

# ASSEMBLY, INSTALLATION, MAINTENANCE AND OPERATING INSTRUCTIONS

INOV8 F125 Multi-fueled Unit Heater & Furnace





Control No. 3120734

**Save These Instructions!**

This manual must be kept near the furnace!

<b>SECTION 1 – GENERAL GUIDELINES.....</b>	<b>0</b>
Codes & Regulations.....	0
U.S. EPA Regulations & Used oil Burning.....	0
Listing Agencies.....	1
Fuels- general information.....	1
Special Precautions!.....	1
Warranty is void if.....	2
Hazardous Atmosphere.....	2
Disposal.....	2
Unpacking & Inspecting.....	2
Shipping & parts information.....	3
FEATURES OF THE F125 DESIGN.....	4
Minimum Clearances.....	4
<i>Figure 1 - Model F125 Dimensions</i> .....	5
<i>F125 Furnace Specifications</i> .....	5
<b>SECTION 2 – FURNACE INSTALLATION.....</b>	<b>6</b>
FURNACE LOCATION.....	6
Ceiling Mount Installation Considerations.....	6
ATTACHING THE BURNER TO THE FURNACE.....	7
Installing the Burner.....	7
Attaching the Oil Delivery Line ('A' in photo).....	7
Attaching the Return Line ('B' in photo).....	7
Installing the Burner Electrical Plug.....	7
Electrical Hookup of the Furnace.....	7
Fan/Limit control.....	8
Attaching the Air Connection.....	8
INSTALLATION DETAILS.....	8
Air Supply Installation.....	8
Photo Illustration of Chimney Connection.....	9
Chimney Installation.....	10
Installing the Barometric Draft Control.....	11
Blocked Vent Switch –supplied with Canadian Furnaces (or optional).....	11
Draft Measurements & Adjustments.....	11
Installing an Optional Sealed Combustion System.....	12
Electrical Supply Installation.....	12
Mounting the Wall Thermostat.....	12
TANK & PIPING CONSIDERATIONS.....	13
Oil Storage Considerations.....	13
Piping & Fitting Recommendations.....	13
Vapor Eliminator Filter / Pressure Relief Assembly.....	14
Installation of Vent Line from Vapor Eliminator back to the Tank.....	14
Vapor Eliminator Filter.....	14
Tank Filter.....	14
Bench Tank Installation.....	14
<i>Figure 2 - Typical Installation Diagram (ceiling hung &amp; with bench tank)</i> .....	16
Boost Pump (optional).....	17
<i>Figure 4 - Diagram Showing Installation of Suntec Boost Pump, Filter, Check valve, Regulator &amp; Gauges</i> .....	18
<i>Figure 5 – Burner Diagram</i> .....	19
Final Installation Checklist.....	20
<b>SECTION 3 – OPERATING THE FURNACE.....</b>	<b>21</b>
FIRST START-UP OF FURNACE.....	21
Priming the Oil System.....	21
Firing up the Furnace the First Time.....	21
NORMAL OPERATION OF FURNACE.....	22
FACTORY SETTINGS.....	23
<i>Figure 6 - Electrode Adjustment Diagram</i> .....	24
FLAME ADJUSTMENTS.....	24
<i>Figure 7 – Proper &amp; Improper Flame appearances</i> .....	25

MAINTENANCE .....	25
General Information .....	25
Changing Filters.....	26
Vacuuming the Combustion Chamber & Heat Exchanger Tubes .....	26
Annual Maintenance .....	27
Chimney Inspection .....	27
Summer Burner Refurbishing Program.....	27
<b>SECTION 4 - TROUBLESHOOTING .....</b>	<b>28</b>
General Failure Categories & Potential Causes .....	28
Using Lights on the Controller to Diagnose Symptoms.....	29
<b>SECTION 5 –DETAILED SERVICING PROCEDURES .....</b>	<b>31</b>
Removing the Module from the Burner .....	31
Replacing the Module into the Burner.....	31
Flushing the Final Delivery.....	31
Checking the Oil Spray .....	32
Checking the Oil System.....	32
Checking the Ignition Arc.....	33
Checking the Atomizing Air System .....	33
Checking the Draft & things that can cause it to be wrong.....	34
By-passing the Bimba Cylinder .....	34
Replacing the Vapor Eliminator Filter .....	35
Cleaning the Nozzle.....	36
Rebuilding the Pump .....	36
Cleaning the Pump Internal Pressure Regulator.....	37
Oil Temperature Controller: Operation & Settings .....	38
<i>Oil Temperature &amp; Pressure Settings</i> .....	38
<i>Adjusting the Temperature Controller</i> .....	39
Removing Excess Oil from Combustion Chamber.....	39
PROCEDURE FOR PARTS REPLACEMENT.....	39
<b>ADDENDUM.....</b>	<b>41</b>
THEORY OF OPERATION.....	41
MAIN COMPONENTS & THEIR FUNCTIONS .....	42
The Fireye Controller .....	42
The Oil System .....	43
The Primary (atomizing) Air System .....	44
ELECTRICAL DIAGRAMS .....	45
<i>Figure 8 – Basic Wiring Diagram for Furnace with Prop Fan</i> .....	45
<i>Figure 9 – Basic Burner Wiring Diagram</i> .....	46
PARTS LIST & TOOLS.....	47
<b>SECTION 6 - GLOSSARY .....</b>	<b>48</b>

<b>Notations Used in this Manual</b>	
 <b>CAUTION</b>	<b>RISK OF INJURY OR SYSTEM DAMAGE</b> – Identifies a possible dangerous situation that can lead to personal injury or physical damage.
 <b>NOTE</b>	<b>NOTICE</b> – This is a tip or notice for optimum use of equipment and adjustment as well as useful information.

# SECTION 1 – GENERAL GUIDELINES

Congratulations on your purchase of this INOV8 Multi-fueled Furnace. You have selected the highest quality, precision-engineered piece of equipment available, designed specifically to allow you to fully benefit from the used oils generated in your business. INOV8 has not compromised in engineering this product for high efficiency, safety, longevity, operating economy, and to allow you a maximum of fuel choices; all while providing the highest standards of environmental considerations. This manual was written for the novice technician with detailed instructions for the installation, start-up, routine operation and maintenance of this furnace. If these instructions and pertinent local regulations are followed closely you will be assured full satisfaction.

## **CODES & REGULATIONS**

This manual covers installation, maintenance and service of the INOV8 model F125 unit heater. Both are referred to using the term "furnace" throughout this manual that covers the installation of the chimney system, fuel storage and piping connections and electrical work. All work shall be performed by a qualified contractor in strict accordance with the requirements of state, provincial and local regulating agencies and codes pertaining to oil-burning equipment installations. After start-up the owner or its representative should be instructed about the furnace operation and be given this manual. This equipment must be installed according to these national standards.

For furnace equipment:	ANSI/NFPA # 31 – <i>Standard for the Installation of Oil-Burning Equipment</i> – 2006 Edition, and in Canada to CSA Standard B139.
For chimney installation:	ANSI/NFPA # 211 – <i>Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliance</i> , 2006 Edition
For oil storage installation:	NFPA # 31 – <i>Standard for the Installation of Oil-Burning Equipment</i> – 2006 Edition
For electrical installation:	NFPA # 70 – <i>National Electrical Code</i> – 2005

Cleaning and routine maintenance must be carried out at least quarterly during operation. This shall include an overall check of the heating system. There should be periodic inspection of the combustion chamber for possible deterioration. Any discrepancies must be corrected immediately.

**NOTE:** This manual is for reference only. The manual does NOT purport to address all design, installation and safety considerations. It is the responsibility of the user of this manual to determine the applicability and safety of each individual application and ensure its compliance with local building codes.



## **U.S. EPA REGULATIONS & USED OIL BURNING**

On August 12, 1992 the U.S. Environmental Protection Agency (EPA) announced that it would not list nor classify as hazardous waste, used oil destined for recycling. They also affirmed the long-standing regulatory exemption, which allows the operation of used oil-fired furnaces. Under this exemption, used oil-fired furnaces may operate without a regulation so long as the owner burns "**on-specification used oil**". Used oil exceeding EPA designated levels of contaminants is classified as "**off-specification used oil**" which means the owner must comply with three requirements: the heater does not exceed 500,000 BTU per hour, it is vented to the outside, and burns oil generated on-site or collected from do-it-yourself oil changers. After years of careful study the EPA concluded that used oils that are recycled in this manner do not pose a substantial present or potential hazard to human health or the environment so long as they are managed properly. To this end, EPA's regulations are designed to provide safe and environmentally sound used oil management practices.

## **LISTING AGENCIES**

This equipment is tested and listed by **Intertek ETL Semko (ETL)** - an internationally recognized third party test agency to UL 296A - Standard for Safety for Waste Oil Burning Air-Heating Appliances, Edition 2, Revision 2006/03/08 (the U.S. used oil standard), and to CSA B140.0 General Requirements for Oil Burning Equipment General Instruction No 2-4 (R1991) Rev: 1991/01/01 and is listed with the European Economic Community with a CE registration number 3884/97. The INOV8 tanks are also tested and listed by ETL to UL 80 *Standard for Steel Tanks for Oil-Burned Fuel*.

## **FUELS- GENERAL INFORMATION**

This product is approved to burn the following oils: crankcase oil, crankcase oil with up to 20% gasoline, fuel oils up to #6 heating oil, jet fuel, mineral spirits and transmission oil. The following additional oils have been tested and passed combustion analysis requirements but are not approved as fuels due to a lack of standards to define them: used and crude vegetable oil, and biodiesel. DO NOT attempt to burn other liquids without written authorization from INOV8 International, Inc. Only used oil generated on the premises of the owner may be used in this equipment, unless written authorization is obtained from the regulatory authority.

**Caution** – used oils may contain gasoline, heavy metallic compounds and foreign materials. When burned, these compounds are emitted from or deposited within this furnace and therefore care should be taken when storing these oils or when using, cleaning and maintaining this equipment.



## **SPECIAL PRECAUTIONS!**

1. This furnace is listed for commercial or industrial use only. It may not be used for residential or any other unauthorized purpose.
2. All furnaces must be wired strictly in accordance with wiring diagram and instructions in this manual.
3. Disconnect the power supply before making wiring connections to prevent electrical shock and equipment damage.
4. Disconnect the power supply before cleaning the furnace.
5. Do not install furnace or chimney connector closer than 18 inches to combustible materials in any direction, except the louver side of the furnace, which must be unobstructed.
6. DO NOT add fluids with the classification of a hazardous waste, or fuels with flash points below 100°F (such as gasoline) to your used oils. (Check your local codes for restrictions.)
7. For your protection - DO NOT store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
8. Canadian standards allow only used oil generated on the premises of the owner to be used as fuel, unless permitted by the regulatory authority.
9. Venting - Failure to provide proper venting could result in death, serious injury, and/or property damage. Units must be installed with a flue connection, draft regulator and proper vent 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.

## ***WARRANTY IS VOID IF ...***

1. The heater is not installed in accordance with these instructions and applicable codes and ordinances.
2. The wiring is not in accordance with drawings in this manual.
3. The Furnace or burner is not maintained in accordance with maintenance requirements – particularly failure to clean the combustion chamber and heat exchanger on a regular basis.
4. Other than specified fuel is burned.
5. Fuel input capacity is over the rated condition of maximum flow rate of .84 US gallons or 3.18 liters per hour.

Note: Information on the Limited Warranty was sent along with the sales order.

## ***HAZARDOUS ATMOSPHERE***

The INOV8 products are not designed for use in hazardous atmospheres containing flammable vapors or combustible dust, or atmospheres containing chlorinated or halogenated hydrocarbons.

## ***DISPOSAL***

Dispose of packaging in an environmentally responsible manner. Dispose of all heating system components that have to be replaced at an authorized disposal site. Dispose of ash in a responsible manner.

## ***UNPACKING & INSPECTING***

Immediately upon receipt, check the cabinet and burner for any damage that may have occurred in shipment. If damage is found, INOV8 or the sales representative must be notified within two days in order to process shipping damage claims. Prior to shipping, all components were inspected and the burner test fired, so the burner will still have oil in it.

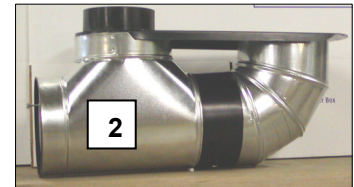
## SHIPPING & PARTS INFORMATION

The INOV8 Waste Oil Furnace is shipped on a pallet with strapping and plastic wrap. This includes the heat exchanger, fan, and fan motor (mounted and wired). The burner is packed in a separate box that also contains other parts, based on the following list and what was purchased. Immediately upon receipt of INOV8 products inspect all parts for possible shipping damage or missing parts and report any problems within 48 hours. Check for the items shown in the photos, that they are received:



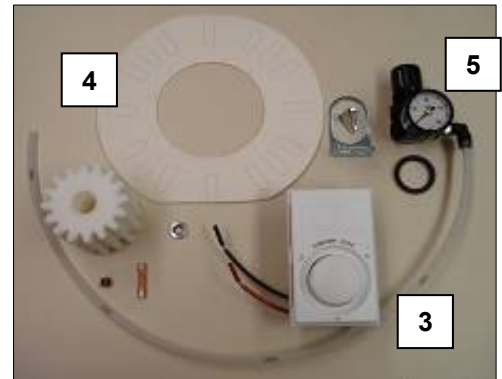
1. **Oil Pickup Assembly**, includes these parts from the top down:
  - a. One 3/4" check valve
  - b. 3/4 " x 2" black nipple
  - c. One 90° street elbow
  - d. Filter mount
  - e. One 90° street elbow
  - f. One 3/4" x 12" pipe nipple
  - g. Double tap bushing, 2" with 3/4" x 1/2" reducing bushing
  - h. One primary filter, model Gar-Ber Spin-on Filter #11V-R2000K with Filter Restriction Indicator

2. **Chimney connection kit with 8" draft control**  
See details on page 10



The following items are shown in the lower photo:

3. **Wall Thermostat** - 120 volt (line voltage).
4. **Other items include:**
  - a. Instruction Manual
  - b. Spare vapor eliminator filter
  - c. Spare 10 amp (brown) & 4 amp (orange) fuses
  - d. Burner gasket
5. **Air regulator Assembly**, includes:
  - a. Air regulator
  - b. Air gauge, 0 – 160 psig
  - c. Plastic nut
  - d. Bracket and screws
  - e. 1/4" air tube



The following items are not shown in the photos:

6. **Bench Tank - (optional)**, which includes:
  - a. 300 gallon bench-type tank
  - b. Optional stands
  - c. Tank gauge, oil supply and lines with fittings

## FEATURES OF THE F125 DESIGN

The F125 furnace has incorporated into its design years of experience in the waste oil furnace industry. Many user-friendly innovations that depart from the “standard designs” need to be explained to provide better understanding.

1. **CLEAN-OUT DOOR.** The clean-out door provides full access to the combustion chamber and the annular heat zone for non-hassle vacuuming of ash. The removal of two bolts allows the sturdy door to swing on a heavy duty ‘piano hinge’. This configuration also provides for easy inspection of the electrodes and oil nozzle.
2. **ACCESSIBLE ASH TRAP.** Because of INOV8’s commitment to providing environmentally responsible products, INOV8 utilizes a heater design that captures most of the ash generated through burning waste oils rather than emitting the ash up the chimney. This is typically accomplished by constructing large heat transfer passageways that allow the ash to settle within the furnace. The **F125** has been designed with high velocity heat transfer passageways that carry the ash out of the furnace where it is captured in a settling chamber or ASH BOX. This is accessed through the cleanout ‘T’ on the chimney connector. This connection can be moved to either side of the furnace for convenience in installation.
3. **PREVENTING STEEL FATIGUE FROM THERMAL EXPANSION.** Adjacent steels expand at different rates when heated to different temperatures. This internal thermal expansion causes straining and tearing of adjacent metals. The heat exchanger in the **F125** furnace is designed to allow unrestrained thermal growth of all interior parts.
4. **COUNTERFLOW CONFIGURATION.** This is the most efficient design available for furnaces. Each metal surface has hot gasses on one side and cool fan air on the other side. No surface within the heat exchanger has hot gasses on both sides.
5. **SQUIRREL CAGE FAN TO PROVIDE STATIC PRESSURE FOR DUCTING APPLICATIONS.** The blower or squirrel cage fan provides quiet, proper airflow for most installations.
6. **SEALED COMBUSTION PRE-HEATED AIR.** Negative building pressure from exhaust systems causes operating problems for furnaces. This will no longer be a problem for the **F125** furnace. Combustion air can be brought in from the outside and is preheated in a small heat exchanger in the door of the furnace.

### MINIMUM CLEARANCES

Furnaces must be installed so that the following clearances are provided for proper air movement, service and distance from combustible materials. In addition to walls and ceilings, combustibles include rags, paper, or any moveable combustibles like gasoline or other flammable fluid.

