MANUAL 2100-050

Bard®
SINCE 1914

OIL HEAT FUNDAMENTALS AND MAINTENANCE PROCEDURES

REFRIGERATION, HEATING AND AIR CONDITIONING

BARD MANUFACTURING CO. • BRYAN, OHIO 43506

Dependable quality equipment. . .since 1914

THE COMBUSTION PROCESS

Fuel oil is one of the heavier hydrocarbon fuels. It contains more carbon than some of the lighter hydrocarbons such as natural gas and LP gas. Oil must be converted from a liquid to a gaseous state for ignition and thorough combustion. This conversion process is called vaporization or vaporizing the oil.

Several grades or weights of oil are available, ranging from grade numbers 1 through 6. No. 1 fuel oil is a light distillate intended for use in vaporizing type burners. High volatility is essential to assure complete evaporation leaving a minimum of residue.

Numbers 3 through 6 include heavier oils intended for use in burners designed to atomize oils of higher viscosity (resistance to flow) than that used for domestic oil burners. Some of the heavier grades need to be preheated to provide better atomization.

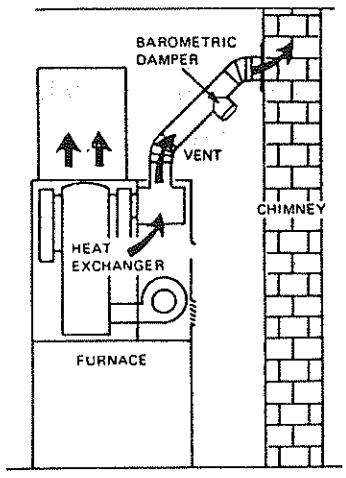
No. 2 fuel oil is the most widely used for residential heating. This oil is heavier than No. 1 and is designed for use in a pressure - atomizing type burner used in Bard oil furnaces. This burner sprays the atomized oil into a combustion chamber where it is heated and vaporized, mixed with air, and ignited.

To provide enough oxygen for complete combustion, each pint (approximately one pound) of No. 2 fuel oil requires over 14 pounds of air (3.3 pounds of oxygen and 11.1 pounds of nitrogen). This weight of air is equal to 215 cu. ft. of air at standard conditions. Another way of expressing the air required for complete combustion of fuel oil is: one gallon of No. 2 fuel oil requires 1,500 cu. ft. of air for theoretically complete combustion. This results in approximately 15% CO_2 in the flue gas.

An oil furnace cannot provide laboratory conditions for theoretically complete combustion. Therefore, more or excess, combustion air is added. This assures complete combustion of the high carbon content fuel. As excess air is added, the percentage of CO_2 decreases. About 10% CO_2 in the flue gas shows an adequate supply of combustion air.

Excess Air	20%	40%	60%
CO_2 in Flue Gas	12.3%	10.5%	9.1%

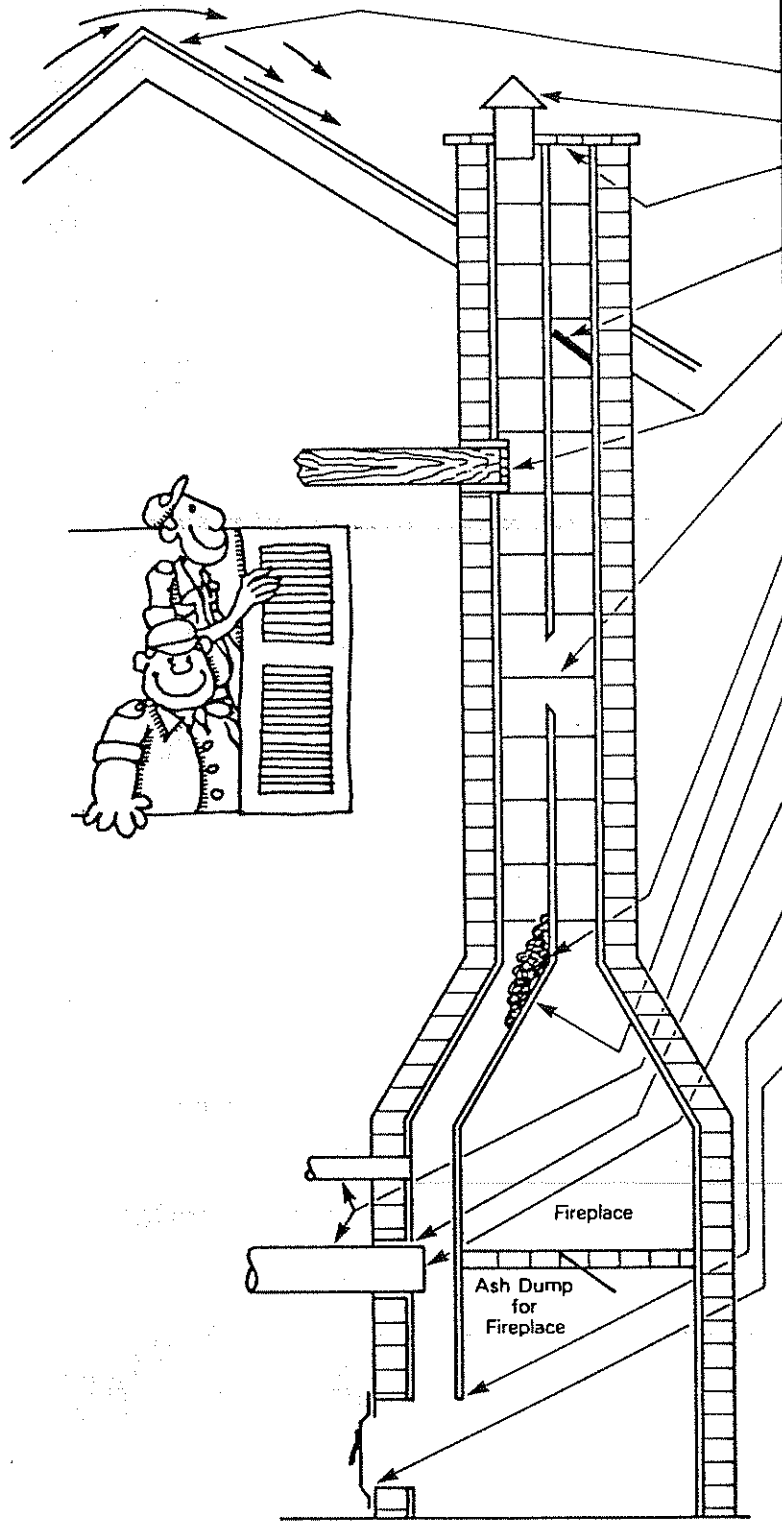
The vent system for an oil furnace is different from that used for a gas furnace. An important difference is that an oil burner is supplied with a combustion air blower. It doesn't depend on the secondary air for combustion. The oil burner blower, when set for the correct amount of air, is much less inclined to be upset by draft conditions in the vent, although reasonable draft control is necessary. Therefore, an oil furnace does not require a draft hood or diverter. The furnace is vented directly into the chimney.



To regulate the draft at the oil furnace, a device called a barometric damper is installed in the vent pipe. This is a hinged and weighted damper which opens to the furnace room. When the chimney draft becomes too great, this damper swings part way open. The excess draft then draws some air from the room into the vent rather than drawing too heavily on the furnace. This damper control means a less costly furnace. Less heat goes up the vent, making this system more efficient. The weight of the damper is adjustable so the draft to the furnace can be set at the desired point. Usually this is -0.03 to -0.04 inches water column into the draft water gauge. If there is too little draft of the vent, there is a chance the furnace could force combustion products into the living space. If too little draft exists, check the following possible causes:

1. Chimney clogged by an obstruction or an accumulation of soot. Chimney should be kept clean.
2. Leakage of air into the chimney through holes or open seams. Check around cleanout door for proper seal, check vent connections.
3. Improper adjustment of draft control. The draft control should be adjusted to give 0.01 inches of water draft over the fire. This should be done on damp or humid days when there is no wind. If the draft control is adjusted on a clear, cold day when there is considerable air movement that improves draft, the adjustment may not be correct. When atmospheric conditions affecting draft are bad, soot, smoke and odor may be noticed, especially on cold starts.
4. Vent gases not hot enough. The lower the temperature of the vent gases, the less will be the draft. Vent gas temperatures should not go below 300°F. Temperatures below this will give erratic performance as the outside temperature gets lower. If a chimney lacks insulating quality, flue gases may lose enough heat to slow their rise considerably and thereby seriously affect draft.
5. A vent with many 90 degree turns. Turns in the vent should be avoided as much as possible and used only if absolutely necessary. Turns should be achieved by 45° or 60° angle smoke pipe elbows.
6. Fireplaces connecting with the oil burner flue open. They should be closed to prevent cooler room air from being drawn into the flue, thereby reducing the draft.
7. Furnace over fired, creating a volume of gases beyond the chimney's ability to handle them.
8. Improper size of chimney. This is usually a chimney which lacks height. The interior should be round.
9. Interference of air flow over chimney caused by high surrounding buildings or other deflecting structures.
10. Vents running through unconditioned space.

