M/SERIES

Installation, Operation, Service, and Parts Manual

INDUSTRIAL COMBUSTION

⚠ WARNING

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

IC-993
11/2023

INDUSTRIAL COMBUSTION

M SERIES

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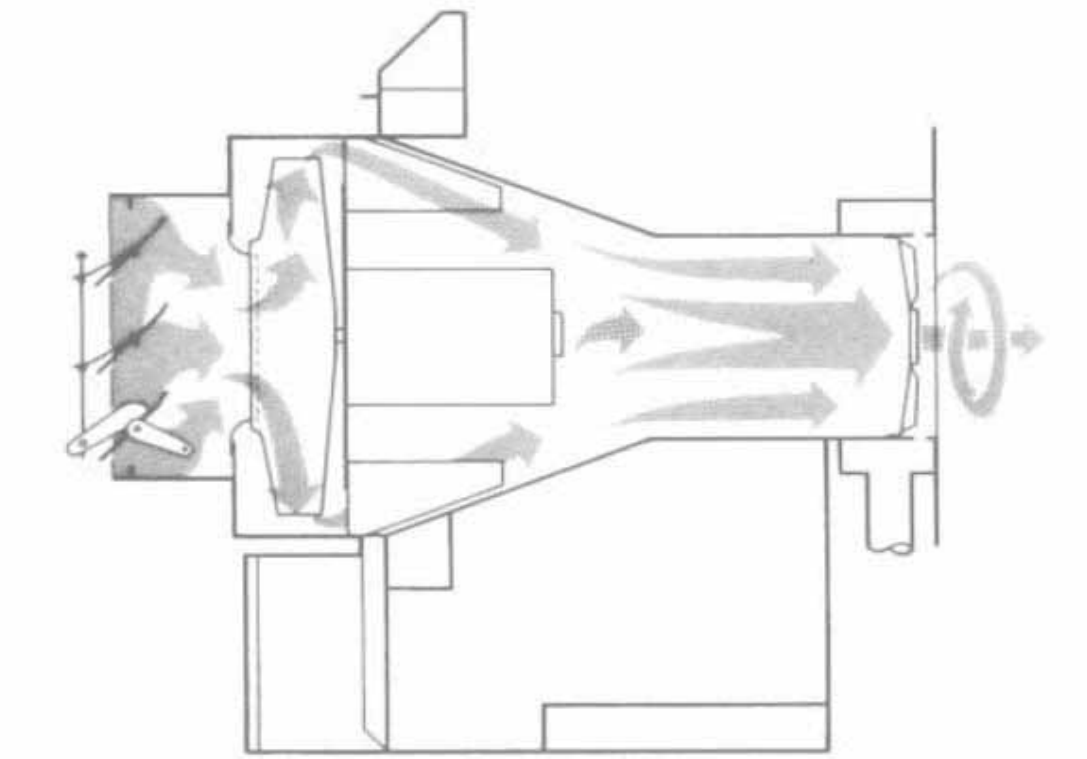

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Industrial Combustion

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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).

Standard Models	Fuel (Air Atomization)
MG	Gas
MLG	#2 Oil and Gas
MM	#2-5 Oil
MMG	#2-5 Oil and Gas
ME	#2-6 Oil
MEG	#2-6 Oil and Gas

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.

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

The M/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.

Example: The model number on the nameplate is MM-42, indicating it is a combination No. 2 to 5 oil burner with input rated at 4,200 MBtu per hour, against furnace pressure to 2.0" W.C.

Burner size and rated furnace pressure - M/Burner:

M14 to 30 1.5" W.C.

M34 to 105 2.0" W.C.

Refer to burner nameplate data for correct manifold procedures.

Standard M Series Specifications											
Burner Model	**Frame Size**	**Gas Input (MBH)**	**Oil Input (GPH)**	**BHP @ 80% Eff.**	**1 Motor HP "S"**	**2 Motor HP "P"**	**Separate Comp. Module Motor HP**	**Oil Metering System Motor HP**	**Nozzle Line Heater 3PH (KW)**	**Std. Gas Train Size (In.)**	**Gas Pressure Required ("W.C.)**
MEG-14	1	1,400	9.3	33	1/2	-	3	1/2	3	1.0	10.9
MEG-16	1	1,680	11.2	40	1/2	-	3	1/2	3	1.0	15.7
MEG-19	1	1,960	13.1	47	1/2	-	3	1/2	3	1.5	8.8
MEG-22	1	2,200	14.7	52	1/2	-	3	1/2	3	1.5	10.3
MEG-25	2	2,490	16.8	59	2	-	3	1/2	3	1.5	10.1
MEG-28	2	2,800	18.7	67	2	-	3	1/2	3	1.5	12.0
MEG-30	2	3,150	21.0	75	2	-	3	1/2	3	1.5	14.9
MEG-34	3	3,500	23.3	83	2	2	3	1/2	3	1.5	19.0
MEG-42	3	4,200	28.0	104	2	2	3	1/2	3	2.0	9.2
MEG-54	3	5,600	37.3	133	2	3	3	1/2	3	2.0	16.1
MEG-63	3	6,300	42.0	150	3	3	3	1/2	3	2.0	20.3
MEG-84	4	8,400	56.0	200	5	7.5	3	1/2	5	2.5	18.0
MEG-105	4	10,500	70.0	250	7.5	7.5	3	1/2	5	3.0	15.3

NOTES:

1. *Gas input based on natural gas at 1,000 Btu/cu. ft. and 0.60 gravity.*
2. *Gas pressure based on zero furnace pressure. For total pressure at manifold, add furnace pressure.*
3. *Oil input based on No.6 oil at 150,000 Btu/gal.*
4. *Boiler overall efficiency of 80% estimated.*
5. *Motor HP is based on altitude up to 2,000 ft. above sea level. For higher altitude or 50 Hz. applications, consult factory.*
6. *Standard motor voltages are 208-230-460/3/60.*

MOTOR SELECTIONS:

1 - Use model "S" up to 0.75" W.C. furnace pressure.
2 - Use model "P" up to 2.0" W.C. furnace pressure.
For higher furnace pressures, consult factory.

Standard M Series Specifications									
Burner Model	Frame Size	Gas Input (MBH)	Oil Input (GPH)	BHP @ 80% Eff.	1 Motor HP "S"	2 Motor HP "P"	Integral Oil/Air System Motor HP	Std. Gas Train Size (In.)	Gas Pressure Required ("W.C.)
MLG-14	1	1,400	10.0	33	1/2	-	3/4	1.0	10.9
MLG-16	1	1,680	12.0	40	1/2	-	3/4	1.0	15.7
MLG-19	1	1,960	14.0	47	1/2	-	3/4	1.5	8.8
MLG-22	1	2,200	15.7	52	1/2	-	3/4	1.5	10.3
MLG-25	2	2,490	18.0	59	2	-	3/4	1.5	10.1
MLG-28	2	2,800	20.0	67	2	-	3/4	1.5	12.0
MLG-30	2	3,150	22.5	75	2	-	3/4	1.5	14.9
MLG-34	3	3,500	25.0	83	2	2	1	1.5	19.0
MLG-42	3	4,200	30.0	104	2	2	1	2.0	9.2
MLG-54	3	5,600	40.0	133	2	3	1	2.0	16.1
MLG-63	3	6,300	45.0	150	3	3	2	2.0	20.3
MLG-84	4	8,400	60.0	200	5	7.5	2	2.5	18.0
MLG-105	4	10,500	75.0	250	7.5	7.5	2	3.0	15.3

NOTES:

1. *Gas input based on natural gas at 1,000 Btu/cu. ft. and 0.60 gravity.*
2. *Gas pressure based on zero furnace pressure. For total pressure at manifold, add furnace pressure.*
3. *Oil input based on No. 2 oil at 140,000 Btu/gal.*
4. *Boiler overall efficiency of 80% estimated.*
5. *Motor HP is based on altitude up to 2,000 ft. above sea level. For higher altitude or 50 Hz. applications, consult factory.*
6. *Standard motor voltages are 208-230-460/3/60.*

MOTOR SELECTIONS:

1 - Use model "S" up to 0.75" W.C. furnace pressure.
2 - Use model "P" up to 2.0" W.C. furnace pressure.
For higher furnace pressures, consult factory.

Standard M Series Specifications										
Burner Model	**Frame Size**	**Gas Input (MBH)**	**Oil Input (GPH)**	**BHP @ 80% Eff.**	**1 Motor HP "S"**	**2 Motor HP "P"**	**Integral Oil/Air System Motor HP**	**Nozzle Line Heater 3PH (KW)**	**Std. Gas Train Size (In.)**	**Gas Pressure Required ("W.C.)**
MMG-14	1	1,400	9.7	33	1/2	-	3/4	3	1.0	10.9
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MMG-28	2	2,800	19.3	67	2	-	3/4	3	1.5	12.0
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MMG-42	3	4,200	29.0	104	2	2	1	3	2.0	9.2
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MMG-63	3	6,300	43.5	150	3	3	2	3	2.0	20.3
MMG-84	4	8,400	58.0	200	5	7.5	2	5	2.5	18.0
MMG-105	4	10,500	72.4	250	7.5	7.5	2	5	3.0	15.3

NOTES:

1. *Gas input based on natural gas at 1,000 Btu/cu. ft. and 0.60 gravity.*
2. *Gas pressure based on zero furnace pressure. For total pressure at manifold, add furnace pressure.*
3. *Oil input based on No. 4 - 5 oil at 145,000 Btu/gal.*
4. *Boiler overall efficiency of 80% estimated.*
5. *Motor HP is based on altitude up to 2,000 ft. above sea level. For higher altitude or 50 Hz. applications, consult factory.*
6. *Standard motor voltages are 208-230-460/3/60.*

MOTOR SELECTIONS:

1 - Use model "S" up to 0.75" W.C. furnace pressure.
2 - Use model "P" up to 2.0" W.C. furnace pressure.
For higher furnace pressures, consult factory.

M/Series

Table of Contents

CHAPTER 1 Introduction

1.1 — Overview

Industrial Combustion M/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., and other regulatory agency control options are available.

The operator of this equipment must be familiar with the individual functioning of all controls to understand the operations and procedures described in this manual, and supplementary instructions provided with optional controls.

⚠Caution

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

1.2 — Description

The industrial Combustion M/Series burners are of the low pressure, air atomizing (nozzle) 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.

M/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.

1.3 — Operating Controls

The burner is supplied with a remote control panel and with a burner mounted junction box.

INDUSTRIAL COMBUSTION

1.3.1 — Control Panel

The control panel contains a flame safeguard programming control, motor starters, relays, time delays, and terminal strips mounted internally on a panel sub-base. Lights, switches, potentiometers, a control circuit breaker, and flame safeguard displays are mounted externally on the panel. The burner control circuit operates on 115 volt, single phase, 60 hertz (or 50 hertz when required) alternating current. The major components are:

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 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.
High Fire Limiting Control (optional)	270 ohm potentiometer, used to limit high fire travel.
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.

⚠ Warning

To prevent serious personal injury or death, read the flame safeguard manual and fully understand its contents before attempting to operate this equipment.

1.3.2 — Flame Safeguard Controls

Automatically programs each starting, operating, and shutdown cycle in conjunction with operating, limit, and interlock devices. This includes, in timed sequence, operation of the blower motor, ignition system, fuel valve(s), and modulating motor. The sequence includes air purge prior to ignition and after shutdown of the burner.

The flame scanner monitors both oil and gas flames and instantly responds to loss of flame.

The control recycles automatically during normal operation, or following a power interruption. It must be manually reset following a safety shutdown. An internal checking circuit, effective on every start, will prevent burner operation in the event the flame relay is held in.

1.3.3 — Flame Scanner

Monitors gas or oil pilot flames and energizes the programmer's flame relay in response to a flame. It monitors main flame (oil or gas) after termination of pilot proving period.

1.3.4 — Motors

Drive impeller, air/oil metering unit, oil metering unit, fuel unit, and air compressor.

1.3.5 — Motor Starters

Energize motors.

1.3.6 — Ignition Transformer

Provides high voltage spark for ignition of gas pilot or main flame on direct spark models.

1.3.7 — Modulating Motor

Operates the air damper and fuel rate valves through a linkage system to adjust air-fuel ratios under all load conditions. The low-fire switch, an integral auxiliary switch, must be closed to prove that the air damper and fuel metering valve or metering unit, are in the low-fire position before ignition can occur.

1.4 — Combustion Air System

The air handling section is hinged for easy access to the air and firing head components. Centrifugal axial air flow is a true forced draft design.

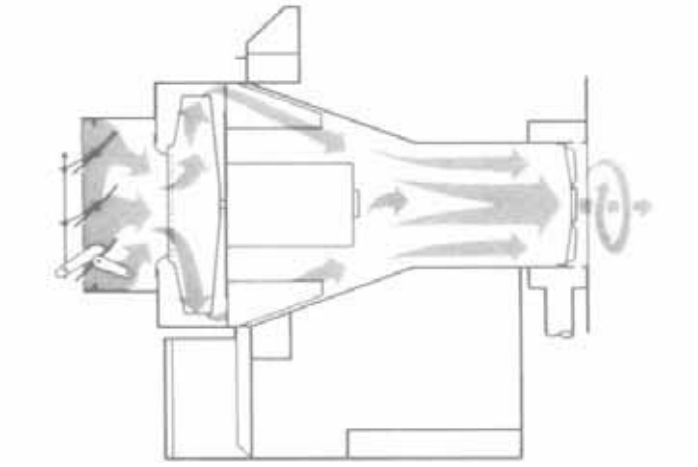


FIGURE 1-1. Centrifugal Axial Air Flow

⚠ Warning

To prevent serious personal injury or death from moving parts, shut off all electrical power before servicing this equipment.

Component	Details
Impeller	Combustion air is supplied by a heavy duty balanced backward curved impeller. This design greatly reduces the accumulation of any dirt, soot, or debris on the impeller.
Motor	The impeller is directly driven by the motor at 3450 rpm. **NOTE:** Optional motor/impeller combinations are available for higher furnace pressures, high altitude locations, and 50 cycle power.
Air Volume Regulator	The volume control blades are positioned by linkage from the modulating motor.
Air Handling Section	The hinged assembly houses the impeller, motor, damper assembly, and air straighteners.
Combustion Air Proving Switch	A pressure sensitive switch actuated by air pressure created by the impeller. Contacts close to prove combustion air flow.
Diffuser	An air flow diffuser stabilizes flame front.

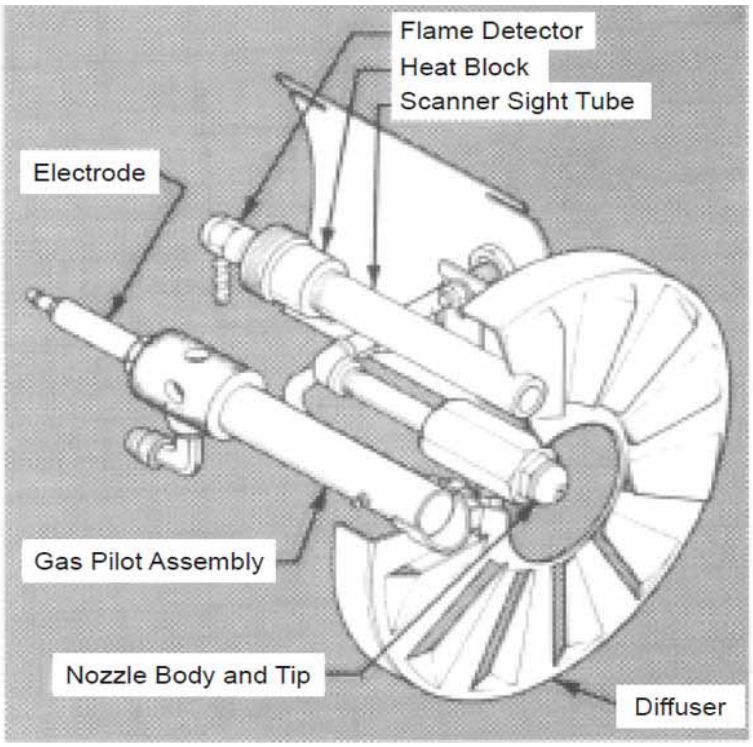


FIGURE 1-2. **Diffuser and Drawer Assembly**

1.4.1 — Operation

Air from the impeller flows through the blast tube and diffuser to mix with fuel in the ignition zone. Combustion air flow rate is determined by the position of the air regulating blades at the inlet of the impeller. Linking the air flow with fuel flow provides efficient combustion at all firing rates.

1.5 — Gas System

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	Details
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 U.L. burners include: Models 14-22, Diaphragm gas valve. Models 28-42, One motorized gas valve w/closure interlock. Models 54-105, One motorized gas valve w/closure interlock and one solenoid valve.
Main Gas Regulator	Regulates gas train pressure to specified pressure required at 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 (Models 28-105)	A pressure actuated switch that remains closed when gas pressure is below a preselected 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 (Models 29-105)	A pressure actuated switch that remains closed when gas pressure is above a preselected setting. Should the pressure drop below this setting, the switch contacts will open, causing the main gas valve(s) to close. This switch requires manual reset after being tripped. **NOTE:** Gas train components upstream of the butterfly valve are shipped loose to be mounted by the installer.

1.6 — Pilot Gas Train

A solenoid valve that opens during the ignition period to admit fuel to the pilot. It closes after main flame is established.

Component	Details
Gas Pressure Regulator	Reduces gas pressure to that required by the pilot.
Gas Pilot Shutoff Cock	For manually closing the pilot gas supply. **NOTE:** Pilot gas supply connection must be upstream of the main gas pressure regulator.

1.6.3 — Operation

Metered gas flows through the main gas shutoff cock, through the pressure regulator to the automatic gas valve(s) 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.

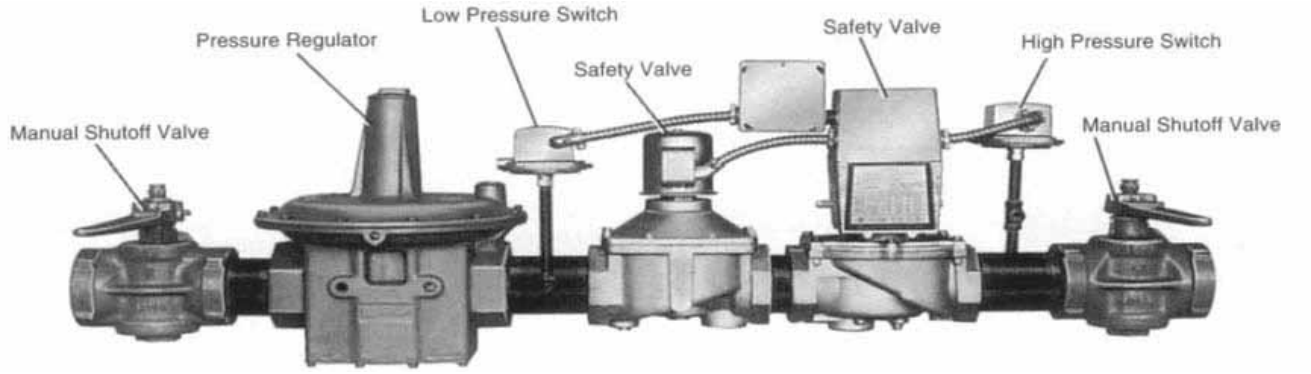


FIGURE 1-3. Gas Train (configurations may vary)

A normally open vent valve, if required, is located between the two automatic gas valve(s). This valve is shut when the automatic gas valve(s) is open. When the automatic valve(s) is closed, the vent valve is open for venting any present gas to the outside.

1.6 — Oil System

1.6.1 — Air Atomizing Burners

Models MM, MMG, ME, and MEG burners use compressed air for atomization. Atomizing air is independent of combustion air. Either of the two air/oil systems are used, depending on burner size and fuel.

Models MM, MMG 14-105: Use an integral air compressor/oil metering unit mounted on the burner and driven by a separate motor.

Models ME, MEG: Supplied with a separate compressor module for mounting near the burner. The separately driven oil metering unit is mounted on the burner.

1.6.2 — 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.

1.6.3 — Nozzle Assembly

The nozzle assembly consists of four main parts: body, compression spring, swirler, and 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 the 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 the 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.

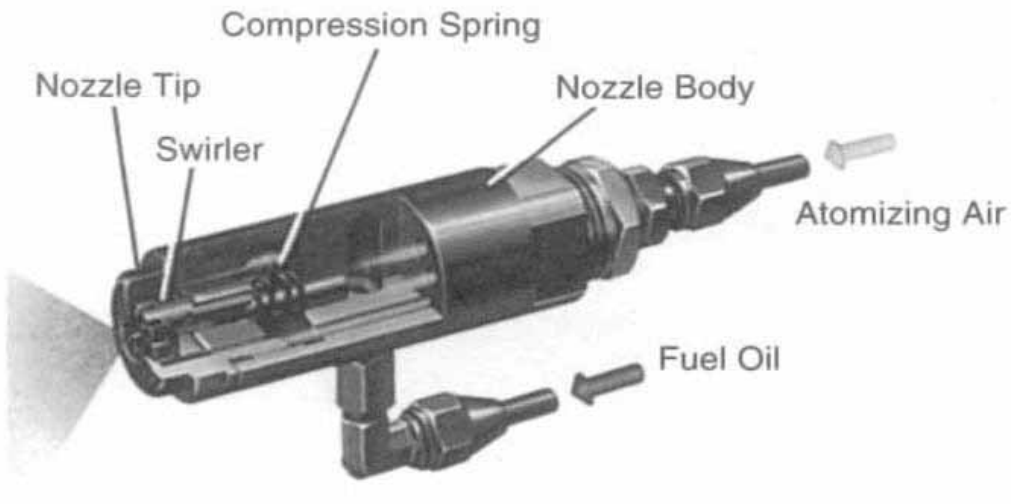


FIGURE 1-4. **Nozzle Assembly**

1.6.4 — Nozzle Line Electric Heater

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 burner from starting until proper atomizing temperature is attained.

1.6.5 — Oil Strainer

Prevents foreign matter from entering the burner oil system.

INDUSTRIAL COMBUSTION

1.6.6 — 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.

1.6.7 — 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.

1.6.8 — Integral Air/Oil Unit

Model designation MM, MMG No. 2 through 5 oil with atomization. These models utilize an integral air compressor/oil metering unit which is separate drive at 1725 rpm and mounted on the burner.

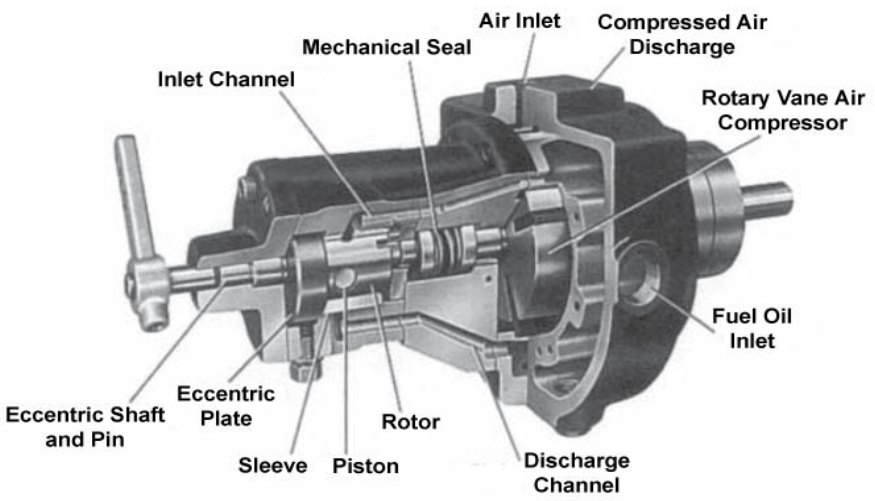


FIGURE 1-5. **Integral Air/Oil Unit**

1.6.9 — 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.

1.6.10 — 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 nozzle), and 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.

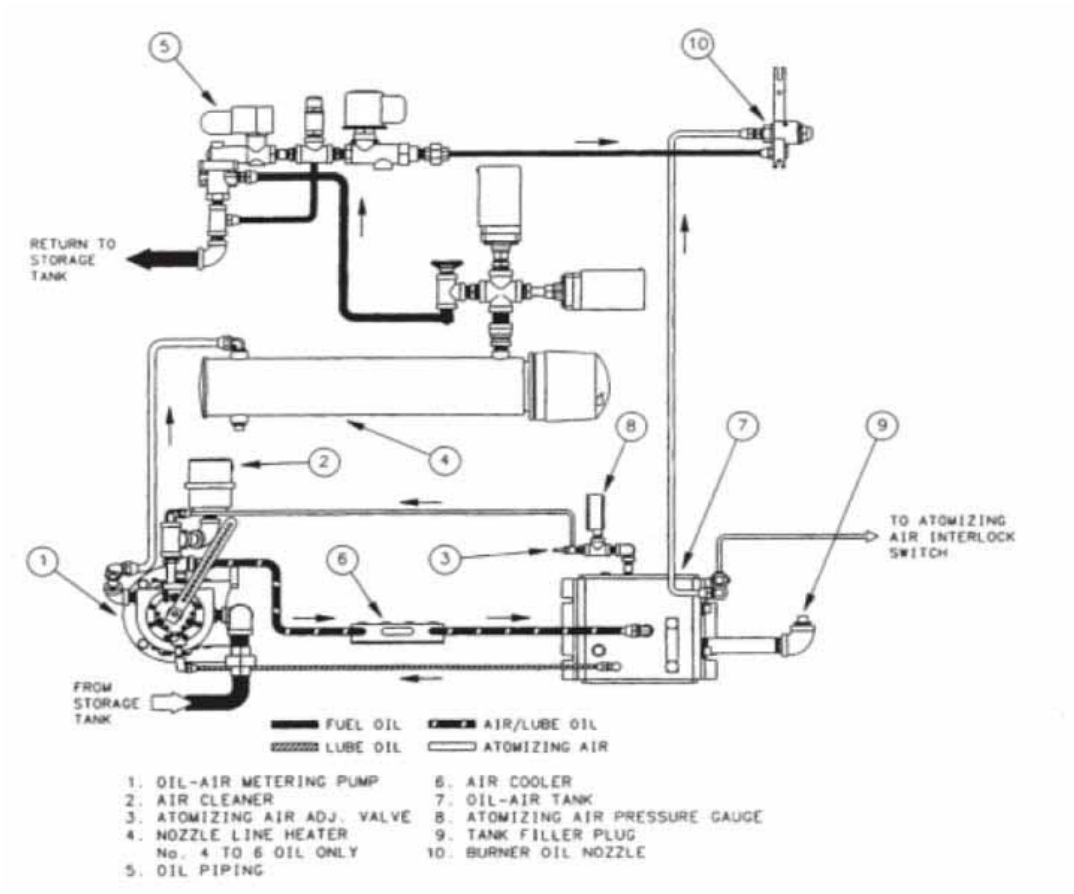


FIGURE 1-6. Integral Compressor Air-Oil Metering System

1.6.11 — Separate Compressor Module Burners

All models ME and MEG burners have a burner mounted oil metering unit and a separate compressor module.

1.6.12 — 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 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.

