REZNOR Thomas&Betts

OIL-FIRED UNIT HEATERS

Installation/Operation Form RGM-417-B
Obsoletes Form RGM 417-A

APPLIES TO: **Models OH, OB**

Table of Contents

Index by Page No.

REFERENCE: Replacement Parts, Form RGM 723

WARNING: Improper installation, adjustment, alteration, service, or maintenance can cause property damage, injury or death. Read the installation, operation, and maintenance instructions thoroughly before installing or servicing this equipment.

FOR YOUR SAFETY

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

General

Installation should be done by a qualified agency in accordance with the instructions in this manual and in compliance with all codes and requirements of authorities having jurisdiction. The instructions in this manual apply to the oil-fired unit heaters listed below.

Model	Characteristics
OH	Suspended, Indoor, Oil-Fired Unit Heater with a Propeller Fan; Requires a Vent Pipe/Chimney with a Barometric Draft Regulator
OB	Suspended, Indoor, Oil-Fired Unit Heater with a Blower (may be connected to ductwork); Requires a Vent Pipe/Chimney with a Barometric Draft Regulator

1. Warranty

Refer to the limited warranty information on the Warranty Card in the "Owner's Envelope.

WARRANTY: Warranty is void if.....

a. Wiring is not in accordance with diagram furnished with the heater.

b. Heater is operated in presence of chlorinated vapors.

c. Air through heater is not in accordance with rating plate.

d. Ducts are attached to fan models.

HAZARD INTENSITY LEVELS

1. DANGER: Failure to comply will result in severe personal injury or death and/or property damage.
2. WARNING: Failure to comply could result in severe personal injury or death and/or property damage.
3. CAUTION: Failure to comply could result in minor personal injury and/or property damage.

WARNING: This appliance is not designed for use in hazardous atmospheres containing flammable vapors or combustible dust, or atmospheres containing chlorinated or halogenated hydrocarbons.

2. Installation Codes

This heater is for commercial or industrial use only. In the United States, the installation must be in accordance with the Standard for the Installation of Oil Burning Equipment NFPA 31, the National Electrical Code NFPA 70, and the requirements of the inspection authorities having jurisdiction. In Canada, the installation must be in accordance with CSA Standard B139-M91, Installation Code for Oil Burning Equipment; CSA Standard C22.1, Canadian Electric Code, Part 1; and with requirements of local regulatory authorities.

This heater should be installed only by an experienced installer. The installer should be trained and thoroughly familiar with the installation of oil-fired appliances.

Prior to beginning installation, become familiar with your model of heater and its particular installation requirements.

3. Uncrating/Shipping Damage

Immediately upon uncrating the unit, check for any damage that may have been incurred in shipment; and if any damage is found, file a claim with the transporting agency. The unit was inspected and tested at the factory prior to crating and was in operating condition at that time.

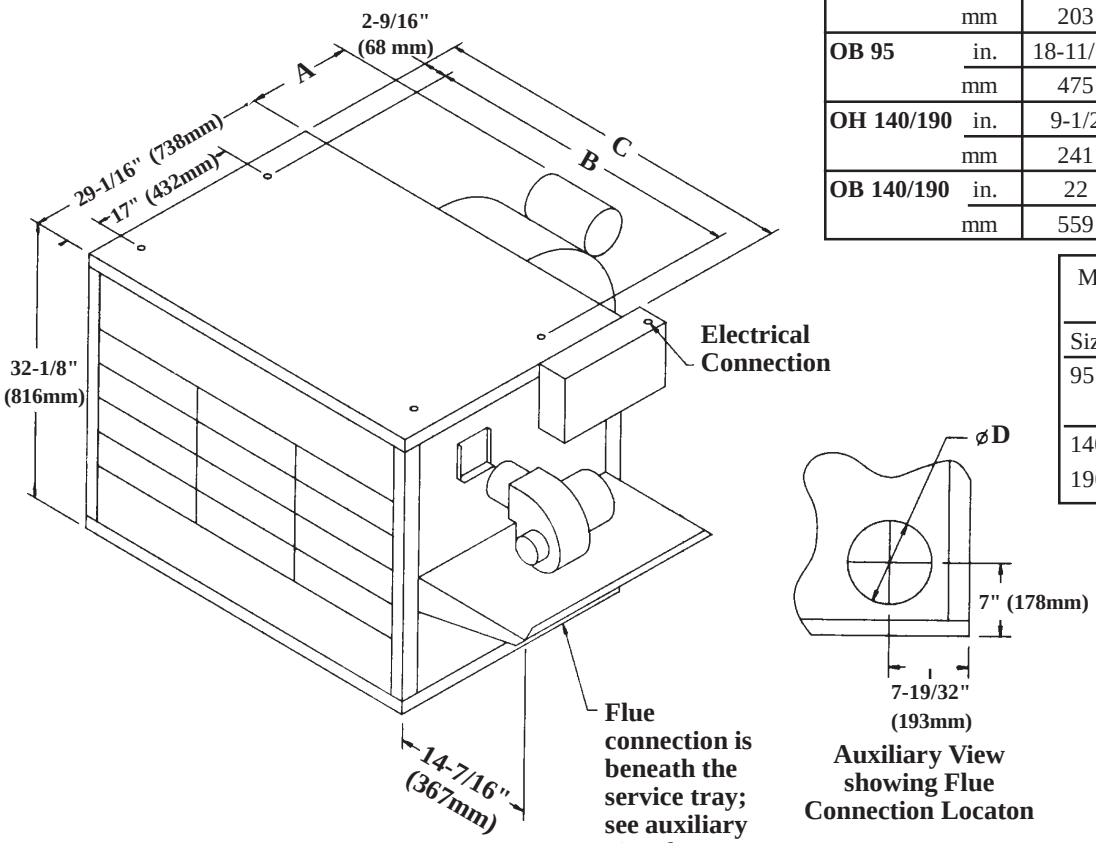
To prevent damage to the painted cabinet, it is recommended that the crate bottom be left in place until after the unit has been suspended. This applies to both blower and fan models.

To protect the unit during shipping, the blower model has special supports that must be removed before installation. Follow these instructions to remove:

1) Blower Support Legs -- Remove the two blower support legs and screws
2) Motor Shipping Block -- Remove the wooden block located under the motor bracket. Find the two rubber pads in the parts package. Place these pads on the ends of the motor bracket bolts.
3) Motor Shipping Plate -- Underneath the belt guard, there is a small metal plate attached between the motor and the blower housing. Remove the belt guard. Remove the metal shipping plate and the screws. Replace the belt guard.

Packaged and shipped with all CSA approved units is a barometric draft regulator and a cleaning rake base. The cleaning rake base is also included with UL approved units. The installation could include a variety of shipped-separate options. Be sure that all optional components to be used in the installation are at the job site.

4. Dimensions



Model		A	B	C	D
OH 95	in.	8	17-3/8	33	7
	mm	203	441	838	178
OB 95	in.	18-11/16	27-3/8	33	7
	mm	475	695	838	178
OH 140/190	in.	9-1/2	37-3/8	43	8
	mm	241	949	1092	203
OB 140/190	in.	22	37-3/8	43	8
	mm	559	949	1092	8

Model OB Discharge Duct Opening Dimensions

Size	Width	Height
95	30"	16-1/4"
	762mm	413mm
140/	40"	16-1/4"
190	1016mm	413mm

5. Fuel Specifications

The burner in this oil-fired heater is designed and orificed for use with #2 fuel oil (140,000 BTU/gallon) at 100 psig. However, the following substitute fuels may be used:

#1 fuel oil - 132,000 BTU/gallon

Kerosene (domestic only; do not use foreign) - 132,000 BTU/gallon

#1 diesel fuel - 132,000 BTU/gallon

#2 diesel fuel - 140,000 BTU/gallon

NOTE: Diesel fuel is not approved for use in Canada (CSA approved heaters).

WARNING: Do not use gasoline, crankcase oil, or any oil containing gasoline. Do not use aviation fuel.

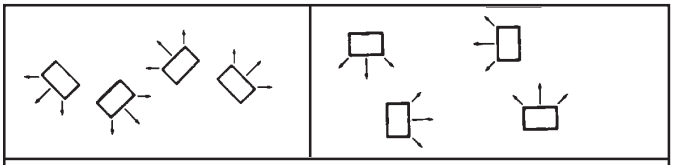
Due to higher viscosity, some #1 oils's BTU/gallon capacity may be 128,000 to 130,000 BTU/gallon. Check BTU content of substitute fuel to determine burner input.

- Size 95 burns an average of .85 gallons per hour.
- Size 140 burns an average of 1.25 gallons per hour.
- Size 190 burns an average of 1.65 gallons per hour.

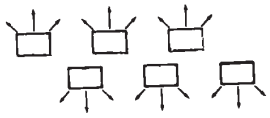
CAUTION: Do not attempt to burn paper or garbage in this heater.

6. Location and Air Throw

These oil-fired unit heaters should be installed in such a manner as to derive maximum efficiency and a minimum of heat loss to the outside environment. As a rule, single heaters should be suspended over an area of low heat loss with output air directed toward the area of the greatest heat loss. Where two or more heaters are used in a common installation, heaters should be arranged around the outside walls and blowing parallel to them. Heaters may be arranged in a supporting consecutive air pattern so that the output of one blows beneath the air-intake side of another. In installations where there are concentrated heat loss areas, a combination of single and multiple arrangements is desirable. See illustrations in Figure 1.



Narrow building - Single units to compensate for heat loss from four exposed outside walls



Wide building - Multiple units arranged to compensate for heat loss from four exposed outside walls.

Figure 1 - Recommended Arrangements

Air Throw : Unit heaters at 9-foot mounting height (distance in feet)

Size	95	140	190
Fan Model	50	65	65
Blower Model	50	65	65

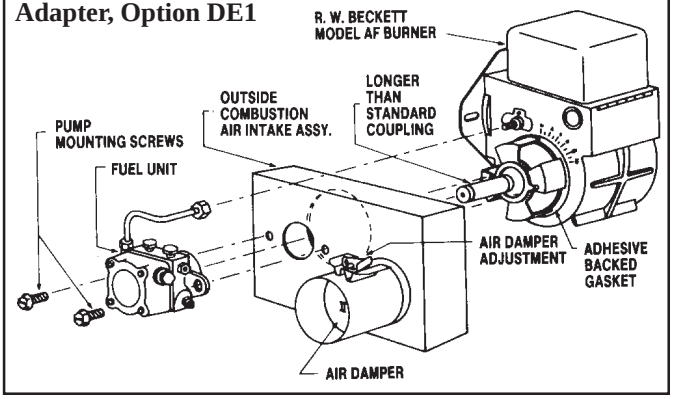
7. Air for Combustion

WARNING: Exercise care to ensure that an adequate supply of combustion air is available and free to enter the air openings on all units.
Openings equal to one inch square per each 1,000 BTUH should be used to allow combustion air to enter the room where the heater is installed.

Optional Outside Combustion Air Intake Adapter Kit -- Option DE1, UL Listed (Not available in Canada) (shipped separately)

The combustion air adapter will provide outside air for combustion in dirty atmospheres or where certain ambient conditions must be maintained. **Follow manufacturer's instructions furnished with the kit.**

Figure 2 - Optional Outside Combustion Air Intake Adapter, Option DE1



8. Clearances

Model	Fan		Blower	
Top	2"	51mm	6"	152mm
Front	48"	1219mm	48"	1219mm
Sides (allow for Service Access)	18"	457mm	18"	457mm
Rear	24"	610mm	6"	152mm
Bottom	6"	152mm	6"	152mm
Flue Pipe	18"	457mm	18"	457mm

WARNING: Clearances apply to all combustibles. Do not leave paper, rags, or any moveable combustibles near the heater.

For additional information on installation clearances, refer to CAN/CSA-B139-M91, "Installation Code for Oil Burning Equipment", Clause 7.0 -- Installation Clearances. One requirement of the CSA installation clearances is that the heater must be suspended at a height so that the heat exchanger cannot be touched.

9. Suspending the Unit

Before suspending the heater, check the supporting structure to ensure that it has sufficient load-carrying capacity to support the weight of the heater. For dimensions, refer to Paragraph 4.

Net Weights (lbs)			
Size	95	140	190
Fan Model	290	345	345
Blower Model	355	410	410

9. Suspending the Unit (cont'd)

Suspension

Use four 1/2" diameter threaded rods. Lock threaded rod using a washer and nut as shown in Figure 3A. Or, use optional swivel connectors (Option CK10) and field-provided 1" threaded pipe. Lock swivel connections as shown in Figure 3B.

NOTE: Units manufactured prior to 10/94 are suspended with 3/8" rods and hardware.

