SERVICE MANUAL
for
Oil Fired Heaters

Low Pressure **High Pressure** **Indirect Fired**

PHP

Preface

Thank you for your purchase of the Oil Fired Heater Service Manual. The manual covers the three types of oil fired heaters: low pressure, high pressure and indirect. If you are not sure what type of heater you have refer to the "Definitions of Oil Fired Heater Types". The major manufacturers or brands of each type of heater are listed. If you are unsure of the manufacturer of your heater, refer to "Identifying Heater Manufacturers".

Safety is very important. Please take a moment to read the "Safety Precautions" section of this manual as well as those of your heaters owners' manual.

The "Theory of Operation" provides an overview of how the heater operates. "Component Description and Operation" explains in detail how each separate part in the heater functions. To use the "Troubleshooting" section, first carefully observe your heater for a symptom, and then turn to the appropriate page for that symptom. For each observed symptom there is a list of possible causes with a solution for each cause.

Remember Portable Heater Parts can help with your technical assistance needs and provide a fast, accurate source for heater parts of all brands and types.

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Safety Precautions

These precautions are in addition to those stated in the owner's manual by the manufacturer of the heater.

Ventilation

Always provide adequate ventilation to ensure a sufficient supply of fresh air. Allow at least 3 square feet of opening per 100,000 btu of heater output. For example: a 50,000 btu heater would require at least 1-1/2 square feet of opening to supply enough fresh air for safe operation. Early signs of carbon monoxide poisoning resemble flu-like symptoms such as headache, dizziness and/or nausea.

Fuel

Only use manufacturers recommended fuels. Never use gasoline, paint thinner, solvents or other flammable liquids.

Electric Shock

Take care to avoid electric shock. A thermostatically controlled heater can turn back on at any time, so always unplug the heater before attempting to perform service work.

Burn Hazard

Do not attempt to service a hot heater. Allow the heater to cool down before performing service work.

Safety Systems

Occasionally to troubleshoot a heater, a safety system will be temporarily by-passed as a test only. Never by-pass a safety system as a repair solution.

Defining Oil Fired Heaters

This book is about oil fired torpedo heaters.

Low Pressure

Low pressure heaters operate with an air pump which consists of a rotor and vanes. Operating pressure rarely goes above 9.0 PSI.

High Pressure

High pressure oil heaters use a mechanical gear type fuel pump driven by the motor to reach a high level of pressure. Operating pressure can vary considerably. Most heaters fall within a range of 80 to 175psi.

Indirect Fired

Indirect oil heaters separate the products of combustion and moisture from the heated output air. The separation is accomplished by the use of a heat exchanger. Combustion heat passes through the heat exchanger which transfers heat to the outside of the exchanger. The clean, moisture free air outside the exchanger is pushed out by a fan. The products of combustion and moisture vent out of a flue stack.

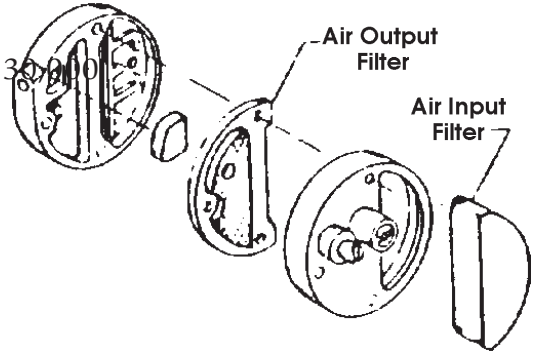
Identifying Heater Manufacturers

There have been five primary manufacturers of low pressure heaters. Desa, Pinnacle, Mr. Heater, Toro and National Riverside (Universal) have made over 100 brands and account for 98% of all oil fired heaters.

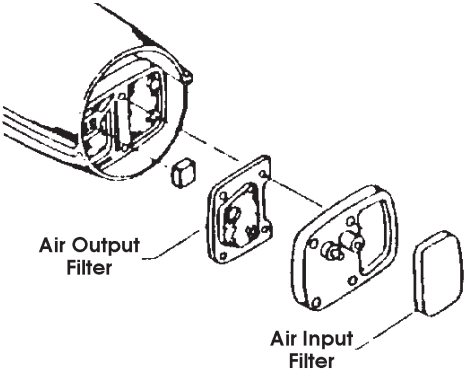
Identifying the manufacturer and/or a "mystery heater" is sometimes very difficult. The best way is to try and find a part number on either the nozzle, motor or fan. This will not only tell us the manufacturer, but its btu size (try to use 2 or more these).

You can also match your heater or filters with the following pictures—that will tell you the manufacturer.

Desa® International
Low Pressure



Models
30,000
35,000
40,000
50,000
55,000
60,000
70,000
BTU

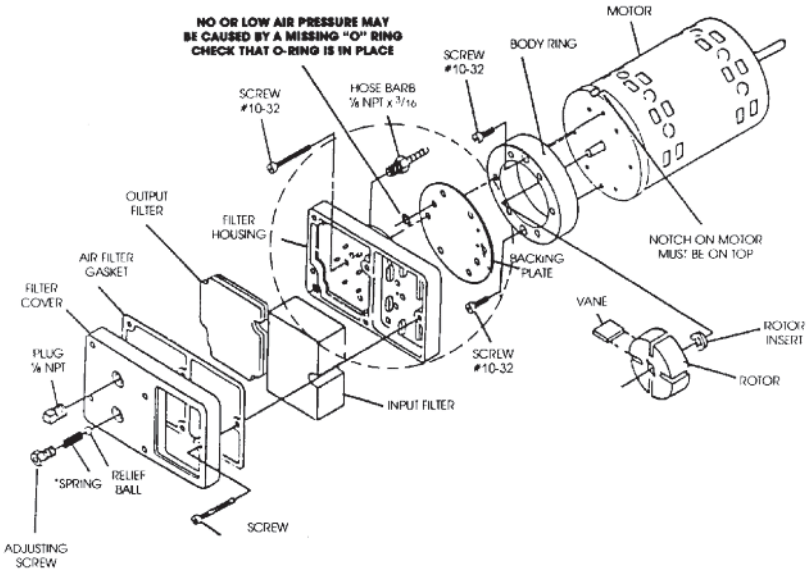


Models
100,000
110,000
115,000
150,000
155,000
165,000
200,000
BTU

Brands

Master®	Reddy®	Remington®
Co-op®	Amoco®	Desa®
Dayton®	Sears®	John Deere®
Homelite®	Knipco®	Koehring®
Queen Bee®	Cenex®	Dart®
Handy Master®	TSC®	LB White®