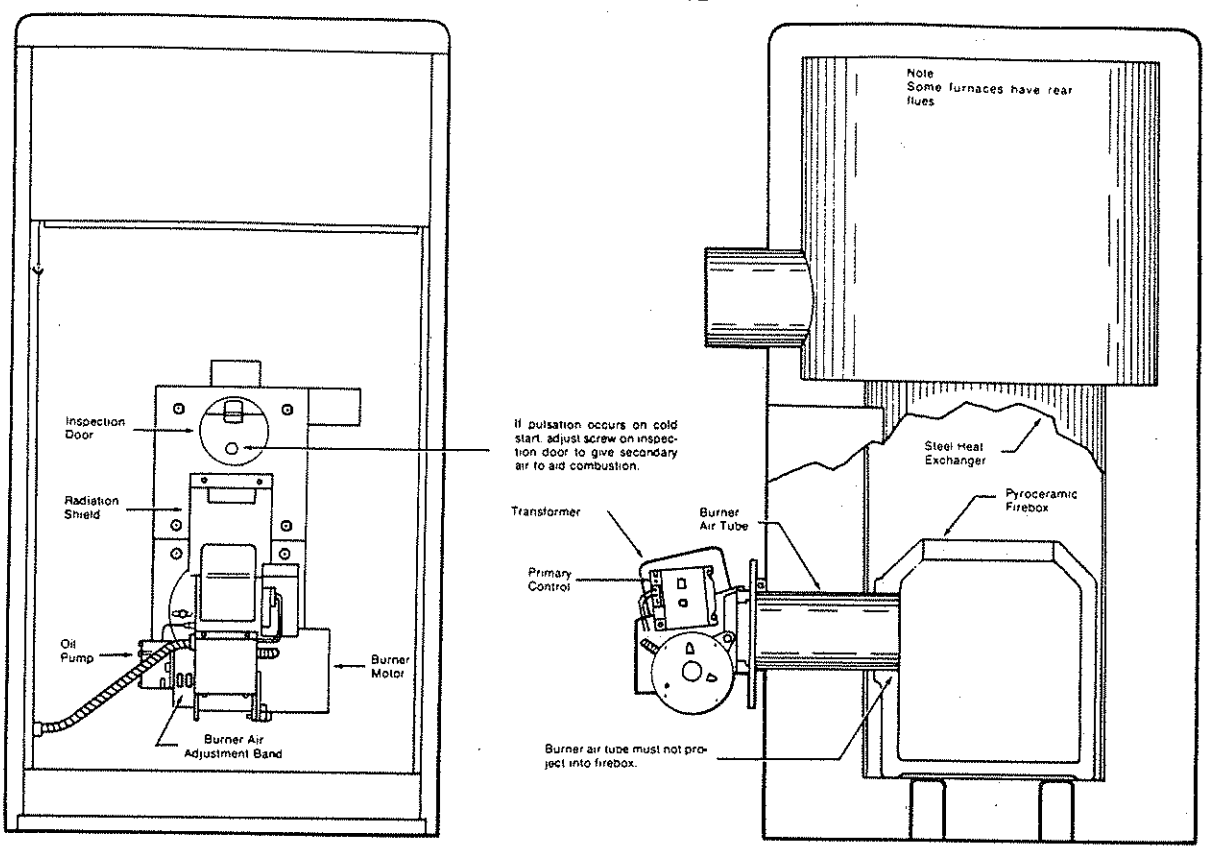
Down draft conditions don't affect oil furnaces adversely since the power of the combustion air blower is sufficient to overcome them and to maintain reasonably good combustion. Furthermore, improper combustion in an oil furnace seldom produces carbon monoxide (CO). Instead, it tends to produce carbon or soot. Also, oil being a heavier fuel, with proportionately fewer hydrogen atoms in it, does not produce the volumes of water vapor that gas does.



Common chimney troubles and their corrections

Troubles	Examination	Corrections
Top of chimney lower than surrounding objects.	Observation.	Extend chimney above all objects within 30 feet.
Chimney cap or ventilator.	Observation.	Remove.
Coping restricts opening.	Observation.	Make opening as large as inside of chimney.
Obstruction in chimney.	Can be found by light and mirror reflecting conditions in chimney.	Use weight to break and dislodge.
Joist projecting into chimney.	Lowering a light on extension cord.	Must be handled by a competent brick contractor.
Break in chimney lining	Smoke test-build smudge fire blocking off other opening, watching for smoke to escape.	Must be handled by a competent brick contractor.
Collection of soot at narrow space in flue opening.	Lower light on extension cord.	Clean out with weighted brush or bag of loose gravel on end of line.
Offset.	Lower light on extension.	Change to straight or to long offset.
Two or more openings into same chimney.	Found by inspection from basement.	The least important opening must be closed, using some other chimney flue.
Loose-seated pipe in flue opening.	Smoke test.	Leaks should be eliminated by cementing all pipe openings.
Smoke pipe extends into chimney.	Measurement of pipe from within or observation of pipe by means of a lowered light.	Length of pipe must be reduced to allow end of pipe to be flush with inside of tile.
Failure to extend the length of flue partition down to the floor.	By inspection or smoke test.	Extend partition to floor level.
Loose-fitted clean-out door.	Smoke test.	Close all leaks with cement.

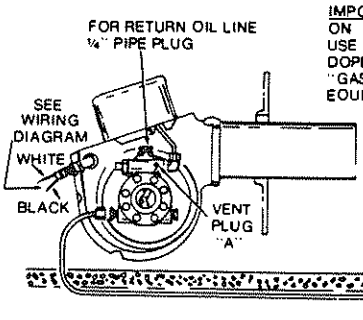
TYPICAL OIL FURNACE



DRAWING SHOWS SINGLE OIL LINE CONNECTED TO OIL TANK. IN CASE A RETURN LINE IS USED. REMOVE ¼" PIPE PLUG FROM TOP OF PUMP AND INSERT SMALL BY-PASS PLUG. THIS PLUG IS FOUND IN CLOTH BAG WITH NECESSARY INSTRUCTIONS ON SINGLE PIPE SYSTEM IT IS NECESSARY TO PROCEED AS FOLLOWS IN ORDER TO START FURNACE

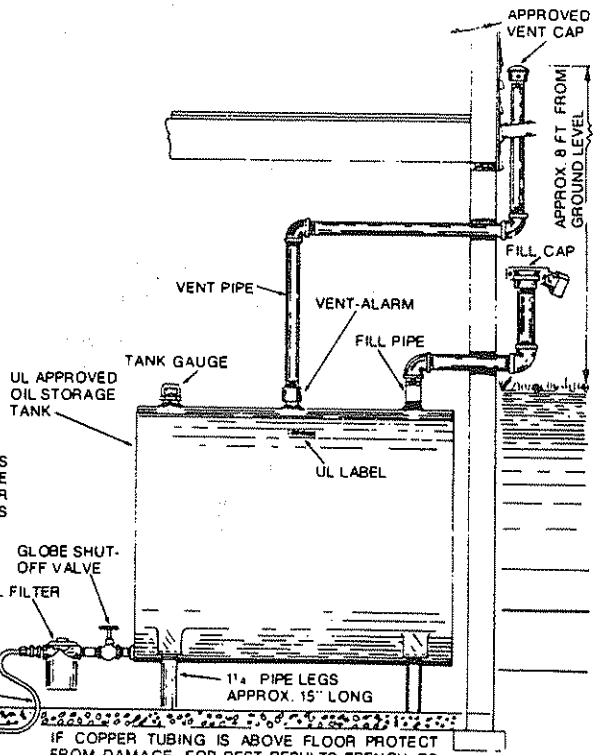
AFTER UNIT HAS BEEN WIRED, TANK PIPED AND BURNER CONNECTED. TURN ON MAIN SAFETY SWITCH. SET THERMOSTAT ABOVE ROOM TEMPERATURE. LOOSEN VENT PLUG "A" SO AS TO RELEASE AIR IN PUMP. AFTER OIL RUNS IN STEADY STREAM QUICKLY SCREW PLUG IN TIGHT — BURNER SHOULD START. THIS OPERATION MUST BE DONE RATHER QUICK BECAUSE YOU ARE WORKING AGAINST TIME.

NOTE:
LOCATION OF OIL TANK IN RELATION TO FURNACE, SIZE OF VENT PIPING (USUALLY 1¼"), SIZE OF FILL PIPE (USUALLY 2"), MUST CONFORM TO LOCAL FIRE BOARD REQUIREMENTS AND ORDINANCES.



IMPORTANT:
ON OIL FITTINGS AND PIPES USE A GOOD TYPE OF PIPE DOPE EITHER "PERMATEX" OR "GASOILA" OR ITS EQUIVALENT.

OIL STORAGE TANK CONNECTED TO BURNER USING SINGLE PIPE SYSTEM

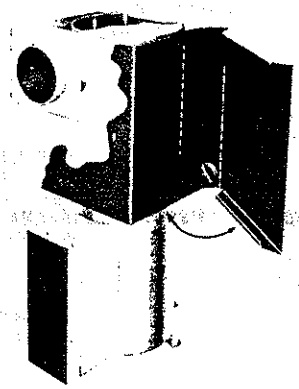


IF COPPER TUBING IS ABOVE FLOOR PROTECT FROM DAMAGE. FOR BEST RESULTS TRENCH OR BURY TUBE IN CONCRETE FLOOR. TUBING MAY BE COVERED ALONG OUTSIDE WALL. TUBING MUST BE CONTINUOUS PIECE. NO JOINTS OR COUPLINGS. THIS IS ESSENTIAL TO PREVENT LEAKS.

HEAT EXCHANGER

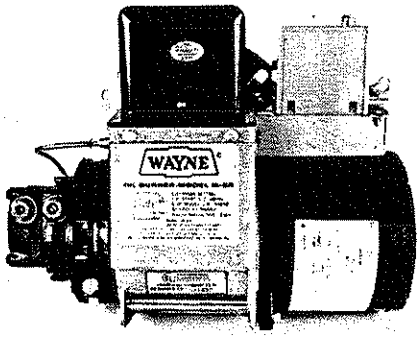
An oil fired heat exchanger has primary and secondary heating surfaces made of a combination of aluminized and cold rolled steel. The primary heating surface is that which surrounds the flame. The lower part of the primary section is lined with a refractory brick which prevents the flame from coming in direct contact with steel. The refractory quickly attains very high temperatures and radiates heat which enhances combustion characteristics. The secondary heating surface is a series of steel sections over which the hot combustion gases must pass before leaving the heat exchanger. This adds more heat surface to the heat exchanger. Usually there are clean-out openings provided in the secondary heating surface and a cleanout access in the primary section. The fire can be viewed through a peep hole in the cast iron inspection door.

HEAT EXCHANGER Wrap-around design provides more prime heating surface than most other furnaces. All welded construction from heavy-guage steel forms a safe, gastight, one-piece assembly.