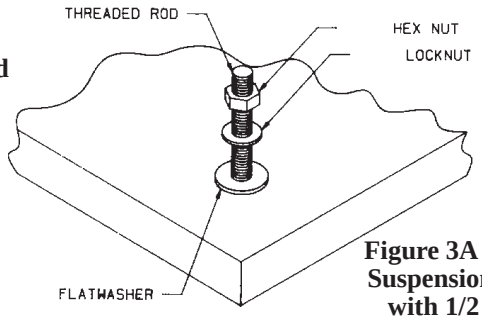


Figure 3A - Suspension with 1/2" threaded rod

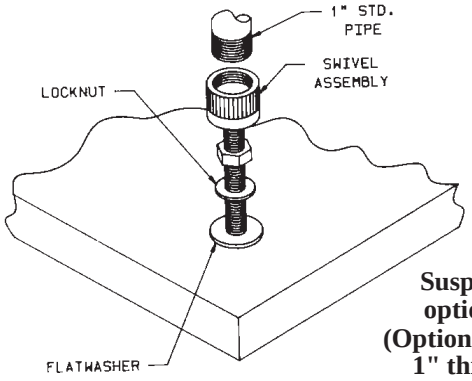


Figure 3B - Suspension with optional swivels (Option CK10) and 1" threaded pipe

Remove the shipping crate bottom from the heater. Remove the angle clips and re-insert the screws into the heater cabinet.

WARNING: Units must be supported level for proper operation. Do not place or add additional weight to the suspended heater.

10. Installing Inlet and Discharge Air Ducts -- Blower Model Only

Inlet Air Duct (Blower model only)

Blower model heaters for Canada **require** field installation of an inlet air duct (return air system). The heater is equipped with a duct flange on the blower side of the unit. The **inside** dimensions of the required, field-supplied ductwork are listed in the following table.

Slip the ductwork over the flange and attach using 1/2" long sheetmetal screws.

Blower Model Size	Inlet Air Duct Dimensions (inside)			
	Height		Width	
95	32-1/8"	816mm	21-3/4"	552mm
140/190	32-1/8"	816mm	31-1/8"	791mm

Return Air System Requirements (CSA approved blower model heater):

"The return-air system will be designed so that the negative pressure from the circulating fan cannot affect the furnace combustion air supply nor draw combustion products from joints or openings in the furnace flue pipe." (National Building Code of Canada 1990, Clause C.2.4.8(9)) Also, Clause C.2.3.11(1) reads, "Air duct systems servicing garages shall not be directly interconnected with other parts of the building."

The design and configuration of the inlet duct system will vary with each installation. Proper sizing, fabrication, and support is necessary to ensure a satisfactory installation. See Discharge Duct below for suggestions on installing ducts.

Discharge Duct (Blower model only)

A duct for discharge air may be attached to a blower model unit. A special duct transition must be field fabricated as shown in Figure 4. Follow these instructions and suggestions for installing the discharge ductwork.

1. Remove the louvers from the furnace.
2. Attach a duct transition which is field fabricated with flanges as shown in Figure 4. Attach, using 1/2" long sheetmetal screws.

IMPORTANT: Never reduce the heater discharge opening size abruptly. Always use a transition like the one illustrated.

Size	A		B (minimum)	
95	30"	762mm	15"	381mm
140/190	40"	1016mm	20"	508mm

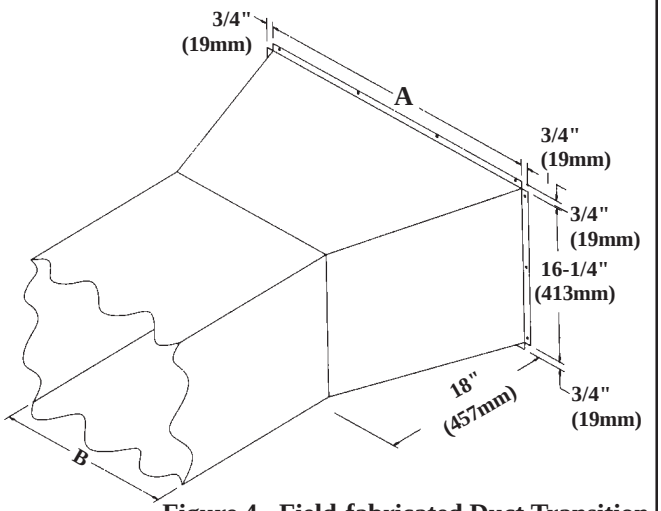


Figure 4 - Field-fabricated Duct Transition

3. Suggestions for installing ducts:

The type of duct installation to be used depends in part on the type of construction of the roof (whether wood joist, steel bar joist, steel truss, pre-cast concrete) and the ceiling (whether hung, flush, etc.).

Rectangular ducts should be constructed of not lighter than No. 26 U.S. gauge galvanized iron or No. 24 B&S gauge aluminum.

All duct sections 24 inches or wider, and over 48 inches in length, should be cross-broken on top and bottom and should have standing seams or angle-iron braces. Joints should be S and drive strip, or locked.

A warm air duct should not come in contact with masonry walls. Insulate around all air ducts through masonry walls with not less than 1/2" of insulation.

Suspend all ducts securely from adjacent building members. Do not support from the heater duct connections.

Duct Sizing - Proper sizing of warm air ductwork is necessary to ensure a satisfactory heating installation. The recognized authority for such information is the Air Conditioning Contractors Association, 1228 17th Street N.W., Washington, D.C. 20036. A manual covering duct sizing in detail may be purchased from them.

The duct should have an opening with a removable access panel that is accessible when the heater is in service. The opening should be 6" x 10" in size so smoke or reflected light may be observed inside the casing to indicate the presence of leaks in the heat exchanger. The access panel for the opening should be attached in such a manner as to prevent leakage.

11. Venting the Heater

WARNING: Failure to provide proper venting could result in death, serious injury, and/or property damage. Unit must be connected to flue having sufficient draft to ensure safe and proper operation. Unit must be properly vented to the outside of the building. Safe operation of any gravity vented heating equipment requires a properly operating vent system, correct provision for combustion air, and regular maintenance and inspection. See Hazard Levels, page 2.

Masonry chimneys and metal chimneys must be built in accordance with accepted building code practice. A Class A chimney or equivalent is required for this heater. Standards for chimneys can be found in NFPA Standard No. 211, published in National Fire Codes, Volume 4; the National Building Code of the American Insurance Association, 85 John Street, New York, NY; ULC Standards for chimneys; or the National Building Code of Canada published by the National Research Council, Ottawa.

If an existing masonry or metal chimney is being used, prior to installing the heater, clean and inspect the chimney. Make any necessary repairs and be sure that the chimney meets all requirements.

If an approved factory-built chimney is being installed, be sure that it meets all requirements and install it according to the manufacturer's instructions. If a field-constructed metal chimney is being installed, follow all of the requirements listed below.

- Use at least 8" diameter vent pipe for Sizes 140/190 and at least 7" for Size 95.
- Use either 24-gauge or heavier, galvanized steel or triple-wall stainless steel vent pipe. (Triple-wall stainless steel vent pipe is recommended.)
- If the venting arrangement includes passing through a ceiling, triple-wall stainless vent pipe is required above the ceiling. The point of passage through a ceiling must be guarded by a metal ventilated thimble not less than 12" larger in diameter than the pipe.
- Install a tee with a cleanout cap at the bottom of the vertical rise.

The smallest dimension of the chimney must be at least 8" in diameter for Size 140 and 190 heaters and at least 7" in diameter for a Size 95 model. The chimney must be at least three feet above the highest point of exit where it passes through the roof, and at least two feet higher than any portion of a building within ten feet of the chimney. Total chimney height must be a minimum of eight feet. The chimney must be capable of maintaining a steady draft of .04" w.c. If draft is below the minimum required, a draft inducer must be installed (See Paragraph 12.)

Vent Connection		
Size	Diameter	
95	7"	178mm
140	8"	203mm
190	8"	203mm

For the vent connection from the flue outlet of the heater to the chimney, use vent pipe of either 24-gauge or heavier galvanized steel or triple-wall stainless steel. For Sizes 140 and 190 use 8" diameter pipe; for Size 95, use 7" diameter pipe. Keep the length of the vent pipe connection as short and direct as possible. As it leaves the heater, slope the horizontal run upward at least one inch for each three feet of pipe. The horizontal run should not be longer than one-half of the vertical or chimney height and never over ten feet unless a draft inducer is being installed.

If the vent pipe connector passes through a combustible wall, it must be guarded at the point of passage by either a metal ventilated thimble not less than 12" larger in diameter than the pipe, or a metal or burned fireclay thimble built in brickwork or other approved fireproofing material extending not less than 8" beyond all sides of the thimble. If a thimble is not installed, all combustible material in the wall or partition must be cut away 9" from the pipe. If any material is used to close this opening, it must be non-combustible.

Fasten all vent piping with sheet metal screws, and support horizontal vent pipe from above with stovepipe wire. Avoid sharp turns in the vent pipe or other construction features that would create resistance to the flow of the flue gases. Do not use a manually operated damper or any other device that will obstruct the free flow of the flue gases.

The end of the vent pipe connection must not extend past the inside wall of the chimney. A thimble may be used in the chimney connection to facilitate removal for cleaning. The thimble should be permanently cemented in place with high-temperature cement.

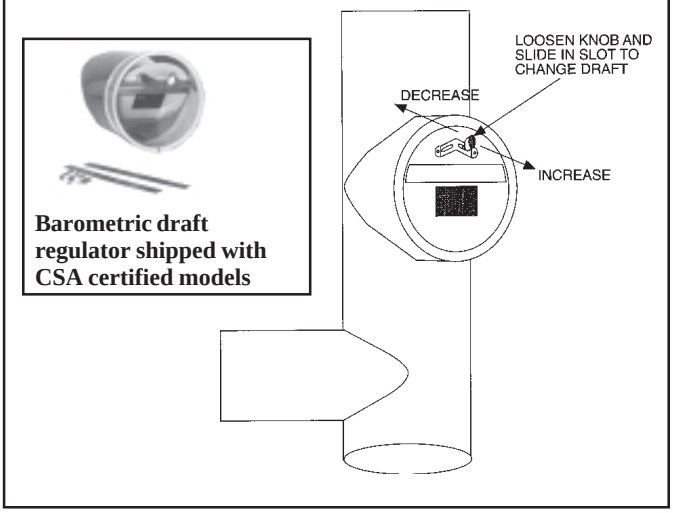
Draft Regulator Requirements

Canadian Model - A CSA/ULC certified barometric draft regulator **is provided and must be installed** near the heater flue outlet. The preferred mounting location for the draft regulator is in the vertical flue pipe (See Figure 5). Depending on the venting arrangement, the alternate location for installing the draft regulator is in the horizontal run. Follow the manufacturer's instructions included with the draft regulator.

U.S.A. Model - A UL listed type barometric draft regulator such as Option DB1, **must be installed** (See Installation Note below for exception) in the flue near the heater flue outlet. The preferred mounting location for the draft regulator is in the vertical flue pipe (See Figure 5). Depending on the venting arrangement, the alternate location for installing the draft regulator is in the horizontal run. Install the draft regulator according to the manufacturer's instructions.

(INSTALLATION NOTE: Do not install a barometric draft regulator if the installation includes an optional outside combustion air inlet, Option DE1.)

Figure 5 - Draft Regulator Installation



12. Optional Draft Inducer Relay (Option DH1)

A field-supplied U.L. (U.S.A.) or CSA/ULC (Canada) listed draft inducer is required when the draft in the flue measures less than .04" w.c. on a draft gauge. Instructions for measuring draft are included in Paragraph 27. A relay (Option DH1) is available for connecting the draft inducer.

When a draft inducer is installed, a safety provision **must** be made to shut off the fuel supply to the burner in the event of the failure of the draft inducer. See optional exhaust flow safety switch on the wiring diagram.

13. Fuel Tank and Supply Lines

Sections 13A through 13D illustrate four methods of piping fuel to oil-fired heaters. The selection of a specific system is arbitrary, however, certain systems are recommended for specific installation conditions. The one-pipe arrangement (Sections 13A) is used with the standard 1-stage burner pump. The two-pipe (Section 13B) arrangement can be used with either the standard 1-stage burner pump or an optional 2-stage burner pump. The second two systems (Sections 13C and 13D) require an additional booster pump for oil delivery to the heater.

Fuel Tank

Oil tanks must be installed in accordance with all local regulations and the National Board of Fire Underwriters or CSA Standard. See Paragraph 28 for some requirements and recommendations for installing supply or storage tanks.

All oil tanks **must** include a vent pipe to the outdoors. The lower end of the vent pipe should not extend more than one inch below the upper most point of the tank. The vent pipe terminal should be weatherproof and clogproof.

Installation of the fuel tank and piping is the responsibility of the installing contractor.

Pipe Tubing

All piping shall be standard full weight black iron pipe with standard fittings or approved brass or copper tubing, with UL listed fittings. At least 1/2" iron pipe or 3/8" O.D. copper tubing (1/2" O.D. copper tubing is preferred) having a wall thickness not less than 0.049" shall be used to connect the burner to the tank.

All piping shall be protected from possible injury and shall be rigidly fastened. Where practical, it should be buried underground or in a concrete floor or placed in a metal-covered pipe trench. If installed above ground, the pipe must be insulated to avoid freezing. Do not cover the piping until the burner has been installed and operated so that any leaks may be corrected. Pipe joints and connections shall be made tight and only unions and tube fittings of an approved type shall be used. Use only pipe thread compound resistant to oil. Do not use TEFLON® tape or TEFLON®-based pipe dope. (TEFLON® is a registered tradename of DuPont Chemical Corporation).