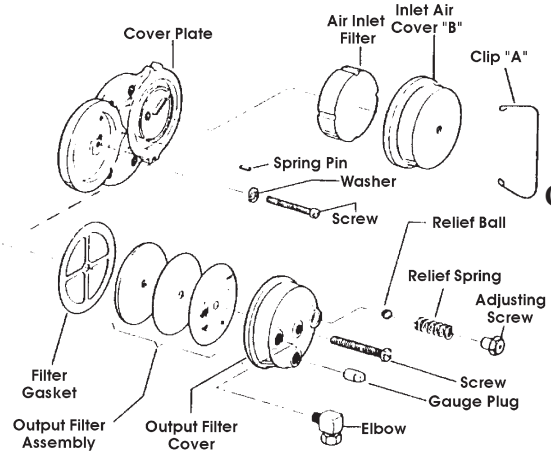
National Riverside®/Mr. Heater®
Low Pressure



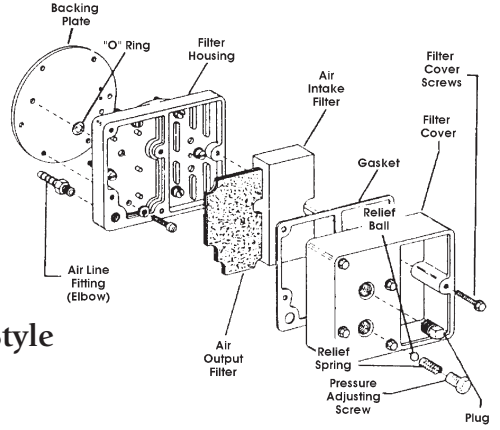
Brands
All Pro®
Stone®
Universal®

All of the above brand and product names are Trademarks or Registered Trademarks of their respective companies.

Toro®
Low Pressure



Old Style



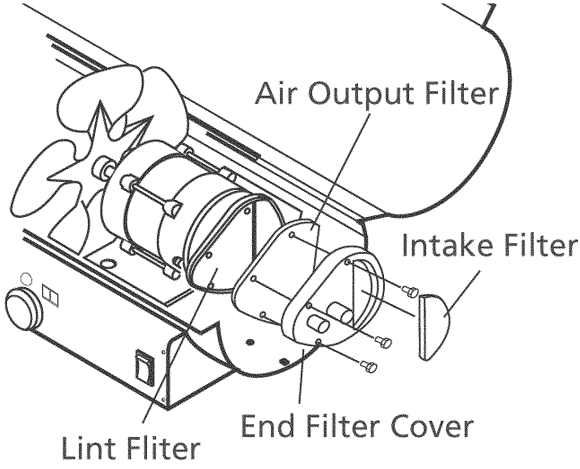
New Style

Brands

Champion®	Little Champ®	Century®
Toro®	Porta Heat®	Lawn Boy®
Red Line®	Green Line®	Central Tractor®
Ford®	Guardian®	Ace®
Jim Dandy®	Farm Heat®	Agway®
Five Points®	Montgomery Ward®	Huskee®
Stone®	Allis Chalmers®	Mr. Heat®
Arctic Flame®	Gilson®	Wheatbelt®

All of the above brand and product names are Trademarks or Registered Trademarks of their respective companies.

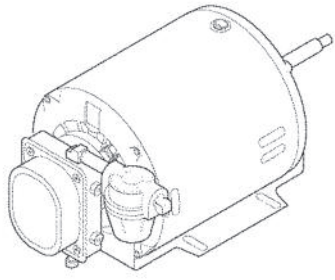
Pinnacle®
Low Pressure



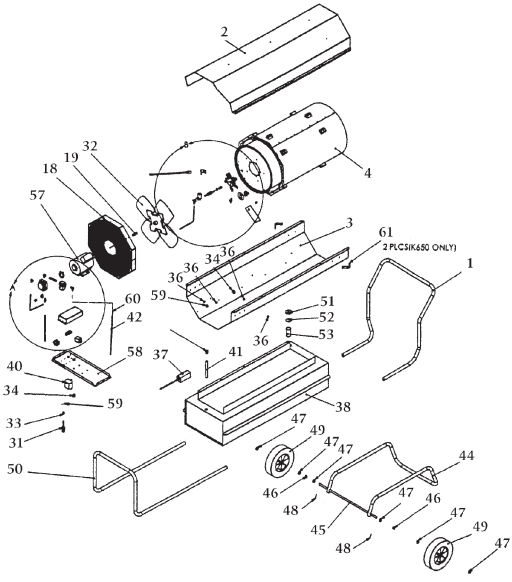
Brands
Pro-Temp
Heat-Hog
Dayton/Grainger

All of the above brand and product names are Trademarks or Registered Trademarks of their respective companies.

Desa® International
High Pressure
B350 and B600

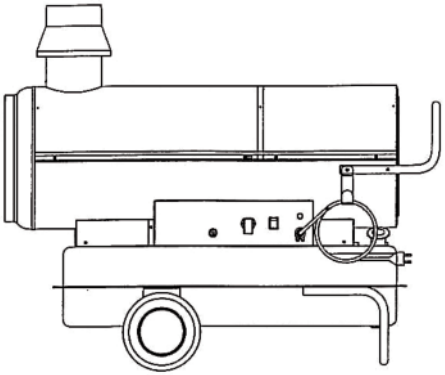


National Riverside®
High Pressure
K350 and K650



Toro®
High Pressure
CH120
CH155
CH230

Desa® International
Indirect Fired



160IF and 280IF

Heat Wagon
Indirect Fired

LVF90A

HVF180A

HVF300A

Preparation/Tools Required

Low Pressure Oil Heaters have many small parts: Start by making a clean work area. This will give you an area to layout the disassembled parts. Gather the tools required before work is started. You will need the following: 1/4" and 5/16" Nut drivers, 1/8" Allen wrench, common size open end wrenches and screwdrivers, 0-15 PSI Pressure gauge (HA1180), 0-200 high pressure gauge (G14494), flashlight, oil drain pan, .001 to .1 Feeler gauge, AC250V/RX1 Volt/Ohm meter,and a few gallons of fresh clean kerosene.

In addition to the tools mentioned above, every shop should have an HA1170 Tester. It is equipped with a three-position switch (off, solid, flashing) for a red LED and a set of alligator clips.

The HA1170 Tester is designed to take the guess work out of repairing HSI heaters. The HA1170 Tester will troubleshoot HSI photocells and Ignition Control Boards. It is an essential tool when telling the difference between a good part and a bad part in HSI heaters. Specific instructions on using the HA1170 Tester are found in the Photocell Section and the Ignition Control Board Section. The HA1170 Tester can also be used to test components for a heater with solid state ignition, making it more practical to own.