	Inches	Millimeters	Purpose
Blower Fan:	6	152	air movement
Chimney connector side (flue pipe):	26	660	safety concern
Opposite chimney connector:	18	457	combustible material
Above Furnace:	24	609	combustible material
Below Furnace:	31	787	combustible material
Burner side:	48	1,219	service access
Outlet Louver:	Unobstructed		air movement

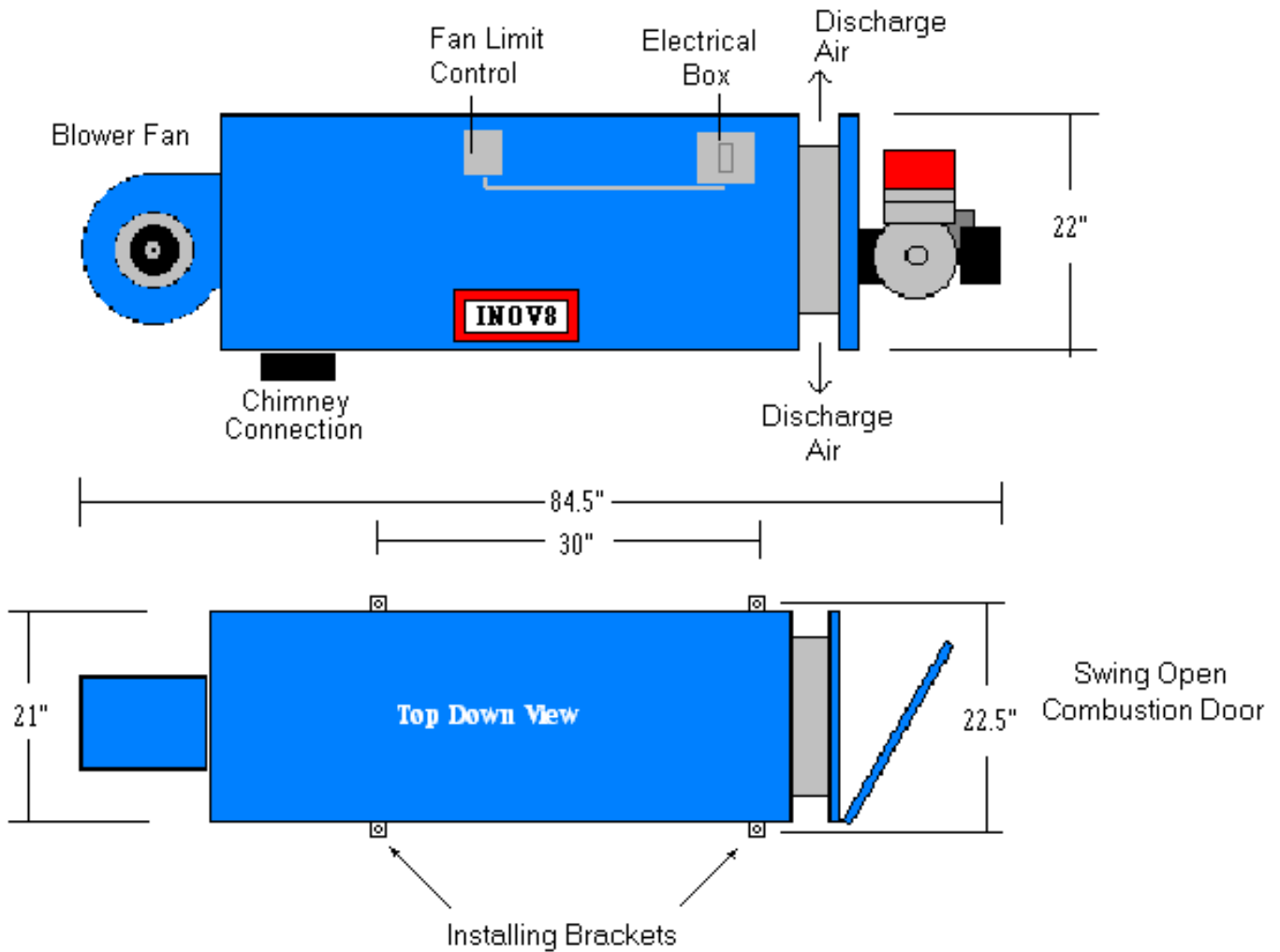
#### Additional comments:

The flue outlet is reversible and can be set up to exit along either side of the furnace. If possible, mount the furnace perpendicular to an end wall of the building or between bays. This will provide better heat distribution than mounting up against a sidewall.





*Figure 1 - Model F125 Dimensions*



*F125 Furnace Specifications*

<b>Description</b>	
Input – BTUH	125,000
Output – BTUH	100,000
Stack Size	8"
Cabinet Dimensions	84.5 L / 22.5" W / 21" H
Fuel Consumption	.84 gallons per hour
Weight	325 pounds
Electrical Voltage	120 volts
Amperage Requirement	20 amps
Compressed Air Requirement	30 PSIG
Cabinet Finish	Power coat – Ford Blue

## SECTION 2 – FURNACE INSTALLATION

### FURNACE LOCATION

Furnace location and other installation requirements were covered in the “Pre-installation Considerations” document that was sent along with the confirmation of order. It is absolutely essential that you have read that document before proceeding with the installation. If you don’t have it, contact INOV8 and it will be faxed or e-mailed.

The furnace location is important to the efficient operation of the system. These abbreviated guidelines will insure the most beneficial location. Further details are found on subsequent pages.

1. The location of the chimney must be considered before other aspects of the installation. See the section entitled, “Chimney Installation” for further details
2. Select a location as close as possible to the oil storage tank. The burner pump can suck laterally easier than it can vertically but there are limits. If the distance from the tank exceeds 30 feet or when the height exceeds 8 feet, a boost pump may be necessary.
3. Furnaces hung higher than the standard 8 feet are not recommended. **The location should provide easy access to the furnace for routine servicing and maintenance and for proper heat distribution.**
4. DO NOT attach ducting to furnace (unless the furnace was ordered with the ducting option that includes the squirrel-cage blower).
5. To prevent premature heat exchanger failure, DO NOT locate in areas where chlorinated, halogenated or acid vapors or other corrosive contaminants may exist.
6. DO NOT install the furnace outdoors or in excessively wet conditions.
7. DO NOT attach air filters to the furnace.
8. In multiple furnace installations, arrange furnaces so that each supports the air stream of the next furnace, thus creating circulatory air movement in the area. A large portion of the heated air should be directed toward the side of the building exposed to prevailing winds. The INOV8 dealer can provide recommendations for the most efficient installation of multiple furnaces. These installations will vary depending upon the unique layout of the facilities.
9. Adequate combustion air is required to maintain combustion. The INOV8 furnace will not operate in a negative building pressure (see section on sealed combustion if this exists).
10. Minimum clearances from combustible surfaces must be adhered to. See the section “Minimum Clearances” for more information.



NOTE

### CEILING MOUNT INSTALLATION CONSIDERATIONS

Be aware that the F125 furnace weighs 500 pounds (186 kg) when planning its installation. Before suspending the unit, check the supporting structure to ensure it has sufficient load-carrying capacity. The furnace comes with 5/8" bolts, lock washers and shackles for suspension purposes. Securely transfer the furnace weight to the roof/ceiling trusses. Use a proper ceiling mounting system, such as a 2" x 2" x 1/4" angle iron. Lock all mounting components in place using lock washers and double nuts. It is important that the furnace be hung level side-to-side and front-to-back and level with the floor. Never hang the furnace with ropes or chains.



NOTE

## ATTACHING THE BURNER TO THE FURNACE

Carefully remove the burner and components from the shipping box. Be careful when handling the burner, as the electrodes and the flame retention head are factory set and if either are bumped or moved, the operation of the burner could be affected. If the electrodes get out of adjustment, refer to page 24 for a diagram of the proper electrode settings. The burner has been pre-fired in the factory prior to shipping and will have oil in it. A plug has been installed in the pump for shipping and should be removed carefully to avoid spilling oil.

### INSTALLING THE BURNER

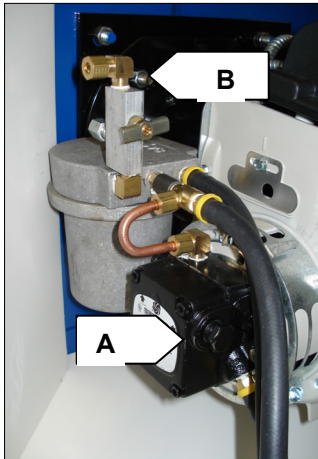
1. Place the burner gasket onto the air tube.
2. Remove the three 3/8"-16 nuts from the burner mounting plate studs.
3. Place burner on mounting plate studs.
4. Now tighten the 3/8" nuts that hold the burner to the mounting plate.

### ATTACHING THE OIL DELIVERY LINE ('A' IN PHOTO)

Specifics on the oil storage and plumbing are covered in the section titled "Tank & Piping Considerations" starting on page 12. The items in that section must have been completed in order to have an oil supply line run to the burner at this time. Assuming the line is in place: the oil supply line will connect to the inlet port of the pump on the burner. There are two inlet ports: one on the bottom of the pump and one on the side. Connect to the one on the side. Attach the line to the pump via a 1/2" x 1/4" NPT flare fitting and use the corresponding female portion with a barb fitting to attach to a flexible oil line. DO NOT do the following:

- plumb the line directly into the pump,
- use any compression fittings,
- use rigid line that will be difficult to remove for servicing the burner.

Be sure to seal the 1/4" NPT threads of the flare fitting at the pump inlet. ONLY Use pipe sealant suitable for waste oil, such as Loctite #565.



### ATTACHING THE RETURN LINE ('B' IN PHOTO)

As noted in the section "Installation of Vent Line from Vapor Eliminator Back to the Tank" on page 14, a 1/4" O.D. (minimum) copper or plastic line must be installed from the burner back to the tank. This line will connect to the brass elbow on top of the oil pressure release mechanism via the compression nut and ferrule supplied on that elbow. There will be no pressure in this line as long as the line is open all the way back to the tank. It is ABSOLUTELY IMPERATIVE that no valves or other constrictions be placed or allowed to exist (like crimps) in this line.

### INSTALLING THE BURNER ELECTRICAL PLUG

Insert the round burner power plug into the socket provided on the bottom of the electrical junction box that houses the GFCI outlet.

### ELECTRICAL HOOKUP OF THE FURNACE

1. Remove a convenient knock-out from the electrical junction box to allow connection of your electrical supply conduit.
2. Attach the hot wire (typically black) to the 6" black pigtail that comes off the GFCI "Line Hot" terminal.

3. Attach the Neutral wire (typically white) to the 6" white pigtail that comes off the GFCI "Line Neutral" terminal.
4. Attach the earth ground wire to the 6" green pigtail that comes off of the junction box.
5. If the furnace has a blower fan hook the other hot wire (typically red) to the red pigtail that comes off the fan contactor.

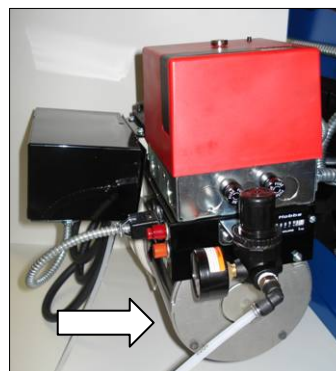
### **FAN/LIMIT CONTROL**

The fan/limit controls the on/off function of the motor that drives the fan or blower unit. It also shuts down the burner in the event of excessive heat in the furnace. This safety control is located in the upper corner (on the louver side of the furnace). Make certain that the switch has the proper settings: Fan ON = 140° F, Fan OFF = 80° F, Limit = 170° F. It should be on the "AUTO" setting.

### **ATTACHING THE AIR CONNECTION**

The air regulator assembly is in a plastic bag in the burner box.

1. Remove the screws and all necessary parts from the plastic bag.
2. Mount the 'L' shaped bracket to the right side of the burner just above the end of the motor (as shown in the photo).
3. Secure with the two screws that are provided.
4. Then mount the air regulator into the bracket, securing it with the black plastic ring nut.
5. Connect the 1/4" air line into the right-most fitting in the bottom of the module block. It just slides in and locks. It can be removed by pushing up on the ring on the fitting and then pulling the line back out.
6. There is a 1/4" NPT hole in the regulator into which you can install a quick-disconnect type of fitting. To this connect the air supply line coming from the compressor. The regulator will be set during the section on "Operating the Furnace".



## **INSTALLATION DETAILS**

### **AIR SUPPLY INSTALLATION**

There are two air supplies used in the combustion process. Combustion air entering the chamber through openings in the burner housing, located next to the oil pump, is referred to as "secondary or combustion air". Air is also supplied to the nozzle under pressure in order to atomize the oil into small particles for burning. A shop air compressor supplies this air. This compressor air is referred to as either primary air or atomizing air. Installation of the primary air is described below:

1. A continuous supply of compressed air (2.0 CFM at 30 psig) is required to operate the furnace. The furnace includes a factory provided pressure regulator rated at 300 PSIG with a gauge rated to 160 PSIG inlet for shop air. The connection requires 1/4 " NPTM. The pressure regulator is located on the right side of the burner housing (see photo on page 7) and controls air for use in atomization.
2. The shop air must be free of dirt and water. A filter should be installed in the line before attaching to the INOV8 burner. Do not attach the shop air directly to the burner module as damage will occur from the high pressure.

3. Air may be piped directly from the air compressor supply tank by using 1/4-inch (or larger) pipe, seamless copper tubing, or air hose. If piping or rigid tubing is used it is recommended that a short piece of hose be used to connect to the air regulator (on the burner) in order to swing the burner away for cleaning the combustion chamber. If air hose is used, it should have a minimum burst pressure rating of 300 psig.
4. Water routinely condenses in the air lines of a shop compressor and must be removed periodically. Water must be kept to a minimum to prevent component failure and operating problems.



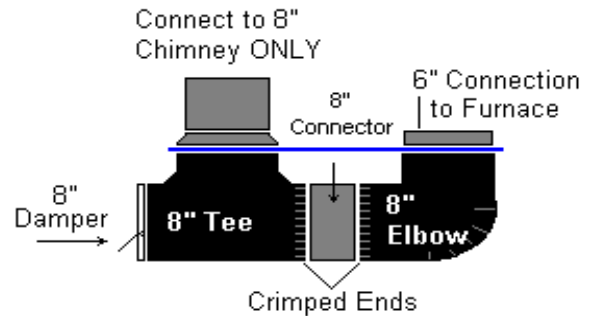
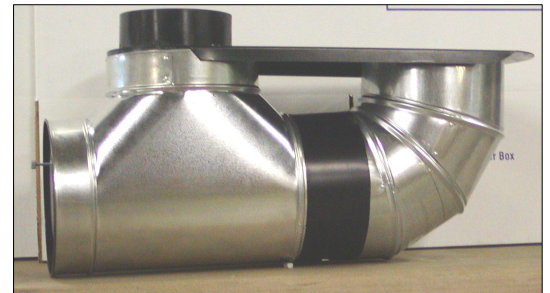
**NOTE**

**Note** – If there are concerns for leaving the air compressor on during nights and weekends, INOV8 has a compressor protection device available.

**PHOTO ILLUSTRATION OF CHIMNEY CONNECTION**

**Assembly Instructions for the F125 Chimney Connector.**

1. This photo shows a side profile of the F125 chimney connector. The black piece slips over the chimney connector on the bottom of the furnace and should be screwed into place with sheet metal screws.
2. The 8" Elbow slips over the furnace connector.
3. The 8" Tee slips over the other end of the black chimney connector. The crimped end should be next to the crimped end of the 8" Elbow.
4. Cut a section of 8" chimney pipe to 3 1/2" and join the two crimped ends together.
5. Install the weighted damper into the normally capped end of the Tee. Secure with two sheet metal screws, being careful not to block the movement of the flapper.
6. Install the chimney sections onto the Tee.



This photo shows the installed 8" weighted damper into the end of the 8" Tee. The weight should be installed on the top and inside the flapper door.

## CHIMNEY INSTALLATION

Included in this section are the critical factors involved in the chimney installation. The complete guidelines can be found in NFPA 211 – *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliance*, 2006 Edition, and in NFPA #31 – *Standard for the Installation of Oil-Burning Equipment* – 2006 Edition. There may also be local codes that need to be adhered to. The most critical factor in the installation of your INOV8 furnace is a properly designed and located chimney. A good draft (air movement up the chimney) is essential to the safe and reliable operation of the furnace. The furnace will not run with any degree of success when attached to an improperly installed chimney. The chimney MUST meet these requirements:

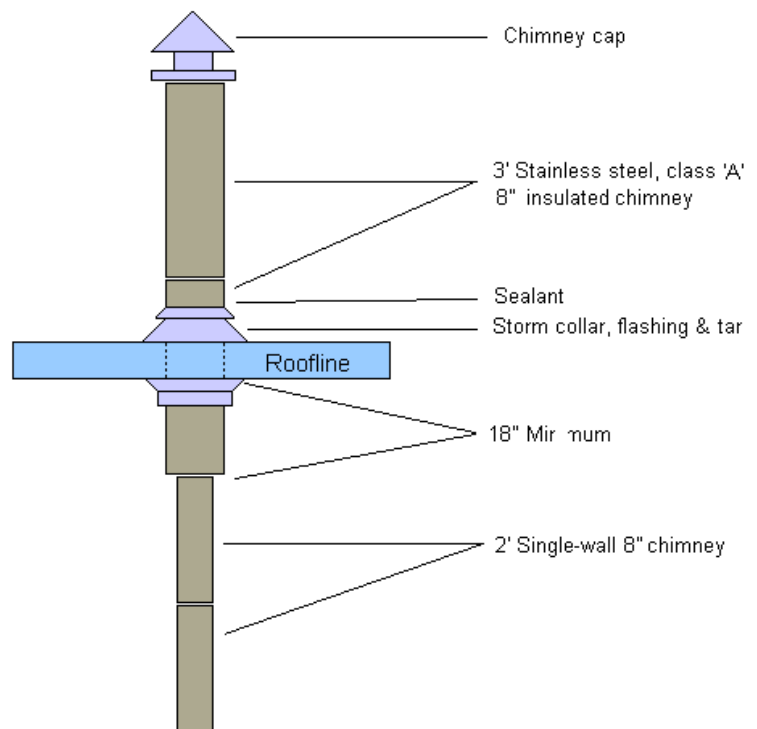


1. The chimney must be 8" diameter pipe with a minimum of 12 vertical feet.
2. It must be tall enough and sufficiently clear of wind obstacles at the top to provide constant, adequate draft to the furnace.
3. It must be free of any horizontal runs in excess of 3 feet. If any section of it must be run laterally, run that section laterally upward at the sharpest possible angle.
4. Avoid using elbows as much as possible, particularly 90° elbows. An additional 2 feet of chimney height is required for each elbow.

Most installation standards recommend that an insulated stainless steel chimney be used from a point 18 inches below the ceiling to the top at the rain cap. The purpose of the insulated chimney is to protect combustible building materials from high temperature, but it also supports the chimney draft and prevents harmful condensation within the chimney. For each gallon of oil burned, there is a gallon of water vapor generated as a product of the combustion process. This water vapor can condense inside the chimney in extremely cold weather. Some waste oils contain various ingredients that will form acids when combined with the condensation. These acids will prematurely corrode non-insulated, non-stainless steel piping and the furnace heat exchanger.

An ideal chimney is 8" chimney pipe going straight up through the roof to sufficient height to provide at least 12 feet between the furnace flue attachment and the top of the chimney. Other items of importance include:

1. Each furnace must have a dedicated chimney.
2. New chimney pipe is recommended. Tying into old stacks often causes problems because of soot build-up inside the chimney, too small of interior pipe, the connection section is often a horizontal piece, concrete chimneys are cold and difficult to heat up to create the draft and additional length is difficult to add.
3. A barometric draft damper must be installed at the bottom of the vertical chimney.
4. Single-wall flue pipe may be used for INTERIOR CHIMNEY ONLY! Stack temperatures in excess of 500° are common.
5. A metal ventilated, approved thimble must be used when passing through a combustible wall. Once through the wall, DO NOT use a single-wall component.
6. Sidewall flue installations are prohibited without written factory authorization.



