# FUEL MASTER C SERIES BURNER

Installation and Service Instructions

# Type CO Series Forced Draft Oil Burner



Designed and built by Canadians for Canadian Winters

Ву

**PENDELL BURNERS** 



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# Installation and Service Instructions

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**Chart #1**Specifications and Capacities – "C" Series Oil Burners

Boiler Model	el Furnace Pressure				at 0.06"	W.C Furnace	Blower Motor H.P	Approx. Crated
Number	G.P.H Oil Input		Max Boiler H.P	G.P.H Oil Inpu	ıt	Max Boiler H.P		Weight LBS.
	Min.	Max.		Min.	Max.			
CO-25	2.5	8	26.8	3	8	30.0	1/2	160
CO-45	7	13	43.6	7.5	15	50.0	3/4	200
CO-60	12	20	66.6	13	22	73.3	1	200
CO-100	17	30	100.0	18	33	110.0	2	265
CO-125	18	37.5	125.0	18	39	130.0	3	300
CO-165	20	50	167.0	20	56	186.7	3	440
CO-230	20	60	200.0	20	75	250.0	5	450
CO-300	20	90	300.0	20	97.5	325.0	7 ½	550
CO-350	20	120	400.0	20	127	425.0	10	625

Note: Ratings based on 2000 ft. above sea level. De-rate burner 4% for each additional 1000ft. altitude.

H.P. Ratings based on 80% combustion efficiency and Maximum capacity firing #2 Oil.

Note: Literature –2 or –S designates increased blower capacity and motor horsepower to meet site conditions.

Note: CO-125 and larger, plus all dual fuel models are supplied with a separate pump set.

**Installation and Service Instructions** 

#### 1.0 - INSTALLATION AND SERVICE MANUAL

This FUEL MASTER CO Series Oil Burner must be installed by qualified licensed personnel, in accordance with Provincial and Local code requirements. Authorities having jurisdiction shall be consulted before installations are made.

Study the manual before assembling or installing the burner and be familiar with the burner. It is important to keep all instructions clean and intact and to deliver them to the owner for future use.

The combustion chamber sizes in Chart #2 are based on boiler and furnace capacities. The correct input and combustion chamber dimensions are determined either from the gross or standing load. Check the standing load and BTU loss to be sure that the boiler or furnace is adequate in size.

#### 1.1 - BURNER DESCRIPTION

The FUEL MASTER CO Series oil burner has been designed to fire boilers or furnaces incorporating a fire brick combustion chamber below the furnace area, (firebox or cast iron sectional). The flame pattern is designed to recirculate in front of the burner rather than blast away at the rear of the chamber. This provides a very high radiant heat release for the full length of the combustion chamber, giving excellent heat transfer to the primary heat exchange surfaces.

The CO Series oil burner is robustly constructed using an all welded housing and blast tube. The burner end cone is of stainless steel to withstand high temperatures.

The CO Series oil burner has been designed for a direct spark ignition of the low fire nozzle. After the trial period the spark is interrupted and the flame must be established and continue to be sensed.

#### 1.2 - UNPACKING THE BURNER

All burners have been completely assembled, checked and inspected under actual firing conditions, and crated at the factory. They are delivered to the carrier in perfect condition. Promptly notify the carrier of any damage.

Carefully uncrate the burner and check all parts received. Component parts and accessories may be shipped in separate boxes within the crate. Make sure all the boxes are empty before discarding.

#### 2.0 - BOILER OR FURANCE ROOM VENTILATION

To insure complete combustion, the proper amount of fresh air must be supplied to the room through an inlet near the floor line or ground level. Building exhaust fans <u>must not</u> affect the fresh air supply to the burner. (See Chart #2)

# 2.1 - COMBUSTION AIR REQUIRED

To ensure that good clean combustion and a reasonable burner room temperature can be maintained, a source of fresh air is required. The usual practice is to provide a grill or louvre in an outside wall with sufficient area to pass the volume of air required. Two methods are used to calculate the free area of these openings:

- X) When the burner is installed in a forced draft unit without a barometric draft regulator or draft hood and unit is sealed, the free area of the opening shall provide at least one square inch for each 30,000 BTUH. If movable dampers or fans are used to provide make up air, then an electrical interlock is required to prove airflow before the burner can operate.
- Y) On installations where the burner is operating at a negative draft and a barometric draft regulator or draft hood is used, the natural ventilation free area shall provide, not less than 100 square inches for the first 400,000 BTUH plus one square inch for each additional 14,000 BTUH.