Low Pressure Theory of Operation

There are four basic systems working together to achieve proper operation:

- Fuel system
- Air system
- Electrical system
- Combustion system

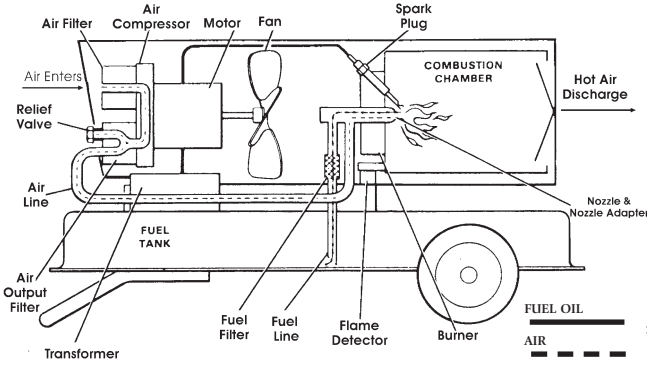
An air pump; driven by the back end of the motor shaft forces air through a tube and out the nozzle head. The moving air over the center hole in the nozzle creates a pressure differential in the burner head causing fuel to be drawn from the tank through a fuel tube and out the center hole of the nozzle.The fuel is mixed with the air swirling around the side of the center hole in the nozzle turning it into a fine mist.

Combustion air is introduced into the combustion chamber by a fan driven by the front end of the motor shaft. The remaining air from the fan is directed over the outside of the combustion chamber. This air mixes with the heated air from the combustion chamber and is ejected as clean heated air.

The ignition system consists of a transformer or electronic igniter and a spark plug. The transformer increases the input voltage to a much greater potential, which causes an arc to jump between the electrodes of the spark plug. This arc will ignite the fuel and air mixture with in the combustion chamber.

In the safety circuit, the flame sensor detects the presence of light from the flame inside the combustion chamber and closes the circuit between neutral and the time delay circuit breaker. Without the presence of light in the combustion chamber the circuit breaker will shut the power off to the whole unit.

Hot Surface Ignition (HSI) heaters replace the spark plug, transformer, circuit breaker, and (in heaters made in 2001 – present) a motor start relay with a Glowbar and an Ignition Control Board (ICB). Some HSI heaters made from 1998 – 2000 have a motor start relay and are considered "older" models. HSI heaters still follow the same theory of operation as described above, except for a few differences. The difference between Solid State heaters and HSI heaters is in the Electrical System. When an HSI heater is plugged into a 120 volt source, there is a five second delay to allow the glowbar to heat up to ignite the fuel. After 5 seconds, the ignition control board (ICB) sends power to the motor. The motor drives the pump and creates the pressure needed to siphon fuel up to the nozzle. The atomized fuel ignites as it hits the radiant heat from the glowbar. Ten seconds into startup, the ICB takes power away from the glowbar and allows it to remain idle. The photocell communicates to the ICB as it sees the color of the flame. As long as the flame is the right color through proper combustion, the photocell will allow the ICB to continue the operation of the heater. These subtle changes in components are what make the HSI heater different from a Solid State heater.



How It Works

If you understand how this heater operates, you will be able to service and maintain it. The principle is simple. No oil pump is needed. The oil is supplied by a siphon system. Air pressure is used for the siphon., therefore it is important to maintain proper air pressure adjustment. Correct air pressure is the most important factor for proper heater operation.

Air enters into the rear of the heater through the air intake filter. It is then drawn through the compressor, mounted on the motor. The compressor increases the air pressure, which is regulated by the pressure relief valve. Carbon, which may be picked up from the carbon vanes of the compressor, is removed from the air by the air output filter. The filtered air at the correct pressure then enters the nozzle adapter through the air line. As the air passes through and exits the nozzle, it creates a partial vacuum in the center of the orifice which siphons the oil from the tank. The filtered oil is atomized with the air as it is injected into the combustion chamber.

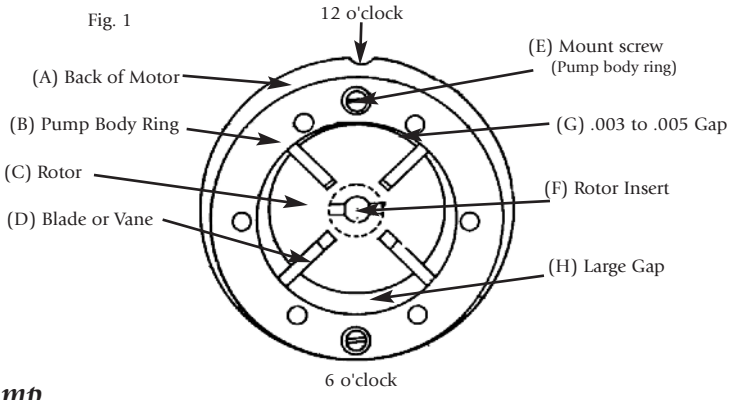
The transformer supplies power to the spark plug, which provides a constant spark inside the combustion chamber. Oil sprayed from the nozzle directly hits the spark and is immediately ignited. A HSI heater works differently. (see previous page)

The fan draws air through the back of the heater in the space around the fan motor compressor assembly. This air performs three functions. It cools the motor, transformer and other heater components, insuring their long operating life. The air also conducts heat through convection from the combustion chamber providing heat to the area to be heated. The remainder of the air enters the burner at the rear of the combustion chamber through the vents in the burner in a swirling pattern. This air mixes in the combustion chamber with the aerated oil spray from the nozzle to give complete fuel combustion, burning with minimal odors or waste.

Power is supplied to the heater by a three-wire electrical cord. When plugged in, the heater will begin to function. No switches are needed for operation; to stop, merely pull the plug.

Your heater is equipped with a flame-out safety control. The purpose of this system is to stop all electrical power to the motor and ignition transformer in approximately 20-35 seconds if ignition should fail to occur on start up or lack of fuel. An HSI heater has a different safety control. (see page 14)

Component Description and Operation



Air Pump

The heater's air pump consists of a rotor (c) with four carbon blades (d) rotating inside a pump body(b). The rotor is driven directly by the motor (a) and is attached to the motor shaft by means of a plastic insert (f). As the motor rotates, the carbon blades travel outward rubbing against the inside surface of the steel pump body (d). The rotor's position inside the pump body is such that it is off centered with the pump body and a .003/.004 of an inch gap is set at the uppermost quadrant (g). As the motor rotates, the air between the blades (h) is compressed and routed to the nozzle through the air line.

Air Filters

The air filtering system consists of an air input filter and air output filter. The air input filter is located at the right rear of the motor and its purpose is to filter all incoming air prior to entering the air pump.

The filter design is such that it can be cleaned in a mild, soapy solution, thoroughly dried and used over again.

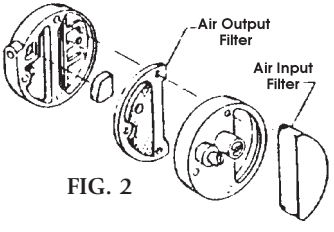


FIG. 2

The air output filter is located under the plastic end cover. This filters purpose is to prevent any carbon dust (from rotor or blade wear) from entering the air passages in the nozzle. This filter is non-cleanable and should be replaced when considerable build-up of carbon dust is observed.