Oil Filter

Install a UL-listed (U.S.A.) or CSA/USC (Canada) oil filter of generous capacity between the tank shutoff valve and the burner. For ease of servicing, locate the filter and shutoff valve close to the oil burner.

Shutoff Valves

Install a readily accessible manual shutoff valve at each point to properly control the flow of fuel in normal operation and where required to avoid oil spillage during servicing. The valve should close against the supply. If the heater will not be operating for an extended period of time, close the shutoff valve.

Where a shutoff is installed in the discharge line of an oil pump that is not an integral part of a burner, connect a pressure relief valve into the discharge line between the pump and the shutoff valve and arrange to return surplus oil to the supply tank or to bypass it around the pump, unless the pump includes an internal bypass.

Any fuel oil line incorporating a heater shall be provided with a relief valve arranged to discharge to the return line when any valve, pump, or other device may prevent the release of excessive pressure because of the expansion of the oil when heated.

Where oil is supplied to a burner requiring uniform flow by gravity feed and a constant level valve is not incorporated in the burner assembly or the oil is not supplied by an automatic pump, install a constant level valve in the supply line at the gravity tank or as close as practical, to ensure uniform delivery of oil to the burner. The vent opening of the constant level valve should be connected by piping or tubing to the outside of the building, unless the constant level valve is provided with an anti-flooding device. Do not connect the vent piping or tubing of constant level valves to tanks or tank vents.

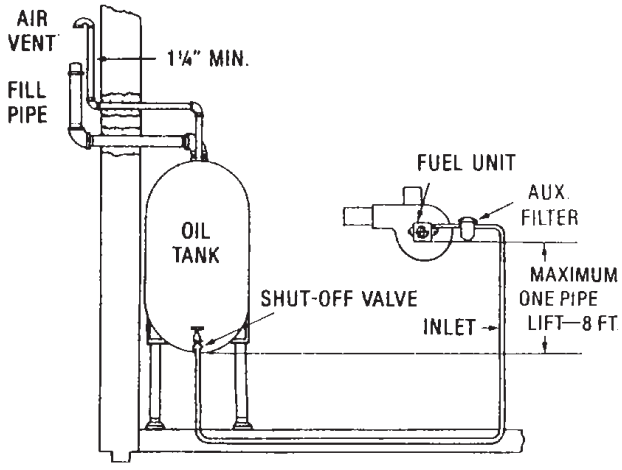
Prior to entering enclosures, such as vaults or pits, where pumps and accessories are installed, provide for adequate ventilation.

Burner Pump Lift Capacity

The standard burner is equipped with a single-stage, 3450 RPM pump with the lift capacity listed in Section 13A for a one-pipe supply system and Section 13B for a two-pipe supply/return system. An optional two-stage, 3450 RPM burner pump (Option BZ1) is available when dual pumping gears are desired. The piping systems in Sections 13C and 13D require an optional booster pump (Option DA1 or DA2). Follow the information that applies to the installation.

- Section 13A/Figure 6 -- **Standard Single-Stage Pump/Single-Pipe Supply System**
- Section 13B/Figure 7 -- **Standard Single-Stage or Optional Two-Stage Pump/Two-Pipe Supply System**
- Section 13C/Figure 8 -- **Standard Single-Stage Pump and an Optional Booster Pump/ Loop Supply System**
- Section 13D/Figure 9 -- **Standard Single-Stage Pump and an Optional Booster Pump/ Pressurized Supply System**

Section 13A/Figure 6 - Single Pipe Supply System (single-stage burner pump)



Maximum Horizontal Line Length (ft) by Heater Size and Size of Tubing

Lift	95		140		190	
(ft)	3/8"	1/2"	3/8"	1/2"	3/8"	1/2"
0	822	3158	556	2222	423	1667
1	719	2763	486	1944	370	1458
2	616	2368	417	1667	317	1250
3	514	1974	347	1389	264	1042
4	411	1579	278	1111	211	833
5	308	1184	208	833	158	625
6	205	789	139	556	106	417
7	103	395	69	278	53	208
8	0	0	0	0	0	0

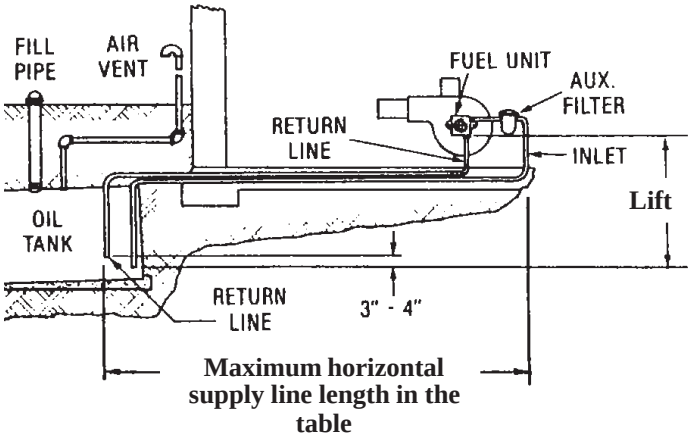
Formula for tabled figures

$$\text{Length} = \frac{6 \text{ ft} - (.75 \times \text{lift})}{(.0086 \text{ for } 3/8" \text{ or } .00218 \text{ for } 1/2") \times (\text{Firing Rate in GPH})}$$

NOTE: GPH = Size 95, .085; Size 140, 1.25; Size 190, 1.65

INSTALLATION NOTES: **1)** Fittings, valves and filters will reduce total line length allowed. Check component manufacturer's information for equivalent length reduction required to compensate for pressure loss. **2)** One-pipe supply systems must be absolutely airtight, or leaks and/or loss of prime may result. Follow instructions in Paragraph 27, Check-Test-Start (Operating Procedure) to bleed the line. Bleed for 15 seconds after last air is seen from easy flow bleed valve to be certain lines are air free.

Section 13B/Figure 7 - Two-Pipe Supply System (standard 1-stage or optional 2-stage burner pump)



NOTE: Remove the 1/4" plug from the return line port and insert the 1/16" bypass plug (shipped in plastic bag). Attach inlet and return lines. Always terminate return line 3-4 inches above the supply line inlet (as shown in the illustration).

Maximum Horizontal Supply Line Length (ft) for Two-Line System (Supply and Return) -- Sizes 95, 140, 190

Lift (ft)	Standard 1-stage pump		Optional 2-stage pump	
	3/8" OD	1/2" OD	3/8" OD	1/2" OD
0	84	100	93	100
1	77	99	88	99
2	71	98	83	98
3	65	97	78	97
4	59	96	73	96
5	52	95	68	95
6	46	94	63	94
7	40	93	68	93
8	34	92	52	92
9	27	91	47	91
10	21	90	42	90
11	15	89	37	89
12	9	71	32	88
13	—	49	27	87
14	—	27	22	86
16	—	—	11	84
18	—	—	—	58

13C. Loop System

A loop system is one in which a boost pump supplies fuel oil from the supply tank to individual heaters in excess of burner requirements. The fuel oil is returned to the supply tank. This system should not be operated at line pressures greater than 3 psi at the first burner supplied. Boost pump operates full time during the heating season.

NOTE: When a two-foot rise cannot be maintained, use "Pressurized System (Section 13D)". All manifold and feeder lines must run in a horizontal plane and elevate above fuel unit intakes, at heater locations. Extend feeder lines downward to fuel burner intakes.

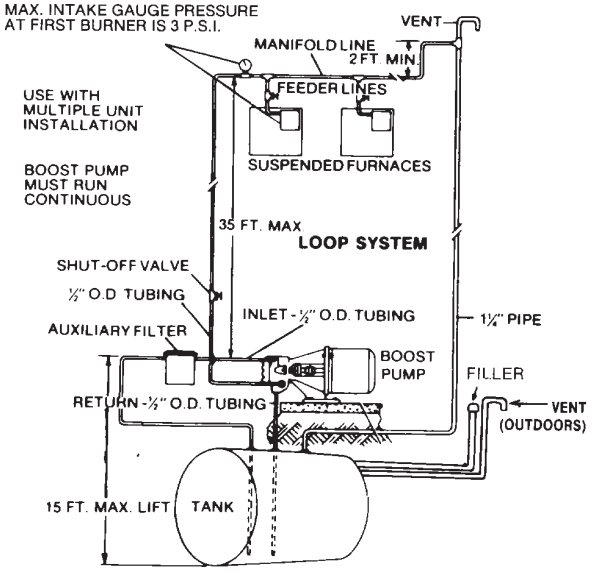


Figure 8 - Loop Supply System (single unit)

13D. Pressurized System

A pressurized system is one in which a boost pump is used to supply fuel oil to a manifold for which branch lines supply each heater. The end of the manifold is capped, and the system is operated at a pressure not exceeding 3 psi at the first burner supplied. BTU output in this type of system is determined by boost pump capacity and the subsequent number of burners that can be supplied adequately by fuel oil. For example, a 30 GPH booster pump will sustain eighteen 1.65 GPH burners. An optional solenoid valve is recommended to protect burner pump seal against excessive pressure. Optional pressure switch monitors nozzle pressure and will start booster pump on pressure fall.

Boost pump operation in a pressurized system may be continuous or may be intermittent when optional pressure switches are used.

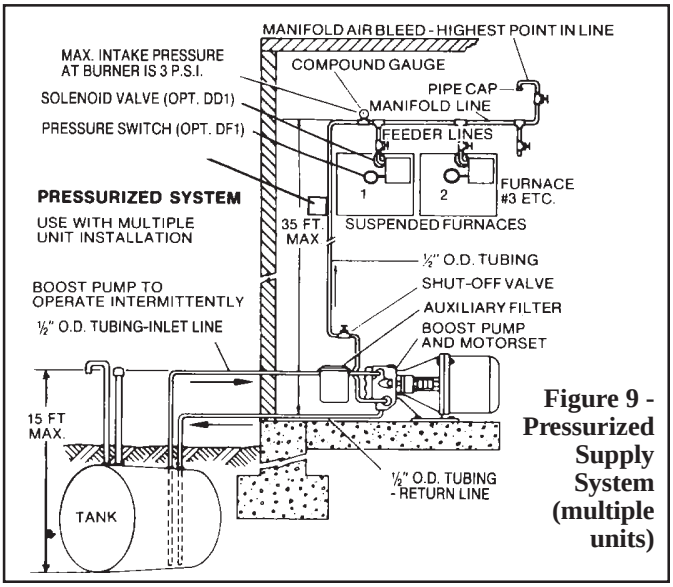


Figure 9 - Pressurized Supply System (multiple units)

14. Boost Pump Assembly (Options DA1, DA2)

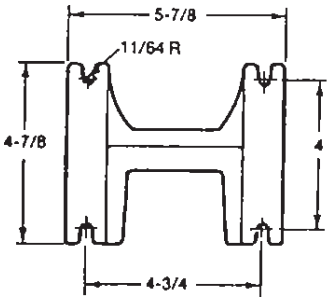
The boost pump is equipped with a motor and is supplied with a two-stage fuel unit incorporating a regulator valve and strainer. The valve acts as a check to prevent loss of oil supply between the boost pump and the burner, thus assuring instantaneous starts following shutdown

14. Boost Pump Assembly (cont'd)

periods. Regulator valve also prevents excessive pressures. Complete assembly with motor is approximately 15" long, 7-1/2" high and 6-3/4" wide overall.

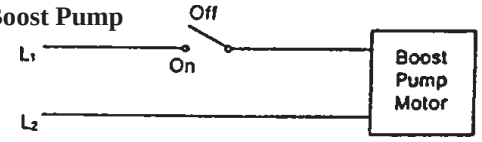
Figure 10

Boost Pump 30GPH/70GPH



Boost Pump Bracket Mounting Dimensions (Bottom View)

Figure 11 - Boost Pump Wiring for Constant Operation



Boost Pump Capacities

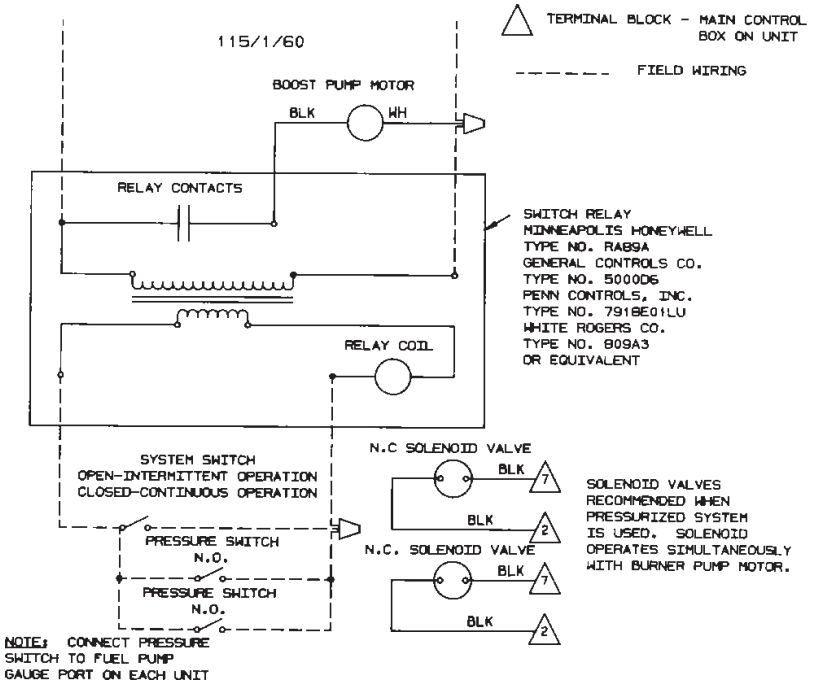
Maximum Height from Boost Pump to Burner -- 35 feet.