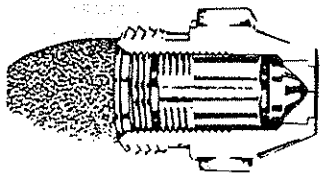


OIL BURNER

An oil burner assembly consists of a burner motor, combustion air blower, pump, ignition transformer and gun sub-assembly which includes electrodes. The oil burner motor supplies the power to drive the pump and the blower. The ignition transformer provides 10,000 volts to the electrodes which creates a spark to ignite the oil. The gun sub-assembly, sometimes called the oil line assembly, includes the oil nozzle, oil pipe and high tension wire leads to the electrodes.

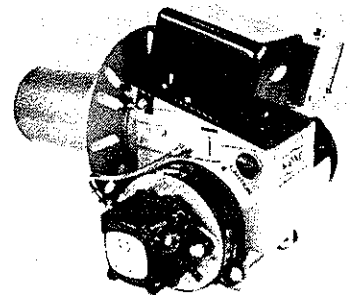


Oil Burner - Direct Drive



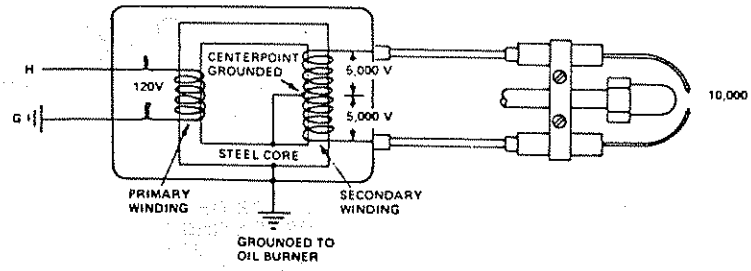
NOZZLE CUTAWAY

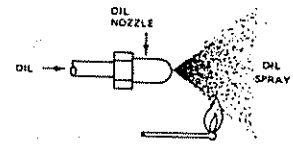
The oil pump pressurizes the fuel oil and forces it through a metering orifice in the nozzle. The orifice in a nozzle is highly engineered and machined to provide the proper oil flow and atomization at the recommended pressure, generally 100 psi. The nozzle projects a cone-shaped, fine spray of oil droplets into the combustion chamber of the heat exchanger. The blower provides combustion air which is mixed with the oil spray. The source of heat needed to vaporize and ignite the oil spray to get combustion started is provided by the high voltage electrical arc which jumps between the two electrode tips. When the burner starts, this arc is blown or fanned into the oil spray by the velocity of air combustion air. The arc is hot enough to vaporize the oil in its vicinity and to ignite that vapor. This ignited vapor then ignites the rest of the oil in the spray cone.

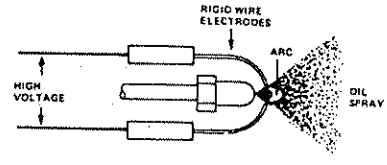


DIRECT DRIVE OIL BURNER

The side view of the gun assembly shows the position of the electrode tips in relation to the oil spray. Note that the tips are not in the oil spray but are close enough so that the arc can be blown into the spray. Otherwise, the oil would form a carbon bridge across the tips, shorting them out like a spark plug. The shape of the electrode tip is very important to produce a good arc. It is cone shaped with the end of the cone slightly flattened or dulled. In time this cone will tend to burn away from electrical erosion and widen the electrode gap. It then must be re-shaped with a file and the gap reset. The gap distance affects the temperature of the spark; the wider the gap, the cooler the spark.





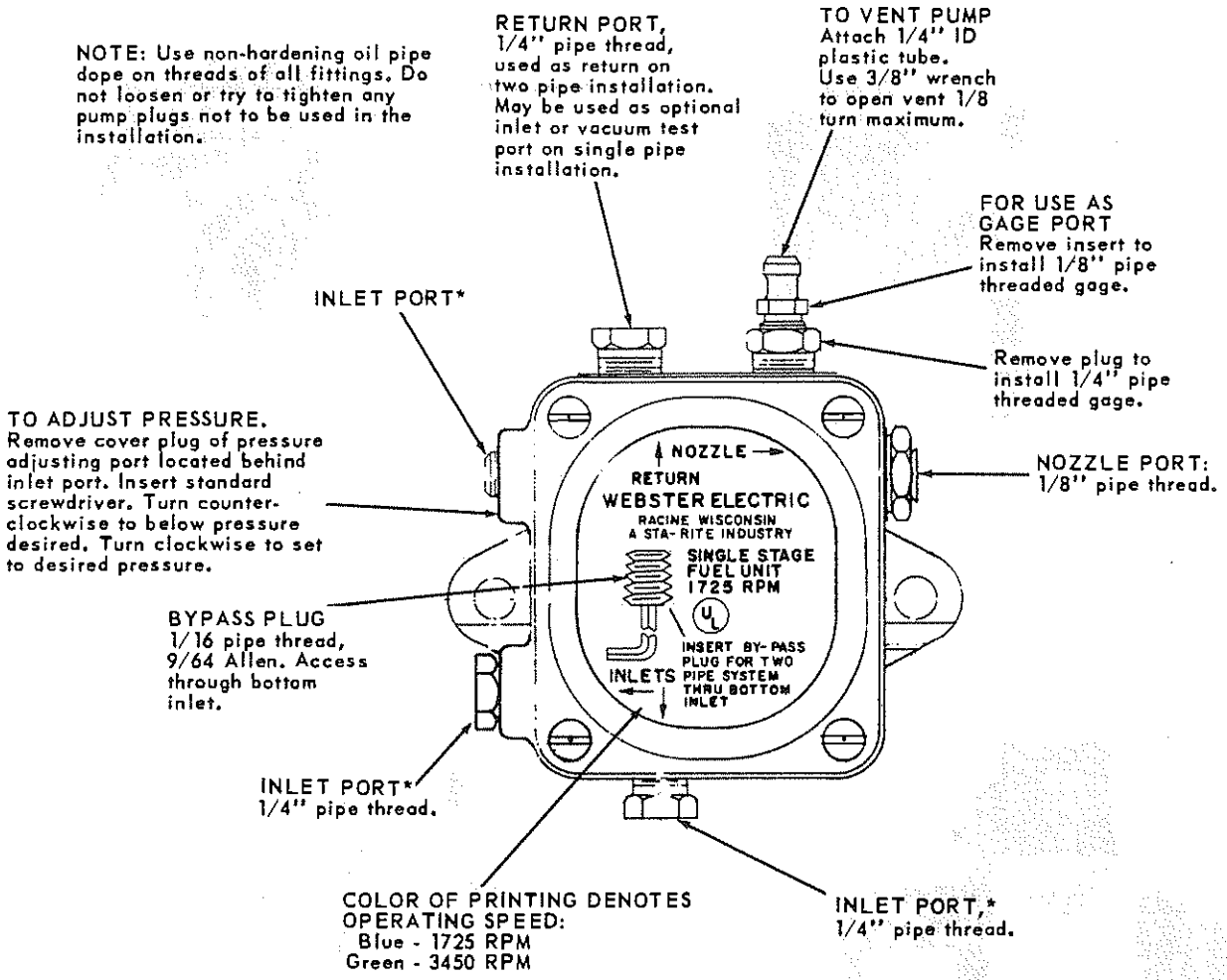


TYPICAL FUEL OIL PUMP

THE STANDARD WEBSTER "M" SERIES PUMP

Has These Features

- Fast Cut-off on -3 and -6 models
- Vacuum capability up to 10" Hg including piping and lift losses
- Single or two pipe installation
- Ratings to 15 GPH on #1, #2 fuel or kerosene



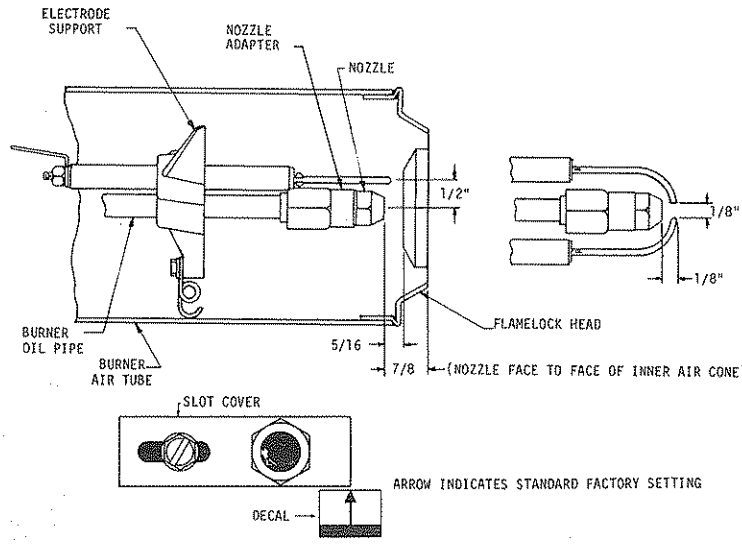
SINGLE PIPE INSTALLATION

1. Remove BYPASS PLUG if installed, through bottom INLET PORT.
2. Connect inlet line to preferred INLET PORT.
3. Plug all unused ports securely.
4. Start burner and bleed all air from the system by opening VENT PLUG. Close VENT securely when oil flow in tube is clear.

TWO-PIPE INSTALLATION

1. Insert BYPASS PLUG if not installed, through bottom INLET PORT.
2. Connect inlet line to preferred INLET PORT.
3. Connect return line to RETURN PORT.
4. Plug all unused ports securely.
5. Start burner. Unit will self vent.

***NOTE:** To assure compliance with National Fire Protection Association's bulletin 31, "Installation of Oil Burning Equipment", fuel unit inlet pressure should not exceed 3 psig.