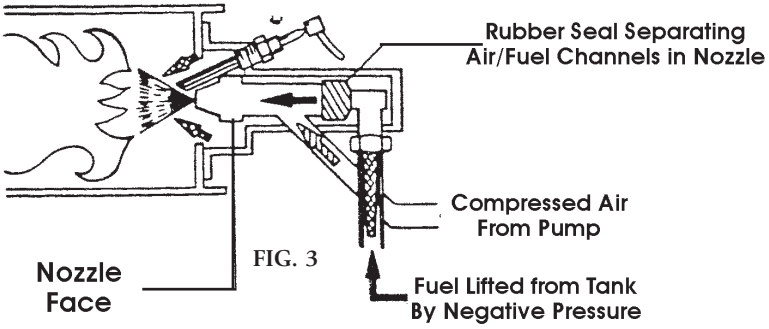


FIG. 3

Nozzle

As mentioned previously, the purpose of the air pump is to compress air and deliver it to the nozzle. The compressed air, as it travels through the nozzle, creates a negative pressure and lifts the fuel from the fuel tank. The fuel from the fuel tank and the compressed air are mixed at the nozzle which results in a very fine mist of fuel being sprayed into the combustion chamber. The air pump/nozzle combination eliminates the need for a conventional type fuel pump. It is important for the service technician to understand the nozzle operation. In many cases concerning improper operation of a heater, the problem is the result of a seal leak or a restriction (dust/dirt) being present within the nozzle. It should also be pointed out that each model heater requires different nozzles due to different fuel flow rates.

Combustion System (Burner Head)

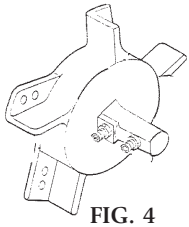


FIG. 4

The burner head is mounted to the rear of the combustion chamber. The purpose of the burner head is to meter and mix the amount of air entering the chamber to obtain proper combustion characteristics. The nozzle is mounted in the chamber from the burner head and is surrounded by fins, so that the amount of air entering the chamber from the burner head is equal and balanced. The size of the slots in the burner head differ between models.

Motors

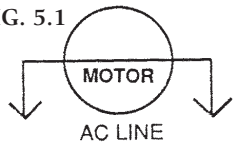


FIG. 5.1
SHADED POLE MOTOR

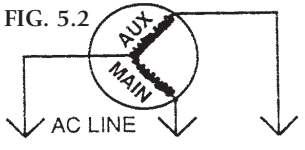


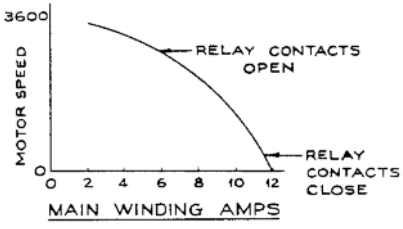
FIG. 5.2
SPLIT-PHASE MOTOR

The motors used on the low pressure heaters are fractional horsepower motors ranging from 1/35 HP on the smallest heaters to 1/4 HP on the largest heaters. The motors used can be grouped into two categories. The first category is the shaded pole motor(FIG. 5.1). The shaded pole motor contains a single winding and does not require an external start relay for operation.

These motors are used on the smaller heaters (30,000, 35,000 & 50,000 BTU) and are easily identified by observing that only two wires (usually red and white) are necessary for operation.

The second category is the split-phase motor(FIG. 5.2). This motor contains two separate windings. The first winding being the auxiliary or start winding and the second being the main or run winding. This motor requires an external means of switching the power off to the auxiliary winding after the motor reaches a predetermined speed. This power off switching is accomplished by a motor start relay or solid state relay. These motors are identified by observing that three wires (black, red and white) are routed from the motor.

Motor Relay



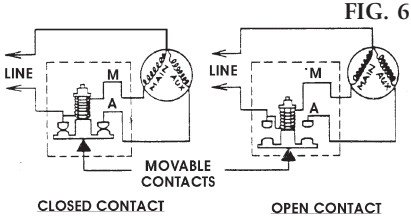
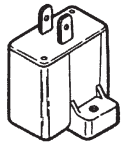


FIG. 6

The motor start relay is used to de-energize the start winding on split-phase motors. As mentioned in the *Motor Section*, remember that split-phase motors have both an auxiliary (start) and a main (run) winding. For proper motor operation, both the auxiliary and main winding are energized during start-up. After the motor starts and reaches approximately 80% of rated speed, the auxiliary winding must be de-energized to prevent overheating. This is accomplished by the use of a motor start relay. The operation of the relay functions because the main winding amperage decreases as the motor speed increases. The coil of the relay is wired in series with the main winding. The contacts of the relay are in series with the auxiliary winding. When voltage is applied to the motor, the high inrush current through the main winding creates a magnetic force in the relay coil and closes the contacts of the relay, which energized the auxiliary winding. As the motor speed increases, the current through the relay decreases and the contacts open, with gravity, de-energizing the auxiliary winding.

Solid State Relay ***(Applicable models use 097061-01 Solid State Relay)***



The solid state relay is used to de-energize the start winding on split-phase motors. As mentioned in the *Motor Section*, remember that split-phase motors have both an auxiliary (start) and a main (run) winding. For proper motor operation, both the auxiliary and main winding are energized during start up. After the motor starts and reaches approximately 80% of rated speed, the auxiliary winding must be de-energized to prevent overheating. This is accomplished by the use of a solid state relay. The operation of the relay functions as a positive temperature coefficient resistor. When voltage is applied to the motor, the main and auxiliary windings are energized as current flows through the solid state relay which is connected in series with the auxiliary winding only. The resistance is increased over time in the solid state relay where it eventually rises to the point theoretically no current flows, de-energizing the auxiliary winding.

Safety Control

The safety control circuit consists of a photocell (light sensitive cell) and a safety control. The photocell is used to sense the presence of light inside the combustion chamber. The photocell varies its electrical resistance in relation to the light rays which contact its surface. When the heater is operating properly, the photocell sees sufficient and the proper color light, which keeps its resistance low. When the photocell does not sense the proper color or amount of light, the resistance of the photocell increases and ceases current to flow to the solid state trigger circuit, which in turn sends current flows into the circuit breaker and heats a (bimetal) bar causing the bar to warp. The warpage releases the spring loaded reset button, which brakes all power to the heater. As a service technician, it is important to understand the operation of the safety control. In the past, it has been the single most misdiagnosed part of the heater. It is suggested that all controls be checked per instructions listed in the *Troubleshooting Section*, prior to replacement.

Hot Surface Ignition Heaters (HSI)

On hot surface ignition (HSI) heaters the ignition control board (ICB) is what controls the entire heater electronically. There is no reset button and no motor start relay, with exception to some older HSI models. The ICB takes care of those components internally. Older HSI models have a motor start relay inline with motor and the ICB. The ICB needs to maintain a reading from the photocell to keep the heater running. All boards are now equipped with an inline fuse that is located on the board or in the main voltage supply line to the board. The fuse is a common GMA-10 fuse that can be found at a local automotive parts retail store or electrical supply store. The ICB should be handled with care. Always handle the board by its edges and never touch the male terminals or the electronics on the board. The oils from your skin can transfer to the ICB and cause a hot spot and will result in failure in the operation of the board. When a board becomes dirty, you should wipe it with a clean cotton cloth. Rubbing alcohol can be used if a solvent is needed.