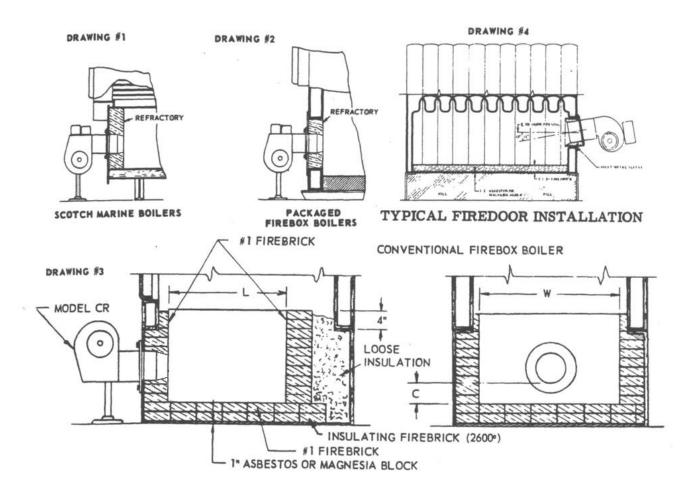
For applications such as bake ovens, incinerators or other types of boilers or furnaces, please consult the factory.

Note: A <u>free</u> opening is clear and unobstructed, and openings with grills or louvers should be increased in overall size so that the manufacturer's free rating is adequate. The minimum dimensions do not provide necessary additional air for other venting devices. Ventilation must meet the requirements of local authorities. Chart #2 indicates the minimum free area required for the burner only.

#### 2.2 - BOILER OR FURNANCE PREPARATION

- **A)** Clean the boiler or furnace thoroughly and remove all grates and obstructions. Check the entire boiler or furnace assembly, including the flue and breeching and repair all leaks.
- **B)** If the burner is operating against positive firebox pressure, the entire installation including cleanout doors, flue connection and inspection doors must be air tight. If the firebox pressure is negative, such extreme care can be omitted, but the tighter the boiler, the better the combustion efficiency.
- **C)** Check the size of the flue. Flue dimensions must conform to the boiler or furnace manufacturer's recommendations. The breeching must slope upward toward the flue at a minimum rate of 1/4 "per linear foot.
- D) Cover the bottom of the boiler or furnace with sufficient amount of insulation material (refer to Drawing #1 to #4) such as Rockwool Mirco fill, or equivalent. Lay the combustion chamber

- floor using #1 fire brick. All brick must be bonded together with a quality grade of refractory cement, such as Sairset, Setcold, Laytite, or equivalent.
- E) Refer to Chart #2 for recommended combustion chamber dimensions. Erect the side back walls according to the selected chart dimensions. The walls should be at least 4" higher than the water legs of the boiler or the return inlet of the furnace. When a Scotch Marine, Packaged Firebox Boiler or Firedoor installation is used, no refractory chamber is needed. In this case, refractory is used only around the perimeter of the burner as shown in Drawings #1 and #2. Consult the boiler manufacturer's recommendations for any other refractory that may be needed.



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**Chart #2**Typical Combustion Chamber Sizing

Typical Combustion Chamber Sizing									
Burner	Input	Firebox Combustion Chamber			Scotch		Combustion Air		
Model	US/GPH	Dimension			Furnace		Opening Sq. In. Free Area		
Number	#2 Oil						At Max. Firing Rate		
		Width	Length	Min.	ID	L	(x)	(y)	
		INS (W)	INS (L)	Blastube					
				Height (C)					
CO-25	7	21	27	4					
	9	23	32	5	15	50	42	160	
CO-45	7.5	21	28	4					
	10	24	34	5					
	15	26	41	5	17	60	70	220	
CO-60	13	25	39	5					
	16	26	43	6					
	22	32	52	6	19	70	97	278	
CO-100	18	29	47	6					
	25	33	53	8					
	33	37	62	10	22	85	154	400	
CO-125	39	38	65	11	24	90	180	460	
CO-165	29	36	60	10					
	40	42	70	11					
	56	49	78	12	28	113	261	630	
CO-230	45	44	74	12					
	60	52	80	12					
	75	58	86	12	32	125	300	714	
CO-300	97.5	56	106	18	36	150	460	1050	
CO-350	127	62	124	22	42	170	590	1330	

<sup>(</sup>x): Pressure fired installations without draft hood or barometric draft control.