Maximum Horizontal Length from Boost Pump to Burner(s)						
Boost Pump	1/2" OD Tubing		1/2" Pipe		3/4" Pipe	
GPH30	175 ft	53.3 M	300 ft	91.4 M	1800 ft	548.6 M
GPH70	50 ft	15.2 M	100 ft	30.5 M	600 ft	182.9 M

Maximum Horizontal Length from Oil Supply to Boost Pump									
Line Size	1/2" OD Tubing			5/8" OD Tubing			1/2" Pipe		
Lift	0-7'	10'	15'	0-7'	10'	15'	0-7'	10'	15'
GPH30	64'	49'	24'	100'	100'	65'	100'	100'	100'
GPH70	44'	34'	17'	100'	95'	48'	100'	90'	65'

Line Size	1/2" OD Tubing			5/8" OD Tubing			1/2" Pipe		
Lift	0-2.1M	3M	4.6M	0-2.1M	3M	4.6M	0-2.1M	3M	4.6M
GPH30	19.5M	14.9M	7.3M	30.4M	30.4M	19.8M	30.4M	30.4M	30.4M
GPH70	13.4M	10.4M	5.2M	30.4M	29M	14.6M	30.4M	27.4M	19.8M

Figure 12 - Boost Pump Wiring for Intermittent Operation



15. Boost Pump Pressure Switch (Option DF1, shipped separately)

Application -- intermittent boost pump operation in a pressurized system. This low voltage, normally open type switch closes at approximately 50 psi. Maximum allowable pressure is 150 psi. **One is required for each burner.** The switch is specifically designed for fuel oil and includes a 1/8" male pipe thread connector and screw terminals.

A manual switch, for initial starting (or continuous operation) is recommended for installation in the low voltage circuit.

Pressurized piping systems must not exceed 3 psi. An oil solenoid valve (Option DD1) is recommended at each unit to prevent seal damage should the pressure for any reason exceed the maximum of 3 psi.

16. Optional Solenoid Valve (Option DD1, shipped separately)

Use of the optional solenoid valve is recommended with the pressurized oil delivery system. It is designed to operate simultaneously with the burner motor.

17. Optional Oil Safety Valve (OSV) (Option DC1, shipped separately)

The oil safety valve is opened by the slight vacuum created by the burner pump and closes when the vacuum condition subsides. This prevents siphoning of the supply line and eliminates spill, if any leaks develop downstream from the OSV. **Use of the optional oil safety valve is highly recommended.**

18. Check Valve

The check valve prevents reverse flow of oil maintaining static head pressure between the check valve and the automatic valve on the burner, thus preventing siphoning. Check valves are field provided and are not needed when an oil safety valve (Option DC1) is used.

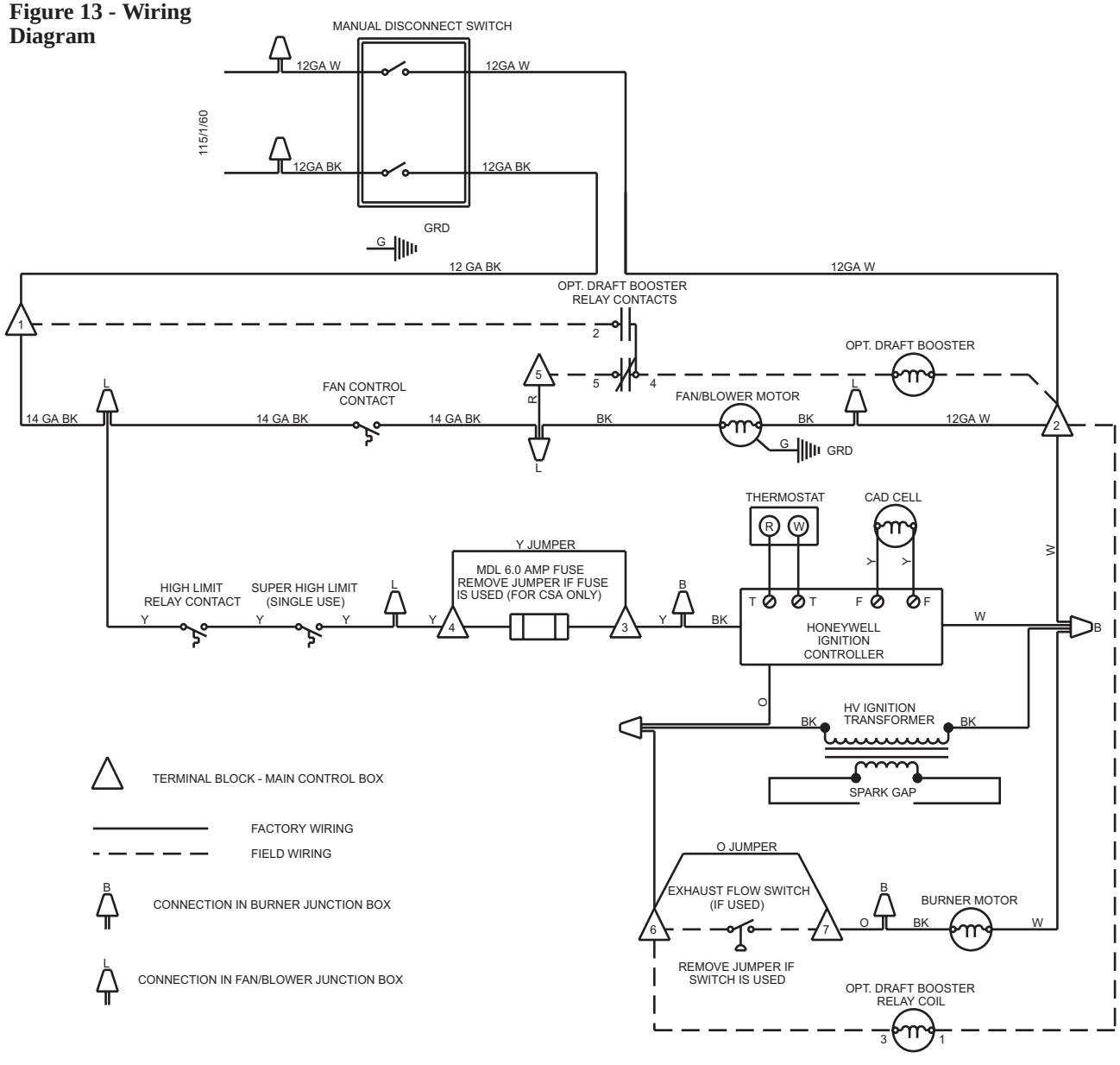
19. Electrical Supply and Connections

All wiring must be done in accordance with the National Electric Code or CSA Standard C22.1, Canadian Electrical Code, Part 1, and local ordinances. In many localities, No. 14 wire run in rigid conduit must be used, but where permissible, two and three wire BX is recommended, particularly for connections to the controls and burner motor. A cutoff switch for the main 115 volt line to the burner should be mounted on a fireproof wall in an accessible place close to the burner.

1. Check the rating plate on the heater for supply voltage and current requirements. A separate line voltage supply with fused disconnect switch should be run directly from the main panel to the heater, making connection to leads in the junction box. All external wiring must be within approved conduit. See wiring diagram in the heater junction box. Conduit from the disconnect switch must be run so as to not interfere with the service panel of the heater.
2. All replacement wiring must be type SF, SEWF, TW, TEW or equivalent. Use 18 gauge wire for control circuits; 14 gauge or larger, depending on current requirements, for line connections.
3. Install room thermostat in accordance with directions furnished with the thermostat. Furnace is equipped with low voltage controls (24V).
4. See separate instructions for any optional equipment provided. Wiring diagrams and manufacturer's instructions are included.
5. Electrical Ratings, 115V, 60 Hz

Model Type	Size	Total Current Amperes	Minimum Circuit Ampacity	Minimum Fuse Size
Fan	95	6	8	15
	140	7	9	15
	190	7	9	15
Blower	95	11	14	20
	140	11	14	20
	190	16	20	30

Figure 13 - Wiring Diagram



CAUTION: IF ANY OF THE ORIGINAL WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACE WITH WIRING MATERIAL HAVING A TEMPERTURE RATING OF AT LEAST 105C. EXCEPT FOR HEATING ELEMENT CIRCUIT, FAN CONTROL AND LIMIT WIRING WHICH MUST BE 150C.

WD# 119645 REV#3

20. Thermostat

Use either an optional thermostat supplied with the heater or a field-supplied thermostat. A 24-volt thermostat is required to actuate the low voltage controls on this heater. A line voltage thermostat can be used when wired for low voltage use. **Do not attempt to wire relays or other accessories to the thermostat connections as these are not load terminals.**

The thermostat should be located five feet above the floor on an inside wall, not in the path of warm or cold air currents, nor in corners where air may be pocketed. DO NOT install on or directly suspend from the heater. DO NOT install the thermostat on a cold, outside wall. For specific connection details and instructions on setting the heat anticipator, refer to manufacturer's instructions with the thermostat.

CAUTION: Make sure the thermostat has an adequate VA rating for the total requirements.

21. Motors

Both the fan motor on a heater equipped with a fan and the blower motor on a blower model are totally enclosed and are equipped with internal overload protection.

Motor	Model	Size	HP	Volts	Amps	RPM
Fan	Fan	95	1/8	115	2.7	1050
	Type	140, 190	1/4	115	3.7	850
Blower	Blower	95, 140	1/2	115	7.0	1725
	Type	190	3/4	115	11.0	1725
Std 1-Stage Burner Pump	Fan	95, 140,	1/7	115	2.0	3450
Opt 2-Stage Burner Pump	and	190	1/7	115	2.0	3450
Optional Boost Pump	Blower		1/8	115	5.8	1725

Use an amp meter to check blower motor amps. The above chart lists full load amps for standard equipment. Blower motor amps may be adjusted downward by reducing blower RPM or by increasing duct system static pressure.

22. Blowers and Drives - Blower Model Only

Check for proper belt tension. Proper belt tension is important to the long life of the belt and motor. A loose belt will cause wear and slippage. Too much tension will cause excessive motor and blower bearing wear. Adjust belt tension by means of the adjusting screw on the motor base until the belt can be depressed 1/2-3/4". Tighten the lock nut on the adjusting screw.

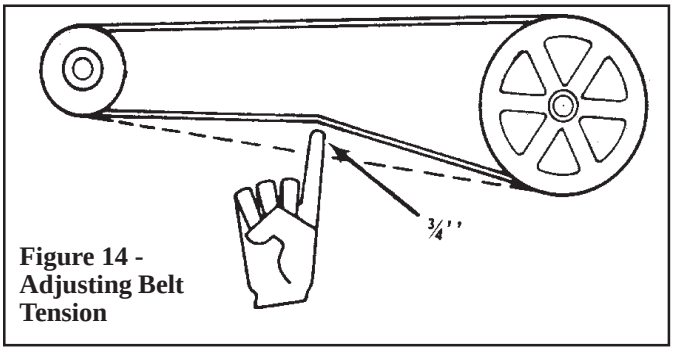


Figure 14 - Adjusting Belt Tension

After the installation is complete including all ductwork, the amp draw of the motor should be checked with an amp meter to verify that the motor amp rating on the motor nameplate is not being exceeded. Amps may be adjusted downward by reducing blower speed or by increasing duct system static pressure. The temperature rise must be within the range specified on the unit rating plate.

Blower Speed Adjustment

The blower speed may be adjusted to achieve the desired outlet temperature, as long as the adjustment is within the temperature rise and static pressure limits shown on the heater rating plate. Motors are factory set at the mid-point between maximum and minimum blower speeds. If the duct resistance is low, the blower may deliver too high an air volume; or if the unit is operated without ductwork, it may deliver sufficient excess air to overload the motor, causing the overload protector to cycle the motor. Reducing the blower speed will correct these conditions. If ductwork is added to an installation, it may be necessary to increase the blower speed. Decreasing blower speed will increase outlet temperature; increasing blower speed will decrease outlet temperature.

Follow these instructions to adjust the blower speed.

1. Turn off the electric power.
2. Loosen belt tension and remove belt.
3. Loosen the set screw on the side of pulley away from the motor.
4. **To increase blower speed**, deceasing outlet temperature, turn the adjustable half of the pulley inward. **To decrease the blower speed,** increasing the outlet temperature, turn the adjustable half of the pulley outward. One turn of the pulley will change the speed 8-10%.

NOTE: CSA certified models have metal spacers to prevent overtightening of the motor pulley. Do not remove spacers.

