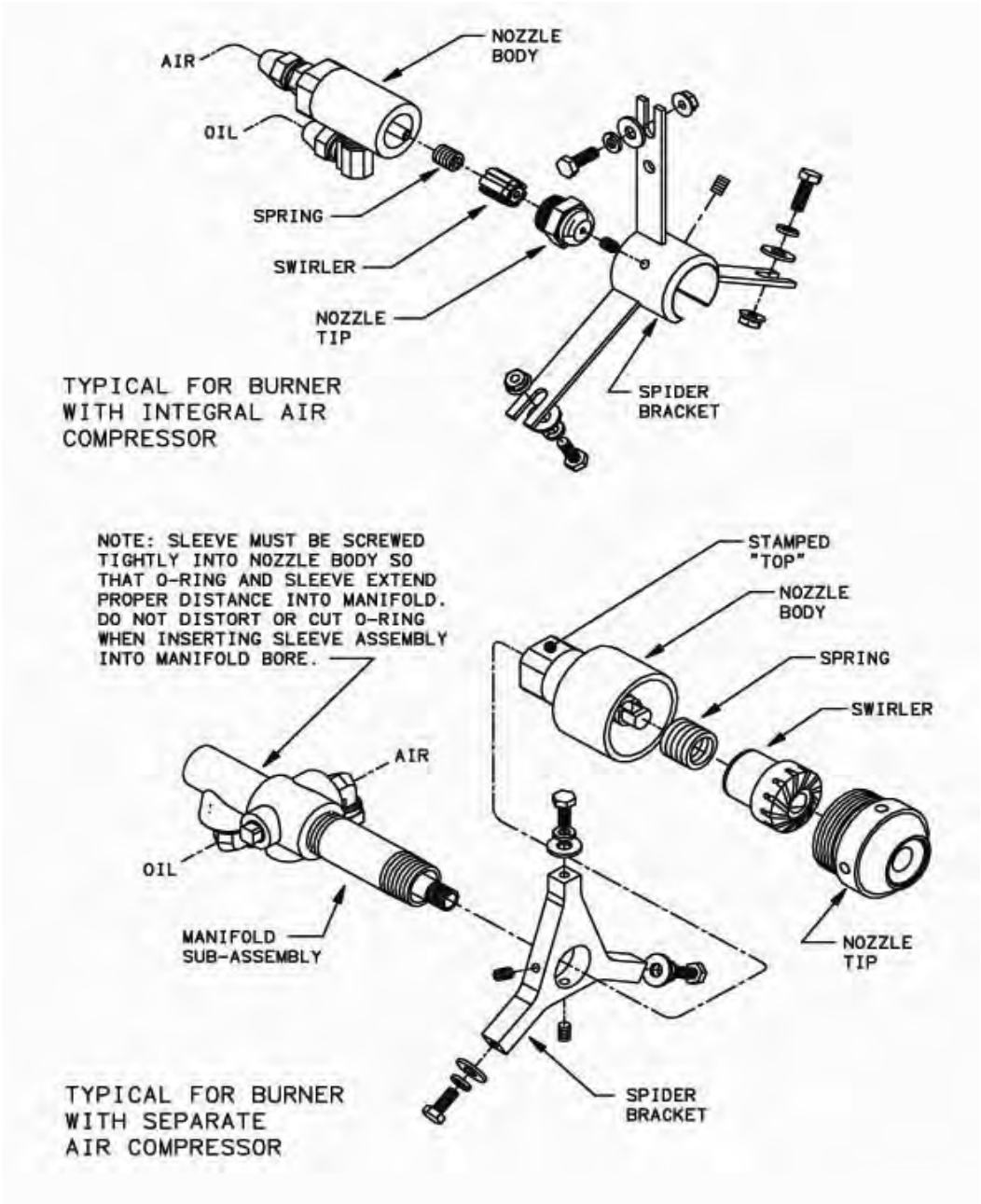


FIGURE 5-5. Oil Nozzle Assemblies

⚠ Caution

Do not attempt to use a wire or a sharp metal tool to clean the nozzle orifice as this will distort the fine orifice and ruin the nozzle. Use a sharp pointed piece of soft wood.

5.8 — Diffuser

The diffuser is factory set and does not require attention under normal operating conditions. If fouled with carbon, the diffuser should be removed for cleaning.

1. First remove the electrode and scanner leads, the gas pilot assembly, air and oil tubes, and the nozzle support assembly before attempting to remove the diffuser.
2. Mark the diffuser's relative position to the blast tube with a scribed or pencil line where the three mounting screws are located, to insure that the diffuser is placed back in the same position.
3. Remove the three screws holding the diffuser to the blast tube and slowly pull the diffuser along the blast tube towards the firing head. Keep the diffuser as parallel as possible. If it should become stuck or tight, do not apply any tool which would distort the shape or blade configuration. A small wooden block tapped gently against the diffuser's outer edge will help expedite its removal.
4. Clean all carbon from the diffuser vanes and reinstall in reverse order of disassembly, aligning the diffuser with the scribed marks. Do not attempt to drive the diffuser back along the blast tube with anything other than a small block of wood tapped against the diffuser's outer edge.
5. When reinstalling, be sure the diffuser is centered with the proper distance as shown in Figures 5-2 and 5-3.

5.9 — Firing Rate Controls

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

NOTE: It is essential that the cam spring, cam follower bearing wheel, and cam follower arm at the pivot point be greased sparingly every month to ensure smooth operation of the cam assembly. Regular automotive bearing grease should be used.

5.10 — Burner Mounting Inspection

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. Replace the gasket if necessary. Inspect the burner head for signs of discoloration. A change in the head color paint might indicate gas leakage between the dry oven and the boiler refractory. If leakage occurs, refer to Chapter 2, Section 2.4 for proper sealing procedure.

5.11 — Fuel Oil System

5.11.1 — Fuel Oil Circulating Pump

Failure or the circulating pump to deliver sufficient oil may be due to one of the following conditions:

1. Insufficient fuel oil in the storage tank.
2. Suction line or check valve clogged.
3. Air leaks or air traps in the suction line. If the line has a high point at which an air trap can occur, the line must be changed.
4. Oil strainer clogged (line strainer or burner strainer).
5. Suction line piping too small.
6. Pump rotating in wrong direction.
7. Three-phase pump motor operating on single phase because of fuse failure.
8. Low voltage applied to pump motor.

NOTE: Heavy fuel oil sometimes will not leak out through a suction line joint when the burner is idle, but the same joint may allow air leakage inward when a vacuum is created in the line by pump action. The cause of a pulsating burner fire can often be traced directly to air leakage in the oil suction line. Always be sure suction line joints are absolutely air tight.

5.11.2 — Air-Oil Metering Pump

⚠ Caution

The metering pump is lubricated by fuel oil and must not be operated longer than one minute if it is not pumping oil. Failure to comply will result in premature pump failure and void any warranty implied or otherwise.

Both the integral air-oil metering pump for light oil and the heavy oil metering pump are precisely fitted nits employing a seal on the shaft to prevent oil leakage. Internal wear can take place due to dirt in the oil and may in time result in excessive clearances, reducing pump capacity. Once adjusted, the pump will continue to operate with a minimum of readjustment. If burner failure appears to be caused by the metering pump, check the following:

1. See that the oil is at a sufficient level in both the fuel oil tank and the air-oil tank on the burner.
2. Make sure all valves between the fuel oil tank and the burner are open.
3. Be sure the oil suction line is not airbound and check the suction line strainer.
4. Check the low fire setting of the metering pump to be sure it has not been disturbed.
5. Make sure the pump turns freely.
6. Inspect the burner oil nozzle for clogging.

⚠ Caution

Do not attempt to disassemble the oil metering pump in the field. Any attempt will void the warranty or the exchange policy.

Whenever an oil metering pump fails to deliver full capacity or pressure, order a replacement pump at once and return the old pump for repair or exchange (where allowed).

INDUSTRIAL COMBUSTION

5.11.3 — Primary Air Pump or Compressor

The air compressor itself requires little maintenance, however, its life is dependent upon sufficient clean, cool lubricating oil. The oil level in the air-oil tank must be checked regularly. Lack of oil will damage the compressor. Disassembly or field repairs to the air compressor are not recommended. Check the air-oil tank sight glass for proper oil level. The level should be kept at the midpoint of the sight glass. The compressor rotor must turn freely. All tube connections must be air tight.

⚠ Caution

Do not attempt field repair of the compressor. Installation of a new compressor is mandatory. Send the old compressor in for repair or exchange (where allowed).

Alignment of the compressor and motor sheaves and proper belt tension are important.

Belt tension is adjusted according to the displacement of the belt with thumb pressure. The displacement should be 3/8” to 1/2”.

To adjust, loosen the two bolts on the compressor mounting flange and the three setscrews which hold the compressor in place.

The mounting flange is slotted at the top, which permits belt tightening. If the slot in the mounting flange is insufficient for obtaining proper belt tension, the modular base has two extra holes for this purpose.

Move the top bolt to the next hole and adjust. Tighten bolts and setscrews. Replace the belt guards. If the belt becomes frayed or cracked, replace it.

5.11.4 — Air Cleaner

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

5.11.5 — Air-Oil Tank

Check the lube oil level in the air-oil tank. Inspect oil level regularly as loss of oil will damage the compressor. Change oil every 2000 hours of operation. The air-oil tank should be drained once a year and thoroughly flushed. Remove the mist eliminator pads from the upper section of the tank, wash thoroughly in kerosene and dry. Refill with non detergent SAE30 oil to a level midway up the sight glass. For normal environment use SAE30 oil. For a 32 º F and below environment, use SAE 10 oil.

5.11.6 — Oil Level Sight Gauge

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

5.11.7 — Compressor Oil Filter (Lube Oil Strainer)

The lube oil strainer prevents foreign materials from entering the compressor. The strainer screen must be cleaned at regular intervals. The screen is easily removed for cleaning by unscrewing the bottom plug. Immerse in solvent and thoroughly clean.

5.11.8 — Nozzle Line Heater

Nozzle line heaters damaged by water accumulation do not qualify for warranty or exchange service. Failure to prevent water accumulation inside the heater manifold constitutes improper care.

Completely drain the heater manifold periodically. This should be part of the preventive maintenance program. maintenance consists primarily of removing the heating element from the manifold and scraping any accumulation of carbonized oil or sludge deposits from the heat exchange surfaces.

Before braking electrical connections to the heating elements, mark all wires and terminals to assure correct replacement of wires.

Periodic cleaning is necessary to prevent overheating or burnout of the elements. If operation of the heater becomes sluggish, examine the elements and clean as required.

Inspect the manifold each time the heater is removed. Flush all accumulated sludge and sediment before it is turned on.

5.11.9 — Oil Strainers

Oil strainers should be cleaned frequently to maintain a free and full flow of fuel. The strainer screen must be removed and cleaned at regular intervals. The screen should be removed and cleaned thoroughly by immersing it in solvent and blowing it dry with compressed air. Light oil strainers should be cleaned each month. Heavy oil strainers should be checked and cleaned as often as the experience indicates the necessity.

5.12 — Gas System

5.12.1 — Motorized Main Gas Valves

Should the valve fail to operate, check for voltage at the valve. Make certain that the main shutoff cock is closed prior to testing. The actuator is not field repairable nor should it be disassembled. Replace the actuator if the valve fails to operate. After replacement, cycle the valve with the fuel shutoff to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

⚠ Caution

All power must be disconnected before servicing the valves.

5.12.2 — Solenoid Valves

A slight hum from the solenoid is normal when the coil is energized. Should the valve fail to operate, check that there is voltage at the valve coil. If there is no voltage at the coil, check for loose wiring connections. If there is proper voltage at the valve coil and the valve still fails to open, replace the coil. Refer to the manufacturer's bulletin for correct procedure in coil replacement.

Should it become necessary to replace the complete valve, be sure that the flow is in the direction of the arrow on the body.

Test for gas leaks and check the valve action several times to ensure proper operation before attempting to relight the burner.

5.13 — Electrical System

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

5.13.1 — Electric Motors

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

5.14 — Extended Shutdown

When shutting down the burner for an extended period of time, the operator should use the following general guidelines to protect the burner from its surrounding elements. This will add to the operating life of the burner.

1. Turn the main electrical disconnect switch to the burner to OFF.
2. Close all main fuel valves.
3. If the burner operates in a damp environment, cover it with plastic to protect all electrical components from moisture. Remove the flame safeguard control and store in a dry atmosphere.

5.15 — Maintenance Flow Chart Recommended Test Schedule

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

CHAPTER 6 Troubleshooting

⚠ Warning

Troubleshooting should be performed only by personnel who are familiar with the equipment and who have read and understood the contents of this manual. Failure to follow these instructions could result in serious personal injury or death.

⚠ Warning

Disconnect and lockout the main power supply in order to avoid the hazard of electrical shock. Failure to follow these instructions could result in serious personal injury or death.

6.1 — Awareness

Chapter 6 assumes that:

- The unit in question has been properly installed and that it has been running for some time.
- The operator has become thoroughly familiar with both the burner and the manual by this time.

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

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

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

Familiarity with the programmer and other controls in the system may be obtained by studying the contents of this manual. Knowledge of the system and its controls will make troubleshooting that much easier.

Costly downtime or delays can be prevented by systematic checks of actual operation against the normal sequence to determine the stage at which performance deviates from normal. Following a set routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

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

Never attempt to circumvent any of the safety features.

⚠ Warning

The cause for loss of flame or any other unusual condition should be investigated and corrected before attempting to restart. Failure to do so may result in serious personal injury or death.

⚠ Warning

Do not repeat unsuccessful lighting attempts without rechecking the burner and pilot adjustments. Failure to do so may result in boiler damage and/or serious personal injury or death.

⚠ Warning

Do not re-light the pilot or attempt to start the main burner, either oil or gas, if the combustion chamber is hot and/or if gas or il vapor combustion gases are present in the furnace or flue passages or when excess oil has accumulated. Promptly correct any conditions causing leakage. Failure to follow these instructions could result in serious personal injury or death.

6.2 — Emergency Shutdown

1. In case of an emergency, shut down the burner by turning the “ON-OFF” switch to the “OFF” position.
2. Turn the fuel selector switch to the “OFF” position.
3. Shut off the main manual fuel shutoff valves on the fuel supply line.
4. The unit can also be shut down with the main electrical power disconnected. Inspect the burner carefully and troubleshoot before restarting the unit.

Follow instructions in Chapter 3 for starting and operating.

6.3 — Troubleshooting

Problem	Solution
Burner Does Not Start	1. No voltage at program relay power input terminals. a. Main disconnect switch open. b. Blown control circuit fuse. c. Loose or broken electrical connection.
	2. Program relay safety switch requires resetting.
	3. Limit circuit not completed - no voltage at end of limit circuit program relay terminal. a. Pressure or temperature is above setting of operation control. b. Water below required level. Low Water light (and alarm horn) should indicate this condition. Check manual reset button, if provided, on low-water control. c. fuel pressure must be within settings of low pressure and high pressure switches. d. Check burner air proving switch and high fire limit switch. e. Heavy oil fired unit - oil temperature below minimum settings.
	4. Fuel valve interlock circuit not completed. a. Fuel valve auxiliary switch not closed.

Problem	Solution
No Ignition	1. Lack of spark. a. Electrode grounded or porcelain cracked. b. Improper electrode setting. c. Loose terminal on ignition cable, cable shorted. d. Inoperative ignition transformer. e. Insufficient or no voltage at pilot ignition circuit terminal.
	2. Spark but no flame. a. Lack of fuel - no gas pressure, closed valve, empty tank, broken line, etc.
	3. Low fire switch open in low fire proving circuit. a. Damper motor not closed, slipped cam, defective switch. b. Damper jammed or linkage binding.
	4. Running interlock circuit not completed. a. Combustion or atomizing air proving switches defective or not properly set. b. Motor starter interlock contact not closed.

Problem	Solution
Pilot Flame, But No Main Flame	1. Insufficient pilot flame.
	2. Gas fired unit: a. Manual gas cock closed. b. Main gas valve inoperative. c. Gas pressure regulator inoperative.
	3. Limit circuit not completed, no voltage at end of limit circuit program relay terminal. a. Oil supply cut off by obstruction, closed valve, or loss of suction. b. Supply pump inoperative. c. No fuel. d. Main oil valve inoperative. e. Check oil nozzle, gun, and lines.
	4. Flame detector defective, sight tube obstructed, or lens dirty.
	5. Insufficient or no voltage at main fuel valve circuit terminal.

Problem	Solution
Burner Stays in Low Fire	1. Pressure or temperature above modulating control setting.
	2. Manual-automatic switch in wrong position.
	3. Inoperative modulating motor.
	4. Defective modulating control.
	5. Binding or loose linkages, cams, setscrews, etc.

Problem	Solution
Shutdown Occurs During Firing	1. Loss or stoppage of fuel supply.
	2. Defective fuel valve, loose electrical connection.
	3. Flame detector weak or defective.
	4. Scanner lens dirty or sight tube obstructed.
	5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
	6. If the programmer lockout switch has tripped: a. Check fuel lines and valves. b. Check flame detector. c. Check for open circuit in running interlock circuit. d. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.
	7. Improper air/fuel ratio (lean fire). a. Slipping linkage. b. Damper stuck open. c. Fluctuating fuel supply: Temporary obstruction in the fuel line. Temporary drop in gas pressure. Orifice gate valve accidentally opened (heavy oil).
	8. Interlock device inoperative or defective.
	9. Air in the oil lines. Bleed the lines.

Problem	Solution
Modulating Motor Does Not Operate	1. Manual/automatic switch in wrong position.
	2. Linkage loose or jammed.
	3. Motor does not drive to open or close during pre-purge or close on burner shutdown. a. Motor defective. b. Loose electrical connection. c. Damper motor transformer defective.
	4. Motor does not operate on demand. a. Manual/automatic switch in wrong position. b. Modulating control improperly set or inoperative. c. Motor defective. d. Loose electrical connection. e. Damper motor transformer defective.

CHAPTER 7 Accessories

7.1 — Overview

The D Series burners are available with a wide selection of accessories. This section will cover some of the most popular accessories.

7.2 — Steam Atomizing System

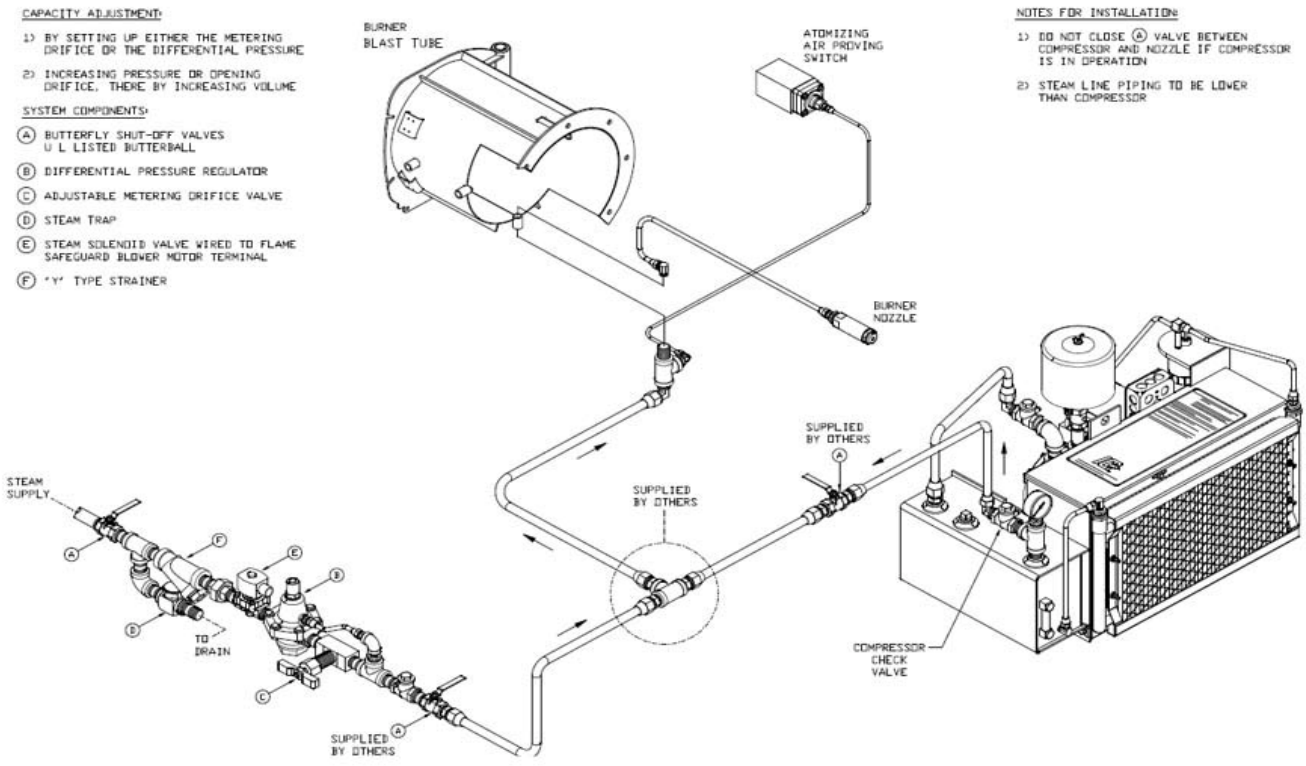
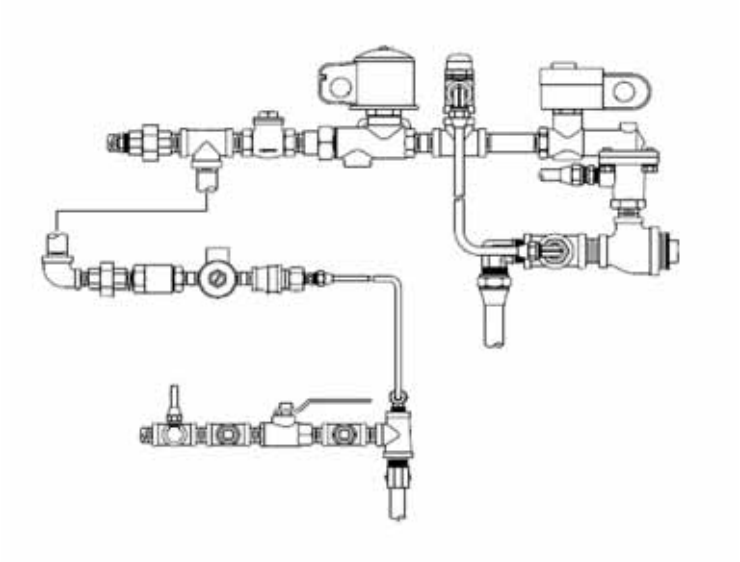


FIGURE 7-1. Steam Atomizing System

The steam atomizing line is shipped loose and must be piped and wired to the burner as shown in the diagram below. Refer to the wiring diagram for the electrical connection. The air compressor is used for cold oil startup. Start the boiler with the air atomizing system first. Once the boiler reaches operating pressure, shut down the unit, close the shut-off valve on the air line and open the one on the steam line. Set the Air / Steam switch to the Steam position. Restart the unit with the steam atomizing system. You must have a minimum of 70 PSI at the inlet of the steam regulator. Open the needle valve to its maximum. Adjust your steam pressure with the regulator to have 30 PSI on the discharge side of the regulator. While the unit is purging, screw in and adjust the needle valve to have 10-15 PSI in low fire. Install a pressure gauge to monitor the pressure. One or two regulator is supplied depending on the boiler operating steam pressure. Follow the instructions in the Chapter 4, Adjustments, to set up the burner. Fine tune the steam atomizing with the needle valve.

7.3 — Air Purge System (optional)



The nozzle line air purge option is used to purge the oil out of the nozzle line using the air compressor on a burner shutdown. The air purge line is mounted and piped on the burner. The air line from the compressor to the air purge line is by others.

FIGURE 7-2. Air Purge System

7.4 — Plant Air System

The D Series burners are able to operate with a plant air system instead of the standard IC compressor. In such cases, the burner is supplied with an atomizing air regulating line.

Adjust the air pressure with the regulator and fine tune with the needle valve to have 10-15 psi on low fire. Refer to Chapter 4 to setup the burner.