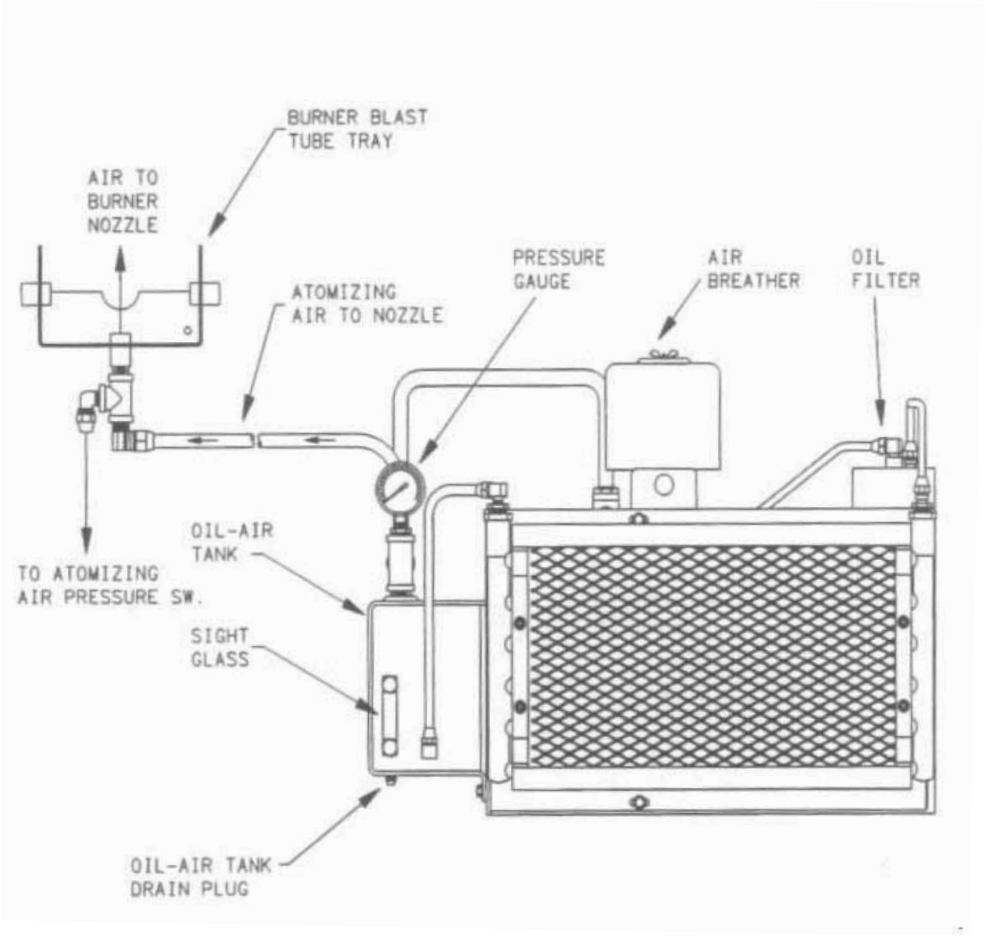


FIGURE 1-7. Integral Air/Oil Unit

1.6.13 — 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.

1.6.14 — Operation

Oil is delivered to the burner at low circulating loop pressure. Metered oil flows through the nozzle line electric heater (heated, if necessary) to the common port of the 3-way solenoid valve to the normally open port and back

to the return line during pre- and post-purge. Metered oil is delivered to the nozzle through the normally closed port during the firing cycle.

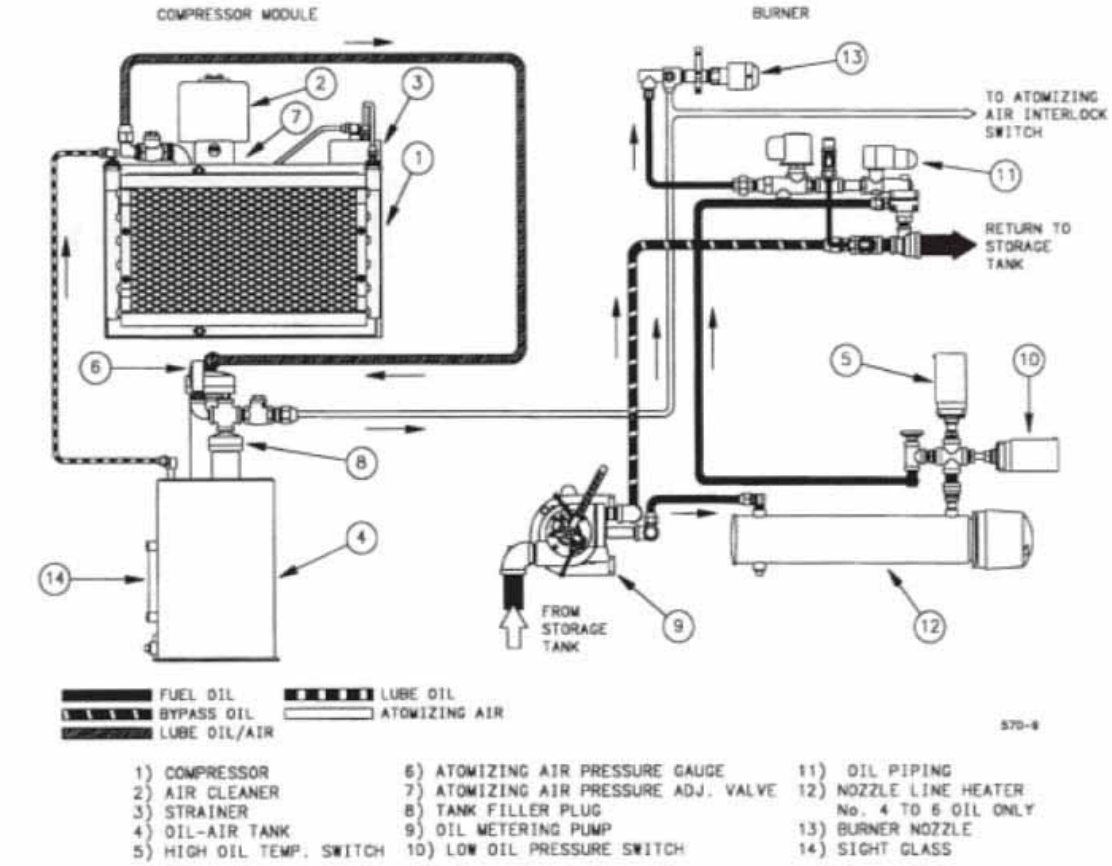


FIGURE 1-8. Separate Compressor Air-Oil Metering System

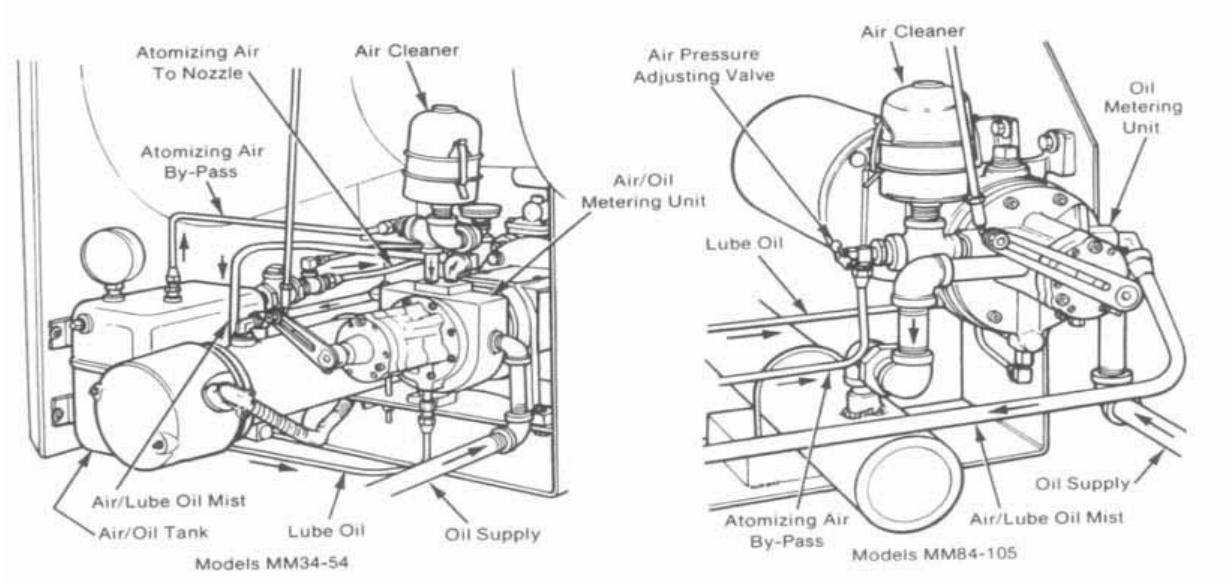


FIGURE 1-9. Burner Mounted Air-Oil Metering Unit

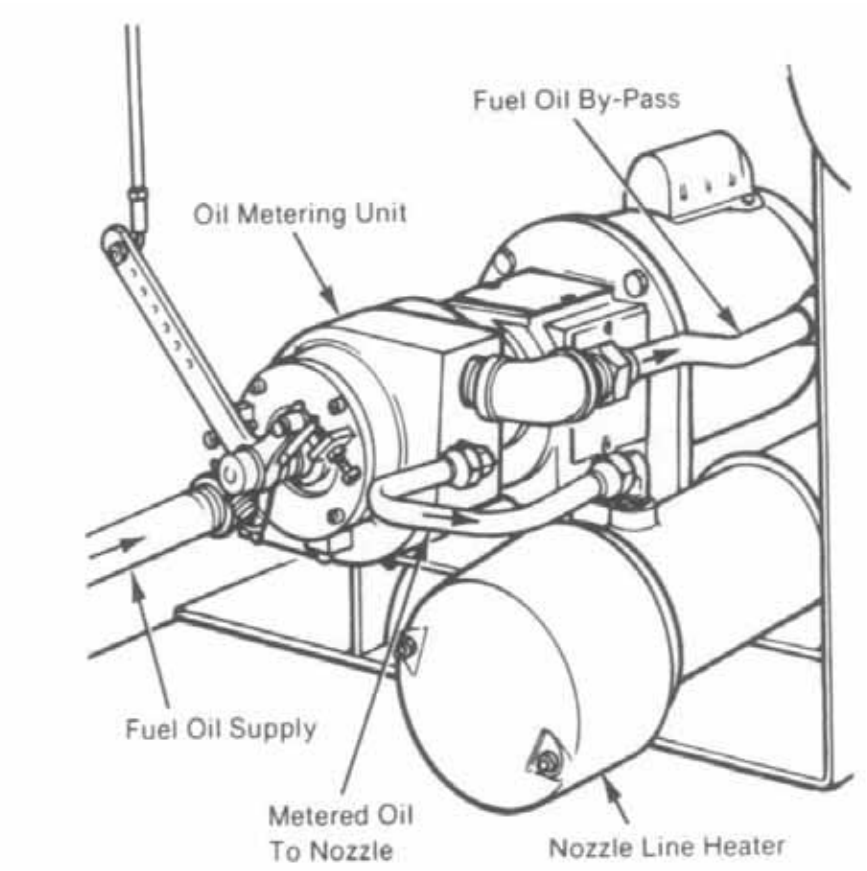


FIGURE 1-10. Burner Mounted Oil Metering Unit

CHAPTER 2 Installation

2.1 — Draft Conditions

A boiler or other heating vessel fired with an M/Series burner does not depend on chimney draft for proper combustion air. Combustion air is supplied by the burner forced draft blower providing adequate air for any normal combustion condition.

Since draft control is essential to maximum efficiency, a draft regulator may be required when the vessel is connected to a tall stack or where wind conditions may cause erratic draft. Excessive furnace draft contributes to inefficient burner operation.

Sealed boilers may be operated under positive firebox pressure within the capability of the burner.

2.2 — Combustion Air Supply

The space in which a burner operates must be supplied with adequate fresh air for combustion and ventilation purposes. Fresh air supply must beet or exceed all code requirements. Consult with the insurance carrier and/or local authorities for specific regulations.

⚠ Warning

The boiler room pressure must be at least equal to the outdoor atmospheric pressure. Where fan ventilation is used, air must be forced into the boiler room. Never exhaust air from the boiler room. Adjoining areas having exhaust fans must be positively isolated from the boiler room.

2.3 — Combustion Chamber Design

It is not possible to include a complete design and construction in this chapter, but the following may be helpful in arranging burner applications in typical boilers. Combustion chambers are of three basic types:

1. Completely water enclosed as in Scotch type boilers.
2. Conventional “dry bottom” firebox boilers having a refractory floor and full water walls.

3. Full refractory combustion chambers in “ash pit” type installations where a complete firebox is required below the level of the boiler water walls.

The M/Series burners are of the forced draft flame retention type. Refractory is required only to protect surfaces not adequately protected by free circulating water. Four basic objective are:

1. Provide adequate combustion space.
2. Avoid flame impingement.
3. Protect surfaces not adequately water cooled.
4. Seal openings.

BURNER MODEL	LENGTH L	WIDTH W	CENTERLINE HEIGHT - CH
14	35	20	8
16	40	21	9
19	42	22	10
22	45	24	11
25	46	24	12
28	48	26	12
30	50	28	13
34	55	28	14
42	56	28	14
54	60	32	15
63	65	34	16
84	74	38	19
105	84	46	23

FIGURE 2-1. Suggested Minimum Combustion Chamber Dimensions

Suggested minimum combustion chamber dimensions are based on the rated capacity of the burner and for a Firebox type boiler.

While these dimensions are typical for good practice, satisfactory results may be achieved with modifications to suit some conditions. Factors such as fuel properties, total combustion volume, and length of flame travel often make fixed requirements impractical. When in doubt, consult the factory.

Figure 2-2 shows a typical Firebox boiler base installation (refer to Figure 2-1 for dimensions).

Combustion chamber firebrick side walls should extend a minimum of 2” above the mudleg of the boiler. The rear wall should be carried 2 or 3 courses higher than the sidewall and may be corbelled to deflect the flame from direct impingement.

Insulation should be provided between the refractory and the boiler base. Mineral wool, or other material not likely to settle is preferred. The chamber front wall may be constructed of firebrick, insulating firebrick, or plastic

refractory. Insulation should be used between refractory and front plate. A metal sleeve may be provided around the burner opening to simplify burner service. Firebrick, or insulating firebrick, should be set in high temperature bonding mortar with provision for expansion.

Figure 2-3 shows a typical fire door type installation in a sealed base Firebox boiler. Where combustion volume is adequate and boiler design permits, fire door installations are acceptable. A suitable hearth can be made by filling the base with rubble and covering with loose or cast refractory.

Figure 2-4 shows a typical installation for Scotch type boilers.

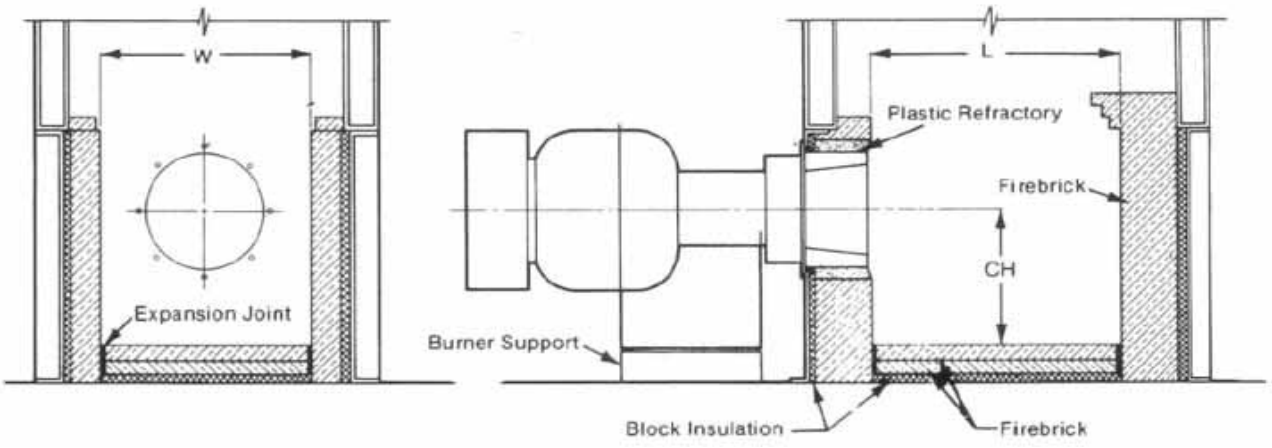


FIGURE 2-2. Typical Application for Firebox Boiler

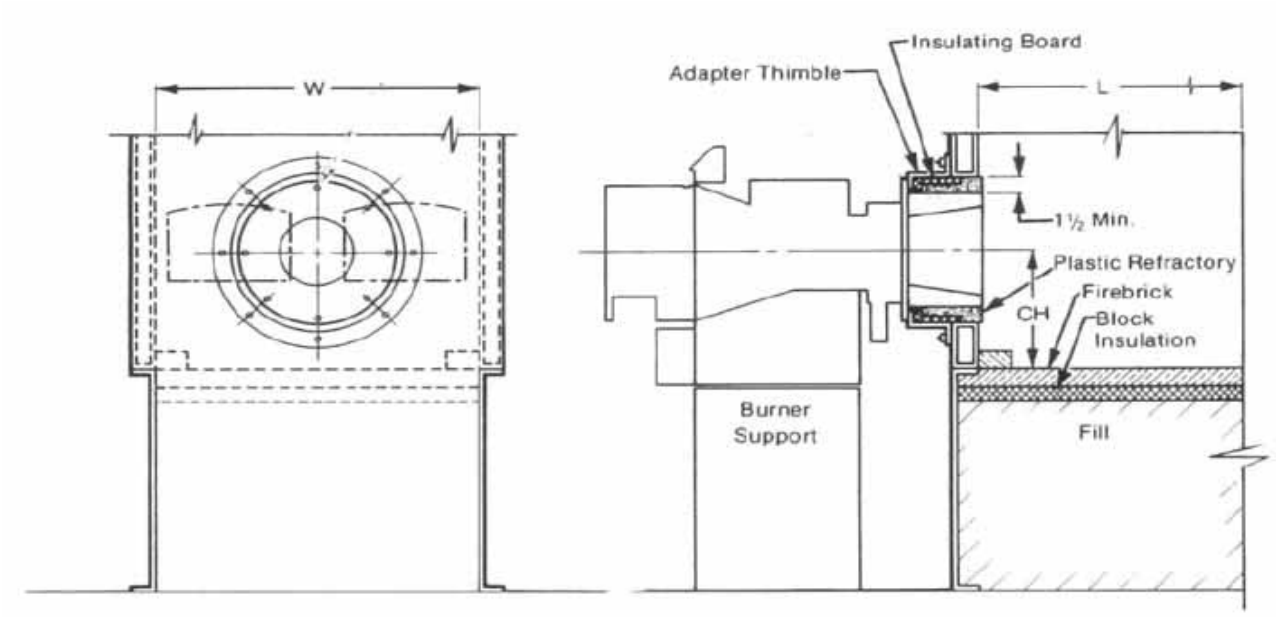


FIGURE 2-3. Typical Application for Firedoor Boiler

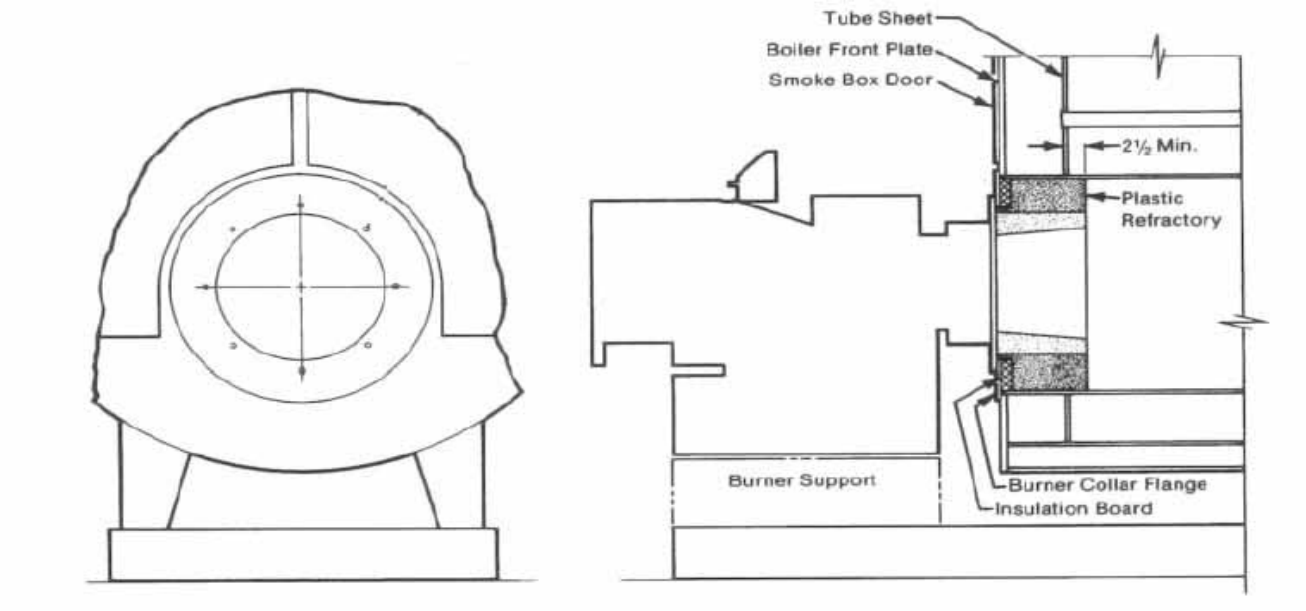


FIGURE 2-4. **Typical Application for Scotch Marine Boiler**

2.4 — Dry Oven and Burner Installation

Prepare the boiler front plate as follows:

1. Determine burner mounting height by referring to Figure 2-1. Locate and scribe a level horizontal centerline across the mounting face.
2. Locate and scribe vertical centerline. Locate studs or bolts so they are fully anchored in front plate.
3. Refer to Figures 2-5 through 2-8 for bolt circle and cut out dimensions.

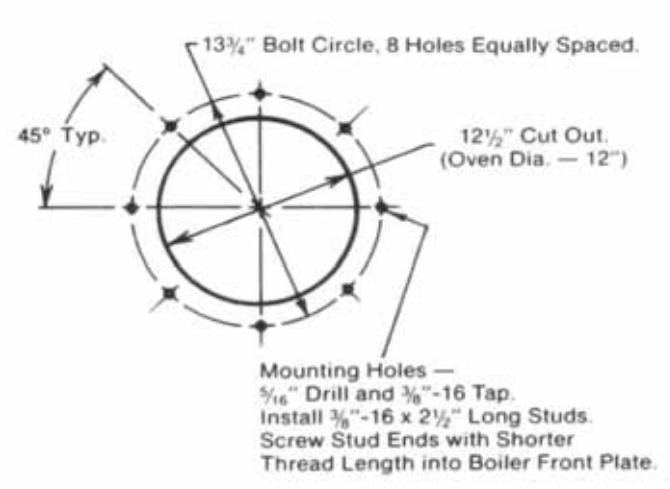


FIGURE 2-5. **M 14-22 Mounting Dimensions**

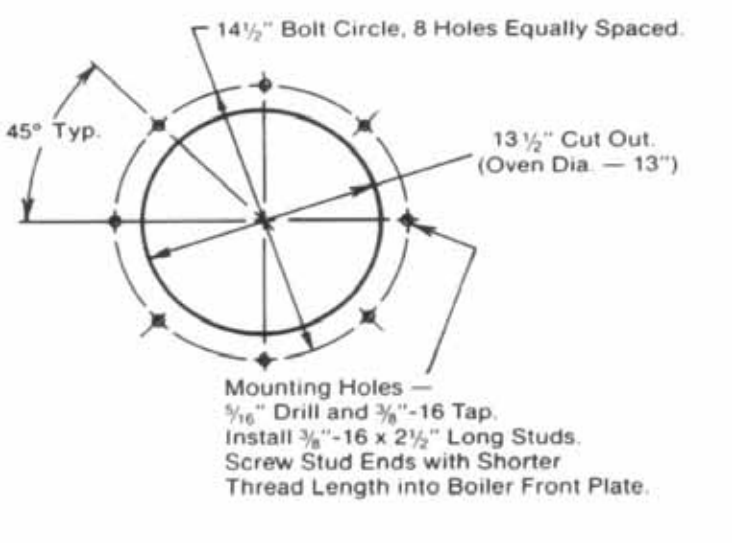


FIGURE 2-6. M 25-30 Mounting Dimensions

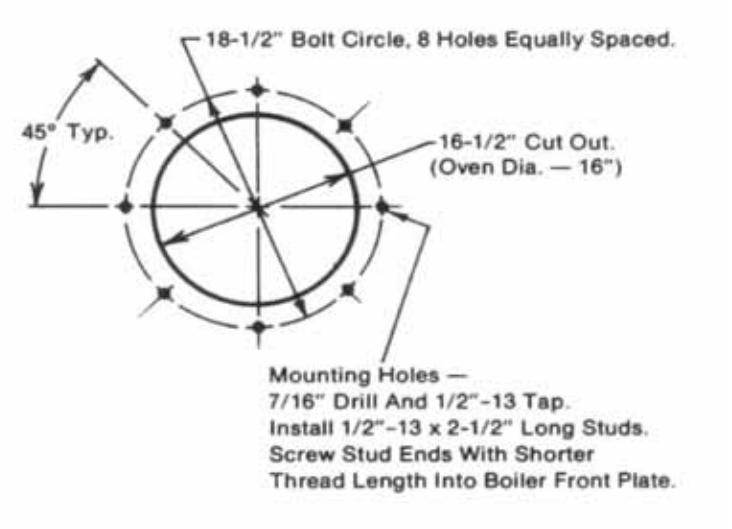


FIGURE 2-7. M 34-63 Mounting Dimensions

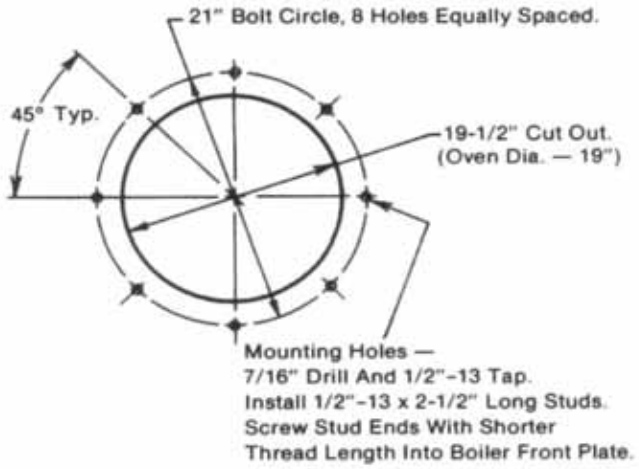


FIGURE 2-8. M 84-105 Mounting Dimensions

⚠ Caution

Gasket should be resilient to seal any uneven area between metal surfaces to prevent escape of combustion products.