The 10,000 volts to the electrodes is supplied by an ignition transformer. This is a set-up transformer which raises the voltage from 120 volts to the required 10,000 volts. Because this high voltage will cause current to flow through resistances which would block the flow of 120 volt currents, insulated conductors are needed. This insulation is provided by the electrode porcelain sleeves and special high tension wire conductors. These need to be kept clean or the high voltage will force the current to flow through a film of dirt, carbon, or oil on the surface of the porcelain and wire insulation. Some burners use a spring type bus bar in place of the flexible wire cables. These bus bars contact the terminals on the transformer by spring tension.

The 120 volt primary of the ignition transformer is connected in parallel with the oil burner motor. Therefore, the ignition spark is on whenever the burner is running and stays on until the burner is turned off. This is called continuous ignition. There are burner models that employ intermittent ignition. After a trial period for ignition and flame is established, the electrodes cease sparking by de-energizing the ignition transformer.

TRANSFORMERS

There are two types of transformers. One is equipped with snap on terminals for high tension leads, the other has bus bar contacts for spring load bus bars. Internally the transformer has 120 volt primary winding and 10,000 volt secondary winding on a steel core. The center of the secondary winding is grounded to both the core and transformer case. These in turn are grounded to the burner and furnace then to earth ground.

Each terminal of the secondary winding is 5,000 volts potential difference to ground even though the total between the electrodes is 10,000 volts. The reason for this center point grounding is to prevent more than 5,000 volts above ground which could cause arcing to the nozzle or other burner parts and overcome the resistance of the porcelain and conductor insulation.

BURNER MOTOR

Most residential burners use a 1/6 or 1/8 horsepower single phase motor. Motor speed can be either 1725 or 3450 rpm depending upon the design of the burner. These ratings along with the amperage draw are stated on the motor name plate. The combustion air blower is mounted directly on the motor shaft. The pump area is directly coupled to the motor shaft. The motor has the speed of 1725 rpm so the pump is directly coupled to the motor shaft.

The oil burner motor is equipped with a manual reset thermal overload protector. If the motor becomes overheated or overloaded, the protector trips and locks out so that the motor cannot recycle. The reset button located on the motor housing provides for manually restarting the motor.

PRIMARY CONTROL

All oil fired furnaces are equipped with a central electrical control for the oil burner to which the thermostat is connected and from which the burner and the furnace are controlled. It is called a primary control and is a combination ignition and safety control. Some old models were referred to as a stack control or protector relay. All of these terms mean the same thing.

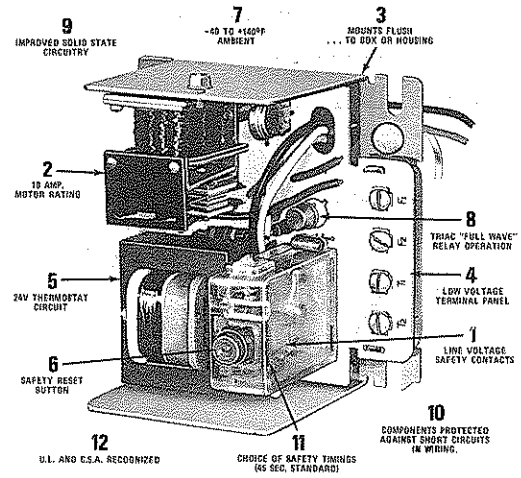
The function of the primary control is to supervise the operation of the burner, providing system safety by:

1. Sensing the presence or absence of flame and shutting down the system if the burner fails to function properly.

2. Being subordinate to the system temperature limit safety controls.

There are two basic types of primary controls. One is an intermittent ignition type which energizes the ignition system until the burner flame is proven and then turns off the ignition. The other type is a constant ignition type which keeps the ignition system energized throughout the entire burner on cycle.

The primary control contains a 24 volt transformer, internal relays including an oil burner relay, a flame detection circuit and a safety switch timer which monitors the system. The line voltage connections are made to pigtail wire leads and a junction box to which the control is attached. (See photo) Low voltage (24v) connections are made to a terminal block located on the base of the control. There are four low voltage connections in some primary controls and six in others. First, the four terminal connections which are common to all will be discussed.



PRIMARY CONTROL

One set of terminals is wired directly to the heating thermostat. These terminals are designated by the letters T1 and T2. A second set of terminals is connected to the flame detector which monitors the oil burner flame to determine whether or not the burner is lit. These two terminals are designated as F1 and F2 (sensor) in our example. Other primary controls may carry other designations such as FD and FD (flame detector). They may provide 24 volt power to the downflow or horizontal unit fan control. They will energize whenever the thermostat is calling for heat and are deenergized when the thermostat is satisfied.

WIRE LEADS

Some of the electrical connections provided in a primary control are wire leads or pigtails. These are connected into the circuit by twisting the exposed ends of the wires together and screwing an insulated wire nut over the bare leads. The wire nut secures the connection mechanically and insulates it electrically. Two or three wires may be twisted together and capped with one wire nut.

LINE VOLTAGE CIRCUITS

In the line voltage circuit the primary control is broken down into two circuits. The first is the 120V connections to the primary side of the control transformer. This connection usually consists of two pigtail leads, one white to the ground leg of the line voltage circuit and the other is black, and is connected to the high limit control. The secondary of the transformer provides 24V power to the control circuit.

The second line voltage circuit within the primary control is to the burner relay contacts. None of the internal circuits of the primary control are called out on a pictorial diagram. However, schematically the normally open burner relay contacts are wired in the hot leg of the burner circuit. The burner is connected to the white pigtail on one side and the orange pigtail from the primary control on the other side.

Now the line voltage section of the circuit is complete. The burner is both protected by the limit controls and can be turned on and off by the burner relay.

FLAME DETECTORS

All oil fired furnaces are equipped with a flame detector. It is a device which senses whether or not the burner flame is lit. This detector then sends a signal to the primary control which passes the information on to the other circuits.

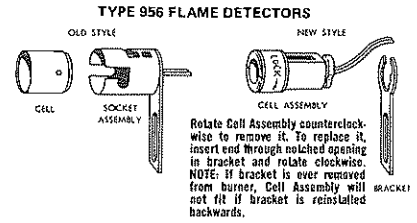
There are two types of flame detectors.

1. Stack mounted thermal sensors. These controls are mounted on the furnace stack or on the front of the furnace above the combustion chamber on equipment with low stack temperatures. They sense changes in stack temperature with a bimetal probe detector which actuates a push rod to break a cold contact and make a hot contact as the oil furnace fires.

2. Burner mounted cadimium sulphide flame detector. The light sensitive cad cell is mounted so that it views the oil flame. The variable resistance of the cad cell in the presence of light is used to actuate a sensitive flame relay which in turn controls the burner. The fast response of the cad cell to light eliminates the lag found in bimetal sensors making it especially advantageous for larger oil installations. (Used by Bard).

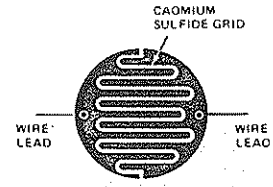
CADMIUM SULPHIDE FLAME SENSOR

Most newer model furnaces are equipped with a cadmium sulphide flame detector. This light sensitive detector is commonly referred to as a cad cell. It is a small device mounted in the oil burner which "looks" at a flame. It is like an eye because it can "see" whether there is light (a flame) or darkness (no flame).



Cadmium sulphide is a photo-conductive material. Its electrical resistance is high in darkness but becomes much lower in the presence of visible light. The more intense the light, the lower the resistance. Cadmium sulphide is applied to the cell in the form of a grid. The length and width of the grid determine the sensitivity of the cell to the light and the amount of current it can carry. The cadmium sulphide grid is enclosed in glass or plastic to protect the cell from air and moisture. A mounting bracket is provided so that the cell can be removed and replaced if necessary. In darkness, the resistance of the cell exceeds two million ohms (two meg ohms) which register on an ohm meter as infinity (∞). This high resistance prevents current from flowing across the cad cell which tells the primary control that there is no burner flame. In the presence of an oil burner flame, this resistance drops to less than 2,000 ohms (2K). In this range, the cadmium sulphide becomes a conductor which allows current to flow across the cell and tells the primary control that there is burner flame.

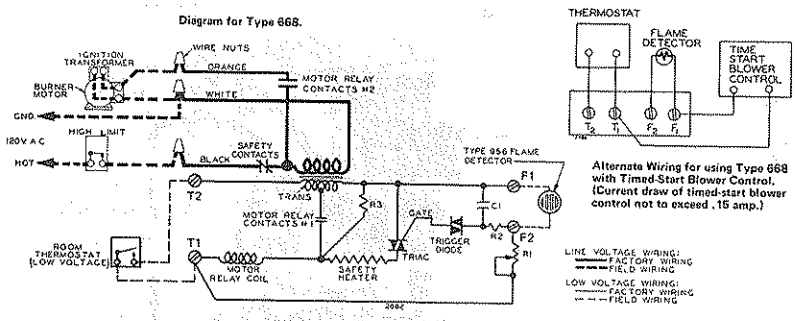
NOTE: The maximum allowable resistance in the presence of burner flame will vary somewhat between makes and models of the primary controls. Refer to the manufacturers' instructions for the maximum and optimum resistance.



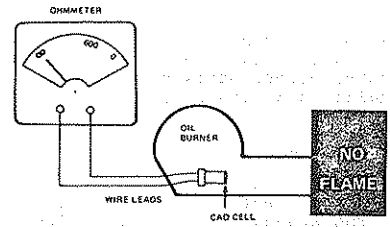
CAD CELL

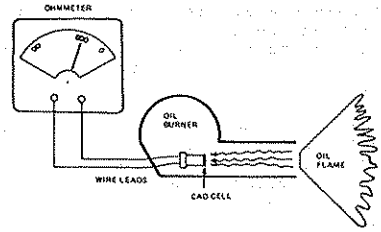
WIRING AND OPERATION

Diagram for Type 868.



Alternate Wiring for using Type 868 with Timed-Start Blower Control. (Current draw of timed-start blower control not to exceed .15 amp.)