A photocell for a Hot Surface heater works entirely differently than one from a Solid State heater. An HSI photocell actually looks at the COLOR of the flame inside the combustion chamber. Under normal operating conditions, the flame will be orange in color. If the heater begins to burn lean, the flame begins to turn a blue in color. The photocell reacts almost immediately and shuts down the heater. A drop in pressure will cause the change in color of the flame thus causing a changed light intensity. This sequence will cause the photocell to build up enough resistance to force the heater to shut down in less than ONE SECOND. This makes proper air pressure adjustment crucial. See specs (Page 99-101) on the proper air pressure adjustment on your model.

Glowbar

Proper Handling

Handle the glowbar with care. Do not touch the heating element with bare fingers. The oils from your skin can cause a hot spot on the heating element, which could result in the glowbar disintegrating. Handle the glowbar by its ceramic mounting block only. If a glowbar becomes dirty, use a clean cotton cloth to wipe debris or dust off the heating element.

When installing the glowbar, it is important not to strike the heating element on any surface. Doing so will cause the glowbar to shatter. Carefully follow the recommended instructions when installing a new glowbar.

Glowbar (cont.)

Installation

1. Unplug the heater from the 120 volt source.
2. Remove the two wires for the existing glowbar from the pc board mounted inside the access panel.
3. Disconnect the air line and fuel line from the fittings on the nozzle adapter or burner head. Note the location placement of the hoses to avoid confusion on reconnection. If you have an older heater with a burner head, skip step 4 and go to step 5.
4. Leave the nozzle bracket attached to the combustion chamber and carefully remove the nozzle by twisting the nozzle adapter in a counter clockwise motion.
5. Remove the combustion chamber from the lower shell of the heater.
6. Stand the combustion chamber up on a workbench in a vertical position, nose cone down.
7. Loosen the set screw from ceramic mounting block on glowbar and carefully remove the glowbar.
8. Install new glowbar into combustion chamber, taking special care not to strike the heating element upon entry.
9. Replace the set screw with a black oxide mounting screw to avoid future vibration problems with original set screw. Repeat steps 2 – 5 in reverse order to re-install combustion chamber.

Desa Spark Plug

The spark plug is the igniter for the fuel. The electrical energy from the ignition transformer causes a spark to jump across the gap between the electrodes of the spark plug. The proper spark gap is shown in FIG 7.

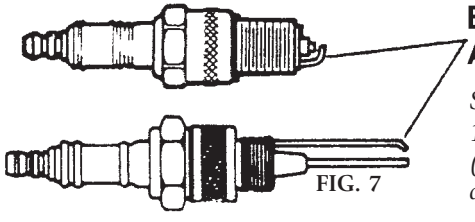


FIG. 7

Spark Plug Gap—.050 inches or 1.27 Millimeters
(For single post electrode use 1/16″ gap or .063)

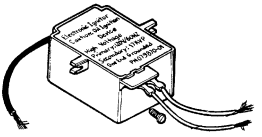
Spark plugs suffer from a number of maladies including dirty electrodes, gap wear or erosion, cracked ceramic, etc. Spark plugs should be inspected frequently and replaced periodically if faulty. Some heaters use two independent electrodes. Independent electrodes also require proper setting.

Electric Igniter (Transformer)

(Applicable models use 079870-01 or 102482-01 Electronic Igniter)

The electronic igniter operates on 120V60 Hz. It delivers approximately 15,000 volts average to the spark plug causing the kerosene sprayed from the nozzle assembly to ignite. The igniter operates on a pulse basis. The igniter has no internal service parts and must be replaced when found defective.

Note: It is important for the service technician to be cautious when working with the electronic igniter due to its high voltage output.



Toro Spark Plug

The spark plug must be positioned all the way in against the housing; line up the red line of the spark plug with the casting line on the burner. Gap the spark plug to .062"(FIG. 9). If plug is fouled, clean or replace.

Test spark plug by removing top cover, remove air gauge plug, loosen setscrew and remove spark plug from the burner. Leave the wire attached to the spark plug and lay the plug across the sheet metal of the heater. Loosen setscrew and remove fan blade, plug in the heater and the spark should jump continuously across the electrodes.

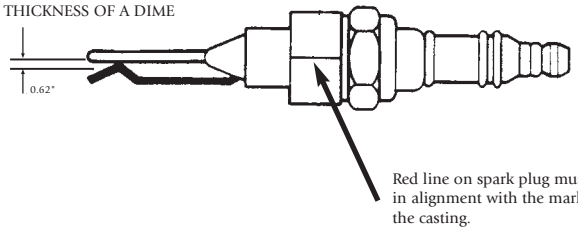


FIG. 9

Important: Spark plug is secured in burner casting with a setscrew only. Burner casting has no threads. Do not "unscrew" spark plug to remove.

Fuel System (Fuel Filters)

There are several types of fuel filters used on different model heaters. The filters are always located in line with the fuel pickup tube (FIG. 10). The purpose of the filter is to eliminate the possibility of dirt, dust, etc. from entering the nozzle and restricting the flow. The filters should be inspected and cleaned whenever a heater is brought in for service. It is also important that the bottom of the tank be inspected for sedimentation or dirt build-up. The filters design is such that a possible restriction in the filter screen can be present during operation and be dislodged back into the tank when the heater is shut off.

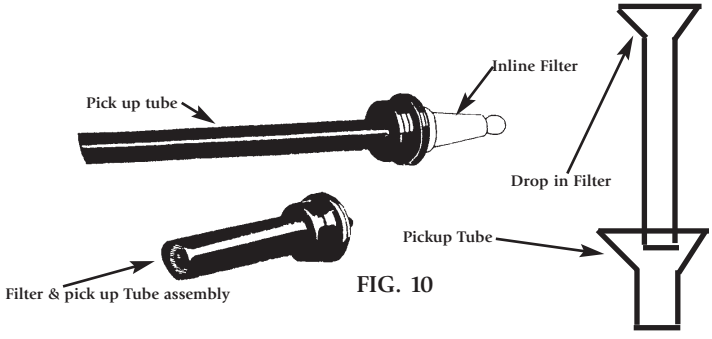


FIG. 10

MAINTENANCE PROCEDURES

Air Compressor Servicing

The air compressor is built to very close tolerances and is susceptible to excessive moisture accumulation. Handle all parts with care and keep them clean and dry. Dirt, oil, water and other foreign material will interfere with proper operation of the compressor.

To check the air compressor remove the filter cover, filter body also compressor plate, and O-ring from the motor if applicable.