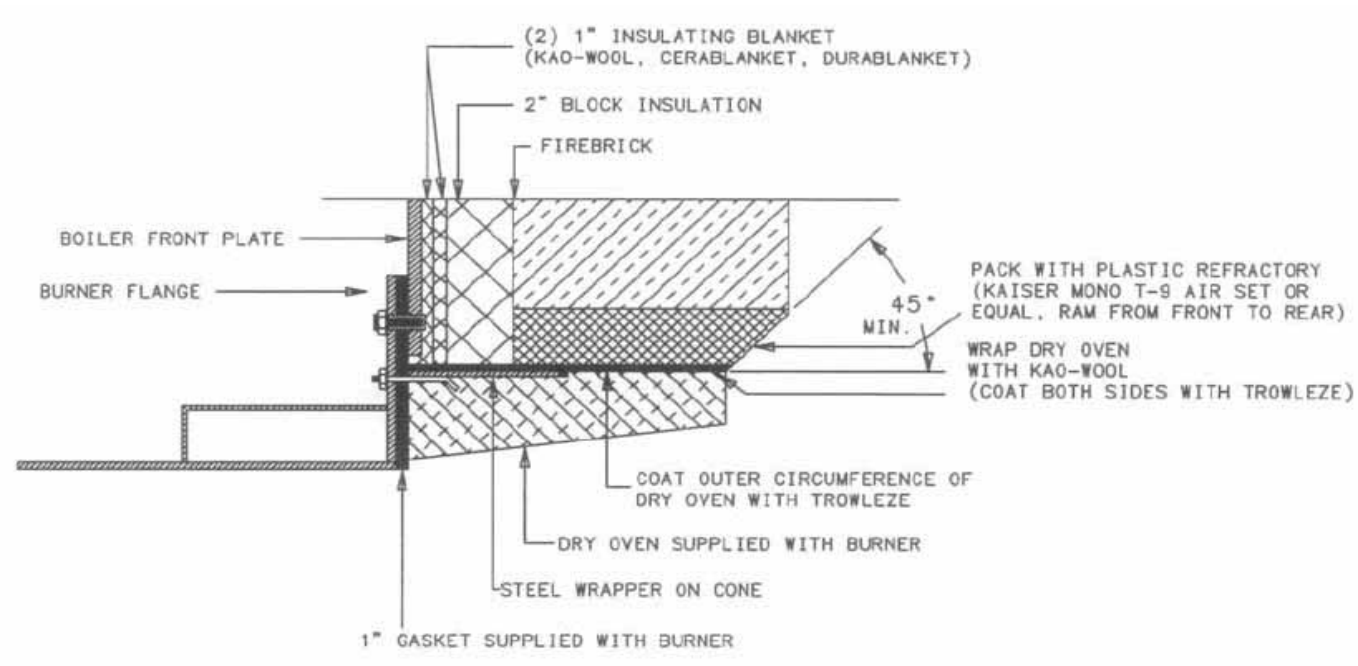


FIGURE 2-9. Burner Mounting Details for Firebox and Watertube Boilers

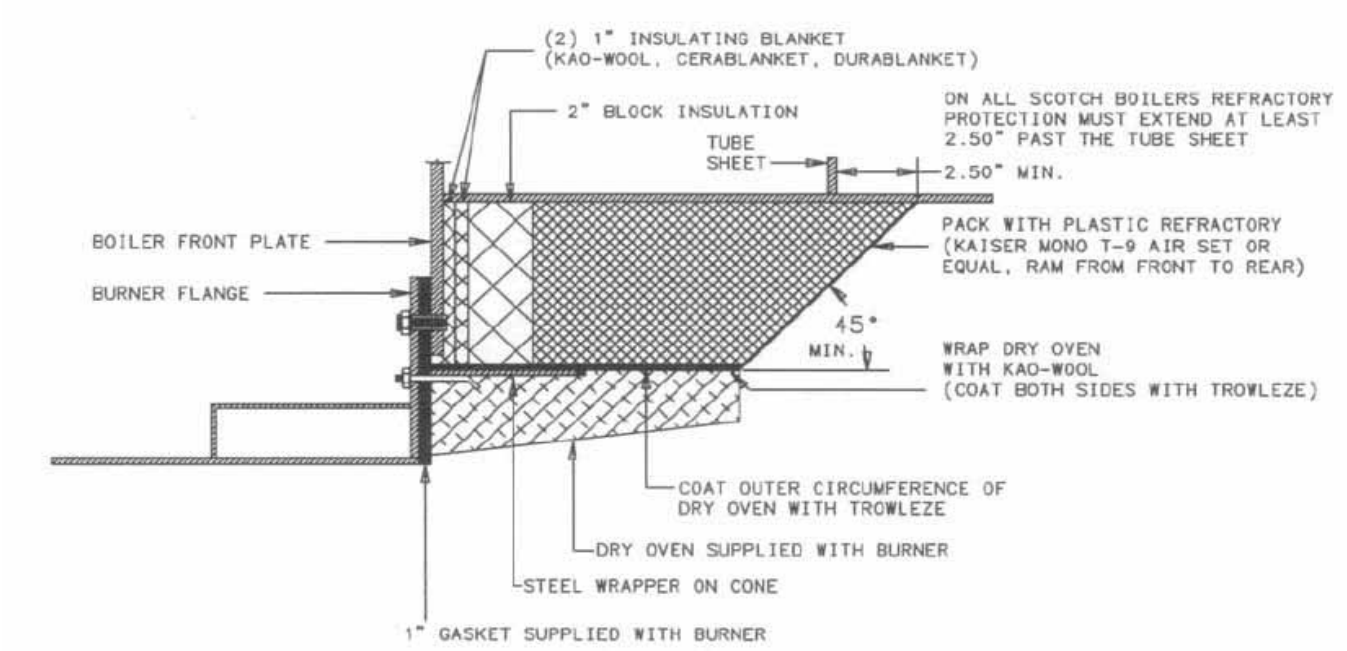


FIGURE 2-10. Burner Mounting Details for Scotch Marine Boilers

4. At this point, check the position of the nozzle as it relates to the diffuser and electrodes, and check the diffuser as it relates to the gas orifices and gas pilot. It is difficult to check these dimensions after the burner is in place. Refer to the Maintenance Section of the manual for the drawer assembly dimensions.

Mounting Dry Oven on Burner:

5. Coat or dip burner gasket with Trowleze on both sides. Trowleze air set mortar should be thinned with water to a consistency of thick pea soup.
6. Place gasket over oven studs and install oven on burner flange. Oven must be centered around burner blast tube. Tighten nuts securely. Coat outer circumference of oven with Trowleze.

Mounting Burner to Heating Vessel:

7. Use rope gasket (not provided with burner) between burner flange and front plate, routing rope inside bolt circle and looped around each stud.
8. Locate burner and dry oven into position taking care not to damage any linkage or tubing on the burner. Install burner and tighten nuts securely.

In Scotch type boilers, the refractory should extend past the tube sheet a minimum of 2” to 2-1/2” (see Figure 2-10). In Firebox boilers, the refractory oven should be flush or set back as shown in Figure 2-9. The outside circumference of the refractory oven must be protected.

Packing Plastic Refractory Around Oven:

9. 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. Ram the plastic refractory from front to rear, parallel to the outside surface of the dry oven.

INDUSTRIAL COMBUSTION

NOTE: The burner support should be long enough to allow the burner to be withdrawn from the heating vessel.

2.6 — Compressor Module

The MM, MMG 63, all ME, and all MEG burners use a compressor module, which must be separately mounted and piped.

The compressor module should be accessible and within close proximity of the burner. Piping from the compressor module consists of an atomizing air line to the drawer assembly, and a lube oil line to and from the burner cooling coil.

2.7 — Gas Piping

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 standards:

"National fuel Gas Code" NFPA No. 54, ANSI No. Z223-1.

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., 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.

2.8 — Fuel Oil Piping

2.8.1 — Air Atomizing Systems

MM, MMG, ME, and MEG models use air atomization. These burners use a separately driven burner mounted oil metering unit, requiring oil supplied to the burner at 10 to 15 psi on MM and MMG models and up to 20 psi on ME and MEG models. Since the scope of this manual is limited to burner installation, operation, and maintenance, pipe sizing is not covered in detail. Please consult factory for more information.

2.8.2 — Circulating Oil Pump

A circulating 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, and the pump suction line as short 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 that it may be easily cleaned.

2.8.3 — Oil Loop Heaters

Heating may be necessary to facilitate pumping and atomization.

The nozzle line heater supplied with MM, ME, MMG, and MEG burners is for startup purposes only. This heater cannot heat the fuel oil for proper burning at fuel 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 for 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

2.9 — Installation Checklist

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

a) Electrical terminals in the control panel and on all electrical components.
b) Piping fittings and unions.
c) Tubing connections.
d) Nuts, bolts, screws.

Check	Area
	Before operating pumps, metering heads, and compressors, make certain that reservoirs are properly filled with the specified lubricant. Open all necessary oil shutoff valves. Do not run compressors, pump, or metering units without oil.
	Before connecting electrical current to any component, be sure the supply voltage is the same as that specified on the component nameplate.
	Before burner operation, be sure all motors are rotating in the proper direction.

Check	Area
	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 operation and maintenance procedures.

⚠ Caution

Lubrication 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.

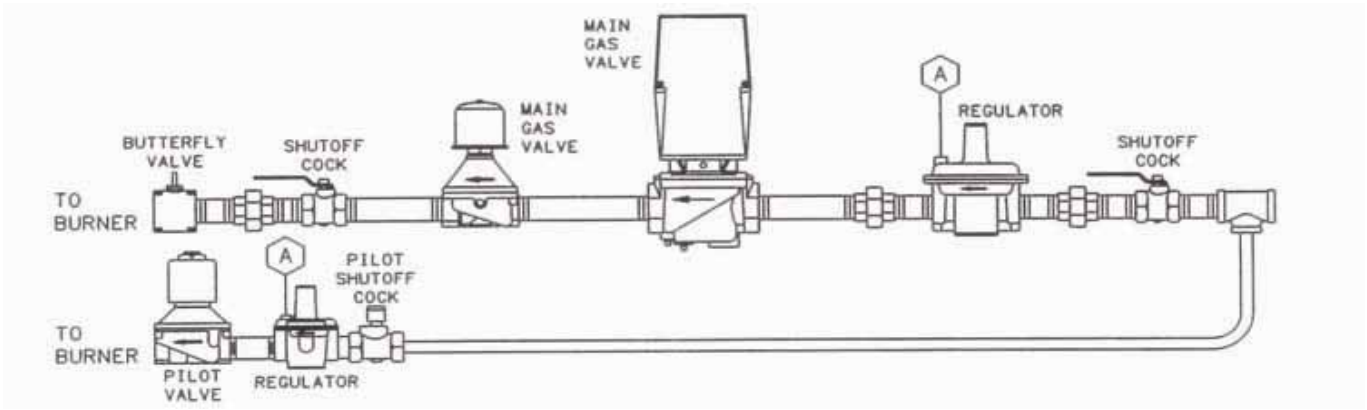


FIGURE 2-11. **Typical U.L. Gas Piping Layout Model M 14-25**

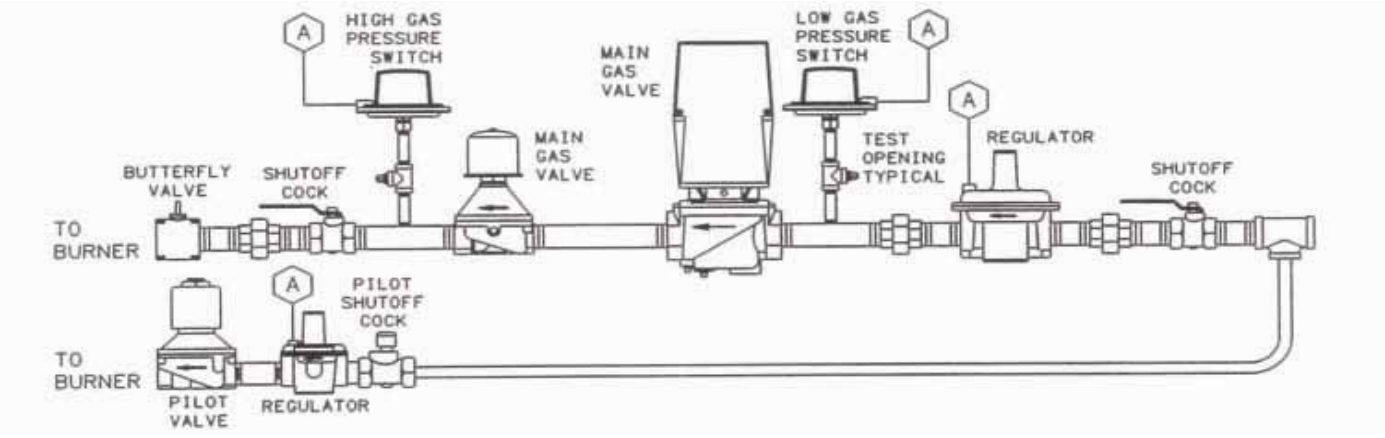


FIGURE 2-12. Typical U.L. Gas Piping Layout Model M 28-42

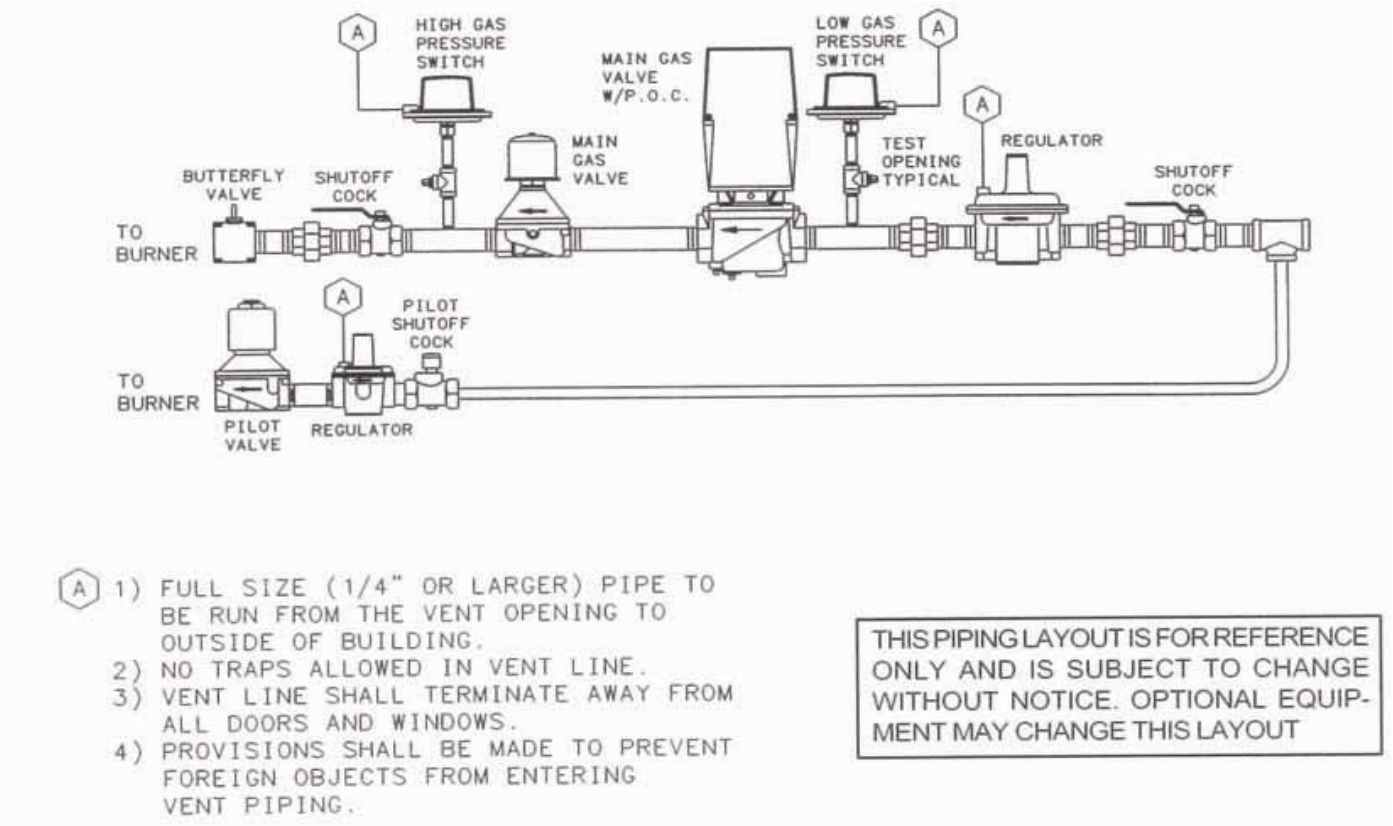
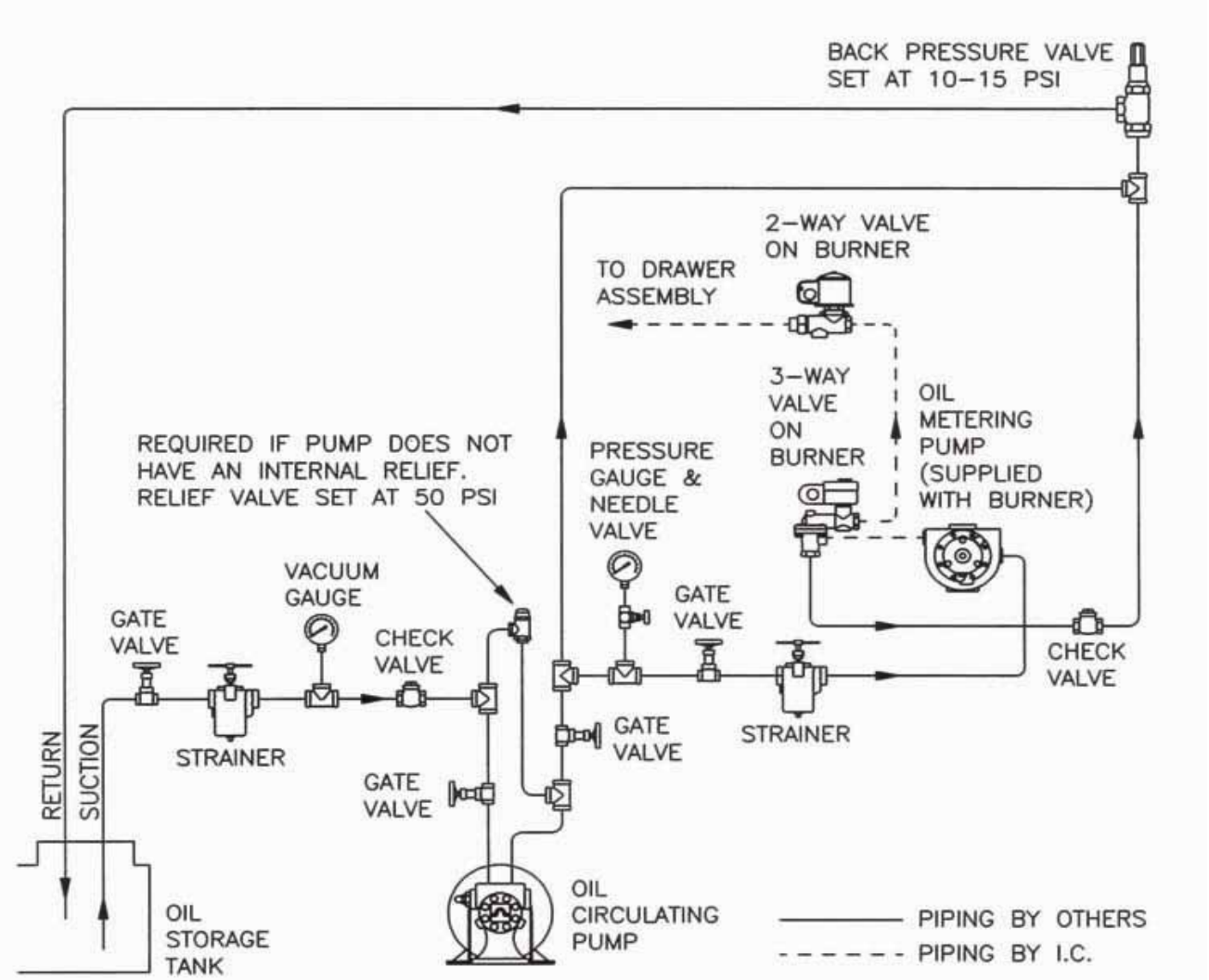


FIGURE 2-13. Typical U.L. Gas Piping Layout Model M 54-105



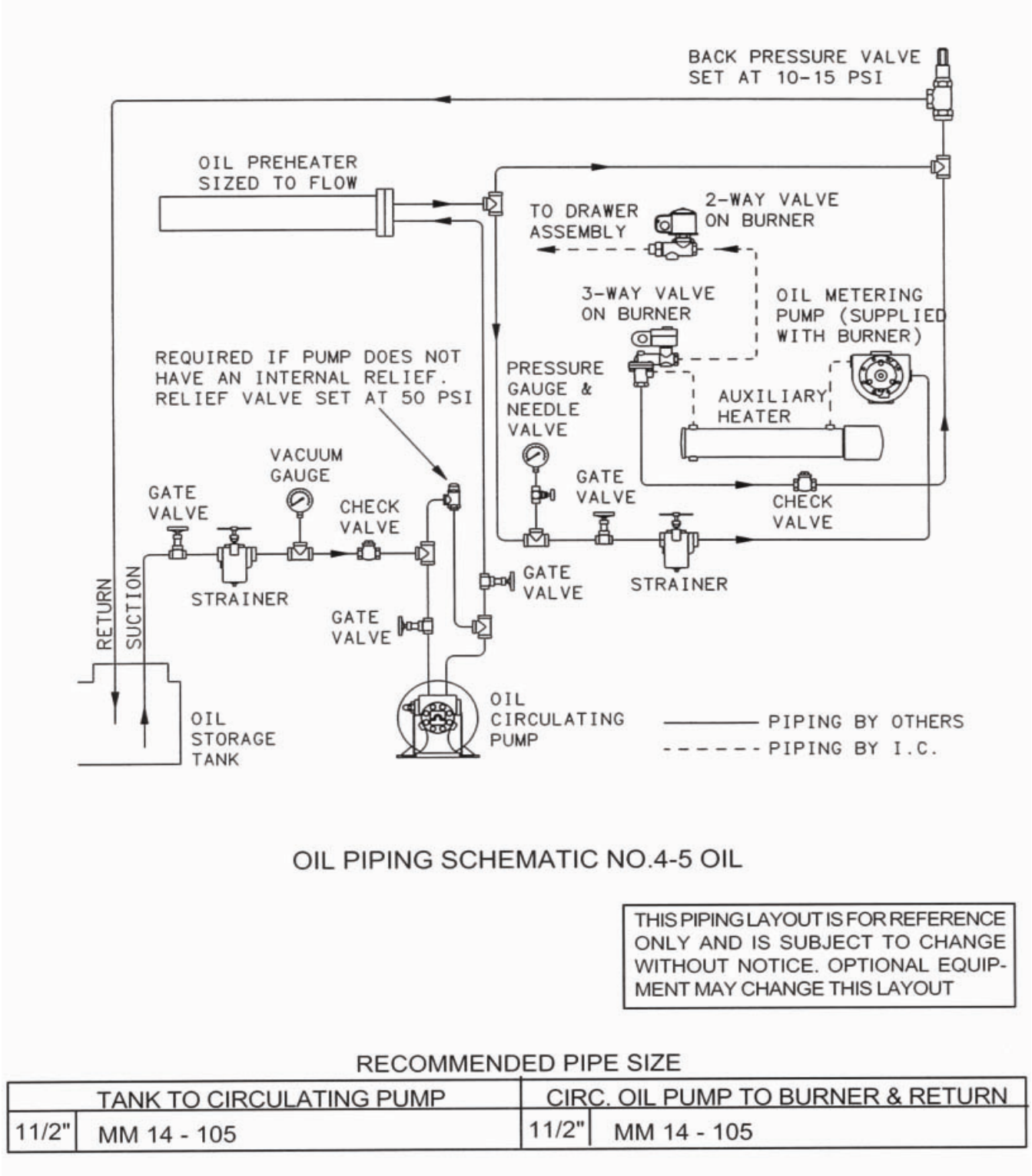
OIL PIPING SCHEMATIC NO.2 OIL

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

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
11/2"	MM 14 - 105	11/2"	MM 14 - 105

FIGURE 2-14. Oil Piping Schematic No. 2 Oil



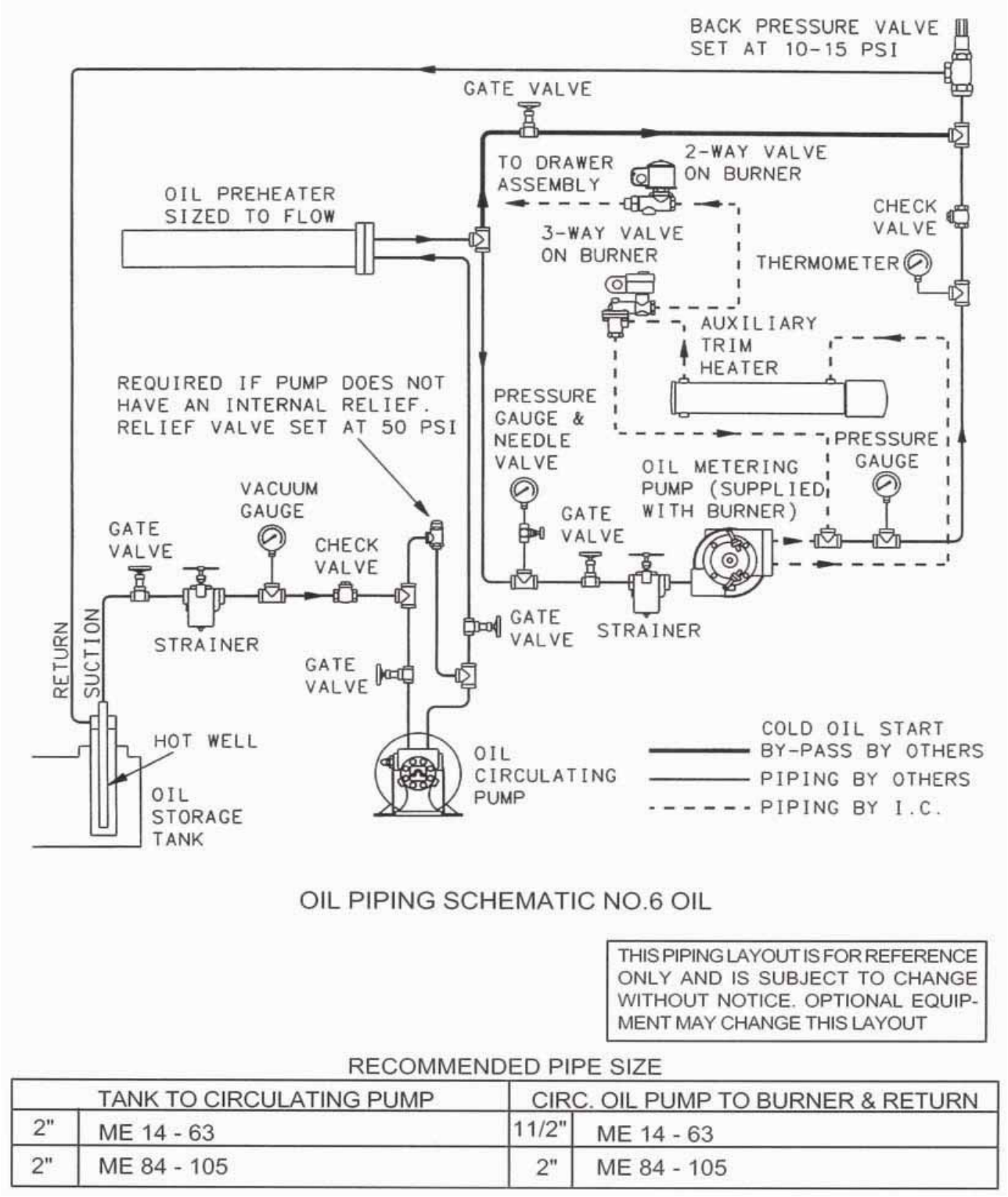
OIL PIPING SCHEMATIC NO.4-5 OIL

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

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
11/2"	MM 14 - 105	11/2"	MM 14 - 105

FIGURE 2-15. Oil Piping Schematic No. 4-5 Oil



OIL PIPING SCHEMATIC NO.6 OIL

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

RECOMMENDED PIPE SIZE

TANK TO CIRCULATING PUMP		CIRC. OIL PUMP TO BURNER & RETURN	
2"	ME 14 - 63	11/2"	ME 14 - 63
2"	ME 84 - 105	2"	ME 84 - 105

FIGURE 2-16. Oil Piping Schematic No. 6 Oil

CHAPTER 3 Operation

3.1 — Preparation for Initial Startup

All Fuels

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 revised 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 following checks must be made:

Area	☑
Boiler	Check thee boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control slightly above the operating control. Set the operating control at the desired temperature or pressure.
Burner	Check the electrical power supply to the burner in accordance with the nameplate voltage on all motors and the control circuit. Check motor rotation by momentarily closing the starter or relay. Blower impeller rotation is clockwise when viewed from the back of the burner. Air compressor and metering unit rotation is clockwise when viewed from its drive end. Open the housing and check the electrode setting. For protection in shipment, the flame safeguard control chassis is shipped unmounted. Check all screw connections before attaching flame the safeguard chassis to the base. The screw must be secure to assure low resistance connections. The relay chassis is mounted on the subbase with a screw which, when tightened, completes the connection between the subbase and chassis contacts. Press the manual reset button to be sure the 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 by hand. Check the air shutter and adjust the low-fire setting.