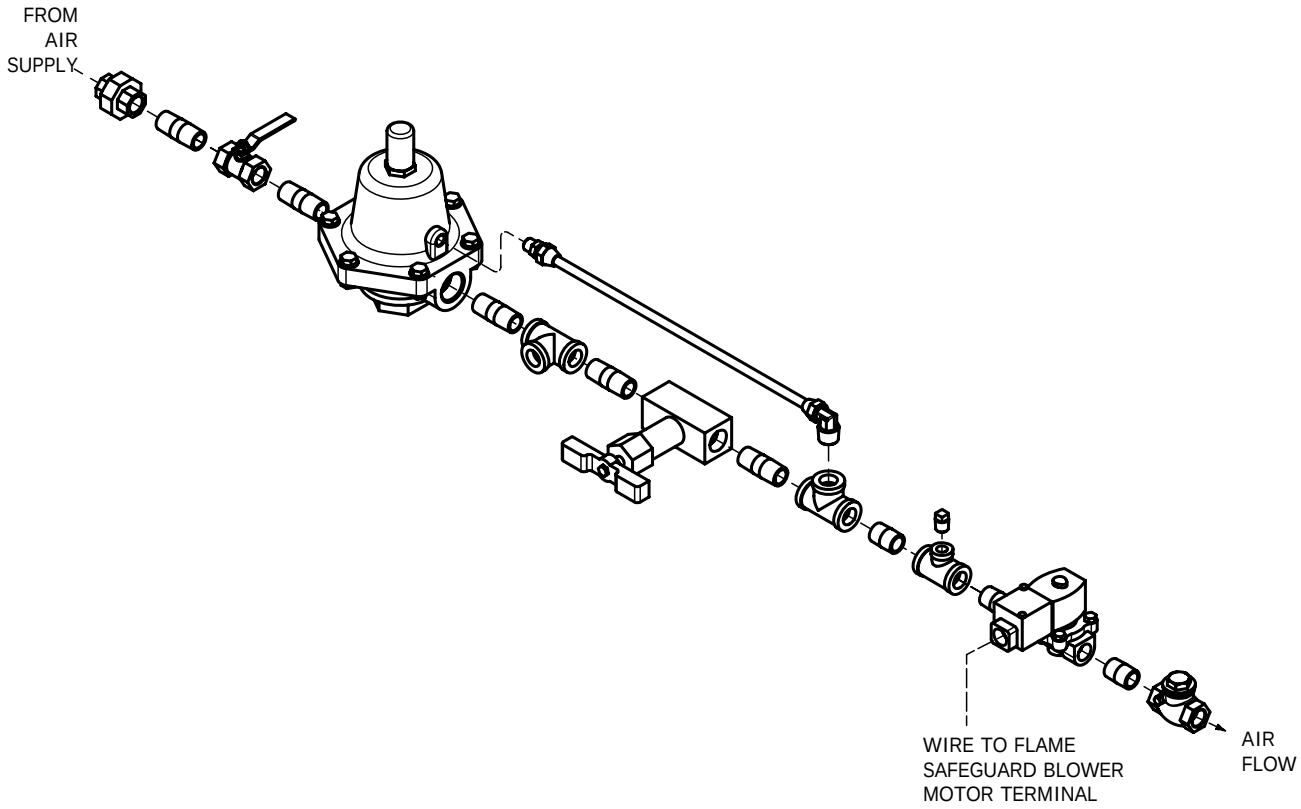
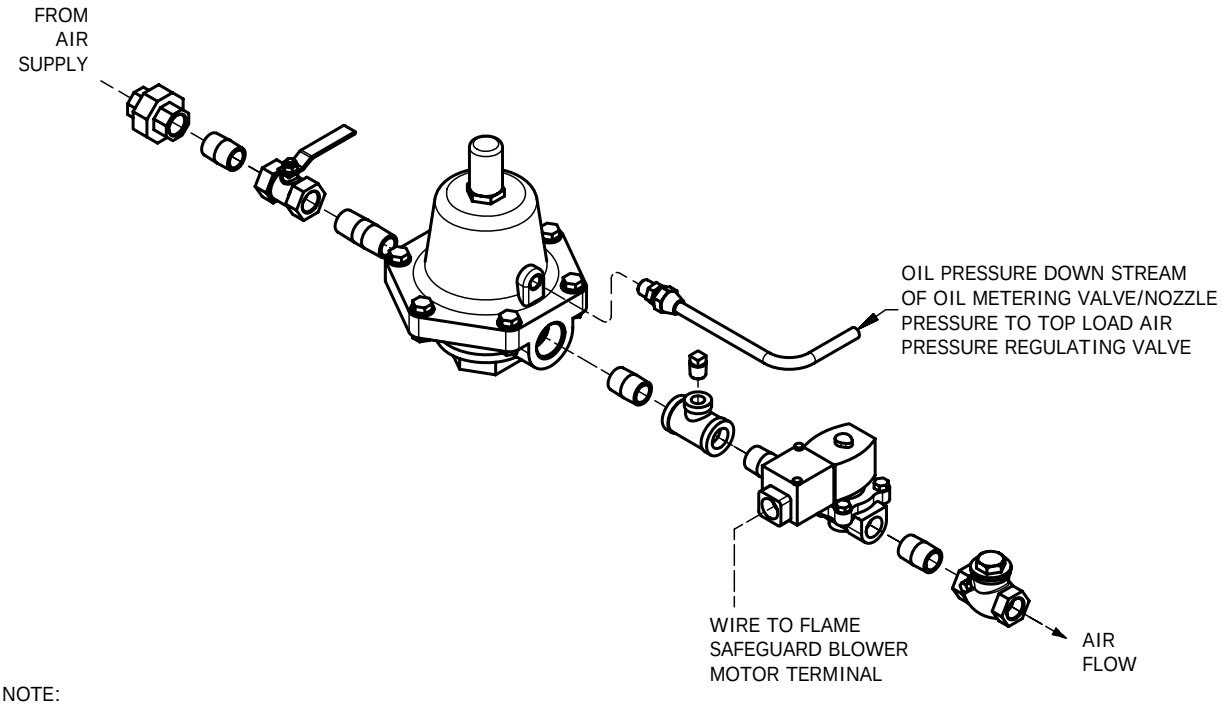


FIGURE 7-3. Plant Air System/Top Loaded with Air



NOTE:
1 - AIR PRESSURE REGULATOR SHOULD HAVE TRIM KIT
TO ALLOW OIL OVER REGULATOR

FIGURE 7-4. Plant Air System/Top Loaded with Oil

CHAPTER 8 Flue Gas Recirculation

8.1 — LN Model Designations, Sizes, and Inputs

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

Models Standard	Fuel-Air Atomization
LNDG	Gas
LNDLG	#2 Oil and Gas

Two designs of low NOx burners are available. One is for less than 30 ppm NOx @ 3% O_2 and the other for less than 20 ppm @ 3% O_2, when firing natural gas.

For example, if the model number on the nameplate is LNDLG-252P-30, it indicates a No. 2 oil and gas burner with input rated at 21,000 MBtu per hour, and NOx performance of less than 30 ppm.

LNDLG-252P-20 indicates a gas and oil burner with input rated at 16,800 MBtu per hour, and NOx performance of less than 20 ppm.

The installation of a burner shall be in accordance with the regulations of authorities having jurisdiction. The equipment must be installed in accordance with applicable local, state, or provincial installation requirements including the National Electrical Code (NEC) and Associate Insurance Underwriters.

Oil and gas burning equipment shall be connected to flues having sufficient draft at all times, to assure safe and proper operation of the burner.

Burner Size	Max. Burner Gas Input MBTU/hr.	
	<30 ppm	<20 ppm
42 P	3,360	--
54 P	4,200	3,360
63 P	5,250	4,200
84 S	6,300	5,250
84 P	7,350	6,300
105 P	8,400	7,350
145 S	10,500	8,400
145 P	12,600	10,500
175 P	14,700	12,600
210 P	16,800	14,700
252 P	21,000	16,800
300 P	25,200	21,000
315 P	29,400	N/A
336 P	31,500	N/A
378 P	33,600	N/A
420 P	37,800	N/A

Gas input based on natural gas at 1,000 But/cu. ft. and 0.60 specific gravity and 60 Hz.

Burner Size	Max. Burner Oil Input U.S.G.P.H.	
	<30 ppm	<20 ppm
42 P	24	--
54 P	30	24
63 P	38	30
84 S	45	38
84 P	53	45
105 P	60	53
145 S	75	60
145 P	90	75
175 P	105	90
210 P	120	105
252 P	150	120
300 P	180	150
315 P	215	N/A
336 P	225	N/A
378 P	240	N/A
420 P	270	N/A

Oil input based on No. 2 Oil at 140,000 Btu/gal. and 60 Hz.

8.2 — Description

NOTE: Check all burner and FGR wiring before operating the unit. Turn all power off when working with any wiring. Power must be turned off at the disconnect to the boiler. Boiler operation and FGR adjustment must be done by a qualified Industrial Combustion Service Representative.

The Industrial Combustion Flue Gas Recirculation (FGR) system is designed to reduce NOx emissions from boilers retrofitted with Industrial Combustion burners by adding a percentage of flue gas to the combustion process. A burner combustion air fan is used to pull flue gas from the stack through the FGR duct and inject it into the combustion zone.

Typical sizing for the FGR ducts are shown in Figure 8-4. All FGR duct piping should be covered with a minimum of 2" of insulation, and supported as required. The following controls are used in the FGR duct for safe operation of the system.

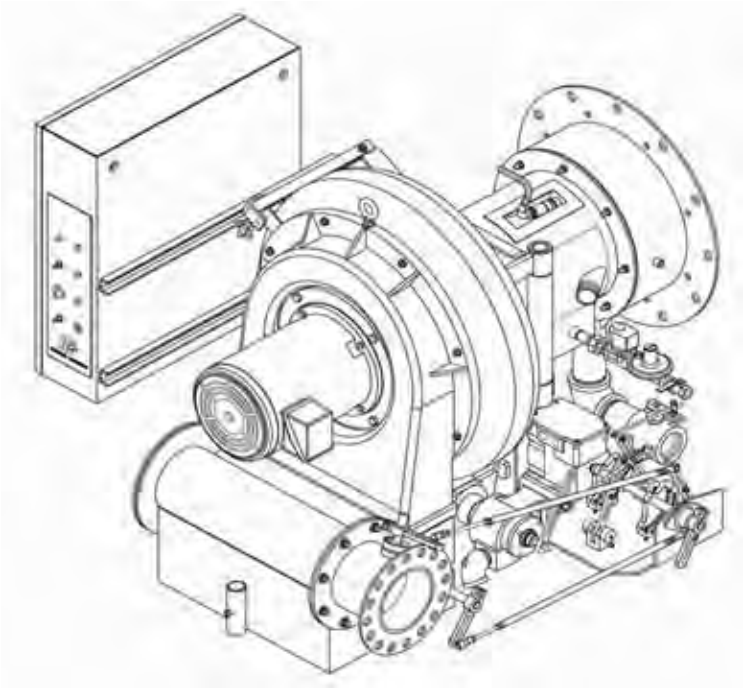
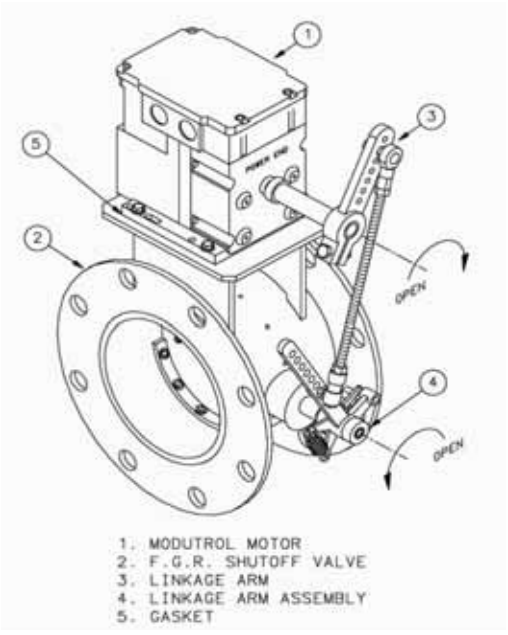


FIGURE 8-1. **General Layout of the Burner**

8.3 — FGR Shutoff Valve



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

FIGURE 8-2. **FGR Shutoff Valve**

8.4 — FGR Control Valve

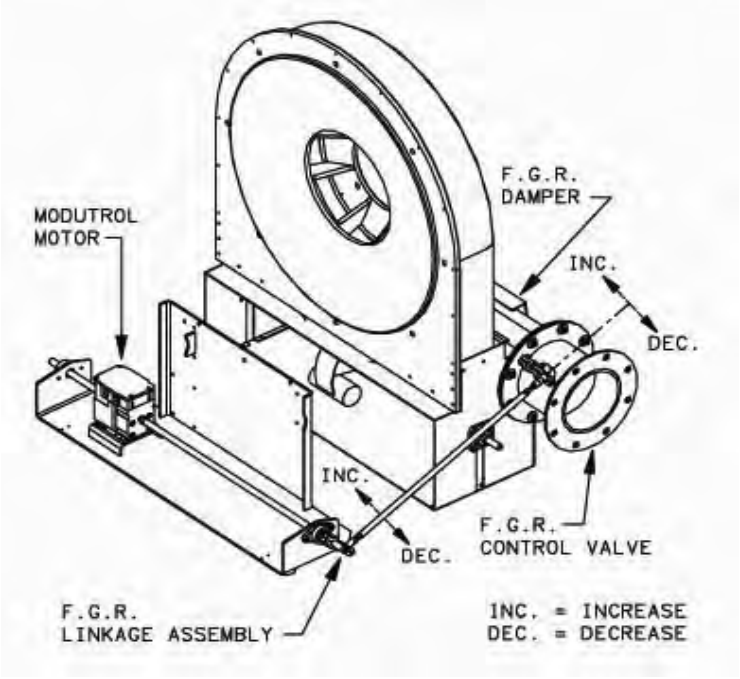


FIGURE 8-3. FGR Control Valve and Air/FGR Damper

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

⚠ Warning

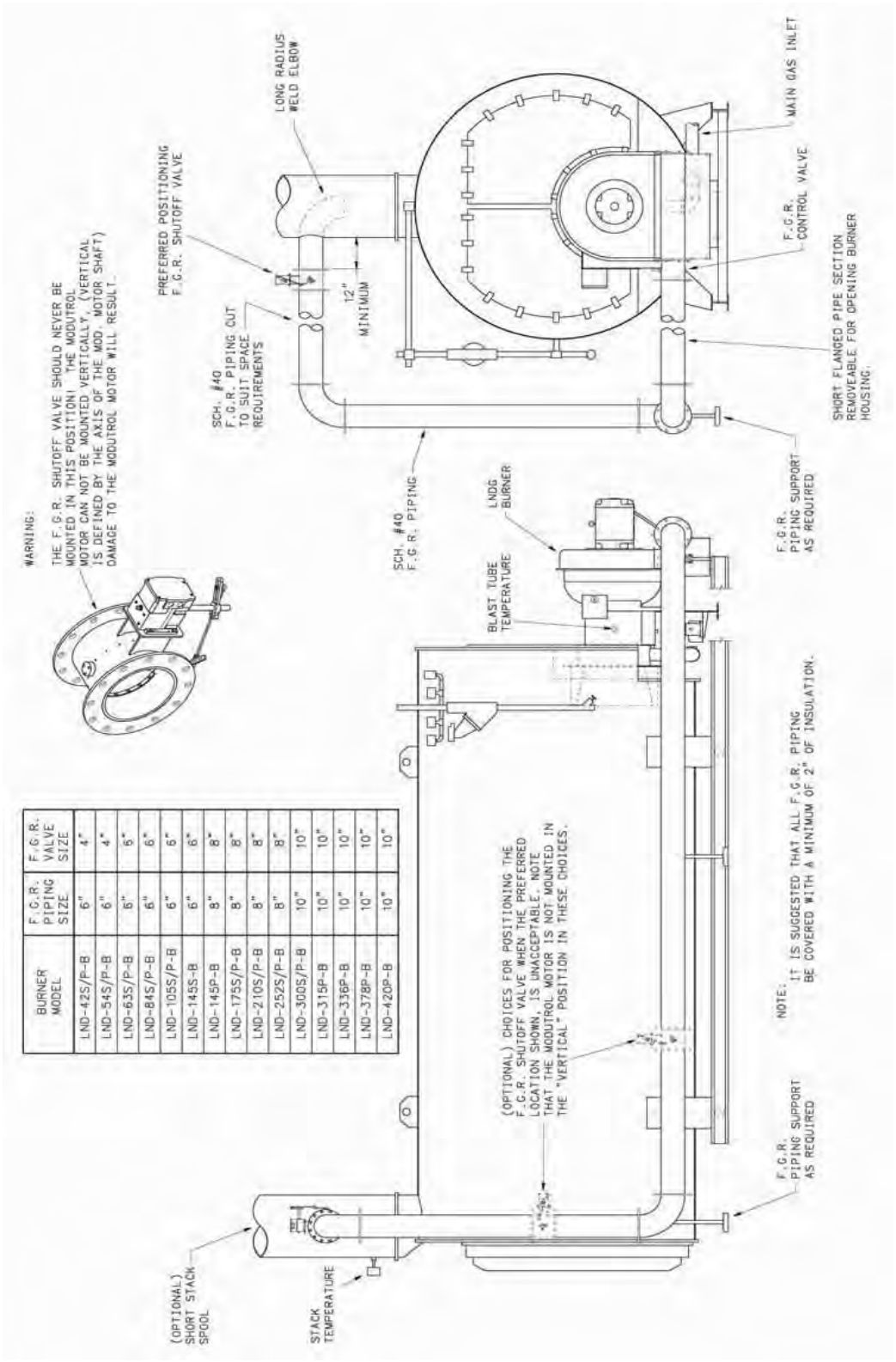
Before starting the boiler, make sure the control valve is closed. The boiler must never be operated if the control valve is open. This will result in hot combustion gases flowing backwards in the system. This will damage the system and can cause bodily harm.

8.5 — Air/FGR Damper Assembly

The air/FGR damper regulates the volume of combustion air. Position of the rotary damper blade is controlled by a modutrol motor.

The damper blade in the low fire position is normally approximately 1” open at low fire. The air/FGR damper and FGR control valve blades open as the modutrol motor drives toward the high fire position where the flue gas is pulled into the regulated combustion air flow above the damper blade as controlled by the FGR control valve. Combustion air mixed with flue gas is passed on through the blast tube to the combustion zone.

INDUSTRIAL COMBUSTION



BURNER MODEL	F.G.R. PIPING SIZE	F.G.R. VALVE SIZE
LND-42S/P-B	6"	4"
LND-54S/P-B	6"	4"
LND-63S/P-B	6"	6"
LND-84S/P-B	6"	6"
LND-105S/P-B	6"	6"
LND-145S-B	6"	6"
LND-145P-B	8"	8"
LND-175S/P-B	8"	8"
LND-210S/P-B	8"	8"
LND-252S/P-B	8"	8"
LND-300S/P-B	10"	10"
LND-315P-B	10"	10"
LND-336P-B	10"	10"
LND-378P-B	10"	10"
LND-420P-B	10"	10"

FIGURE 8-4. FGR Piping and Valve Sizes

8.6 — Blast Tube Temperature Interlock (optional)

A blast tube temperature interlock device monitors air temperature in the blast tube area of the burner. If the blast tube temperature rises above 200º F maximum. An external scanner is used on the low emission burners.

8.7 — Stack Temperature Interlock (optional)

A stack temperature interlock device monitors flue gas temperature in the stack. The stack temperature interlock is used as a low fire hold device. The stack temperature interlock is set at 25º F below the minimum stack temperature at low fire (nominal 200º F). After the stack temperature rises above the set point, the interlock stack temperature rises above the set point, the interlock closes and allows the burner to modulate.

8.8 — 20 PPM Design

The 20 ppm design features a dual gas manifold. Each zone is controlled by a butterfly valve linked to a 14 point adjustment cam. The primary large butterfly valve controls the main gas orifices and the secondary small butterfly valve controls the pre-mix gas spuds. See Figures 8-5 and 8-6.

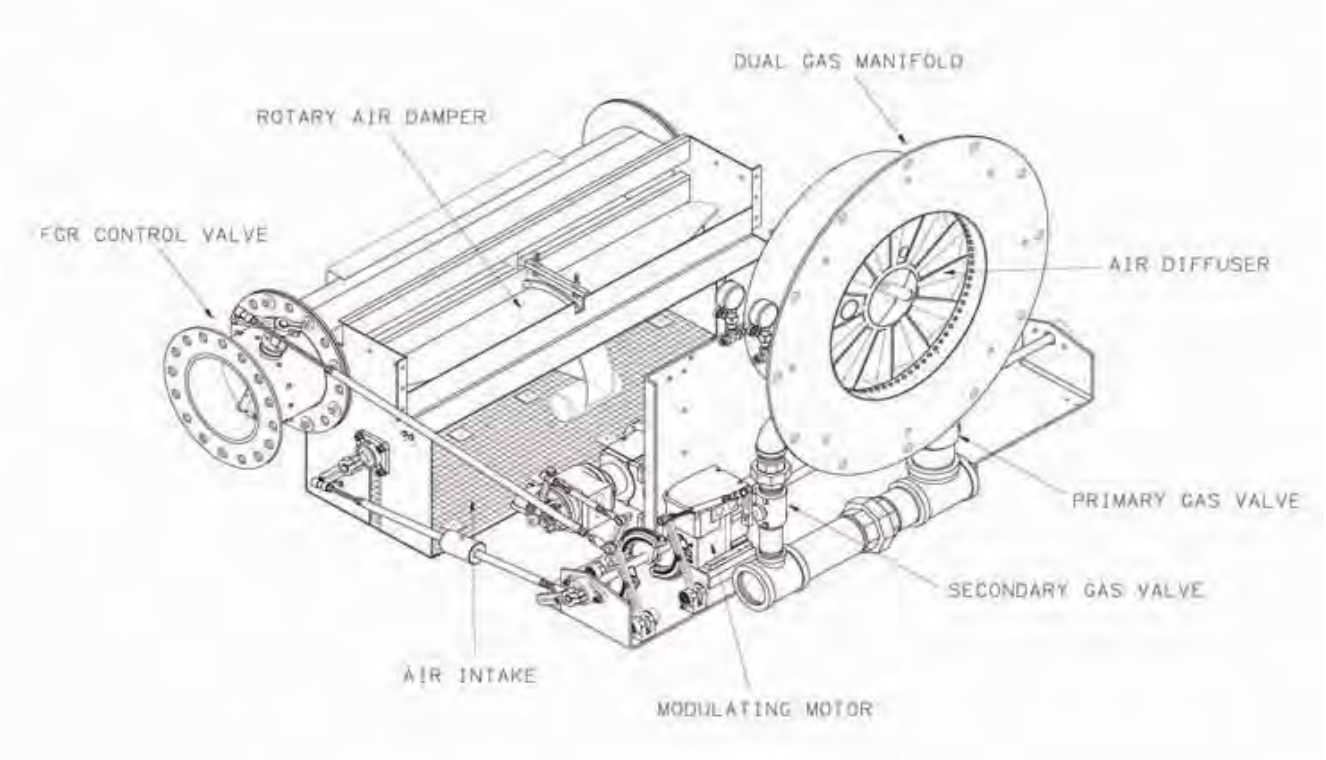


FIGURE 8-5. Secondary Gas Valve

Refer to the adjustment section to setup the burner. In the low fire position, the secondary valve controlling the pre-mix spuds is almost closed. After all adjustments are made throughout the modulating range, go back and relight the burner. Upon startup, check that the fire is not burning behind the diffuser. If this happens, close the secondary valve until this situation is corrected. Repeat several times.

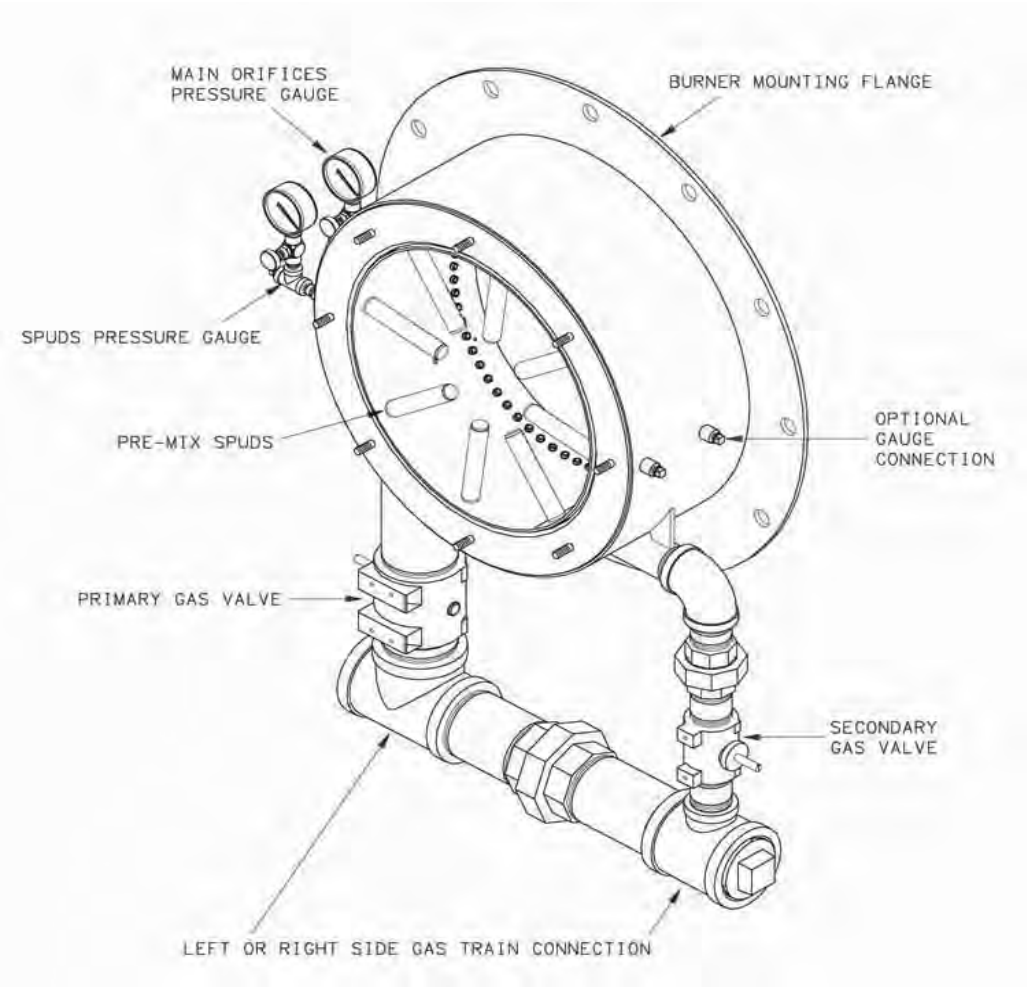


FIGURE 8-6. 20 PPM Head Assembly

CHAPTER 9 Parts Lists and Drawings

9.1 — Instructions

When ordering repair parts, please include:

- Part Number
- Burner Serial Number
- Model
- Size
- Voltage

This information can be obtained from the burner nameplate and the data label (voltage) on the panel door.

When ordering fan wheels, give the overall diameter, width, bore manufacturer, and motor HP.

This parts section does not include such common hardware items as nuts, washers, electrical parts, copper tubing, flare fittings, and pipe. Items such as these can be readily purchased locally.

The following parts are sold on an exchange basis:

- Air-Oil Metering Pumps
- Oil and Air Pumps
- Bearing Assembly
- Air Modulators
- Relief Valves

9.2 — Parts Shipping Policy

All orders for stocked items will be processed and ready for shipment within twenty-four (24) hours of its receipt.

Air shipments (U.P.S. or otherwise) will be shipped the same day if the order is received before 2:30 P.M. (weather permitting).

Ground shipments to Wisconsin and bordering states will be shipped the same day upon request.