Note: Ratings are based on 2000 ft. above sea level with a 20% piping and pick-up allowance. De-rate 4% for each additional 1000 ft. altitude.

Note: This is a guide only, providing approximate chamber dimensions to accommodate the flame shape and provide combustion volume.

<sup>(</sup>y): Natural draft installation with barometric draft control.

**Installation and Service Instructions** 

#### 2.3 - BURNER WIRING

To protect the motor and electrical equipment, and prevent nuisance lock-outs by the voltage-sensitive fame safeguard system, an adequate, stable dependable, and properly fused electrical supply must be provided.

A wiring diagram which outlines the power supply and other external controls is furnished with each burner. The installer should familiarize himself with each diagram and follow it closely.

- A) Connect the main power supply and safety controls to the panel. All wiring must comply with local electrical codes and regulations.
- **B)** With the power supply switch in the OFF position, check all fuses and all terminals for loose wiring connections.
- C) It is good practice to the wire the operating controls right back to the burner, in a separate loop from the safety limit controls, to obtain maximum protection from the limit circuit.

#### 2.4 - OIL PIPING

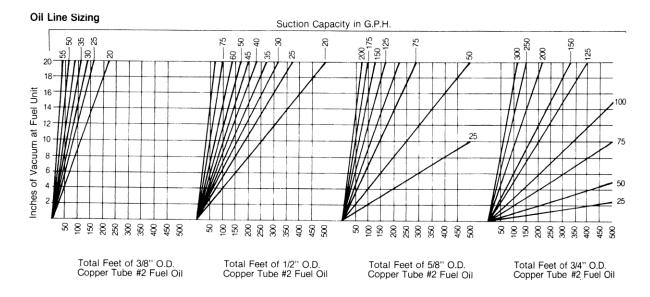
- A) All fuel lines and storage tanks must be installed in accordance with local regulations.
- **B)** A two pipe system must always be used. The fuel pumps are pre-set at factory for use with this type of system. (The warranty on the fuel pump will null and void if a one pipe system is used).
- C) Use copper or iron pipe on all installations. Size the pipe according to Section 2.4.
- **D)** If the oil storage system has been used for fuel oil heavier than #3, be sure it is thoroughly cleaned before installing new fuel lines.

#### Oil Safety Valve:

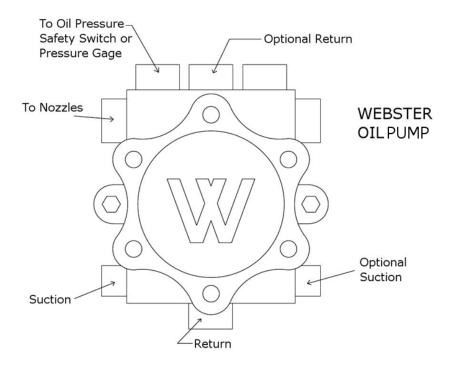
Where the oil is supplied by a primary pumped system or where the oil storage tank is at a higher elevation than the burner fuel pump such that pressure may bear on the pump inlet in excess of 3 PSI, an OSV should be installed. The OSV opens only when its outlet is under vacuum from the fuel pump.

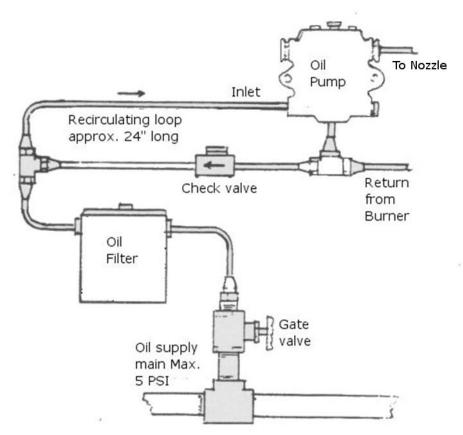
# 2.5 - TO DETERMINE SUCTION LINE SIZE ON TWO-PIPE SYSTEMS

- 1. Check the pump gross gear capacity.
- 2. Measure total tube length (horizontal and vertical).
- **3.** Read up on "Oil Line Sizing" from "total feet of copper" to "suction capacity" for the required GPH.
- **4.** From the Junction, read left column "inches of vacuum at fuel unit". (This is vacuum required to draw oil through tube listed of given length).
- 5. If the installation has lift, add 1" of vacuum for every foot of lift.
- **6.** Total the results from Step 4 and Step 5, then add %10 to the sum.
- **7.** If total is over 10" when a two stage unit is employed on a two pipe system, recheck on the next larger tube size chart.
- **8.** The above does not allow for any added restrictions such as line filter, elbows, sharp bends, check valves, etc.
- **9.** It is safe to make the return pipe the same size as the suction.