MAINTENANCE CHECKSHEET

Dealer _____ Address _____
Customer _____ Address _____
Date _____ Person _____ Time In _____ Time Out _____
Equipment Make & Model _____
Notes _____

PRE-SERVICE CHECK

☐ Customer satisfied with system performance: _____

☐ Customer dissatisfied with system performance: _____

THERMOSTAT CHECKS

☐ Record thermostat settings: Temp: _____ °F. Mode: ☐HEAT ☐OFF ☐COOL FAN: ☐ON ☐AUTO
☐ Check terminal connections for tightness
☐ Clean bimetal. Inspect mercury switch
☐ Check thermostat for level
☐ Check control circuit amperage: _____ A
☐ If customer dissatisfied with temperature control in heating season, adjust anticipator to match control circuit amp draw
☐ Initiate appropriate seasonal demand from thermostat

BLOWER COMPARTMENT CHECKS

☐ Check supply voltage at junction box: _____ vac
_____ time
☐ Check blower motor amperage: _____ A
_____ nameplate rating
☐ Turn power at unit main disconnect to OFF
☐ Check all wiring for loose connections and bad insulation
☐ Clean or change filter

Direct Drive Blower

☐ Check blower bearings
☐ Lubricate blower bearings
☐ Clean blower and compartment
☐ Check blower wheel for free and balanced rotation
☐ Check all blower housing mounts and setscrews for tightness
☐ Unused motor leads taped and out of way

Belt Drive Blower

☐ Remove blower belt and check for wear
☐ Check motor bearings for wear
☐ Lubricate motor bearings
☐ Check blower wheel bearings for wear
☐ Lubricate blower wheel bearings
☐ Clean blower and compartment
☐ Check blower wheel for free and balanced rotation
☐ Check pulley alignment
☐ Check motor and blower pulley setscrews for tightness
☐ Put belt back on blower and motor pulley and check belt tension
☐ Check all blower housing and motor mounts for tightness

HEATING SECTION CHECKS

ELECTRIC

☐ Check electrical wiring -- connections and insulation
☐ Check amperage draw of each element
☐ Check total amperage draw of elements _____ amps
☐ Check temperature rise _____ °F.
☐ Return outdoor thermostats to original settings if present

GAS

☐ Check all electrical wiring for loose connections and damaged insulation
☐ Check burners for lint, dust and scale
☐ Check for cracks in heat exchanger
☐ Check pilot flame
☐ Check for quiet, even burner ignition
☐ Check manifold gas pressure NAT. _____ in. wc. L.P. _____ in. wc.

Standing Pilot

☐ Check thermocouple open circuit _____ dcmv
closed circuit _____ dcmv
☐ Check pilot valve safety drop-out time _____ min.
☐ Check automatic vent damper system
☐ Check electronic spark ignition control
☐ Check safety lockout
☐ Check limit safety
☐ Check temperature rise ___ °F.
☐ Check draft diverter
☐ Check furnace vent for rust
☐ Gas manifold hand valve is open before leaving

OIL

☐ Check electrical wiring -- connections and insulation
☐ Inspect combustion chamber
☐ Inspect for soot in heat exchanger
☐ Check fuel oil tank for sludge/water
☐ Change oil line filter
☐ Check oil lines
☐ Service oil burner
☐ Conduct combustion efficiency test
___ in wc. ___ smoke ___% CO2 ___ °F. net
☐ Check limit safety
☐ Check temperature rise
☐ Check primary control
☐ Check furnace vent for rust

COOLING

☐ Check electrical wiring -connections and insulation (indoor)
☐ Check/clean evaporator coil
☐ Check/clean condensate drain
☐ Check static pressure drop ___ in. wc. ___ cfm (dry coil)
☐ Check wiring — connections and insulation (outdoor)
☐ Check/clean condenser coil
☐ Lubricate condenser fan motor
☐ Check line set and connections for evidence of leaks
☐ Check and record supply voltage
☐ Check refrigerant charge
☐ Check amperage draw on condenser fan motor
☐ Check amperage draw on compressor

HUMIDIFIER

☐ Check electrical wiring — connections and insulation
☐ Check transformer voltage _____ vac
☐ Check damper position

SPRAY TYPE

☐ Check solenoid valve
☐ Check nozzle spray pattern

DRUM TYPE

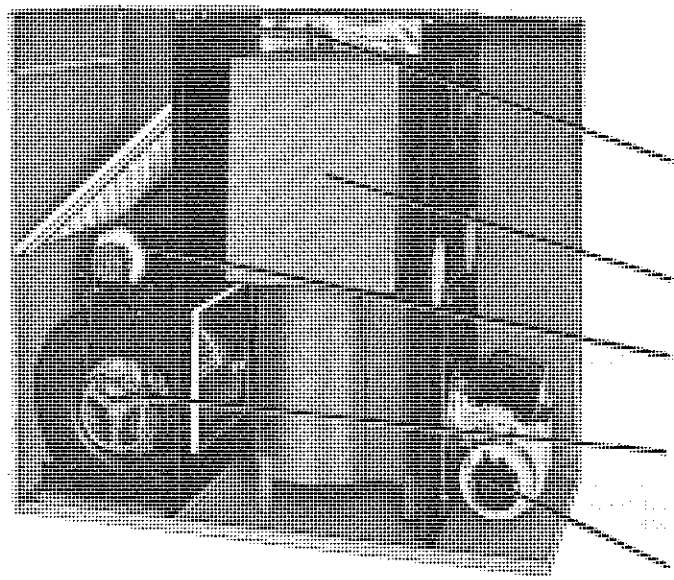
☐ Check for free rotation and scale
☐ Check water level adjustment
☐ Check overflow/drain line

ELECTRONIC AIR CLEANER

☐ Check electrical wiring — connections and insulation
☐ Check sail switch or electrical blower interlock
☐ Check test button operation
☐ Check supply voltage _____ vac (120 vac)
☐ Check voltage to collecting plates _____ vdc (3500 vdc)
☐ Check voltage to ionization wires _____ vdc (8000 vdc)
☐ TURN POWER OFF
☐ Wash cells
☐ Wash prefilter screens

POST-SERVICE CHECKS

☐ Return thermostat to original settings recorded at beginning of service call
☐ Leave copy of completed checksheet with customer
☐ Power ON before leaving



Steel Cabinet is accoustically and thermally insulated for quieter operation and minimum heat loss.

Fan and Limit Control with helex element automatically controls blower and burner operation.

Heat Exchanger provides more heating surface for efficiency.

Motor has resilient base mounting for both heating or cooling applications.

Blower is centrifugal type, dynamically balanced and mounted on rubber grommets for quieter operation.

Burner is designed for super-quiet efficiency.

TYPICAL LOW-BOY OIL FURNACE

OIL

☐ Check electrical wiring, connections and insulation.

☐ Inspect combustion chamber.

1. Using a hand mirror and a trouble light, visually inspect the combustion chamber. Look for carbon buildup, holes in combustion chamber and burned off oil burner head.

☐ Inspect for soot in heat exchanger.

1. Remove flue pipe.
2. Inspect inside flue and inside drum for carbon.

Note: Do not clean heat exchanger unless excessive carbon or scale is evident from an inspection.

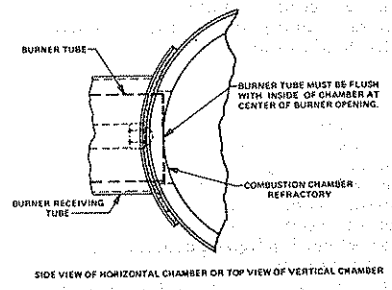
CLEANING OF FURNACE

All units have one or more clean out plugs for easy cleaning of the heat exchanger. They are accessible either from the front or back on some units and the sides on other units. The furnace should be checked periodically to see if it needs cleaning.

1. Remove the two cleanout plugs.
2. Remove gaskets
   Note: Be sure to have replacement gaskets on hand or 1/8 inch asbestos sheet to make new gaskets. Always wet asbestos before replacing cleanout covers.
3. Brush out clam shells with long wire brush. Insert brush in top of clam shell, push to rear, lower brush and pull scale forward. Then remove with scooper vacuum.
4. Clean flue pipes and inspect for damage in loose connections.
5. Replace all gaskets and plugs by reversing steps 1 through 3.
6. Replace burner in preparation for fire panel combustion check.

WARNING: To prevent burn-out of the furnace receiving tube or damage to the burner tube, the end of the burner tube must be flush with the inside of the combustion chamber.

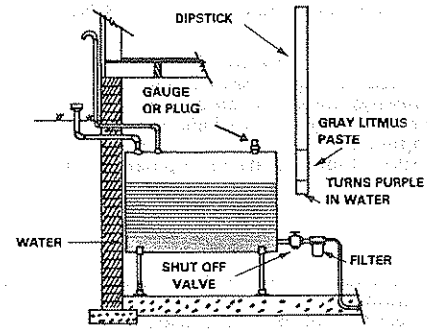
If the front of the chamber is flat the burner tube must also be flush with the inside of the chamber.



SIDE VIEW OF HORIZONTAL CHAMBER OR TOP VIEW OF VERTICAL CHAMBER

☐ Check fuel oil tank for sludge/water.

1. Check fuel level in oil tank by reading gauge or using dip stick.



LITMUS PASTE USAGE

2. At the same time, check for water in the tank using litmus paste on the end of the dip stick. Water level should not exceed one inch in bottom of tank. Water is indicated when litmus turns purple.

3. Inspect tank for damage, oil seepage around connections and for secure mountings.

4. Clean tank of excess dirt and oil film on outside of tank.

5. Close oil tank valve in preparation for servicing the oil line filter.

☐ Change oil line filter.

1. Determine the make and type of replacement cartridge needed. This information is on the filter bowl. Make sure the correct replacement cartridge is on hand or obtain one before attempting to effect a replacement.

2. Place a container below the filter to catch any oil which may be spilled. This will also serve as a container for the oil cartridge.