1. **Inspect and Check Condition of Internal Parts**
   (Rotor, vanes, back plate, drive insert FIG. 13)
   Rotor must not be cracked, chipped, or contain deep grooves
   Vanes must not stick in the vane slots and also be free of any chips, cracks and moisture accumulation. The compressor vanes are not "square". When properly installed, the vanes will be flush with the surface of the rotor. (FIG. 12)
   Backing Plate—Clean any carbon accumulation that may exist on it and the back surface of the motor with crocus cloth. Be certain these surfaces are **dry** and do not contain deep nicks, scratches, or burrs. Polished/ smooth side of aluminum backing plate must face toward the motor.
   Body Ring inner surface must not be rusty or corroded. Clean with crocus cloth.
   Drive Insert Check flats and drive pins for excessive wear.
2. **Assembly of Compressor Parts**
   A. Reinstall the body ring to back of motor. DO NOT TIGHTEN the 2 mounting screws at this time.
   B. Install drive insert onto motor shaft, slide rotor onto shaft and align into the drive insert.
   C. Place .005" feeler gauge between body ring and the top of rotor. Hold body ring to establish this clearance and tighten the two mounting screws securely. (FIG. 13)
   D. Install vanes into the vane slots of rotor (FIG. 11).
   NOTE: Vanes are not "SQUARE". Correctly installed vanes should be "FLUSH" or even with the surface of the rotor. Incorrect installation of even one vane will cause low air pressure. (FIG. 12)
   E. Assemble backing plate, filter housing inner half and "O" ring to compressor/body ring. Use FIG. 14 as a guide. The smooth, polished side of back plate must face forward (toward motor/compres sor). Place "O" ring in recessed cavity in filter housing. Secure the 6 screws. Tighten securely and check motor/fan rotation

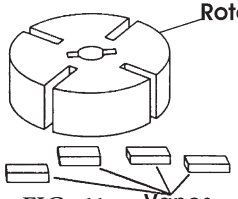


FIG. 11

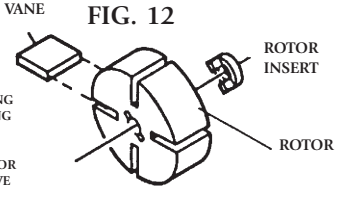


FIG. 12

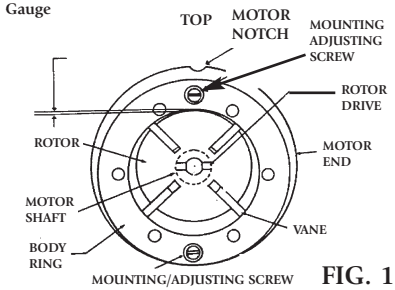


FIG. 13

F. Using a new air-filter housing gasket between housing halves and new/clean output filter, install outer housing to inner housing and secure with the five (5) remaining. Be certain gasket is properly installed around the perimeter and in center section. Air leakage from the HIGH PRESSURE (left) side will result in lower air pressure readings.

G. Install clean intake filter (reinstall top cover if previously removed).

H. Install pressure gauge into gauge part adjacent to adjusting screw.

I. Test run unit and adjust pressure to establish proper PSI setting.
Turn IN (Clockwise) to increase PSI reading
Turn OUT (Counter clockwise) to decrease PSI readings.

Refer to specifications for pressure settings on pages 97-106 if unit does not contain pressure setting decal.

Removal and Replacement of Output Filter

Round Style Filters: Remove center mounting screw to remove outer cover and filter, service as required. When replacing the cover, be sure gasket is firmly in place and the screw is tight to prevent air leaks.

Rectangular Style Filters: Remove the five (5) filter cover screws securing the outer filter cover to the inner filter housing. Service as required. When installing, be sure gasket is installed and screws are tight to prevent air leaks.

Important: Whenever service is performed on the output filter side, the heater must be re-checked for proper output air pressure with a test guage.

No or low air pressure may be caused by a missing "O" ring check that O-Ring is in place.

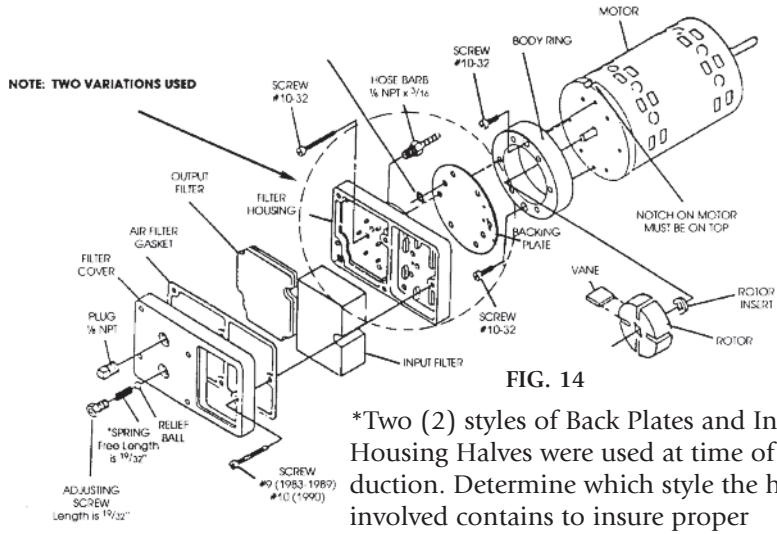
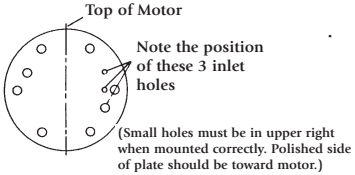
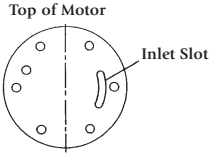
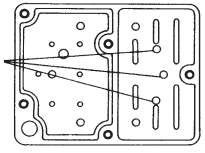


FIG. 14

*Two (2) styles of Back Plates and Inner Housing Halves were used at time of production. Determine which style the heater involved contains to insure proper Assembly and Operation.







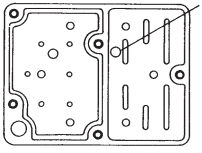


FIG. 15

ORIGINAL STYLE 1983-1989
Inlet holes on R.H. side of back plate and housing half.

Inlet Slot

NEW "QUIET" STYLE 1990 & NEWER
Backing plate has slot in it instead of holes and housing half has inlet hole moved to location.

The original style has been replaced by the newer style.

Air and Fuel Lines

These lines are made of special material which resists swelling and is not affected by heat or fuel. DO NOT use substitute hose as operation will be affected. Order by proper part number only.

*Toro Fuel Tube Dimensions**

Lower fuel tube must be a replacement item ordered from PHP, as its length will affect pick up tube length. Excessive length will cause the tube to kink and block fuel flow.