OIL NOZZLE CAPACITIES AT VARIOUS PRESSURES										
Oil Nozzle US-GPH capacities are rated at 100 PSI - #2 oil @ 35 ssu										
Pressure at nozzle	75	100	125	150	175	200	250	300	350	400
Rating multiplier for capacity	.87	1.00	1.12	1.23	1.32	1.41	1.58	1.73	1.87	2.00





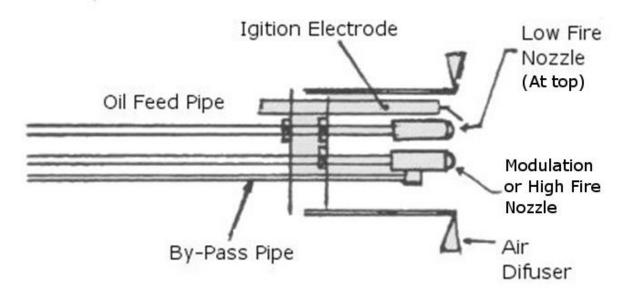
Method of Connecting Oil Burner to Pressure Supply Loop

#### 3.0 - TWO NOZZLE SYSTEM

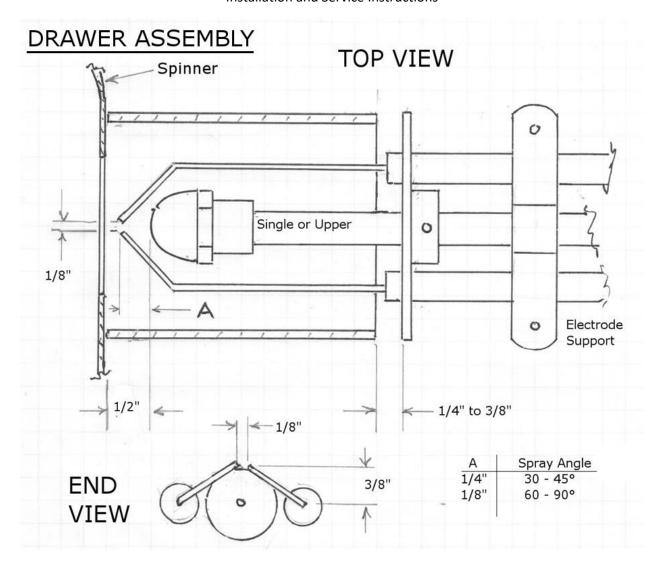
The burner is factory tested to correct input and a set of test pressure readings are provided with the burner. These readings are made at the test ports shown on the drawing.

High turn down rates are a distinct advantage in the use of return flow systems. It is possible, however, to adjust for a fire so small that it is being "chilled". Through a chamber sight glass it will look excellent and appear bright and uniform. But, a combustion efficiency test will reveal high smoke content and low CO<sub>2</sub>. The corrective action is to increase the oil or decrease the air- or a combination of both. Be sure to test with instruments to insure good, clean efficient combustion throughout the range.

The electrodes are set to ignite the oil at the low fire nozzle. The normal settings as shown on the electrode are used. The oil from the modulating nozzle is ignited from the low fire.



Schematic of Nozzle Arrangement



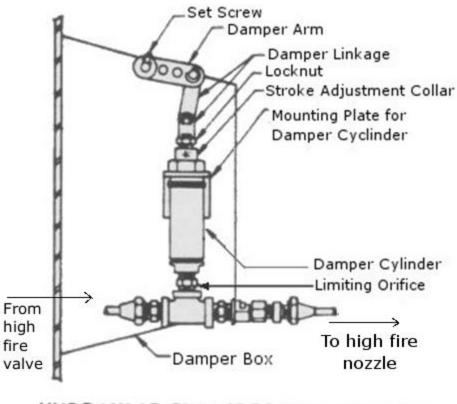
# 4.0 - START UP PROCEDURE - HIGH/LOW

It is necessary for the installer to utilize the following test equipment when the burner is started and adjusted.