3. Unscrew the bowl mounting screw and carefully remove the bowl. Quite often it will have to be gently pried loose or given a light tap to break the gasket seal. BE CAREFUL NOT TO PLACE A STRAIN ON THE SHUTOFF VALVE AND LINE CONNECTIONS.

4. Remove the filter and place it in the container. Also dump the oil from the filter bowl into the container.

5. Wipe the inside of the bowl CLEAN.

6. Remove ring gaskets from filter cap.

7. Insert the new filter into the bowl. Also remove and replace the oil gasket with a new one packed with the replacement cartridge.

8. Reinstall the bowl and firmly tighten the mounting bolt.

9. Most filters are provided with bleed ports to purge the air from the filter. Loosen the bleed port or ports and slowly open the oil tank valve. When clear oil starts to discharge from the ports, close the tank valve.

10. Tighten the bleed ports. Then wipe dry the entire filtered housing in all line connections on the filter and shutoff valve.

11. Open the shutoff valve all the way and inspect all connections and gaskets for any sign of a leak. Correct the cause of the leak, if necessary.

☐ Check oil lines.

1. Inspect all oil lines between the oil tank and burner for damage, loose connections or breaks.

2. Check for proper support of oil lines and exposure to possible damage. A loose line will vibrate and transmit noise back to the oil tank.

☐ Service oil burner.

1. Turn power "off".

2. Open hinge to transformer by loosening locking tab screw.

3. Loosen oil line nut.

4. Remove the gun assembly.

   CAUTION: Do not loosen or change position of oil pipe stop (metal stop, generally located on bottom of burner). Otherwise, the entire burner must be removed from furnace and air deflector position must be reset.

5. Clean burner tube.

6. Clean blower wheel.

7. Loosen electrode clamp locking screw.

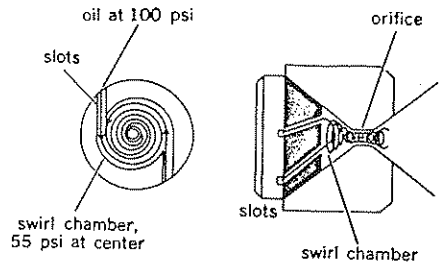
8. Remove, clean and inspect electrodes. Replace if cracked or chipped.

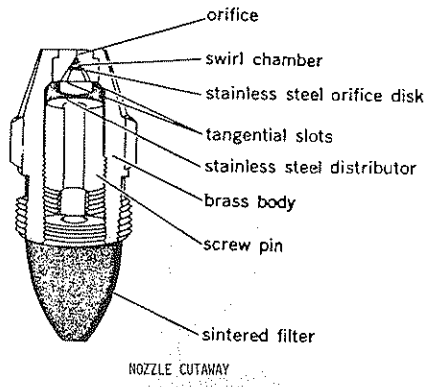
9. Dress up the electrode tips with a file to obtain a flattened cone point.

10. Replace nozzle only if necessary. If it is necessary, first determine size and spray angle (marked on body of old nozzle). Replace only with nozzle of like size, spray angle and spray type.

11. Remove old nozzle with nozzle wrench.

12. Carefully handle replacement nozzle with clean hands to prevent contamination.

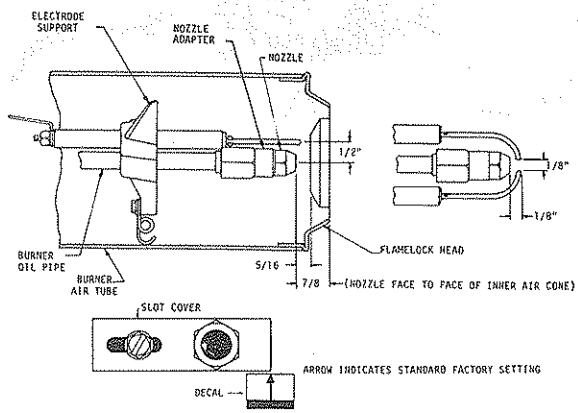




NOZZLE CUTAWAY

13. Seat the new nozzle with a firm squeeze of nozzle wrench handles. Don't overtighten.

14. Replace the electrodes and tighten electrode clamp.



15. Check the position of the electrode tips for gap and spacing from nozzle.

16. Check alignment of bus bar contacts.

17. Unplug cad cell and wipe lens with a soft clean cloth. Re-install lens.

18. Replace gun assembly and reassemble.

HOW TO CHECK COMBUSTION WHEEL ON A DIRECT DRIVE OIL BURNER

☐ Check combustion air blower wheel.

1. Slide fingers through burner air intake and feel the edges of the blower wheel blades. Generally, dirty or clean wheels can be determined in this manner. If a dirty wheel is found, remove wheel from burner and clean.

   a. Remove motor mounting bolts.

   b. Disengage coupling from pump with 1/4" Allen wrench.

   c. Remove motor and blower wheel from burner.

   d. Clean scroll.

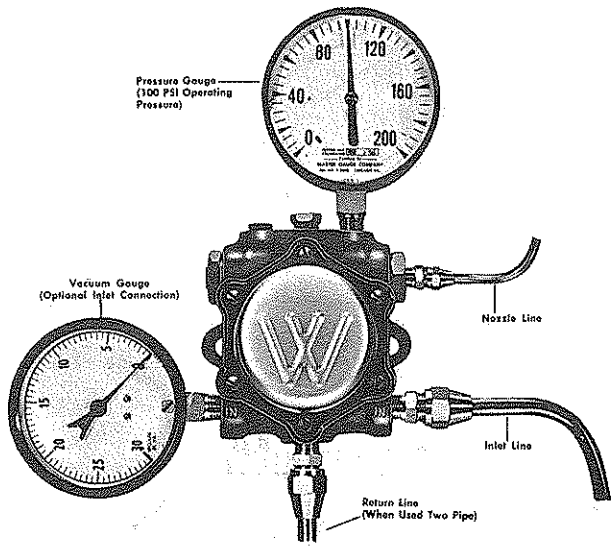
☐ Check burner motor drive belt or coupling.

1. When checking for line on blower wheel blades, push wheel with fingers to determine if coupling is loose on pump or motor shaft.

2. If loose, tighten Allen screws. The wheel must be removed to get to the set screw for the motor.

☐ Check fuel oil pump pressures.

1. Listen for pump whine (indication of high suction and restriction in supply line). Install vacuum gauge in supply line. Vacuum should be less than 5 inches (gravity feed) or not more than 10 inches (outside buried tank-oil level below burner).



2. Install pressure gauge on pump gauge port and read pressure. The pressure should be 100 psi.

   a. Fuel pressure too low - adjust pressure to 100 psi.

   b. Coupling disengaged or broken (no pressure) re-engage or replace coupling.

☐ Conduct combustion efficiency test.

1. Make sure the inspection door is tightly closed.

2. Allow the burner to run for at least 10 minutes before making the combustion check.

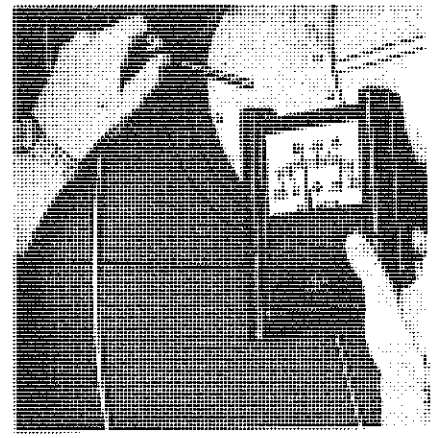
DRAFT GAUGE (PROCEDURE)

a. Make sure the draft gauge is level.

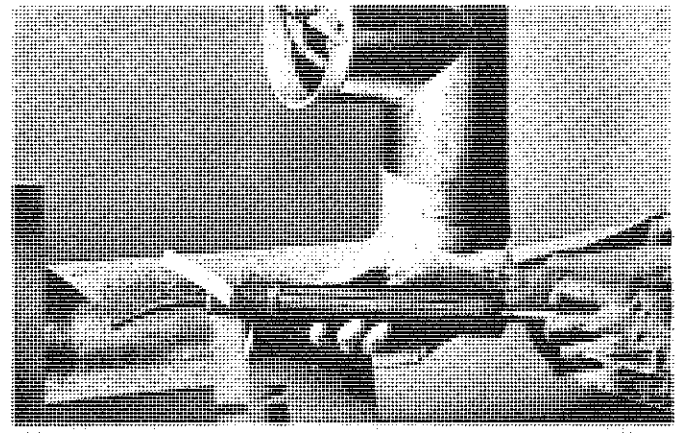
b. Adjust the draft gauge to zero.

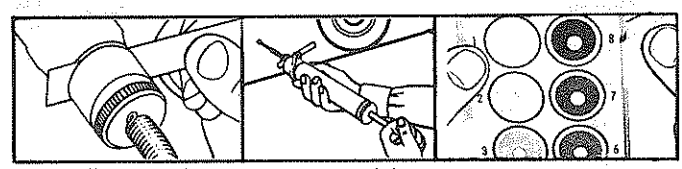
c. Insert draft tube into test hole in vent.

3. Take a draft reading in the vent and record. If necessary, readjust barometric damper to obtain between 0.03 and 0.04 inches draft.



4. Take a draft reading through the inspection door and record. If the difference between this reading and the vent reading is more than 0.02 inches, a dirty or restricted heat exchanger is indicated.





Smoke Test.

5. Take smoke reading in the vent pipe. Record.

SMOKE TESTER (PROCEDURE)

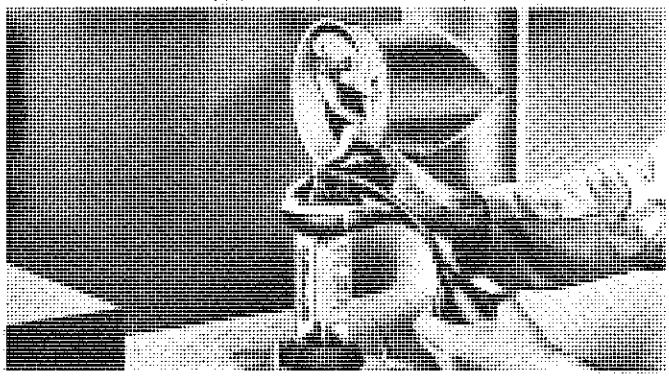
a. Insert the tester sampling tube into the vent pipe sampling hole.