7. The last stack section must extend at least 3 feet above the highest point at which it comes in contact with the roof, and at least 2 feet higher than any ridge, parapet wall or roof structure within 10 feet of the chimney.
8. Install a non-restrictive stack cap (rain cap). In extremely windy locations, a Breidert type vent cap is recommended. A screen to restrict birds from access to the chimney is recommended.
9. It may be necessary to install a draft inducer on chimneys that fall short of providing sufficient draft for whatever reason. See the following section for more information.

### ***INSTALLING THE BAROMETRIC DRAFT CONTROL***

The barometric draft control is intended to provide consistent draft, especially in tall chimneys where there may be excessive draft that could impact the flame. The best location for the barometric draft control is in the first vertical section within one to three feet of the furnace. The flapper on the barometric draft control should be installed so it is facing away from the fan on the furnace. The flapper must be vertical when closed. Use a spirit level to make sure the barometric draft control is plumb in all directions, regardless of whether the flue is horizontal, vertical or sloping. Do not attach the barometric draft control in a horizontal section of flue pipe or in a room separate from the furnace. Additional installation instructions are included with each damper.

### ***BLOCKED VENT SWITCH – SUPPLIED WITH CANADIAN FURNACES (OR OPTIONAL)***

The Blocked Vent Switch responds to hot flue gases backing up through its heat transfer tube during a blockage and shuts off the burner. The Backflow Sensor Switch is supplied with furnaces shipped to Canada (or as an optional purchase) and must be installed in accordance with these instructions and those that accompany the switch, that are abbreviated here.



1. Drill or pierce a clean hole (about 3/4" diameter) in the vent pipe near the heater outlet.
2. The heat transfer tube must have the fiber gasket installed against the mounting plate before attaching the unit to the vent pipe.
3. Insert the heat transfer tube with gasket into the 3/4" diameter hole placed in the vent pipe during step 1.
4. Secure the assembly to the vent pipe with a minimum of 4 sheet metal screws. The channel must be mounted horizontally.
5. Refer to the electrical diagram in the Addendum for wiring connections – DO NOT refer to the diagrams that accompany the switch.

This switch requires annual inspection and maintenance to remove any ash buildup on the thermal switch surface.

### ***DRAFT MEASUREMENTS & ADJUSTMENTS***

Tools Required: Dwyer Pressure Gauge, Draft Rite or Bacharach Draft Gauge

The barometric draft control must be set to maintain proper draft. Draft measurements must be re-done any time there is a change in the combustion air adjustment located on the burner housing (secondary air). Follow these instructions for measuring the draft over the fire:

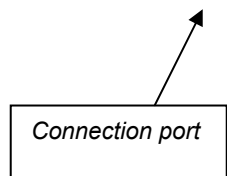
1. Check the draft while the burner is up to temperature and the cabinet fan is running. Insert the draft gauge into the 1/4" hole in the 2" view port. The measurement must indicate a draft of 0.02 to 0.04 inches WC (water column) for newly installed or newly cleaned furnaces. The furnace will not operate properly with a draft less than 0.01.

2. A draft greater than 0.05 will induce excessive heat up the chimney resulting in low heat output and abnormally high stack temperature. Make necessary adjustments to the barometric draft damper, according to the factory instruction sheet found in the box the damper comes in.

### ***INSTALLING AN OPTIONAL SEALED COMBUSTION SYSTEM***

Refer to the burner diagram on page 19 for identification and location of parts, and the photo on the next page.

1. Cut a 4" round hole through the wall near the chimney. The termination of the vent must be on the same plane as the termination of the chimney.
2. Install the provided air intake mechanism and secure it to the wall.
3. Connect the 1" port on the intake mechanism to the 4" port on the sealed combustion boot with solid vent hose (Not provided)
4. Secure the hose at both ends with hose clamps. (Not provided)
5. Set the combustion air adjustment knob in the boot to around 60.
6. Assure that the barometric draft control flapper is shut.
7. Start the furnace and allow time for the chimney to get hot.
8. Make further adjustment to the combustion air as necessary to produce a good flame. You want as little combustion air as possible to produce a clean flame. Check the draft to be sure the setting is proper.



### ***ELECTRICAL SUPPLY INSTALLATION***

Installation must be done only by a licensed electrician in accordance with the NFPA 70-2005, National Electric Code® International Electrical Code® Series. See electrical diagrams in the Addendum. The furnace requires a 20 amp, 120 volt service. It will have a maximum draw of 17 amps.

### ***MOUNTING THE WALL THERMOSTAT***

A 120 volt 'line' type thermostat will have been included with the furnace shipment. It should be mounted at eye level above the floor on an inside wall and not in the path of warm or cold air currents. Do not install on, or suspend from the furnace. Do not install on a cold outside wall unless over insulation. Do not wire relays or other accessories to the thermostat. Use two conductor 12 or 14 gauge wire to connect the thermostat back to the electrical junction box on the furnace. Since the furnace is usually mounted eight feet above the floor, a good location for the thermostat would be at eye level immediately under the furnace.

Two wires are needed to connect the wall thermostat into the electrical junction box on the furnace. There are two unconnected wires in the junction box – one from the burner socket is brown and one from the fan/limit control is yellow. Attach the wall thermostat wires to these wires. It doesn't matter which thermostat wire goes to which wire. They both carry 120 volts.



## TANK & PIPING CONSIDERATIONS

### OIL STORAGE CONSIDERATIONS

The proper storage and handling of oil is monitored by the federal EPA and most state environmental agencies, such as the Department of Natural Resources (DNR), your local Fire Marshall and/or the Regional Environmental Protection Agency. Installation of the oil storage and piping must be done in accordance with the pertinent state and local codes and the nationally accepted standard, NFPA 31 – Standard for the Installation of Oil-Burning Equipment 2006 Edition.

Some states have adopted more stringent regulations which must be identified and adhered to. Your installer is responsible for knowing these regulations and of any pertinent application and/or approval requirements for your oil storage system.



Federal and some state and local regulations restrict the burning of gasoline, paint thinners and other volatile (low-flash point) solvents, PCBs, benzenes (carburetor solvent), and fluorinated hydrocarbons (refrigerants). DO NOT add anti-freeze, oil additives, or paint as these will not burn and cause operating problems.

Many operational problems can be eliminated if proper care is taken in setting up an oil storage system. All waste oil contains substantial amounts of water and sludge, both of which settle to the bottom of a tank over a period of time. A storage system that allows sufficient settlement time will provide trouble free operation. A two-tank system is recommended allowing one tank to settle while drawing from the other.

Use a fill pipe when adding oil. This fill pipe should extend to within two inches of the bottom of the tank to minimize the disturbance of the upper oil that is supplied to the burner. At least once a year the water and sludge should be drained off the bottom of the tank. If not drained, the pump will draw the water and sludge into the filters and may cause a shutdown in operation. The tank should be located in close proximity to the furnace. Inside, outside or buried tanks must be used in accordance with state and local installation codes.

### PIPING & FITTING RECOMMENDATIONS

Air leaks in the oil line will cause sporadic operation. The pipe or tubing size is important for the best operation of the pump. The following recommendations will produce airtight connections and trouble-free operations.

1. If the storage tank is inside the building, use 1/2" i.d. (Up to 30 feet to the furnace).
2. If the tank is more than 30 feet away then 1" i.d. or bigger is required (depending on the distance).
3. Copper piping or iron piping can be used if care is taken with each joint and the line has a continuous upward incline of at least 1-inch per 1 foot to vent air to the burner. Flexible copper tubing may be suitable. When using soft copper tubing or plastic tubing *flare fittings* are required. Proper sized copper tubing with proper flare fittings has the least potential for leaks. DO NOT use numerous short lengths of pipe as each fitting is a potential source of a leak.
4. **At no time should pipe unions or compression fittings be used. Sealant (such as Loctite #565 or Permatex #2 Non-hardening Gasket Sealer) must be used on all pipe threads.**



## **VAPOR ELIMINATOR FILTER / PRESSURE RELIEF ASSEMBLY**

The vapor eliminator/pressure relief assembly located on the left side of the burner (see items #2 and 26 on page 19) serves three functions:

1. It vents any vapors that accumulate in the burner's oil circulating system back to the oil supply tank.
2. It filters the oil as it is heated and re-circulated at the burner.
3. It shunts the full volume of the pump back to the tank in the event the vapor eliminator filter should become totally plugged.



## **INSTALLATION OF VENT LINE FROM VAPOR ELIMINATOR BACK TO THE TANK**

A minimum of ¼" copper line or plastic tubing must be run from the compression fitting on the pressure relief assembly (see item #13 on page 19) back to the oil supply tank. There must be no valves or constrictions in this line. See "Burner Ignition Start-up" for adjustment of the valve controlling flow through this line.

1. Insert one end of the return line into the nut and ferrule (provided) on the pressure relief valve on the vapor eliminator.
2. Run the line along the oil supply line back to the oil storage tank through an available opening. Make sure the return line nearly touches the bottom of the tank to prevent loss of prime in the oil supply line. If no opening is available, use a "T" fitting to share the opening with the supply or fill opening.
3. While the burner is running there should be a steady rapid drip (not a stream) coming from the end of the return line. Adjust the valve accordingly. Excessive flow will take all the hot oil back to the tank, inadequate flow will cause vapor to build in the pump.

## **VAPOR ELIMINATOR FILTER**

The filter element in the vapor eliminator canister can plug up over time due to the normal collection of debris. When the filter is plugged, an amber light on the burner will come on while the burner is firing to indicate that the filter should be changed. If the filter is not changed, the pressure relief assembly will vent the over pressured oil back to the tank through the ¼" return line.

## **TANK FILTER**

INOV8 provides an in-line filter assembly to be installed in the oil supply line. This filter will need to be changed every six months or as indicated on the filter restriction indicator; the frequency depends on the type of oil. This filter is a General Filter, model 11V-R2000K Gar-Ber Fuel/Water Separator. It has a machined aluminum head. The filter dimensions are: 9" H x 4-3/4" W. It comes with a 1/8" vacuum bleed port, a 3/8" NPT inlet and outlet, has 10 micron removal, filtering area of 500 square inches, working pressure of 15 psig and a flow rate of 90 gph, and is UL listed. Replacement elements require part number R2000 Epoxy-coated Disposable Spin-On Filter.

## **BENCH TANK INSTALLATION**

Tanks are available in a variety of sizes and configurations. Our model T300 HB, a 300 gallon tank with steel supports, holds the INOV8 furnace eight feet above the floor. Installations using this bench tank are easier than those without a bench tank because of the ease in mounting the furnace versus hanging and the short distance for running the oil supply line. The bench tank comes fully supplied with all necessary fittings for a complete installation. Many states and cities have additional regulations regarding the storage of waste or other fuels that may require stricter measures. It is very important to

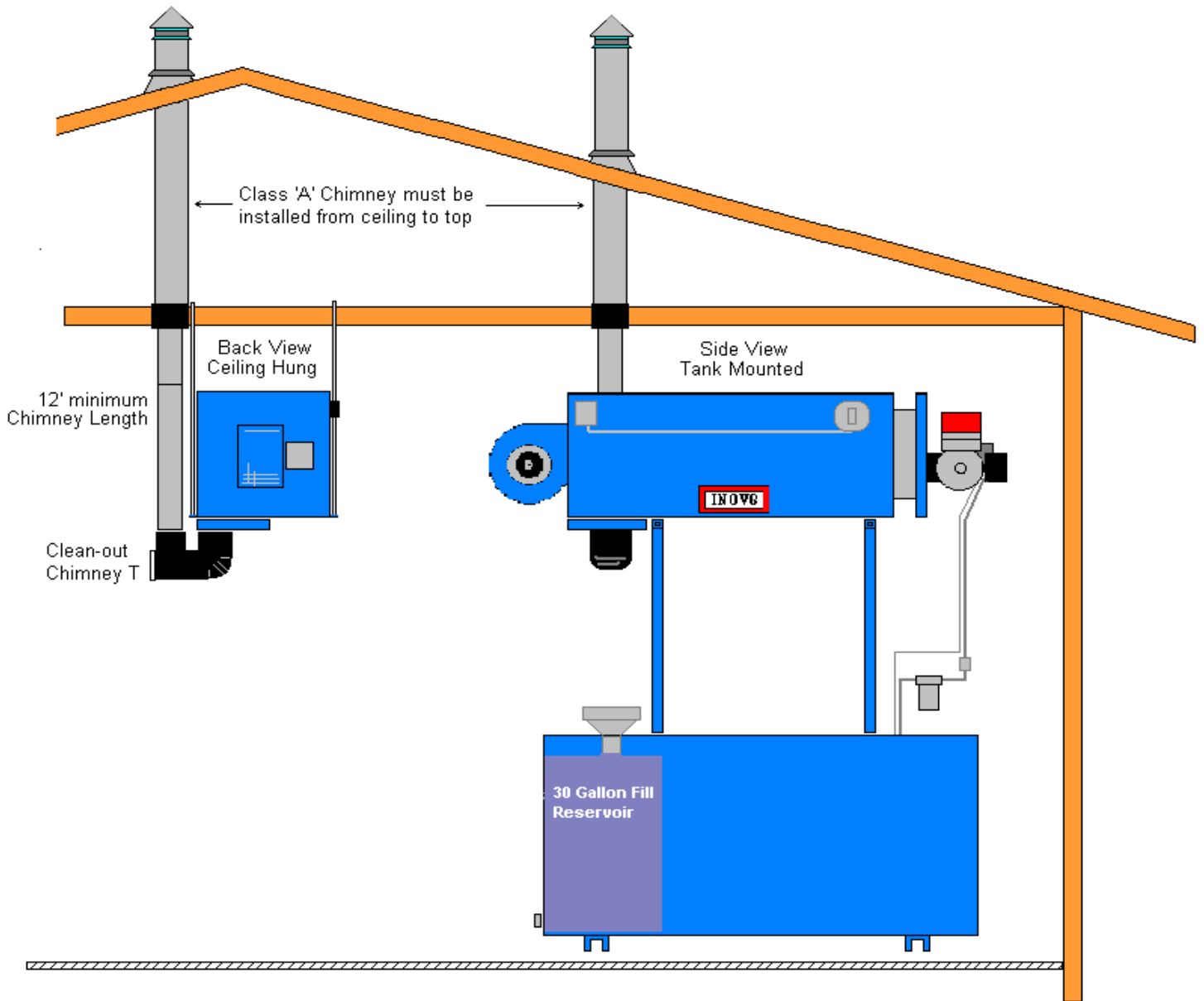
check with your local fire inspector, or the proper authority, or a qualified tank installer regarding the requirements in your area. Refer to these steps for a basic installation.

### Detailed Bench Tank Installation Instructions

1. It's generally a good idea to locate the bench tank on an outside wall for ease in venting the tank and venting the flue gases of the furnace.
2. Attach the upright support brackets to the back of the tank by sliding them into the square tube receptacles having the support brackets. Use two 3/8" bolts per support bracket to secure.
3. Secure the furnace to the top of the support brackets. Secure to the support brackets with the four bolts provided. **This is critical and if left undone may result in the furnace falling.**
4. There are four openings on top of the tank, to be used for:
  - a. The fill – left front, 2"
  - b. The gauge – back middle
  - c. Venting – left back, 3"
  - d. Supply line to burner, right back, 2"
5. DO NOT MOVE the tank once the furnace has been mounted.



**Figure 2 - Typical Installation Diagram (ceiling hung & with bench tank)**



NOTE: Carefully read **Section II - Furnace Installation** before installing the INOV8 system. The above diagram is intended for illustration purposes only and cannot be used in place of the detailed instructions.

## ***BOOST PUMP (OPTIONAL)***

INOV8 supplies two different boost pumps: 1) an electric gear pump manufactured by Suntec Industries, and 2) a Husky diaphragm pump manufactured by Graco Industries. Both do a fine job moving waste oil from a storage tank to the burner. The installations are different in that the Suntec pump requires an electrical connection to power the pump, while the Graco pump requires air pressure to drive the pump.

- Suntec pump: The pump **MUST** be mounted so the motor / pump shaft line are horizontal and the pressure relief valve in the boost pump must be set to 20 PSI. The pump will not work if mounted upside down. See the electrical hookup for the boost pump on the electrical diagram on page 45.
- Graco Diaphragm pump: an air pressure regulator and gauge assembly must be installed in the airline prior to the pump. The air regulator controls the pumping pressure and is usually set at 30 - 40 PSIG. This may be varied to accommodate your installation. Instructions accompany the pump and must be followed for the installation.