All parts orders and exchange parts must be sent to:

Industrial Combustion
351 21st Street
Monroe, Wisconsin 53566

Plant Phone: (608) 325-3141
Fax: (608) 325-4379

Parts Direct: (608) 325-5003
Fax: (608) 329-3190

9.3 — Return Goods Procedures (Credit or Replacement Parts)

Defective Warranty parts or parts to be repaired are not to be returned to the Parts Department without calling for a Return Goods Authorization Number.

1. Before any item is returned, please call the Parts Department to obtain an RGA (Return Goods Authorization) Number. Please have the following information available when calling:
   A) Item Part Number
   B) Description of Item
   C) Reason for the return with a full description of the defect(s)
   D) Parts Order or Sales Order on which the item was purchased
   E) Name, address, and date of installation
   F) Indicate if a credit or a replacement is to be issued
2. Once an RGA number has been issued, the item may be returned. You will have thirty (30) days from the RGA date of issue to return the item. After the thirty days there will be a 10% handling charge.
3. Returned goods must have the RGA number appearing on the address label attached to the outside of the box being returned. If the RGA number is not on the label, your credit may be delayed and there will be a $50.00 service charge for paperwork. All new parts returned to the factory will be charged with a 25% restocking fee.

Please Note:

Failure to provide complete and correct information may result in delayed or credit refusal.

Return of warranty parts: Warranty parts must be returned to the factory freight prepaid within thirty (30) days after a new part has been received or there will be a 10% handling charge.

Shipping charges: On a warranty part, we will assume standard shipping charges. This does not include special handling such as air freight, U.P.S. Next Day Air Service, or U.P.S. Second Day Air Service, etc.

Motor Warranty Policy:

The following procedure must be used for proper replacement and/or repair of electric motors that have failed under warranty.

1. Remove the motor from the unit and take the motor to a Manufacturer Authorized Service Station.
2. The Service Station will determine the warranty status be installation date of the unit, and date of failure, along with the age of the motor, determined by the code date.
3. If the unit is within warranty, the unit will be inspected for cause of failure and repair requirements.
4. If the units is within warranty limitations, the service station will repair on a “No Charge” basis.
5. If the repairs are extensive, the Service Station will contact the motor manufacturer warranty manager to decide if the motor is to be repaired or replaced.

Exception to the Above Procedure:

Emergency situations may dictate that because of the distance between user and authorized Service Stations, severe damage or interruptions may result.

The following procedure should be used:

1. Select a knowledgeable motor repair shop.
2. Repair shop to contact motor manufacturer warranty repair manager, detailing repairs necessary along with the complete nameplate data before any repairs are made.
3. If any problems occur, the Industrial Combustion Parts Department will provide assistance.

Failure to Follow the Next Procedure Will Result in Repairs Being Made at the Customer’s Expense

***Marathon Electric - Electric Motors Warranty Repair Procedure**

The following procedure must be used for proper replacement and/or repair of Marathon Electric Motors that have failed under warranty.

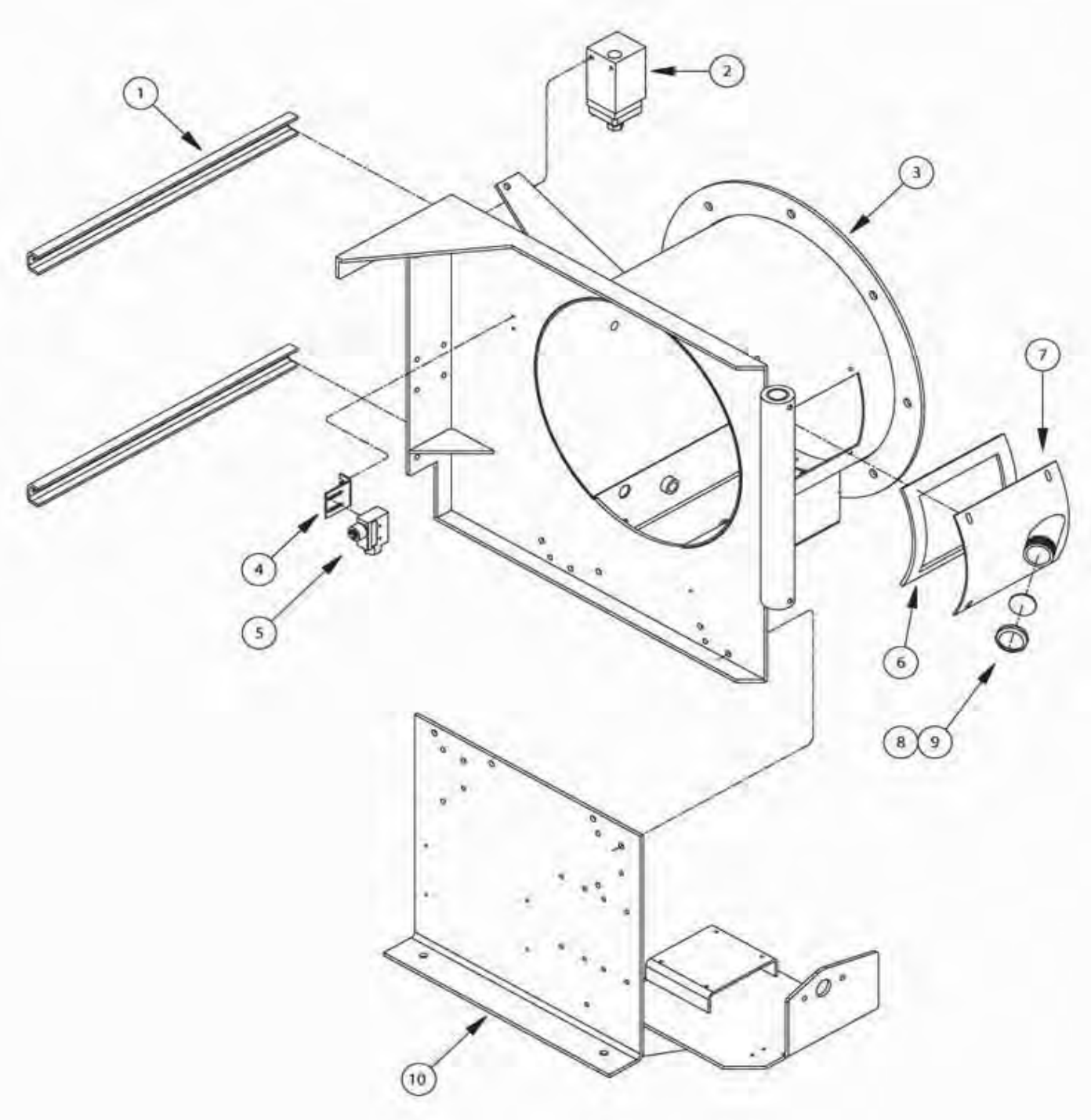
1. End user will remove motor from unit and take failed motor to Marathon Electric authorized service station.
2. Service station will determine warranty status by installation date of unit and date of failure along with age of motor determined by date code.
3. If within warranty limitations, unit will be inspected for cause of failure and repair requirements. Determination will be made that failure was caused by defect in materials or workmanship and not by misuse, abuse, accident, or other exclusions listed in our warranty.
4. If minor repair is required, service station will repair motor and return to user on a “no charge” basis.
5. If major repair (rewind) is required, service station may:
   A) Rewind motor and return to user on a “no charge” basis if user requirement is not an emergency and repair can be made within Marathon Electric price guidelines, or
   B) Nameplate will be removed and along with a report of cause of failure will be given to the user.
6. User will present nameplate and report to distributor.
7. Distributor will furnish user with a new motor, no charge, either from his inventory or secure replacement unit direct from parent organization.

*Marathon Electric
Warranty Repair Procedure, DPN-79-113
Electric Motors, 48-215 Frame

INDUSTRIAL COMBUSTION

9.4 — Parts Lists and Drawings

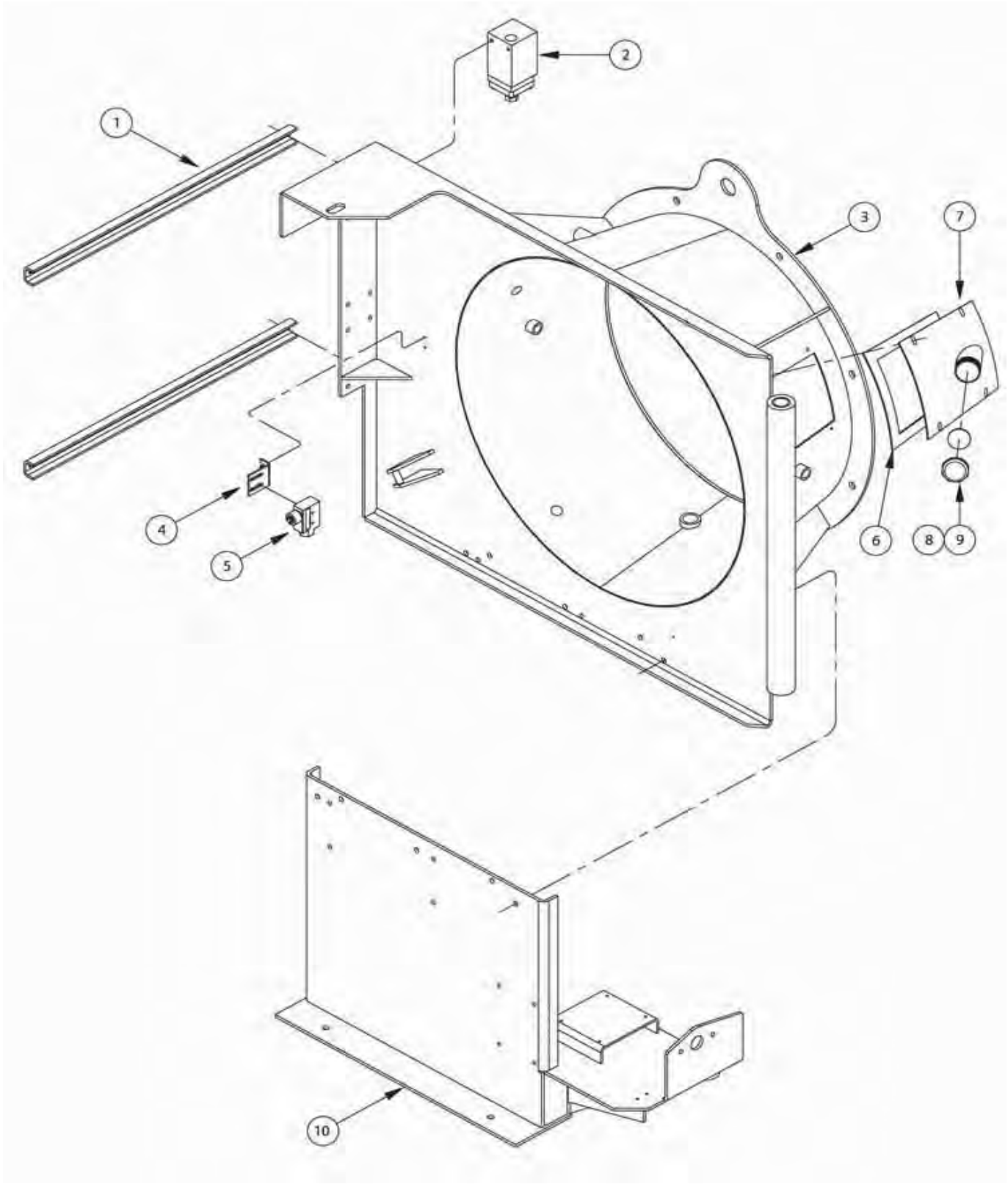
9.4.2 — Blast Tube Assembly D42 - 336



Blast Tube Assembly			Quantity										
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300	315	336
1	8-1029	Bracket, 23" Support, Standard Panel	2	2	2	2	2	2						
	8-1275	Bracket, 28" Support, Standard Panel							2	2	2	2	2	2
2	817-829	Switch, Pressure, Air Oil, 4-12 psi							*1	*1	*1	*1	*1	*1
3	40-377	Housing Assembly, Firing Head	1	1	1									
	40-378	Housing Assembly, Firing Head				1	1							
	40-400	Housing Assembly, Firing Head						1						
	40-381	Housing Assembly, Firing Head							1					
	40-382	Housing Assembly, Firing Head								1				
	40-380	Housing Assembly, Firing Head									1	1	1	
	40-410	Housing Assembly, Firing Head												1
4	8-1025	Bracket, Safety Interlock Switch	1	1	1	1	1	1	1	1	1	1	1	1
5	836-301	Switch, Safety Interlock	1	1	1	1	1	1	1	1	1	1	1	1
6	32-1127	Seal (varies)												
7	19-485	Cover, Firing Head Access	1	1	1									
	19-486	Cover, Firing Head Access				1	1							
	19-487	Cover, Firing Head Access						1						
	19-489	Cover, Firing Head Access							1	1				
	19-488	Cover, Firing Head Access									1	1	1	1
8	31-36	Glass, Flame Sight	1	1	1	1	1	1	1	1	1	1	1	1
9	869-184	Nut, Sight Glass	1	1	1	1	1	1	1	1	1	1	1	1
10	85-885	Support Assembly, Burner	1	1	1	1	1							
	85-886	Support Assembly, Burner						1	1					
	85-887	Support Assembly, Burner								1	1	1	1	1
		*DLG												

INDUSTRIAL COMBUSTION

9.4.2 — Blast Tube Assembly D378 - 420



Blast Tube Assembly			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	8-1275	Bracket, 28” Support, Standard Panel	2	2	2	2
2	817	Switch, Pressure Air-Oil, 4-12 psi	*1	*1	*1	*1
3	40-380	Housing Assembly, Firing Head	1			
	40-410	Housing Assembly, Firing Head		1		
	40-402	Housing Assembly, Firing Head			1	1
4	8-1018	Bracket	1	1	1	1
5	836-301	Switch, Safety Interlock	1	1	1	1
6	32-1127	Seal (varies)	1	1	1	1
7	19-488	Cover, Firing Head Access	1	1		
	19-529	Cover, Firing Head Access			1	1
8	31-36	Glass, Flame Sight	1	1	1	1
9	869-184	Nut, Sight Glass	1	1	1	1
10	85-187	Support Assembly, Burner	1	1	1	1

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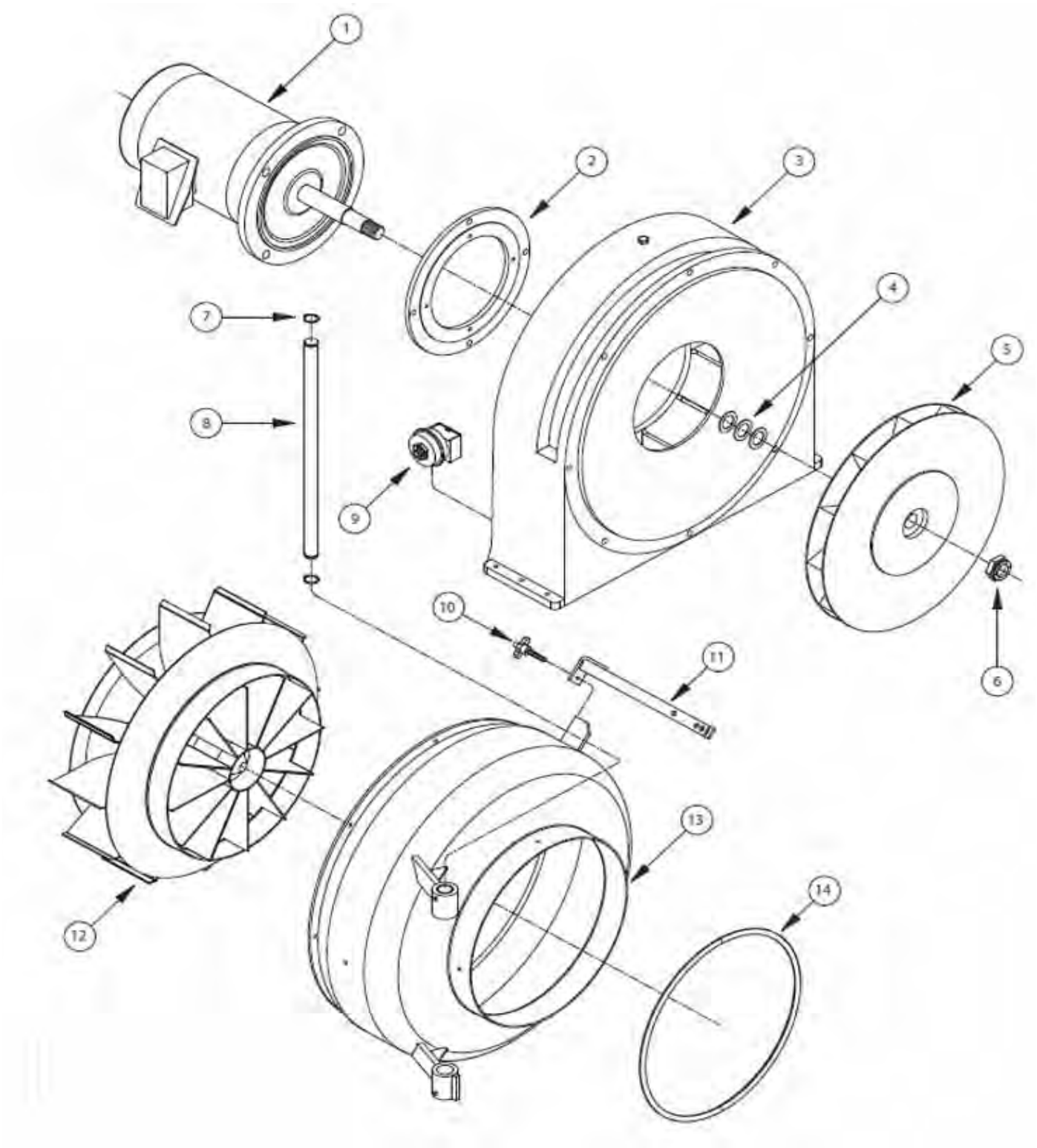
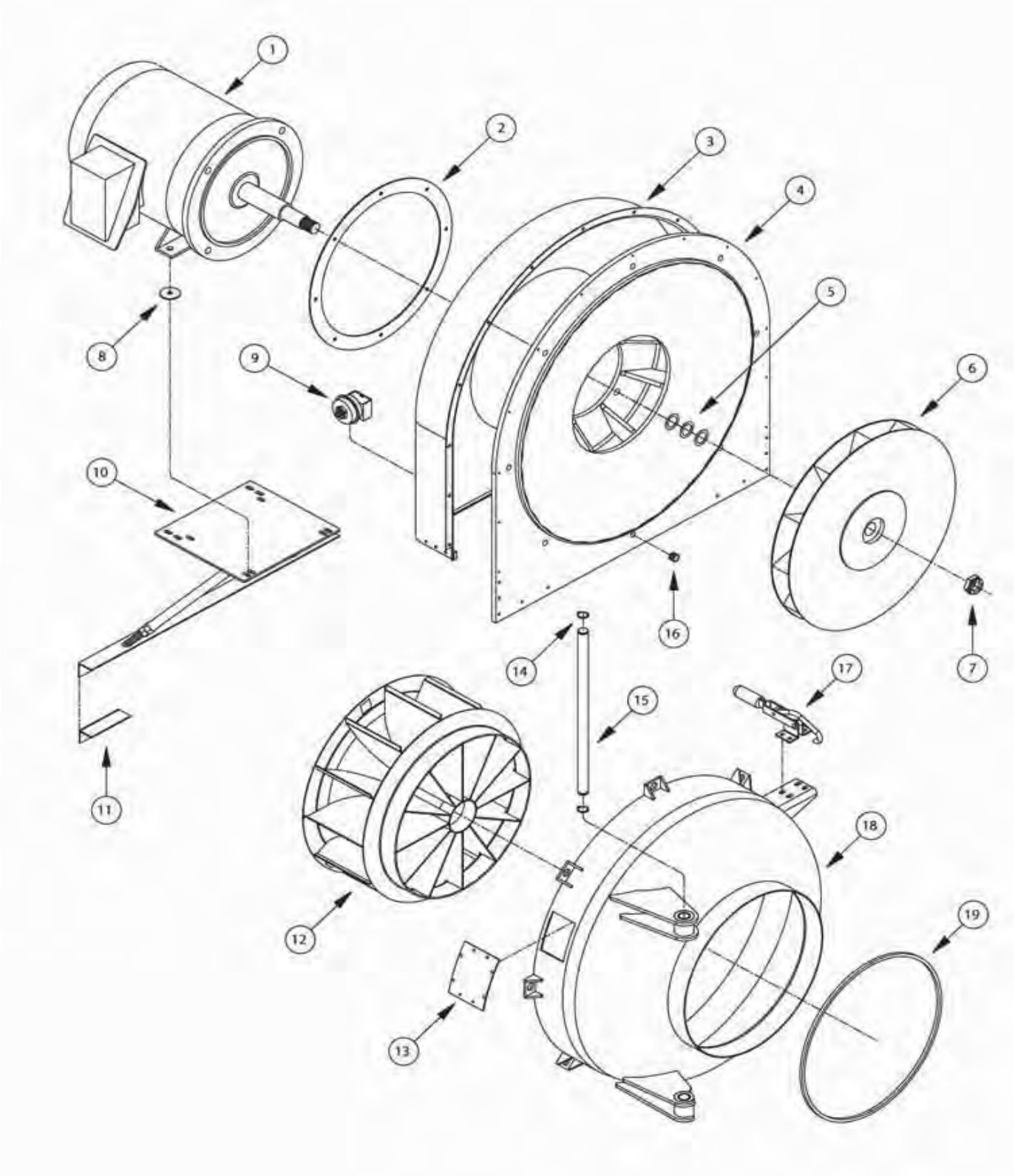
9.4.3 — Blower Housing Assembly D42 - 175



Blower Housing Assemblies			Quantity						
Item No.	Part No.	Description	42	54	63	84	105	145	175
1	894-1200	Motor, 3 HP	S&P	S					
	894-1237	Motor, 5 HP		*P	S&P	S			
	894-1240	Motor, 7.5 HP				P	S		
	894-1209	Motor, 10 HP					P		
	894-1245	Motor, 15 HP						S&P	
	894-1247	Motor, 20 HP							S&P
2	29-834	Flange, Motor Mounting	1	1	1				
	29-815	Flange, Motor Mounting				1	1		
3	85-807	Support, Motor & Air Damper	1	1	1	1	1		
	85-815	Support, Motor & Air Damper						1	1
4	91-	Spacer (varies)							
5	192-302	Impeller Assembly, 13-1/2" O.D. X 1-7/32" Wide X 1-1/4" Shaft	**S	**S					
	192-301	Impeller Assembly, 15" O.D. X 1-1/32" Wide X 1-1/4" Shaft		**P					
	192-300	Impeller Assembly, 16" O.D. X 1-21/32" Wide X 1-1/4" Shaft		S					
	192-305	Impeller Assembly, 16" O.D. X 1-1/32" Wide X 1-1/4" Shaft			S&P	S			
	192-314	Impeller Assembly, 18" O.D. X 11/16" Wide X 1-1/4" Shaft	P						
	192-313	Impeller Assembly, 19-1/8" O.D. X 1-1/32" Wide X 1-1/4" Shaft			P	**P			
	192-304	Impeller Assembly, 19-1/4" O.D. X 1-7/32" Wide X 1-3/4" Shaft					P	S	
	192-310	Impeller Assembly, 20" O.D. X 1-19/32" Wide X 1-3/8" Shaft						S	
	192-303	Impeller Assembly, 21" O.D. X 1-3/32" Wide X 1-3/8" Shaft					P		
	192-309	Impeller Assembly, 21" O.D. X 1-1/2" Wide X 1-3/8" Shaft						P	
	192-312	Impeller Assembly, 21" O.D. X 2-1/32" Wide X 1-3/8" Shaft							S
	192-311	Impeller Assembly, 23" O.D. X 1-13/16" Wide X 1-3/8" Shaft							P
6	869-119	Nut, Hex Lock 1" 14 UNF	1	1	1	1	1		
	869-145	Nut, Hex Lock 1-1/4" 12 UNF						1	1
7	914-205	Ring, Retaining Ext. Snap	2	2	2	2	2	2	2
8	56-272	Pin, Hinge	1	1	1	1	1		
	56-275	Pin, Hinge						1	1
9	836-366	Switch, Air Pressure	1	1	1	1	1	1	1
10	865-28	Knob, Blower Housing Latch	1	1	1	1	1	1	1
11	43-10	Latch Assembly	1	1	1	1	1	1	1
12	265-21	Cone Assembly, Stator	1	1	1				
	265-24	Cone Assembly, Stator				1	1		
	265-22	Cone Assembly, Stator						1	
	265-27	Cone Assembly, Stator							1
13	40-246	Housing Assembly, Fan	1	1	1				
	40-250	Housing Assembly, Fan				1	1		
	40-247	Housing Assembly, Fan						1	
	40-268	Housing Assembly, Fan							1
14	32-1060	Gasket, Fan Housing Seal	1	1	1	1	1	1	1
		*DE DEG 3 HP							
		** DE DEG 42,54 & 63							