5. Tighten the set screw on the flat portion of the pulley shaft.
6. Replace the belt and adjust belt tension. Adjust belt tension by means of the adjusting screw on the motor base until the belt can be depressed 1/2-3/4". Tighten the lock nut on the adjusting screw.
7. Turn on the electric and light the heater.
8. Check motor amps with an amp meter. The maximum motor amp rating on the motor nameplate must not be exceeded.

CAUTION: An external duct system static pressure not within the limits shown on the rating plate or improper adjustment of the motor pulley or belt may overload the motor.

Blower Rotation

Each blower housing is marked for proper rotation. Rotation may be changed on single phase motors by re-wiring in the motor terminal box. Three phase motors may be reversed by interchanging two wires of the three phase supply connections.

23. Electrodes and Nozzle Location

IMPORTANT

Check the electrode adjustment prior to firing the unit. Electrodes are adjusted at the time of manufacture. However, they should be checked at time of installation to be sure that they are still set as illustrated in Figures 15 and 16.

CAUTION: Turn off main electric supply switch before attempting to check or adjust electrodes.

Figure 15 - Electrode Gap for Beckett Burner

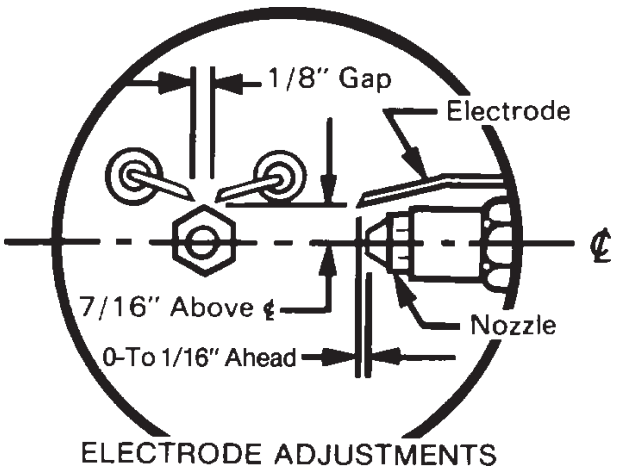
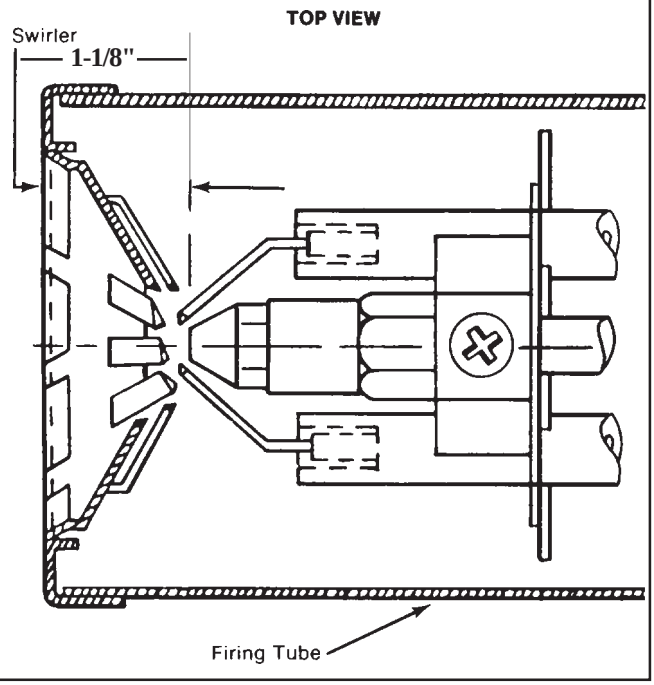


Figure 16 - Nozzle Position in Relation to Burner Head



24. Burner Pump

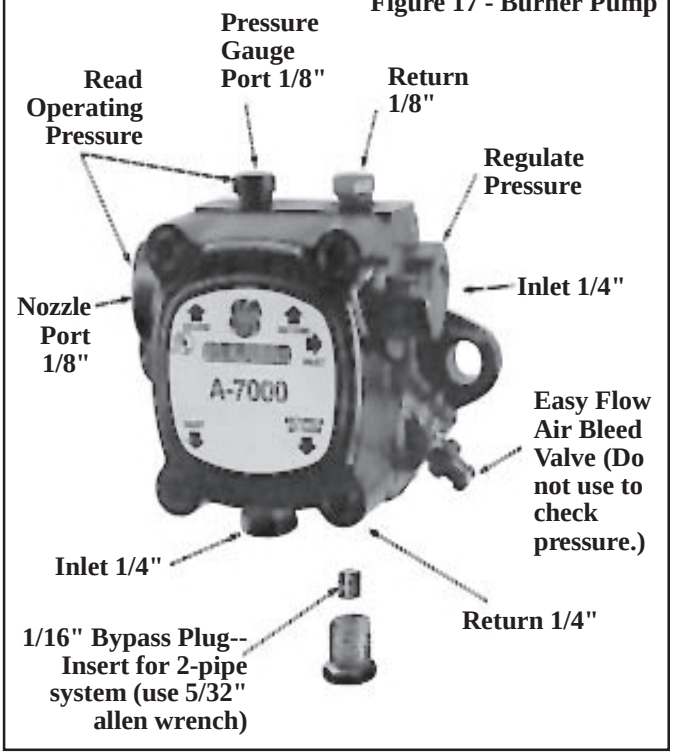
This oil-fired heater has either a standard single-stage, 3450 RPM pump or an optional two-stage, 3450 pump (Option BZ1). Review the burner pump illustration, Figure 17, for port, bleed, inlet, regulator, and by-pass plug locations. NOTE: Bypass plug must be inserted when return connection is made by two-pipe supply system.

Pump Pressure Check (See Paragraph 27)

If a pressure check is made, use either the gauge port or nozzle port. Do not use easy flow bleed valve port. The easy flow bleed valve port contains pressure higher than operating pressure. Setting pump pressure with gauge in the easy flow bleed valve port results in WRONG operating pressure.

CAUTION: Pressurized or gravity feed installations must not exceed 3 PSI on inlet line or return line at the pump. A pressure greater than 3 PSI may cause damage to the shaft seal.

Figure 17 - Burner Pump



Vacuum Check

A vacuum gauge may be installed on either side of the 1/4" inlet ports or in the 1/8" return port (on single pipe installation), whichever is most convenient. With a standard 1-stage pump, vacuum should not exceed 6" hg on single-pipe system or 12" hg on two-pipe system. With an optional 2-stage pump, vacuum should not exceed 17" hg.

IMPORTANT: Long or oversized inlet lines may require the pump to operate during initial bleeding period. In such cases, the priming may be assisted by injecting fuel oil into the pump gearset. Under lift conditions, oil lines and fittings must be airtight. To assure this, oil resistant pipe dope should be applied to both the used and unused inlet and both return fittings.

25. Fan and Limit Controls

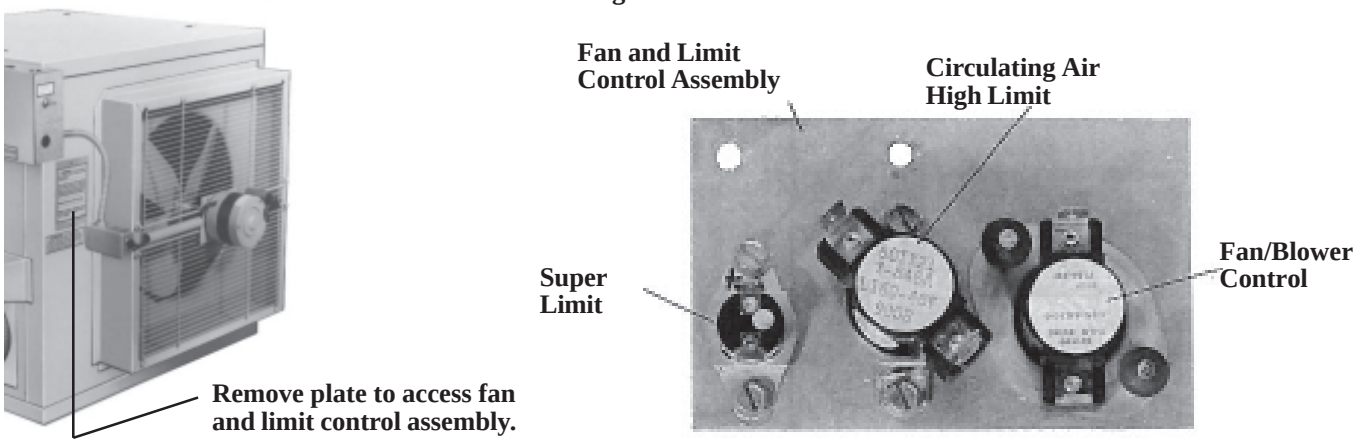
This heater is equipped with a fan and limit control assembly consisting of a specially designed control mounting bracket with a fan control, a circulating air high limit control, and a super high limit control attached. To access the fan and limit control assembly, remove the plate as illustrated in Figure 18 (page 12). For service information, see Troubleshooting Guide, High Limit Cycles, Paragraph 34.

The main functions of the fan/blower control are to provide (1) delay of fan or blower operation, preventing circulation of cold air at startup, and (2) continued fan or blower operation as long as the unit temperature is above the minimum setting (120°F). The fan/blower control also provides additional safety control by keeping the fan or blower in operation in the event that a malfunction would cause the oil burner to continue to fire when the thermostat is satisfied.

The circulating air high limit switch has a nonadjustable setting of 145°F for a Size 95 heater and 160°F for Sizes 140 and 190. The limit control automatically cycles when the internal temperature exceeds those setpoints. For the heater to operate properly and safely, the cause for the temperature exceeding the high limit setpoint must be corrected.

The super high limit switch provides redundant safety control and is calibrated to open at a much higher temperature (350°F) than the standard automatic reset limit switch. An interruption of the circuit by the super high limit switch indicates a major failure caused by a malfunction of the primary safety controls or mis-wiring. Before attempting to re-start the heater, the cause must be corrected and the fan and limit assembly replaced.

Figure 18 - Access and Identification of the Fan and Limit Controls



26. Primary Control System

The primary control, mounted on a 4x4 outlet box on the burner is responsible for starting the burner, supervising a safety operating cycle, shutting the burner off at the end of the call for heat, and locking out "on safety" if there is a flame failure beyond the safety timing.

The primary control system has a cadmium sulfide cell that responds to light intensity to sense the presence or absence of flame. The ignition system is comprised of an ignition transformer and two electrodes that deliver a concentrated spark across a fixed gap to ignite the oil droplets in the nozzle spray. If the spark is inadequate, the cadmium sulfide cell will not sense the presence of flame and the primary control system will lock out "on safety".

27. Check-Test-Startup Procedure

Check-Test (Prior to Startup)

- ☐ **Check clearances**. Be certain that the clearances listed in Paragraph 8 have been observed.
- ☐ **Check hangers.** Be certain that all hangers are adequately anchored and that all unions or threaded fittings are snug and do not rotate under conditions of vibration. Heater must be level.
- ☐ **Blower Model** -- Check to be sure that all shipping supports have been removed. See Paragraph 3.
- ☐ **Check electrical supply.** Be sure that wire gauges are as recommended and that the voltage is as stated on the furnace. A service disconnect switch should be used. Also determine that fusing or circuit breakers are adequate for the load use.
- ☐ **Check oil supply.**
- ☐ **Check piping.** After installation and before being covered, piping should be tested for leaks. Before testing, disconnect supply piping at the burner and cap. Test piping hydrostatically, or with equivalent air pressure, not less than 1-1/2 times the maximum working pressure but not less than 5 pounds per square inch at the highest point of the system. The test shall be made so as not to impose a pressure of more than ten pounds per square inch on the tank. This test shall be maintained for at least 30 minutes or for sufficient time to complete a visual inspection of all joints and connections. Instead of a pressure test to check piping, suction lines may be used under a vacuum of not less than 20 inches of mercury maintained for at least 30 minutes.
- ☐ **Check vents.** Be sure that vent pipe and chimney meet requirements shown in Paragraph 11. An approved draft regulator is required. **In order to measure the draft in the stack after firing, drill a 5/16" hole in the flue pipe halfway between the heater and the draft regulator for insertion of the draft gauge.**
- ☐ **Check electrode adjustment.** See instructions in Paragraph 23. Turn off the electric power before making check.
- ☐ **Check oil delivery.** For an accurate check on the oil delivery, remove the burner assembly and connect it outside the firebox. Disconnect high tension lead. Start the burner, collect the oil flow for one minute and measure it in a container marked in cubic centimeters. (Some safety controls may trip when operated for one minute. If this occurs, collect the flow from the nozzle for 30 seconds, measure the cubic centimeters, multiply by two and check with the chart.)

Listed in the table is the required flow in cubic centimeters (cc) per minute to obtain the output in gallons per hour.