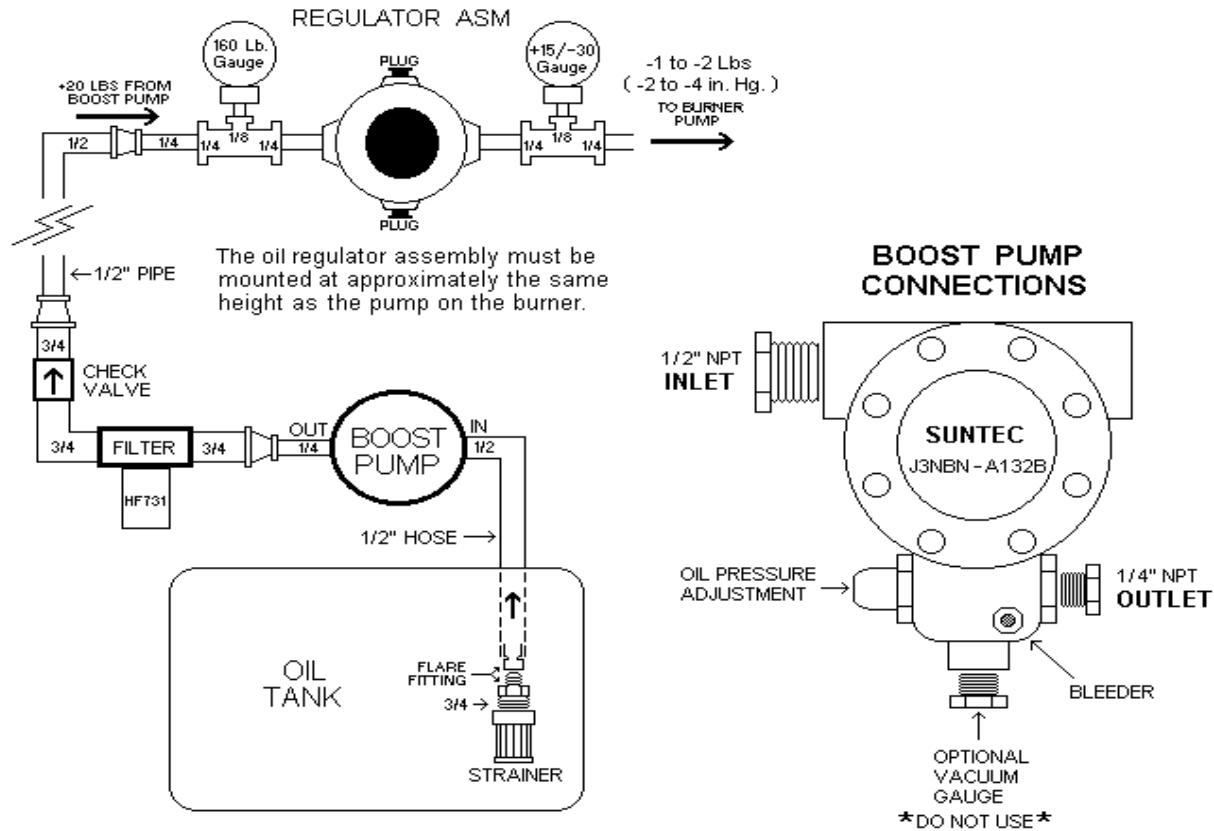
### **Follow these guidelines for either pump:**

1. Install the boost pump as close to the oil tank as local code allows, but always inside the building. Keep the suction line and suction lift as short as possible. The maximum horizontal suction run is 30 feet and the maximum suction lift is 4 feet.
2. Make sure the boost pump can be easily primed and serviced and it is protected from water and combustible fumes. A strainer (not supplied by INOV8) should be installed at the end of the oil suction line within the tank to protect the boost pump from debris.
3. Locate the filter/check valve assembly at a convenient location between the boost pump and the oil pressure regulator assembly (supplied by INOV8 with boost pumps). Connect to the outlet side of the boost pump with 1/2 inch copper tubing.
4. After the proper piping/tubing has been installed the pump may be turned on for priming. For the Suntec Pump, leave the bleeder port of the boost pump fully open until all entrapped air is purged from the suction line (at least one-gallon of oil). When a steady stream of oil is flowing, close the bleeder port and snug it tight with a 3/8" wrench. If the oil stream fluctuates and sputters, check for air leaks in the suction line.
5. The oil pressure regulator and gauge assembly must be installed near and at the same height as the burner.
6. The oil line between the tank and the boost pump must be absolutely airtight so the pump does not suck air. It is very important that pipe compound be used on all fittings and that they are tight. Pressure test the line prior to use. Follow the recommendations in the following section for installing the piping.

If multiple furnaces are installed, one boost pump will supply a maximum of three burners; however, a separate filter and regulator assembly is recommended for each furnace.

Figure 4 - Diagram Showing Installation of Suntec Boost Pump, Filter, Check valve, Regulator & Gauges

## BOOST PUMP INSTALLATION DIAGRAMS

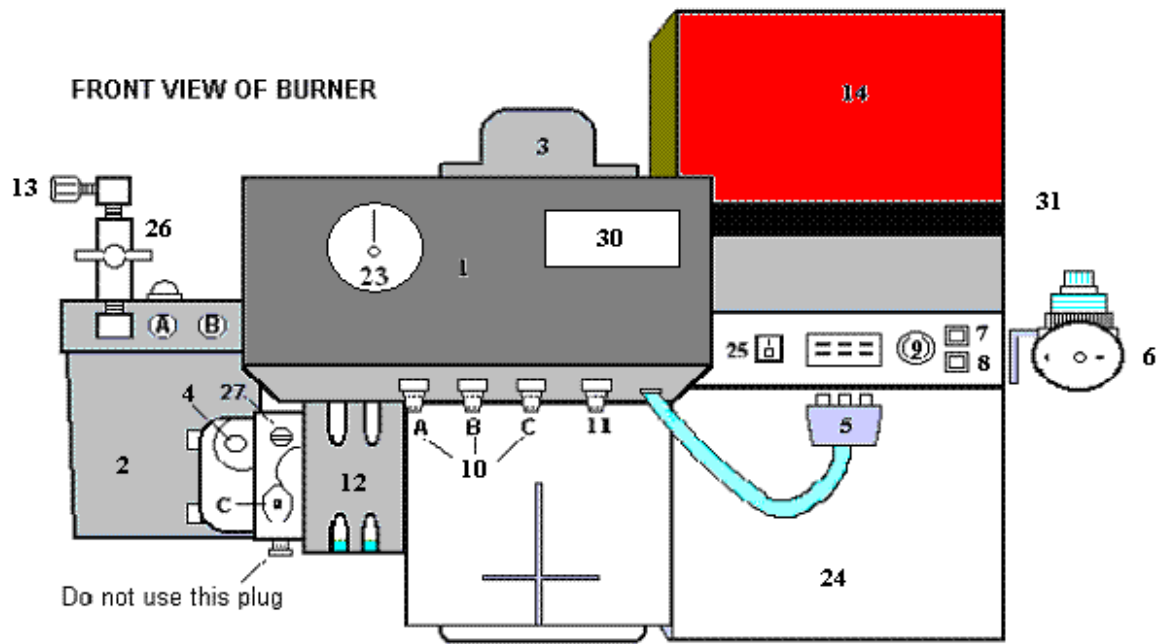


**NOTE:** The boost pump can be mounted at or below the level of the oil tank BUT MUST NOT be mounted more than four feet above.

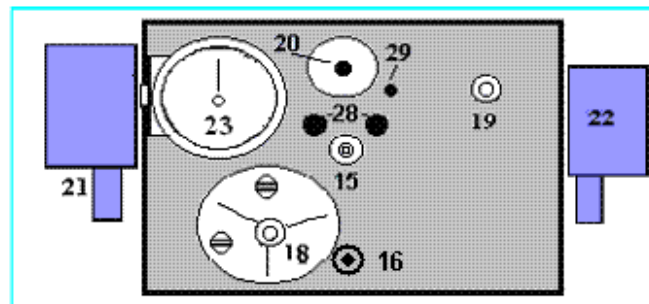
**ALSO:** The (+) (-) gauge on the outlet of the regulator shows positive (+) pressure in pounds per square inch (PSI) and negative pressure in inches of mercury (in. Hg). One PSI is equal to two inches of mercury and, with earth's air pressure being around 15 PSIG at sea level, a reading of -30 inches of mercury is equal to a complete vacuum. A setting of -4 on this gauge should be adequate. If the pressure falls below -10 there is an increased chance that you will start sucking air through the pump seal or fail to get adequate firing pressure due to normal pump wear. Positive pressure on this gauge means you are shoving oil into the burner pump. The internal regulator in this pump will regulate properly only when the pump is sucking on the inlet line – so don't run with a positive pressure on this gauge. A good rule of thumb for setting the pressure is to first set the regulating screw in the burner pump at mid range and then adjust the external regulator for a proper flame length. This allows you to make future flame length adjustments using the burner pump pressure regulator screw – which is the correct procedure.



Figure 5 – Burner Diagram



EXPANDED VIEW OF MODULE CONTROLS



**KEY**

- |   |   |
|---|---|
| 1 - Module  | 16 - Temperature controller probe             |
| 2 - Oil filter & vapor eliminator                 | 17 -  |
| 3 - Ignition transformer                          | 18 - Dirty filter pressure switch             |
| 4 - Oil supply (port) connection on pump          | 19 - Air connection                           |
| 5 - Module plug                                   | 20 - Bimba cylinder & needle                  |
| 6 - Regulator for shop air supply                 | 21 - Oil solenoid                             |
| 7 - Safety shutdown light - red                   | 22 - Air solenoid                             |
| 8 - Dirty filter light - amber                    | 23 - Oil pressure gauge (0-60)                |
| 9 - Ignition transformer test switch (red button) | 24 - Burner motor                             |
| 10 - Oil line connections                         | 25 - Heater rocker switch (black)             |
| 11 - Air connection from regulator                | 26 - Pressure relief valve                    |
| 12 - Secondary air adjustment                     | 27 - Oil pressure adjusting screw             |
| 13 - Return vent line connection                  | 28 - U-bend cleanout holes                    |
| 14 - Combustion controller                        | 29 - Air apportioning adjusting screw         |
| 15 - Heating element                              | 30 - LED temperature controller (new in 8/07) |
|   | 31 - Fuse & circuit breaker location          |

## ***FINAL INSTALLATION CHECKLIST***

DO NOT operate your furnace until it is properly installed in all respects and your installation meets all applicable national and local codes! Correct any deficiencies prior to operation.

1. Were all items identified on the "Parts List" received in good order?
2. Was this furnace installed by a qualified HVAC installer?
3. Has the Installation Manual been reviewed thoroughly?
4. Have all oil, air and vent connections been checked ?
5. Have the oil lines been installed according to specifications?
6. Have you verified compressor air quality?
7. Have you met draft specifications?
8. Have you verified oil quality?



## SECTION 3 – OPERATING THE FURNACE

### FIRST START-UP OF FURNACE

If this is the first time firing the furnace there will be no oil in the supply system and it will have to be primed. The following section tells how to do that. Once primed, the next step is to fire up the furnace.

#### ***PRIMING THE OIL SYSTEM***

1. Push the heater switch into the ON ('1') position and disconnect the 6-prong module plug. This will allow the burner pump to run without the burner trying to fire during the priming.
2. Turn up the wall thermostat to bring power to the burner. (Power to the burner will start the burner motor that drives the oil pump.)
3. If your oil delivery passes through an external oil pressure regulator assembly (typically installations with a boost pump installed), screw the knob of the regulator all the way in to set the regulator to the maximum open position.
4. Open the valve on the oil pressure relief mechanism to allow oil to flow back to the tank through the return line. If after a few minutes it seems that no oil is being drawn up to the burner, screw the oil pressure adjusting screw (item #27 on figure 5) all the way in and see if that helps.
5. When oil flow through the return line is steady, reduce it to fast drips.
6. If you screwed the knob of the external oil regulator assembly all the way in back in step 3, unscrew it until the larger gauge on the oil regulator assembly reads -2 in Hg. This gauge will be very slow to react so keep correcting the adjustment until -2 in Hg. Becomes the constant reading.
7. Turn the wall thermostat down until the burner motor stops.
8. Plug the 6-prong module plug back in. DO NOT try to force this plug back in as it will only go in one way.
9. If you screwed the oil pressure adjusting screw in back in step 4 then unscrew it back out now to where it's flush with the nut.
10. The burner is now primed and ready to be test fired, at which time the air and oil pressures will be set.

#### ***FIRING UP THE FURNACE THE FIRST TIME***



1. Set the Heater Switch ON if burning waste oil, OFF for diesel, etc.
2. Adjust the Air Regulator between 30 and 35 PSI.
3. Turn up the Wall Thermostat.
4. The following sequence of events will then take place:
5. The burner power will come on (by having turned up the Wall Thermostat).
6. The burner pump will start circulating the oil through the burner.
7. If the HEATER SWITCH is ON, the oil will begin to heat and, after about 5 minutes, will be hot enough to turn on the INTRLCK light. The INTRLCK light will blink until the oil reaches temperature.

8. If the heater switch is OFF, the INTRLCK light will come on immediately. Note: The INTRLCK light is ON when it quits blinking and comes on solid.
9. The INTRLCK light coming on starts the PRE PURGE cycle.
10. At the end of the PRE PURGE cycle which is 90 seconds, the PTFI light comes on.
11. PTFI light ON means the burner is trying to fire.
12. During the period that the PTFI light is on (and thereafter if the burner fires) the air pressure can be corrected to 30 psig if necessary and the oil pressure can be set to produce a flame that falls just short of hitting the far end of the burning chamber. Look through the viewing port. Typical oil pressure is 6 psig. Be aware that oil pressure can be adjusted ONLY when PTFI is on or the burner is actually firing. Also be aware that the air pressure typically drops a number of pounds from where you had it preset as soon as the PTFI light comes on.
13. Adjust the return line oil flow to a very rapid drip.
14. If the oil is coming through an external regulator assembly, set the external regulator so that the +/- outlet gauge on the assembly reads in the minus 2 to minus 4 range with the oil pressure adjustment on the burner pump set to produce a flame of the correct length.
15. The cabinet fan will cycle on and off as necessary while the furnace runs.
16. The burner will run continuously until the room temperature satisfies the wall thermostat.
17. After its runs 10 minutes, check the draft and CO<sub>2</sub> reading. (See Maintenance Procedure: Checking the Draft.)
18. When obtaining the CO<sub>2</sub> readings use a combustion analyzer or equivalent measuring device. With a clean heat exchanger and proper oil and air settings the CO<sub>2</sub> should be within a range of 9 to 12%, and a Bacharach smoke reading not greater than No. 1.
19. If the CO<sub>2</sub>, smoke reading and draft are OK then your installation is complete. If not, call INOV8 service and we'll take you through the possible causes.

\*\*\*\*\*DO NOT LET IT RUN WITH NO DRAFT\*\*\*\*\*

## NORMAL OPERATION OF FURNACE

Although this furnace has been inspected and fire-tested at the factory, the following procedures should be performed to assure proper on-site operation. After completion of the following steps, the operation of the INOV8 Furnace is automatic. For a more complete description of how the burner works, see Theory of Operation starting on page 41.

1. Set the wall thermostat to the desired room temperature.
2. Adjust the primary air pressure to 30 psig on the furnace by turning the knurled knob at the top of the regulator.
3. Turn the furnace power "ON". The automatic operating sequence is as follows:
  - a. The thermostat calls for heat.
  - b. The combustion motor (and the boost pump motor if used) start providing combustion air and oil circulation.
  - c. The "Safe Start" self-electronic check begins (which insures there is no residual fire).

- d. The oil heater located in the module (item #15 in figure 5) begins heating, as long as the rocker switch is in the ON or "1" position (item #25).
- e. The oil reaches firing temperature in about 5 minutes.
- f. The (draft inducer turns on, if used) and the 90-second purge of the combustion chamber starts.
- g. The ignition transformer is activated for a 10-second period during the PTFI sequence.
- h. The atomizing air solenoid is activated and the Bimba cylinder retracts the needle.
- i. The oil solenoid is activated and oil is delivered to the nozzle, fire must be detected within 10 seconds for continued operation.
- j. When flame is detected 10 seconds after running in PTFI Mode, the burner control automatically changes from the "PTFI" mode to the "RUN" mode and the ignition transformer is deactivated (ignition is self-sustaining).
- k. The burner will continue operating under control of the wall thermostat.



**Note:** If the flame is extinguished while in the "RUN" sequence the combustion control will terminate oil flow in 3 seconds and revert back to a 90 second purge. The burner will make one attempt to re-establish the flame for each time the burner has reached the "RUN" mode. If flame is not established during the first 10 second "PTFI" Pilot sequence, the Fireye combustion control will terminate oil flow in 10 seconds and revert to a full safety shutdown that requires a manual reset. Safety shutdown will be indicated by the red light on the control panel. Depress the reset button (located on the top of the controller box) and hold it down for at least one second to initiate the 90-second purge cycle. If a safety shutdown occurs again, refer to the Trouble Shooting section of this manual.

## FACTORY SETTINGS

<b>DESCRIPTION</b>	<b>LOCATION</b>	<b>SETTING</b>
Atomizing Air *	See Burner Diagram, item #6 on page 19	30 psig with burner is firing
Combustion Air	See item #12 on page 19	#2 on combustion air scale
Sealed Air Setting (optional)	Air boot by pump	#60 (may be adjusted)
Oil Pressure*	See item #27 on page 19	5 to 6 psig* (maximum)
Maximum input of fuel	Liters/hour or Gallons per hours	3.18 liters / .84 US gallons
Fan/Limit Control	Upper corner of cabinet, burner side	Fan ON = 140° Fan OFF = 80° Limit = 170°
IgnitionTransformer Switch	Button right of 6-prong module plug	Out - 10 second ignition (normal) Depressed - continuous ignition
Heater Switch	See item #25 on page 19	ON (1) for waste oil OFF (0) for diesel, fuel oil, etc.
Nozzle Tightness	End of module tube	Torque =10 in-lb. (snug)
Draft	Measure in small hole in view port	.02 - .04 inches of w.c.
Electrode configuration	Mounted on module tube	See figure 6
Excess Air		10%
CO <sub>2</sub>	Measured in chimney	8% to 12%
Smoke Patch	Measured in chimney	#0 to #1

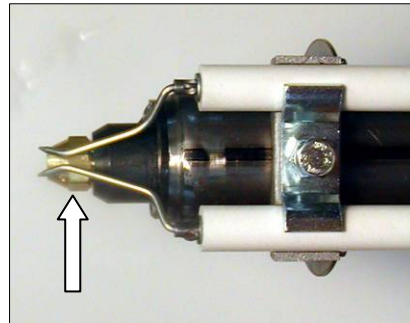
- Adjustments must be made when the burner is running. During warm-up it is normal for the oil pressure gauge to reach 30 psig.
- Adjustments to these settings are discussed in greater detail in the appropriate section of the Trouble shooting section. See the glossary for more information on these items.
- Adjustments to the temperature controller are found on page 39.

### Figure 6 - Electrode Adjustment Diagram

Insure that the spacing between the electrodes and the module components or flame retention head is never less than the 1/8" gap between the electrodes, or the ignition transformer will short out and fail.



*Maximum 1/8" between nozzle tip & end of electrodes, and no less than 1/8" between electrodes & any part of the nozzle or flame retention head*

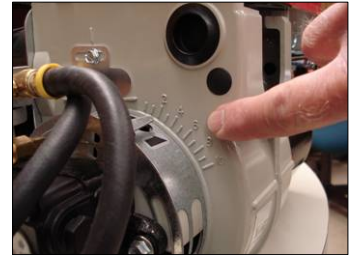


## FLAME ADJUSTMENTS

The appearance of the flame provides a good indication of proper oil and air settings. The secondary air adjustment is factory set to create the most efficient combustion; however, unique situations may require changing this setting in the field. A properly burning flame should burn just short of the target and never mushroom off the back or side walls. Damage to the furnace could result from over-firing and the warranty may be voided. The size and appearance of the flame are essentially determined by three things: the oil pressure adjustment, the atomizing air pressure adjustment and the combustion air adjustment.