- 1. CO<sub>2</sub> indicator
- **2.** Stack thermometer
- 3. Draft gage
- 4. Combination voltmeter and ammeter
- 5. Smoke test kit
- 6. Oil pressure gage
- **7.** Oil vacuum gage
- **A)** Fill the boiler with water to the proper level.
- B) Connect the oil pressure gage to fuel pump. (A minimum of 300 PSI must be maintained).
- **C)** Connect the appropriate monitoring equipment.
- **D)** Set the air intake dampers open approximately  $\frac{1}{2}$ ".
- E) Turn the thermostat or operating control so that the system is calling for heat.
- **F)** Turn ON the main power supply switch and allow the controls to warm up. The relay then pulls in to start the burner motor and eventually energize the low fire oil valve and ignition transformer.
- **G)** The burner will fire. When the flame is proven, the high fire oil valves will be energized and the burner will be in the normal running cycle.
- **H)** Check the flame signal on the combustion control and make sure the reading is within the acceptable limits for the control being used.
- 1) Pump pressure should be approximately 300 psi at on-off or low fire start operations. 300 psi is also utilized on modulating oil burners.
- J) The CO<sub>2</sub> reading should be between 9% and 13%.

# 4.1 - DAMPER ADJUSTMENTS

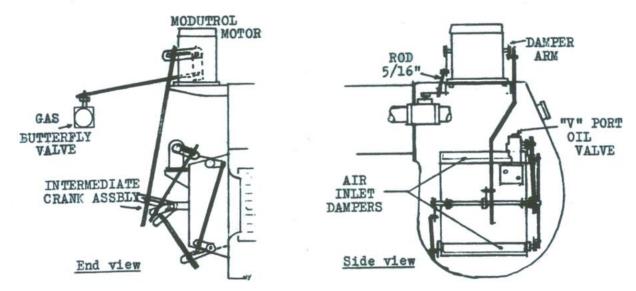
- A) If manual dampers are supplied on the burner, they should be set so that a clean stable fire is maintained and with CO<sub>2</sub> of not less than 9% or more than 13% with no trace of smoke.
- B) If the burner is equipped with one low fire damper and one high fire damper operated by a hydraulic cylinder, set the low fire damper for the correct amount of air needed for proper combustion on low fire and adjust the high fire damper linkage to allow for enough additional air for proper combustion on high fire.



HYDRAULIC CYLINDER AND LINKAGE

The amount of damper opening is determined by the damper arm attached to the damper linkage. By using the hole nearest the shaft of the damper, maximum damper movement is obtained. The hole farthest from the damper shaft will give minimum damper movement. Additional and finer adjustment may be obtained by locking the stroke adjustment collar to the shaft of the oil cylinder, thus limiting the total travel of the shaft.

#### 4.2 - BY-PASS NOZZLE SYSTEM - FULL MODULATION



Combination Gas/Oil Burner Linkage Arrangement - Full Modulation

The Fuel Master modulating oil burner operates with two nozzles. The fixed fire nozzle is operated at full pump pressure. The by-pass nozzle which modulates the fire up to the maximum rate operates at a range of pressure measured on the by-pass line between the nozzle and the modulating valve. A pressure increase indicates a higher firing rate.

In order to set this system up properly, it is necessary to use a 400 PSI and a 600 PSI oil pressure gauge. Install one gauge in the duel pump pressure port to ensure a constant supply pressure, and the second gauge in the Tee on the return line, upstream of the V port valve. DO NOT LEAVE A PRESSURE GAUGE ON THE BURNER AFTER CHECKING, AIR TRAPPED IN THE OIL LINE AT THE GAUGE CAN CAUSE DRIP.

The high fire valves are actuated by the end switch on the modulating motor. The switch is adjusted so that the valves are opened after the modulating motor has started to open the air shutter and to close off the oil by-pass modulating valve. If the arm travels more than 5 degrees before the oil valves are opened, the low fire will have too much excess air. If the valves open too soon, the fire will be smokey just at the start of the modulating fire.