Heater	Exposed Length of Tube
40,000	2-3/8"
50,000/55,000	2-3/8"
60,000/75,000	5-3/8"
97,000/100,000	4-1/8"
150,000	4-1/8"

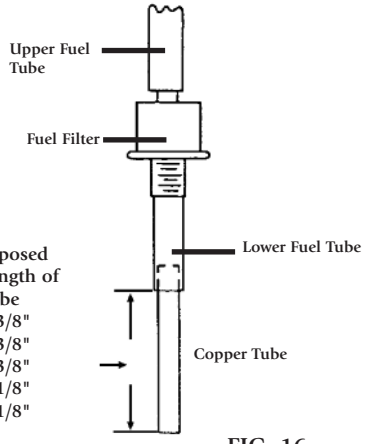


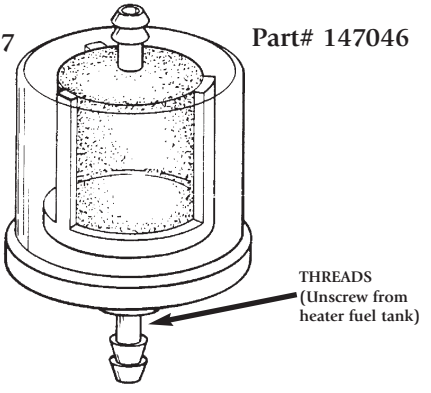
FIG. 16

*Does not apply to Toro Portaheat 40,000 and 55,000 BTU models.

Fuel Filter

Annually (or as needed), remove the filter from the fuel line and replace it with a new one.

FIG. 17 **Part# 147046**



Nozzle Servicing

Accumulation of dirt from fuel and carbon from the compressor vanes will eventually fill up the passages in the nozzle, resulting in reduction of fuel and air flow. Pressure will gradually increase giving improper fuel-air mixture causing excess odor and smoke.

To clean the nozzle, usually compressed air is sufficient.**Caution: Safety glasses should be worn.** Blow air through the delivery end of the nozzle(FIG. 18). If air does not clear the nozzle, wipe the nozzle with a soft cloth. In extreme cases, it may be necessary to remove the end part of the nozzle.

To disassemble the nozzle, remove the nozzle hex cap from the adapter. Care should be used to avoid damaging the nozzle adapter. Place the nozzle stem between two pieces of wood to prevent damaging the air passages on the stem. Clamp the protected stem securely in a vise and loosen the hex cap.

Carefully remove the hex cap which will expose the stainless steel orifice(FIG. 19). The orifice can now be lifted from the stem and cleaned with a soft cloth or a wood toothpick. Do not use an orifice (tip) cleaner or metal object to clean the orifice. Using a dry cloth, wipe the nozzle hex cap and stem clean. Never clean the nozzle parts in kerosene or fuel oil as these fluids will leave an oil film which will cause an accumulation of contaminant's to build in the air passages during future use.

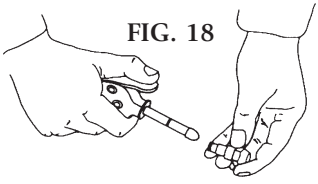
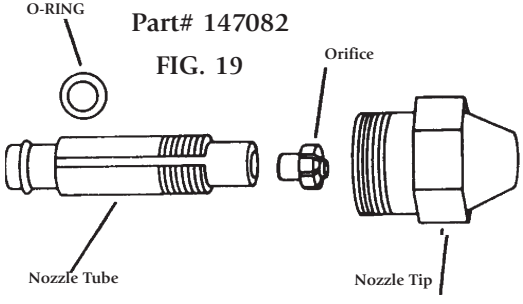


FIG. 18

After cleaning, be sure to install the orifice before replacing the nozzle hex cap. Carefully clamp the stem between two wood blocks in a vise and tighten nozzle hex cap. Check "O" ring seal* for damage or cracks before replacing on the stem. If damage is evident, replace the seal. Firmly screw the nozzle hex cap into the adapter. Do not overtighten as damage could occur to the threads inside the nozzle adapter. Reinstall the nozzle adaptor making sure its is tight against the burner casting. Tighten setscrew and replace air and fuel lines.

** Individual Nozzle "O" rings are available as service replacement parts. See Fig. 19.*



Part# 147082

FIG. 19

Toro Nozzle Adjustment

Nozzle adjustments may be necessary to alter the spray pattern-to-spark-plug relationship, due to changes in **climate, oil, altitude,** or after **cleaning**. If the heater operates properly there is no reason to change the factory setting. However, if the unit starts sluggishly in cold weather, make the following adjustments.

1. Unplug the power cord and remove the service cover or top.

2. Loosen the setscrew in the burner casting which holds the nozzle adapter in place.

3. Pull the nozzle adapter back one notch (about 1/16"). (FIG. 20).

4. Retighten the setscrew.

5. Replace the service cover or top and plug in the power cord.

6. If excessive wear on the spark plug electrode is noticed, nozzle is set back too far and should be adjusted in the opposite direction.

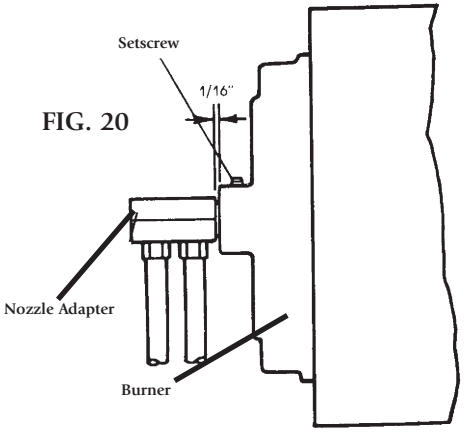


FIG. 20

Transformer Test

Three styles of transformers have been used in the Low Pressure Heaters. Prior to 1986 an enclosed style was used and mounted as shown in FIG. 21. Since 1986 an open style transformer has been used it is shown FIG. 22 and mounts through the same two mounting bracket holes as the enclosed style transformer. When mounted it will be positioned diagonally from the mounting bracket.

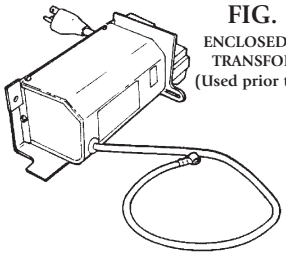


FIG. 21
ENCLOSED STYLE TRANSFORMER
(Used prior to 1986)

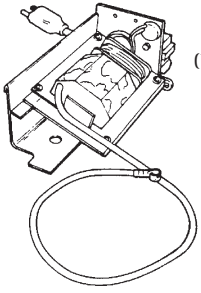
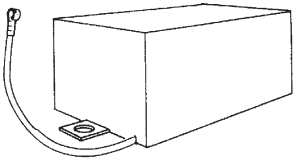


FIG. 22
(Used 1986 and Newer)



IGNITER
(Models 40 & 55
1992 & Newer)

Testing of each is performed as follows:

1. Remove top cover, air pressure gauge port plug, spark plug, and fan blade.

2. Attach ignition wire to spark plug and and position spark plug in heater such that it is grounded.

SAFETY WARNING: REMOVE FAN!

3. Plug unit in. Spark should exist if plug and transformer are good. If very weak or no spark exists, test again with a new properly gapped plug. If spark is still weak or non-existent, replace transformer.