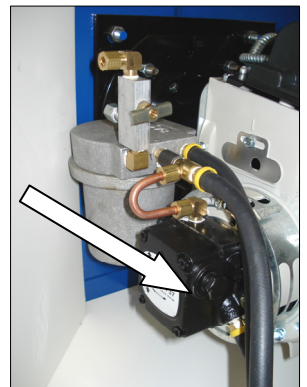
Increasing either atomizing air or combustion air will shorten the flame. Decreasing either will, of course, lengthen the flame and also cause it to take on a softer, more orange and billowy appearance. If reduced sufficiently you will start to see smoke coming out the chimney indicating poor burning.

Set the atomizing air pressure at 30 psig, the combustion air adjustment should already be set at the factory to the #2 on the scale. Then adjust the oil pressure to provide a flame that stops just short of hitting the far end of the burning chamber. If you hear a rumbling or pulsation there is usually excess oil pressure and can be eliminated by reducing the pressure until the rumble stops. Call INOV8 service for help if needed.

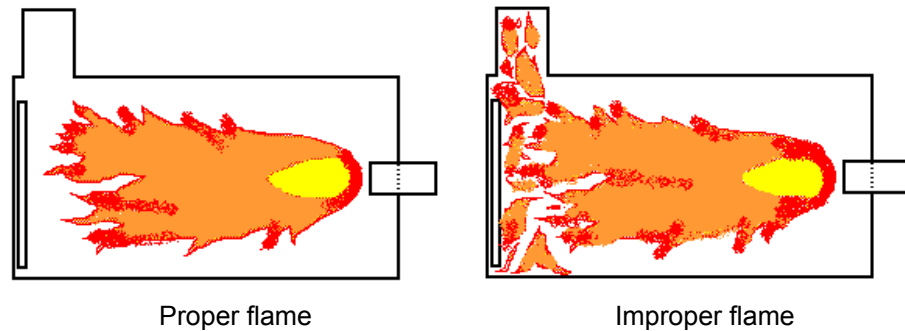


### Procedure:

1. To adjust the oil pressure, turn the adjusting screw in the center of the nut on the pump clockwise to increase pressure (located to the right of the oil inlet on the pump). See photo at right or item #27 on the burner diagram on page 19. DO NOT loosen nut.
2. To reduce the length of the flame, turn the adjusting screw in the counterclockwise direction.
3. Smoke coming from the chimney always indicates there is too much fuel for the available air. Continue adjusting the combustion air or oil pressure until there is no smoke.
4. Combustion tests done by Bacharach equipment should result in smoke spot tests of either zero or #1 on the Bacharach scale. If the test yields higher presence of smoke, then adjustment should be made.



*Figure 7 – Proper & Improper Flame appearances*



## **MAINTENANCE**

### **GENERAL INFORMATION**

The INOV8 furnace was designed to eliminate much of the time associated with servicing waste oil burning equipment. The fact remains that the oils we are burning were not originally intended to be used for fuel and involve additional attention over conventional heating equipment. The additives in crankcase oil combined with contaminants generated by the normal operation of the engine, amount to about 1-½ quarts of solids for every 55 gallons (US gallon). To obtain maximum benefit from your used oil-burning furnace, routine maintenance must be performed. This manual has detailed instructions for routine servicing, which if not performed will result in damage to your furnace and voiding of the warranty.

A powdery ash will slowly build up on the inside walls of the combustion chamber and heat exchanger tubes as the oil is burned and, if not removed will cause the furnace to put less heat into the building and more heat up the chimney. One-eighth of an inch of ash has the insulating capacity of one inch of fiberglass! Even less desirable is the deterioration of the burner and frequent furnace outages that result from loss of draft due to this ash build-up. We recommend that you perform your first maintenance at 500 hours of operation or the end of the season whichever occurs first. Inspect your furnace after the first month of operation to determine how much ash is accumulating, and adjust your service schedule accordingly. If you are using transmission fluid, fuel oil, diesel or other clean fuel, your cleaning requirements will be much less often.

Many operational problems can be eliminated if proper care is taken in setting up an oil storage system. All waste oil contains substantial amounts of water and sludge, both of which settle to the bottom of a tank over a period of time. A storage system that allows sufficient settlement time will provide trouble free operation. A complete description of a factory recommended oil storage system can be found starting on page 12.

## **CHANGING FILTERS**

The amber indicator light, located on the front of the burner, will light when the oil flow through the filter in the vapor eliminator is restricted. To prevent operating problems INOV8 recommends changing the filter every time the furnace is vacuumed or at least every 500 hours of usage. Clean fuels don't require that changing frequency. Reduced oil pressure at the burner is an indication that the tank filter is getting dirty and needs to be replaced. **Always check the flame length after changing the tank filter.** Reset oil pressure if necessary.

## **VACUUMING THE COMBUSTION CHAMBER & HEAT EXCHANGER**

Make sure the furnace has been off long enough to cool to room temperature before trying to vacuum or the equipment may be damaged. This is a good time to take a look at the ash, as it can tell you how well the furnace is operating. With waste oil it should be a light tan or gray powder. If it is dark or hard to vacuum then the furnace is being over fired or running with insufficient draft.

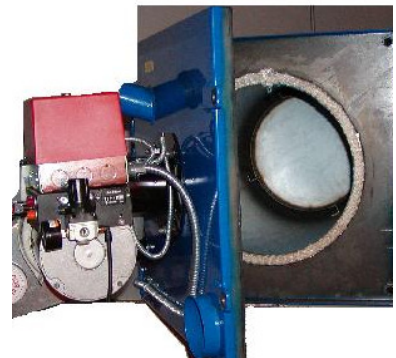
### **Procedure for cleaning the combustion chamber:**

1. Turn the wall thermostat "DOWN". Wait for the furnace to cool to room temperature.
2. Access the combustion chamber by removing the four nuts that hold the door closed. There is no need to remove the burner but the 4" tubing connected to the door must be removed.
3. Swing the door open.
4. Vacuum the combustion chamber.
5. Inspect the target at the far end of the burning chamber to make sure it's in place and not broken.
6. Use a small brush to loosen any ash on the perimeter of the target. Vacuum as necessary.
7. Close the door and reinstall the nuts.



### **Procedure for cleaning the chimney connector:**

While the furnace is cool, remove any ash accumulation in the chimney. You will need to remove the damper to access the settling area of the chimney 'T'.



## ***ANNUAL MAINTENANCE***

Under average conditions, it is recommended that the following routine be performed at least once a year along with a spot inspection prior to the heating season. In excessively dirty environments, service should be performed more often. At the end of the heating season do these things:

1. Run the burner on fuel oil or diesel fuel before finally shutting it off. That will help keep the inside of the burner clean.
2. Keep the fuel valve nearest to the supply tank shut off when the burner is shut off for extended periods.
3. Vacuum the combustion chamber and heat exchanger.
4. Remove water from the bottom of the oil tank.
5. Check the chimney.
6. Inspect and clean Blocked Vent Switch (only on Canadian units but optional on US units) – see instructions that accompanied the switch.

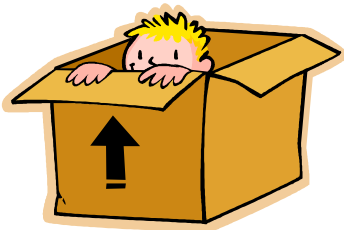
## ***CHIMNEY INSPECTION***

At the end of each heating season check the entire chimney, inside and outside. Unfasten the clean out cap at the bottom of the chimney Tee and empty the residue. At the same time check the chimney and the flue to see if there is enough residue build-up to require cleaning the chimney. The summer humidity mixes with the ash producing acids that will corrode the chimney pipe. Replace broken or rusted sections. Make sure any guy wires and wall supports are secure, and re-caulk roof flashing. Check the chimney top to insure it has not been damaged in a storm. Insure that the barometric draft control operates freely.

## ***SUMMER BURNER REFURBISHING PROGRAM***

During the early summer months, INOV8 provides a burner-reconditioning program. This involves returning the burner to the factory. It will be completely disassembled, thoroughly cleaned, reassembled, inspected, tested and all settings returned to factory specs. Defective, worn and unreliable components will be replaced. If desired, optional equipment updates will be installed. Upon request samples of waste oil will be tested and measured for flash point and a report provided for your files.

When sending the burner in for this service be sure to notate your company name, contact information, phone number and any performance details that would be helpful to the technician. These burners are returned in order of their receipt. The best time to send a burner in is during the months of May, June and July during INOV8's slower time. The work is discounted 20% to encourage participation ONLY during these three months. Burners sent in for service after July risk receiving them back in time for the heating season.



When packaging the burner for shipping remember to plug the oil lines as the oil will leak out damaging the packaging material and shipping damage can occur. Also protect the Fireeye control from damage. Replacing the Fireeye will be hundreds of dollars. Do not use newspapers as packing materials – preferably use several layers of bubble wrap. INOV8 sells burner boxes with all necessary packing materials already included for \$10 per box. It can be shipped to you.

## SECTION 4 - TROUBLESHOOTING

### GENERAL FAILURE CATEGORIES & POTENTIAL CAUSES

#### 1. The burner motor isn't running.

- The controller has shut the burner down on alarm
- The wall thermostat is not "ON" calling for heat
- The 120v power to the furnace is lost
- The burner motor has failed
- The burner controller has failed.

#### 2. The burner motor runs & runs but nothing else happens.

- The heating element isn't heating
- The oil temperature controller set points have been programmed incorrectly or the controller is not working correctly.

#### 3. The burner motor runs for a while and then the burner shuts off on alarm. It did not try to fire. (the "PTFI" light never came on.)

- The UV sensor thinks it is seeing a constant flame

#### 4. The unit tried to fire (PTFI light came on) but no flame was established.

*Section A* – If there is no oil spray and no pressure on the oil gauge during PTFI, then:

- You're out of oil or the oil is not being drawn up to the pump
- The oil solenoid isn't opening

*Section B* – If there is no oil spray but good pressure on the oil gauge during PTFI, then:

- The Bimba cylinder didn't pull back
- The final delivery tube is coked shut
- The nozzle is blocked
- There is no atomizing air getting to the nozzle
- The oil gauge is misleading

*Section C* – If there is oil spray and oil gauge pressure looks OK during PTFI, then:

- The oil has not been heated enough to burn
- There is no ignition arc
- The oil is bad
- There is too much secondary (combustion) air
- There is too much primary (atomizing) air
- The flame retention head is misplaced, missing or dirty
- The heater switch is "OFF"

#### 5. The unit fires but runs badly. May lose the flame and have to restart.

- Air is getting in the oil stream and is being vented out the nozzle
- The oil pressure is too high causing over-firing
- The oil is not hot enough to burn well
- The oil is bad and may have water in it
- The draft is inadequate or inconsistent
- Particles are getting to the nozzle and blocking the spinner

#### 6. The unit fires fine but shuts off on alarm about 10 seconds later.

- The UV sensor is not seeing the flame





7. The unit fires but runs badly at first, after a few minutes it has straightened out and will run fine until the next time it is fired.
  - a. The OUT2 set point (Interlock) of the oil temperature controller has been programmed too low.
  - b. Draft is insufficient until the chimney warms up
  
8. The unit fires and runs well for a short time. Then abruptly shuts off, re-fires, runs, shuts off, etc.
  - a. The oil temperature is falling below the OUT2 (Interlock) set point in the oil temperature controller. The OUT1 and OUT2 set points may have been programmed too close together – they require at least 20 degrees separation.
  
9. The unit fires and (probably) continues burning but it will burn OK for a few minutes and then poorly for a few minutes in a repeating cycle.
  - a. The OUT1 set point in the oil temperature controller has either been set too low (cool oil burns poorly) or too high (oil at too high temperature will boil)
  
10. The unit fires (possibly only after multiple tries), may or may not run smoothly for a while, shuts off (retries) periodically through the day and is most likely down on alarm when you come in the following morning.
  - a. Air is getting in the oil stream and being vented out the nozzle
  - b. The oil pressure is too high
  - c. The oil is not hot enough to burn well
  - d. The oil is bad (perhaps has water in it)
  - e. The draft is inadequate or inconsistent
  - f. Particles are getting to the nozzle and blocking the spinner.

### ***USING LIGHTS ON THE CONTROLLER TO DIAGNOSE SYMPTOMS***

There are 5 lights on top of the controller. They are (and their function is):

**“OPR CTRL”** – This light will come on when power is applied to the burner i.e. when the wall thermostat is turned up. It means there’s 120v on controller terminal 7.

**“INTRLCK”** – This light comes on (quits blinking) when the oil thermostat has reached the OUT2 set point in the oil temperature controller. OUT2 active sends 120V to Fireye controller terminal 6.

**“PTFI”** – ‘Pilot Trial For Ignition’ – comes on for 10 seconds when the burner fires. When it is on, the ignition transformer is on and there is 120v on controller terminal 3 – which provides power to the air and oil solenoid valves.

**“FLAME”** – Comes on when the U.V. sensor sees a flame (or the ignition arc). It goes off 3 seconds after the U.V. sensor stops seeing a flame.

**“ALARM”** – Comes on when the controller has shut the burner down abnormally. It signals the same thing as the red alarm light by the 6-prong plug. When on, there is 120v on controller terminal “A”.

Their value comes into play primarily for failures that occur after the burner has been running for a while and then shuts off. This, along with a failure to fire at all, comprises the bulk of the problems reported. Other than a loss of power, there are really only three things that cause the burner to shut off. The controller initiates the first two. The third is due to some condition that the controller doesn’t become aware of until three seconds after the flame has gone out. They are:

1. The U.V. sensor can't see a flame, even though there might be one.
2. The oil temperature has fallen below the OUT2 (Interlock) set point in the oil temperature controller.
3. Anything else – including a blocked nozzle, loss of air pressure, loss of oil, and the flow from the tank turned from oil to water, etc.

**Of the five lights on the controller, we need only the flame light and the OUT2 light on the oil temperature controller to tell us if the failure is due to item 1, 2 or 3 above.** Both lights will be on when the burner is firing. What they do when the flame goes out will aim us at item 1, 2 or 3. Observe the lights when the flame goes out:

- If the flame light stays on for 3 seconds after the flame goes out, the problem is item 3. Call INOV8 for help identifying the failure.
- If flame light goes off at the same time the flame goes out, then the problem is either item 1 or 2. To tell which, you must continue watching the lights until the 5 second Fireye initiation and the 5 second oil temperature controller initiation sequences complete. At that time, see if the OUT2 light is ON.
  - If it is ON, the burner shut off because the UV sensor couldn't see the flame.
  - If it is OFF, the burner shut off because the oil temperature fell below the OUT2 set point in the oil temperature controller.

## SECTION 5 – DETAILED SERVICING PROCEDURES

In the course of servicing your burner, you may be required to perform or be knowledgeable of the following procedures. Refer to the glossary.

### **REMOVING THE MODULE FROM THE BURNER**

1. Shut the burner off.
2. Pull the 6-prong plug.
3. Remove screws from front lip of transformer. Tip the ignition transformer back on its hinge.
4. Move the UV sensor out of the way. Take note of its position as it must be returned to exactly the same position.
5. Grasp the module cover box, lift and pull straight back to carefully withdraw the module from the burner. The hoses are long enough to allow removal without having to disconnect them.

### **REPLACING THE MODULE INTO THE BURNER**

1. Shut the burner off.
2. Slide the module back into the burner, being careful not to hit the electrodes. Be aware that the head of the electrode bolt must slide into a bracket that is attached to the top of the inside of the air tube that the module fits into. This mating of the bolt and bracket positions the nozzle in the center of the flame retention head. The head of the bolt can be seen through an inspection hole on top of the air tube.
3. Return the UV sensor to its location securing it in place. It must be aimed at the nozzle.
4. Lower the ignition transformer. Make sure the transformer springs are resting on the electrode rods. Reinstall screws.
5. Plug in the 6-prong plug.

### **FLUSHING THE FINAL DELIVERY**

1. Perform steps 1 through 4 in “Removing the Module from the Burner”.
2. Disconnect the leftmost (final delivery) oil line from the module.
3. Angle it downward into a bucket, turn on the burner motor and squirt oil into a bucket for about 10 seconds to flush it out. Then reconnect it.
4. Turn the air regulator up to 90 PSI.
5. Pull the module out of the burner (see above instructions).
6. Remove the nozzle (which includes the spinner). Take care with the spinner as it will be impossible to run your furnace if it gets lost.
7. Plug in the 6-prong plug.
8. Aim the module downward into a bucket and run the burner through PTFI. When PTFI comes on, the needle should pull back and oil should squirt out the end of the module where the nozzle was. If no oil squirts out, it could be because the needle stuck and failed to pull back. Use the plastic handle of a screwdriver to

push in on the tip of the needle that protrudes from the nozzle. Then let it back out gently and try the procedure again. You should get a stream of oil for 10 seconds. Repeat the procedure three or four times (popping the needle loose each time, if necessary) to insure complete flushing.

9. Perform the Maintenance Procedure: Cleaning the Nozzle.
10. With the spinner replaced and the nozzle back on, put the module back into the burner, turn the air pressure back down to where it was originally and see if the burner fires.
11. **Note:** This procedure will fail if you have a long, small diameter airline running from your compressor to the burner. The pressure will drop so much in the airline that there's not enough left to pull the Bimba back.

## **CHECKING THE OIL SPRAY**

Unplug the 6-prong plug, pull the module out of the burner, plug the 6-prong plug back in, hold the module horizontal and run the burner through PTFI. When PTFI comes on, you should see an elongated gray cloud of atomized oil come out the nozzle. It should extend seven feet or more. A cloud less than seven feet indicates a partial nozzle blockage. An erratic cloud (fluctuating length) means the same thing. To know exactly what it should look like, do this check at a time when the burner is running well.

**Note:** Don't worry about the fuel cloud igniting – You've got the electrodes in your hand and the ignition transformer's still on the burner. However, it will make a mess on your floor so you will want to cover the floor with a tarp.



NOTE

## **CHECKING THE OIL SYSTEM**

**Note:** It's not uncommon for the pump seal to wear a groove in the pump shaft. When badly grooved, oil may leak out and get thrown around inside the burner housing by the fan. It's also possible that the groove is letting air get sucked into the oil system which may cause rough burning or, if the air leak is large, prevent the pump from drawing oil from the tank. Keep this in mind as you go through the following checks. If you find the bottom of the ignition transformer all covered with oil it's a sure sign that the shaft is grooved; however that does not necessarily mean that it's letting in air and lack of oil on the transformer doesn't necessarily mean that there is no groove. Refer to maintenance procedure: "Rebuilding the pump" if you need to replace the shaft and seal before going on.