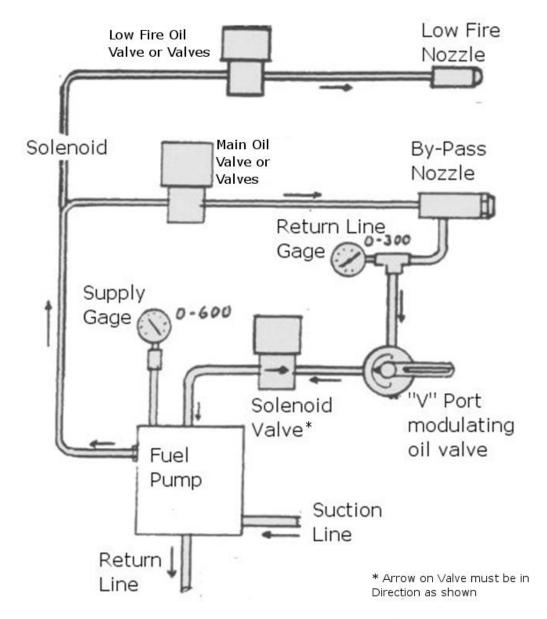
The fuel unit must be capable of pumping double the amount of oil that is to be burned. If the pump is subject to excessive wear or is replaced by a pump of lower oil capacity, the burner will not operate up to rating.

If the burner has a manual potentiometer, set the Auto and Manual switch to Manual and turn the manual pot control to fully counterclockwise. Slowly turn the control knob up, about ten degrees at a time, checking the fire at each set point to see if the air is maintaining a proper ratio.

If there is not a manual potentiometer on the burner, remove the top cover on the modutrol motor and loosen one of the wires on the T&T terminals. By making momentary contact with this wire after main flame has been established, you can advance the mod. motor in the same manner as the manual pot.

When the burner is on high fire the return port pressure will be from 120 to 180 PSI depending on the nozzle size and fuel pump capacity. After the burner has been set up visually, the same procedure should be followed and the flue gas and smoke readings should be checked.

When the burner is fully adjusted remove the pressure gauges, these will trap air and can cause after drip.



Modulating Oil Burner Typical Piping Arrangement

#### **Installation and Service Instructions**

#### **CAUTION:**

- **1.** The spray angle becomes wider as the discharge rate is reduced. Adjust the nozzle position to avoid oil impingement on the air diffuser cone.
- 2. Smokey fires with apparent large droplet size in the spray are generally caused by reduced supply pressure. Also, check the adaptor and the nozzle strainer to be sure that they are not partially plugged.
- **3.** Careless cleaning or handling of the nozzles may damage the orifice, causing heavy streaks in the oil spray. This will show up as large droplets and sparks in the fire.
- **4.** Off-Centre fires, reduced by-pass line pressure, and safety lockouts due to ignition failure may result from plugged slots in the distributor head.
- **5.** Excessive "after squirt" of oil is caused by air in the system. Be sure air is not trapped in pressure gauges, overhead oil lines or fittings, or leaking check valve on by-pass return from nozzle.
- **6.** The Teflon seal should stay in the adaptor. If it comes out it may be reinserted by using a pencil or flat end tool. The seal should last for years. If it becomes damaged, the resulting leak will cause the by-pass flow rate to increase, thereby reducing the fire at low settings and it may cause over firing when the burner goes to high fire and the by-pass valve is closed.
- **7.** The variable flow nozzles are especially sensitive to accumulation of carbon and dirt within the nozzle. Keep the nozzle clean at all times.

#### 4.3 - MAINTENCE AND CARE OF BURNER

- A) The burner motor is permanently lubricated. Oil is required only if the ambient temperature is high.
- B) The floor area around the burner should be kept clean. Excessive dust and lint can accumulate on the fan blades and restrict performance. The fan should be cleaned at least once a year.
- C) The contact points of the controls should be cleaned periodically. NEVER USE ABRASIVE. Contact spray cleaner or stiff paper can be used to wipe the surface area of the points.
- D) The oil assembly should be checked at least once a year and all components should be cleaned and inspected. Be sure that all wires are intact and the electrode porcelains are not cracked. Clean the oil nozzles thoroughly. Reset the ignition electrodes according to the dimensions given in "Drawer Assembly". Be sure that the UV scanner is clean and set so that nothing obstructs its view of the flame.
- E) The area adjacent to the burner or appliance must be kept free from any inflammable or combustible materials.