INDUSTRIAL COMBUSTION

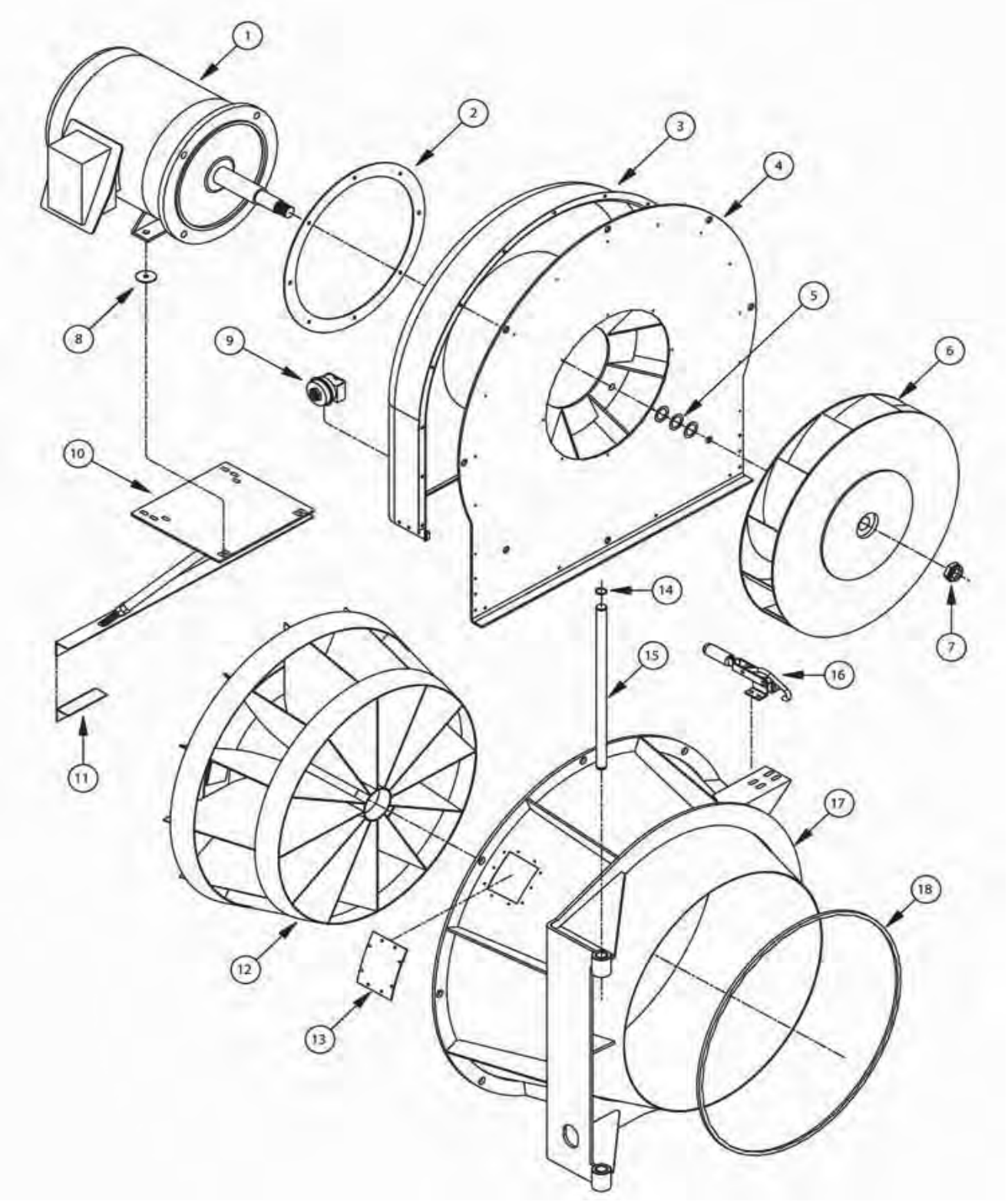
9.4.4 — Blower Housing Assembly D210 - 336



Blower Housing Assemblies			Quantity				
Item No.	Part No.	Description	210	252	300	315	336
1	894-1249	Motor, 20 HP	S				
	894-1251	Motor, 25 HP	P	S			
	894-1255	Motor, 40 HP			p	S&P	
	894-1351	Motor, 60 HP				1	1
2	515-16	Seal	1	1	1		
3	39-452	Shroud Assembly, Air Hood	1	1	1	1	1
4	85-812	Support, Motor and Air Damper	S	S			
	85-813	Support, Motor and Air Damper		P	1	1	1
5	91-	Spacer (varies)					
6	192-308	Impeller Assembly 21-1/2” O.D. X 2-1/2” Wide X 1-5/8” Shaft	S				
	192-299	Impeller Assembly 23” O.D. X 2-11/32” Wide X 1-5/8” Shaft	P	S			
	192-307	Impeller Assembly 23-1/2” O.D. X 2-9/32” Wide X 1-5/8” Shaft		P			
	192-321	Impeller Assembly 25-1/2” O.D. X 2-5/8” Wide X 1-5/8” Shaft			S&P		
	192-306	Impeller Assembly 25-1/2” O.D. X 3-9/32” Wide X 1-5/8” Shaft				1	1
7	869-185	Nut, Hex Lock 1-3/8” 12 UNF	1	1	1	1	1
8	152-17	Pad, Blower Motor MTG. 2-1/4” O.D. X 1/2” I.D. X 1/8” THK.			4	4	4
9	836-366	Switch, Air Pressure	1	1	1	1	1
10	85-878	Support Assembly, Damper to Motor		P	S&P	1	1
11	152-18	Pad, Motor Support 1-3/4” Wide X 6” LG. X 1/8” THK.		*4	4	4	4
12	265-26	Cone Assembly, Stator	1				
	265-25	Cone Assembly, Stator		1	1	1	
	265-135	Cone Assembly, Stator					1
13	19-520	Cover, Access, Fan Housing				1	1
14	914-205	Ring, Retaining Ext. Snap	2	2	2	2	2
15	56-276	Pin, Hinge	1				
	52-278	Pin, Hinge		1	1	1	1
16	835-001	Insert, Coil	8	8	8	8	8
17	43-13	Latch, Toggle Clamp	2	2	2	2	2
18	40-257	Housing Assembly, Fan	1				
	40-264	Housing Assembly, Fan		1	1		
	40-383	Housing Assembly, Fan				1	
	40-144	Housing Assembly, Fan					1
19	32-1060	Gasket, Fan Housing Seal	1	1	1	1	1
		*252P					

INDUSTRIAL COMBUSTION

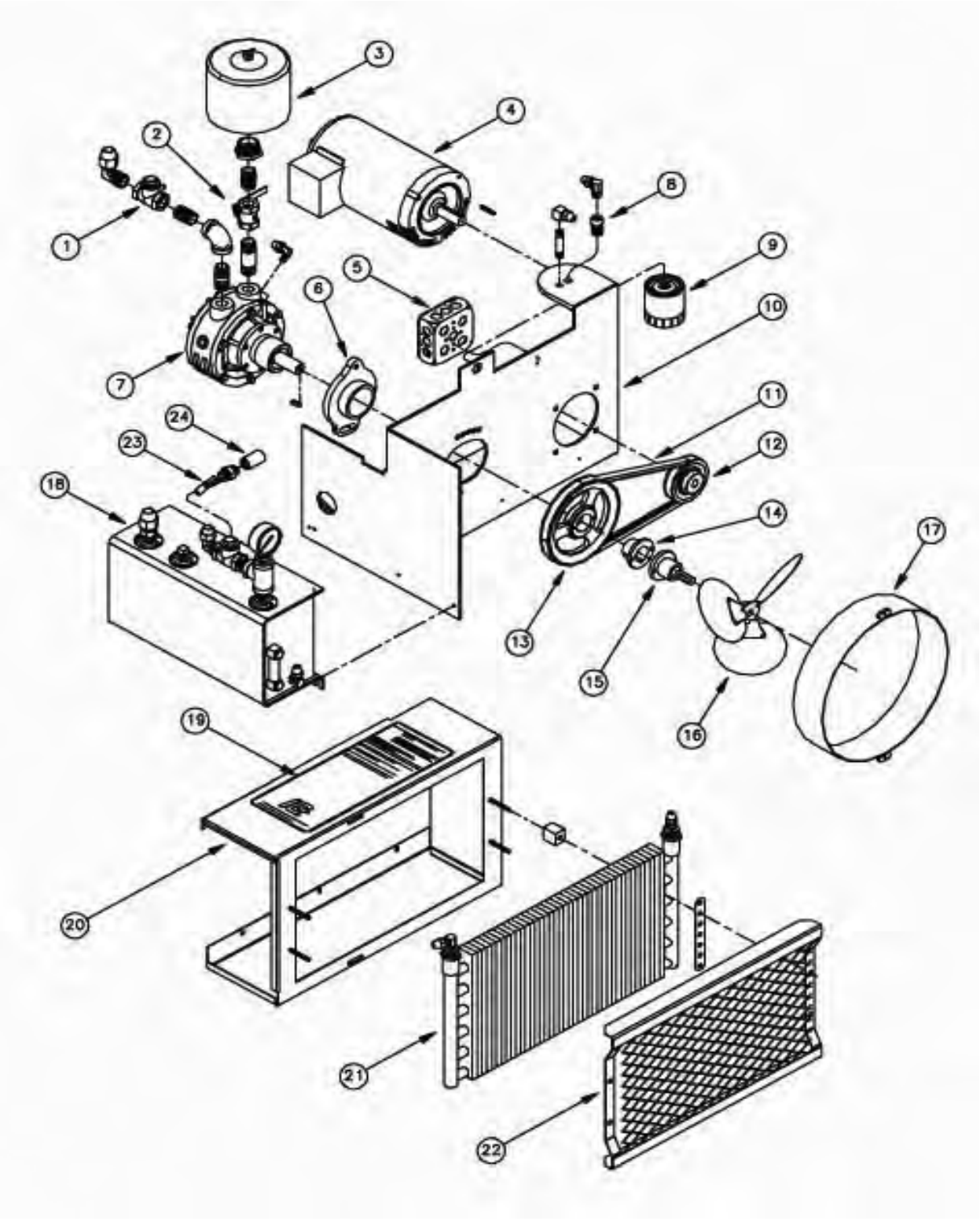
9.4.5 — Blower Housing Assembly D378 - 420



Blower Housing Assemblies			Quantity	
Item No.	Part No.	Description	378	420
1	894-1368	Blower Motor	1	1
2	515-16	Seal Plate	1	1
3	85-813	Shroud Assembly, Air Hood	1	1
4	85-891	Support, Motor and Air Damper	1	1
5	91-	Spacer (varies)	1	1
6	192-327	Impeller Assembly	1	1
7	869-185	Nut, Hex Lock 1-3/8" 12 UNF	1	1
8	152-17	Pad, Blower Motor Mounting	1	1
9	836-336	Switch, Air Pressure	1	1
10	85-892	Support Assembly, Damper to Motor	1	1
11	152-18	Pad, Motor Support	1	1
12	265-142	Stator Cone Assembly	1	1
13	19-530	Access Cover	1	1
14	914-205	External Retaining Snap Ring	1	1
15	56-290	Hinge Pin	1	1
16	43-13	Latch Toggle Clamp	2	2
17	40-403	Fan Housing Assembly	1	1
18	32-1060	Gasket, Fan Housing Seal	1	1

INDUSTRIAL COMBUSTION

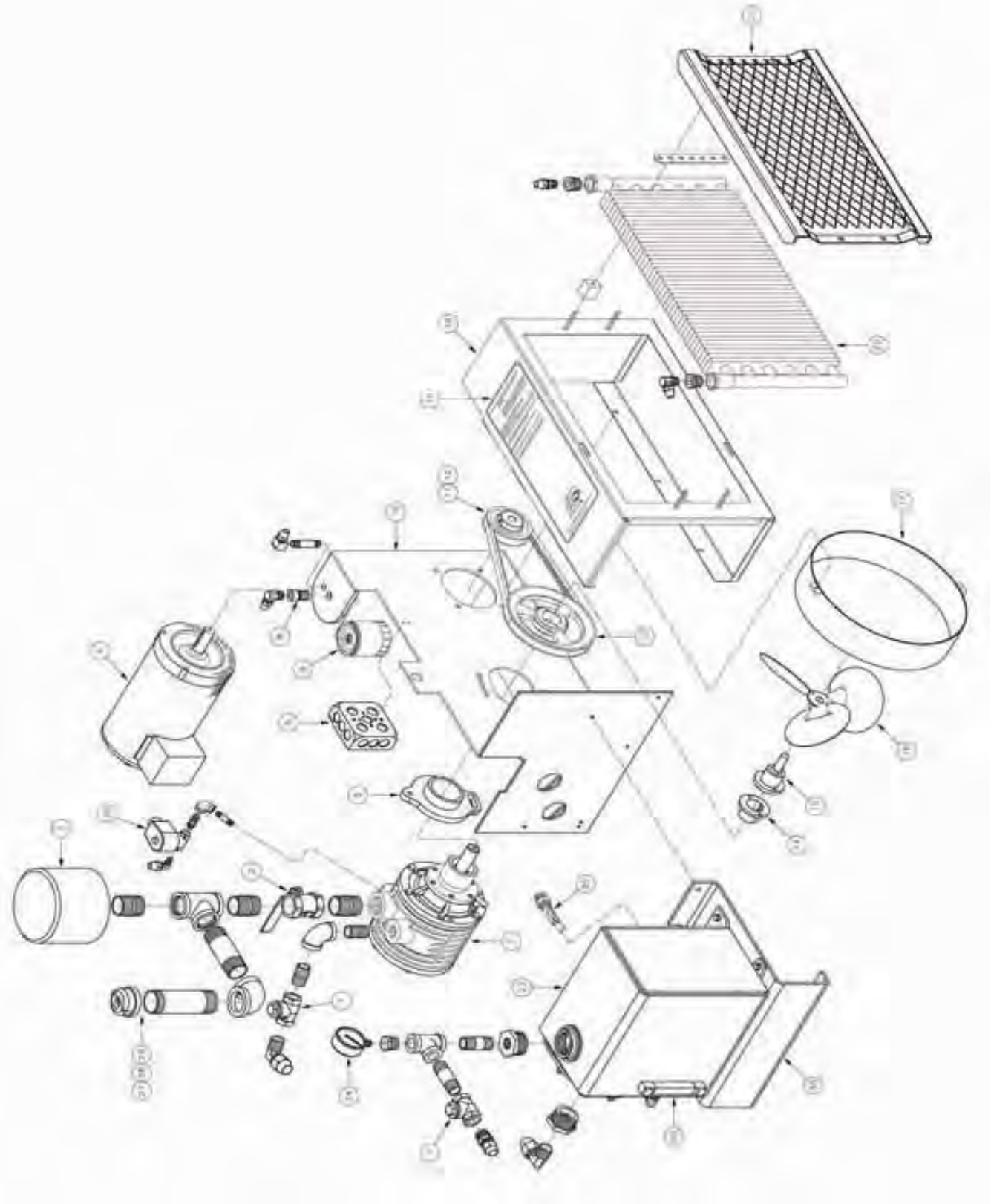
9.4.6 — Compressor Set D42 - 145



Separate Compressor Modules			Quantity					
Item No.	Part No.	Description	42	54	63	84	105	145
1	940-1205	Valve, Check 3/4" Horizontal	1	1	1	1	1	1
2	941-562	Valve, Shutoff 3/4" NPT (Butterball)	1	1	1	1		
	941-584	Valve, Shutoff 1-1/4" NPT (Butterball)					1	1
3	923-112	Filter, Air	1	1	1	1	1	1
4	894-1291	Motor, 3 HP	1	1	1	1	1	
	894-1302	Motor, 5 HP						1
5	848-499	Box, Electrical W/Cover	1	1	1	1	1	1
6	29-841	Flange, Compressor Mounting	1	1	1	1	1	1
7	505-169	Compressor Assembly, Air 2" Single Shaft	1	1	1	1		
	505-152	Compressor Assembly, Air 2-3/4" Single Shaft					1	1
8	10-315	Bushing, Oil Filter	1	1	1	1	1	1
9	843-106	Filter, Oil	1	1	1	1	1	1
10	3-361	Base Assembly, Compressor Set	1	1	1	1	1	1
11	809-220	Belt, "V"	1	1	1	1	1	1
12	921-526	Sheave, 3.45" P.D. X 5/8" Bore 1B Groove	1	1	1	1		
	921-525	Sheave, 2.9" P.D. X 7/8" Bore 1B Groove					1	
13	921-527	Sheave, 3.15" P.D. X 7/8" Bore 1B Groove						1
14	810-70	Bushing, Split Taper 1" Bore X 1-9/16" Dia.	1	1	1	1	1	1
15	74-516	Shaft, Cooling Fan, Mounting	1	1	1	1	1	1
16	951-174	Fan, 3 Blade 12" Dia. 5/8" Bore	1	1	1	1	1	1
17	39-446	Shroud, Assembly, Cooling Fan	1	1	1	1	1	1
18	195-256	Tank Assembly, Oil/Air 350 Cu. In.	1	1	1	1	1	1
19	118-747	Nameplate	1	1	1	1	1	1
20	39-443	Shroud Assembly, Fan Enclosure	1	1	1	1	1	1
21	17-193	Coil, Lube Oil Cooling	1	1	1	1	1	1
22	35-413	Guard Assembly, Radiator	1	1	1	1	1	1
23	832-925	Sensor, Oil, Low Lube (optional)	1	1	1	1	1	1

INDUSTRIAL COMBUSTION

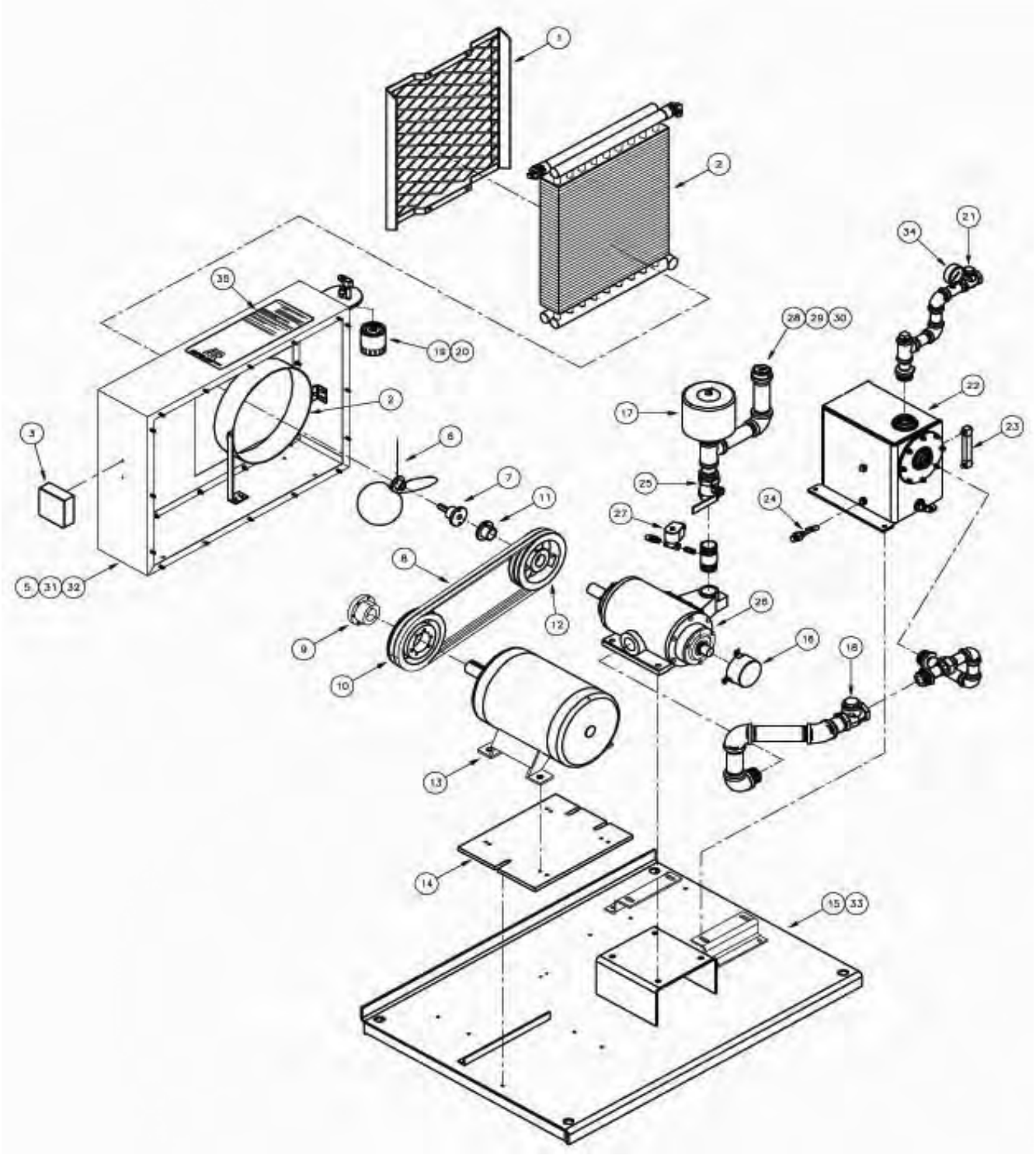
9.4.7 — Compressor Set D175 - 336



Separate Compressor Modules			Quantity					
Item No.	Part No.	Description	175	210	252	300	315	336
1	940-1205	Valve, Check 3/4" Horizontal	2	2	2	2	2	2
2	941-584	Valve, Shutoff 1-1/4" NPT (Butterball)	1	1	1	1	1	1
3	923-112	Filter, Air	1	1	1	1	1	1
4	894-1302	Motor, 5 HP					1	1
	894-1309	Motor, 7.5 HP	1	1	1	1		
5	848-499	Box, Electrical W/Cover 4" X 4"	1	1	1	1	1	1
6	29-841	Flange, Compressor Mounting	1	1	1	1	1	1
7	505-153	Compressor Assembly, Air 5" Single Shaft	1	1	1	1	1	1
8	10-315	Bushing, Oil Filter	1	1	1	1	1	1
9	843-106	Filter, Oil	1	1	1	1	1	1
10	3-361	Base, Assembly, Compressor Set	1	1	1	1	1	1
11	809-220	Belt, "V" B X 38	1	1	1	1	1	1
12	921-527	Sheave, 3.5" P.D. X 7/8" Bore 1B Groove	1	1				
	921-528	Sheave, 3.85" P.D. X 7/8" Bore 1B Groove	1	1	1	1		
13	921-524	Sheave, 7.1" P.D. X 1-9/16" Dia.	1	1	1	1		
14	810-70	Bushing, Split Taper 1" Bore X 1-9/16" Dia.	1	1	1	1		
15	74-516	Shaft, Cooling Fan, Mounting	1	1	1	1	1	1
16	951-174	Fan, 3 Wing 12" Dia.	1	1	1	1	1	1
17	39-446	Shroud, Assembly, Cooling Fan	1	1	1	1	1	1
18	118-749	Nameplate	1	1	1	1	1	1
19	39-446	Shroud Assembly, Fan Enclosure	1	1	1	1		
20	17-193	Coil, Lube Oil Cooling	1	1	1	1		
21	35-413	Guard Assembly, Radiator	1	1	1	1		
22	851-180	Glass, Sight, Oil Level 6" Centres	1	1	1	1		
23	195-261	Tank Assembly, Oil/Air 1175 Cu. In.	1	1	1	1	1	1
24	850-3	Gauge, Pressure 0-60 PSI, 2.5" Dial 1/4 NPT	1	1	1	1	1	1
25	832-925	Sensor, Oil, Low Lube (optional)	1	1	1	1	1	1
26	940-659	1/4" Oil Valves, 2-Way N.C.	1	1	1	1	1	1
27	900-676	Filter Compressor Pipe	1	1	1	1	1	1
28	171-104	Filter Basket	1	1	1	1	1	1
29	13-251	1-1/2" NPT Pipe Cap	1	1	1	1	1	1
30	59-1473	Plate, Tank Mounting	1	1	1	1	1	1

INDUSTRIAL COMBUSTION

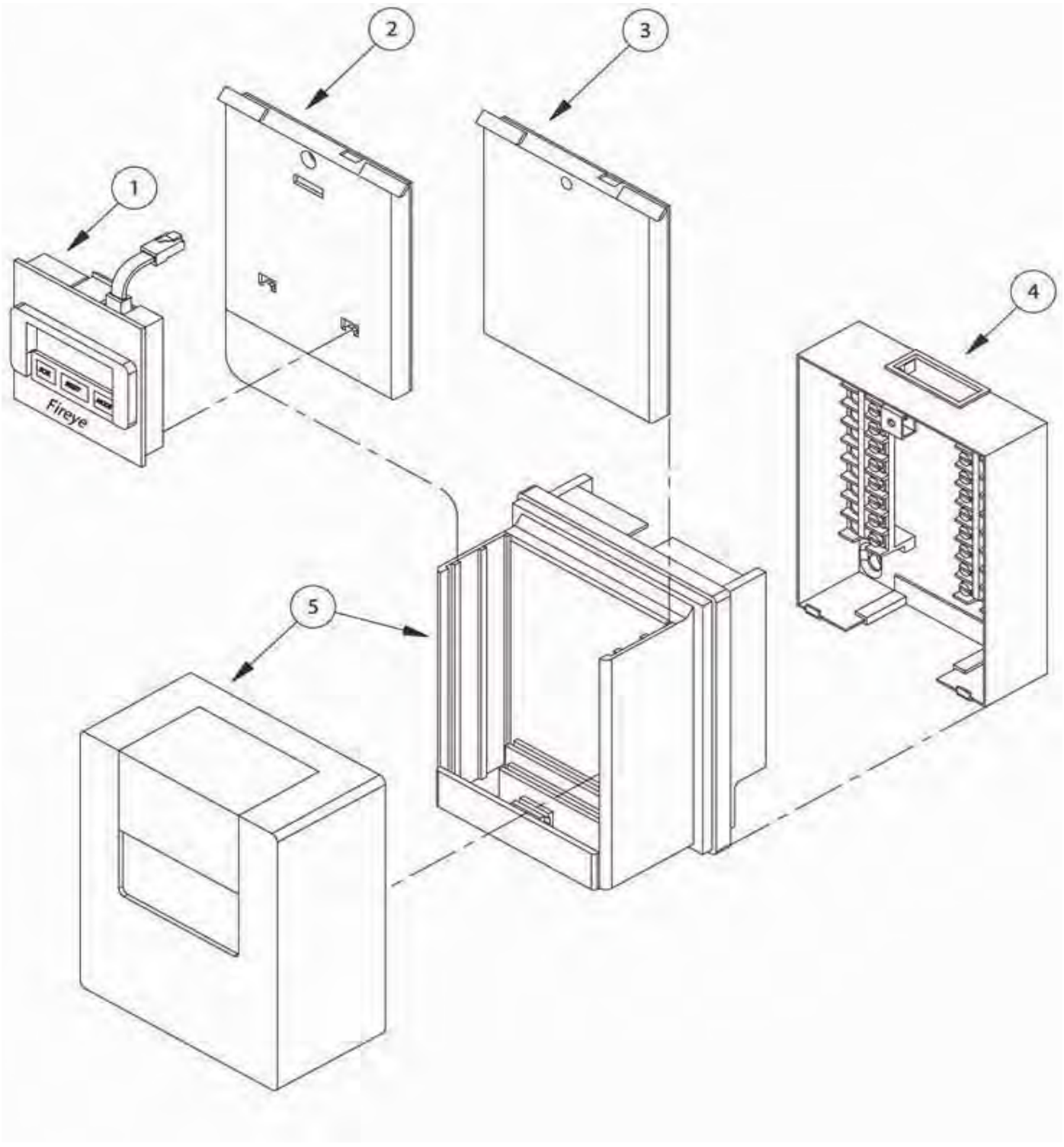
9.4.8 — Compressor Set D378 - 420



Compressor Set Assemblies			Quantity	
Item No.	Part No.	Description	378	420
1	35-440	Radiator Guard Assembly	1	1
2	17-234	Radiator Assembly	1	1
3	848-514	Electrical Junction Box	1	1
4	39-446	Air Flow Duct Assembly	1	1
5	35-439	Belt Guard Weldment	1	1
6	951-174	Fan Blade	1	1
7	74-516	Fan Mounting Shaft	1	1
8	809-223	V-Belt	1	1
9	810-73	Bushing	1	1
10	921-538	Sheave	1	1
11	810-72	Bushing	1	1
12	921-537	Sheave	1	1
13	894-1380	Motor, 15 HP, 3 PH 208 Volt	1	1
	894-1381	Motor, 15 HP, 3 PH 230/460 Volt	1	1
14	59-1284	Motor Mounting Base	1	1
15	3-377	Compressor Base	1	1
16	35-438	Compressor Shaft End Guard	1	1
17	923-112	Air Filter	1	1
18	940-1281	1-1/2” NPT Horizontal Check Valve	1	1
19	843-106	Oil Filter	1	1
20	10-315	Oil Filter Mounting Bushing	1	1
21	940-1279	1” NPT Horizontal Check Valve	1	1
22	195-261	Oil/Air Tank Assembly	1	1
23	851-180	Sight Gauge	1	1
24	832-925	Low Lube Oil Sensor (optional)	1	1
25	941-127	1-1/2” NPT Shutoff Valve	1	1
26	505-322	Air Compressor	1	1
27	940-654	1/4” Oil Valve, 2-Way N.C.	1	1
28	900-676	Filter Compressor Pipe	1	1
29	171-104	Filter Basket	1	1
30	13-251	1-1/2” NPT Pipe Cap	1	1
31	19-532	Cover, Belt Guard	1	1
32	19-533	Cover, Belt Guard	1	1
33	8-1903	Bracket, Tank Mounting	2	2
34	850-3	Gauge, Pressure 0-60 PSI 2.5” Dial 1/4 NPT	1	1
35	118-832	Nameplate	1	1