3.2 — 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 the 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.

On burners equipped with high and low gas pressure switches, set switch pressure actuating levels and record settings for future service reference.

When the conditions covered above and in Chapter 2 are assured, the burner is ready for firing. Refer to Section 3.5 for starting and operating information.

3.3 — Firing Preparations for Oil Burners

Prior to initial firing, oil flow pressure and temperature should be verified.

On MM and ME models, inspect the lube oil sump level. Add oil to bring the oil level to the midpoint or slightly higher in the reservoir sight glass.

Check the oil level in the compressor air intake strainer. 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, Figure 1-8 and Figure 1-9, indicates the flow of fuel and atomizing air.

If the burner is a dual fuel model, make certain that the main gas shutoff cock is closed and the fuel selector switch is set to “OIL.”

3.3.1 — Oil Flow

Light Oil (refer to Figure 2-13)

Open all valves in the oil suction and return line. 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 Figure 2-14 and Figure 2-15)

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.

NOTE: See directions for "Oil Temperature" as outlined in Section 3.3. Those preparations must be accomplished simultaneously during oil flow and pressure establishment.

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 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 20 psi (15 psi on MM models). 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.

3.3.2 — Oil Pressure

The system pressure is regulated by the back pressure valve. This should be set between 10 to 15 psi on MM models, and between 12 to 20 psi on ME models, at the burner inlet after the temperature stabilizes.

3.3.3 — 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 my be considered as typical:

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

NOTE: Fuel oil of any grade may vary necessitating a higher or lower temperature. The best viscosity of the oil at the nozzle is usually 100-150 SSU. The best temperature of the oil at the burner is determined by flame characteristics and combustion results.

If conditions do not permit the loop heater to develop the required temperature, the nozzle line heater on the burner should be depended upon only to raise the oil to the atomizing temperature during the initial low-fire start.

The nozzle line heater is intended to supply heated oil at a rate no greater than that required for low-fire. In nominal operation the nozzle line thermostat is set lower than the loop oil temperature, so that nozzle line heating is not required except during a cold start.

When the conditions covered above and in Section 3.1 are assured, the burner is ready for firing. Refer to Section 3.5 for starting and operating information.

INDUSTRIAL COMBUSTION

3.4 — Sequence of Operation

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:

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

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

3.5 — Startup and Operating

3.5.1 — 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 set to "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 the "MANUAL" position.
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 (refer to Sections 4.3 and 4.4).
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 let the programmer 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." The main gas valve will be energized after pilot ignition, when the flame relay pulls in.
9. 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.
10. 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.
11. Set the gas low-fire rate by adjusting the butterfly valve and air linkage. When low-fire is adjusted, shut the burner down. 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.
12. After combustion adjustments settings are acceptable, allow the heating vessel to slowly reach normal operating pressure or temperature.
13. Turn the potentiometer switch to the high-fire position. Check high-fire at this point using combustion instruments. Do not disturb established low-fire adjustment.
14. Allow the burner to return to low-fire position before adjusting high or intermediate settings.

High-fire combustion analysis is typically 9% to 10.5% CO_2. When conditions covered above are assured, refer to Sections 3.6 and 3.7.

3.5.2 — Oil Burners

1. Set the fuel selector switch to “OIL.” On initial startup of a combination burner, it is recommended that oil firing be adjusted before gas firing. Gas low-firing rate is set to match the oil low-fire rate.
2. Set the “ON-OFF” switch to the “OFF” position and the fuel selector switch to “OIL.”
3. 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.
4. Set the manual modulating control potentiometer to the “LO” fire position. Open the pilot gas valve (if used).
5. Set the “ON-OFF” switch to “ON.” The burner will start and pre-purge.After pre-purge, the ignition transformer and gas pilot (if used) are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done (refer to Sections 4.3 and 4.4).
6. Observe the primary air pressure gauge on the air/oil tank. The gauge reading should be approximately 10 psi during pre-purge.
7. 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.
8. 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.
9. Allow the burner to return to the 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.

When conditions covered above are assured, refer to Sections 3.6 and 3.7.

3.6 — Normal Operation

Normal operation must be with the “MANUAL-AUTO” switch selector set to “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 demands 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.

3.7 — Shutdown

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

The fuel valve(s) de-energizes and flame extinguishes. The blower motor continues running during post-purge.

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 the cause and correct the situation 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 during 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.

3.8 — 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 it in a dry atmosphere.

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 misadjustments 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.

NOTE: When residual oils are used, make fire adjustments after fuel reaches proper temperature.

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, or 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). 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.

NOTE: Some conditions may make it impossible to attain accurate combustion analysis. Air infiltration through the boiler at any point will dilute flue gas.

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 time of pilot trial with just the electrical ignition system energized - the flame relay should not pull in.
3. Upon completion of a successful test, proceed with startup.

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. Reconnect oil safety shutoff valve and turn on the manual pilot gas valve.
7. Reconnect the power supply and proceed with startup.

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 train inlet and manifold. The pressures listed are based on normal 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 the 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 is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 3” to 6” WC 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 in this chapter 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 at full input. Refer to manufacturer’s literature for regulator adjustment.

4.4.5 — Low Gas Pressure Switch (28-105)

Turn the adjusting screw until the indicator moves to a pressure setting slightly below the maximum operating gas pressure. The control will break a circuit if pressure is below this value. The control should be adjusted 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.

4.4.6 — High Gas Pressure Switch (28-105)

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.

4.5 — Oil System

4.5.1 — Oil Metering Unit

Fuel oil supply to the integral metering unit must be 10 to 15 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 contain oil.
2. Make sure all oil valves between the burner and the tank are open and that the suction line is not air bound.
3. Ensure that the low-fire setting has not been disturbed.
4. Make sure there is pressure at the integral metering unit, but it is not to exceed 15 psi (20 psi on separate metering unit).
5. See that the pump turns freely.
6. Check for a clogged strainer at the suction side of the circulating pump.
7. Check for a dirty burner strainer.
8. Check for a plugged or carboned nozzle. This will show up as excessive primary air pressure.
9. Make sure 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 oil 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 the 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.

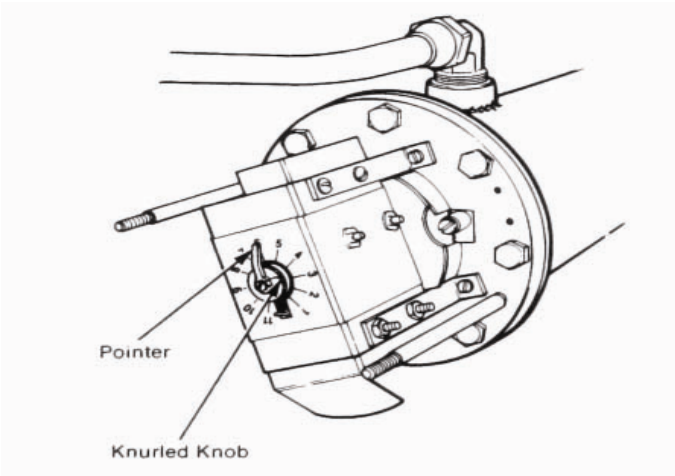
4.5.3 — Atomizing Air Proving Switch

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.

4.5.4 — Nozzle Line Heater

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

1. Remove the cover which 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.



3. 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. The nozzle line heater operates only during cold starts.
4. 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 below the oil thermostat setting. If the cold oil interlock is set higher than the oil temperature, the burner will not run.
5. Replace the cover.

FIGURE 4-1. **Nozzle Line Heater Adjustment**

4.6 — Combustion Air System

The damper has multiple blades and regulates the combustion air volume (see Figure 4-2). Normally, the upper damper blade will be closed and the lower blade will be slightly open in low-fire. As the burner advances toward high-fire, the adjustable stops on the damper rod open the intermediate blade, then the upper blades in sequence. Adjust intermediate combustion air volume by relocating these stops.

The blades are closed by return springs, except the lower blade, which moves with the modulating motor.

For low-fire, the lower blade position is set by the length of the damper linkage rod for best pilot operation. The low-fire damper should be set as low as practical, 1/4" approximate opening. The damper must be in the proper low-fire position for reliable ignition.

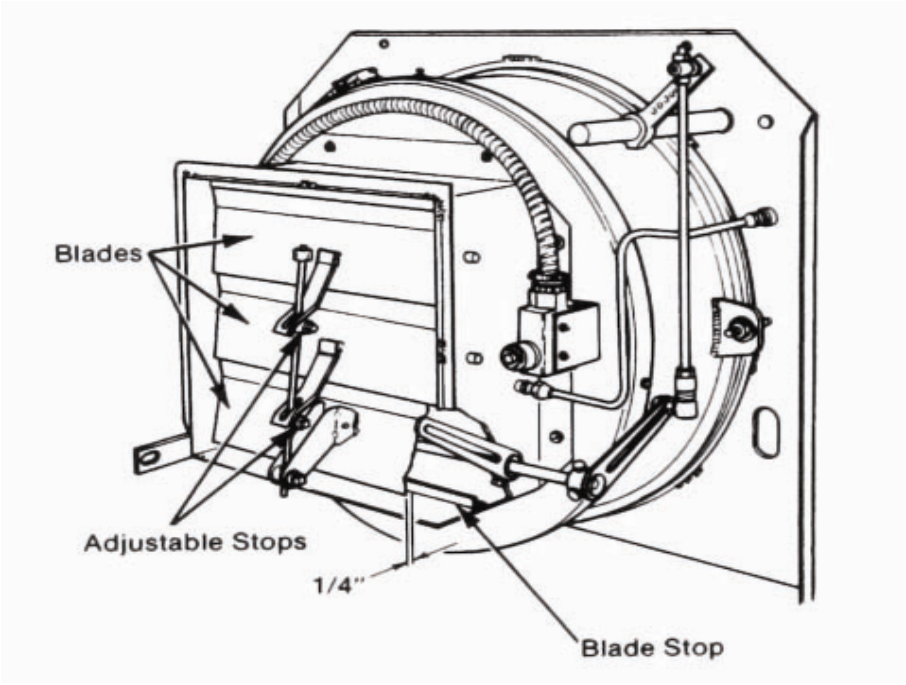


FIGURE 4-2. Air Damper Blades

4.7 — Modulating Motor

The modulating motor, through a linkage arrangement, positions the air damper, the butterfly gas valve, or metering unit to maintain proper air-fuel ratio throughout the firing range.

The motor is controlled by either a temperature or pressure actuated modulating control. Normal operation is with the "HI-LO" switch in "HI" position or "MANUAL-AUTO" switch in the "AUTO" position. A manually operated potentiometer may be provided to position the motor at a fixed firing rate for initial adjustment, or subsequent checking.

During normal operation, the motor moves in either direction or stops at any position within a 90º range to follow load demand.

If a modulating motor is replaced, verify the 90º stroke before installing.

The flame safeguard programmer holds the modulating motor in low-fire during ignition and until the main flame is established. A low-fire switch, integral to the motor or damper mounted, is actuated by the rotation of the motor. This switch must be closed to probe that the damper and fuel metering units are in low-fire position before ignition. During this time, neither a manual potentiometer nor modulating control have any effect on the damper motor.

Some burners have a second integral switch to prove the motor has driven the damper to an open position during pre-purge. This switch closes at the high-fire position to allow continuation of the programming cycle.

Refer to the manufacturer's literature for adjusting the modulating motor switch.

4.8 — Linkage Adjustments

The linkage consists of 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.
- All adjustments should be made with the motor in fully closed position, that is with the shaft on the power end of the motor in its most counterclockwise position.
- Over-travel linkage, where used, should not extend tis spring more than 1/4".

⚠ Caution

The modulating motor will be stopped at the end of its stroke by an integral limit switch and must not be installed by the damper, metering valve, or fuel units. Do not turn the motor shaft by hand or with a wrench. Settings are adjusted by the length of the linkage rods, length of lever arms, and the angular positions of the levers on the shafts.

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.

The angles of the driven levers on the jackshaft can be adjusted to vary the rate of change. The closer the rod is 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 the flow rate.

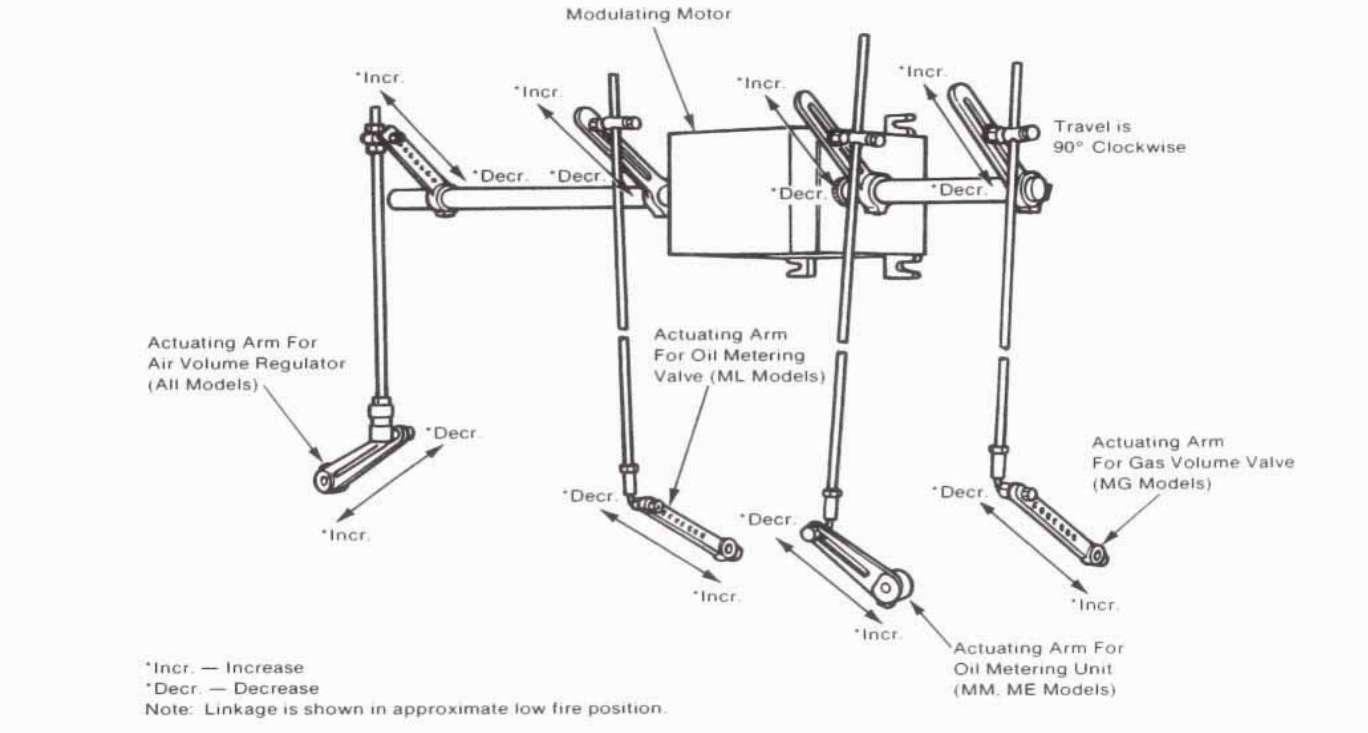


FIGURE 4-3. Fuel-Air Linkage Adjustments

4.8.1 — Cam Trim (Fine Tuning the Modulating Cam)

After low- and high-fire adjustments are complete for efficient operation, final adjustment is made to the cam assembly to obtain a constant air/fuel ratio throughout the entire firing range.

NOTE: The cam profile spring should match the cam quadrant at this time.

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 the flow. Flow rate is lowest when the cam follower is closest to the jackshaft. A 3/32” hex key is required.

NOTE: 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.

Through the manual modulating control, position the roller guide over each of the setscrews starting with high-fire and working down to low-fire. Make a combustion analysis at each of these setscrew points. Adjustment can be made without cycling the burner. Recheck combustion analysis until the desired result is obtained. Recheck the modulating cycle to assure satisfactory results.

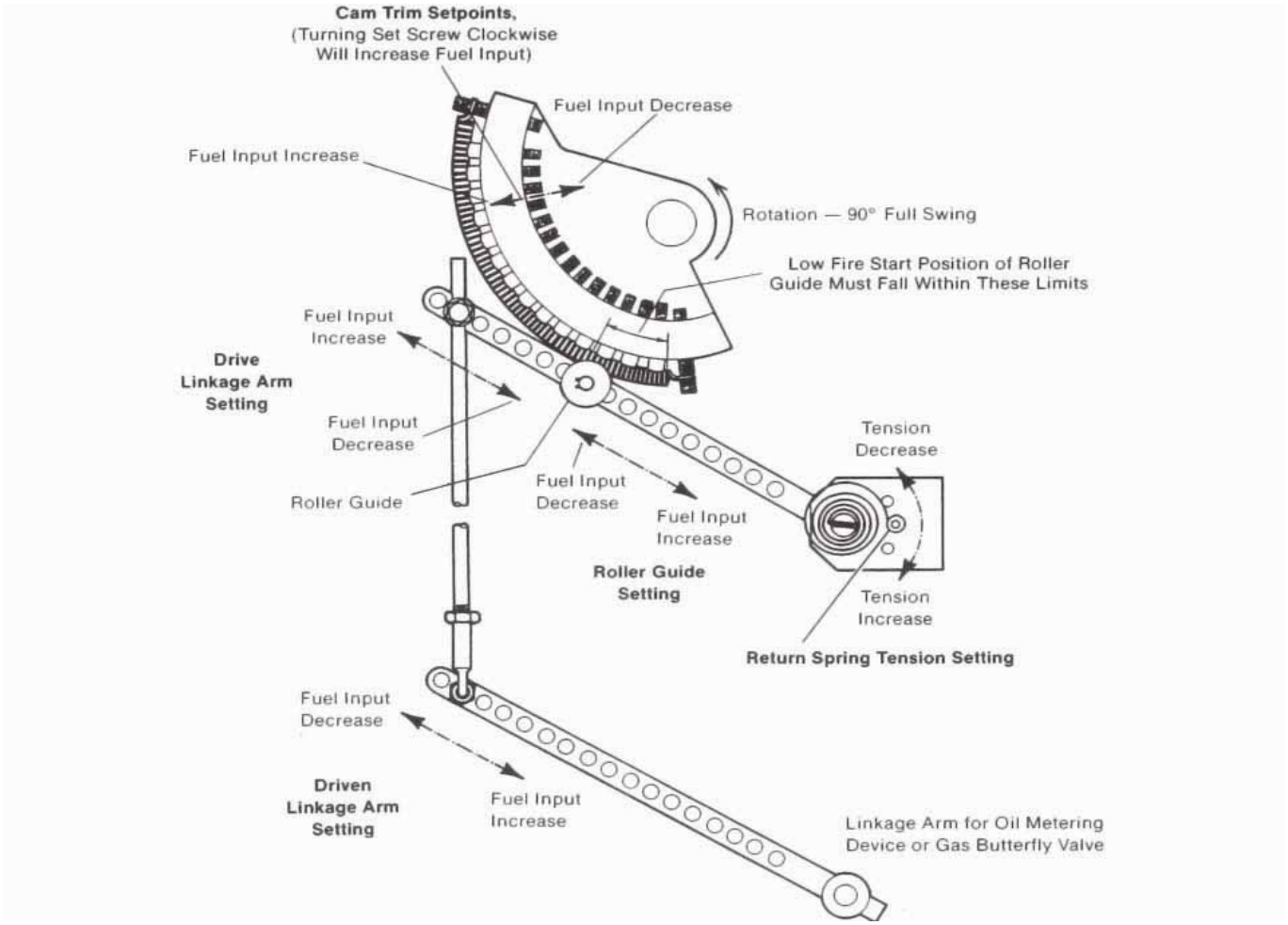


FIGURE 4-4. Cam Trim Adjustments

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

5.1 — Introduction

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” feature does 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.

INDUSTRIAL COMBUSTION

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.

⚠ Caution

When replacing a control or cleaning contacts, be sure to open the main power supply switch since the control is "hot" even though the burner switch is "OFF." More than one disconnect switch may be required to disconnect all power.

5.2.2 — Combustion Air Impeller

The method of retaining the fabricated impeller on the motor shaft has been revised. This change took effect starting with burner serial number A1918.

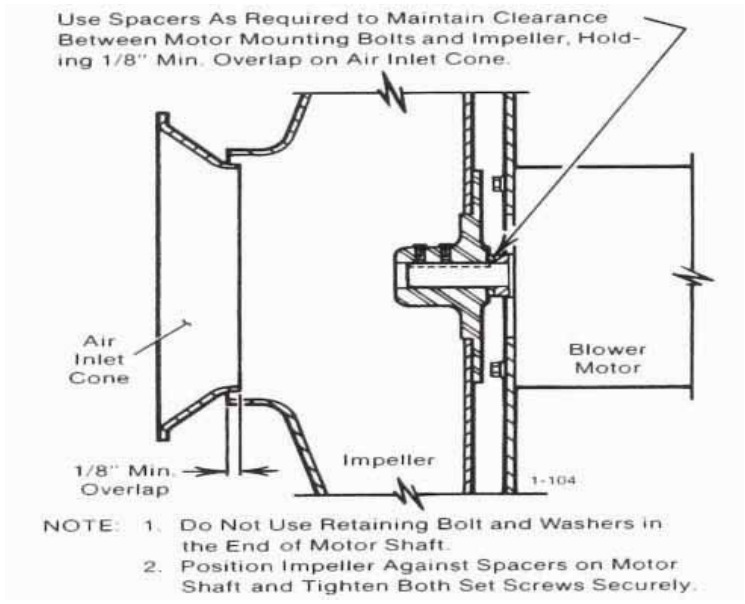


FIGURE 5-1. Impeller Mounting Instructions

Two setscrews directly over the key replaces the retaining bolt with washers on the end of the motor shaft and the single setscrew. Spacers are used to maintain the clearance between the motor mounting bolts and impeller which also maintains the correct overlap on the air inlet cone (see Figure 5-1).

NOTE: An impeller puller tool, part number 632-1856, is available for removing the fabricated impeller.

5.4 — Gas System

5.4.1 — 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.

NOTE: All power must be disconnected before servicing the valves.

5.4.2 — 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 coil replacement procedure.

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.

5.5 — Oil System

5.5.1 — Oil Metering Unit

The oil metering unit is a precisely built unit. Internal wear due to dirt in the oil can occur and may in time result in reduced capacity. If burner failure appears to be caused by the metering unit, check the following:

- See that the oil level in both the fuel oil tank and air-oil tank.
- Make sure all valves between the fuel oil tank and the burner are open.
- Be sure the oil suction line is not air bound and check the suction line strainer to see that it is not plugged.
- Check the low-fire setting of the metering pump to be sure it is properly set.
- Make sure the pump turns.
- Inspect for a clogged nozzle.

When an oil metering pump is proven faulty, order a replacement unit and return the old pump for repair or exchange (where allowed). Do not disassemble.

5.5.2 — 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 breaking 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 reinstalling the heater. The heater must be full of oil before power is turned on.

5.5.3 — Air 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.

5.5.4 — Lubricating Oil

Lubricating oil must be visible in the sight gauge at all times. The oil level should be maintained midway in the sight gauge. AW ISO 68 hydraulic fluid is recommended in a normal operating environment. For $\leq$ 32 deg F use SAE 10 non-detergent oil.

Adding oil is accomplished through the fill pipe on the side of the air-oil tank. The compressor (burner) must be shut off during filling.

⚠ Caution

Never add lube oil through the air inlet to the compressor. The lubricating oil should be changed every 2000 hours or annually. The lube oil filter (part number 843-106) should be replaced every 2000 hours or annually.

5.5.5 — Air-Oil Tank

A wire mesh filter is used in this tank to separate the lube oil from the compressed air. Figure 5-2 shows the tank and location of the filter.

This filter is very important and should be replaced if dirty. To replace the filter:

1. Turn the burner off.
2. Remove the air piping from the cap.
3. Remove the cap.
4. Remove the filter and wash it thoroughly in kerosene or replace with a new filter.

5. Flush the tank.
6. Insert the filter.
7. Reinstall the cap and reconnect the piping.

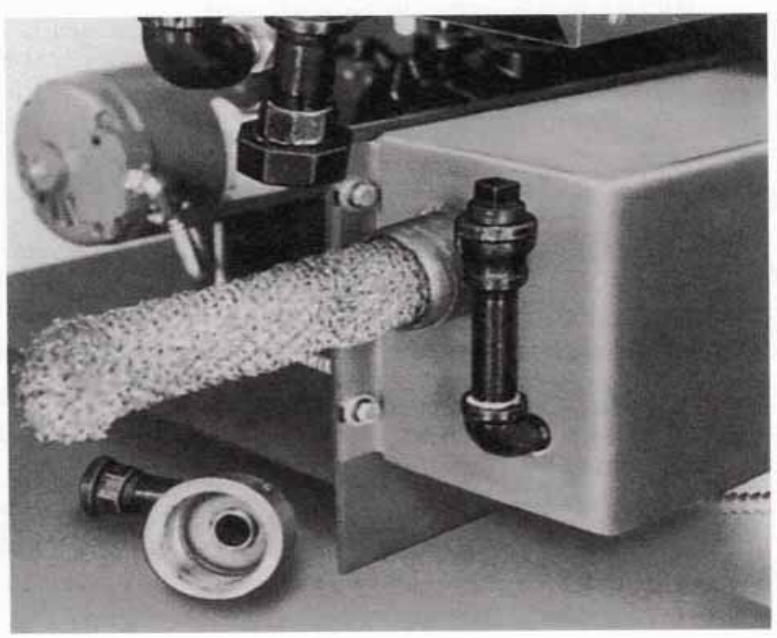


FIGURE 5-2. **Air-Oil Tank Filter**

5.5.6 — 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.

5.5.7 — Compressor Inlet Oil Strainer (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 the screen in solvent and thoroughly clean.

5.5.8 — 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.

5.5.9 — Lube Oil Cooling Coil

The fins on the tubing must be kept clean and free of dust and dirt.

INDUSTRIAL COMBUSTION

5.5.10 — Motor

Keep the motor clean. Motor lubrication should follow manufacturer's recommendations. Check the coupling/sheave alignment frequently and replace the coupling insert/belt as required. Keep cover plate or belt guard in place.

⚠ Caution

The maintenance intervals on the compressor module components are affected by the environment in which the equipment is placed. The "regular intervals" or "as required" maintenance requirements may be daily, weekly, or monthly, depending on the environment and the operating time of the equipment. Follow the preventive maintenance schedule shown in Section 5.10 or develop a maintenance program exclusively for the equipment.

5.5.11 — Sheave Alignment and Belt Tightening

ME, MEG. Alignment of the compressor and motor sheaves and proper belt tension are important. Figure 5-3 shows how to check parallel alignment of the sheaves.

Belt tension is adjusted according to the displacement on the belt with thumb pressure. This 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 the bolts and setscrews. Replace the belt guards. If the belt becomes frayed or cracked, replace it.