NOTE

1. Remove the final delivery hose (leftmost hose) from the module and aim it into a bucket. Turn the burner on and inspect the flow from the hose. Let it squirt for at least 30 seconds. It should be a steady stream strong enough to reach across the bucket. It should not be spurting at all, as that would indicate air in the oil. To check for air that may not be sufficient to cause spurting, submerge the hose in the oil and look for small bubbles to accumulate on the surface. There should be none. Also notice the color of the oil – it should be black. A gray or milky appearance indicates water in the oil. If you're not sure, but you suspect bad oil could be causing problems with the burner, get a bucket of known good oil and suck out of it. Be sure the 'bad' oil has been replaced by the 'good' before concluding anything. i.e. Open the vent line and run a stream of oil back to the tank for a few minutes. This will clear all but the final delivery hose and passage. Four or five firing attempts should then clear that.
2. If you got little or no flow from the hose, you should suspect the tank filter right away. Screw on a fresh one and see if that fixes it. If not, it could be the vapor eliminator filter. There are specific indicators to tell you when that filter is plugged (Dirty filter light on @ PTFI or a full and uncontrollable full flow through the return line) but you could try a fresh one anyway to be on the safe side.

3. Assuming you've ruled out the filters, there is possibly an air leak or blockage in the oil supply line. Install a test hose to the pump inlet and suck from a bucket of oil on the floor. Then see if you can get good oil flow. If you do, there is an air leak or obstruction in the line coming from the oil tank. (Or you're out of oil.)
4. If you still get no flow, squirt some oil into the oil inlet in the pump and try again – the pump may have just needed priming. Try screwing the oil pressure adjusting screw all the way in if priming didn't help.
5. If you still get no flow, look through the secondary air holes and make sure the pump coupling looks OK. Remove the pump to inspect it if you're not sure that the motor is actually turning the pump.
6. Assuming the pump was turning, remove the copper "U" bend from the top of the pump. Then remove the pump hose from the right-most module oil fitting and aim it into a can. Then, with your finger blocking the brass fitting on top of the pump that the "U" bend was on, start the motor and see if you get any flow from the pump hose. If you still get no flow, either there is an air leak right at the pump (fittings, shaft seal or cork gasket) or the pump is misbehaving. (See Maintenance Procedure: "Rebuilding the pump"). Call INOV8 service for assistance.

### ***CHECKING THE IGNITION ARC***



**Danger:** The ignition transformer produces a very high voltage. You are not in danger of electrocution from it because it cannot supply a lethal current, however it can give you a good enough shock to knock you off a ladder. Be constantly aware of this.

1. Disconnect the 6-prong plug, cover the UV sensor, swing the burner out from the burning chamber, start the burner motor, depress the ignition test switch and inspect the arc (if any). You should see a rough horseshoe shaped spark fanning out beyond the nozzle. If the arcing does not match this description insure the electrodes are in position and properly shaped. Look for arcing between the electrodes and flame retention head, nozzle or module tube. Even if the arc looks good, make sure the electrode wires aren't bent down so far that they could be in contact with the fuel spray. That can prevent firing.
2. If you see no arc, flip up the ignition transformer, take a plastic handled screwdriver and, with the burner motor running and the ignition test switch on, slide the screwdriver shank from one transformer spring toward the other and see if you can draw an arc. It should occur back when the screwdriver blade is approximately 1/4" from the second spring and be able to be drawn back to at least 3/4" in length. If all you get is a tiny little blue spark, the transformer is bad. If you get no arc, either the transformer is bad or no voltage is getting to it. If you get a good arc, make sure the transformer springs are not slipping off the electrode rods when the transformer is put back down. Be aware that a plugged up (or absent) flame retention head will affect the spark dramatically. If you see nothing obvious, call INOV8 service.

### ***CHECKING THE ATOMIZING AIR SYSTEM***

When the Fireye controller attempts to fire the burner it does so by putting 120v on the orange wire coming to the module. (It also turns on the ignition transformer.) The 120v on the orange wire energizes the air solenoid coil causing it to open and let air flow into the module block. This air splits up and flows two places:

1. Through the small plastic line to the Bimba cylinder causing the cylinder to actuate, pulling the needle out of the nozzle.

2. Past the Air Apportioning Adjustment and then on to (and out) the nozzle where it atomizes the oil. A quick check to see if you're getting sufficient atomizing air is to place a small rod (nail, Allen wrench, coat hanger, etc.) into the threaded hole in the end of the Bimba cylinder until it bottoms out. Then see if you feel it kick back about ½" when PTFI comes on. It should.

Here are some things that could be wrong in the air supply system:

- Supply from building air compressor is absent. See if you have any pressure on the air regulator gauge.
- The air regulator pressure is not adjusted to 30 lbs @ PTFI. Check the air regulator gauge when the PTFI light is on.
- The 4-amp orange burner fuse or the 10-amp fuse in the controller (or both) is blown. If either is blown, you will not have 120v on the orange wire to open the air solenoid when the PTFI light comes on. Remove the fuses and check them with a meter. **Note:** The Trouble-Shooting section in this manual gives help on how to check for voltage and pin down a bad fuse if you don't have a meter.
- The air solenoid is defective. To check it, remove the plastic line from the Bimba cylinder elbow. (Push the ring in and pull the line out) Try to fire the burner and see if any air comes out the plastic line at PTFI time. If not, the solenoid isn't opening. Perform the Maintenance Procedure: Bypassing the Air Solenoid to see if it's bad.



NOTE

### ***CHECKING THE DRAFT & THINGS THAT CAN CAUSE IT TO BE WRONG***

Draft can be checked with a draft gauge, of course, but another way that seems to work well enough is to hold a cigarette lighter flame by the ¼" hole in the 2" flame viewing port to see if the flame gets sucked into the hole. If it does, your draft is probably OK. If there is too much air blowing around the hole to get a good check, hold a tube like a ¼" brake line to the hole and place the flame at the other end of the tube. If the flame is not sucked into the hole, you have a draft problem. The burner must be firing and time should be given for the chimney to heat up before making this check. Should you have a draft gauge, use it to measure the draft at the same place: .02" wc is bare minimum. A reading of around .04" wc is typical. If your reading is much higher than this, too much heat is being lost up the chimney. Reduce it to .04" wc by opening the barometric damper flap. Here are things that typically cause insufficient draft:

- The heat exchanger tubes are dirty.
- The barometric damper flap is open too far.
- The burner is over firing.
- The combustion air adjustment is open too far.
- The chimney is ineffective – Too short, too many elbows, too much horizontal.
- There is an exhaust fan running somewhere in your building. These things don't tend to require explanation of how to detect and correct. Bear in mind that draft improves when the chimney is hot, so, if you have problems getting the burner to start but then find it running well later, the problem could be draft. If you can't correct your poor draft, contact INOV8. You may require a draft inducer.

### ***BY-PASSING THE BIMBA CYLINDER***

**CRITICAL WARNING: DO NOT bypass the Bimba cylinder if the oil solenoid is not functioning properly.**

A Bimba cylinder that is leaking air internally causes the burner to run roughly or go out. This is due to the air getting into the oil stream and venting out the nozzle. When an air bubble vents out the nozzle, the flame extinguishes – maybe very briefly. Air venting out the nozzle is always indicated by a bouncing of the oil gauge needle and there are things other than the Bimba cylinder that can cause it but, if you've been directed here from the Trouble-Shooting section because symptoms pointed at the Bimba, here's how to bypass it:

1. Remove the little 1/8" plastic airline completely by disconnecting both ends from the quick-disconnects. (Push in the ring, pull out the line.) Put the plastic line somewhere that you won't lose it.
2. We need to keep the air from coming out the quick-disconnect that's screwed into the block. You can both remove it and replace it with a 1/16" pipe plug or you can stick something like an 8-penny (8D) nail into it. Don't use anything that's likely to damage it.
3. Remove the 90° elbow from the Bimba cylinder. It will be damaged if not removed before attempting to remove the Bimba cylinder.
4. Remove the Bimba cylinder. (The needle comes out with it and don't lose the "O" ring that seals the Bimba to the module block. (Place a rag against the module block beneath the cylinder to catch any oil that runs out the vacated hole so it doesn't get down into the heating element.)
5. Unscrew the needle from the Bimba cylinder and put it with the plastic line.
6. Screw the Bimba cylinder back into the block just to plug the hole. Make sure the 'O' ring's there.
7. If the trouble that brought you here has been corrected by this bypassing procedure, you can run with it bypassed until you receive a new cylinder, but check to make sure no oil is squirting out the nozzle before PTFI. If oil is squirting out, the oil solenoid is not functioning and you cannot run with the Bimba bypassed.

### ***REPLACING THE VAPOR ELIMINATOR FILTER***

Place a small bucket under the vapor eliminator canister to catch any oil that may spill as you are doing this procedure.

1. Loosen the nut on top of the vapor eliminator canister.
2. Carefully lower the canister **as it will be full of oil**. Pour the oil into the bucket (this can then be returned to the oil storage tank).
3. Pull the vapor eliminator filter out of the canister and discard. It is rayon and will be soft.
4. Clean the canister before inserting the new filter. Canister debris can get shifted to the bolt area during removal of the old filter and that debris can then run up by the bolt, through the center of the new filter and on to the nozzle.
5. Replace the filter being sure to use care. Don't shove the new filter down into the canister so far that the top of the filter doesn't press against the vapor eliminator head when the canister is screwed back on. Otherwise the oil just flows over the top of the filter.
6. Return the o-ring and secure with the rubber-backed washer. Replace both items every other filter change.
7. Don't be too rough with the new filter. The fibers can be rubbed loose and loose fibers in the passage running up through the middle of the filter can pass to the nozzle.

## ***CLEANING THE NOZZLE***

Your furnace uses what we call a 3.1 nozzle. The nozzle is made up of two parts plus an aluminum washer that we add to it. There is the nozzle cap (the brass part that unscrews) and the 'spinner' which you will see sitting in a small tube after removing the 'cap'. The aluminum washer seals the spinner into the tube that it sits in. We refer to it as the 'spinner washer'. The oil passes through the small passage in the center of the spinner and that's where nozzle blockages occur. For cleaning:

1. Pull the module out of the burner to get better access to the nozzle. Refer to the section on Removing the Module from the Burner on page 31.
2. Unscrew the nozzle cap with a 5/8" open-end wrench. Be careful when taking it off as the spinner could get knocked out of its tube and fall on the floor. The furnace will not operate without the spinner properly in place.
3. Remove the spinner. If stuck, grip it with a rag and pliers and give it a twist. Remember the spinner sits in the END of the tube. Don't try twisting the whole tube and be aware that the spinner doesn't actually spin. It distributes the air when it passes through mixing it with the oil.
4. The passage through the spinner is of two diameters and is best cleaned by using two drill bits: a #50 to clean the larger entryway passage and a #74 to clean the exit hole. You will turn the drill bits by hand and will likely need a pin vise to hold the #74 bit. If you don't have a #50 bit, a 1/16" bit will do.
5. After the drill bits, squirt some carburetor cleaner through it and put it back together. Make sure the aluminum washer is still on the spinner and don't torque the cap back on too tight. We say 10 inch-pounds which means "snug". (You're tightening it down onto the spinner washer; you're not seating the brass cap into the threaded steel module tip.) If the nozzle plugs up again shortly after this cleaning, perform the Maintenance Procedure: Flushing the Final Delivery System.

## ***REBUILDING THE PUMP***

A pump "rebuild" may be necessary for either of two conditions:

- The pump shaft has a groove worn into it by the seal.
- The pump internal pressure regulator is sticking.

As long as you have the pump apart to correct one condition, you should also check the other. A pump "rebuild kit" is available from INOV8. They contain the shaft, seal and cork cover gasket.

Replacing the pump shaft and seal:

1. Remove the pump from the burner in the following way:
2. Disconnect the oil inlet line from the pump and plug the inlet hole.
3. Disconnect the pump hose from the module fitting and plug it.
4. Remove the copper "U" bend from the top of the pump.
5. Remove the 2 bolts that hold the pump in. (3/8" socket)
6. Slide the pump out of the burner housing.
7. **Note:** the pump coupling may or may not come out with the pump. If it didn't reach in and pull it out; you'll need it later. Insure the shaft is properly aligned with the coupling when reassembling.
8. Drain the oil out of the pump as best you can.
9. Remove the 4 cover bolts, cover and screen.



10. Remove the 3 gear set bolts and the gear set pieces noting the position of the plates. Don't lose the moon-shaped piece.
11. Remove the shaft (with gear).
12. Remove the seal-retaining clip. (C-clip)
13. Stick something like a large Phillips screwdriver into the seal and pry it out. Don't stick the tool in any further than necessary to catch the seal, as it will nick the area where the seal seats if you do.
14. Clean all the pump parts with solvent. (Carb cleaner will melt the paint.)
15. Inspect the pump base to see if the shaft gear has worn into it significantly. If you can catch the groove readily with your fingernail, the pump is near the end of its life. It's hard to say how much wear is too much; if you're drawing oil from far away or up quite a few feet, or if you're burning something thin like diesel fuel then a small amount of wear might be too much. Call if you want to run your situation by us.
16. Lubricate the new seal and press it in.
17. Replace the fiber washer (if there was one) and retaining clip.
18. Oil the new shaft and place it in the pump.
19. Oil the 3 pieces of the gear set, put them back together, and bolt them back on the pump base.

**Note:** You can't put these together wrong – if you try, the bolt holes won't line up. Tighten the bolts a little at a time, all the while turning the shaft with the pump coupling. The shaft should turn freely when the bolts are tight. If it binds (or “clicks”), loosen the bolts, wiggle the gear set and try again.

- Using the new cork gasket, reinstall the strainer and cover.
- Replace the pump on the burner.

### ***CLEANING THE PUMP INTERNAL PRESSURE REGULATOR***

1. Perform the 1<sup>st</sup> 2 steps of “Replacing the pump shaft and seal” above.
2. Remove the 11/16-inch “nut” from the back of the pump.
3. Remove the 11/16-inch “nut” from the front of the pump. (The pressure adjusting screw will come out with the nut.)
4. Remove the spring centering device – noting its orientation.
5. Remove the spring.
6. Remove the piston. It can be removed out the front or back – whichever is easier. You'll probably have to push it out with something (dull)
7. Clean all the parts. If the piston was stuck you'll need to scrub out the passage with something. A gun cleaning brush on an air drill works well. \*\*\*Don't use anything that could mar the walls of the passage.
8. Oil the parts and put them back together. Be aware that there was an aluminum washer under each “nut” – as they may have fallen off during cleaning.
9. Replace the pump on the burner.

## OIL TEMPERATURE CONTROLLER: OPERATION & SETTINGS

This device is installed in the module cover box and controls the temperature to which the oil will be heated and the temperature that must be reached before the Fireeye controller will be allowed to fire the burner. The control can be easily changed to accommodate different oils that require higher or lower preheat temperatures, for example vegetable oil, heavy oil and synthetic lubricants or lightweight oils like solvents. The readout as shown at left can be easily adjusted by depressing up and down arrow buttons. Refer to the recommended settings.



### Oil Temperature & Pressure Settings

The INOV8 burner has been tested to burn fuel oils up to #6, and a variety of used petroleum based shop and vehicle oils. Testing has also been done on a variety of vegetable based oils, such as corn, soybean, and canola oils – both used and new. All of these oils make potential fuels but have different BTU values and flashpoints that require adjustments to the burner pressure and preheat temperature. It's also important to be aware that the preheat temperature showing on the LED readout is the temperature of the steel block in the module and not the direct temperature of the oil – which can be 30° to 50°F higher than the steel block temperature. If the oil being burned is not standard waste crankcase oil, oil analysis will determine the flashpoint and BTU value for proper setting of the oil temperature and pressure settings. The settings below are typical:

Type of Oil	*BTU/Gal	* Flashpoint in degrees F	SP1 Setting	SP2 Setting
<i>Petroleum based oils</i>				
Used crankcase - regular	147,000	240 - 350	150	110
Used crankcase – synthetic	140,000	440 - 507	170	120
Used crankcase with 10% gas	144,500	180	140	110
Used crankcase with 20% gas	142,000	120	Off	Off
90W gear lube	144,000	250 - 300	150	110
Transmission fluid	143,000	340 - 400	150	110
Hydraulic oil	144,000	336	150	110
Mineral oil	138,000	325 - 400	160	120
Mineral spirits	136,000	115	Off	Off
Jet fuel – JP 4	141,000	100 - 128	Off	Off
Fuel oil - #2 & diesel	140,000	126	Off	Off

\* Flashpoints and BTU values have been obtained from US Oil Chek analysis, data available from NFPA, and various MSDS publications and may not accurately represent all samples. \*\* When adjusting oil pressure refer to instructions found on page 24.

### *Adjusting the Temperature Controller*

Two temperature settings control the preheat function; OUT1 maintains the temperature within 5 degrees of the set point, and OUT2 prevents the burner from firing with oil that is not yet at the set point temperature ( also know as interlock). There are two basic factory set points based on the type of oil specified to be used as fuel.

	SP1	SP2
Petroleum based oils	150°F	110°F
Vegetable based oils	170°F	120°F

When making adjustments follow this procedure:

1. Press and release the SET button. The current value of OUT1 is displayed and the SP1 and the LED for the OUT1 lights blink. Press UP or DOWN to increase or decrease the value. The range of OUT1 temperature is 120°F to 180°F. Press SET to confirm the new value. This will then cause SP2 and the LED for OUT2 lights to blink.
2. Press UP or DOWN to increase or decrease the value of SP2 and press SET to confirm the new value and exit. The range of temperature for this setting is 100°F to 140° F.

**Note:** At least 20° F span must be between the OUT1 and OUT2 settings for this to function properly. Also be aware that when the preheater switch (see item #24 on the burner diagram for location) is in the OFF or “0” position, the lights on the temperature control will be off.



### **Message Display**

Under normal operation, the temperature of the probe will be displayed. Call INOV8 if any of the following messages appear:

- Err Memory reading error
- AH1 Maximum temperature alarm
- AL1 Minimum temperature alarm
- ooo Open probe
- --- Shorted probe

### **REMOVING EXCESS OIL FROM COMBUSTION CHAMBER**

While this should never happen with the Fireye combustion control that is specifically designed to prevent excess oil, follow this procedure if necessary. **If unburned oil accumulates, DO NOT attempt to fire the heater and burn off the oil.** Perform steps on page 26 for shutting down power and removing the burner for cleaning the combustion chamber. Scoop out any excess oil. It can be returned to the tank if properly filtered. Put in “Oil Dry” to absorb any wet oil, and scrape out and discard. If oil is present in the heat exchanger tubes, perform the same cleaning routine in them.