Size	GPH	CC per Minute
95	0.85	54.0
140	1.25	78.5
190	1.65	104.0

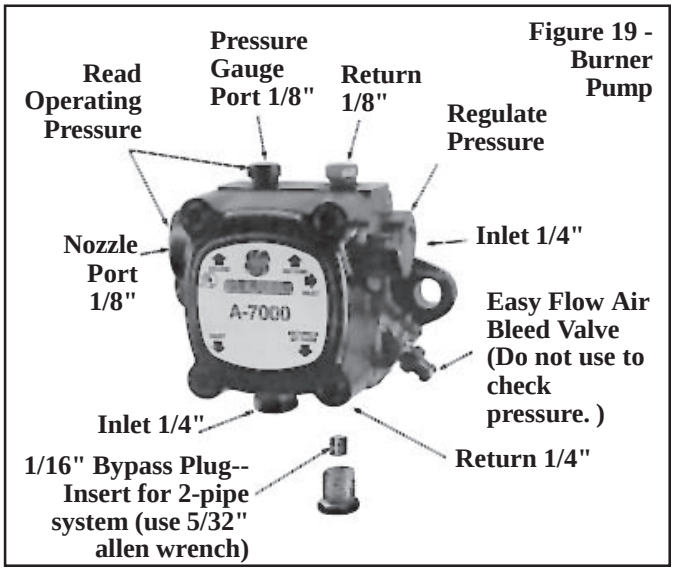
- ☐ Check belt tension on blower model. See Paragraph 22.

Check-Test-Start (Operating Procedure)

- ☐ **Priming the heater -- single pipe system.** The oil supply line to the heater must be full of oil and free of air for proper heater operation. Follow the steps below to fill the oil line. **Note:** Priming the oil line could take up to 30 minutes depending on the size of heater and the length of the supply line.

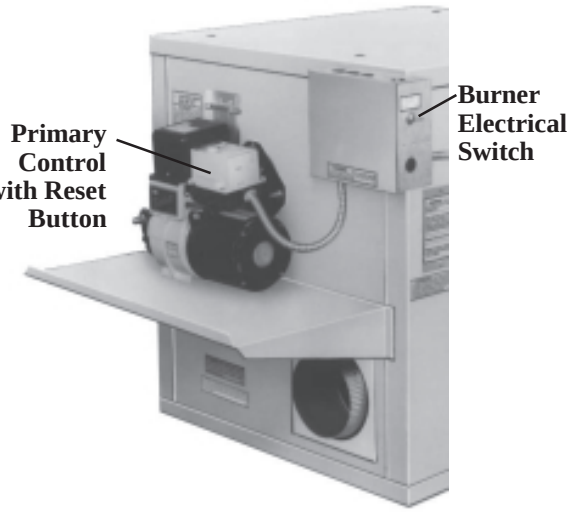
1) Be sure that the oil tank is filled to a level at least 6" above the foot valve.
2) Set the thermostat to its lowest setting.
3) Connect a piece of rubber tubing to the air bleed valve on the burner pump (See Figure 19) and place the other end into an open container (no smaller than a pint).
4) Turn off the electrical power at the switch on the heater electrical box. See Figure 20.

Figure 19 - Burner Pump



5) Using a 3/8" wrench, loosen the air bleed valve two or three turns.
6) Set the thermostat well above room temperature.

Figure 20 - Heater Controls



7) Turn the electric power on. Burner pump will operate.
8) Oil will run into the container when the air has been bled from the line. (While operating under these conditions, the heater will not light because the pressure valve in the pump will not open.) If the primary control activates to shut down the pump before the line is bled, push the reset button. (See Figure 20). It may be necessary to push the reset button several times while bleeding off air. Wait three to four minutes between pushes of the reset button to allow the internal bimetal strip to cool down. The pump will run for 45 seconds each time.
9) After all of the air is bled from the line, close the bleeder valve. Turn the main power off.

☐ **Priming the Unit -- two-pipe supply system**. Install a pressure gauge and turn the burner on. The system will vent itself through the return line. Flame will appear as soon as the air has been eliminated.

☐ **Check and adjust nozzle pressure.**

1) Install a pressure gauge (125 psig minimum) into the pressure gauge port on the burner pump. (See Figure 19.)
2) The air shutter was preset at the factory. Verify the air shutter setting on the burner with the chart in Figure 21. All other controls should be in normal position.
3) Turn off the electrical power.
4) Set the thermostat to above room temperature.
5) The pump will start and the burner ignite. With the burner ignited, check the oil pressure and adjust, if necessary, to a pressure of 100 pounds.

☐ **Check draft.** Prior to continued operation, check to be sure that there is sufficient draft for proper combustion. A draft of negative .01" w.c. is required over the fire. When firing, the draft measurement in the stack should be a negative .03-.04" w.c.

Instructions for measuring draft:

1) **To measure draft over the fire**, remove the metal plug in the observation door (See Figure 21).
2) Insert air pressure gauge (such as Dwyer pressure gauge). Draft measurement gauge must read a negative .01".
3) If measurement is not correct, adjust draft regulator until measurement is correct.
4) Replace plug.
5) **To measure flue draft**, insert air pressure gauge in the 5/16" hole that was drilled in the flue pipe halfway between the furnace and the draft regulator. Flue draft measurement must be a negative .03-.04" w.c.

If there is insufficient draft, it will create a back pressure resulting in oil fumes in the building and/or pulsating when the burner starts and stops. It may cause excess deposits of soot. To correct this problem, the height of the chimney may need increased and/or a UL listed draft inducer may be used. If a draft inducer is used, provision must be made to shut off the fuel supply to the burner in the event of the failure of the draft inducer.

If there is too much draft, it could cause ignition problems, erratic burner, and loss of thermal efficiency. To correct this problem, adjust the barometric damper regulator to reduce the draft.

CAUTION: If there is a backdraft or downdraft, do not continue operation of the heater until the situation is corrected. Equipment and/or property damage could result. Back pressure (backdraft or downdraft) may be caused by the chimney being lower than surrounding objects, such as buildings, hills, trees, rooftops, etc. It may be caused by an exhaust fan in the building. The air intake in the room where the heater is installed must be sufficient size so that there is no change in the draft reading in the flue with the exhaust fan running.

☐ **Check combustion air shutter and air band settings.** The heater is shipped from the factory with the settings shown in the table in Figure 21. Ordinarily, these settings will result in a CO_2 level shown in the tabled ranges. However, certain field conditions may require a change. In order to determine if the air setting needs to be adjusted, a smoke tester and CO_2 analyzer are required.

Air Adjustment Procedure:

1) Service and clean the burner, combustion chamber, and heat exchanger if necessary.
2) Operate the unit for at least 10 minutes.
3) Adjust the overfire draft to read between -0.01" to -0.02" w.c. Draft readings in the breaching will be higher depending on the flue passages of the heater. The more restrictive and lengthy the flue, the higher the draft necessary to obtain accepted overfire conditions.
4) Follow the instructions of the manufacturer of the smoke tester and take a smoke reading. Adjust the combustion air to obtain a preliminary reading of about a No. 3 smoke spot. Then readjust the air until a reading between No. 0 and No. 1 (trace smoke) is achieved. Do not open the air adjustment more than absolutely necessary to obtain a trace or No. 0 smoke spot.
5) Follow the instructions of the manufacturer of the CO_2 gas analyzer and take a CO_2 sample. Open the air shutter until the CO_2 level lowers by 1%. The CO_2 reading should fall within the range specified in the table shown in Figure 21. Your burner is now set for optimum but stable efficiency.

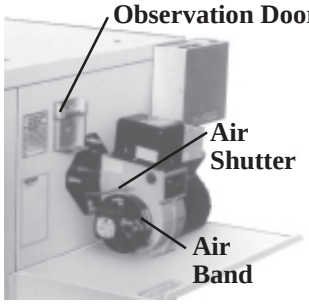


Figure 21 - Combustion Air Band and Air Shutter Settings

Size	Air Shutter	Air Band	CO2 Range
95	#6	#0	9-11%
140	#6	#0	10-12%
190*	#7-1/2	#0	11-13%

*Size 190 manufactured before 6/96 had same settings as Size 140.

27. Check-Test-Startup (cont'd)

☐ **Check Discharge Air Temperature (Blower models with ductwork)** - This heater is designed for a maximum of .25" w.c. static pressure and for discharge air temperature rises from 60° to 70° F. If the heater has been field equipped with a duct (blower model only), the discharge air temperature should be checked. Place a thermometer or a thermocouple in the middle of the outlet or at the end of the discharge duct and measure the discharge air temperature after the heater has operated for at least 20 minutes. If the temperature rise is not within the 60° to 70° F range, the blower speed will have to be adjusted or ductwork changed.

Follow these instructions to adjust blower speed.

1) Turn off the electrical power.
2) Loosen belt tension and remove belt.
3) Loosen the set screw on the side of the pulley away from the motor.
4) **To increase blower speed**, decreasing outlet temperature, turn the adjustable half of the pulley inward. **To decrease the blower speed,** increasing the outlet temperature, turn the adjustable half of the pulley outward. One turn of the pulley will change the speed 8-10%.
5) Tighten the set screw on the flat portion of the pulley shaft.
6) Replace the belt and adjust belt tension. Belt tension is adjusted by means of the adjusting screw on the motor base until the belt can be depressed 1/2-3/4". (See Figure 14.) Tighten the lock nut on the adjusting screw.
7) Turn on the electric power. Start the heater by turning the thermostat to a setting higher than room temperature.
8) Check motor amps with an amp meter. The maximum motor amp rating on the motor nameplate must not be exceeded.

CAUTION: An external duct system static pressure not within the .25" w.c. limit or improper adjustment of the motor pulley or belt may overload the motor.

☐ Return this manual to the owner's envelope.

28. Storage Tank (Installation Recommendations for Field-Supplied Tank and Piping)

The oil tank should be installed in accordance with local regulations and those of the National Board of Fire Underwriters. Galvanized tanks and piping are not recommended.

In the U.S., regulations require that storage tanks located inside buildings shall not exceed 275 gallons (1,041 L) individual capacity or 550 gallons (2,082 L) aggregate capacity in one building. In Canada, regulations require storage tanks located inside buildings shall not exceed 550 gallons (2,082 L) individual capacity or 1,100 gallons (4,164 L) aggregate in one building. Check with the local Fire marshal to assure compliance with local ordinances and codes. Installation of the tank and supply line is the responsibility of the installer.

Inside tanks larger than the above must be installed in an enclosure or casing constructed of reinforced concrete at least 6" thick. A well-tamped earth foundation shall be provided beneath the concrete slab, which shall extend at least one foot beyond the tank in all directions. The tank shall be set on a firm foundation, and soft earth or sand shall be packed around it. When necessary, to prevent floating, it shall be securely anchored or weighted.

Proper allowance shall be made for expansion, contraction, jarring and vibration. With the exception of oil lines and test wells, pipe lines shall be provided with double swing joints, which will permit the tank to settle without straining the pipe connections. Tanks shall be equipped with an open vent or an approved automatically operated vent, which will permit discharge to the open air. Vent pipe and vent opening shall be large enough to prevent abnormal pressure in the tank during filling, 1-1/2" pipe size being the minimum. The vent and fill pipes should drain to the tank, and the lower end of the vent pipe shall not be cross-connected with the fill pipe. The outer end of vent pipes shall be provided with a weatherproof hood which shall be high enough above the ground to prevent its being obstructed with snow or ice. The vent pipe shall not be closer than two feet, either vertically or horizontally from any windows or other building opening.

The storage tank shall be filled only through a 2" fill pipe terminating outside of the building, no closer than five feet from any building opening at the same or lower level. A metal cover designed to prevent tampering shall be provided.

All piping shall be standard full weight wrought iron, steel or brass pipe, with standard fittings, or approved brass or copper tubing, with UL listed fittings. At least 1/4" iron pipe or 3/8" O.D. copper tubing (1/2" O.D. copper tubing is preferred) having a wall thickness not less than 0.049" shall be used in connecting the burner to the tank. The piping shall be protected from possible injury and shall be rigidly fastened in place in a workmanlike manner. Where practical, it should be buried underground, or in a concrete floor or placed in a metal covered pipe trench. Do not cover the piping until the burner has been installed and operated so that any leaks may be corrected. Pipe joints and connections shall be tight and unions and tube fittings of an approved type only shall be used. Use only pipe thread compound resistant to oil. A UL listed strainer shall be installed in the oil supply line to the burner.

UL listed shutoff valve shall be installed in the oil supply line in an accessible location close to the tank and to the burner. UL requirements stipulate a bottom outlet on all 275 gallon tanks. This is to prevent the accumulation of condensate which causes the tank to rust. A water trap can be installed at the tank outlet to prevent the water from entering the burner. Consult a local fuel oil dealer for additional information.