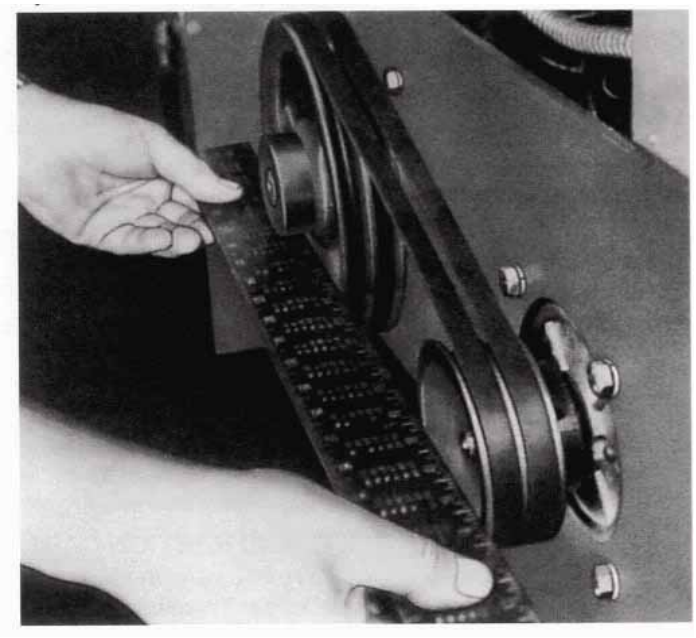


FIGURE 5-3. **Sheave Alignment**

5.6 — Burner Head

The burner head can be serviced through the throat of the blast tube on all models by opening the “swing way” air handling section. The procedure for service and inspection of the burner head on models 14-105 burners through the blast tube is as follows:

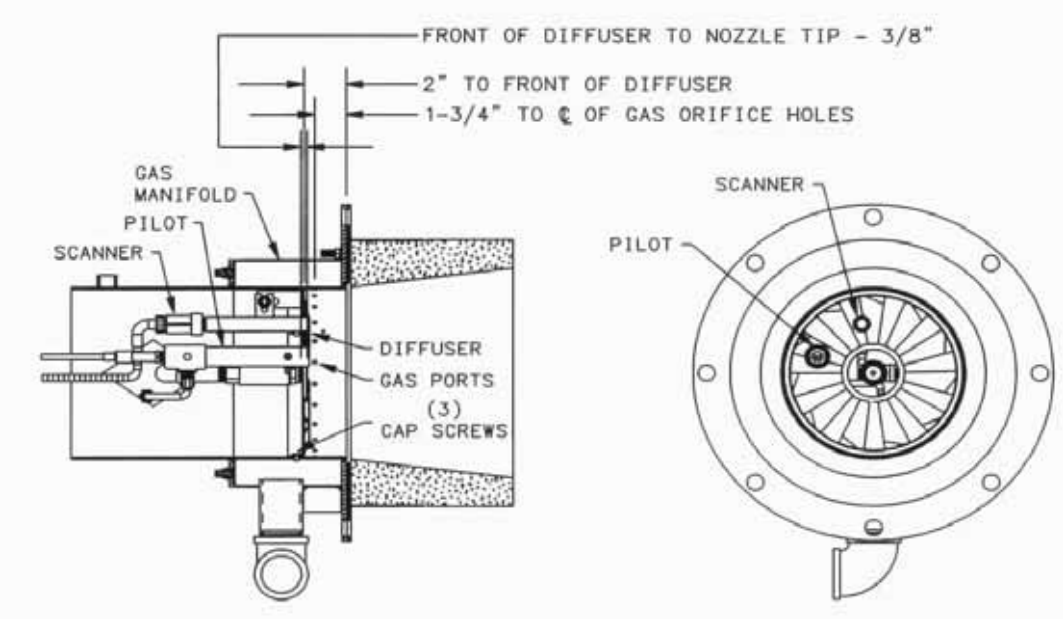


FIGURE 5-4. Burner Head

1. Shut off the burner, set switch in the “OFF” position.
2. Shut off electric power to the burner.
3. Disconnect the damper linkage, air proving switch tubing, and remove the nut from the latch on the air handling section.
4. Swing the air handling section open for access to the firing head.
5. An access opening to the burner head is available by disconnecting the fuel and airlines on the removable cover assembly located on the side of the burner blast tube. An indicator and arrow show the position of the nozzle to the diffuser. Make sure to note this position and reassemble the cover with the same adjustment.
6. Remove wing nuts on the cover and pullout drawer assembly.

5.6.1 — Pilot, Ignition Electrode and Ignition Cable

The gas pilot and ignition electrode are held in place by a close fitting support tube in the diffuser. The gas pilot slides into the support tube in the diffuser. The gas pilot slides into the support tube. The gas piping to the pilot holds the assembly in place.

To remove the pilot assembly, loosen the flare nut fitting at the pilot or at the housing connection. Disconnect the ignition cable. Slide the pilot assembly out of the support tube and remove from the burner.

Refer to Figure 5-5 for electrode adjustments. Defective or cracked porcelain requires replacement. A gradual wearing away of the electrode tip(s) may require they be re-spaced or replaced. Thoroughly clean and adjust the porcelain insulated electrodes. Correct all variations from the clearance dimensions.

If the insulation on the high voltage cables becomes cracked or charred, install new cables. Ignition cable should not be exposed to moisture, abrasion, or rough handling. See that the connectors are in proper contact with the cable ends. Unscrewing the snap portion of the connector will show whether this is true.

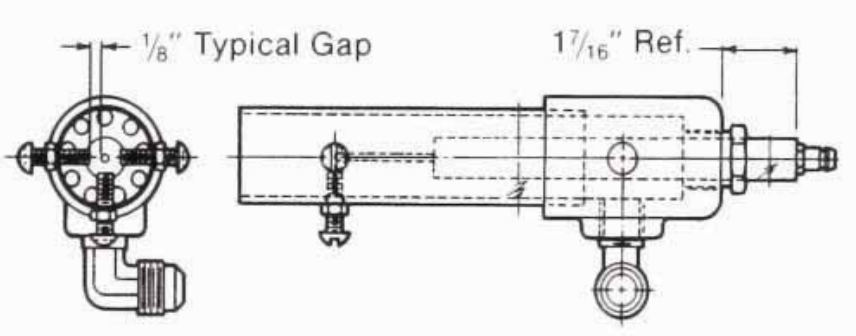


FIGURE 5-5. **Electrode Adjustment**

5.6.2 — Air Atomizing Nozzles

If the burner flame becomes stringy or lazy, it is possible that 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 clean the nozzle tip and swirler, unscrew the tip from the nozzle body. Use care not to distort the tip. Disassemble the nozzle tip.

Carefully clean all parts in solvent. Never use wire or sharp metal tools to clean the nozzle orifice. Use a sharply pointed piece of soft wood. A metal tool will distort the orifice and ruin the nozzle. Reassemble the nozzle.

To ensure proper atomizing, the tip must be screwed in tightly with the swirler seating spring pressing the swirler tight against the nozzle tip.

5.6.3 — 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.

5.6.4 — 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. Remove the electrode and scanner leads, the gas pilot assembly, air and oil tubes, and the nozzle support assembly.

Before removing the three screws holding the diffuser to the blast tube, scribe a line on the edge of the diffuser so that the exact location can be made at the time of reassembly. Clean all carbon from the diffuser vanes and re-install the parts in reverse order of the disassembly.

5.7 — Burner Mounting Inspection

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. If leakage occurs, refer to Chapter 2, Section 2.4 for proper sealing procedure.

5.8 — 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.

5.9 — Drawer Assembly

The following graphics illustrate the drawer assembly for the various M/Series models and sizes.

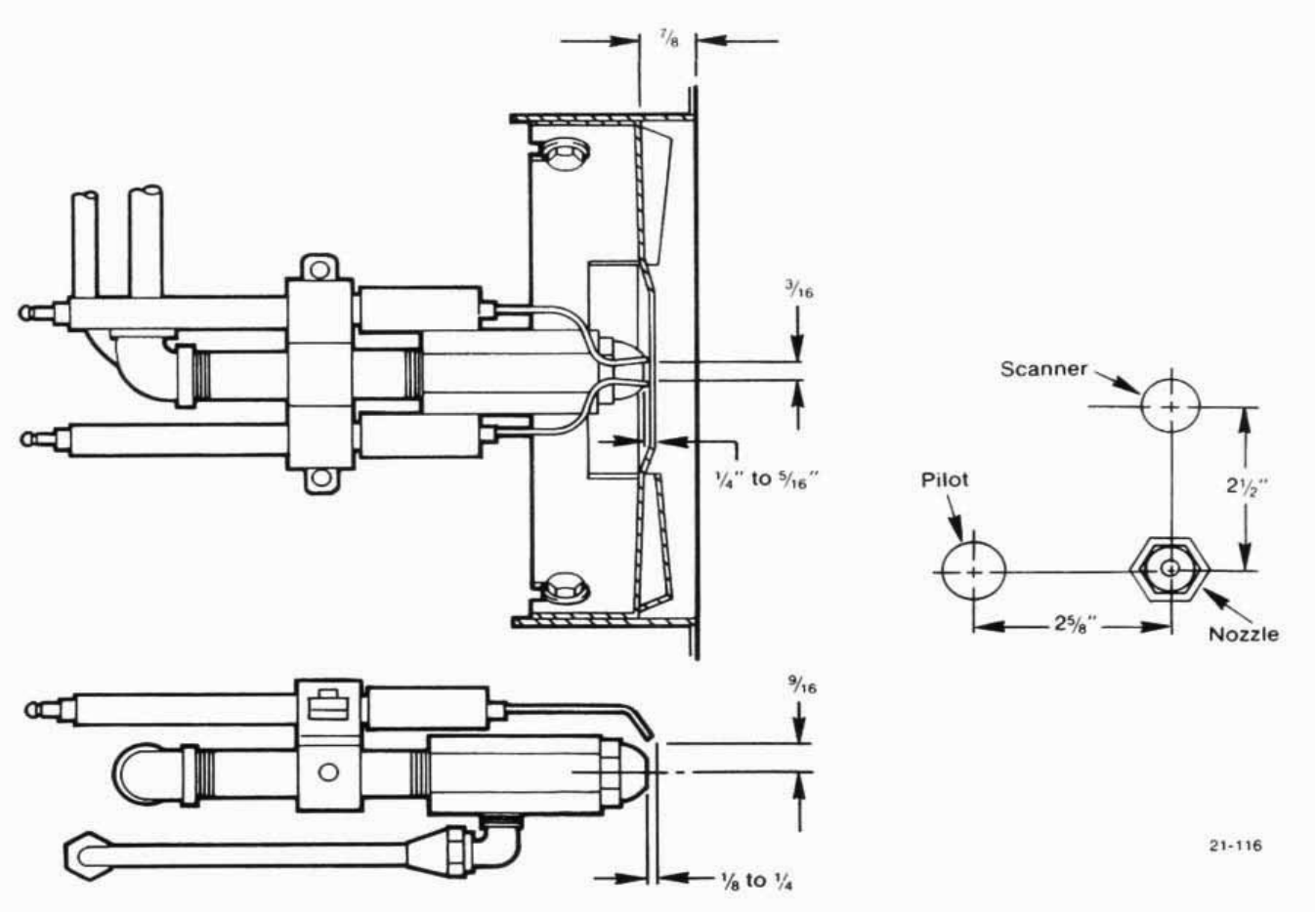


FIGURE 5-6. MM 14-30 Drawer Assembly Dimensions

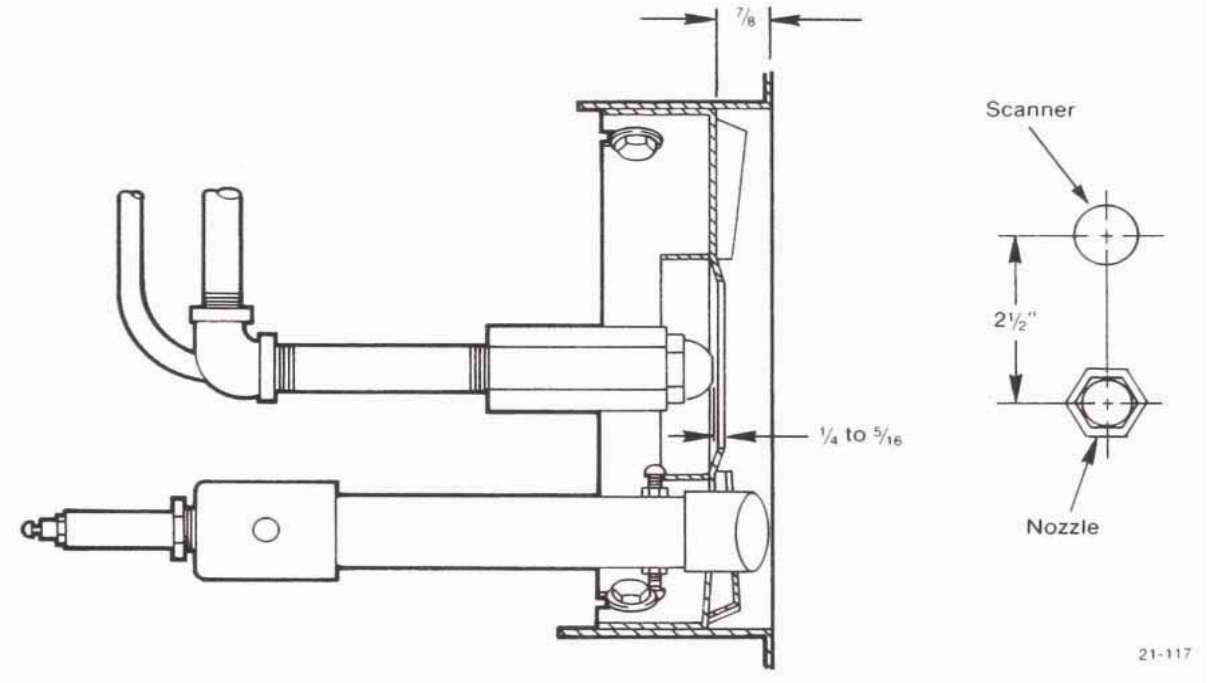


FIGURE 5-7. **MMG 14-30 Drawer Assembly Dimensions**

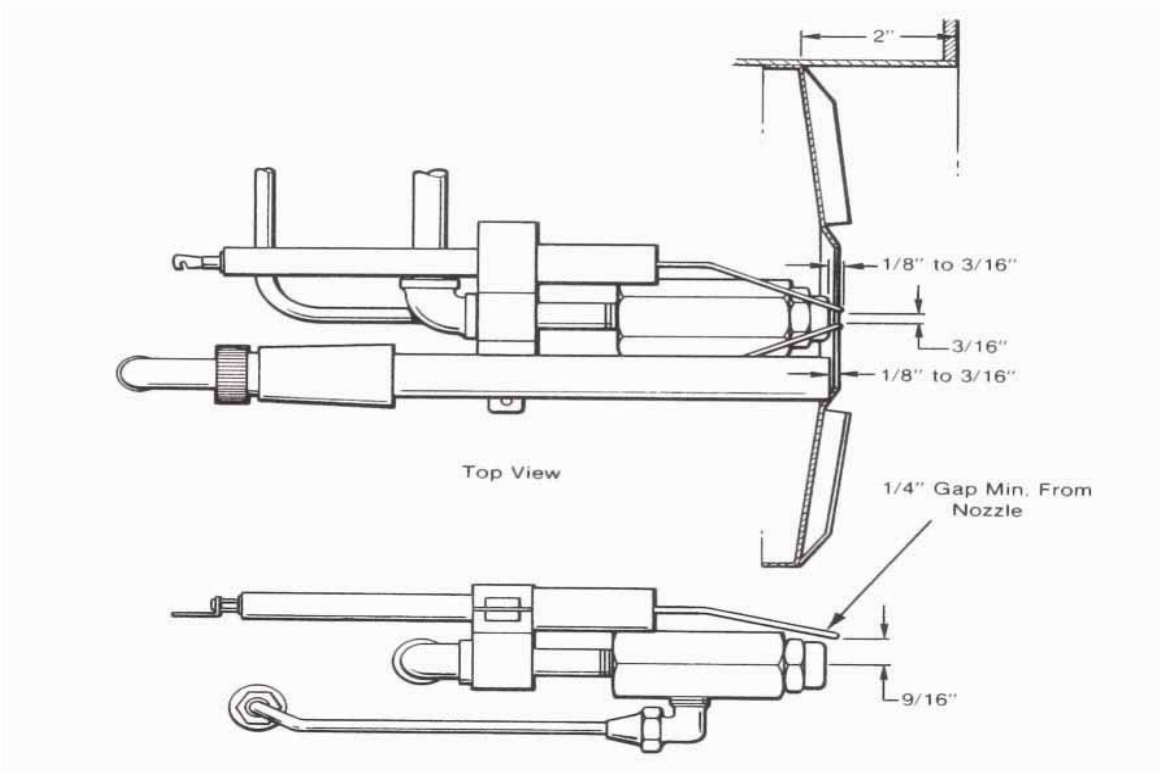


FIGURE 5-8. **MM 34-63 Drawer Assembly Dimensions**

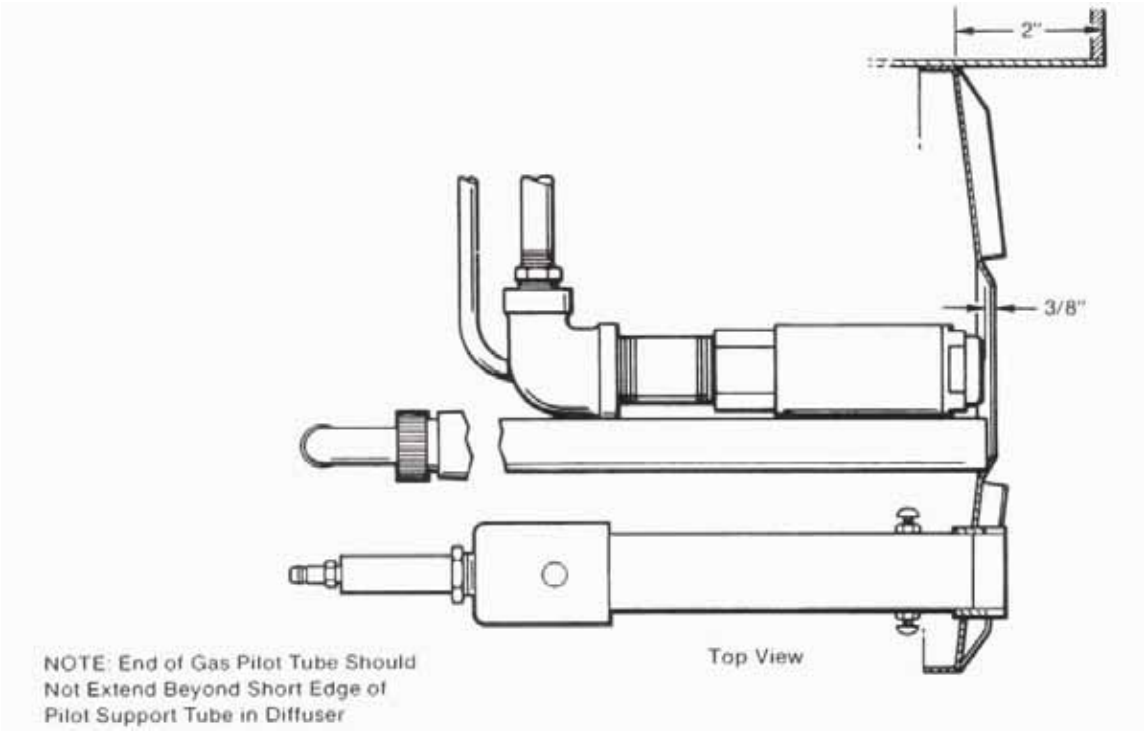


FIGURE 5-9. **MM, MMG, ME, MEG 34-63 Drawer Assembly Dimensions**

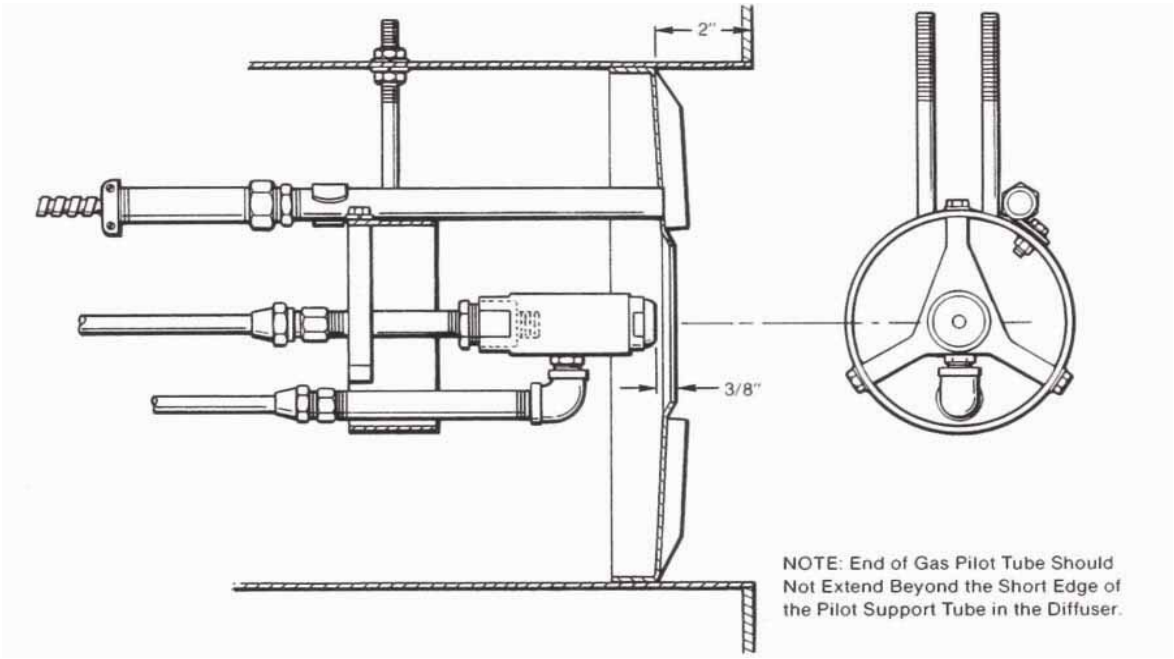


FIGURE 5-10. **MM 34-63 Drawer Assembly Dimensions**

INDUSTRIAL COMBUSTION

5.10 — Maintenance Flow Chart

Recommended Test Schedule:

ITEM	SERVICE BY	REMARKS
DAILY		
Gauges, Monitors, and 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 and 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 meter.
Flame Failure Controls	Operator	Close manual fuel supply for (1) pilot and (2) main fuel cock and/or valve(s). Check safety shutdown timing.
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 down-time 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. By 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.

⚠ Caution

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 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 oil 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 do so may result in serious personal injury or death.

6.2 — Emergency Shutdown

In case of emergency, shut down the burner by turning the “ON-OFF” switch to the “OFF” position. Turn the fuel selector switch to the “OFF” position. Shut off the main manual fuel shutoff valves on the fuel supply line. The unit can also be shut down with the main electrical power disconnect. Inspect the burner carefully and trouble-shoot before restarting the unit. Follow the instructions in Chapter 3 for starting and operating.

6.3 — Troubleshooting

Problem	Possible Causes
Burner Does Not Start	1. No voltage at the 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.
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	Possible Causes
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. Oil fired unit: 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.
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	Possible Causes
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 lines.
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 Ordering and Parts Lists

7.1 — Instructions

7.1.1 — Ordering

When ordering repair parts, please include the part number, the burner serial number, the burner model, burner size, and voltage. The burner model and size information can be obtained from the burner nameplate and the voltage information can be found on the data label on the panel door.

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

This parts section does not included 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:

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

7.1.2 — Parts Shipping Policy

All orders for stocked items will be processed and ready for shipment with 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 shipment to Wisconsin and bordering states will be shipped the same day upon request.

Industrial Combustion
351 21st Street
Monroe, WI 53566

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

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

INDUSTRIAL COMBUSTION

7.1.3 — 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. Item description
   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. Identify if credit or replacement is to be issued
2. Once an RGA number has been issued, the item may be returned. You will have thirty (30) days to return the item from the date of the issued RGA or 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.

7.1.4 — 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 motor from unit and take motor to a manufacturer authorized service station.
2. The service station will determine the warranty status by installation date of the unit and the 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 unit 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 Dept. will provide assistance.

7.1.5 — Marathon 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.

NOTE: Failure to follow this procedure will result in repairs being made at the customer's expense.

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

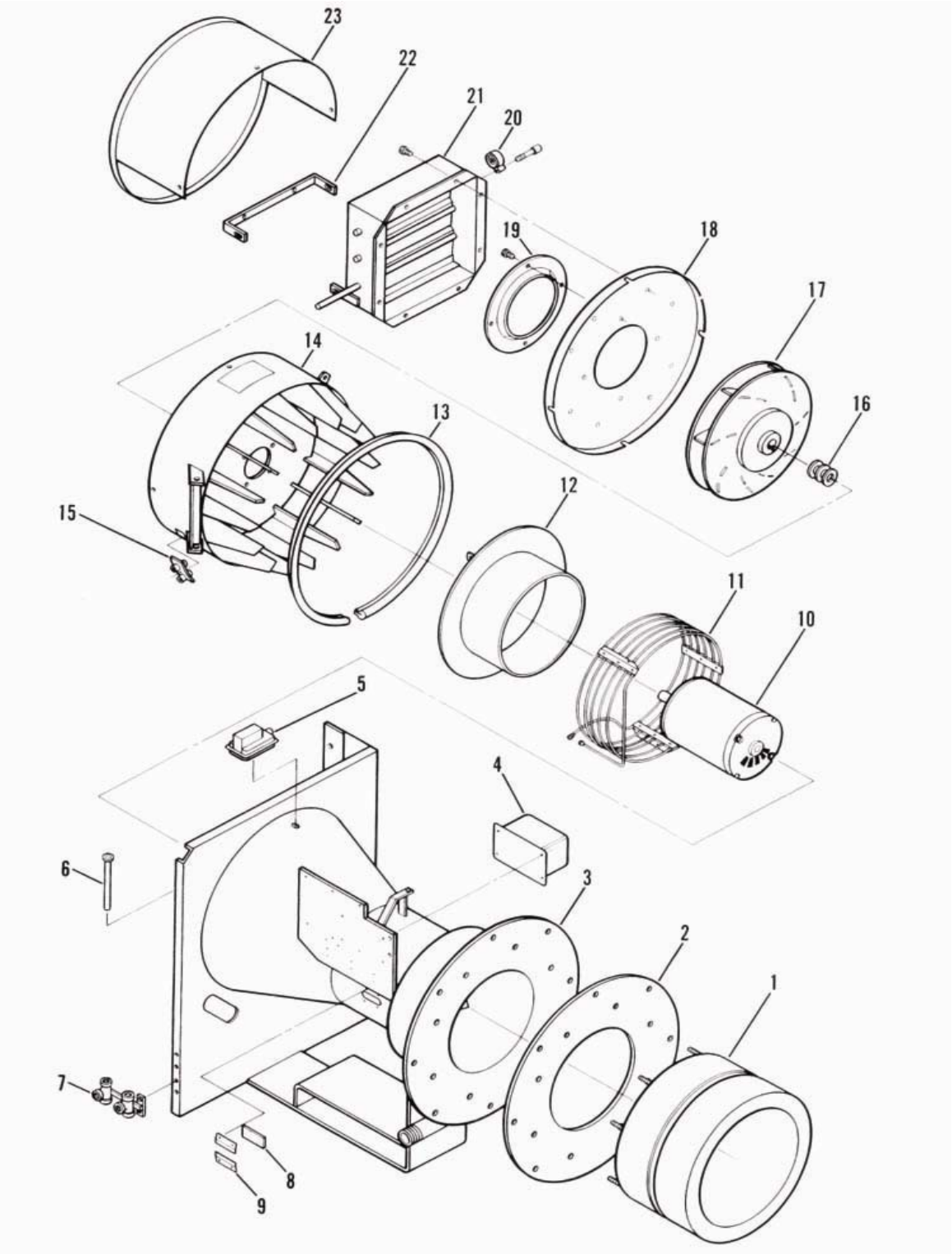
   b. Nameplate will be removed and along with a report of cause of failure will be given to the user.
6. User will present nameplate and report to distributor.
7. Distributor will furnish user with a new motor, no charge, either from distributor's inventory or secure replacement unit directly from parent organization.