INDUSTRIAL COMBUSTION

9.4.9 — Control Package, Fireye

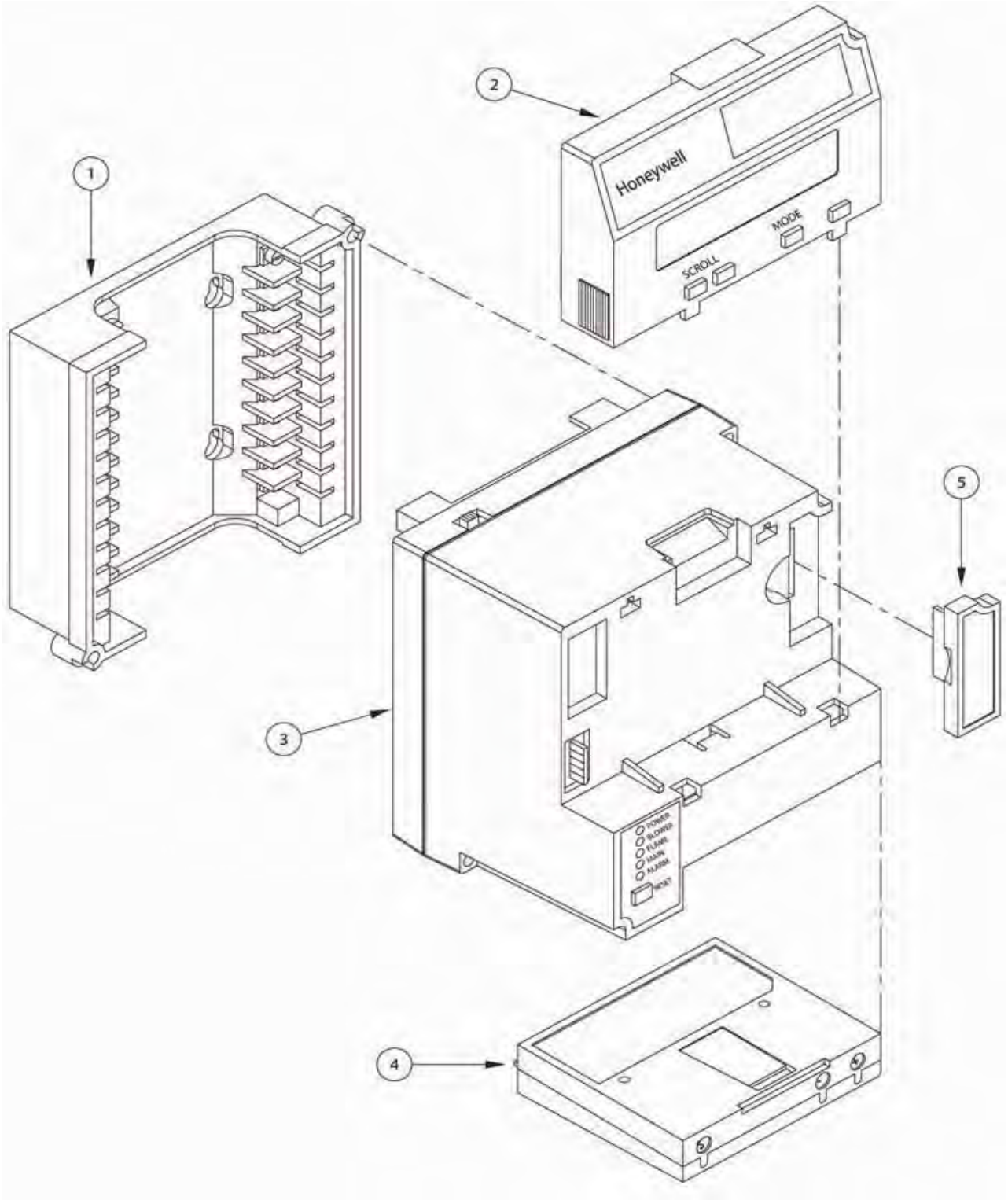


Fireye Control Package			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	833-1340	Module, Display W/Controller Mounting Cable	1	1	1	1	1	1	1	1	1	1
2	832-915	Program Module, EP160, 60 Sec. Pre-Purge	1	1	1	1	1	1	1	1	1	1
	832-916	Program Module, EP360, 60 Sec. Pre-Purge	1	1	1	1	1	1	1	1	1	1
	832-917	Program Module, EP390, 90 Sec. Pre-Purge	1	1	1	1	1	1	1	1	1	1
3	832-914	Amplifier, Signal Autochecking (Infrared)	1	1	1	1	1	1	1	1	1	1
	832-918	Amplifier, Ultra Violet	1	1	1	1	1	1	1	1	1	1
4	833-1018	Base, Controller	1	1	1	1	1	1	1	1	1	1
5	833-1337	Chassis, E110	1	1	1	1	1	1	1	1	1	1

Fireye Control Package			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	833-1340	Module, Display W/Controller Mounting Cable	1	1	1	1
2	832-915	Program Module, EP160, 60 Sec. Pre-Purge	1	1	1	1
	832-916	Program Module, EP360, 60 Sec. Pre-Purge	1	1	1	1
	832-917	Program Module, EP390, 90 Sec. Pre-Purge	1	1	1	1
3	832-914	Amplifier, Signal Autochecking (Infrared)	1	1	1	1
	832-918	Amplifier, Ultra Violet	1	1	1	1
4	833-1018	Base, Controller	1	1	1	1
5	833-1337	Chassis, E110	1	1	1	1

INDUSTRIAL COMBUSTION

9.4.10 — Control Package, Honeywell

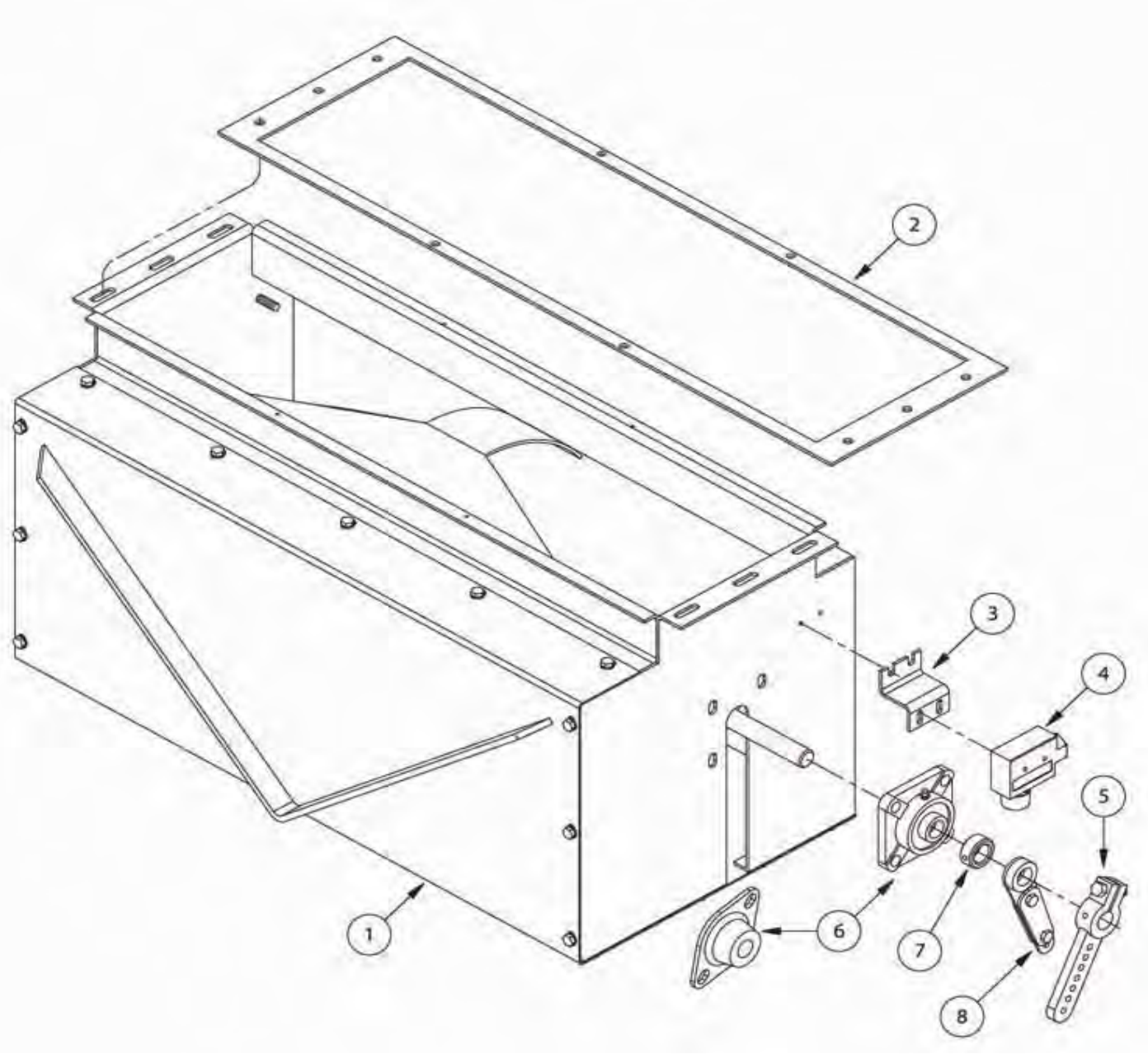


Honeywell Control Package			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	833-1278	Base Controller	1	1	1	1	1	1	1	1	1	1
2	833-1335	Control, Keyboard Display Module	1	1	1	1	1	1	1	1	1	1
3	833-1276	Controller, Program	1	1	1	1	1	1	1	1	1	1
4	832-1067	Amplifier, Infrared, 3 Second, Non Self Check	1	1	1	1	1	1	1	1	1	1
	832-1069	Amplifier, Ultra Violet, 3 Second	1	1	1	1	1	1	1	1	1	1
5	832-1070	Timer, 30 Second	1	1	1	1	1	1	1	1	1	1
	832-1065	Timer, 60 Second	1	1	1	1	1	1	1	1	1	1
	832-1066	Timer, 90 Second	1	1	1	1	1	1	1	1	1	1

Honeywell Control Package			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	833-1278	Base Controller	1	1	1	1
2	833-1335	Control, Keyboard Display Module	1	1	1	1
3	833-1276	Controller, Program	1	1	1	1
4	832-1067	Amplifier, Infrared, 3 Second, Non Self Check	1	1	1	1
	832-1069	Amplifier, Ultra Violet, 3 Seconds	1	1	1	1
5	832-1070	Timer, 30 Second	1	1	1	1
	832-1065	Timer, 60 Second	1	1	1	1
	832-1066	Timer, 90 Second	1	1	1	1

INDUSTRIAL COMBUSTION

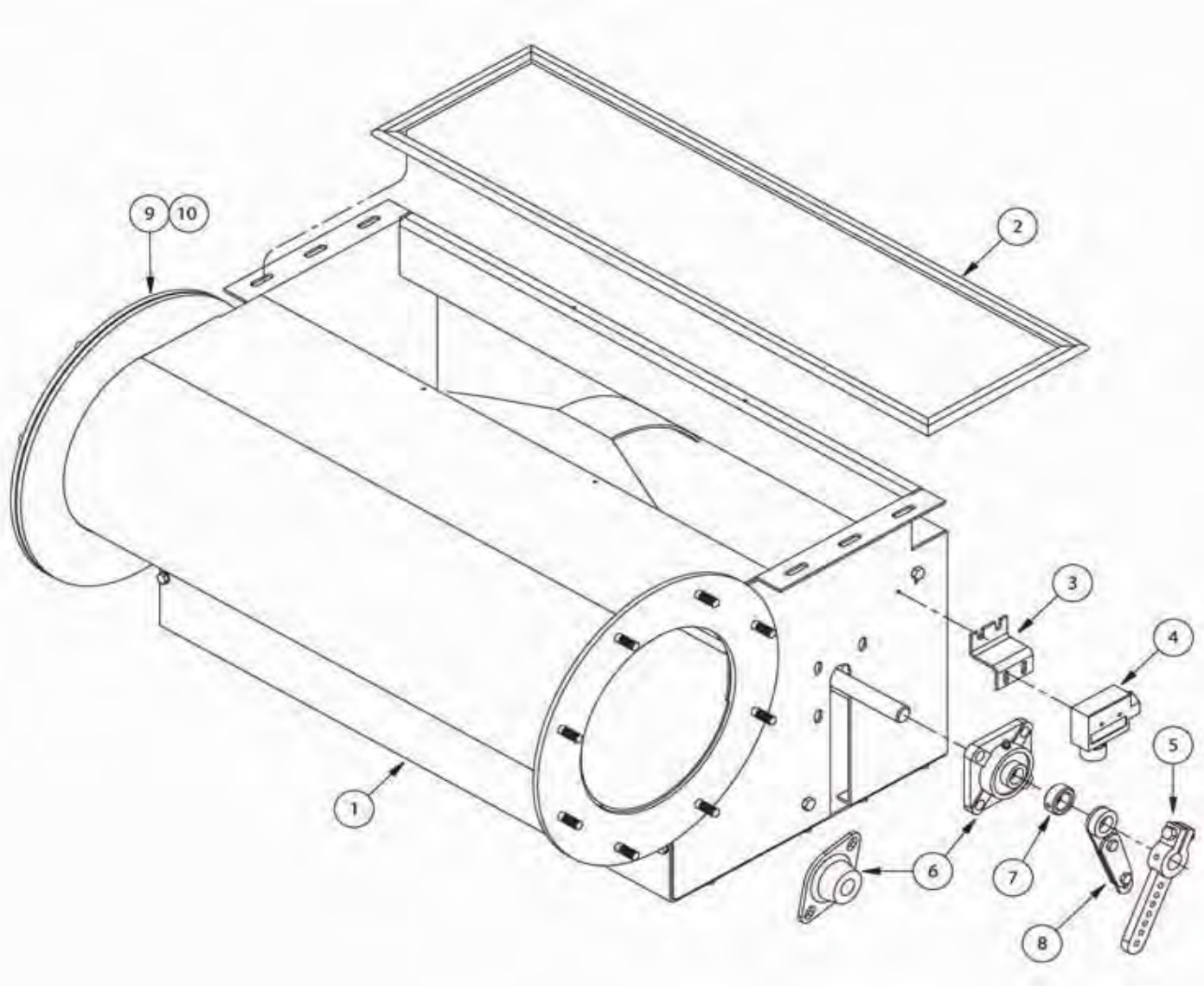
9.4.11 — Damper Assembly D42 - 420



Damper Assemblies			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	427-42	Damper Assembly, Air	1	1	1	1	1					
	427-40	Damper Assembly, Air						1	1			
	427-41	Damper Assembly, Air								1	1	1
2	32-1124	Gasket	1	1	1	1	1					
	32-1125	Gasket						1	1			
	32-1127	Gasket (varies)								1	1	1
3	8-1272	Bracket, Damper High Fire Switch	1	1	1	1	1	1	1	1	1	1
4	836-301	Switch, High Fire Air Interlock	1	1	1	1	1	1	1	1	1	1
5	2-141	Arm, Linkage Assembly	1	1	1	1	1	1	1			
	2-259	Arm, Linkage Assembly								1	1	1
6	807-335	Bearing, Flanged 2 PT, Damper Shaft 3/4”	2	2	2	2	2					
	807-333	Bearing, Square 4 PT, Damper Shaft 3/4”						2	2	2	2	2
7	18-149	Collar	2	2	2	2	2					
8	2-189	Arm, Linkage Assembly, High Fire Switch	1	1	1	1	1	1	1	1	1	1

Damper Assemblies			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	427-41	Damper Assembly, Air	1	1		
	427-156	Damper Assembly, Air			1	1
2	32-1127	Gasket (varies)	1	1		
	32-1126	Gasket			1	1
3	8-1272	Bracket, Damper High Fire Switch	1	1	1	1
4	836-301	Switch, High Fire Air Interlock	1	1	1	1
5	2-259	Arm, Linkage Assembly	1	1	1	1
6	807-333	Bearing, Square 4 PT, Damper Shaft 3/4”	2	2	2	2

9.4.12 — Damper Assembly LND42 - 420

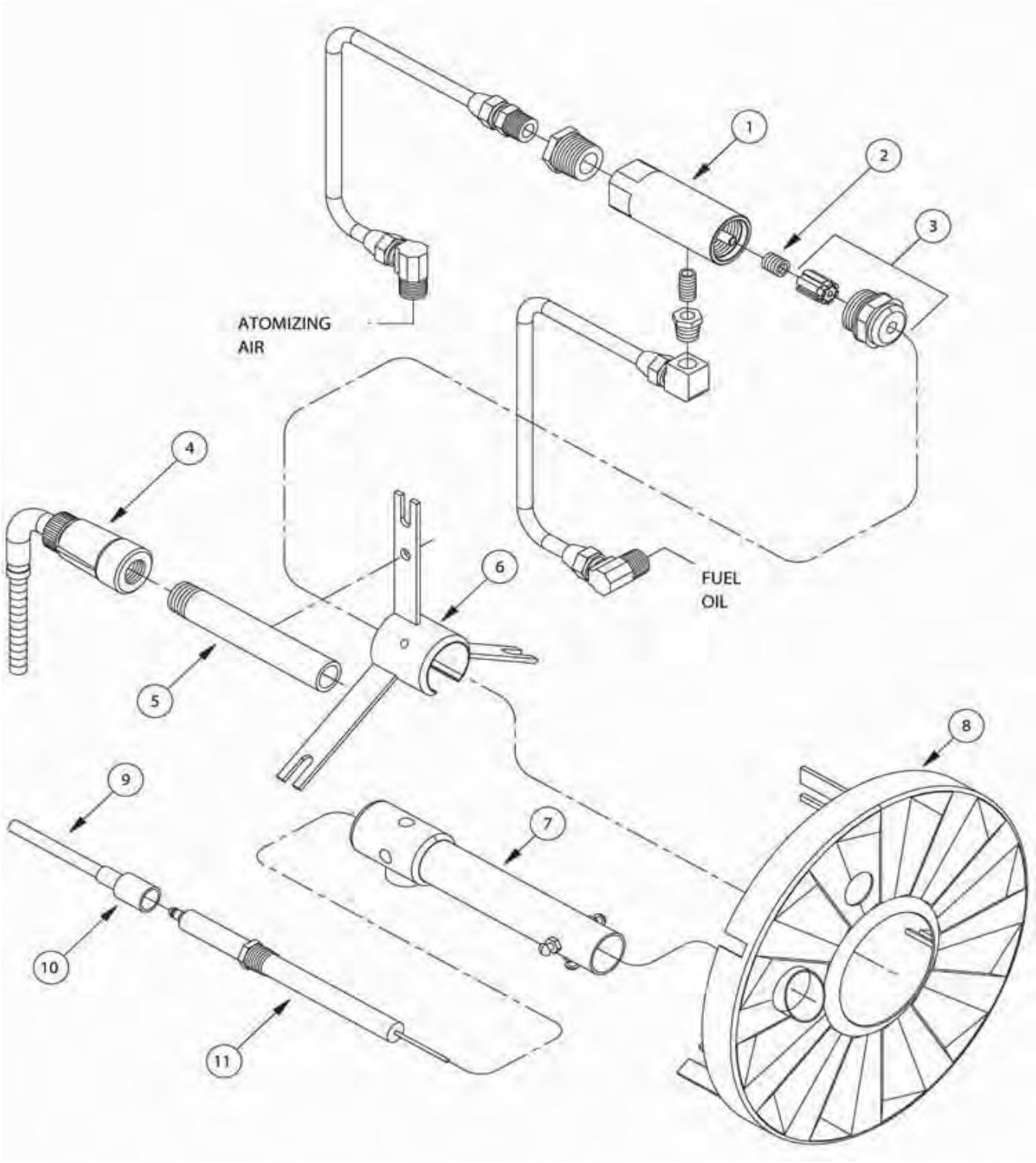


Damper Assemblies			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	427-117	Damper Assembly, Air 4" FGR Inlet	1	1								
	427-127	Damper Assembly, Air 6" FGR Inlet	1	1	1	1	1					
	427-113	Damper Assembly, Air 6" FGR Inlet						1	1			
	427-129	Damper Assembly, Air 8" FGR Inlet						1	1			
	427-114	Damper Assembly, Air 8" FGR Inlet								1	1	
	427-138	Damper Assembly, Air 10" FGR Inlet										1
2	32-1144	Gasket, Tadpole Tape, 3/8" Bulb X 1" Wide	1	1	1	1	1	1	1	1	1	1
3	8-1272	Bracket, Damper High Fire Switch	1	1	1	1	1	1	1	1	1	1
4	836-301	Switch, High Fire Interlock	1	1	1	1	1	1	1	1	1	1
5	2-184	Arm, Linkage Assembly	1	1	1	1	1	1	1	1	1	1
6	807-335	Bearing, Flanged 2 PT, Damper Shaft 3/4"	2	2	2	2	2					
	807-333	Bearing, Square 4 PT, Damper Shaft 3/4"						2	2	2	2	2
7	18-149	Collar	2	2	2	2	2					
8	2-189	Arm, Linkage Assembly, High Fire Switch	1	1	1	1	1	1	1	1	1	1

Damper Assemblies			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	427-117	Damper Assembly, Air 10" FGR Inlet	1	1	1	1
2	32-1126	Gasket	1	1	1	1
3	8-1272	Bracket, Damper High Fire Switch	1	1	1	1
4	836-301	Switch, High Fire Air Interlock	1	1	1	1
5	2-184	Arm, Linkage Assembly	1	1	1	1
6	807-333	Bearing, Square 4 PT, Damper Shaft 3/4"	2	2	2	2
8	2-189	Arm, Linkage Assembly, High Fire Switch	1	1	1	1