Figure 22 - Basement Tank Installation

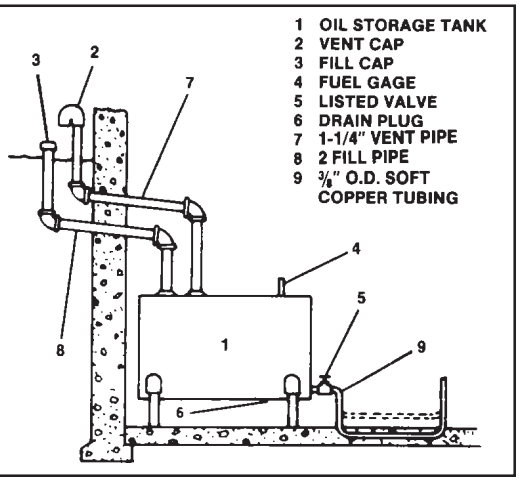
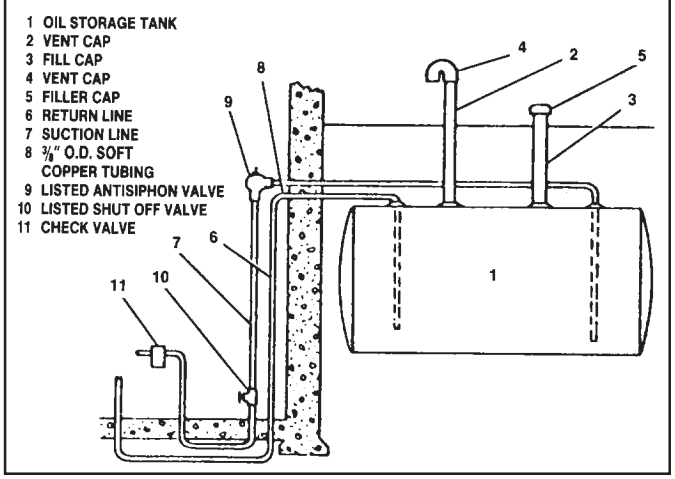


Figure 23 - Outside Tank Installation.



MAINTENANCE AND SERVICE

The service and troubleshooting information in this section is designed to assist a qualified service person.

29. Maintenance Requirements

Like all quality equipment, this oil-fired unit heater will operate with a minimum of maintenance. However, to ensure long life and satisfactory performance, the following service regimen is recommended.

Heaters should be inspected once every four months where the equipment is operating under normal conditions. If the heater is located in an area where an unusual amount of dust or soot or other impurities are contained in the air, more frequent inspection is recommended. Check the motor for cleanliness. Remove dirt and grease from the outside of the motor, and especially around the shaft. Lubricate, if provided with oil cups or grease fittings.

Keep air openings free of grease and dirt. The heat exchanger should be checked at least once a year and more often in areas where the air is heavily dust laden.

30. Cleaning Combustion Chamber, Heat Exchanger and Flue Pipe

WARNING: Turn off electric power before inspecting or cleaning this heater.

Instructions for removing soot from the combustion chamber/heat exchanger

1. On the burner end of the heater, locate the small exhaust door panel underneath the burner tray. See Figure 24. On Canadian Models, there is a screw (not shown in the illustration) at the bottom of the panel. Using a straight screwdriver, remove that screw.
   On all models, remove the outer door panel by lifting upward and outward on the handle. The exhaust box cover is now in view.

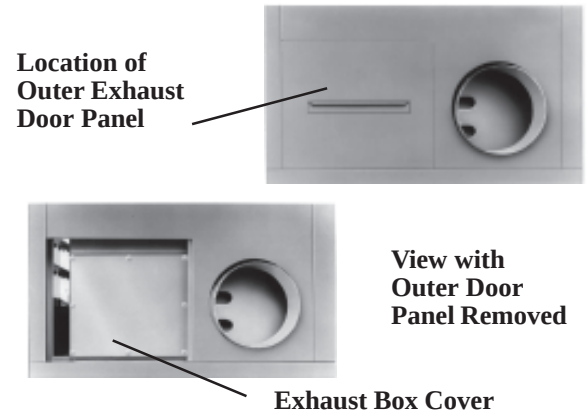


Figure 24 - Exhaust Door Panel (Illustration does not show vent pipe. Vent pipe is connected to the collar on the right.)

2. Remove the nuts that hold the exhaust box cover. Pull the cover directly forward off the welded studs. Remove the two vertical pieces of woven gasketing. (The horizontal gasket pieces are still attached to the vent pipe side of the opening.)

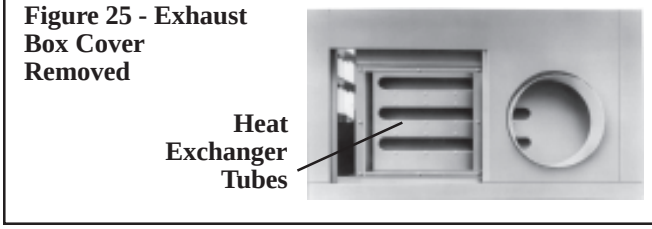


Figure 25 - Exhaust Box Cover Removed

3. On the end of the heater opposite the burner, remove the large outer door panel.
   On Canadian Models, there is a screw (not shown in the illustration) at the bottom center of the panel. Using a straight screwdriver, remove that screw.
   While supporting the large panel, remove it by lifting upward and outward on the handle. With the panel removed, the access door cover is exposed a shown in Figure 26.

Figure 26 - Large Door Panel and Access Cover

4. Remove the nuts that hold the large inner cover. Pull the cover directly forward off the welded studs, exposing the combustion chamber and heat exchanger passages. Remove the woven gasket material. See Figure 27.

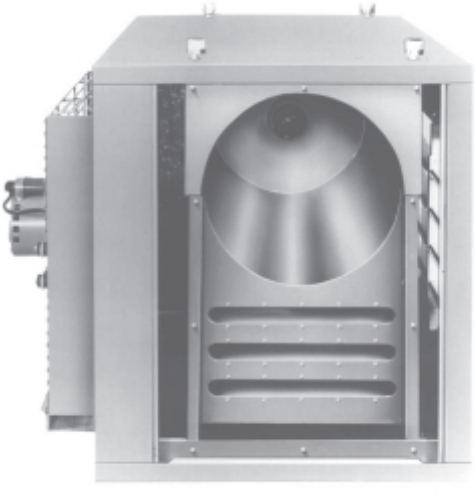


Figure 27 - Combustion Chamber and Heat Exchanger Passages

30. Cleaning Combustion Chamber, Heat Exchanger & Flue Pipe (cont'd)

5. Scrape the soot from the combustion chamber walls and the passages of the heat exchanger. Use a furnace brush and/or fabricate a "rake" from the 3/4" x 6" plate furnished with the heater by attaching a 3/8" diameter threaded rod. Refer to Figure 28 for details on assembling "rake". A shop vacuum may be used to aid in the cleaning process.

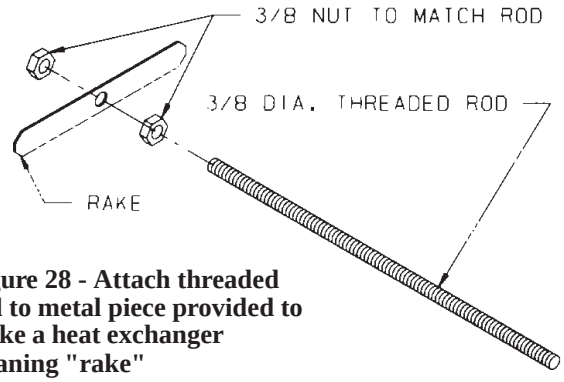


Figure 28 - Attach threaded rod to metal piece provided to make a heat exchanger cleaning "rake"

6. To clean the flue pipe, remove the cleanout cap from the tee. Tap the pipe gently to cause any loose soot that may be out of reach to fall out. Scrape the flue pipe walls that are accessible.
7. After the cleaning operation is completed, replace all covers being careful that gaskets are in place. If gaskets are damaged or deteriorated, they must be replaced.

31. Removing Burner and Cleaning End Cone

WARNING: Turn off the electric power before burner is removed for service.

To gain access to the end cone, the burner must be removed.

1) Locate the two yellow wires that go from the burner to the ignition controller. Disconnect these wires at the terminals on the ignition controller.
2) Remove the three nuts that retain the burner to the heater. See Figure 29. Slide the burner off the bolts and rotate.
3) With the burner on the service tray, you can remove the screws that hold the end cone to the burner tube. Clean the end cone using a stiff wire brush. Check the end cone for deterioration and replace if deterioration exists.
4) When cleaning/service is completed, place the mounting plate gasket (NOTE: If gasket is damaged it should be replaced.) on the studs. Align the burner mounting plate with the bolts and slide the tube into the heater. Attach the mounting plate with the three nuts.
5) Reconnect the yellow wires to the ignition controller.

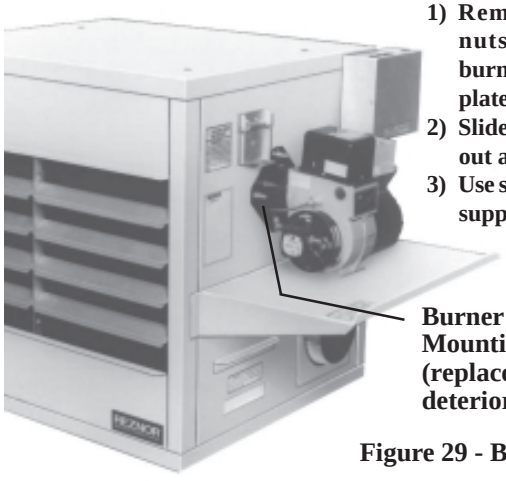


Figure 29 - Burner End of Heater

32. Removing Fuel Line Assembly to Service Nozzle and Spark Electrodes

In order to service the oil nozzle and spark electrodes, it is necessary to remove the fuel line assembly.

Instructions for Removing Fuel Line Assembly

1. Loosen the connection nut (where line connects to the burner) one or two turns.
2. Disconnect the fuel connection assembly by loosening the 5/16" inverted flare fitting. Pull the fuel connection assembly clear of the burner housing.
3. Remove the two screws retaining the spark transformer cover to the burner housing. Lift the hinged transformer to its open position.
4. The fuel line assembly may now be removed. Pull the assembly up slightly and toward the rear of the burner housing.

Oil Nozzle Replacement -- With the fuel line assembly removed, use a box wrench to remove the oil nozzle. Replace the oil nozzle with the identical nozzle. See table below for nozzle selection. **Do not substitute nozzles.** Substitution of nozzle could cause an operational problem and/or a safety problem.

Replacement Burner Nozzles

Size	Reznor P/N	Delavan Nozzle Type
95	32437	0.85, 80°, B
140*	146815	1.25, 70°, B
190*	146816	1.35, 70°, B

*These replacement nozzle sizes apply to heaters manufactured beginning 6/96. **Always check the nozzle for size and replace with an identical nozzle.**

When replacing the nozzle, inspect electrodes and check electrode adjustment before reassembling the heater.

Servicing/Replacing Spark Electrodes --Remove any carbon formation on the spark electrodes. Check the electrodes for deterioration and the insulators for cracks or damage. Replace the electrode assemblies if any damage or deterioration exists. After service or replacement, check the position of the electrodes. Adjust the electrode location precisely. Refer to Figure 30.

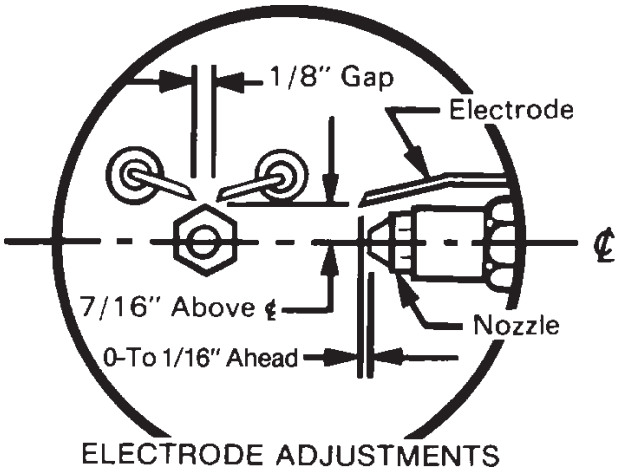


Figure 30 - Electrode Adjustment

33. Cleaning Exterior Surfaces of the Combustion Chamber/Heat Exchanger and Air Moving Device

WARNING: Turn off the electric power before cleaning the heater.

To gain access to the front of the combustion chamber/heat exchanger assembly, remove the discharge louvers. To access the rear side, remove the fan assembly or blower assembly. To remove the air moving device, disconnect the wiring in the fan/blower junction box and the flexible conduit. Refer to Figure 31.

Use a stiff brush and a shop vac to clean the accumulated dust and dirt from the exterior surface of the combustion chamber and the heat exchanger.

Clean the air moving device (fan or blower). Use a brush and a shop vac, being careful not to bend or damage either the fan blade or the blower wheel. Use a shop vac to remove accumulated dirt from the motor.

Reattach the air moving device and the discharge louvers. Connect the flexible conduit and wiring. Check operation.

Cleaning ensures maximum efficiency and eliminates the possibility of the heater cycling on the limit switch from lack of air flow.

Figure 31 - Fan/Blower Junction Box Located on Rear of Heater.

34. Troubleshooting

This oil-fired heater has been designed and manufactured to provide trouble free operation. However, as with any type of mechanical equipment, it can fail. For your safety, if there is a problem, contact a qualified service person.

To diagnose malfunctions properly, the following testing equipment is required:

- √ An electrical test meter that can measure volts, ohms, and amps
- √ An ignition transformer tester
- √ A combustion analyzer kit to measure oxygen or carbon dioxide, smoke, stack temperature, draft, and system efficiency
- √ A pressure/vacuum gauge with a scale of 0-200 psig and 0-30" hg.

Before test firing any heater, check the combustion chamber for an excessive accumulation of unburned oil and restore to a safe condition before firing.