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

INDUSTRIAL COMBUSTION

7.2 — Parts Lists and Drawings

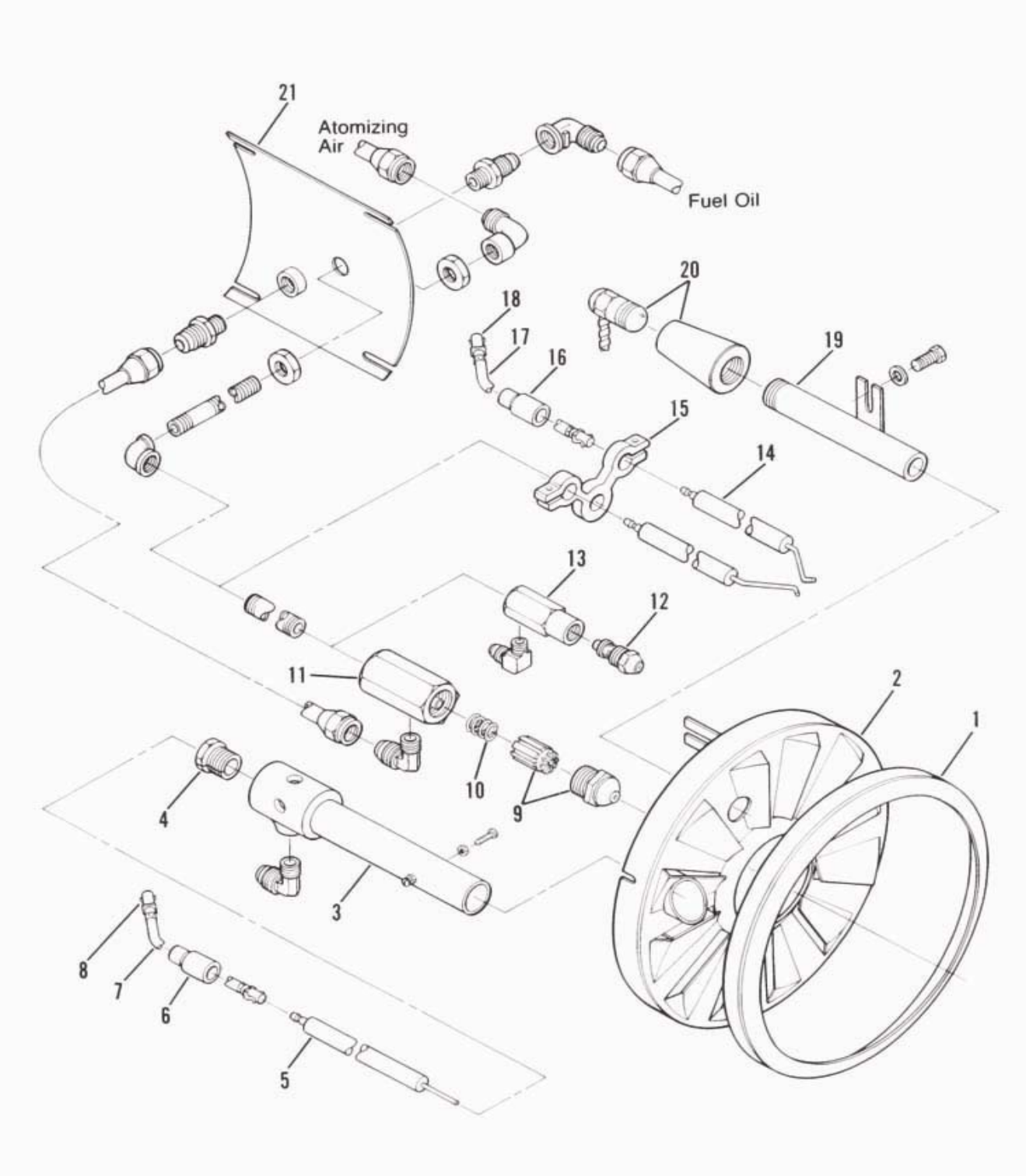
7.2.1 — Blower Housing & Blast Tube Assemblies



Blower Housing & Blast Tube Assemblies			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
1	279-121	Dry Oven	1	1								
	279-120	Dry Oven			1	1						
	279-58	Dry Oven					1	1	1	1		
	279-60	Dry Oven									1	1
2	32-1072	Gasket, Dry Oven	1	1								
	32-1062	Gasket, Dry Oven			1	1						
	32-1020	Gasket, Dry Oven					1	1	1	1		
	32-1021	Gasket, Dry Oven									1	1
3	40-332	Housing, Blast Tube	1	1								
	40-331	Housing, Blast Tube			1	1						
	40-327	Housing, Blast Tube					1	1	1	1		
	40-279	Housing, Blast Tube									1	1
4	832-118	Ignition Transformer, 10,000 Volt, Direct Spark	1	1	1	1	1	1	1	1	1	1
	832-107	Ignition Transformer, 6,000 Volt, Gas Pilot	1	1	1	1	1	1	1	1	1	1
5	836-366	Switch, Air Pressure	1	1	1	1	1	1	1	1	1	1
6	56-281	Pin, Hinge	1	1	1	1	1	1	1	1		
	56-284	Pin, Hinge									1	1
7	8-1242	Bracket, Cooling Coil Connection ME, MEG Only					1	1	1	1	1	1
8	31-38	Glass, Flame Sight	1	1	1	1	1	1	1	1	1	1
9	8-1203	Bracket, Sight Glass Retainer	2	2	2	2	2	2	2	2	2	2
10	See Chart	Motor, Blower	1	1	1	1	1	1	1	1	1	1
11	17-124	Coil, Cooling					1	1	1	1	1	1
12	80-183	Ring, Air Deflection (3-Phase)	1	1								
	80-191	Ring, Air Deflection (1-Phase)	1	1								
	8-178	Ring, Air Deflection					1	1	1	1		
13	32-1060	Gasket, Fan Housing Seal, 5 Ft.	1	1	1	1	1	1	1	1		
	32-1060	Gasket, Fan Housing Seal, 7 Ft.									1	1
14	85-877	Fan Housing	1	1								
	85-876	Fan Housing			1	1						
	85-874	Fan Housing					1	1	1	1		
	85-875	Fan Housing (63-P)								1		
	40-280	Fan Housing									1	1
15	19-430	Cover, Coil Inlet, ME, MEG					1	1	1	1	1	1
	19-429	Cover					1	1	1	1	1	1

Blower Housing & Blast Tube Assemblies			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
16	77-207	Spacer, Impeller (quantity varies)										
	77-197	Spacer, Impeller (quantity varies)										
17	See Chart	Impeller	1	1	1	1	1	1	1	1	1	1
18	22-300	Plate, Air Inlet	1	1								
	22-295	Plate, Air Inlet			1	1						
	22-192	Plate, Air Inlet					1	1	1	1		
	22-217	Plate, Air Inlet									1	1
19	265-31	Cone, Air Inlet	1	1	1	1	1	1	1	1		
	265-34	Cone, Air Inlet (84S)									1	
	265-36	Cone, Air Inlet (84P)									1	1
20	82-750	Spring	2	2	2	2	2	2	2	2	3	3
21	427-72	Damper, Air Assembly with Air Modulation	1	1								
	427-71	Damper, Air Assembly	1	1	1	1						
	427-64	Damper, Air Assembly					1	1	1	1		
	427-48	Damper, Air Assembly									1	1
22	8-1359	Bracket, Rear Cover Mounting	1	1	1	1						
	8-1213	Bracket, Rear Cover Mounting					1	1	1	1		
23	19-463	Cover, Damper Inlet with Air Modulation	1	1								
	19-450	Cover, Damper Inlet	1	1								
	19-447	Cover, Damper Inlet			1	1						
	19-427	Cover, Damper Inlet					1	1	1	1		
	461-89	Cover, Damper Inlet									1	1

7.2.2 — Drawer Assembly, M 14-63



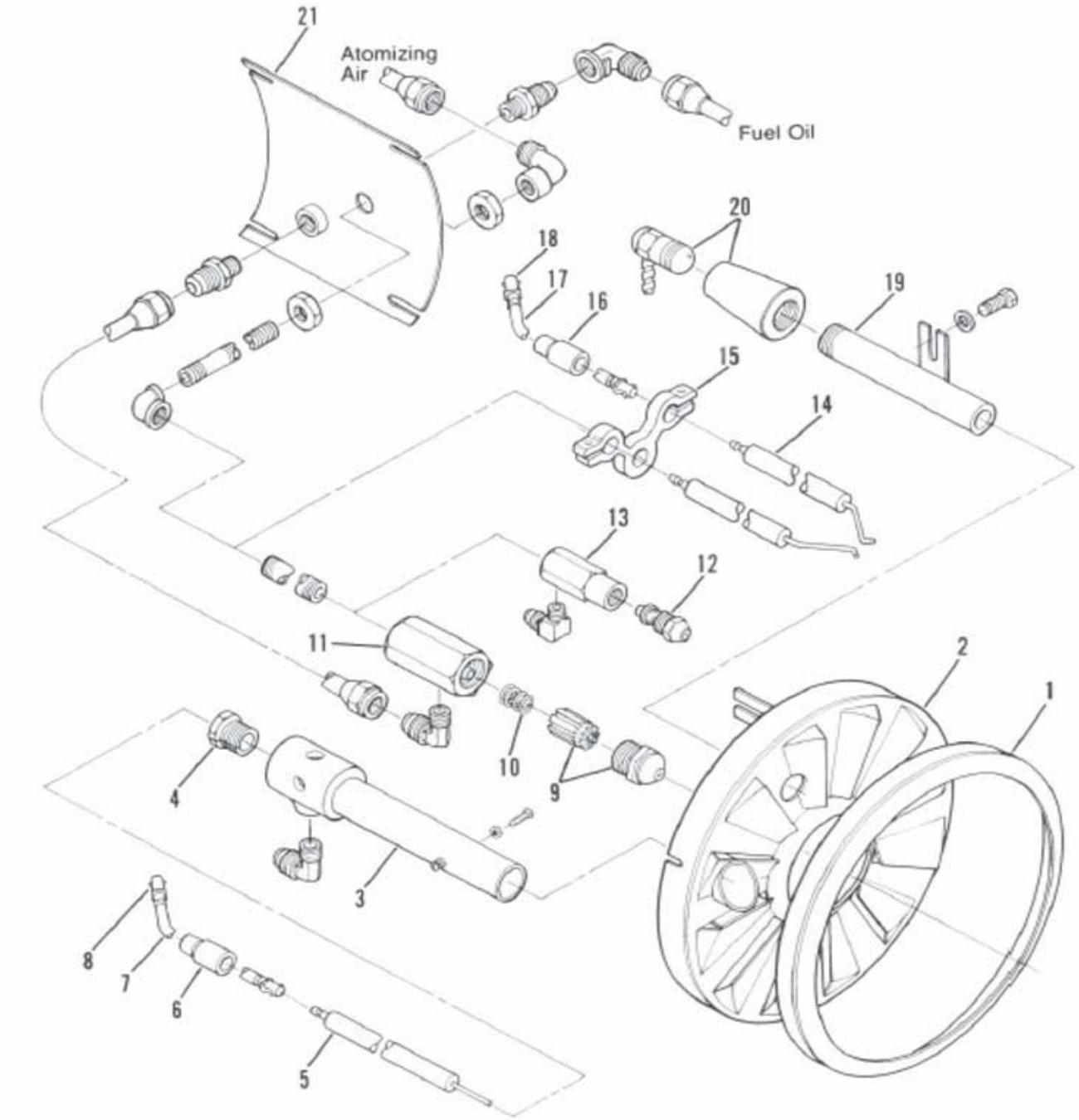
INDUSTRIAL COMBUSTION

Drawer Assembly M 14-63			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
1	97-63	Choke, Down-stream, ML, MLG					1	1	1	1		
2	275-346	Diffuser, ML, MLG					1					
	275-347	Diffuser, ML, MLG						1				
	275-348	Diffuser, ML, MLG							1			
	275-349	Diffuser, ML, MLG								1		
	275-341	Diffuser, MG, MM, MMG	1	1								
	275-338	Diffuser, MG, MM, MMG			1	1	1					
	275-241	Diffuser, MG, MM, MMG						1				
	275-240	Diffuser, MG, MM, MMG							1			
	275-239	Diffuser, MG, MM, MMG								1		
	275-199	Diffuser, ME, MEG					1	1	1			
	275-198	Diffuser, ME, MEG								1		
3	48-139	Gas Pilot Assem-bly, MG, ML, MLG. MMG, ME, MEG					1	1	1	1		
	48-142	Gas Pilot Assem-bly, MG, MM, MEG	1	1	1	1						
	48-147	Gas Pilot Tube and Head	1	1	1	1	1	1	1	1		
4	10-311	Bushing, Electrode Mounting	1	1	1	1	1	1	1	1		
5	873-87	Electrode	1	1	1	1	1	1	1	1		
6	848-166	Connector, GTO	1	1	1	1	1	1	1	1		
7	826-40	Ignition Cable	1	1	1	1	1	1	1	1		
8	848-157	Terminal	2	2	2	2	2	2	2	2		
9	528-12	Nozzle Tip & Swirler Assembly, MM, MMG	1	1	1	1						
	528-9	Nozzle Tip & Swirler Assembly, MM, MMG					1	1	1			
	528-33	Nozzle Tip & Swirler Assembly, MM, MMG								1		
	528-47	Nozzle Tip & Swirler Assembly, ME, MEG					1	1	1			
	528-33	Nozzle Tip & Swirler Assembly, ME, MEG								1		
10	82-33	Spring, Compres-sion, MM, MMG	1	1	1	1	1	1	1			
	82-129	Spring, Compres-sion, ME, MEG (MM, MMG63)					1	1	1	1		

11	277-139	Nozzle Body, MM, MMG	1	1	1	1	1	1	1			
	277-105	Nozzle Body, ME, MEG (MM, MMG63)					1	1	1	1		

Drawer Assembly M 14-63			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
12	899-171	Nozzle Tip, 14.0 GPH, 80°, ML, MLG					1					
	899-187	Nozzle Tip, 17.0 GPH, 80°, ML, MLG						1				
	899-170	Nozzle Tip, 24.0 GPH, 80°, ML, MLG							1			
	89-183	Nozzle Tip, 26.0 GPH, 80°, ML, MLG								1		
13	899-168	Body, Nozzle, ML, MLG					1	1	1	1		
14	873-69	Electrode, ML, MM, Direct Spark Modified	2	2	2	2	2	2	2	2		
15	8-1206	Bracket, Electrode, MM	1	1	1	1	1	1	1			
	8-1216	Bracket, Electrode, MM								1		
	8-1207	Bracket, Electrode, ML					1	1	1	1		
16	848-166	Connector, GTO	2	2	2	2	2	2	2	2		
17	826-40	Ignition Cable	2	2	2	2	2	2	2	2		
18	848-157	Terminal	4	4	4	4	4	4	4	4		
19	90-381	Sight Tube, Scanner	1	1								
	90-392	Sight Tube, Scanner			1	1						
	90-290	Sight Tube, Scanner					1	1	1	1		
20	See Chart	Scanner	1	1	1	1	1	1	1	1		
21	13-163	Backcap	1	1	1	1	1	1	1	1		

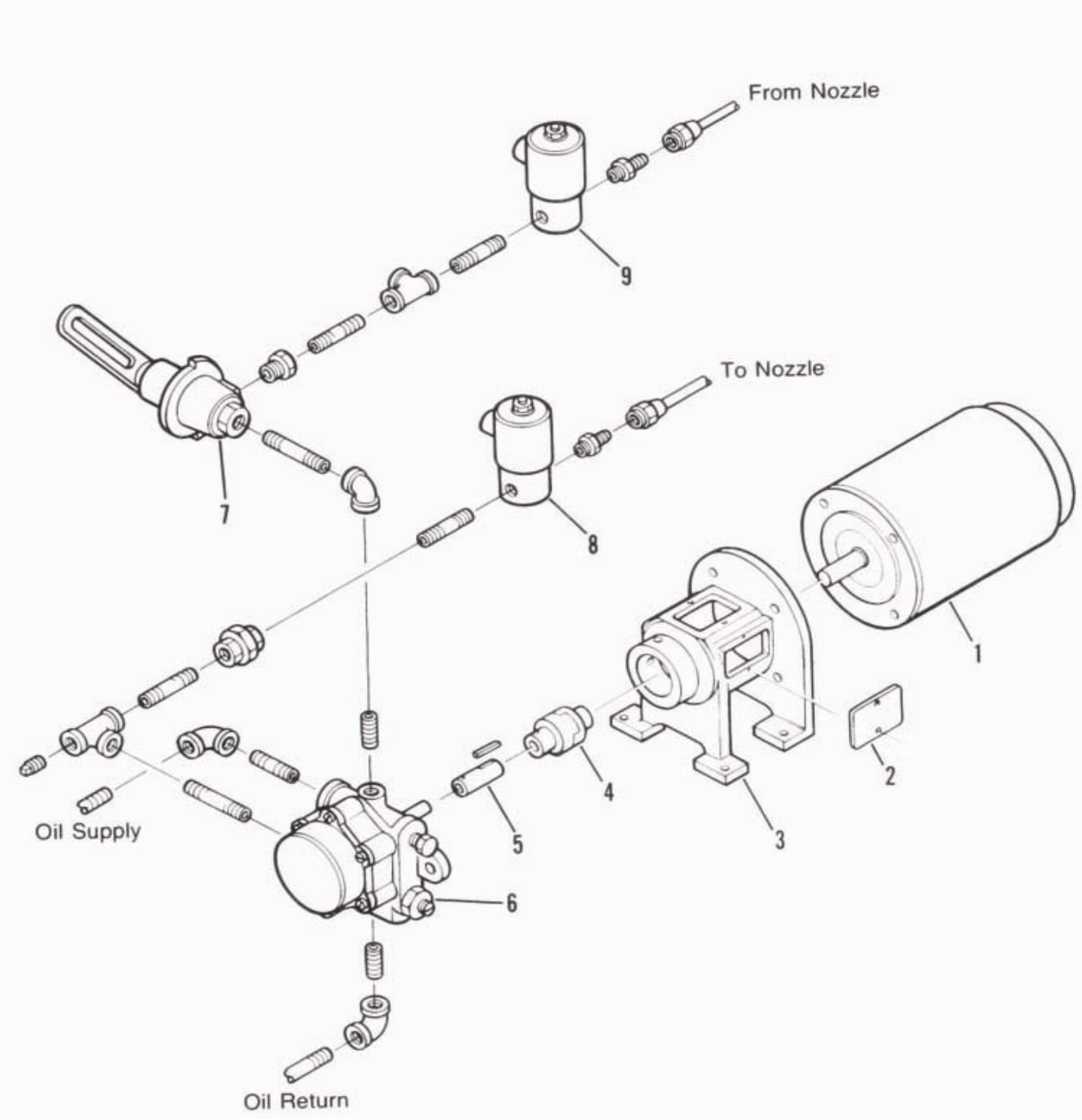
7.2.3 — Drawer Assembly, M 84-105



INDUSTRIAL COMBUSTION

Drawer Assembly M 84-105			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
*	97-65	Choke, Down-stream, ML, MLG									1	1
1	275-235	Diffuser, ML, MLG									1	
	275-226	Diffuser, ML, MLG										1
	275-264	Diffuser, MG, MM, MMG (ME, MEG84)									1	1
	275-269	Diffuser, ME, MEG										1
2	48-153	Gas Pilot Assem-bly, ML, MLG									1	1
	48-140	Gas Pilot Assem-bly, MM, MMG, ME, MEG									1	1
	90-374	Gas Pilot Tube									1	1
	284-68	Inspirating Head, Pilot									1	1
3	10-310	Bushing, Electrode Mounting									1	1
4	873-87	Electrode									1	1
5	848-166	Connector, GTO									1	1
6	826-40	Ignition Cable									1	1
7	848-157	Terminal									2	2
8	528-36	Nozzle Tip & Swirler Assembly, MM, MMG									1	1
	528-31	Nozzle Tip & Swirler Assembly, ME, MEG									1	1
9	82-129	Spring, Compres-sion, MM, ME, MMG, MEG									1	1
10	899-105	Nozzle Body, MM, ME, MMG, MEG									1	1
11	8-1248	Bracket, Drawer Support									1	1
12	90-338	Sight Tube, Scanner									1	1
13	See Chart	Scanner									1	1
14	899-177	Nozzle Tip, 12.0 GPH, 80º, ML, MLG									3	
	899-171	Nozzle Tip, 14.0 GPH, 80º, ML, MLG										2
	899-173	Nozzle Tip, 16.0 GPH, 80º, ML, MLG										1
15	899-200	Body, Nozzle, ML, MLG									1	1
16	8-1042	Bracket, Nozzle Support									1	1

7.2.4 — Oil Piping Assembly, Pressure Atomizing - ML

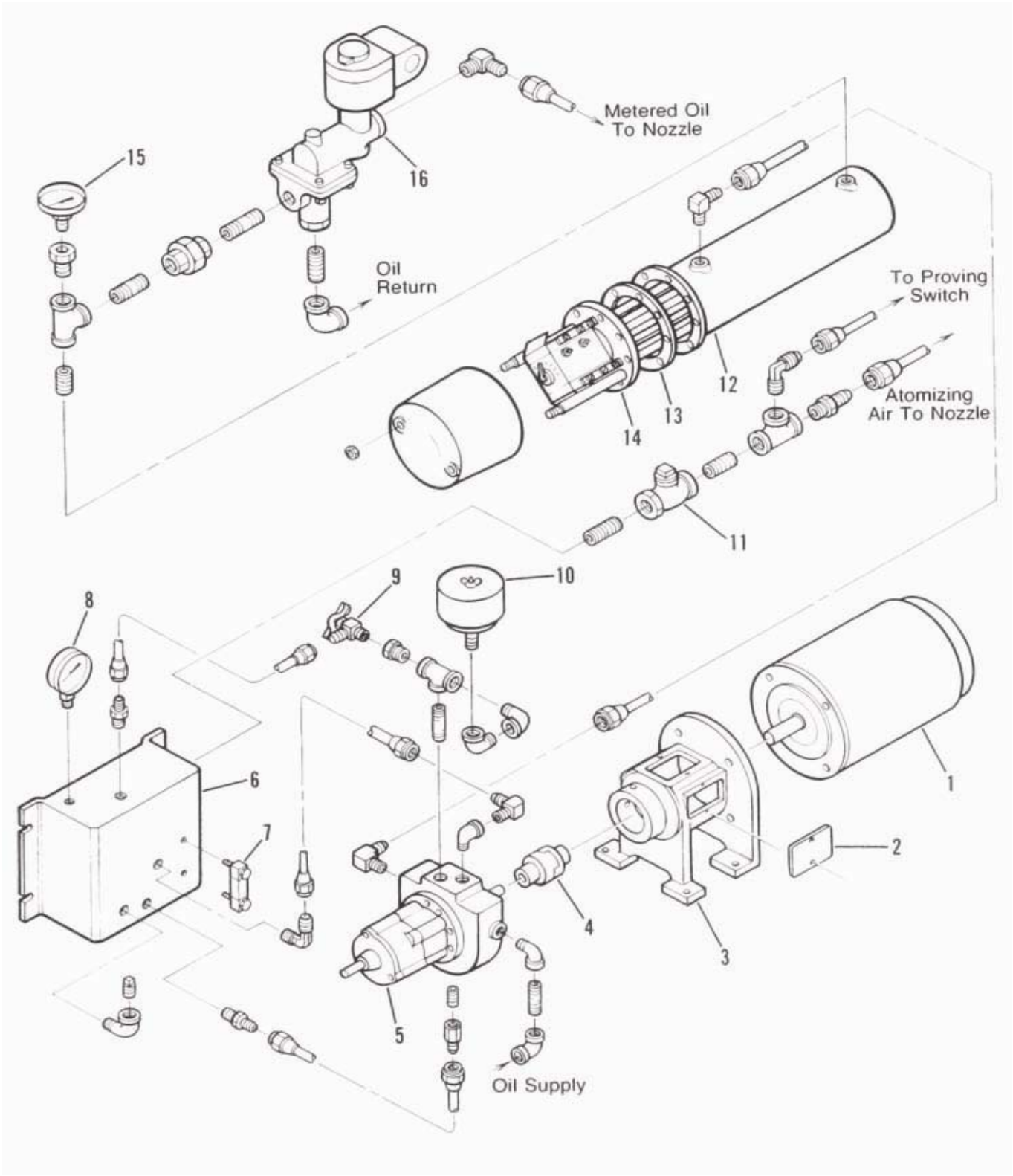


INDUSTRIAL COMBUSTION

Oil Piping Assembly, Pressure Atomizing - ML			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
1	894-884	Motor, 115-230/1/60, 1/2 HP, 3450 RPM					1	1	1			
	894-923	Motor, 208-230-460/33/60, 1/2 HP, 3450 RPM					1	1	1			
	894-1048	Motor, 115-230/1/60, 3/4 HP, 3450 RPM								1		
	894-1067	Motor, 208-230-460/3/60, 3/4 HP, 1725 RPM								1		
	894-1289	Motor, 208-230-460/3/60, 1 HP, 1725 RPM									1	1
2	19-342	Cover, Pump Mounting Foot					3	3	3	3	3	3
3	40-296	Housing, Pump Mounting Foot					1	1	1	1	1	1
4	819-117	Coupling, 7/16" X 5/8"					1	1	1			
	819-136	Coupling, 5/8" X 7/8"								1		
	819-128	Coupling, 5/8" X 7/8"									1	1
5	74-479	Jackshaft								1	1	1
6	901-462	Fuel Unit					1					
	901-437	Fuel Unit						1	1			
	901-498	Fuel Unit								1		
	901-478	Fuel Unit									1	1
7	940-1259	Metering Valve					1	1	1	1	1	1
8	940-654	Oil Solenoid Valve, N.C. 400 PSI					1	1				
	940-1258	Oil solenoid Valve, N.C. 300 PSI							1	1	1	1
9	940-1302	Oil Solenoid Valve, N.C. 300 PSI					1	1	1	1	1	1