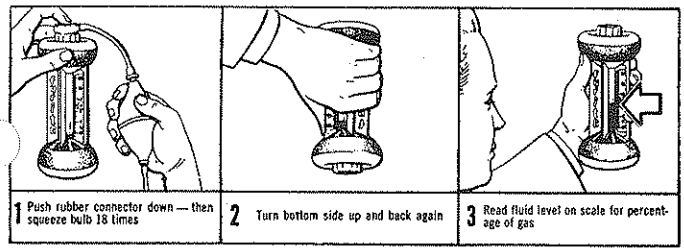
b. Place the filter paper into the "holding slot" of the tester.

c. Pull smoke tester handle through ten full pump strokes, holding for several seconds between each pumping stroke.

d. Compare the smoke spot on the filter paper with the Smoke Scale Numbers on the scale, matching the sample with the closest color on the smoke scale. Not more than No. 1 spot. On some older furnaces, it might be a No. 2 spot.

6. Take a CO_2 reading at the same location and record.





CO_2 Test.

CO_2 INDICATOR (PROCEDURE)

a. Depress the plunger valve and adjust the CO_2 scale to 0.

b. Insert the sampling tube of the CO_2 indicator's gas aspirating assembly into the hole in the flue pipe. The rubber cap end is placed on the top, or plunger valve, of the indicator and held at a depressed position. The aspirator rubber bulb is next squeezed 18 times in succession. On the 18th squeeze, the depressed plunger valve is released before releasing the rubber bulb.

c. The indicator is now turned over twice, permitting the test fluid to run back and forth, and forcing it to absorb the flue gas sample. This turn-over motion is the same action one might make with an hourglass or egg-timer.

d. The indicator is placed or held in an upright, level position and the test liquid is read on the scale which is calibrated directly in percent CO_2.

7. The CO_2 should be between 8 and 10 percent and the smoke reading should not be more than a No. 1 spot.

8. If the smoke is more than No. 1, open the combustion air control until the smoke drops to the No. 1 reading, then recheck the CO_2. It should not be less than 8%.

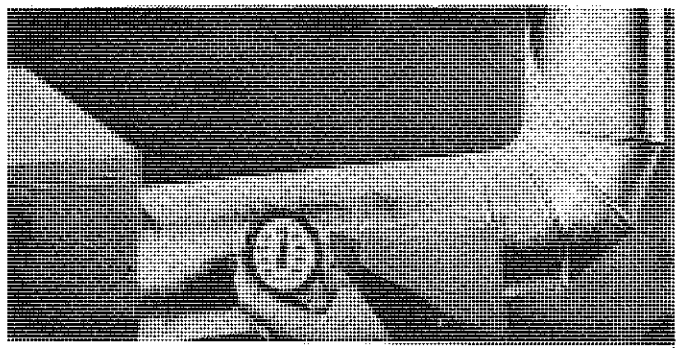
NOTE: After changing the air setting allow the burner to run for 3 or 4 minutes before again checking smoke and CO_2.

9. If the CO_2 is less than 8% but the smoke reading is 0, then close the combustion air control until a light No. 1 smoke reading is obtained. Tighten control locking screw.

10. If the CO_2 reading is less than 8% and the smoke more than No. 1, then corrective measure must be taken.

    a. Check for leakage around the inspection door, burner receiving tube and at the flue pipe connection.

    b. If there is no air leakage, then the nozzle may be bad and need replacement.



Stack Gas Temperature Test.

11. Measure the stack temperature, record.

STACK THERMOMETER (PROCEDURE)

a. Insert thermometer into the flue pipe sampling hole.

b. Read the temperature on the scale when the temperature has leveled out (ceases to increase).

c. Determine the "net" stack temperature by subtracting the basement air temperature from the thermometer.

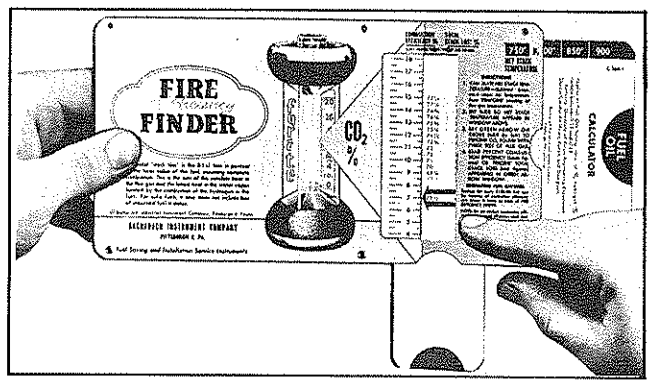
12. Check combustion inefficiency. This is determined by the measured CO_2 and net stack temperature. These two values should be set on the efficiency slide rule as described below. The efficiency should not be less than 75%. If it is less than 75% and the CO_2 and smoke are satisfactory, then the stack temperature is too high. Check the causes of high stack.

    a. Too much restriction in warm air or return air system.

    b. Over-fired unit-nozzle too large.

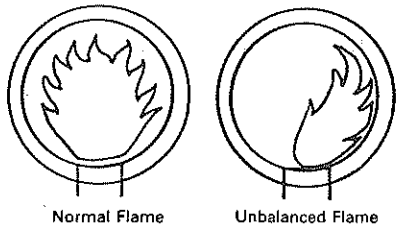
COMBUSTION EFFICIENCY (PROCEDURE)

The slide rule has horizontal and vertical slide inserts. The horizontal slide is moved until the "net" stack temperature appears in the window marked "stack temperature". Next, the vertical slide is moved until the black arrow points to the measured percent CO_2. Percent combustion efficiency in stack loss are then indicated in the cut-out of the arrow on the vertical slide.



Combustion Efficiency Check.

13. Check flame with mirror. A poor or unbalanced flame indicates a bad nozzle.



☐ Check limit safety.

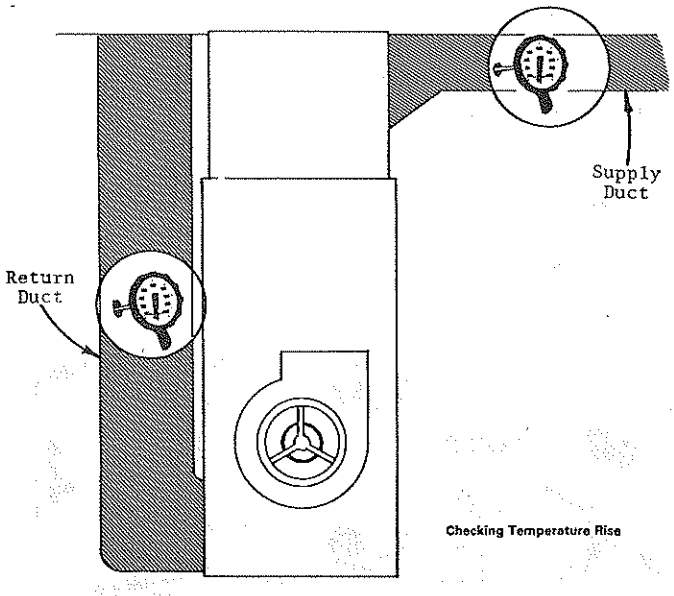
1. Turn off power to furnace.
2. Disconnect one lead to blower motor.
3. Insert high temperature thermometer in plenum.
4. Turn power on and thermostat up. Furnace should shut off on limit when temperature reaches about 200°F. plus or minus 10%. This should take place in about 2 or 3 minutes.

☐ Check temperature rise.

If the homeowner is satisfied with the comfort level in the home, this check could be skipped.

1. Make sure all doors are on furnace.
2. Place the thermometer in supply plenum positioned out of direct line of the heat exchanger.
3. Place thermometer in return air plenum close to the furnace.
4. There should be 85 degrees to 95 degrees difference between the thermometer in the return air duct and the thermometer in the supply duct.
5. If the temperature difference is less than 85 to 95 degrees, the blower is running too fast. Slow blower down.
6. If the temperature difference is more than 85 to 95 degrees, the blower is running too slowly, speed it up.

NOTE: Systems with less Btu will have lower temperature rise. Check AGA name plate for correct temperature rise.

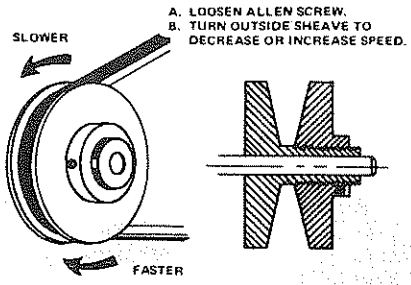


Checking Temperature Rise

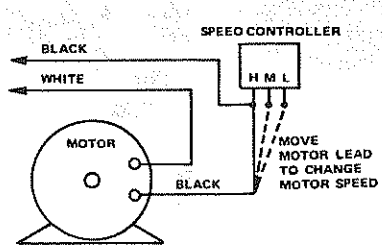
HOW TO REDUCE OR INCREASE BLOWER SPEEDS

The speed of the various types of blowers can be changed where necessary in the following ways:

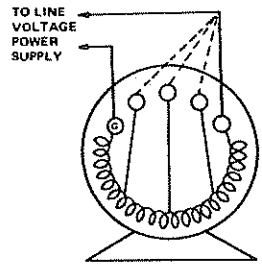
BELT-DRIVE ADJUSTABLE SHEAVE



DIRECT-DRIVE SPEED CONTROLLER



TAP WOUND MOTORS



USE PROPER COLOR TAP FOR APPROPRIATE SPEED.

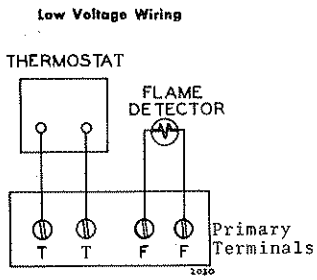
☐ Check primary controls.