### **PROCEDURE FOR PARTS REPLACEMENT**

If it is determined that part of the furnace is faulty, a replacement part will be sent via UPS regular delivery. If overnight delivery is desired, the service will be billed to you. The billing will depend upon the warranty provisions. These additional conditions apply to the replacement policy:

1. For the first twelve months of owning the furnace, all shipping of warranted parts from the factory is paid for by INOV8. The customer is responsible for returning the faulty part to INOV8 or the INOV8 dealer. After the first year the owner shall pay the costs of shipping.

2. During the first year an invoice will be issued for the replacement part. When the faulty part is received at the factory, full credit will be issued.
3. INOV8 reserves the right to send a representative for an on-site inspection.
4. INOV8 is not responsible for any labor cost for the servicing, removal or replacement of parts.
5. Repaired or exchanged equipment will carry the unexpired portion of the original equipment warranty or six months, whichever is greater.
6. If inspection by INOV8 discloses a defect not covered by this warranty, the equipment will be returned as is, repaired, or replaced at the discretion of the owner. If repaired in the factory, INOV8's regular labor charges will apply.
7. This provision expires one (1) calendar year from the date of delivery.

## THEORY OF OPERATION

### Overview:

When the wall thermostat calls for heat, it does so by sending power to the Fireye controller, which then turns on the burner motor and oil heater. The burner motor drives the oil pump which circulates the oil through the module, vapor eliminator and back to the pump to be circulated again. On each pass through the module, the oil gets a little hotter by passing close by the oil heater. Each pass through the vapor eliminator filters it and vents off any vapor that may have been released by heating and the churning action of the pump. This heating and circulating continues until the oil reaches firing temperature. At that time a signal is sent to the controller, causing it to start the 90-second pre-purge timeout and then fire the burner.

The ultraviolet sensor (U.V. sensor) will be watching the flame while the burner is running and a loss of flame will cause it to shut off for 90 seconds and then try to fire again (retry). Should the burner fail to ignite (whether on the initial attempt or on a retry), the U.V. sensor will notice the absence of flame and signal the controller to shut off the burner on alarm.

Assuming the burner started and is running O.K., it will continue circulating and heating the oil as necessary maintaining it at firing temperature, until the wall thermostat is satisfied that the building is hot enough and turns it off.

### In Depth

### Sequence of Events:

1. The wall thermostat sends 120v to controller terminals 1 and 7. The voltage on terminal 7 causes the controller to turn on the OPR CTRL light and close a relay, which puts 120v onto controller terminal 8.
2. Voltage on terminal 8 is fed to:
  - a. The burner motor that will now start circulating the oil through the burner.
  - b. The heater switch which, if ON, will start heating the circulating oil.
  - c. The Ignition test switch which, if depressed, will turn on the electrodes.
  - d. The orange boost pump control wire which, if you have an electrically controlled boost pump, will cause it to start running.
3. At this time the controller also starts looking for flame in the burning chamber. There should be none, if a continuous flame signal is detected for some reason, the controller will shut off the burner on alarm without trying to fire.
4. When the module block (oil) reaches the OUT2 set point in the oil temperature controller, that controller will place 120V on its OUT2 terminal (9) which is tied back to the Fireye interlock terminal (6). Note: If the heater switch had been OFF, the 120v signal would have been sent back as soon as the burner motor started.
5. The controller, seeing voltage on terminal #6, turns the blinking INTRLCK light on solid and starts the 90-second pre-purge.
6. At the end of the 90 seconds the controller puts 120v on terminal 4 to turn on the ignition transformer and terminal 3 to 'turn on' the orange wire firing circuit. The next 10-second period is called "Pilot Trial For Ignition" and is represented by the PTFI light on the controller being on.

7. The 120v on the orange wire energizes (opens) the air and oil solenoids.
8. The air now coming into the module will cause:
  - a. The Bimba cylinder to withdraw the needle from the nozzle.
  - b. Air to flow out the nozzle (To atomize the oil stream when it arrives.)
9. The 120v on the orange wire also energizes (opens) the oil solenoid causing it to allow oil to flow to the oil gauge and out the nozzle.
10. The hot atomized oil sprays through the ignition arc, causing it to ignite. This state continues throughout the 10 second PTFI interval – whether a flame was established or not.
11. At the end of the PTFI period the controller will:
 

If a flame was established:

  - a. Turn off the PTFI light.
  - b. Remove voltage from terminal 4, which turns off the ignition transformer.
  - c. Apply voltage to terminal 5 (Main valve which is unused in an F200).
  - d. Leave the voltage on pilot valve terminal 3 (Orange wire firing circuit).
  - e. Enter “RUN” mode – Meaning only that, should the burner now lose the flame, it will go into another 90 second pre-purge and then retry.

If no flame was established, shut down the burner by:

  - a. Removing voltage from terminal 4. (Ignition transformer circuit)
  - b. Removing voltage from terminal 3. (Orange wire firing circuit)
  - c. Removing voltage from terminal 8. (Burner motor and heater circuit)
  - d. Turning on the ALARM light on the controller.
  - e. Applying voltage to terminal “A” which turns on the red alarm light.
  - f. Tripping the controller’s reset button, which must be depressed for one second to get the burner going again.

## MAIN COMPONENTS & THEIR FUNCTIONS

### ***THE FIREYE CONTROLLER***

The Fireye combustion controller provides these functions:

1. It turns on the burner motor and heating element when the wall thermostat supplies power to it.
2. It delays firing for 90 seconds after being told the oil is hot, in order to purge out any fumes that may still be in the burning chamber.
3. It turns on the ignition transformer for the 10 seconds that PTFI is on.
4. It puts 120 volts on the orange wire circuit that causes the burner to fire.
5. It monitors the flame via the U.V. sensor and shuts the burner down or causes it to go through a 90 second purge and retry if it loses sight of the flame. (If flame is not detected in the 1<sup>st</sup> 10 seconds of any firing attempt, the burner will be shut down with the ALARM light on the controller and the red light on the front of the burner ON. If the U.V. sensor saw a flame for the first ten seconds that went away later, the controller will do a 90 second purge and retry.)
6. It monitors the signal coming from the module that tells it that the oil is hot enough to fire. If at anytime that signal goes away, it will shut off the burner until

the signal reappears. Then the 90 second purge and re-firing will occur. The signal comes from the OUT2 in the oil temperature controller.

7. It monitors (via the U.V. sensor) any flame in the burning chamber that is present when there should be none – such as residual oil. It will wait for the flame to go out and then do the 90 second purge and fire. If, however, the flame does not go out in ~ 15 seconds, it will shut the burner down on alarm.

**The Burner Motor** has two functions: It blows air for combustion into the combustion chamber and it drives the oil pump via a slip-on coupling that connects their shafts together. Prior to the burner firing, the air being blown in is for purging residual fumes from the burning chamber rather than combustion. The amount of air being blown in is controlled by the Combustion Air adjustment that is a band and plate on the left side of the burner casing unless the sealed combustion adaptor is installed, in which case it's a knob adjustment. Adjustment is made to provide sufficient air to cause complete burning (no smoke) but not so much as to cause the flame to be blown away from the nozzle or to overpower the chimney's draft that would produce unacceptable operation.

**The Heating Element** is an 800-watt, 9" long by 3/8" diameter rod that runs from the center of the module block to within a couple of inches of the nozzle. It heats the oil that flows through the module under control of the OUT1 set point in the oil temperature controller.

**The Ignition Test Switch** allows the ignition transformer to be turned on for inspection of the arc or for debugging an ignition problem. The switch is active anytime the burner motor is running.

**The Heater Switch** allows the burner to be run with or without heating the fuel; Waste oil requires the heater to be in the '1' position (ON). Fuel oil, diesel fuel, etc. can be burned without heating by setting the switch to the '0' (OFF) position.

The orange wire connects to the coil of a boost pump control relay if you have an electric boost pump installed. The boost pump will run when the burner pump runs.

## ***THE OIL SYSTEM***

As the pump turns, it will draw oil to the burner from the tank to replace any air that may have accumulated in the supply line or burner. This air is vented out through the 1/4" copper tube that runs from the vapor eliminator back to the tank. For this air venting to take place, a constant drip rate of a few drops per second must be maintained through the tube. This is done with the valve at the vapor eliminator - which also may be opened up wide to speed purging if your line or burner has been drained of oil or if you got water in the oil supply that you need to purge out. The pump sends the oil over to the right-most module oil fitting where it enters the module and flows through an internal "U" bend where the oil heating takes place. It then flows out the "U" bend through the middle module oil fitting and over to the vapor eliminator. At the point of exit from the module, its pressure is monitored by the Dirty Filter pressure switch. Should pressure at this point exceed 35 lbs., the amber light on the burner will turn on letting you know that the vapor eliminator filter is plugging up - causing the 35-lb. backpressure. Normal pressure in the circulating system should only be 2 or 3 pounds higher than the firing pressure showing on the oil gauge. Adjusting the oil return pressure relief screw in the pump sets it.

The oil entering the vapor eliminator from the module will flow through the filter and out the center fitting on the vapor eliminator where it is returned to the pump through the copper "U" bend to be circulated again. A small part of the oil entering the vapor eliminator from the module is vented back to the tank through the copper or plastic drip tube. The oil that is sent to the nozzle is also taken from the center fitting on the vapor eliminator - through the hose that goes to the left- most oil fitting on the module. We

generally term this hose the "final delivery hose" since it supplies oil to the "final delivery passage" that runs to the nozzle. Flow through this hose is prevented by the oil solenoid until the burner fires. At that time, the opening of the solenoid allows the oil to flow to the oil gauge and out to the nozzle. Be aware that any pressure showing on the oil gauge prior to firing is due to heat expansion of the oil in the final delivery passage and has nothing to do with true circulating system pressure.

### ***THE PRIMARY (ATOMIZING) AIR SYSTEM***

This is the air that is supplied by your air compressor and its function comes into play when the burner fires. On the module, the air solenoid coil will open when voltage is applied. Opening the solenoid allows air to flow into the module and go into the Bimba cylinder (to withdraw the needle) and out the nozzle (to atomize the oil stream). From there an orange jumper wire conducts the voltage over to the left-most screw of the Dirty Filter pressure switch to which is also attached the oil solenoid coil wire. This is also the earliest that the amber Dirty Filter light can come on, since the voltage that drives it comes from the orange wire circuit. Opening the oil solenoid allows oil to flow to the oil gauge and nozzle. At the nozzle, it flows through the small hole in the 'spinner' and is then mixed with the 30-lb. air to form a mist as it squirts out the nozzle. For the oil to get through the spinner there is one other thing that must also happen: The Bimba cylinder must draw back.

The Bimba cylinder is a pneumatically operated plunger that is attached to a long needle that enters the spinner hole between firings. It serves the purpose of purging debris from the nozzle and preventing oil from dripping out the nozzle and being replaced by air. Air in the final delivery passage cannot be purged by the vapor eliminator and will cause a rough start at the next firing. As was mentioned earlier, the opening of the air solenoid allows air pressure into the Bimba cylinder. This causes it to draw the needle back out of the spinner hole, allowing oil to flow through. There is a hole in the end of the Bimba cylinder that extends to the actuator. By placing a wire or small screwdriver in the hole, you can feel it push back when it draws the needle out of the spinner. At this point, you have hot atomized oil spraying out the nozzle and through the ignition arc that was turned on at the same time the orange wire was energized. There should be a flame.



# ELECTRICAL DIAGRAMS

Figure 8 – Basic Wiring Diagram for Furnace with Prop Fan

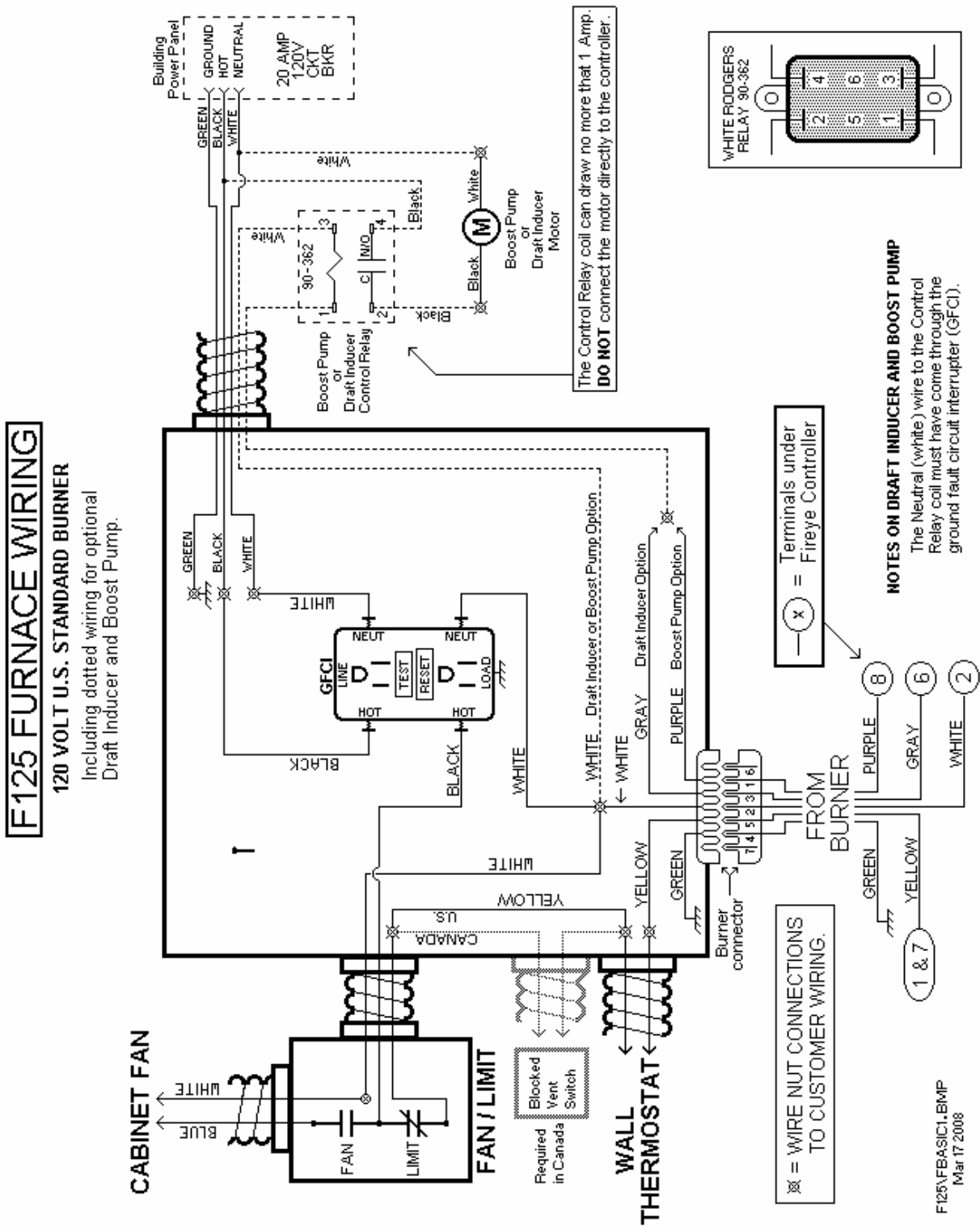


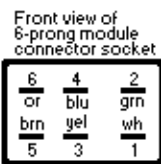
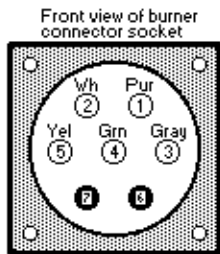
Figure 9 – Basic Burner Wiring Diagram

# F125 BURNER WIRING

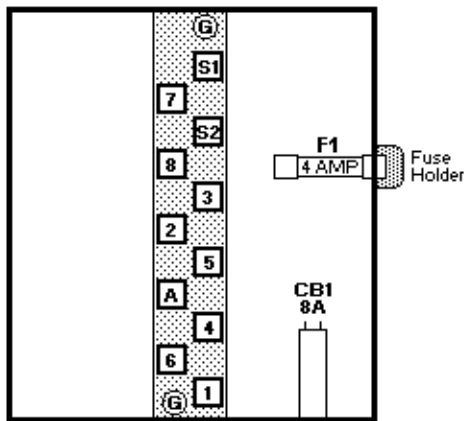
120 VOLT U.S. STANDARD

**INDEX**

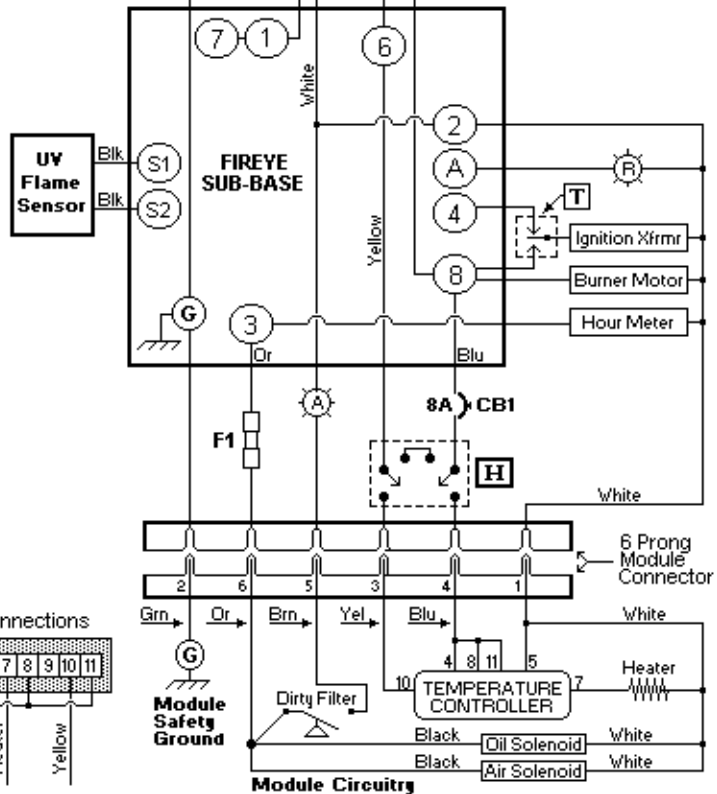
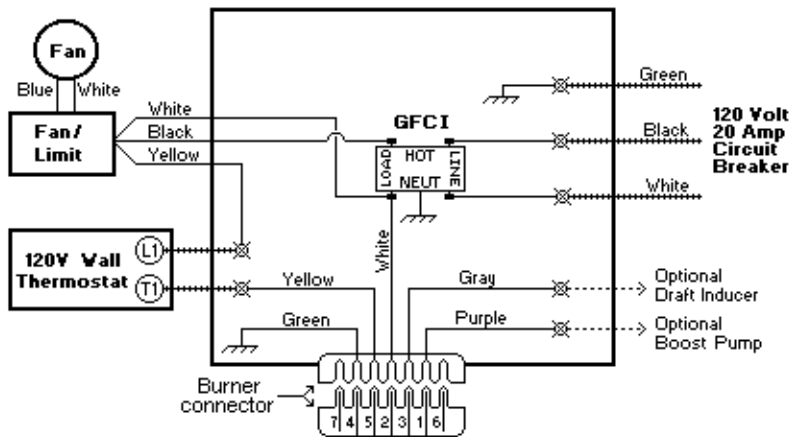
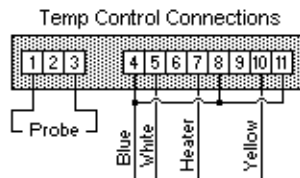
- Amber Light - indicates dirty vapor eliminator filter.
- Red Light - indicates shutdown
- Heater On/Off Switch
- Ignition Test Switch
- Safety Ground
- Customer Wiring
- Wire Nuts



Actual Fireye sub-base terminal locations are shown below:



Micro-M	MEC120
Chassis	MEP238
Module	MEUV4
U.V. Amp	UV 1A3
U.V. Scanner	61-3060
Sub-base	



SUBBASE\F125-120.BMP  
Apr 03 2008



## PARTS LIST & TOOLS

Installation and maintenance of the INOV8 furnace requires the standard tools used in heating oil installations. For your convenience they are listed here. Also listed are small replacement parts that are good to stock and a few unique trouble shooting tools available only from INOV8. Advanced servicing tools are also listed.