INDUSTRIAL COMBUSTION

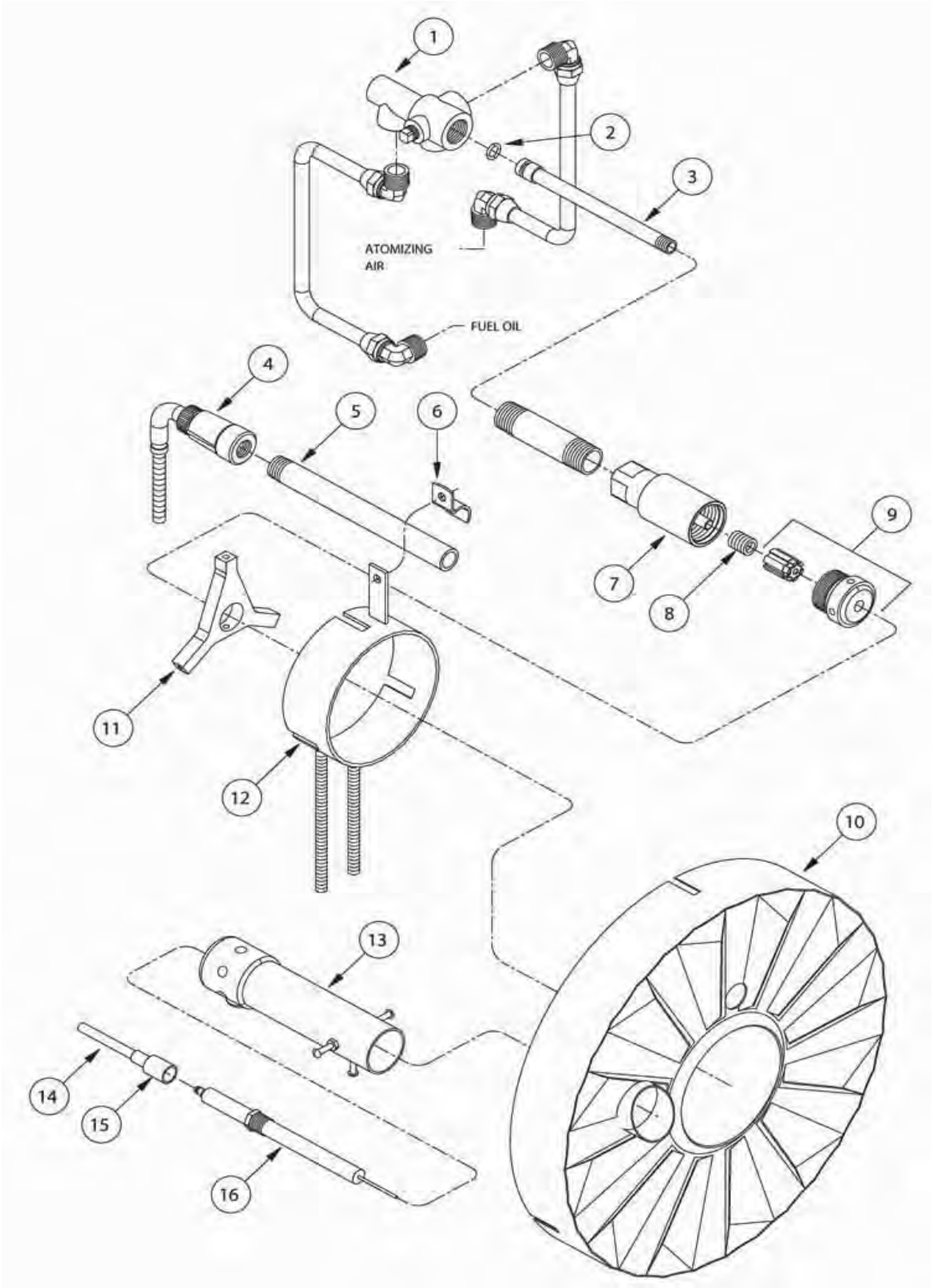
9.4.13 — Drawer Assembly D42 - 63



Drawer Assemblies			Quantity		
Item No.	**Part No.**	**Description**	**42**	**54**	**63**
1	277-139	Nozzle Body Assembly, 22 MM X 1.5 MM Nozzle Thds. All Models Except DE, DEG	1	1	1
	277-105	Nozzle Body Assembly, 1-1/8" - 16 Nozzle Thds. Models DE, DEG	1	1	1
2	82-33	Spring, Nozzle Compression .5" FL X 5/16" I.D. X .072" All Models Except DE, DEG	1	1	1
	82-129	Spring, Nozzle Compression .6" FL X 5/16" I.D. X .082" Models DE, DEG	1	1	1
3	528-9	Nozzle Assembly Models DL, DLG	1	1	
	528-13	Nozzle Assembly Models DL, DLG			1
	528-9	Nozzle Assembly Models DG, DM, DMG	1		
	528-13	Nozzle Assembly Models DG, DM, DMG		1	
	528-29	Nozzle Assembly Models DG, DM, DMG			1
	528-47	Nozzle Assembly Models DE, DEG	1	1	1
4	817-	varies	1	1	1
5	90-228	Tube, Scanner, Sight 8"	1	1	1
6	8-1152	Bracket Assembly, Nozzle Support	1	1	1
7	48-140	Gas Pilot Assembly	1	1	1
8	275-243	Diffuser Assembly, Air, Standard Models DL, DLG	1		
	275-244	Diffuser Assembly, Air, Standard Models DL, DLG		1	1
	275-243	Diffuser Assembly, Air, Standard Models DG, DM, DMG	1		
	275-244	Diffuser Assembly, Air, Standard Models DG, DM, DMG		1	1
	275-244	Diffuser Assembly, Air, Standard Models DE, DEG	1	1	1
9	826-40	As Required	1	1	1
10	848-166	Connector, Ignition Cable, Straight	1	1	1
11	873-93	Electrode Assembly, Ignition with Bushing	1	1	1

INDUSTRIAL COMBUSTION

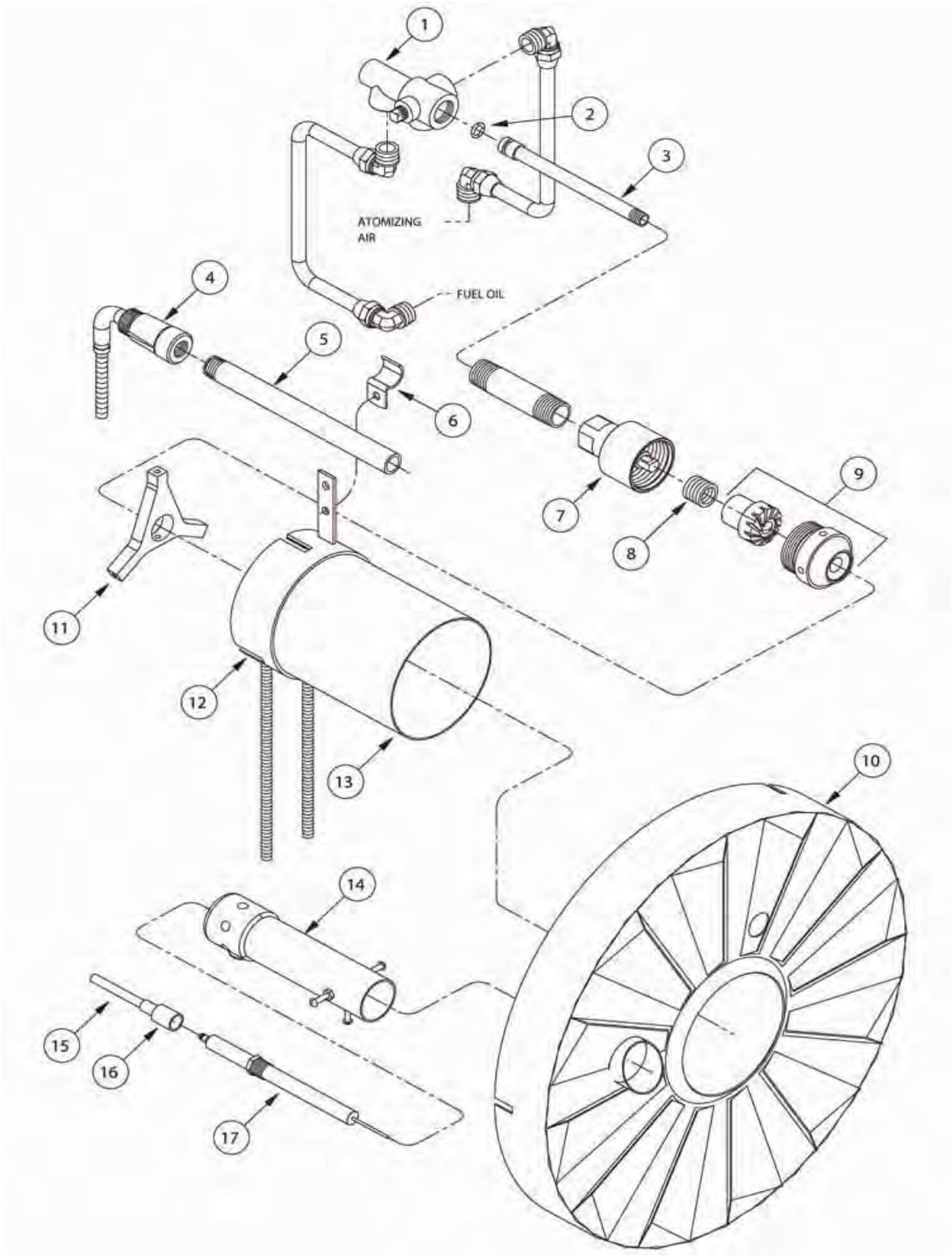
9.4.14 — Drawer Assembly D84 - 145



Drawer Assemblies			Quantity		
Item No.	Part No.	Description	84	105	145
1	106-101	Block, Oil Air Inlet Manifold			1
2	853-613	O-Ring, 5/8" O.D. X 3/32 Thk.			1
3	90-241	Tube Assembly, Oil Nozzle Deliver		1	1
4	817-	Varies	1	1	1
5	90-338	Tube, Scanner, Sight 9"	1	1	1
6	928-44	Clamp, Conduit 1/2"	1	1	1
7	277-139	Nozzle Body Assembly, 22 MM X 1.5 MM Nozzle Thds. Models DL, DLG	1		
	277-105	Nozzle Body Assembly, 1-1/8" X 16 Nozzle Thds. Models DL, DLG		1	1
	277-139	Nozzle Body Assembly, 22 MM X 1.5 MM Nozzle Thds. Models DG, DM, DMG	1		
	277-105	Nozzle Body Assembly, 1-1/8" X 16 Nozzle Thds. Models DG, DM, DMG		1	1
	277-105	Nozzle Body Assembly, 1-1/8" X 16 Nozzle Thds. Models DG, DM, DMG	1	1	
	277-106	Nozzle Body Assembly, 1-1/2" X 12 Nozzle Thds. Models DE, DEG			1
8	82-33	Spring, Nozzle Compression .5" FL X .312" I.D. X .072" All Models Except DE, DEG	1		
	82-129	Spring, Nozzle Compression .6" FL X .312" I.D. X .082" Models DE, DEG	1		
	82-129	Spring, Nozzle Compression .6" FL X .312" I.D. X .082" All Models		1	
	82-129	Spring, Nozzle Compression .6" FL X .312" I.D. X .082" All Models Except DE, DEG			1
	82-128	Spring, Nozzle Compression .732" FL X .405" I.D. X .092" Models DE, DEG			1
9	528-13	Nozzle Assembly Models DL, DLG	1		
	528-36	Nozzle Assembly Models DL, DLG		1	
	528-34	Nozzle Assembly Models DL, DLG			1
	528-32	Nozzle Assembly Models DG, DM, DMG	1		
	528-36	Nozzle Assembly Models DG, DM, DMG		1	
	528-34	Nozzle Assembly Models DG, DM, DMG			1
	528-31	Nozzle Assembly Models DE, DEG	1		
	528-24	Nozzle Assembly Models DE, DEG		1	
	528-25	Nozzle Assembly Models DE, DEG			1
10	275-234	Diffuser, Assembly, Air Models DL, DLG	1		
	275-225	Diffuser, Assembly, Air Models DL, DLG		1	
	275-167	Diffuser, Assembly, Air, Standard Models DL, DLG			1
	275-234	Diffuser, Assembly, Air, Standard Models DG, DM, DMG	1		
	275-225	Diffuser, Assembly, Air, Standard Models DG, DM, DMG		1	
	275-167	Diffuser, Assembly, Air, Standard Models DG, DM, DMG			1
	275-237	Diffuser, Assembly, Air, Standard Models DE, DEG	1	1	
	275-167	Diffuser, Assembly, Air, Standard Models DE, DEG			1
11	8-1042	Bracket, Nozzle Support	1	1	1
	8-1095	Bracket, Nozzle Support			1
12	8-1026	Bracket Assembly, Drawer Support	1	1	
	8-1041	Bracket Assembly, Drawer Support			1
13	48-141	Gas Pilot Assembly	1	1	1
14	826-40	As Required	1	1	1
15	848-166	Connector, Ignition Cable, Straight	1	1	1
16	873-93	Electrode Assembly, Ignition W/Bushing	1	1	1

INDUSTRIAL COMBUSTION

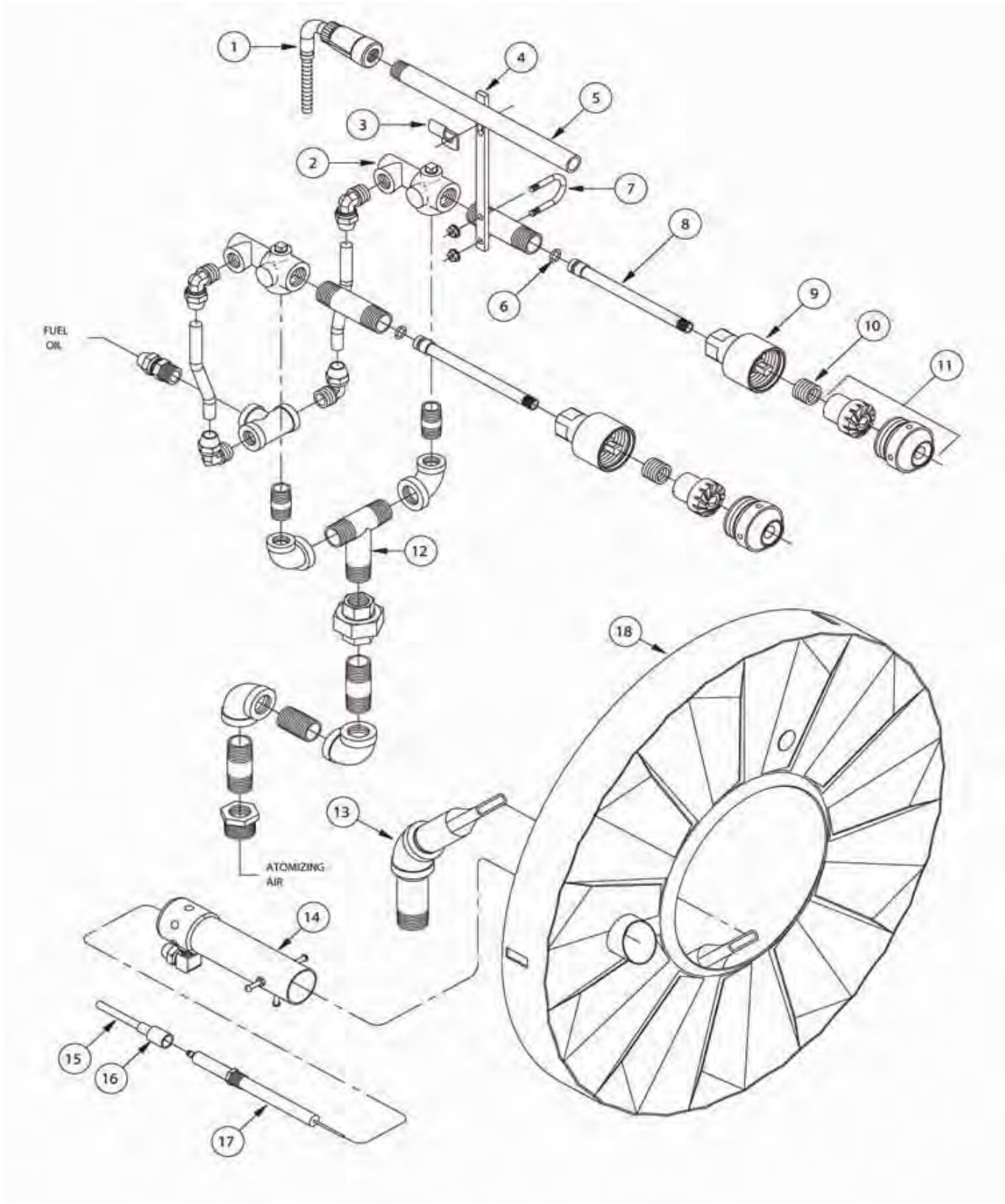
9.4.15 — Drawer Assembly D175 - 336



Drawer Assemblies			Quantity					
Item No.	Part No.	Description	175	210	252	300	315	336
1	106-101	Block, Oil Air inlet Manifold	1	1	1	1	1	1
2	853-613	O-Ring, 5/8" O.D. X 3/32 Thk.	1	1	1	1	1	1
3	90-241	Tube Assembly, Oil Nozzle Deliver	1	1	1	1	1	1
4	817-	Varies	1	1	1	1	1	1
5	90-339	Tube, Scanner, Sight 9"	1	1	1	1	1	1
6	928-44	Clamp, Conduit 1/2"	1	1	1	1	1	1
7	277-107	Nozzle Body Assembly, 2" - 12 Nozzle Body Thds. All Models	1	1	1	1	1	1
8	82-121	Spring, Nozzle Compression 49/64" F.L. X .7" I.D. X 1" All Models	1	1	1	1	1	1
9	528-26	Nozzle Assembly All Models	1	1	1			
	528-30	Nozzle Assembly All Models				1	1	1
10	275-190	Diffuser Assembly, Air, Standard All Models	1					
	275-189	Diffuser Assembly, Air, Standard All Models		1				
	275-169	Diffuser Assembly, Air, Standard All Models			1			
	275-188	Diffuser Assembly, Air, Standard All Models				1	1	
	275-446	Diffuser Assembly, Air, Standard All Models						1
11	8-1095	Bracket, Nozzle Support	1	1	1	1	1	1
12	8-1622	Bracket Assembly, Drawer Support	1	1	1	1	1	1
13	76-109	Sleeve, Inner for Drawer Assembly	1	1	1	1	1	1
14	48-141	Gas Pilot Assembly	1	1	1	1	1	1
15	826-40	As Required	1	1	1	1	1	1
16	848-166	Connector, Ignition Cable, Straight	1	1	1	1	1	1
17	873-93	Electrode Assembly, Ignition W/Bushing	1	1	1	1	1	1

INDUSTRIAL COMBUSTION

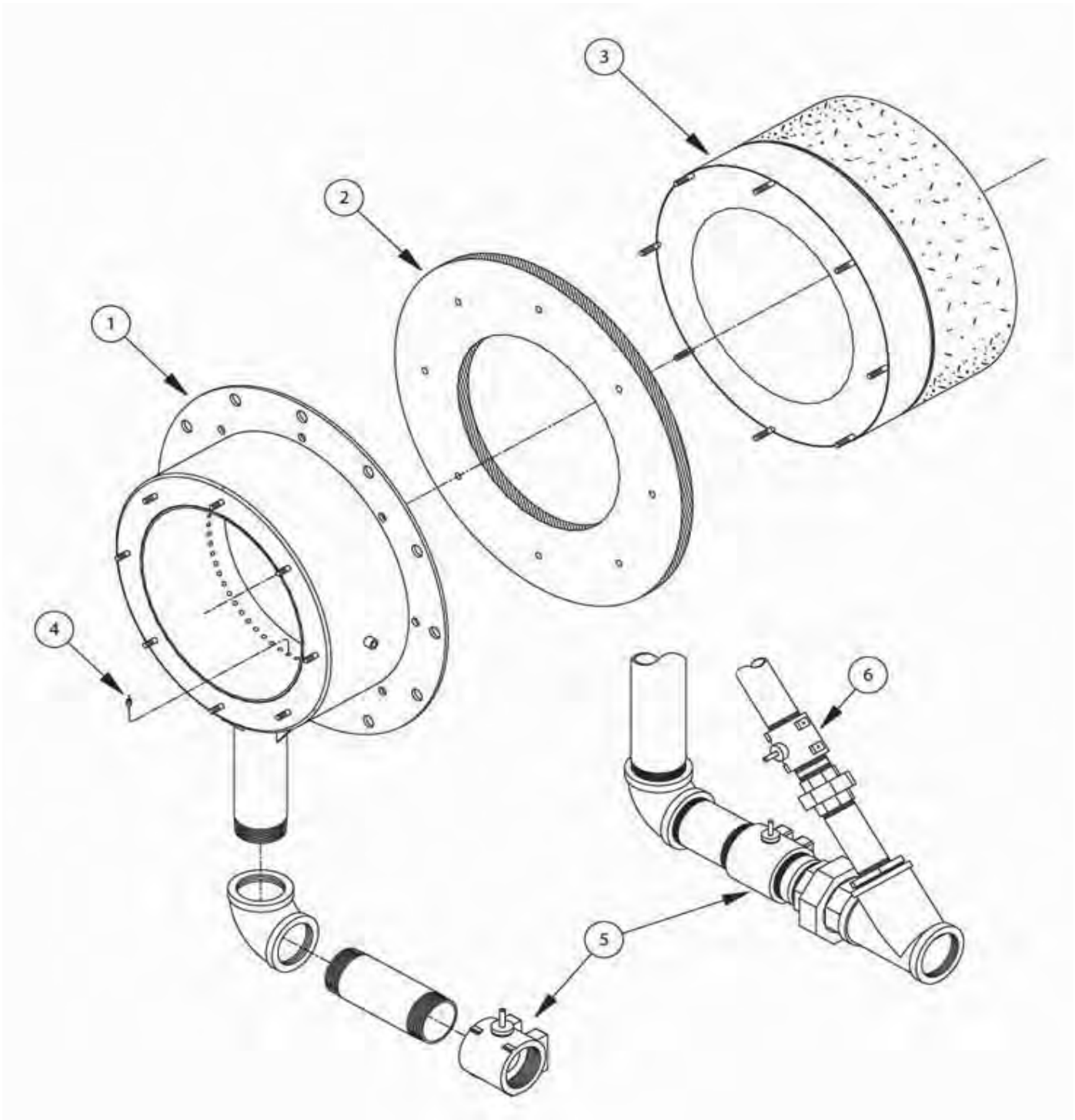
9.4.16 — Drawer Assembly D378 - 420



Drawer Assemblies			Quantity	
Item No.	Part No.	Description	378	420
1	817-	Varies	1	1
2	106-101	Block, Oil Air Inlet Manifold	2	2
3	928-80	Clamp, Conduit 3/4”	1	1
4	8-1627	Bracket, Scanner Mount	1	1
5	90-338	Tube, Scanner, Sight 9”	1	1
6	853-613	O-Ring, 5/8” O.D. X 7/16” I.D. X 3/32” Thk.	2	2
7	7-196	U-Bolt, 3/4” Pipe Thd. 1/4-20	1	1
8	90-559	Tube Assembly, Oil Nozzle Deliver	2	2
9	277-107	Nozzle Body Assembly, 2” - 12 Nozzle Thds. All Models	1	1
10	82-121	Spring, Nozzle Compression 49/64” F.L. X 7” I.D. X 1”	2	2
11	528-49	Nozzle Assembly All Models	1	1
12	85-894	Nozzle, Support Assembly	1	1
13	42-79	Spud, Secondary	1	1
14	48-141	Gas Pilot Assembly	1	1
15	826-40	As Required	1	1
16	848-166	Connector, Ignition Cable, Straight	1	1
17	873-93	Electrode Assembly, Ignition W/Bushing	1	1
18	275-439	Diffuser Assembly, Air, Standard All Models	1	1

INDUSTRIAL COMBUSTION

9.4.17 — Firing Head Assembly D42 - 420

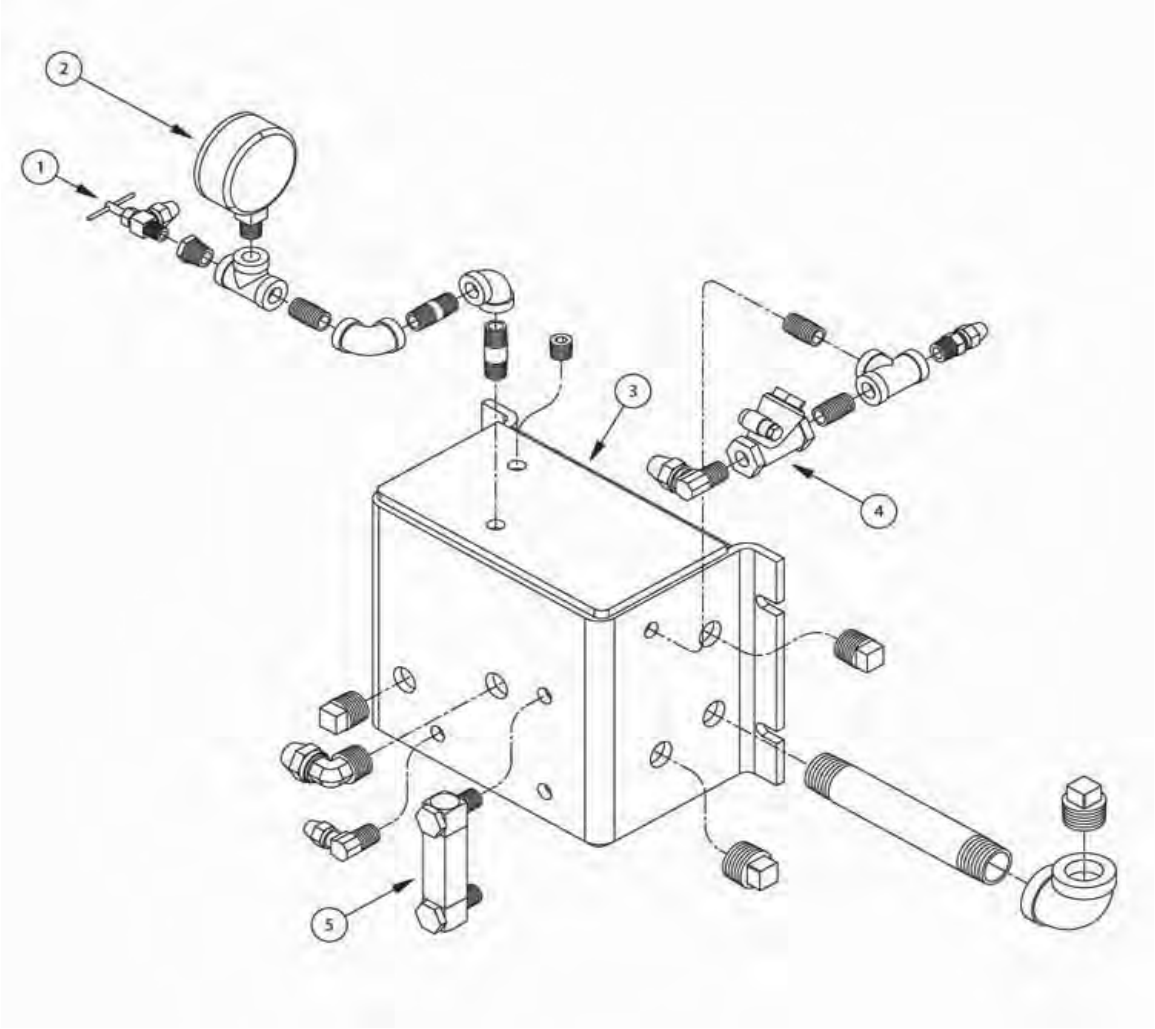


Firing Head Assemblies			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	257-156	Manifold Assembly, Gas Firing Head	1									
	257-157	Manifold Assembly, Gas Firing Head		1	1							
	257-147	Manifold Assembly, Gas Firing Head				1						
	257-148	Manifold Assembly, Gas Firing Head					1					
	257-149	Manifold Assembly, Gas Firing Head						1				
	257-153	Manifold Assembly, Gas Firing Head							1	1		
	257-154	Manifold Assembly, Gas Firing Head									1	1
2	32-1095	Gasket, Mounting, Dry Oven	1	1	1							
	32-1096	Gasket, Mounting, Dry Oven				1	1					
	32-1097	Gasket, Mounting, Dry Oven						1				
	32-1098	Gasket, Mounting, Dry Oven							1	1		
	32-1099	Gasket, Mounting, Dry Oven									1	1
3	279-58	Dry Oven Assembly	1	1	1							
	279-60	Dry Oven Assembly				1	1					
	279-59	Dry Oven Assembly						1				
	279-76	Dry Oven Assembly							1	1		
	279-77	Dry Oven Assembly									1	1
4	42-52	Spud, Gas Orifice Protection .312" O.D.	3	3	3	3	3	4	4	5	5	5
5	940-1192	Valve, Gas Butterfly 2" F.P.	1									
	940-1257	Valve, Gas Butterfly 2" R.P.		1	1							
	940-1193	Valve, Gas Butterfly 2-1/2" R.P.				1						
	940-1230	Valve, Gas Butterfly 2-1/2" F.P.					1					
	940-1194	Valve, Gas Butterfly 3" R.P.						1	1	1		
	940-1195	Valve, Gas Butterfly 4" R.P.									1	1