WARNING: Do not attempt to start the burner when excess oil has accumulated, when the furnace is full of vapor, or when the combustion chamber is very hot.

Troubleshooting Oil Burner

Symptom	Cause	Action
Burner motor does not start	1. Incomplete electrical circuit	1. Measure the line voltage at the primary control input connection. Should have nominal 120 volts. (Lower than 105 volts may cause operating problems.) If there is no reading, check disconnect switch, fuses, and thermostat connections.
	2. Primary control activated. Relay in "on safety" position will lock out burner operation.	2. *Follow the instructions on page 19 to determine the cause of the lockout. Correct the malfunction.
	3. Inadequate voltage between motor/primary lead and neutral connection.	3. Line voltage must be within 10% of the voltage specified on the motor rating plate.
	4. Motor hums but shaft does not rotate.	4. Start switch may be defective. With the power turned off, rotate the blower wheel by hand. If it turns freely, replace the motor.
	5. Motor bearings frozen.	5. Free shaft and lubricate or replace motor.
	6. Overload protection activated	6. Allow the motor to cool. Start the motor and measure the current draw. This reading should not exceed the rating plate specifications under load conditions by more than 10%. Excessive amp draw usually means an overload condition, defective start switch or shorted windings. Replace motor if necessary. (It is difficult and not usually cost effective to attempt to rebuild the motor.)
Burner motor operates but no fuel is delivered at the nozzle	1. Oil level below intake in tank	1. Fill and bleed air from fuel line.
	2. Clogged strainer	2. Remove and clean strainer
	3. Restricted fuel supply line	3. Open all valves in supply line. Replace any kinked tubing.
	4. Clogged nozzle	4. Replace nozzle.
	5. Air leak in the supply line	5. Tighten all fittings in the line. Tighten unused intake port plug in the fuel pump. If there are valves in the line, be sure the valve stems are packed solid and tightened securely.
	6. Two pipe system that becomes air bound.	6. Insert bypass plug if not in place. Re-start unit and prime pump.
	7. Motor operates but does not drive the pump shaft	7. Check the coupling for slippage due to stripped end caps. Replace coupling.
	8. Frozen oil pump shaft	8. Replace oil pump.
	9. Suction line oil filter cartridge dirty	9. Replace cartridge.

34. Troubleshooting (cont'd)

Troubleshooting Oil Burner (cont'd)

Symptom (cont'd)	Cause (cont'd)	Action (cont'd)
Burner motor operates and delivers oil, but there is no flame	1. No spark	1. Measure voltage between transformer/primary lead and neutral connection. Check transformer, insulators and electrodes. The secondary terminals of a good transformer deliver 5000 volts arc to ground, for a total of 10,000 volts between the terminals. Measure this with a transformer tester or use a well-insulated screwdriver to draw an arc across the two springs. This should be at least 3/4" in length. Check each secondary output terminal by drawing a strong arc between the spring and the base. If arc is erratic, weak, or unbalanced between the two terminals, replace the transformer. Replace electrodes when the tips become worn or eroded. Replace any insulators that are questionable. Transformer failures and ignition problems can be caused by the following: a) Excessive gap on the ignition electrodes. Gap should be 1/8". b) High ambient temperatures c) High humidity d) Carbon residue on the porcelain bushings e) Low input line voltage f) Arcing between the ignition electrodes and the transformer springs. They must have good contact. g) Carbon residue, moisture, crazing or pin holes on the insulators. h) Improper positioning of nozzle in relation to the radius of the endcone. i) Carbon residue on electrode parts.
Burner starts but flame blows away from nozzle	1. Excessive combustion air	1. Adjust air gap and air shutter. See Paragraph 27.
	2. Excessive draft	2. Adjust draft regulator for .01" w.c. overfire draft.
	3. Poor atomization of oil	3. Adjust fuel feed pressure; change nozzle.
Poor light off and shutdown	1. Air pocket between pressure shutdown valve and nozzle	1. Tighten unused intake port plug in the fuel pump. Run burner stopping and starting occasionally until pulsation, smoke, and after flame disappear.
	2. Insufficient draft over fire	2. Check venting for excessive length, insufficient pitch upward to chimney, too many elbows, obstructed chimney, or too small chimney. Check for too high combustion air setting.
Noise	1. Noisy motor	1. Check for alignment of the shaft with the coupling. Tighten or slightly loosen the motor-to-burner-housing bolts in an alternate sequence, which may solve the problem. Check for a loose blower wheel, excessive radial shaft play and for loose start switch parts. Check if thermocouple is laying on the blower wheel.
	2. Clogged strainer	2. Remove and clean strainer.
	3. Burner vibrations transmitted through rigid electrical conduit or oil lines	3. Tubing or conduit should not be fastened to studs, or beams so securely that vibration can be transmitted to floor or roof.
Oil Odors	1. Oil leaks	1. Check fittings and valve seals.
	2. Poor burner shutoff	2. Check fuel shutoff valve and time delay relay.
	3. Smoky flame	3. Check nozzle spray, air gap, and air shutter setting.
	4. Oil carbonization on the burner endcone	4. Check nozzle location relative to inside radius of endcone.
	5. Downdraft causing smoke to enter the building through the barometric draft regulator	5. Increase draft by extending chimney height, or adding a ventilating cap or draft inducer

*Procedure for determining the malfunction that caused the primary control to activate

1. Disconnect the nozzle line connector tube and re-position it so that oil goes into a container. Tighten the flare nut at the pump discharge fitting.

2. Reset the primary control safety switch and immediately be alert to watch and listen for the following:

a) Contact action of the primary control relay. Relay should pull in promptly without arcing erratically or chattering. If relay does not function properly, see Step 4.

b) Quality of oil delivery. Oil stream should be immediate, clear and steady. A white, frothy oil delivery indicates air in the supply system. No oil delivery indicates a severe restriction.

c) Ignition Arc - When the ignition activates, you hear a buzz. If the ignition does not activate, check the transformer and electrodes.

d) Motor Operating Characteristics - The motor should start quickly and smoothly. You can hear the RPM change and a click as the centrifugal switch disconnects the start (auxiliary) winding.

3. If the malfunction has not been revealed, reconnect the nozzle line fittings and prepare for a fire test. Be sure to check the combustion chamber and remove any accumulation of unburned oil. Reset the primary control, if necessary, and observe the overall performance with concentration on the light-off. Run several cycles. Observe the flame quality using a flame mirror, if possible. Flame base should be stable and close to the combustion head. Flame should be centered, uniform in shape and relatively quiet in operation. Check the heat and combustion chamber for carbon or impingements., indicating a defective or partially clogged nozzle.

4. If the problem is not apparent, check the primary control system.

Measure the electrical voltage at the primary input (usually black) and neural lead (usually white) connections.

Jumper the thermostat (TT terminals) or otherwise energize the primary control.

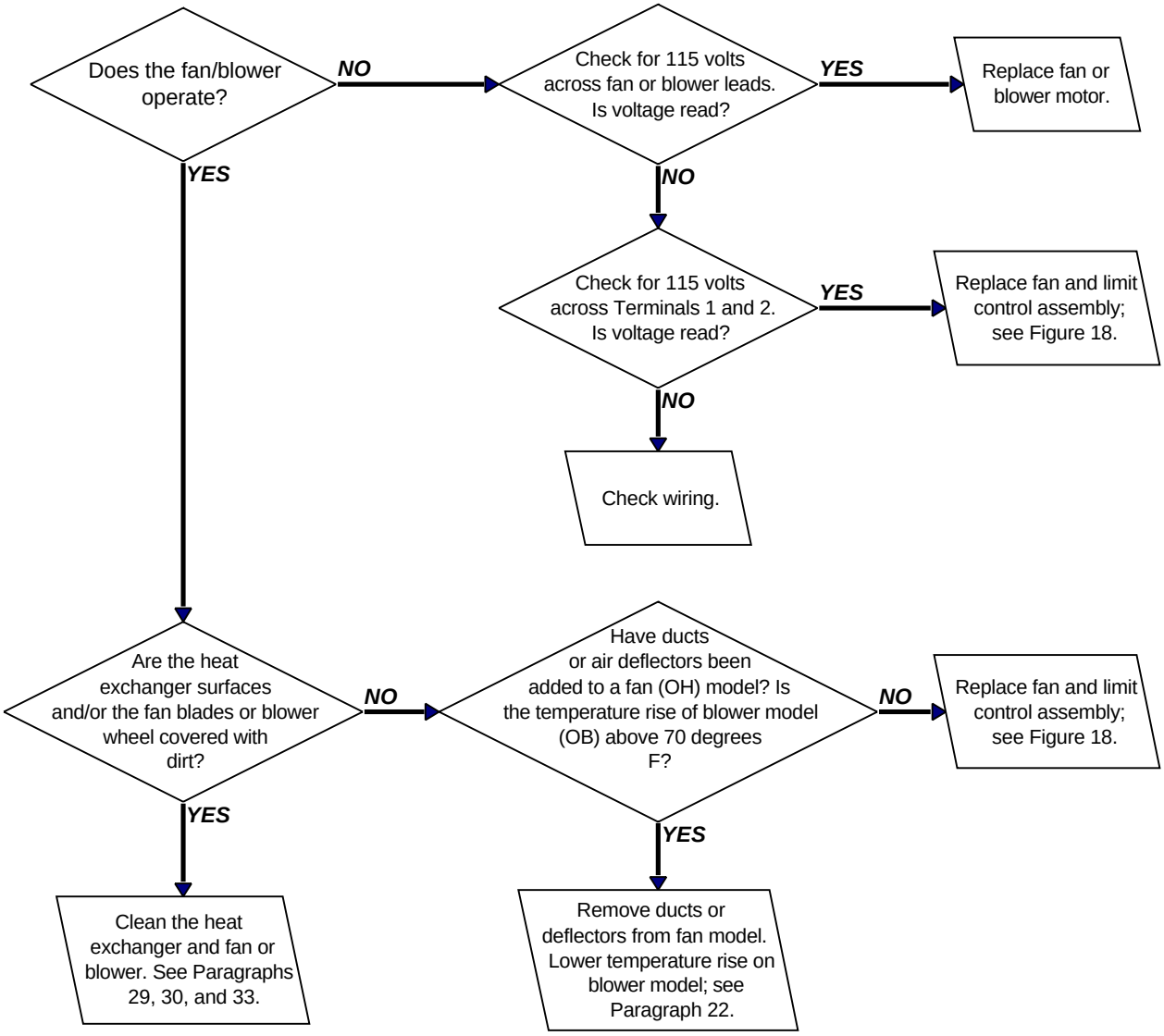
The control relay should pull in. If not, make sure that the wiring connections are secure. If wiring connections are secure, check that the cad cell which controls the safety lockout timing on ignition is not seeing too much stray light. Check the cad cell by starting the burner and disconnecting both cad cell leads from the control FF terminals. Jumper the FF terminals to keep the burner operating. Measure the ohms resistance across the cad cell leads as it views the flame. This should be 1600 ohms or less. A preferred reading is 300-1000 ohms. Next, with the meter still connected to the cad cell leads, turn the burner off. The dark condition should give a reading of 20,000 ohms or infinity. If the reading is lower, let the refractory cool down or look for stray light that might be entering the burner through the air inlet, or around the transformer baseplate. If the cad cell is not performing within these guidelines, replace it. If the wiring connections are secure and the safety lock timing and cad cell are functioning properly, replace the primary control.

If the primary control relay pulls in and then locks out again quickly, check the safety lockout timing. The safety lockout timing can be checked by removing one of the F (cad cell) leads from the control. Count the seconds until the control locks out. The time should be close to the rating plate specification found on the control body.

If the primary control relay pulls in erratically and chatters, check the wiring connections and verify that the heat anticipator setting of the thermostat matches the 24 volt current draw. Erratic operation can sometimes be traced to improper anticipator settings of the primary control. These settings are typically .2 or .4 amps (printed on the side of the control). Measure this value by connecting your multitester in series with one of the TT lead and reading the value of the appropriate milliampere scale. If the wiring connections are secure and the anticipator settings are correct, replace the primary control.

If the primary control relay pulls in, but the motor fails to start, measure the voltage between the neutral lead an the primary control lead for the motor. A severe voltage drop here would indicate that the relay switch contacts are defective. Replace the primary control.

Troubleshooting Guide - High Temperature Limit Cycles **



**** High temperature limit cycles when internal temperature exceeds nonadjustable limit setpoint (Size 95, 145°F; Sizes 140 and 190, 160°F). Cause must be found and corrected for heater to function safely/properly.**

CAUTION: DO NOT TAMPER WITH THE UNIT OR CONTROLS. CALL YOUR SERVICE PERSON.

FOR SERVICE OR REPAIR, FOLLOW THESE STEPS IN ORDER:

FIRST: Contact the installer.

Name _____

Address _____

_____

_____

Phone _____

SECOND: Contact the nearest distributor (See telephone Yellow Pages.)

THIRD: Contact: REZNOR®/Thomas & Betts Corporation
150 McKinley Avenue
Mercer, PA 16137
Phone: (724) 662-4400

Model No. _____

Unit Serial No. _____

Date of Installation _____

Thomas&Betts

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1/00 1M M Form 417-B.1