INDUSTRIAL COMBUSTION

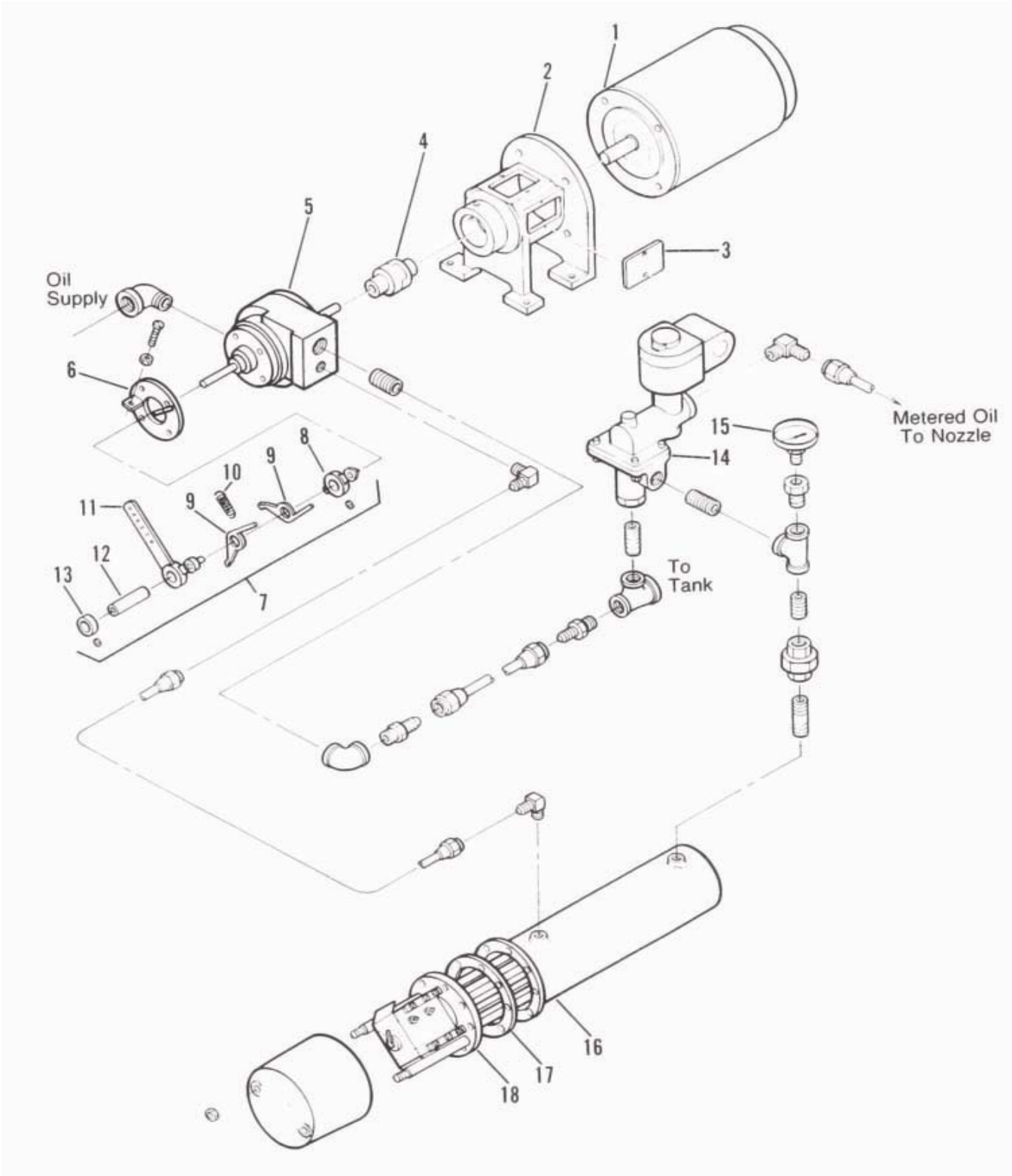
7.2.5 — Air Atomizing Oil Metering Assembly MM, ME



Air Atomizing Oil Metering Assembly MM, ME			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
1	894-935	Motor, 3/4 HP, 115-230/1/60	1	1	1	1						
	894-936	Motor, 3/4 HP, 208-230-460/3/60	1	1	1	1						
	894-1292	Motor, 1 HP, 115-230/1/60					1	1	1			
	894-1289	Motor, 1 HP, 208-230-460/3/60					1	1	1			
	894-1294	Motor, 2 HP, 115-230/1/60								1		
	894-1295	Motor, 2 HP, 208-230-460/3/60								1	1	1
2	19-342	Cover, Pump Mounting Housing	3	3	3	3	3	3	3	3	3	3
3	40-243	Housing, Pump Mounting	1	1	1	1	1	1	1	1	1	1
4	819-114	Coupling 5/8" X 9/16"	1	1	1	1	1	1	1		1	1
	819-127	Coupling 5/8" X 9/16"								1		
5	695-104	Pump, Air/Oil, No. 3-4	1									
	695-88	Pump, Air/Oil, No. 4-4		1								
	695-90	Pump, Air/Oil, No. 5-4			1	1	1	1				
	695-92	Pump, Air/Oil, No. 6-4							1			
	695-111	Pump, Air/Oil, No. 7-7S								1		
	695-98	Pump, Air/Oil, No. 8-7S									1	1
6	195-257	Tank, Air/Oil	1	1								
	195-256	Tank, Air/Oil			1	1	1	1	1	1	1	1
	195-246	Tank, Air/Oil									1	1
7	851-176	Sight Glass, Oil Level	1	1	1	1	1	1	1	1	1	1
8	850-3	Gauge, Pressure, 0-60#, 2 1/2" Dial	1	1	1	1	1	1	1	1	1	1
9	941-187	Valve, Needle, Air Shutoff 1/8" X 1/4"	1	1	1	1	1	1	1	1	1	1
10	923-115	Cleaner, Air w/Filter	1	1	1	1	1	1	1	1	1	1
	843-114	Filter, Air (replacement)	1	1	1	1	1	1	1	1	1	1
11	940-1200	Valve, Check, Horizontal, 125 PSI W.O.G. 1/4"	1	1	1	1	1	1	1	1		
	940-1169	Valve, Check, Horizontal, 125 PSI W.O.G. 1/2"									1	1
*	940-1205	Valve, Check, Horizontal, 125 PSI W.O.G. 3/4"									1	1

Air Atomizing Oil Metering Assembly MM, ME			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
12	257-74	Manifold, 14 1/2" Long, (2KW)	1	1								
	257-70	Manifold, 21 1/2" Long, (3 & 5 KW)			1	1	1	1	1	1	1	1
13	32-1000	Gasket	1	1	1	1	1	1	1	1	1	1
14	832-395	Heater, 2 KW, 230/ 1/60 W/C.O.L.	1	1								
	832-394	Heater, 2 KW, 115/ 1/60 W/C.O.L.	1	1								
	832-691	Heater, 3 KW, 230/ 1/60 W/C.O.L.			1	1	1	1	1	1		
	832-692	Heater, 5 KW, 230/ 1/60 W/C.O.L.									1	1
15	937-163	Gauge, Tempera-ture, 50-300°	1	1	1	1	1	1	1	1	1	1
16	940-1270	Valve, Oil, 3-way, 3/8"	1	1	1	1	1	1	1	1	1	
	940-1271	Valve, Oil, 3-way 1/2"										1

7.2.6 — Oil Piping Assembly, Air Atomizing, ME 34-105

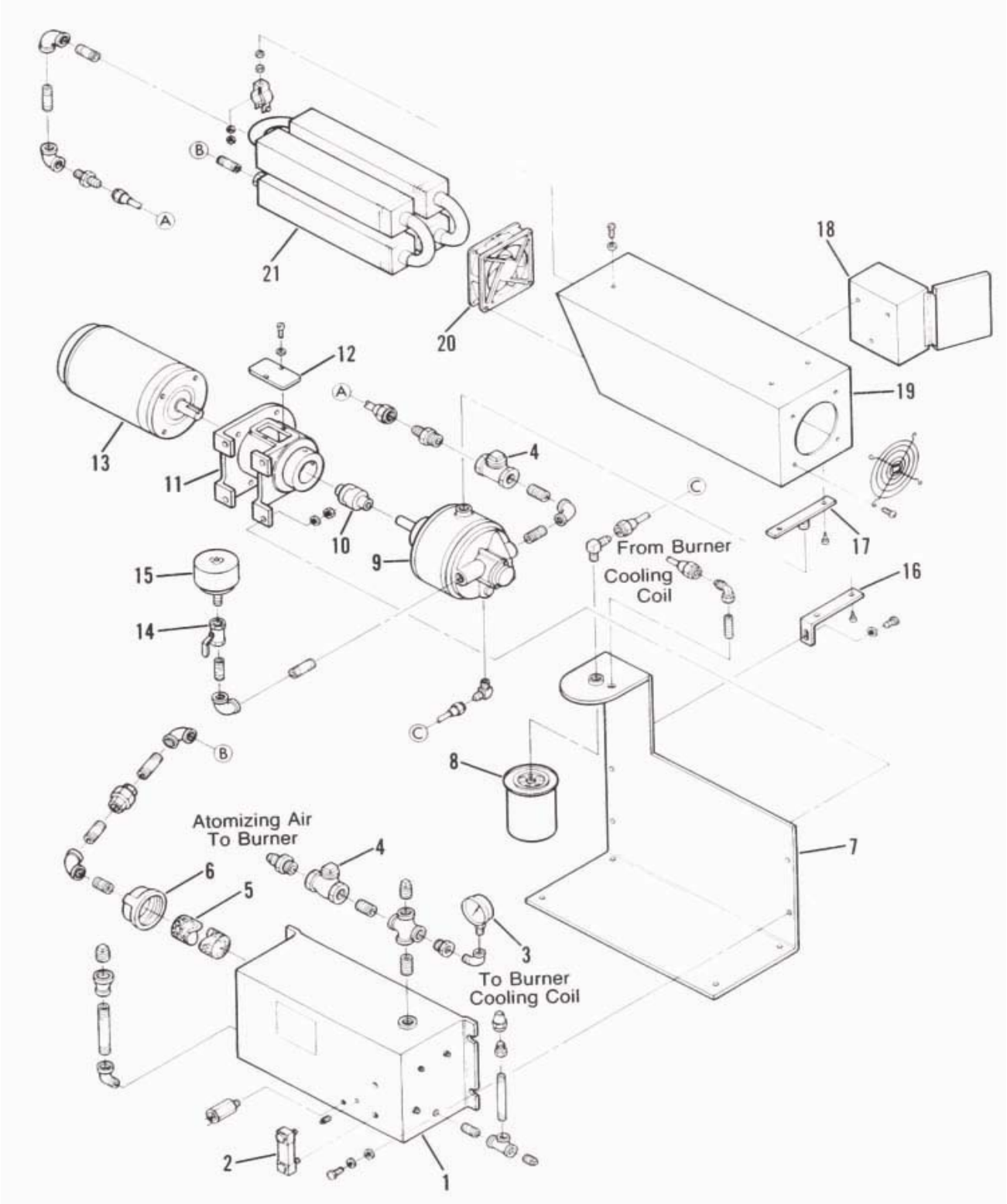


INDUSTRIAL COMBUSTION

Oil Piping Assembly, Air Atomizing, M 34-105			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
1	894-933	Motor, 115-230/1/60, 1/2 HP, 1725 RPM					1	1	1	1	1	1
2	40-243	Housing, Pump Mounting					1	1	1	1	1	1
3	19-342	Cover, Pump Mounting Housing					3	3	3	3	3	3
4	819-105	Coupling, 5/8" X 5/8"					1	1	1	1	1	1
5	695-80	Metering Head, #30					1	1				
	695-70	Metering Head, #40							1	1		
	695-71	Metering Head, #60									1	
	695-81	Metering Head, #75										1
6	282-13	Over Ride Stop					1	1	1	1	1	1
7	476-54	Arm, Assembly					1	1	1	1	1	1
8	882-14	Arm, Actuating (smaller)					1	1	1	1	1	1
9	2-134	Arm, Strain Release					2	2	2	2	2	2
10	924-50	Spring, Strain Release					1	1	1	1	1	1
11	882-27	Arm, Actuating (larger)					1	1	1	1	1	1
12	10-254	Bushing, Meter Pump					1	1	1	1	1	1
13	824-6	Collar					1	1	1	1	1	1
14	940-1271	Valve, Oil, 3-way, 1/2"					1	1	1	1	1	1
15	937-163	Gauge, Temperature, 50º-300º					1	1	1	1	1	1
16	257-70	Manifold, 21 1/2" Long					1	1	1	1	1	1
17	32-1000	Gasket					1	1	1	1	1	1
18	832-691	Heater, 3 KW, 230/1/60					1	1	1	1		
	832-692	Heater, 5 KW, 230/1/60									1	1

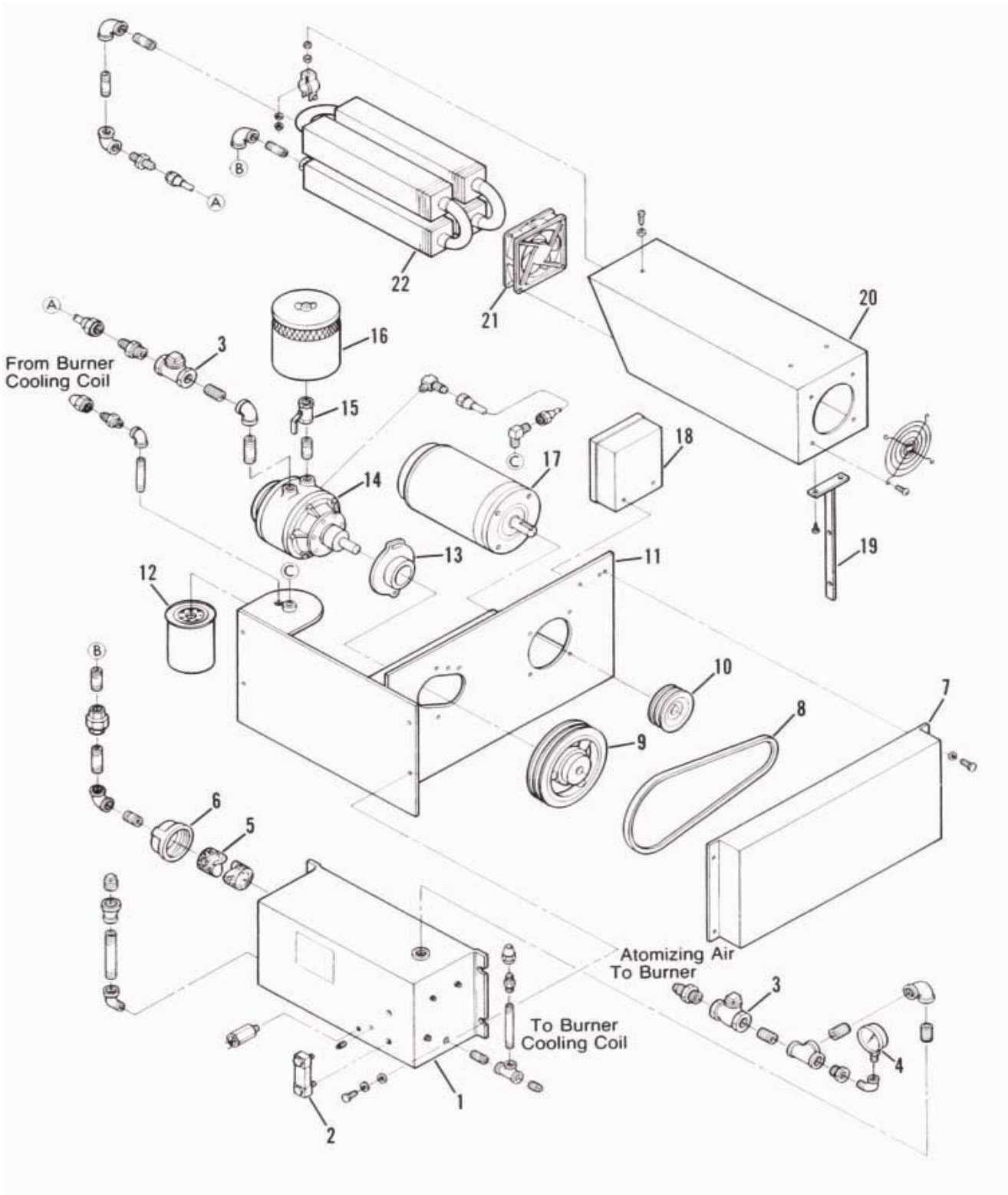
INDUSTRIAL COMBUSTION

7.2.7 — Separate Compressor Module, ME 34-54



Separate Compressor Module, ME 34-54			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
	732-102	Separate Compressor Assembly					1	1	1			
1	195-246	Tank, Air/Oil					1	1	1			
2	851-176	Sightglass, Oil Level					1	1	1			
3	850-3	Gauge, Pressure, 0-60#					1	1	1			
4	940-1205	Valve, Check, 3/4"					2	2	2			
5	843-97	Filter, Mesh, 2" X 12"					1	1	1			
6	13-167	Cap, Strainer					1	1	1			
7	3-281	Base					1	1	1			
8	843-106	Filter, Full Flow					1	1	1			
9	505-205	Compressor, Air #7					1	1	1			
10	819-105	Coupling, Flexible, 5/8" X 5/8"					1	1	1			
11	40-243	Housing, Pump Mounting					1	1	1			
12	19-342	Cover, Pump Mounting Housing					3	3	3			
13	894-1295	Motor, Electric, 2 HP, 208-230-460/ 3/60, 1725 RPM					1	1	1			
14	941-585	Cock, Shutoff					1	1	1			
15	923-115	Cleaner, Air w/Filter					1	1	1			
	843-114	Filter, Air (replacement)					1	1	1			
16	8-1292	Bracket, Support, Cooling Coil					1	1	1			
17	8-1252	Bracket, Support, Cooling Coil					1	1	1			
18	848-416	Box, Junction, 4" X 5"					1	1	1			
*	832-653	Terminal Block, 1 Pair					6	6	6			
*	832-654	Terminal Block, End					1	1	1			
19	17-133	Cooling Coil Assembly (includes guards, fan, coil)					1	1	1			
	35-320	Guard, Cooling Coil Cover & Motor Mount					1	1	1			
	35-321	Guard, Cooling Coil					1	1	1			
20	951-144	Fan, Cooling Coil 115/1/60, 3100 RPM					1	1	1			
21	17-134	Coil, Cooling					1	1	1			

7.2.8 — Separate Compressor Module, ME 63-105

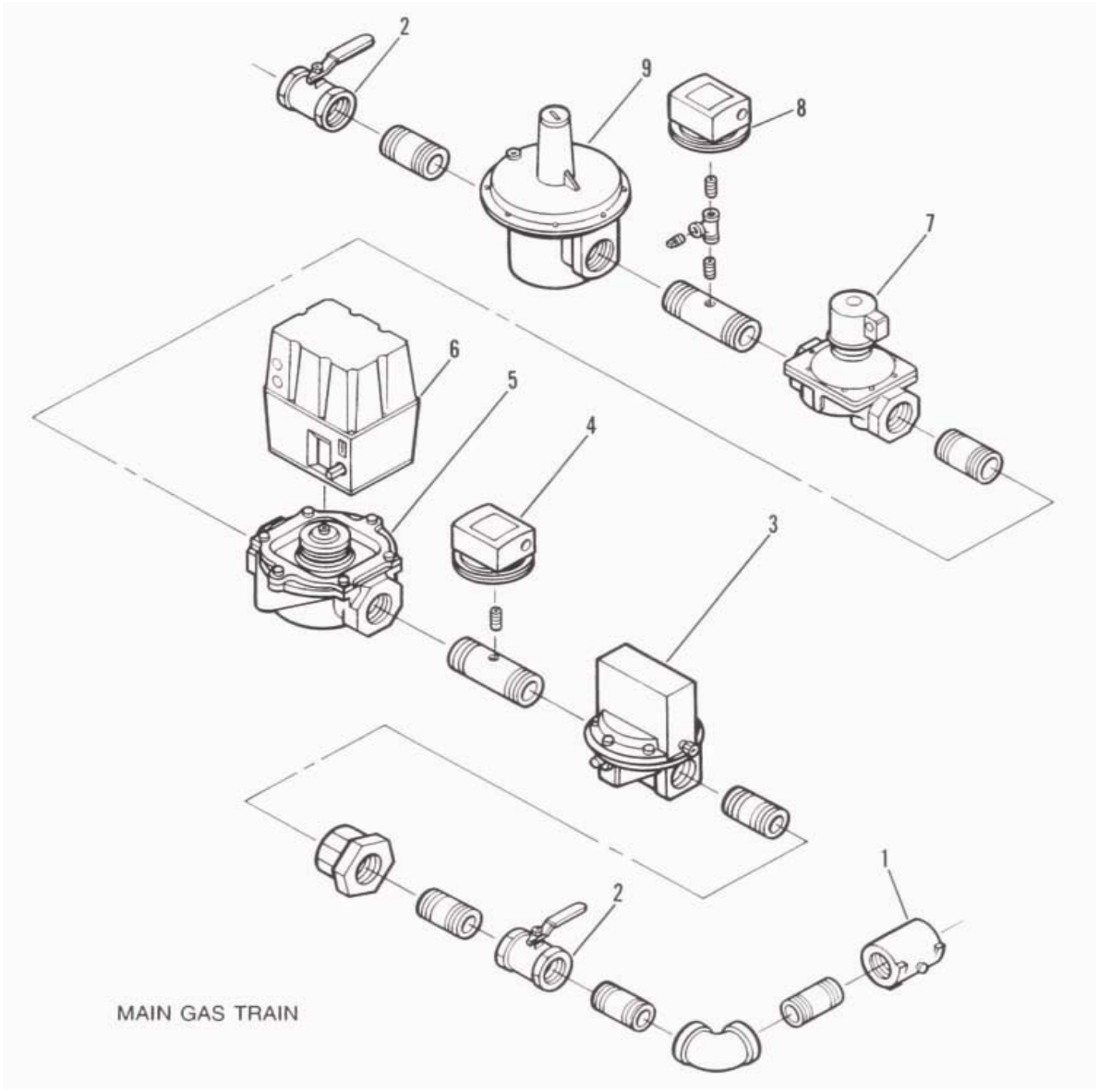


INDUSTRIAL COMBUSTION

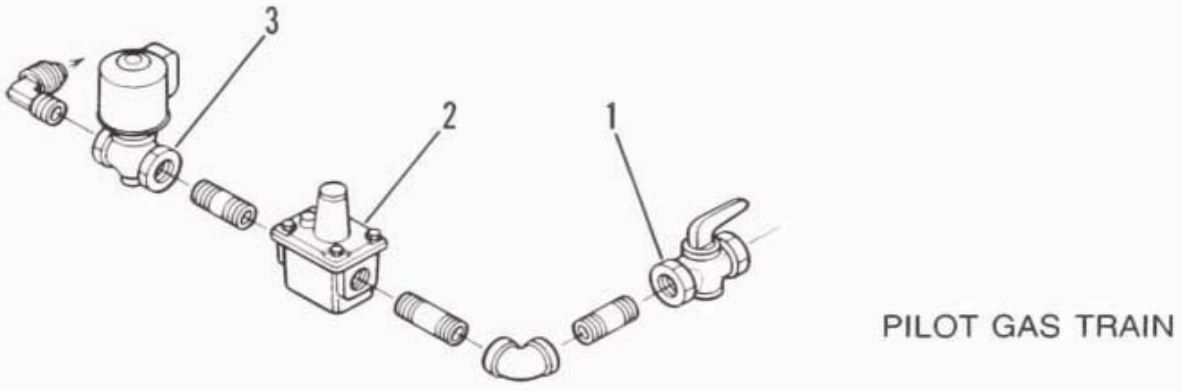
Separate Compressor Module, ME 63-105			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
	732-104	Separate Comprssor Assembly ME-MEG 63, 84,105										
1	832-101	Tank, Air/Oil Assembly								1	1	1
	195-246	Tank, Air/Oil								1	1	1
2	851-176	Sightglass, Oil Level								1	1	1
3	940-1205	Valve, Check, 3/4”								2	2	2
4	850-3	Gauge, Pressure, 2 1/2” Dial, 0-60#								1	1	1
5	843-97	Filter, Mesh, 2” X 12”								1	1	1
6	13-167	Cap, Strainer								1	1	1
7	35-290	Guard, Belt								1	1	1
8	809-212	Belt, V								2	2	2
9	921-485	Sheave, Compres-sor								1	1	1
10	921-505	Sheave, Motor								1	1	1
11	3-273	Base								1	1	1
12	843-106	Filter, Full Flow								1	1	1
13	29-841	Flange, Mounting, Compressor								1	1	1
14	505-169	Compressor, Air, 2”								1	1	1
15	941-562	Cock, Shutoff, 3/4”								1	1	1
16	923-112	Cleaner, Air w/Filter								1	1	1
	843-112	Filter, Air (replace-ment)								1	1	1
17	894-1291	Motor, 3 HP, 3450 RPM								1	1	1
18	848-416	Box, Junction 4” X 5”, w/Terminal Block								1	1	1
19	8-1251	Bracket, Cooling Coil Support								1	1	1
20	17-133	Cooling Coil Assem-bly (includes Guards, Fan, & Coil)								1	1	1
	35-321	Guard, Cooling Coil								1	1	1
	35-320	Guard, Cooling Coil Cover & Motor Mount								1	1	1
21	951-144	Fan, Cooling Coil,115/1/60, 3100 RPM								1	1	1
22	17-134	Coil, Cooling								1	1	1