Firing Head Assemblies			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	257-154	Manifold Assembly, Gas Firing Head	1			
	257-165	Manifold Assembly, Gas Firing Head		1		
	257-164	Manifold Assembly, Gas Firing Head			1	1
2	32-1099	Gasket, Mounting, Dry Oven	1			
	32-1132	Gasket, Mounting, Dry Oven		1	1	1
3	279-77	Dry Oven Assembly	1			
	279-138	Dry Oven Assembly		1	1	1
4	42-52	Spud, Gas Orifice Protection .312" O.D.	5	5	5	5
5	940-1195	Valve, Gas Butterfly 4" R.P.	1	1	1	1
6	940-1230	Valve, Gas Butterfly 2-1/2" F.P.			1	1

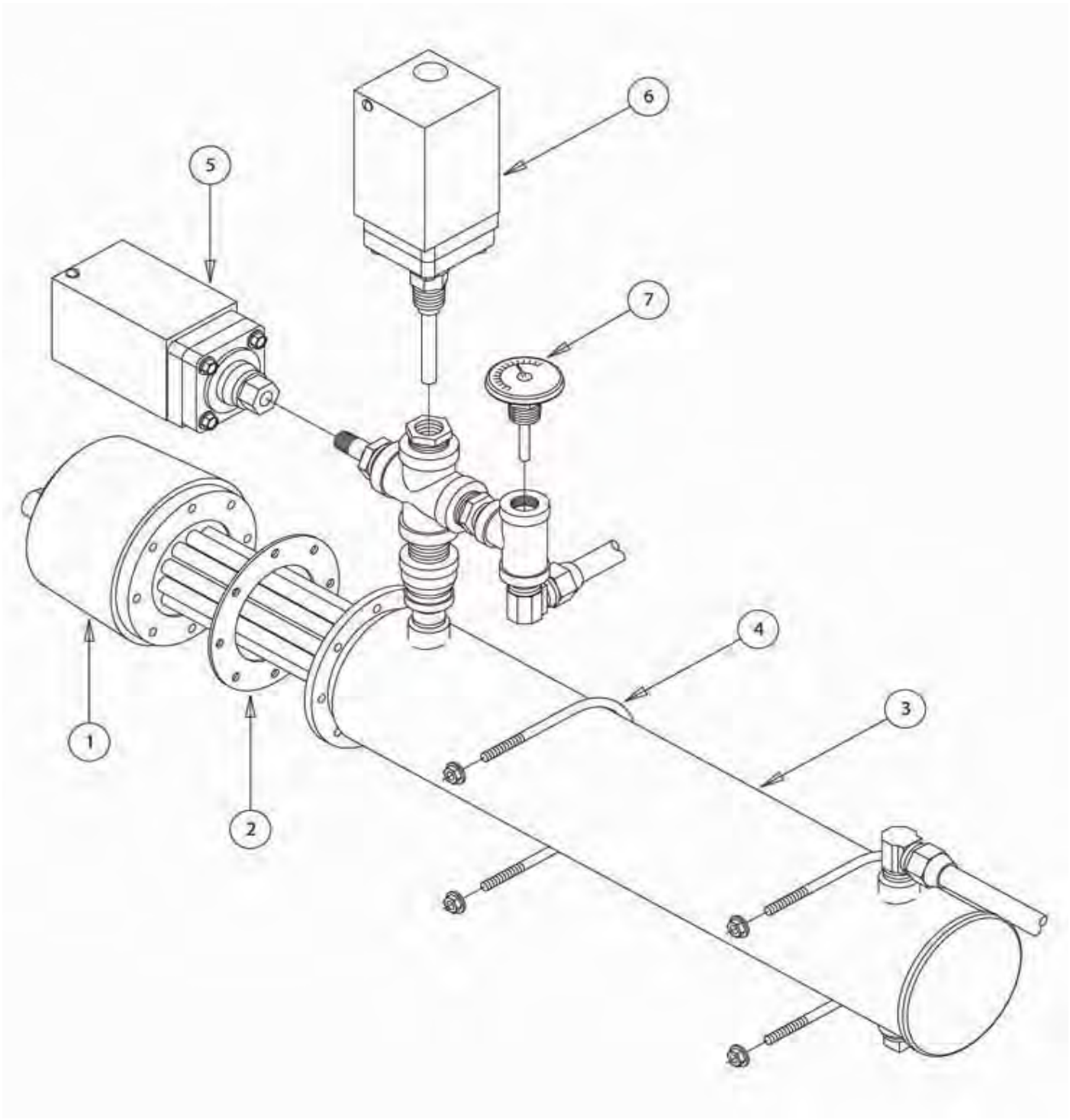
INDUSTRIAL COMBUSTION

9.4.18 — Oil Air Tank DL, DM42 - 145



Oil Air Tank Assemblies			Quantity					
Item No.	Part No.	Description	42	54	63	84	105	145
1	941-187	Valve, Needle, Shutoff	1	1	1	1	1	1
2	850-3	Gauge, Pressure 0 - 60 PSI	1	1	1	1	1	1
3	195-256	Tank Assembly, Air Oil 350 Cu. In.	1	1	1	1	1	1
4	940-1200	Valve, Check 1/4" Horizontal	1	1	1	1	1	1
5	851-176	Glass, Sight Oil Level 3" Centre	1	1	1	1	1	1

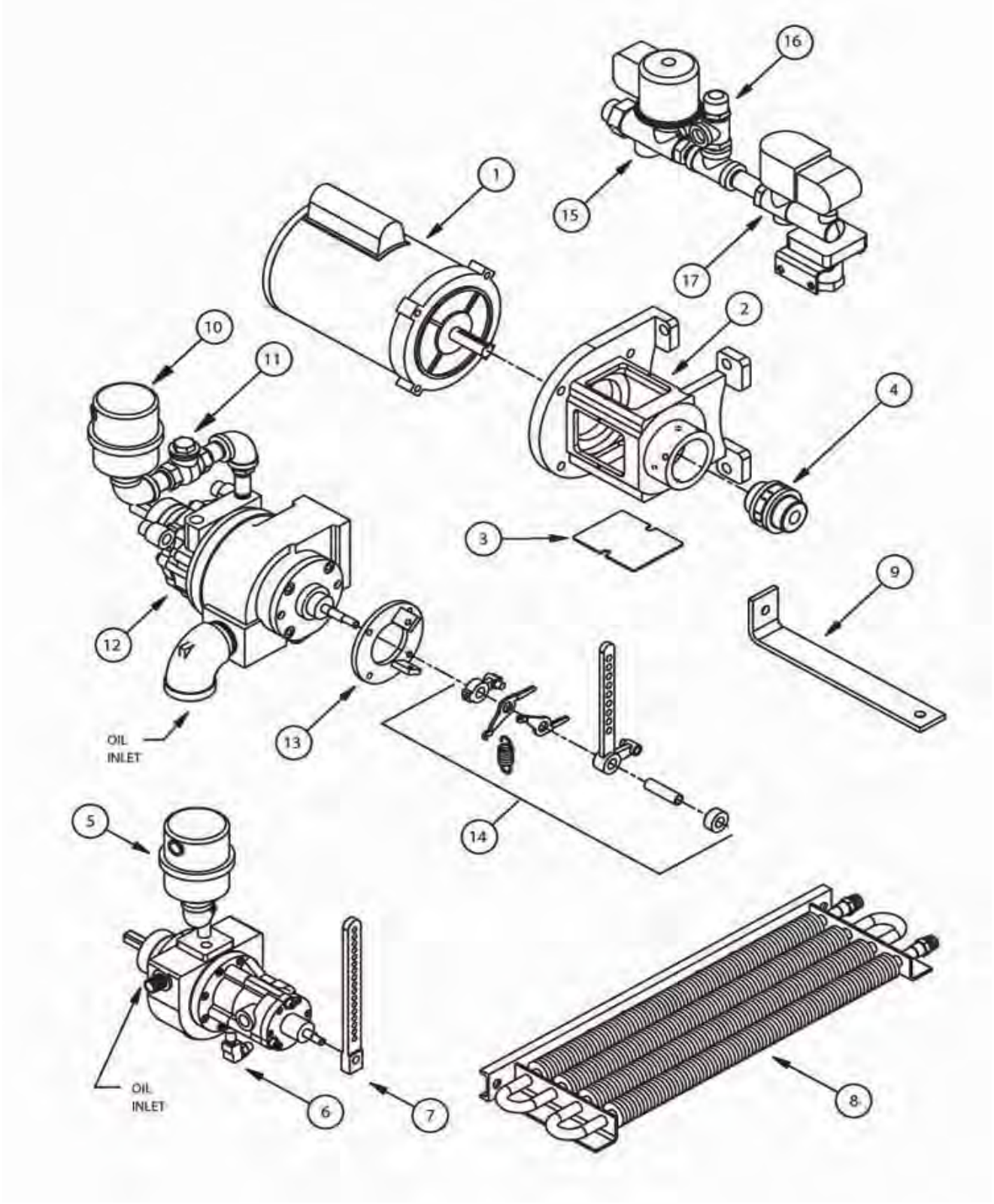
9.4.19 — Oil Heater D42 -420



Heater			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	832-690	Heater, Electric, Oil 3KW 230/3/60	1	1	1							
	832-689	Heater, Electric, Oil 5KW 230/3/60				1	1	1	1			
	832-724	Heater, Electric, Oil 7KW 230/3/60								1		
	832-717	Heater, Electric, Oil 10KW 230/3/60									1	
	832-718	Heater, Electric, Oil 10KW 440/3/60										1
2	77-200	Spacer, Auxiliary Heater Shim	1	1	1	1	1	1	1			
3	257-70	Manifold Assembly, 3 KW & 5 KW Heaters	1	1	1	1	1	1	1			
	257-72	Manifold Assembly, 7 KW & 10 KW Heaters								1	1	1
4	7-144	U-Bolt, 3-1/2" I.D. X 5" Legs, Threaded 1/4-20	2	2	2	2	2	2	2			
	7-144	U-Bolt, 4" I.D. X 6" Legs, Threaded 1/4-20								2	2	2
5	817-829	Switch, Air-Oil Pressure 4-12 PSI	1	1	1	1	1	1	1	1	1	1
6	817-620	Switch, High Oil Temperature 160-260 Deg.	1	1	1	1	1	1	1	1	1	1
7	937-163	Gauge, Temperature 50-300 Deg. 1/2" NPT	1	1	1	1	1	1	1	1	1	1

Heater			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	832-718	Heater, Electric, Oil 10KW 440/3/60	1	1	1	1
3	257-72	Manifold Assembly, 7 KW & 10 KW Heaters	1	1	1	1
4	7-144	U-Bolt, 4" I.D. X 6" Legs, Threaded 1/4-20	2	2	2	2
5	817-829	Switch, Air-Oil Pressure 4-12 PSI	1	1	1	1
6	817-620	Switch, High Oil Temperature 160-260 Deg.	1	1	1	1
7	937-163	Gauge, Temperature 50-300 Deg. 1/2" NPT	1	1	1	1

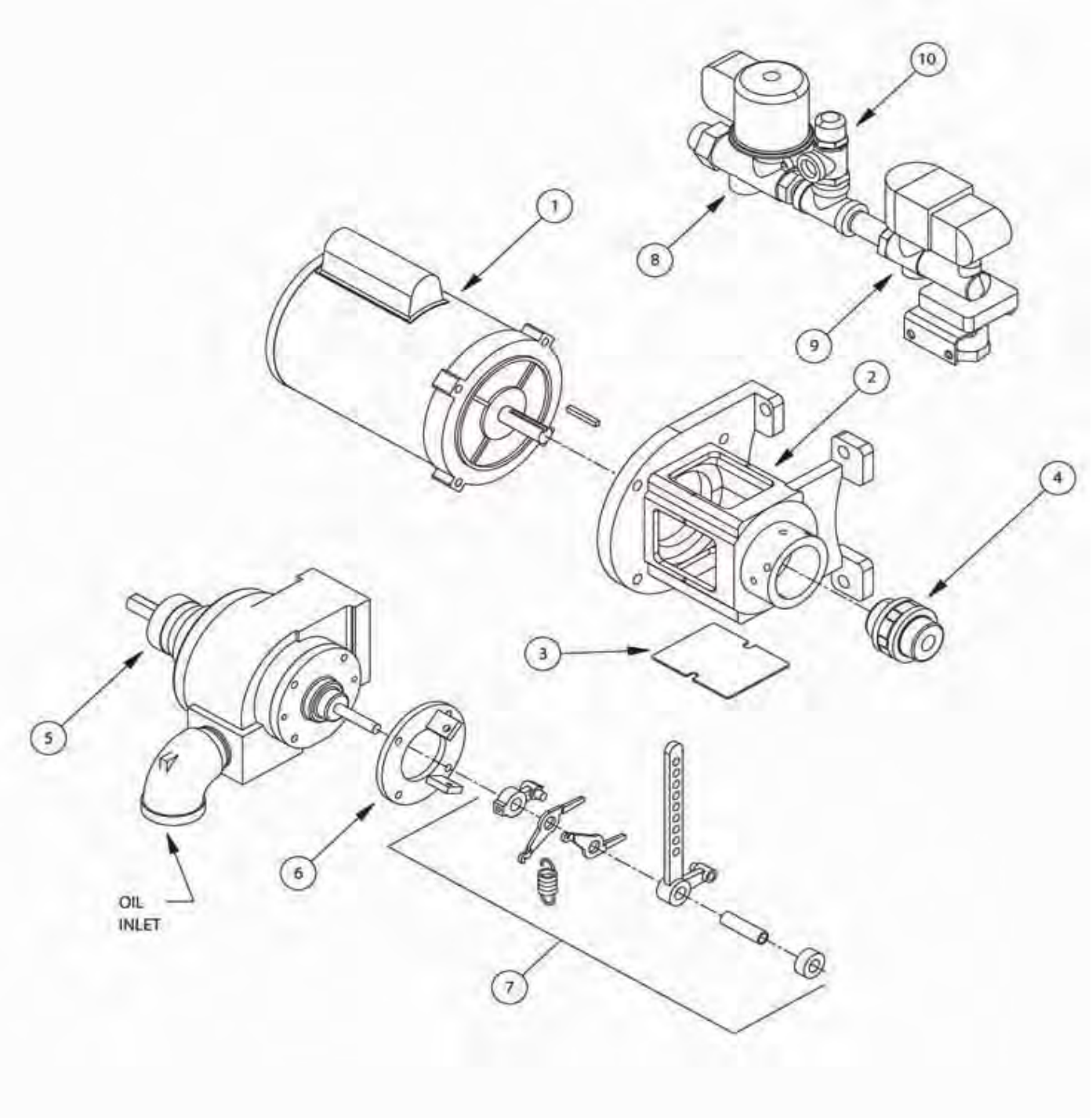
9.4.20 — Oil Metering Assembly DL, DLG, DM, DMG42 - 145



INDUSTRIAL COMBUSTION

Oil Metering Assemblies			Quantity					
Item No.	Part No.	Description	42	54	63	84	105	145
1	894-1289	Motor, 1 HP, Models DL, DLG	1	1	1	1		
	894-1295	Motor, 2 HP, Models DL, DLG					1	1
	894-1289	Motor, 1 HP, Models DM, DMG	1	1				
	894-1295	Motor, 2 HP, Models DM, DMG			1	1	1	1
2	40-296	Housing, Mounting Oil Pump to Motor	1	1	1	1	1	1
3	19-342	Cover, Drive Coupling Access	2	2	2	2	2	2
4	819-114	Coupling, Drive Models DL, DLG	1	1	1	1		
	819-105	Coupling, Drive Models DL, DLG					1	1
	819-114	Coupling, Drive Models DM, DMG	1	1				
	819-105	Coupling, Drive Models DM, DMG			1	1	1	1
5	923-115	Filter, Air	1	1	1	1	1	1
6	695-90	Meter & Compressor Assembly, Oil-Air #5-4 Models DL, DLG	1					
	695-92	Meter & Compressor Assembly, Oil-Air #6-4 Models DL, DLG		1				
	695-94	Meter & Compressor Assembly, Oil-Air #7-4 Models DL, DLG			1			
	695-100	Meter & Compressor Assembly, Oil-Air #8-4 Models DL, DLG				1		
	695-90	Meter & Compressor Assembly, Oil-Air #5-4 Models DM, DMG	1					
	695-92	Meter & Compressor Assembly, Oil-Air #6-4 Models DM, DMG		1				
12	695-64	Meter & Compressor Assembly, Oil-Air #5-5 Models DM, DMG			1			
12	695-66	Meter & Compressor Assembly, Oil-Air #7-5 Models DM, DMG				1		
7	287-1	Arm, Assembly	1	1	1	1		
8	17-143	Coil Assembly, Cooling			1	1	1	1
9	8-1572	Bracket, Cooling Coil, Mounting			2			2
	8-1260	Bracket, Cooling coil, Mounting				2	2	
10	923-115	Filter, Air	1	1	1	1	1	1
11	940-1169	Valve, Check 1/2" Horizontal					1	1
12	695-101	Meter & Compressor Assembly, Oil-Air #7-6 E Style Models DL, DLG					1	
	695-78	Meter & Compressor Assembly, Oil-Air #8-6 E Style Models DL, DLG						1
6	695-90	Meter & Compressor Assembly, Oil-Air #7-7 E Style Models DM, DMG					1	
6	695-92	Meter & Compressor Assembly, Oil-Air #6-4 E Style Models DM, DMG						1
13	282-13	Stop Assembly, Override, Metering Head	1	1	1	1	1	1
14	476-53	Linkage Assembly, Limiting Arm, 9 Holes 5/16"	1	1	1	1	1	1
15	940-1142	Valve, Oil Solenoid 3/8" 2 Way N.C.	1	1	1	1		
	940-1372	Valve, Oil Solenoid 1/2" 2 Way N.C.					1	1
16	940-1224	Valve, Relief 1/2" 60 PSI	1	1	1	1	1	1
17	940-1347	Valve, Oil Solenoid 3/8" 3 Way N.C.	1	1	1	1		
	940-1348	Valve, Oil Solenoid 1/2" 3 Way N.C.					1	1

9.4.21 — Oil Metering Assembly DL, DLG, DM, DMG175-420 & DE, DEG42 - 420

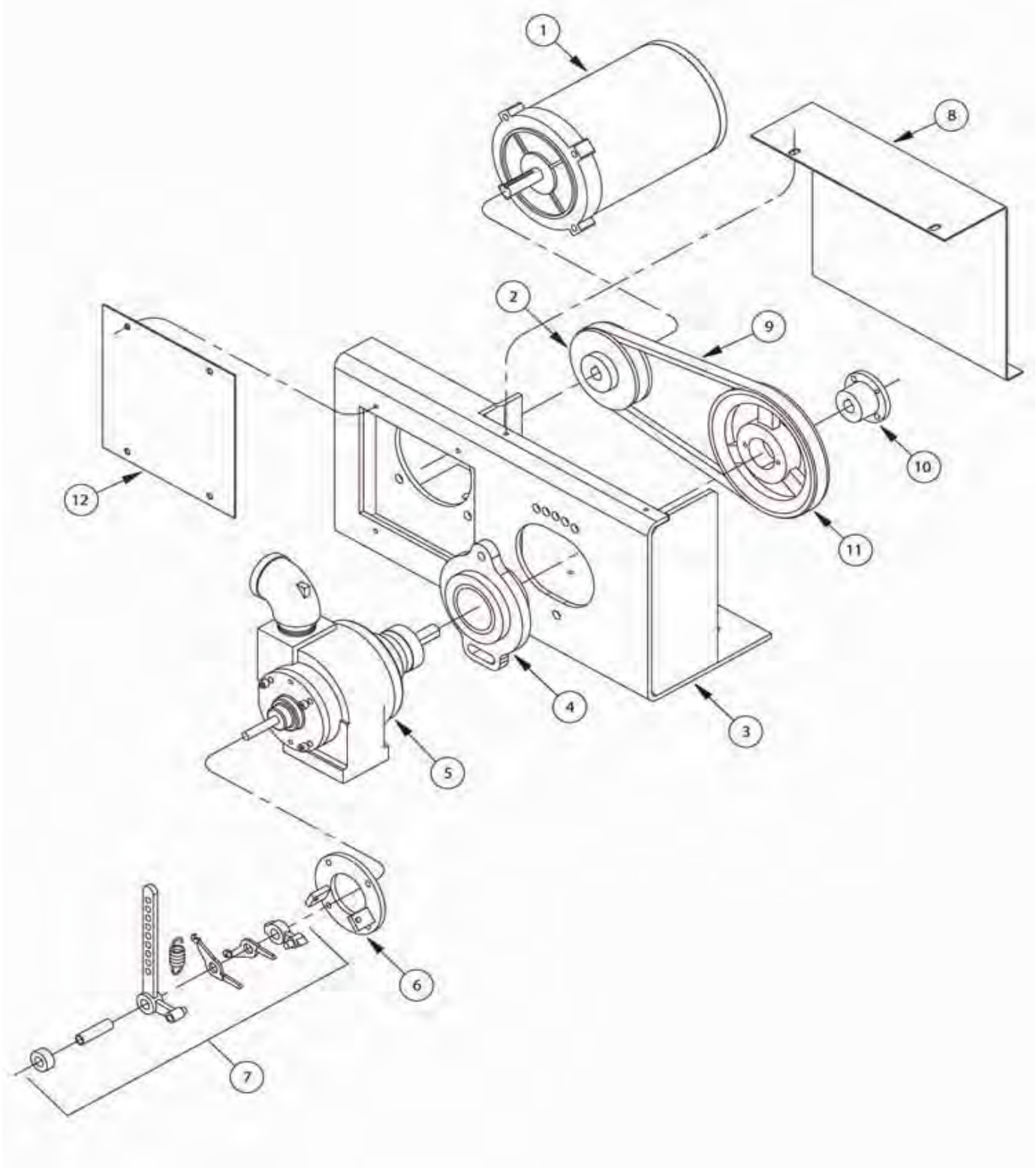


Oil Metering Assemblies			Quantity										
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300	315	336
1	894-934	Motor, 1/2 HP	1	1	1	1	1	1	1					
	894-936	Motor, 3/4 HP								1	1	1	1	1
2	40-296	Housing, Mounting Oil Pump to Motor	1	1	1	1	1	1	1	1	1	1	1	1
3	19-342	Cover, Drive Coupling Access	2	2	2	2	2	2	2	2	2	2	2	2
4	819-114	Coupling, Drive 9/16" X 5/8" Bore	1	1	1	1								
	819-105	Coupling, Drive 5/8" X 5/8" Bore					1	1	1	1	1	1	1	1
5	695-80	Metering Head Ass'y, Oil #30L	1											
	695-70	Metering Head Ass'y, Oil #40L		1	1									
	695-71	Metering Head Ass'y, Oil #60L				1								
	695-81	Metering Head Ass'y, Oil #75L					1							
	695-72	Metering Head Ass'y, Oil #100L						1						
	695-82	Metering Head Ass'y, Oil #125L							1					
	695-73	Metering Head Ass'y, OIl #150L								1				
	695-83	Metering Head Ass'y, Oil #180L									1			
	695-74	Metering Head Ass'y, Oil #200L										1		
	695-75	Metering Head Ass'y, Oil #350L											1	1
6	282-13	Stop Ass'y, Override, Metering Head	1	1	1	1	1	1	1	1	1	1	1	1
7	476-53	Linkage Ass'y, Limiting Arm, 9 Holes 5/16"	1	1	1	1	1	1	1	1	1	1	1	1
8	940-1372	Valve, Oil Solenoid 1/2" 2 Way N.C. DL							1	1	1	1	1	1
		Valve, Oil Solenoid 1/2" 2 Way N.C. DM							1	1	1	1	1	1
		Valve, Oil Solenoid 1/2" 2 Way N.C. DE	1	1	1	1	1	1	1	1	1	1	1	1
9	940-1348	Valve, Oil Solenoid 1/2" 2 Way N.C. DL							1	1				
		Valve, Oil Solenoid 1/2" 2 Way N.C. DM							1	1				
		Valve, Oil Solenoid 1/2" 2 Way N.C. DE	1	1	1	1	1	1	1	1				
	940-1233	Valve, Oil Motorized W/POC. DE									1	1	1	1
		Valve, Oil Motorized W/POC. DM									1	1	1	1
		Valve, Oil Motorized W/POC. DE									1	1	1	1
10	940-1224	Valve, Relief 1/2" 60 PSI	1	1	1	1	1	1	1	1	1	1	1	1