CHECK CAD CELL

Cad cell leads are connected to terminals indicated. Either may be connected to either terminal since there is no polarity.

1. While the burner is operating disconnect the cad cell leads at the primary controls. The burner should stop in 30 to 90 seconds. If it does not, the primary control is faulty and should be replaced.

2. After two minutes, connect an ohmeter to the cad cell leads and read the cell resistance. This resistance must be more than 100,000 ohms. A lower reading indicates light leakage into the burner. Check all burner access openings and seal against light if necessary.



3. Turn off the disconnect switch. Insert a jumper wire into one of the cad cell connections on the primary control.

4. Turn the power back "on." Burner should not start. If it does, the primary control is faulty and should be replaced.

5. Push the reset lever on the primary control. The burner should start.

6. When the burner has fired, jumper the cad cell connections on the primary control.

7. While the burner is running, read the resistance of the cad cell. It should not be more than 1000 ohms. If the resistance exceeds 1000 ohms, the cad cell is either dirty or faulty. Clean or replace the cell when oil burner service is reached.

Possible Cause of Trouble	Correction
Open circuit in Cell	Replace Cell (or Cell Assembly) of 956 Flame Detector. Do not disturb position of bracket or socket assembly.
Flame detector improperly positioned.	Locate flame detector according to the burner manufacturer's specifications.

8. Turn off the power, burner will stop. Turn the power back on and burner should not start. If it does, the primary control is faulty and should be replaced. Turn off the power, remove the jumper wire and reconnect the cad cell leads to the primary controls.

9. Turn power "OFF". Remove the jumper wire and reconnect the cad cell leads to the primary control.

☐ Check furnace vent for rust.

BENCH PRIMARY CONTROL CHECK OUT

1. Connect light bulb in place of the oil burner motor using the orange and white wires.

2. Apply 115 volt power as per diagram.

3. Check transformer for 24 volts across R & C, stick wire in R & C terminals. Wipe ends to see if you get spark. If you get spark, transformer is OK. If not, transformer is defective; no further need to check control.

4. Jumper R & W low voltage terminal block.

5. Place a 2000 ohm resistor in one terminal of flame detector F terminal.

6. Energize power supply.

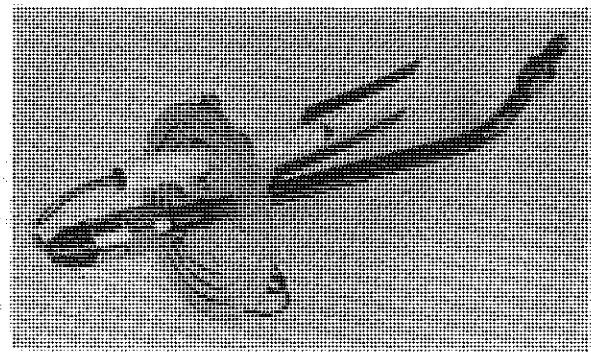
7. Reset manual reset.

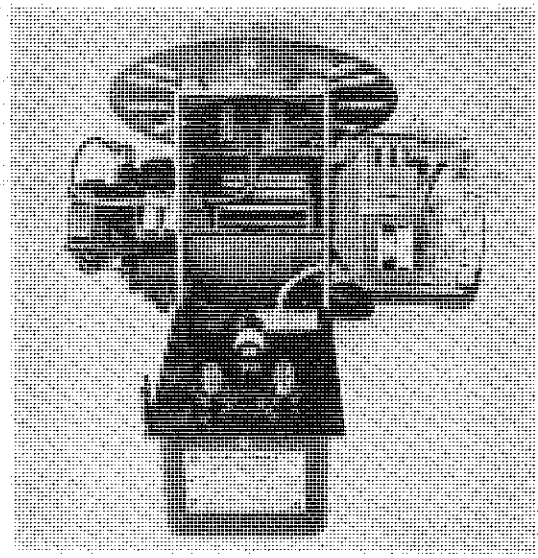
8. Bulb should light indicating burner is operating.

9. Let control operate in this fashion. Control should trip out on safety in 30 to 50 seconds. Light bulb goes out. This proves safety switch is working properly.

10. Let safety switch cool for about 5 minutes or a little longer.

11. Reset manual reset lever.





COMBUSTION SERVICE RECORD

For Use with BACHARACH Combustion Testing Instruments

HIGH PRESSURE GUN-TYPE BURNERS

Owner_____

Street_____

City_____ Phone_____

Occupant_____

Street_____

City_____ Phone_____

Work Authorized ☐ by Owner ☐ by Occupant _____
Signature of person authorizing work

Order No._____ Date_____

Taken by_____

Condition Reported

☐ No Fire ☐ Insufficient Heat
☐ Excessive Oil Consumption ☐ Odor
☐ Burner Ignites, then Goes Out ☐ Noise
☐ Burner puffs . . . ☐ On Start; ☐ On Stop
OTHER_____

When Service Wanted

DATE_____ TIME_____
☐ PHONE FOR APPOINTMENT_____

Job Assigned to:

NAME_____ DATE_____

Job Completed:

DATE_____ TIME_____
BY_____
Signature of Service Man

I—Preparing for Combustion Test

1. Open main burner switch.
2. Inspect and clean out accumulated oil in combustion chamber.
3. Advance thermostat. (5-10° F.)
4. Close remote control burner switch.
5. Make ¼" diameter hole in flue pipe and overfire (for BACHARACH test instruments).
6. Insert TEMPOINT thermometer (200-1000° F. range). through ¼" diameter hole in flue pipe.
7. Open inspection port or door.
8. Adjust flame mirror.
9. Close main burner switch. (Starting burner.)

II—Combustion Test Procedure and Inspection Data

STEP	Observe—and mark with √		TEST NO. 1	2	3	4
1	**FLAME IGNITION**	Instant				
		Delayed				
		Doesn't Ignite				
2	**FLAME COLOR** If flame shows two colors check both	Orange				
		Yellow				
		White				
		Sparks				
3	**FLAME SHAPE**	Uniform				
		Lop-sided				
4	**FLAME IMPINGEMENT**	At bottom				
		At sides				
		At rear				
5	**ODOR** Use Symbol (x) • (√)	Near Burner				
		Draft Regulator				
		Observation Door				
6	**NOISE** Use Symbol (x) (√)	Rattle				
		Hum				
		Pulsation				
		Start				
		Running				
		After fire				
7	**SOOT DEPOSIT** Use Symbol (x) (√)	Flue				
		Comb. Chamber				
		Furnace/Boiler				

Symbols — (x) = Heavy, (√) = Light

STEP	Observe—and write in data	TEST NO. 1	2	3	4
8	(Close observation door) **OVERFIRE DRAFT** in inches Water				
9	**TEMPOINT READING FLUE GAS TEMP. °F.** When constant temperature is reached				

STEP	Observe—and write in data		TEST NO. 1	2	3	4
10	**AIR TEMP. °F.**					
11	**NET STACK TEMP. °F.** Subtract basement temp. (step 10) from flue gas temp. (step 9)					
12	**FLUE DRAFT** in inches water, (use same hole used for stack temp. test)					
13	**FYRITE READING % CO_2** (use same hole used for stack temp. test)					
14	**TRUE-SPOT SMOKE READING** (use same hole used for stack temp. test)					
15	**FIRE EFFICIENCY FINDER % COMBUSTION EFFICIENCY**					
16	(Open Main Burner Switch) **FLAME CUT-OFF (Seconds)** Estimate time required in seconds for flame to disappear after burner stops					
17	(Close Main Burner Switch) **OIL PRESSURE (psi)** Measured with oil gauge installed on pump					
18	**FEED LINE SUCTION (inches)** Measured with vacuum gauge installed in feed line					
19	(Open Main Burner Switch Remove Nozzle Assembly) **NOZZLE** (service if necessary, then reinstall)	Size—Gph				
		Type—S/H				
		Spray Angle				
20	**COMBUSTION CHAMBER SIZE**	Depth "				
		Length "				
		Width "				
		Area sq. in.				

Use Reverse Side to List Equipment and for Notes and Comments

III—Adjustments and Repairs

Make adjustments, install replacements, and tune-up as required. Indicate, in spaces provided below, work done before repeating the tests listed under "II".

Write in "A" for "Adjust"; "C" for "Clean", "R" for "Replace". Mark "√" for other work, and describe it on the back of this sheet, if necessary.

WORK PERFORMED	BEFORE TEST NO. 2	3	4
BURNER AIR SHUTTER			
SEAL AIR LEAKS			
BURNER AIR BLOWER			
TURBULATOR			
AIR CONE			
BAROMETRIC DAMPER			
BURNER IGNITION—SAFETY CONTROL			
LIMIT CONTROL			
ELECTRODES			
ELECTRODE CABLE			
TRANSFORMER			
AIR FILTERS			
NOZZLE			
NOZZLE STRAINER			
PUMP STRAINER			
PUMP			
OIL FILTER			
OIL PRESSURE			
PUMP CUT OFF			
COMBUSTION CHAMBER			
BURNER POSITION			
BELT-COUPLING			
OIL LINE			
CHIMNEY REPAIRS			
FURNACE/BOILER CLEANED			

IV—Final Inspection

(a) Repeat the combustion check-ups listed under "II", and enter data in proper spaces.

(b) Check each of the following for proper setting, operation, or condition.

☐ MAIN BURNER SWITCH ☐ THERMOSTAT
☐ BLOWER CONTROL ☐ LIMIT CONTROL
☐ PUMP CONTROL ☐ LUBRICATION
☐ LOW WATER CUT OFF ☐ OIL LEAKS
☐ CIRCULATING-AIR FAN ☐ AIR FILTERS

CONDITION OF FUEL OIL_____
FLAME FAILURE CUT OFF TIME_____ SEC.
IGNITION CUT OFF TIME_____ SEC.

F 50-2-R