INDUSTRIAL COMBUSTION

7.2.9 — Main & Pilot Gas Trains



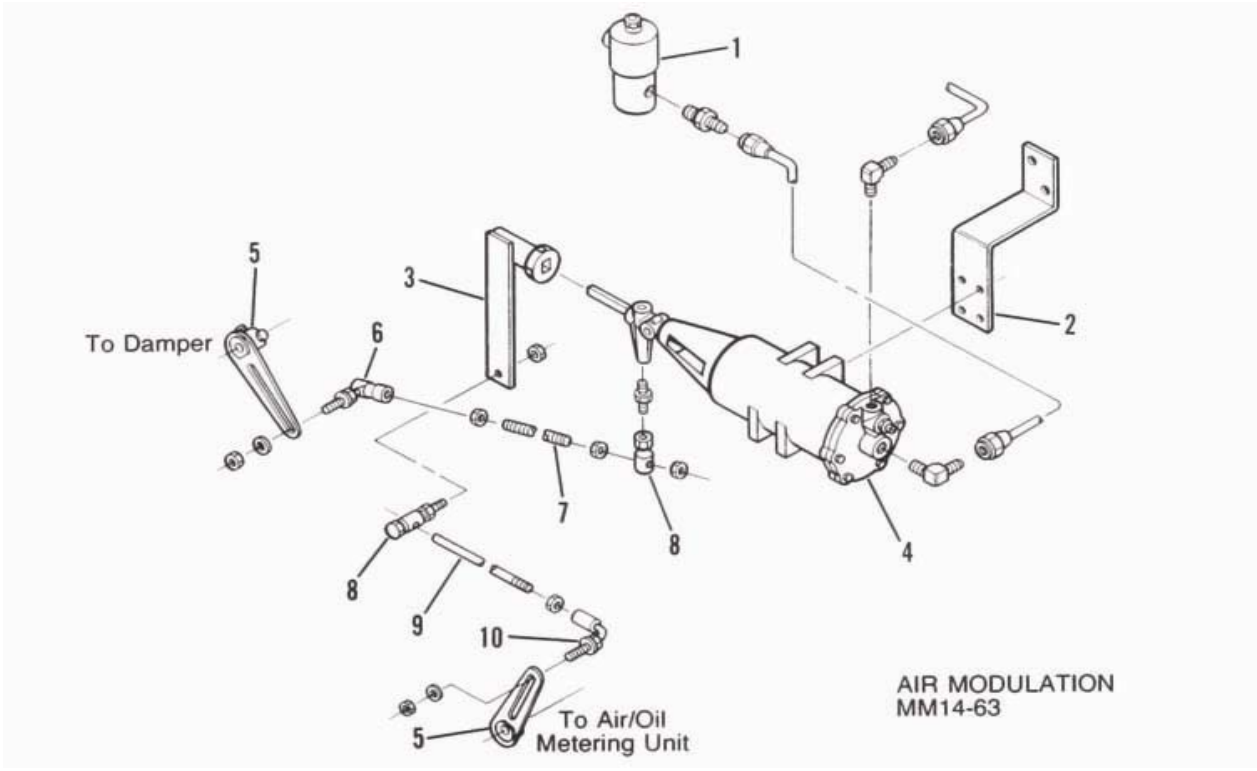
MAIN GAS TRAIN

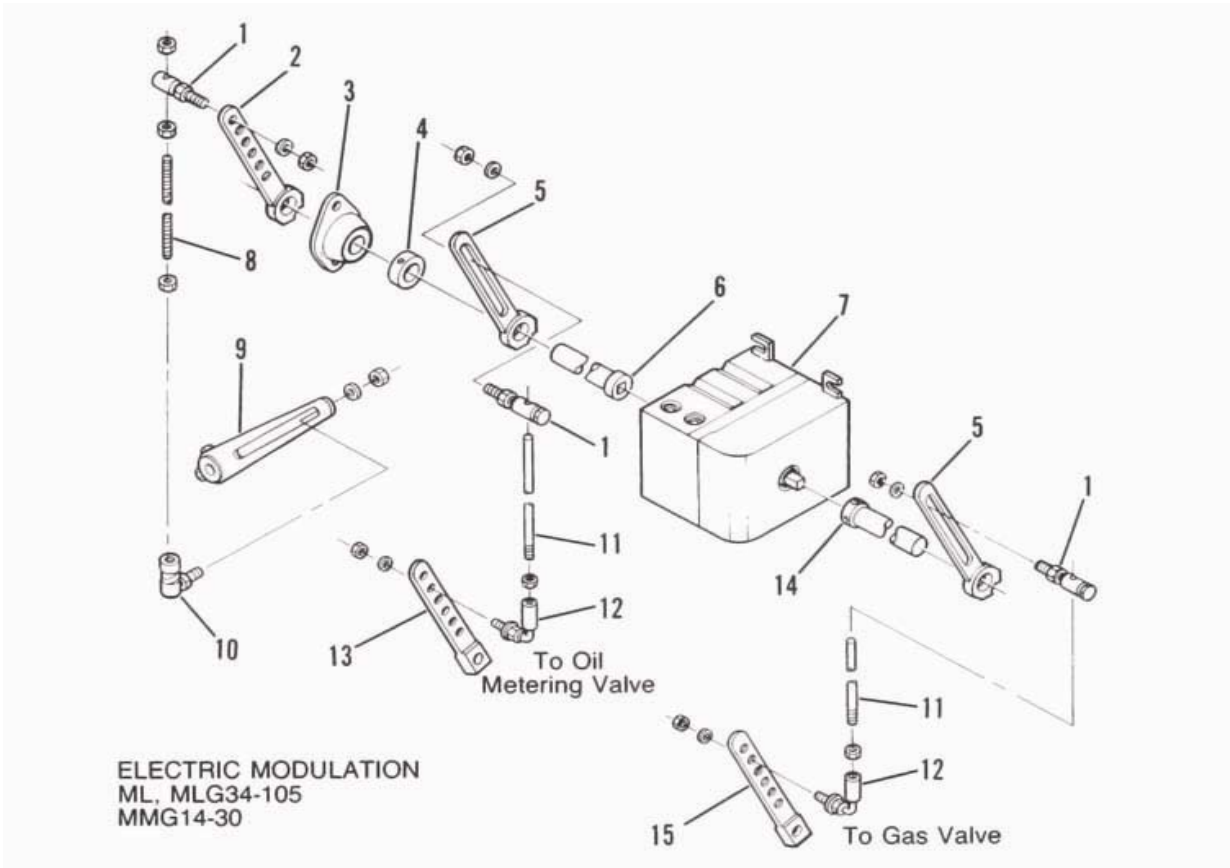


PILOT GAS TRAIN

Main & Pilot Gas Trains			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
MAIN GAS TRAIN												
1	940-1129	Vlave, Butterfly, 1”	1									
	940-1254	Valve, Butterly, 1 1/2”		1								
	940-1192	Valve, Butterfly, 2” Full Port			1	1	1	1	1	1		
	940-1230	Valve, Butterfly, 2 1/2” Full Port									1	1
2	941-594	Shutoff Cock 1”	2									
	941-127	Shutoff Cock 1 1/2”		2								
	941-128	Shutoff Cock 2”			2	2	2	2				
	941-129	Shutoff Cock 2 1/2” Lubricated							2	2		
	941-130	Shutoff Cock 3” Lubricated									2	2
3	940-1103	Valve, Gas Diaphragm, 1”	1									
	940-1090	Valve, Gas Diaphragm, 1 1/2”		1								
4	817-571	Switch, Pressure, High			1	1	1	1	1	1	1	1
5	940-1221	Valve, Body, 2”			1	1	1	1				
	940-1203	Valve, Body, 2 1/2” P.O.C.							1	1		
	940-1222	Valve, Body, 3”									1	1
6	945-122	Actuator, 13 Sec.			1	1	1	1	1	1	1	1
7	940-1173	Valve, Solenoid, K3E, 2 1/2”							1	1		
	940-1098	Valve, Solenoid, K3E, 3”									1	1
8	817-570	Switch, Gas Pressure, Low			1	1	1	1	1	1	1	1
9	817-582	Regulator, Gas Pressure, 1” RV 60	1									
	817-622	Regulator, Gas Pressure, 1 1/2”		1								
	817-617	Regulator, Gas Pressure, 2” RV 91			1	1	1	1				
	817-634	Regulator, Gas Pressure, 2 1/2” RV 110							1	1		
	817-588	Regulator, Gas Pressure, 3” RV 110									1	1
PILOT GAS TRAIN												
1	825-137	Shutoff Cock 1/2”	1	1	1	1	1	1	1	1	1	1
2	817-695	Regulator, Gas Pressure, 1/2”	1	1	1	1						
	817-580	Regulator, Gas Pressure, 1/2” RV 52					1	1	1	1	1	1
3	940-1127	Valve, Gas Pilot, 1/2”	1	1	1	1	1	1	1	1	1	1

7.2.10 — Air & Electric Modulation, Linkage

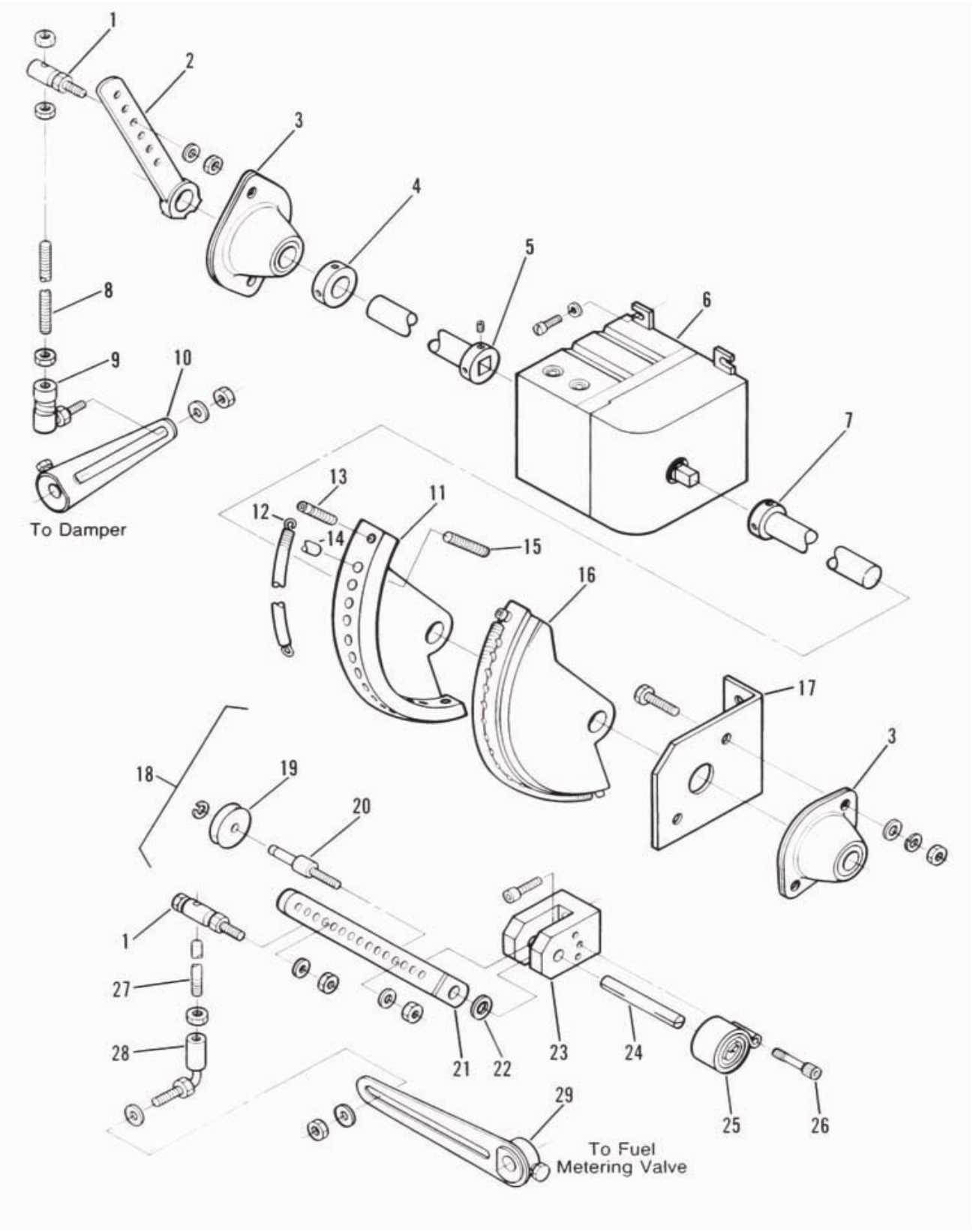




INDUSTRIAL COMBUSTION

Air & Electric Modulation, Linkage			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
AIR MODULATION MM 14-63												
1	940-1213	Valve, Solenoid, N.O. 325 PSI	1	1	1	1	1	1	1	1		
2	8-1383	Bracket, Air Modulator	1	1	1	1						
	8-1184	Bracket, Air Modulator					1	1	1	1		
3	2-147	Arm, Air Modulator					1	1	1	1		
4	269-1	Air Modulator	1	1	1	1	1	1	1	1		
5	2-111	Arm, Actuating	2	2	2	2	2	2	2	2		
6	883-35	Ball Joint, 5/16" - 24 Disconnect	1	1	1	1	1	1	1	1		
7	970-1	Threaded Rod, 5/16" - 24 (specify length)	1	1	1	1	1	1	1	1		
8	883-8	Ball Joint, 5/16" X Straight	2	2	2	2	2	2	2	2		
9	67-123	Rod, Brass, 1/4" X 12" Long, T.O.E.	1	1	1	1	1	1	1	1		
10	883-11	Ball Joint, 1/4" X 90°	1	1	1	1	1	1	1	1		
ELECTRIC MODULATION ML, MLG 34-105, MM, MMG 14-30												
1	883-008	Ball Joint, 5/16" X Straight	3	3	3	3	3	3	3	3	3	3
2	2-30	Arm, Actuating	1	1	1	1	1	1	1	1	1	1
3	807-335	Bearing	1	1	1	1	1	1	1	1	1	1
4	18-111	Collar	1	1	1	1	1	1	1	1	1	1
5	2-14	Arm, Actuating, Slotted	2	2	2	2	2	2	2	2	2	2
6	10-308	Bushing, 15 1/4" LG	1	1								
	10-314	Bushing, 18 1/2" LG			1	1	1	1	1	1		
	10-307	Bushing, 28" LG									1	1
7	894-1288	Modulation Motor, 90° (MG84)	1	1	1	1	1	1	1	1		
	894-1305	Modulation Motor 90°									1	1
8	970-1	Threaded Rod, 5/16" - 24" (specify length)	1	1	1	1	1	1	1	1	1	1
9	2-112	Arm, Actuating	1	1	1	1	1	1	1	1	1	1
10	883-35	Ball Joint 5/16" - 24 Disconnect	1	1	1	1	1	1	1	1	1	1
11	977-6	Rod, Brass, 1/4" Dia. (specify length)	1	1	1	1	1	1	1	1	1	1
12	883-11	Ball Joint, 1/4" X 90°	2	2	2	2	2	2	2	2	2	2
13	2-103	Arm, Actuating					1	1	1	1	1	1
	2-111	Arm, Actuating	1	1	1	1						
14	10-295	Bushing, 1 1/2"			1	1	1	1	1	1	1	1
	10-305	Bushing, 6 1/4"	1	1								
15	2-103	Arm, Actuating	1	1	1	1	1	1	1	1	1	1

7.2.11 — Electric Modulation with Cam Trim: MM, MMG, ME, MEG 34-105



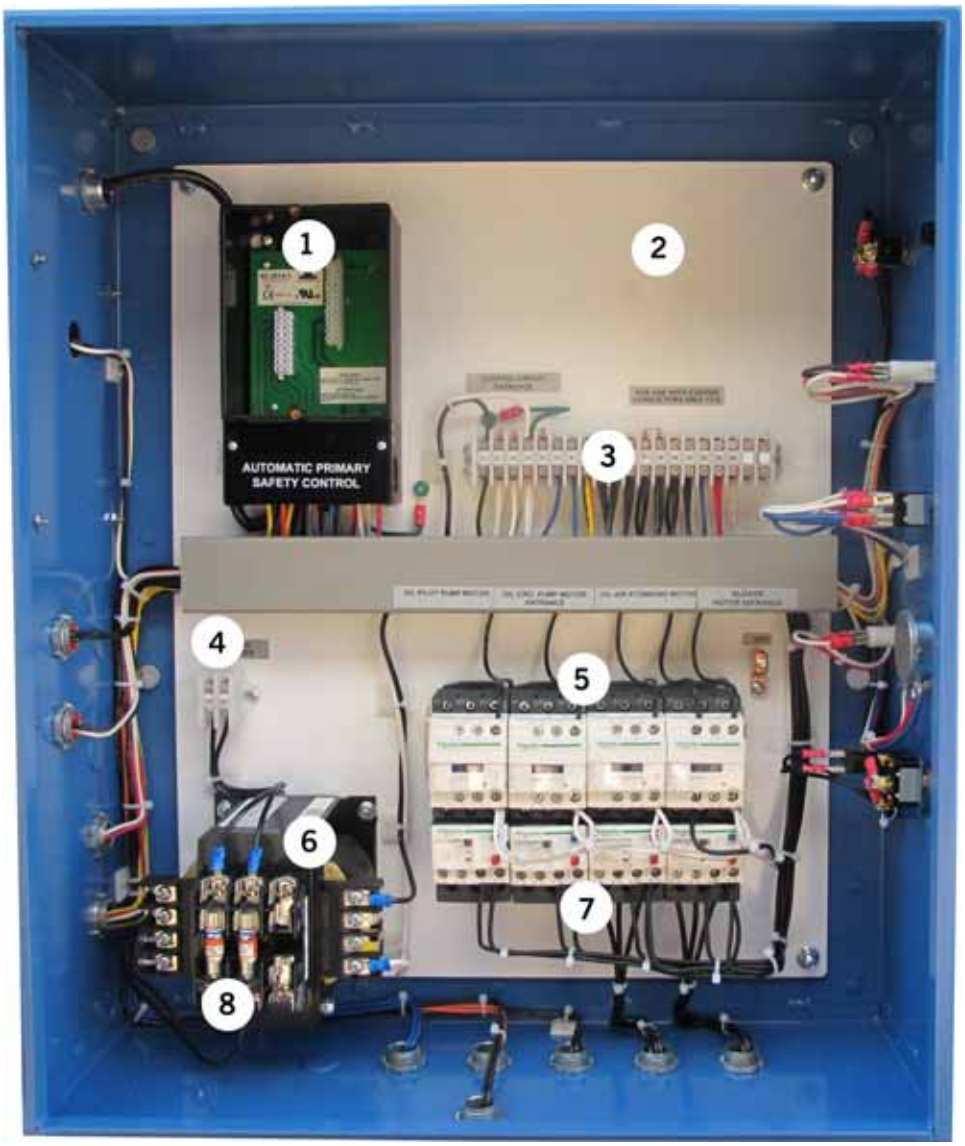
INDUSTRIAL COMBUSTION

Electric Modulation with Cam Trim: MM, MMG, ME, MEG 34-105			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
1	883-8	Ball Joint, 5/16" X Straight					3	3	3	3	3	3
2	2-30	Arm, Actuating					1	1	1	1	1	1
3	807-335	Bearing					2	2	2	2	2	2
4	18-111	Collar					2	2	2	2	2	2
5	10-308	Bushing, 15 1/4"					1	1	1	1		
	10-314	Bushing, 18 1/2"					1	1	1	1		
	10-307	Bushing, 28"									1	1
6	894-1288	Modulation Motor, 90°					1	1	1	1	1	1
7	10-309	Bushing, 9 1/4"					1	1	1	1		
	10-305	Bushing, 6 1/4"					1	1	1	1	1	1
8	67-321	Threaded, Rod					1	1	1	1		
	67-320	Threaded, Rod									1	1
9	883-35	Ball Joint, 5/16" - 24, Disconnect					1	1	1	1	1	1
10	2-112	Arm Actuating, Use 2-183					1	1	1	1	1	1
11	313-12	Cam Assembly, Right Hand, MM					1	1	1	1	1	1
12	82-153	Spring, Roller Guide					1	1	1	1	1	1
13	71-24	Screw, Spring Fastening Screw						2	2	2	2	2
14	36-111	Guide, Cam Spring					14	14	14	14	14	14
15	860-276	Screw, Set					14	14	14	14	14	14
16	313-13	Cam Assembly, Left Hand, MG, ME					1	1	1	1	1	1
17	8-1442	Bracket					1	1	1	1	1	1
18	476-82	Linkage Assembly, Oil Cam Follower					2	2	2	2	2	2
	476-84	Linkage Assembly, Gas Cam Follower					2	2	2	2	2	2
19	69-299	Roller					1	1	1	1	1	1
20	74-492	Shaft, Roller Guide					1	1	1	1	1	1
21	2-13	Arm, Linkage					1	1	1	1	1	1
22	807-339	Bearing, Plastic					2	2	2	2	2	2
23	8-1356	Bracket, Linkage Arm					1	1	1	1	1	1
24	74-506	Shaft, Linkage Arm					1	1	1	1	1	1
25	82-140	Spring, Return (Gas)					2	2	2	2	2	2
	82-155	Spring, Return (Oil)					2	2	2	2	2	2
26	868-212	Socket Head Cap Screw, 1/4" X 20 X 3/4" (Gas)					2	2	2	2	2	2
	868-213	Socket Head Cap Screw, 1/4" X 20 X 1" (Oil)					2	2	2	2	2	2

Electric Modulation with Cam Trim: MM, MMG, ME, MEG 34-105			Quantity									
Item No.	Part No.	Description	14	22	28	30	34	42	54	63	84	105
27	67-128	Rod, Linkage, 1/4" X 24" Long (MM 34-63)					1	1	1	1	1	1
	67-300	Rod, Linkage, 1/4" X 22" Long (ME, MG)					2	2	2	2		
	67-314	Rod, Linkage, 1/4" X 26" Long (MG)									1	1
28	883-11	Ball Joint, 1/4" X 90º					2	2	2	2	2	2
29	2-111	Arm, Actuating, MM					1	1	1	1	1	1
	2-183	Arm, Actuating, MG					1	1	1	1	1	1
	476-54	Arm, Linkage Assembly, ME					1	1	1	1	1	1

INDUSTRIAL COMBUSTION

7.2.12 — Panel Box and Control System



Item	Description
1	Flame Safeguard Wiring Base (varies)
2	Sub Base
3	Terminal Blocks
4	Terminal Blocks
5	Motor Contactors (varies)
6	Control Circuit Transformer (varies)
7	Overload (varies)
8	Fuses (varies)


Switch, Manual Auto S.P.D.T. With Center Off
OIL CIRC. PUMP HAND OFF AUTO
Light, Neon, White (Power On)
POWER ON
IGNITION ON
Light, Neon, Amber (Ignition On)
Switch, Manual Auto D.P.D.T. Without Center Off
MAN
AUTO
MODULATING SELECTOR
FUEL VALVE OPEN
Light, Neon, Green (Full Valve Open)
Optional Manual Modulating Control, Potentiometer
CLOSE
OPEN
MODULATING CONTROL
FLAME FAILURE
Light, Neon, Red (Flame Failure)
Switch, Low/Auto, S.P.D.T.
ON
BURNER SWITCH
Circuit Breaker 15 Amp
INDUSTRIAL COMBUSTION, LLC

INDUSTRIAL COMBUSTION

7.2.13 — Standard Components

Standard Blower Motors & Impellers										
Burner Size	S Models					P Models				
	Blower Motor			Impeller		Blower Motor			Impeller	
	HP	P/N 894-		P/N 192-	Size O.D.	HP	P/N 894-		P/N 192-	Size O.D.
		1 PH	3 PH				1 PH	3 PH		
14	1/2	894	923	283	11	-	-	-	-	-
22	1/2	894	923	283	11	-	-	-	-	-
28	1	885	928	286	13	-	-	-	-	-
30	1	885	928	286	13	-	-	-	-	-
34	2	1293	1290	285	12	2	1293	1290	286	12
42	2	1293	1290	286	13	2	1293	1290	287	14
54	2	1293	1290	287	14	3	1296	1291	288	14.5
63	3	1296	1291	288	14.5	3	1296	1291	289	15.25
84	5	-	1302	292	15	7 1/2	-	1309	293	16
105	7 1/2	-	1309	293	16	7 1/2	-	1309	294	17

Standard Flame Safeguard Controls				
Burner Size	Fireye IC Package Number		Honeywell IC Package Number	
	High-Low*	Full Modulation	High-Low*	Full Modulation
14	132	89	-	102
22	132	89	-	102
28	132	89	-	102
30	89	89	-	102
34	89	89	102	102
42	89	89	102	102
54	89	89	102	102
63	89	89	102	102
84	-	89	-	102
105	-	89	-	102
**MM Models with pneumatic modulation*				

Standard Flame Safeguard Control Components					
Control	Package no.132 (Fireye)	Control	Package No. 102 (Honeywell)	Control	Package No. 89 (Fireye)
833-1155	Controller UVM3-90 (Assy)	833-1062	Controller R4140G 1106 (Assy)	833-1034	Controller D20-5023 (Assy)
833-1154	Control UVM3	817-1742	Scanner C7027A UV	833-1073	Control 70D20
832-830	Timing Card MT9010	833-986	Base	832-790	Amplifier 72DIR-1
817-672	Scanner UV-2	832-765	Amplifier R7248A1004	832-792	Timer 71D60 (60 Sec.)
833-963	Base			817-631	Scanner 48PT2PBS
				833-1018	Base (Open Bottom Standard)

Warranty Policy

Limited Warranty: The Company warrants that at the time of shipment the equipment manufactured by it shall be merchantable, free from defects in material and workmanship, and shall possess the characteristics represented in writing by the Company. The Company's warranty is conditioned upon the equipment being properly installed and maintained and operated within the equipment's capacity under normal load conditions with competent supervised operators. Equipment, accessories, and other parts and components not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty to the Company. In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer than the Company's warranty covering equipment manufactured by the Company.

Exclusions From Warranty: (I) The foregoing is in lieu of all other warranties, oral or express or implied, including any warranties that extend beyond the description of the equipment. There are no express warranties other than those contained herein to the extent permitted by the law. There are no implied warranties of fitness for a particular purpose. The provisions as to duration, warranty adjustment, and limitation of liability shall be the same for both implied warranties (if any) and expressed warranties.

(II) The Company's warranty is solely as stated the above paragraph and does not apply or extend, for example, to:

- expendable items
- ordinary wear and tear
- altered units
- units repaired by persons not expressly approved by the Company
- materials not of the Company's manufacture
- damage caused by accident, the elements, abuse, misuse, temporary heat, overloading, or by erosive or corrosive substances
- alien presence of oil, grease, scale, deposits, or other contaminants in the equipment

Warranty Adjustment: Buyer must make claim of any breach of any warranty by written notice to the Company's home office within thirty (30) days of the discovery of any defect. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts of the equipment which within twelve (12) months from the date of initial operation but no more than eighteen (18) months from date of shipment shall prove the Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within the above warranty. Any warranty adjustments made by the Company shall not extend the initial warranty period set forth above. Expenses incurred by Buyer in replacing or repairing or returning the equipment or any part or parts will not be reimbursed by the Company.

Spare and Replacement Parts Warranty Adjustment: The Company sells spare and replacement parts. This subparagraph (7.4) is the warranty adjustment for such parts. Buyer must make claim of any breach of any spare or replacement parts by written notice to the Company's home office within thirty (30) days of the discovery of any alleged defect for all such parts manufactured by the Company. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts or material it manufactures which, within one (1) year from the date of shipment shall prove to Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within this past warranty. The warranty and warranty period for spare and replacement parts not manufactured by the company (pur-

chased by the Company, from third party suppliers) shall be limited to the warranty and warranty adjustment extended to the Company by the original manufacturer of such parts. In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer for such parts than the Company's warranty adjustment covering parts manufactured by the Company as set forth in this subparagraph. Expenses incurred by Buyer in replacing or repairing or returning the spare or replacement parts will not be reimbursed by the Company.

Limitation of Liability: The above warranty adjustment set forth Buyer's exclusive remedy and the extent of the Company's liability for breach of implied (if any) and express warranties, representations, instructions or defects from any cause in connection with the sale or use of the equipment. THE COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT OR CONSEQENTIAL DAMAGES OR FOR LOSS, DAMAGE OR EXPENSE, DIRECTLY OR INDIRECTLY ARISING FROM THE USE OF THE EQUIPMENT OR FROM ANY OTHER CAUSE WHETHER BASED ON WARRANTY (EXPRESS OR IMPLIED) OR TORT OR CONTRACT, and regardless of any advice or recommendations that may have been rendered concerning the purchase, installation, or use of the equipment.

Startup/Service Report

The following information should be filled in by the service technician at startup or after any adjustment to the burner.

A copy of the startup report MUST be forwarded to IC in order to validate the warranty of the burner.

Burner Model _____ Serial Number_____ Startup Date_____

Electric Motors	Voltage			Amperage		
	L1	L2	L3	L1	L2	L3
Control Voltage						
Blower Motor						
Air Compressor						
Air-Oil or Metering						

Test Conducted	Gas			Oil		
	Low	50 %	High	Low	50 %	High
Firing Rate MMBtu/gph						
Stack Temp (gross) º F						
Room Temp º F						
O2%						
CO%						
CO (PPM)						
NOx (PPM)						
Smoke (Bacharach)						
Combustion Eff. %						
Stack Draft " W.C.						
Furnace Pressure " W.C.						
Blast Tube Pressure " W.C.						
Steam Pressure PSIG						
Water Temp º F						
Supply Oil Pressure PSIG						
Return Oil Pressure PSIG						
Vacuum Oil Pump " HG						
Oil Temp						
Atom. Air Pressure						
Gas Pressure @ Burner Manifold " W.C.	Inner Manifold					
	Outer Manifold					
Center Gas Pressure " W.C.						
Gas Pressure @ Regulator Inlet PSIG						
Gas Pressure @ Regulator Outlet PSIG						
Pilot Gas Pressure @ Regulator Outlet " W.C.						
Flame Signal Main	Low		50%		High	

Control Check	Test	Set Point
Low Water Cutoff		
Aux. LWCO		
High Water Cutoff		
Operating Limit		
High Limit		
Operating Control		
Stack Temp Interlock		
Flame Failure		
Combustion Air Switch		
High Purge Switch		
Low Fire Interlock		
Oil Pressure Switch		
Oil Valve w/P.O.C. Interlock		
High Gas Pressure Switch		
Low Gas Pressure Switch		
Gas Valve P.O.C. Interlock		
Pilot Turndown Test		
Flame Signal Pilot		
(For Low NOx Burners)		
Blast Tube Temp Interlock		
FGR Line Purge Switch		
FGR Valve P.O.C.		

Adjusted by:

Date:

Accepted by:

(Signature Required)

Product Satisfaction Survey

Burner Model _____ Serial Number_____

As a requirement of our ISO certification, please fill in this form and return it to Industrial Combustion.

Please rate your satisfaction with the following:

Item	Poor	Good	Excellent
Delivery Time			
Appearance of Equipment After Delivery			
Piping and Tubing			
Wiring			
All Components Arrived with Equipment			
Ease of Startup			
Performance of Equipment			
Quality of Information Provided			
Sales			
Engineering			
Service			
Parts			
Overall Way Any Problems Were Handled			

Comments:

Date:_____ By:_____

Comments (continued):