Oil Metering Assemblies			Quantity	
Item No.	Part No.	Description	378	420
1	894-936	Motor, 3/4 HP	1	1
2	40-296	Housing, Mounting Oil Pump to Motor	1	1
3	19-342	Cover, Drive Coupling Access	1	1
4	819-105	Coupling, Drive 5/8" X 5/8" Bore	1	1
5	695-112	Metering Head Assembly, Oil #300L	1	1
6	282-13	Stop Ass'y, Override, Metering Head	1	1
7	476-53	Linkage Ass'y, Limiting Arm, 9 Holes 5/16"	1	1
8	940-1372	Valve, Oil Solenoid 1/2" 2 Way N.C. DL	1	1
		Valve, Oil Solenoid 1/2" 2 Way N.C. DM	1	1
		Valve, Oil Solenoid 1/2" 2 Way N.C. DE	1	1
9	940-1233	Valve, Oil Motorized W/POC. DL	1	1
		Valve, Oil Motorized W/POC. DM	1	1
		Valve, Oil Motorized W/POC DE	1	1
10	940-1224	Valve, Relief 1/2" 60 PSI	1	1

INDUSTRIAL COMBUSTION

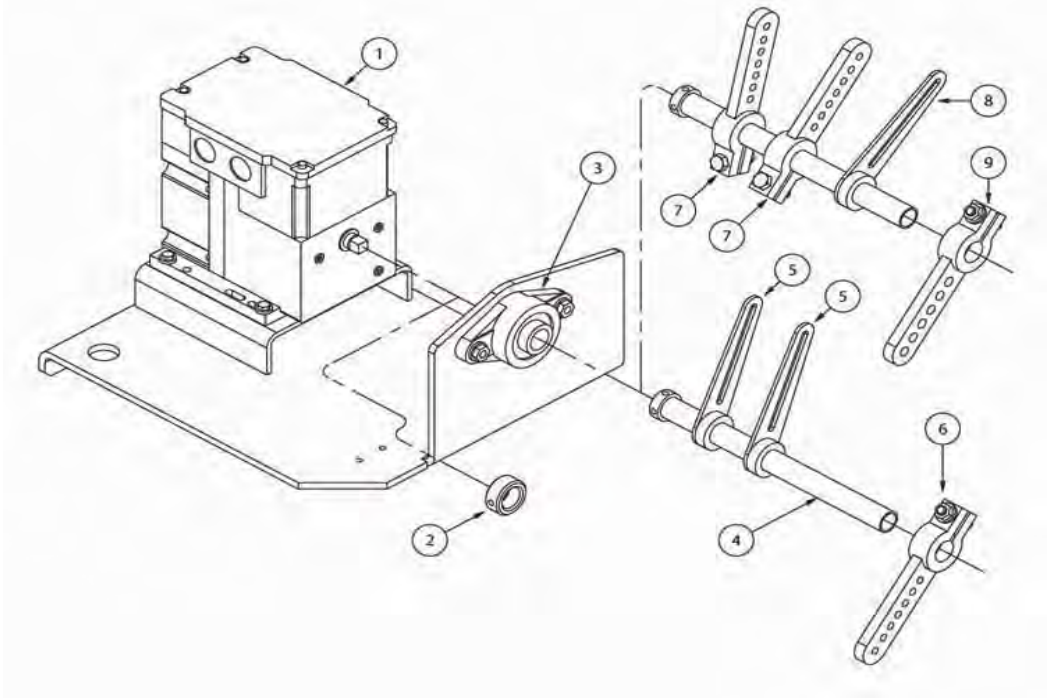
9.4.22 — Oil Metering Assembly D378 - 420



Oil Metering Assembly			Quantity	
Item No.	Part No.	Description	378	420
1	894-928	Motor, 1 HP	1	1
2	921-526	Sheave, BC38, 5/8" Bore	1	1
3	8-1633	Bracket, Assembly, Metering Head	1	1
4	29-1149	Flange, Oil Metering Adaptor	1	1
5	695-112	Metering Head Assembly, Oil #300L	1	1
6	282-13	Stop Assembly, Override, 'E' Style Metering Head	1	1
7	476-53	Linkage Assembly, Limiting Arm, 9 Holes 5/16"	1	1
8	35-437	Guard, Metering Head and Motor Belt	1	1
9	809-222	Belt, 'V'	1	1
10	810-71	Bushing	1	1
11	921-536	Sheave, 6-1/2" O.D. X 6" P.D. X 1-9/16" I.D.	1	1
12	19-531	Cover, Motor Sheave	1	1

INDUSTRIAL COMBUSTION

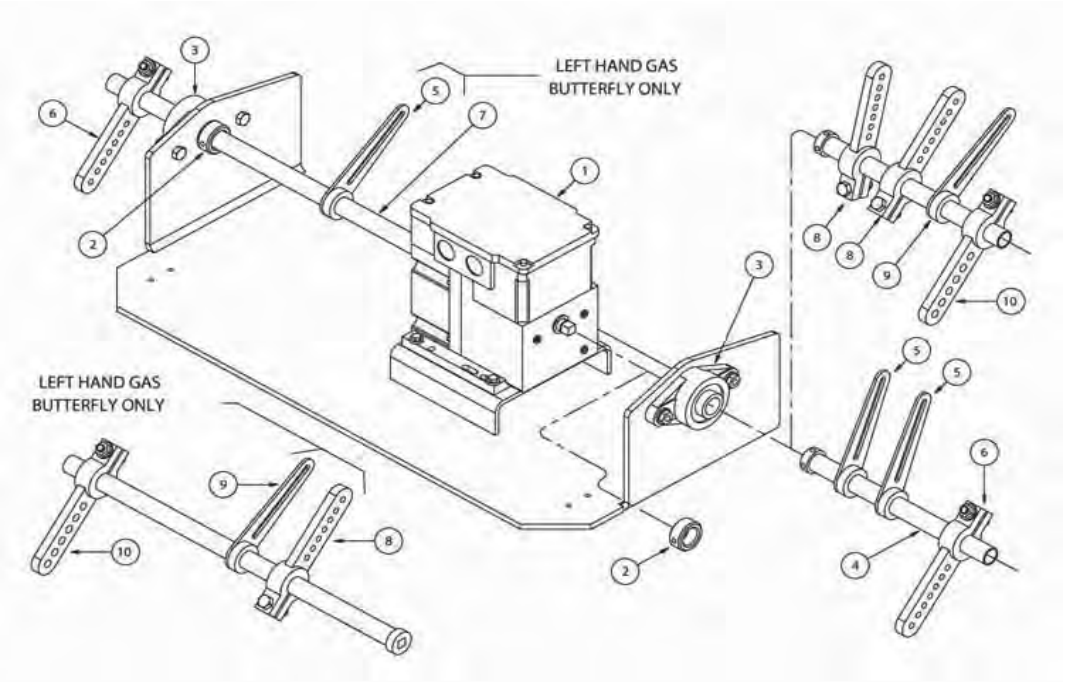
9.4.23 — Modulation, Standard



Standard Modulation			Quantity						
Item No.	Part No.	Description	42	54	63	84	105	145	175
1	894-1345	Motor Modulation, 120V, 35 Sec.	1	1	1	1	1		
	894-1346	Motor Modulation, 24V, 30 Sec.						1	1
2	18-149	Collar, Steel	1	1	1	1	1		
3	807-335	Bearing, Flanged 2 PT, 3/4" Shaft	1	1	1	1	1		
	807-341	Bearing, Flanged 2 PT, 3/4" Shaft						1	1
4	10-309	Bushing, Mod. Motor Control Arm, 9-1/2" LG	1	1	1	1	1	1	1
5	2-184	Arm, Linkage, 3/4" Shaft X 3" Slot	2	2	2	2	2	2	2
6	2-141	Arm, Linkage, 3/4" Shaft, 7 Holes	1	1	1	1	1	1	1

Standard Modulation			Quantity						
Item No.	Part No.	Description	210	252	300	315	336	378	420
1	894-1346	Motor Modulation, 24V, 30 Sec.	1	1	1	1	1	1	1
3	807-341	Bearing, Flanged 2 PT, 3/4" Shaft	1	1	1	1	1	1	1
4	10-309	Bushing, Mod. Motor Control Arm, 9-1/2" LG	1	1	1	1	1	1	1
7	2-141	Arm, Linkage, 3/4" Shaft, 7 Holes	2	2	2	2	2	2	2
8	2-184	Arm, Linkage, 3/4" Shaft, X 3" Slot	1	1	1	1	1	1	1
9	2-259	Arm, Linkage, 3/4" Shaft, 6 Holes	1	1	1	1	1	1	1

9.4.24 — Modulation, Standard Low NOx or Left Hand Gas



Standard Modulation			Quantity						
Item No.	Part No.	Description	42	54	63	84	105	145	175
1	894-1345	Motor Modulation, 120V, 35 Sec.	1	1	1	1	1		
	894-1346	Motor Modulation, 24V, 30 Sec.						1	1
2	18-149	Collar, Steel	1	1	1	1	1		
3	807-335	Bearing, Flanged 2 PT, 3/4" Shaft	2	2	2	2	2		
	807-341	Bearing, Flanged 2 PT, 3/4" Shaft						2	2
4	10-322	Bushing, Mod. Motor Control Arm 12" LG	1	1	1	1	1	1	1
5	2-184	Arm, Linkage, 3/4" Shaft X 3" Slot	2	2	2	2	2	2	2
6	2-141	Arm, Linkage, 3/4" Shaft, 7 Holes	2	2	2	2	2	2	2
7	10-307	Bushing, Mod. Motor Control Arm, 22" LG	1	1	1	1	1	1	1

Standard Modulation			Quantity						
Item No.	Part No.	Description	210	252	300	315	336	378	420
1	894-1346	Motor, Modulation, 24V, 30 Sec.	1	1	1	1	1	1	1
3	807-341	Bearing, Flanged 2 PT, 3/4" Shaft	2	2	2	2	2	2	2
4	10-322	Bushing, Mod. Motor Control Arm, 12" LG	1	1	1	1	1	1	1
7	10-343	Bushing, Mod. Motor Control Arm, 34-11/16" LG	1	1	1	1	1	1	1
8	2-141	Arm, Linkage, 3/4" Shaft, 7 Holes	2	2	2	2	2	2	2
9	2-184	Arm, Linkage, 3/4" Shaft X 3" Slot	1	1	1	1	1	1	1
10	2-259	Arm, Linkage, 3/4" Shaft, 6 Holes	2	2	2	2	2	2	2

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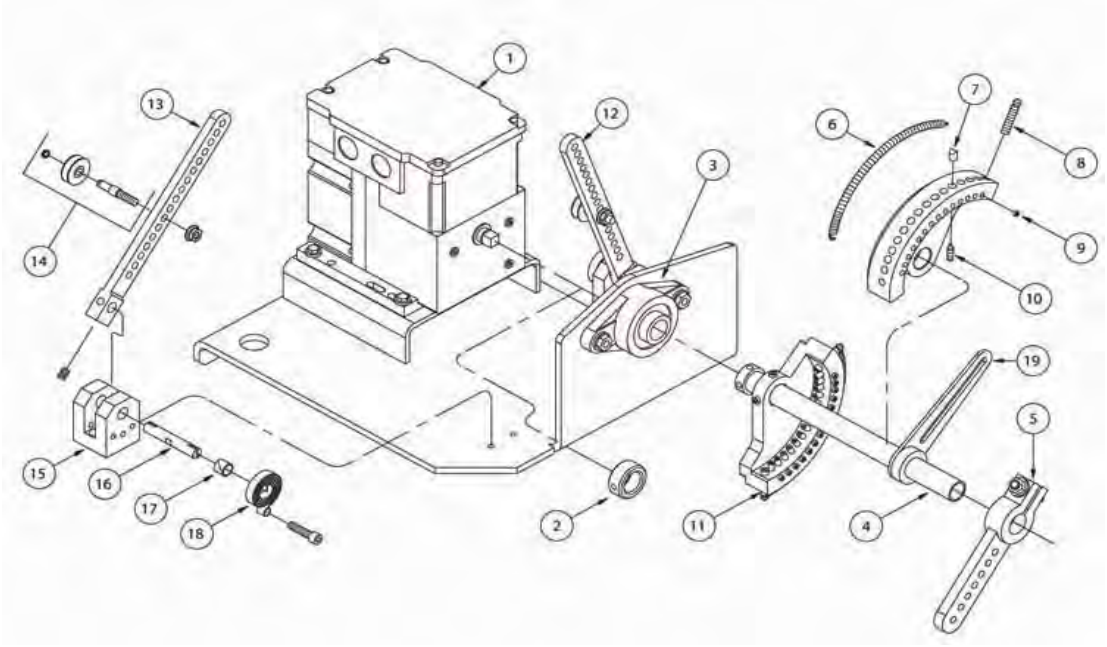
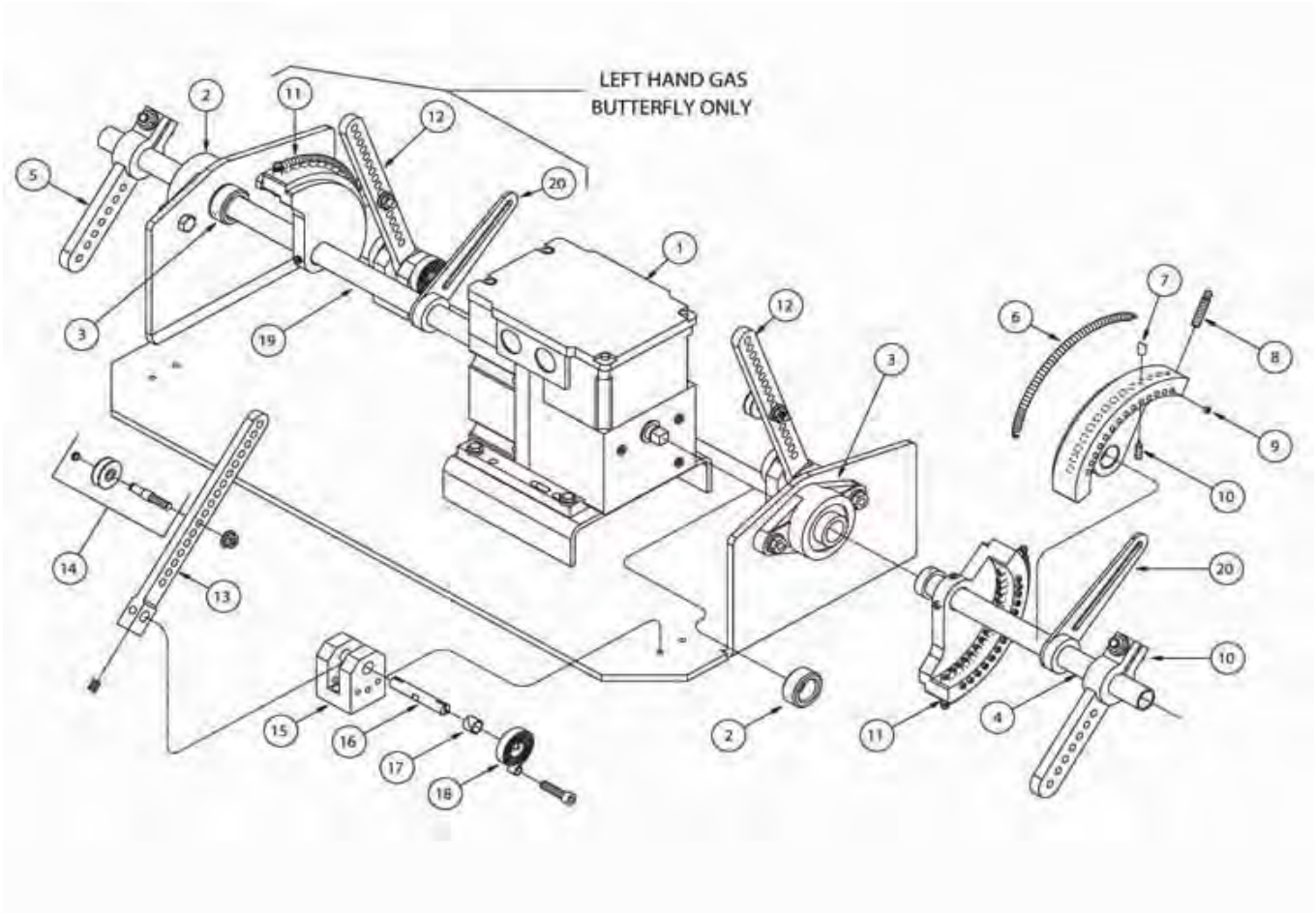
9.4.25 — Modulation, Cam Trim



Standard Modulation			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	894-1345	Motor Modulation, 120V, 35 Sec.	1	1	1	1	1					
	894-1346	Motor Modulation, 24V, 30 Sec.						1	1	1	1	1
2	18-149	Collar, Steel	1	1	1	1	1					
3	807-335	Bearing, Flanged 2 PT, 3/4" Shaft	1	1	1	1	1					
	807-341	Bearing, Flanged 2 PT, 3/4" Shaft						1	1	1	1	1
4	10-322	Bushing, Mod. Motor Control Arm, 12" LG	1	1	1	1	1	1	1	1	1	1
5	2-141	Arm, Linkage, 3/4" Shaft, 7 Holes	1	1	1	1	1	1	1			
	2-259	Arm, Linkage, 3/4" Shaft, 6 Holes								1	1	1
6	82-153	Spring, Roller Guide, Cam	1	1	1	1	1	1	1	1	1	1
7	36-111	Guide, Cam Spring	16	16	16	16	16	16	16	16	16	16
8	71-24	Screw, Spring Fastener	2	2	2	2	2	2	2	2	2	2
9	860-301	Screw, Locking Set, Kit (16 per kit)	1	1	1	1	1	1	1	1	1	1
10	860-299	Screw, Set #10-32 X 1" LG, Half Dog Point	16	16	16	16	16	16	16	16	16	16
11	313-15	Cam Assembly (Right Hand)	2	2	2	2	2	2	2	2	2	2
12	476-84	Linkage, Cam Follower Assembly (Gas)	1	1	1	1	1	1	1	1	1	1
	476-82	Linkage, Cam Follower Assembly (Oil)	1	1	1	1	1	1	1	1	1	1
13	2-13	Arm, Linkage, 5/16" Shaft, 17 Holes	1	1	1	1	1	1	1	1	1	1
14	69-303	Roller Guide Assembly	2	2	2	2	2	2	2	2	2	2
15	8-1356	Bracket, Linkage Arm, Mounting	2	2	2	2	2	2	2	2	2	2
16	74-504	Shaft, Linkage Arm, Mounting, Single Spring (Gas)	1	1	1	1	1	1	1	1	1	1
	74-506	Shaft, Linkage Arm, Mounting, Double Spring (Oil)	1	1	1	1	1	1	1	1	1	1
17	807-339	Bearing, Nylon, 3/8" I.D.	2	2	2	2	2	2	2	2	2	2
18	82-140	Spring, Cam Assembly Return (Gas)	1	1	1	1	1	1	1	1	1	1
	82-155	Spring, Cam Assembly Return (Oil)	1	1	1	1	1	1	1	1	1	1

Standard Modulation			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	894-1346	Motor, Modutrol, 24V, 30 Sec.	1	1	1	1
3	807-341	Bearing, Flanged 2 PT, 3/4" Shaft	1	1	1	1
4	10-309	Bushing, Mod. Motor Control Arm, 12" LG	1	1	1	1
5	2-259	Arm, Linkage, 3/4" Shaft, 6 Holes	1	1	1	1
6	82-153	Spring, Roller Guide, Cam	1	1	1	1
7	36-111	Guide, Cam Spring	16	16	16	16
8	71-24	Screw, Spring Fastener	2	2	2	2
9	860-301	Screw, Locking Set, Kit (16 per kit)	1	1	1	1
10	860-299	Screw, Set #10-32 X 1" LG, Half Dog Point	16	16	16	16
11	313-15	Cam Assembly (Right Hand)	2	2	2	1
12	476-84	Linkage, Cam Follower Assembly (Gas)	1	1	1	1
	476-82	Linkage, Cam Follower Assembly (Oil)	1	1	1	1
13	2-13	Arm, Linkage, 5/16" Shaft, 17 Holes	1	1	1	1
14	69-303	Roller Guide Assembly	2	2	2	2
15	8-1356	Bracket, Linkage Arm, Mounting	2	2	2	2
16	74-504	Shaft, Linkage Arm, Mounting, Single Spring (Gas)	1	1	1	1
	74-506	Shaft, Linkage Arm, Mounting, Double Spring (Oil)	1	1	1	1
17	807-339	Bearing, Nylon, 3/8" I.D.	2	2	2	2
18	82-140	Spring, Cam Assembly Return (Gas)	1	1	1	1
	82-155	Spring, Cam Assembly Return (Oil)	1	1	1	1
19	2-184	Arm, Linkage, 3/4" Shaft X 3" Slot			1	1

9.4.26 — Modulation, Cam Trim Low NOx or Left Hand Gas



Standard Modulation			Quantity									
Item No.	Part No.	Description	42	54	63	84	105	145	175	210	252	300
1	894-1345	Motor Modulation, 120V, 35 Sec.	1	1	1	1	1					
	894-1346	Motor Modulation, 24V, 30 Sec.						1	1	1	1	1
2	18-149	Collar, Steel	1	1	1	1	1					
3	807-335	Bearing, Flanged 2 PT, 3/4" Shaft	1	1	1	1	1					
	807-341	Bearing, Flanged 2 PT, 3/4" Shaft						1	1	1	1	1
4	10-322	Bushing, Mod. Motor Control Arm, 12" LG	1	1	1	1	1	1	1	1	1	1
5	2-141	Arm, Linkage, 3/4" Shaft, 7 Holes	1	1	1	1	1	1	1			
	2-259	Arm, Linkage, 3/4" Shaft, 6 Holes								1	1	1
6	82-153	Spring, Roller Guide, Cam	1	1	1	1	1	1	1	1	1	1
7	36-111	Guide, Cam Spring	16	16	16	16	16	16	16	16	16	16
8	71-24	Screw, Spring Fastener	2	2	2	2	2	2	2	2	2	2
9	860-301	Screw, Locking Set, Kit (16 per kit)	1	1	1	1	1	1	1	1	1	1
10	860-299	Screw, Set #10-32 X 1" LG, Half Dog Point	16	16	16	16	16	16	16	16	16	16
11	313-14	Cam Assembly (Left Hand)	1	1	1	1	1	1	1	1	1	1
	313-15	Cam Assembly (Right Hand)	2	2	2	2	2	2	2	2	2	2
12	476-84	Linkage, Cam Follower Assembly (Gas)	1	1	1	1	1	1	1	1	1	1
	476-82	Linkage, Cam Follower Assembly (Oil)	1	1	1	1	1	1	1	1	1	1
13	2-13	Arm, Linkage, 5/16" Shaft, 17 Holes	1	1	1	1	1	1	1	1	1	1
14	69-303	Roller Guide Assembly	2	2	2	2	2	2	2	2	2	2
15	8-1356	Bracket, Linkage Arm, Mounting	2	2	2	2	2	2	2	2	2	2
16	74-504	Shaft, Linkage Arm, Mounting, Single Spring (Gas)	1	1	1	1	1	1	1	1	1	1
	74-506	Shaft, Linkage Arm, Mounting, Double Spring (Oil)	1	1	1	1	1	1	1	1	1	1
17	807-339	Bearing, Nylon, 3/8" I.D.	2	2	2	2	2	2	2	2	2	2
18	82-140	Spring, Cam Assembly Return (Gas)	1	1	1	1	1	1	1	1	1	1
	82-155	Spring, Cam Assembly Return (Oil)	1	1	1	1	1	1	1	1	1	1
19	10-307	Bushing, Mod. Motor Control Arm, 22" LG	1	1	1	1	1	1	1			
	10-343	Bushing, Mod. Motor Control Arm, 34-11/16" LG								1	1	1

Modulation			Quantity			
Item No.	Part No.	Description	315	336	378	420
1	894-1346	Motor, Modutrol, 24V, 30 Sec.	1	1	1	1
3	807-341	Bearing, Flanged 2 PT, 3/4" Shaft	1	1	1	1
4	10-322	Bushing, Mod. Motor Control Arm, 12" LG	1	1	1	1
5	2-259	Arm, Linkage, 3/4" Shaft, 6 Holes	2	2	2	2
6	82-153	Spring, Roller Guide, Cam	1	1	1	1
7	36-111	Guiide, Cam Spring	16	16	16	16
8	71-24	Screw, Spring Fastener	2	2	2	2
9	860-301	Screw, Locking Set, Kit (16 per kit)	1	1	1	1
10	860-299	Screw, Set #10-32 X1" LG, Half Dog Point	16	16	16	16
11	313-14	Cam Assembly (Left Hand)	1	1	1	1
	313-15	Cam Assembly (Right Hand)	2	2	2	2
12	476-84	Linkage, Cam Follower Assembly (Gas)	1	1	1	1
	476-82	Linkage, Cam Follower Assembly (Oil)	1	1	1	1
13	2-13	Arm, Linkage, 5/16" Shaft, 17 Holes	1	1	1	1
14	69-303	Roller Guide Assembly	2	2	2	2
15	8-1356	Bracket, Linkage Arm, Mounting	2	2	2	2
16	74-504	Shaft, Linkage Arm, Mounting, Single Spring (Gas)	1	1	1	1
	74-506	Shaft, Linkage Arm, Mounting, Double Spring (Oil)	1	1	1	1
17	807-339	Bearing, Nylon, 3/8" I.D.	2	2	2	2
18	82-140	Spring, Cam Asembly Return (Gas)	1	1	1	1
	82-155	Spring, Cam Assembly Return (Oil)	1	1	1	1
19	10-343	Bushing, Mod. Motor Control Arm 34-11/16" LG	1	1	1	1
20	2-184	Arm, Linkage, 3/4" Shaft X 3" Slot			1	1