Item Description	Part #	Source
<b>Tools for Installing &amp; Servicing:</b>		
Combination Wrenches, a set or: 7/16, 1/2, 9/16, 5/8, 11/32, 5/16 & 3/8		Sears
Needle nose pliers		Sears
Allen wrench with 'T' handle - 1/8"		Sears
Screwdrivers, phillips		Sears
Screwdrivers, flathead		Sears
Multi-meter, Craftsman		Sears
Cleaning brushes	SA260	INOV8
Temperature measure gun, Craftsman		Sears
<b>Small replacement parts:</b>		
VE replacement filter with rubber backed washer - set of six	30406	INOV8
Nozzles: one # 3.1	20240	INOV8
Aluminum gaskets	20060	INOV8
O-ring set: for vapor eliminator & bimba	20272	INOV8
Replacement o-rings & parts with Viton	20273	INOV8
Fuse set: 2 each of 4, 8 & 10 amp fuses	30236	INOV8
<b>Troubleshooting Tools:</b>		
Test hose - 1/2" id reinforced hose with a fittings to attach to the pump and a +/- pressure gauge, long enough to reach from burner to floor	TA105	INOV8
Drill bits: #74 & #50	TA110	INOV8
Pin vise to hold the small drill bits	TA115	INOV8
2' long piece of 22 gauge single-strand insulated wire		INOV8
1 1/2' long piece of 1/4" o.d. tubing (copper or brake line)		INOV8
<b>Combustion Analysis &amp; Advanced Tools</b>		
Amprobe clip-on current measuring device		Sears
Craftsman Electrician Kit - above three items		Sears
Bacharach Draft Gauge		Bacharach
Bacharach Hand-held Combustion Analyzer, model		Bacharach

## SECTION 6 - GLOSSARY

<b>Air Apportioning Adjustment</b>	A setscrew adjustment in the module block which reduces the 30-psi atomizing air coming in to the correct pressure at the nozzle. It is factory set and held with Loctite.
<b>Air Regulator</b>	The air hose connects to this. It regulates the primary air for combustion. It is located on the right side of the burner. Used to reduce the high air pressure from your compressor to the 30 psi atomizing air pressure required by the burner. Location: See #6 in Figure 5.
<b>Air Tube</b>	The 4" diameter black metal tube with the flange on it by which you attach the burner to the furnace cabinet.
<b>Alarm Light (Red)</b>	A warning light which indicates that the combustion controller has shut the burner down because it failed to fire (or the controller couldn't 'see' that it fired) during the 10 second pilot (PTFI) ignition period. There are actually 2 alarm lights, one on top of the combustion controller and one on the front panel of the burner (See #7 in Figure 5). The one on the panel is just a more visible duplicate of the other.
<b>Amber Light</b>	This is lit when there is a pressure increase within the oil circulating system signaling a dirty vapor eliminator filter. This bulb will light to signal that the vapor eliminator filter is dirty. It will not signal until the burner is firing (or trying to fire). It has NOTHING TO DO WITH the condition of the tank filter. It only signals...i.e. It doesn't cause the burner to shut off or anything. Location: See #8 in Figure 5. (aka: Yellow light, Orange light and Dirty Filter light)
<b>Atomizing Air</b>	The term given to the compressed air fed to the burner. It's primary role is to mix in the nozzle with the oil to produce a combustible fuel cloud which would then be said to have been ATOMIZED – much like a perfume atomizer. Secondly, it supplies the air pressure to pull back the Bimba cylinder.
<b>Ash</b>	Each 55 gallon barrel of oil contains 1-1/2 quarts of non-burnable solids that collect in the combustion chamber. This ash consists of the additive package within new lubricating oil plus trace amounts of wear metals.
<b>Barometric Draft Control</b>	When installed into the chimney, this device helps to control the draft. It is included with each order. This device is intended to smooth out draft variations caused by wind gusts and chimney performance. The more the flapper is open the less draft you have in the burning chamber. Normal chimneys require it be closed; only opening slightly during wind gusts.
<b>Bimba Cylinder</b>	A pneumatically operated plunger attached to the needle that actuates at PTFI time and de-actuates when the controller shuts off the burner. (Also see Needle) Location: See #20 in Figure 5.
<b>Boost Pump</b>	A stand-alone oil pump required at installations where the burner is quite distant from, or too highly elevated above the oil supply tank. Specifics of boost pump installation are covered elsewhere in this manual.
<b>Burner</b>	The flame producing mechanism that mounts onto the furnace cabinet. Rather self-explanatory but we use the term to distinguish it from the furnace as a whole. There is the furnace 'cabinet' and the 'burner'. Together they form the 'furnace'.
<b>Burning Chamber</b>	See combustion chamber.
<b>Burner Flange</b>	See Air Tube

<b>Calling for Heat</b>	A term that you will see used in this manual. It means that the wall thermostat is set at a temperature higher than the temperature in the room so the burner will run to get the room temperature up to what the wall thermostat is 'calling for'.
<b>Check Valve</b>	It is part of the floating pickup and filter assembly that is included your furnace order. The check valve holds the oil in the lines to prevent having to prime the pump each time a filter is changed. Located downstream from the tank filter, this valve will attempt to prevent the fuel from running from the burner back to the tank.
<b>Clinker</b>	A build-up of unburned oil inside the combustion chamber. Clinkers are caused by too much water in the air or oil supply and will cause problems.
<b>Coking</b>	Burned, hardened oil inside the oil circulation passages in the module that is created from an excessive preheat setting of the OUT1 set point in the temperature controller.
<b>Combustion Air</b>	Atomizing air injects through the nozzle to create a fuel cloud but there isn't enough of it to supply all the oxygen needed for combustion. Combustion air is drawn through the adjustable shutters (see #12 in figure 19) into the burner's fan and then blown down the air tube, through the flame retention head and then into the combustion chamber. If you have installed a Sealed Combustion Adaptor, a knob controls the shutters.
<b>Combustion Chamber</b>	Also called burning chamber and fire box. The large barrel shaped chamber that the flame is contained in. Unburned ash collects in this chamber.
<b>Combustion Control</b>	Also called controller, red box, Fireye, brain box. This device monitors and controls the combustion and provides numerous safety features. This device controls all the burner sequences and shuts the burner off if it finds things not running properly.
<b>Compression Fitting</b>	A nut and ferrule type gland fitting for sealing to steel tubing, but poorly on copper or plastic suction lines. Don't use such a fitting anywhere in your fuel supply line.
<b>Dirty Filter Switch</b>	A switch, which monitors the pressure in the oil circulating system of the burner. Pressure exceeding 35 psi – indicating the vapor eliminator filter is dirty – will cause this switch to close which turns on the amber light.
<b>Delivery Line</b>	Copper piping, oil-approved hose or steel pipe that connects the oil tanks with the furnace.
<b>Draft</b>	The vacuum pressure inside the burning chamber that moves the air up the chimney. The furnace requires this pressure to be negative and, unless you have a draft inducer installed, the only thing producing this vacuum is the chimney itself by the action of the hot air rising up. Draft is measured in hundredths of an inch of water column and our furnaces run fine with a draft of negative 3 to 5 hundredths. See the Maintenance Procedures section of the manual for checking draft.
<b>Draft Inducers</b>	A fan mounted in the chimney that increases draft by helping the chimney pull the flue gasses out of the furnace. Furnaces rarely need one if a proper chimney has been installed.
<b>External Oil Regulator Assembly</b>	An assembly comprised of an inlet pressure gauge, an oil regulator and an outlet pressure gauge. It is used in boost pump applications and boiler installations to provide a correct inlet pressure to the pump on the burner. Additional information exists in the Boost Pump section of this manual.
<b>Fan/limit control</b>	Controls the heat exchanger temperature by regulating the fan. It will also shut down the burner if the heat exchanger should exceed normal limits. Fan ON, Fan OFF and Limit are individually adjustable. The fan/limit control is located in the upper left or right corner on the burner side of the cabinet. The settings should be: fan on = 140°, fan off = 80°, high limit shutdown = 170°.

<b>Flame Retention Head</b>	Located in the end of the air tube of the burner, the flame retention head mixes the atomized oil with combustion air.
<b>Flared Fittings</b>	The only fitting to be used with soft copper tubing at disconnection points in the fuel delivery line. Disconnection is easy and flare fittings form a good seal.
<b>GFCI</b>	Ground Fault Circuit Interrupter. This also functions as the on/off switch.
<b>Heat exchanger</b>	The passages through which the hot flue gasses pass on their way to the chimney after leaving the burning chamber. Although the burning chamber itself contributes to the heat exchange process it is considered to be separate from the 'heat exchanger'.
<b>Heater element</b>	An electrical device residing in and removable from the module. This device provides the heat necessary to raise the oil to a temperature at which it will burn. Location: See #15 in Figure 5.
<b>Heater switch</b>	A black rocker switch labeled "1" and "0" to indicate the universal positions of 1=ON and 0=OFF. The switch must be in the 1 (ON) position when burning fuels such as waste oil. If fuel oil, diesel fuel, kerosene, etc. is being burned, the switch should be turned off. Location: See #25 in Figure 5.
<b>Hour Meter</b>	Located in the panel that attaches to the burner motor, this meter will accumulate time whenever the burner is firing.
<b>Ignition Test Switch</b>	A momentary push-button switch (red) that is active whenever the burner motor is running. Depressing it will turn on the ignition transformer allowing you to check the appearance of the electrode arc.
<b>Ignition Transformer</b>	Supplies voltage for the ignition arc. Voltage is transferred to the electrodes via the springs, which rest on the electrode rods. Location: See #3 in Figure 5.
<b>INTRLCK Light</b>	A light on the Fireye combustion controller indicating that the fuel is at a temperature at which it will burn.
<b>Module</b>	The "firing gun" part of the burner that can be slid out of the air tube for servicing. The portion of the burner that houses the components required to accomplish firing including the nozzle, electrodes, dirty filter switch, air and oil solenoids, heating element, etc.
<b>Module Block</b>	A 1" x 3" x4" steel block upon which are mounted the components as described above. It is visible when the module cover box is flipped open.
<b>Module Connector</b>	Also called the 6-prong plug. This plug allows the module to be electrically disconnected from the burner proper. Location: See #5 in Figure 5.
<b>Module Cover Box</b>	A sheet-metal box that is hinged to allow access to the components mounted on the module block. The shipping screws in the front lip of the ignition transformer must be removed and the transformer flipped up to allow it to be opened. Location: See #1 in Figure 5 designated "Module".
<b>Module Hanging Bracket</b>	A notched plate mounted inside the air tube. A bolt on the module slides into a slot in this bracket for the purpose of centering the nozzle in the flame retention head.
<b>Needle</b>	A device that seats into the nozzle when the burner is not firing. It prevents oil from seeping out the nozzle between firings and also aids in clearing nozzle obstructions.
<b>Nozzle</b>	The mechanism responsible for mixing the oil with the atomizing air and producing the

	atomized fuel cloud for combustion. It is comprised of two parts: The outer brass cap that screws into the module tube and the 'spinner' which sits in the end of the oil delivery tube accessible once the outer brass cap is removed. A nozzle blockage is the blockage of the small passage through the spinner. The spinner doesn't 'spin'. It's fixed in place; it only causes the air passing through the slots around its perimeter to 'spin' as it mixes with the oil.
<b>Oil Delivery Line</b>	In general terms this includes all the plumbing and components involved in transferring oil from the tank to the burner. The name is also used to describe just that final portion of plastic line that connects to the pump on the burner.
<b>Oil Pressure</b>	The pressure of the oil at the nozzle. This pressure can be read on the oil gauge whenever the PTFI light is on or the burner is firing. It is controlled by a screw adjustment on the burner pump (See #27 in Figure 5) and must be set by the customer. It cannot be pre-set by INOV8 since it will vary depending on the suction required to draw oil from the tank.
<b>Oil Pressure Gauge</b>	A 0-60 psi gauge, which reflects the oil pressure on the nozzle. It is visible through a hole in the module cover box. Location: See #23 in Figure 5.
<b>Oil Pressure Relief Mechanism</b>	A combination oil pressure relief and oil flow adjustment device. It houses the valve by which you set the return oil flow to the tank and also a pressure relief valve which will open up, bypassing the adjustable valve, if pressure in the system gets very high due to a blocked vapor eliminator filter. When relieving, it dumps the pump flow back to the tank. Location: See #26 in Figure 5.
<b>OPR CTRL Light</b>	A light on the combustion controller indicating that power is ON. (i.e. the wall thermostat is calling for heat).
<b>Oil Hoses</b>	These three hoses connect the burner to the module. They are rated for high temperature, high pressure and are fire resistant.
<b>Oil Temperature Controller</b>	A device installed in the module cover box which controls the temperature to which the oil will be heated and the temperature that must be reached before the Fireeye controller will be allowed to fire the burner.
<b>Oil Supply Connection</b>	When facing the burner, the inlet is the farthest opening on the left side of the pump. When new this inlet will have a 1/4" pipe plug inserted.
<b>Pre Purge</b>	A function provided by the combustion controller that causes the burner's blower fan to run for 90 seconds before the burner would fire. It does this to insure no combustible vapors remain in the combustion chamber at the time of firing.
<b>PTFI Light</b>	A light on the combustion controller that will come on for the first 10 seconds of firing. It stands for Pilot Trial For Ignition and indicates that voltage is being applied to the solenoid valves and ignition transformer.
<b>Red Light</b>	When lit, this signals a safety shutdown situation.
<b>Reinforced Hose</b>	A clear, braided, oil-approved hose, recommended for supply oil line.
<b>Reset Button</b>	A push-button type switch located on the top of the combustion controller. This switch must be pressed to restart the burner if the red alarm light is ON.
<b>Residual Flame</b>	A flame that continues after the burner shuts off. This is not normal. The combustion controller will not allow the burner to fire if residual flame is present.
<b>Return Line</b>	A 1/4" (minimum) copper or plastic line that runs from the oil pressure relief mechanism on the vapor eliminator back to the fuel tank. Flow through it is normally set to a rapid drip by the valve on the pressure relief mechanism. Should the vapor eliminator filter plug up, the pressure relief mechanism will shunt the full 18 GPH flow from the pump back to the tank.

<b>Sealed Combustion Adaptor</b>	A device that can be attached to the burner to allow it to draw its combustion air from outside the building. It would be an essential item in a building that has negative internal pressure due to exhausting equipment.
<b>Six-Prong Connector</b>	This connector completes the circuit between the module and the burner.
<b>Solenoid</b>	Two essentially identical solenoid valves provide control for atomizing air and oil delivery to the nozzle. They energize (open) when the controller fires the burner. Location: #21 and #22 in Figure 5.
<b>Spinner</b>	See Nozzle.
<b>Sub-base</b>	The metal electrical box that the controller sits on. It contains all the wiring attachments for the controller plus a 4 amp fuse and an 8 amp circuit breaker. It is accessed by removing the Fireye controller.
<b>Tank</b>	Storage for waste oil.
<b>Tank Filter</b>	A spin-on filter, generally in the 75-micron range, that filters the oil coming out of the tank.
<b>Target</b>	Located in the back of the heat exchanger, the target is designed to take the high temperature flame and abuse from the non-burnable particulates in the waste oil that would otherwise destroy the back of the furnace. A refractory type of ceramic, which forms the wall at the far end of the combustion chamber through direct contact with the metal.
<b>Test Hose</b>	A good tool to have if you've got trouble drawing oil from the tank due to suspected obstruction or air leak. It's also useful if you think the quality of your oil might be causing burning problems. You can make it yourself out of ½" reinforced plastic hose. Make it long enough to reach from the burner to the floor and attach a fitting to one end that allows attachment to your pump. You can then use it to suck from a bucket of known good oil sitting on the floor, which should tell you if there's a problem with the normal delivery system.
<b>Ultra Violet (UV) Sensor</b>	The part of the Fireye combustion control that detects the flame. It is a blue device installed under the transformer.
<b>Vapor Eliminator</b>	This cast aluminum canister houses a replaceable filter element and provides a settling chamber which provides for the venting off of vapor that can accumulate during the oil heating process.
<b>Vapor Eliminator Filter</b>	A replaceable 10-micron filter element intended to remove fine particles that have passed through the tank filter.
<b>Viewing port</b>	There is a 2" pipe cap just above the burner. Remove it to inspect the flame. Be aware that it gets very hot. Use gloves or a rag to take it off and, when you screw it back on, just make it finger tight.
<b>Wall Thermostat</b>	Usually mounted on the wall near the furnace, it instructs the furnace to operate, as any other thermostat, to control the room temperature. INOV8 provides this thermostat with the furnace order.