**Installation and Service Instructions** 

#### 4.4 - SERVICE SUGGESTIONS

No service man can properly adjust and service any piece of heating equipment without the use of proper test instruments. We strongly recommend that anyone servicing our equipment, use the following instruments:

- 1. CO<sub>2</sub> indicator
- **2.** Stack thermometer
- 3. Draft gage
- 4. Combination voltmeter and ammeter
- 5. Smoke test kit
- 6. Oil pressure gage
- **7.** Oil vacuum gage

It should be never assumed that any component of the system is defective until the component has been thoroughly tested. All the controls and burners are tested under actual firing conditions at the factory, and unless damaged, wired, or installed incorrectly, all equipment should operate properly.

#### Burner will not start with disconnect and service switches closed.

- 1. Check power (1 to 2) on terminal strip or relay. Replace fuses in disconnect if circuit is open.
- Check Power through limit circuit if circuit is open, jumper each control in external operating circuit (operating control, limit and low water cutoff) until open switch is found and condition corrected.
- **3.** With power through limit circuit, load relay of primary control should pull in and burner motor relay should pull in and burner motor should start. If motor fails to start, check motor starter for no heaters or heaters under size. If motor still fails to start, check power to motor leads and check motor lead connections. Reset motor overload switch if used.

#### Burner motor starts but no oil pressure and burner fails to fire.

- 1. Check oil storage tank for oil.
- 2. On initial startup or after an oil outage and with a high vacuum lift, it may be necessary to prime the fuel pump. A good method is to use a hand suction pump connected at the optional suction port of the fuel pump.
- 3. The fuel pump is for two pipe system. Be sure bypass plug is in pump and tight.
- **4.** Be sure pump drive coupling is not broken and that pump is rotating. If pump is frozen or damaged, due to a long run without oil, replace pump.
- 5. Check for suction line air leakage indicated by a fluctuating vacuum gage reading at optional suction port of pump or by frothy oil discharge from pump. Replace any compression fitting in suction line with flare fittings. Buried lines may be perforated by sharp fill. IF necessary, run temporary suction line from tank to burner as a temporary measure, until line can be repaired.

#### **Installation and Service Instructions**

- **6.** A higher than normal vacuum reading may indicate a plugged filter or suction line. Check and replace filter if needed and/or blow out suction line.
- **7.** Vacuum readings are normally 12 inches or less. Higher readings will eventually result in operating problems. High vacuum readings may be caused by one or more of the following:
  - a. Suction line size too small.
  - b. High resistance check valves
  - c. A kinked or Punched suction line
  - d. Excessive vertical lift
  - e. Excessive length of suction line run

Note: Items D and E can be overcome by using an oil transfer pump. (Note: caution under "Oil Safety Valve" on Page 8)

#### Burner motor runs with correct oil pressure but burner does not fire.

- 1. No oil delivery from first stage nozzle as indicated by no discharge on flame mirror. Check power to low fire oil valve on terminal strip or delay. Check oil delivery through first stage valve by disconnecting discharge line from valve. Check for plugged first stage nozzle.
- 2. Check spark ignition with flame mirror. Check power to ignition transformer on terminal strip or relay. Remove drawer assembly and inspect electrodes for spacing and location and correct as needed. Look for evidence of cracked insulators or electrode shorting. If electrodes have been burned flat or irregular at tips, sharpen tips and adjust spacing. Be sure ignition cables are in good condition and make good connections at both ends.
- **3.** Check power at primary of ignition transformer and make sure connections are good. If correctly spaced and electrodes do not start, replace transformer. Note: IF startup is rough and erratic, check voltage drop at terminal 1 on startup of burner motor. Voltage should not drop below 100 volts.

#### Burner fires but locks out on safety.

- 1. Check the flame signal on the combustion control and make sure the reading is within the acceptable limits for the control being used.
- 2. Check adjustment of first stage air shutter for better readings and/or replace UV scanner.

# Installation and Service Instructions

# Burner operates on low fire but does not go to high fire.

- **1.** Second stage oil valve may fail to open.
- 2. Check for plugged second stage nozzle or nozzles.
- 3. Check oil delivery through second stage valve. Repair or replace as necessary.

# Top air damper sticks in open position

- 1. Defective damper solenoid
- 2. Defective damper cylinder.