Note: See page 47, for an optional transformer test.

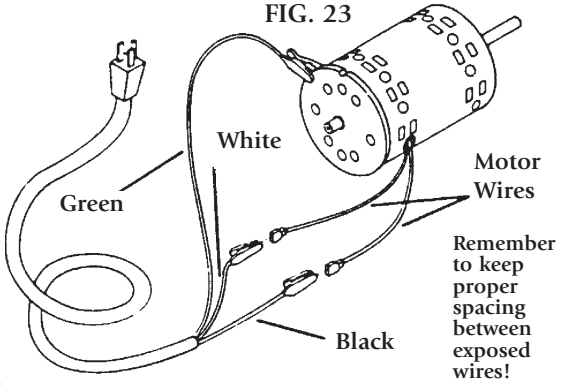
Motor Test

1. Remove motor from heater or disconnect motor wires from their connection points for testing with 115 volt power supply direct.

2. **Wire Motor (Shaded Pole)**
   Connect wires as illustrated (FIG. 23). Plug in test cord. Motor should come up to and maintain speed.

3. **Wire Motor (Split Phase)**
   Connect wires as illustrated (FIG. 24).
   A. White Motor Wire - to White Power Cord Lead
   B. Red Motor Wire - to Black Power Cord Lead
   C. Momentarily (2-3 seconds maximum) touch the black motor wire to the black power cord then release. This engages the "START" winding long enough to bring motor up to speed for the "RUN" windings to take over and continue running.

FIG. 23



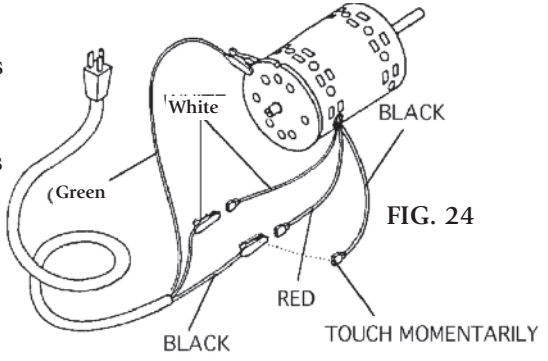


FIG. 24

Note: *The start windings are burned out when the motor turns slowly and does not increase speed after Step C.*

The motor is no longer usable if during Step C the motor comes up to speed but stops when black motor wire is released from the power lead.

Motor Relay Test

Conduct "Split-Phase" motor test, if motor is good, connect it into heater. Check the wiring of unit, plug in the heater. If motor works, the relay is okay. If motor fails to turn or turns to slow, the relay should be replaced.

Surface marked "TOP" must be up.

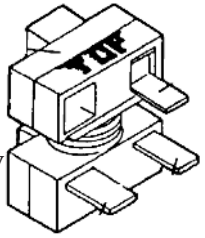


FIG 25
Motor Start Relay

Note: *Present style motor start relays which are of "Gravity – Drop Out" style by design have the word* ***"TOP"*** *molded into the body. These must be installed as indicated to function correctly. Older style relays which are fully enclosed are not position sensitive.*

For the location and correct wiring of the motor start relay refer to the wiring diagrams at the end of this section or to the decal under the heater's access cover.

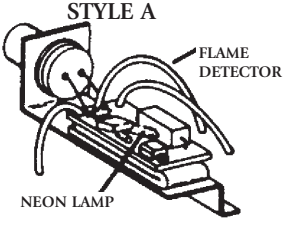
Flame Out Safety Control System

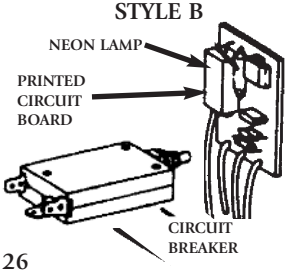
Printed Circuit Board (PCB) and Circuit Breaker Test:

1. To test and isolate the components in the system follow the cad cell wires to their connections on the PC Board. Remove wires and attach a jumper lead across these two terminals. Plug in heater and observe neon bulb on the PC Board.

A) If bulb flickers or stays on, replace PC Board (or PCB/Breaker Assembly if PC Board and Breaker are joined as an assembly). If circuit breaker trips, replace circuit breaker (or the PCB/Breaker assembly if PC Board and Breaker are joined as an assembly).

B) If unit continues to run and perform properly with jumper wire attached, PCB and Breaker are good and problem exists with the cad cell or its mounting on the unit. Refer to "CAD CELL TESTING."





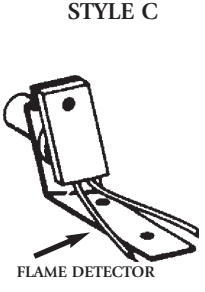


FIG 26

(Used on 1985 & Earlier)

2. To test for a flame "OUT" condition, disconnect jumper lead connection and separate the terminals (They must not touch anything.) Plug unit in, neon light should come on and stay on and in 20 to 35 seconds the circuit breaker should trip. If the light does not light, replace the PC Board (or PC Board/Breaker Assembly if joined as an assembly). If the circuit breaker does not trip after 20-35 seconds, replace the circuit breaker (or PC Board/Breaker Assembly if joined as an assembly).

Remember: The neon light action should always be opposite the condition in combustion chamber. When "Flame" or "Light" state exists, the neon light should be "OFF". When "No Flame" exists, or burning stops the neon light should be "ON".

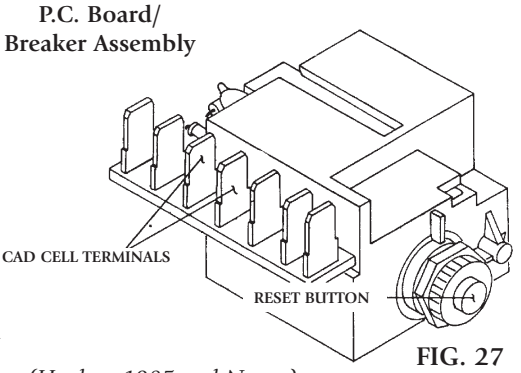


FIG. 27

(Used on 1985 and Newer)

Cad Cell Test

Perform Printed Circuit Board (PCB) and Circuit Breaker Tests. If testing indicates cad cell function being questionable, further testing is performed with an ohmmeter. Clean glass in cad cell of any dust/dirt accumulation.

A) Connect ohmmeter leads to the lead wires of cad cell
1. **At Room Light:** Resistance value should be 100-300 OHMS (R x 1 K Scale)
2. **In Darkened State:** Cover end of cad cell with black tape and wrap assembly in heavy dark cloth(FIG. 28). **Resistance after 15 seconds should be a minimum of 100 times the reading obtained in the lighted state (Above).** (Use R x 10 or R x 1 K Scale).

If resistance values are correct, cad cell should be good. Checks should be made as to alignment of cad cell when mounted, the access hole or slot for sufficient opening, or for dirt or residue on the "eye" of the cad cell. Clean with a cotton swab.

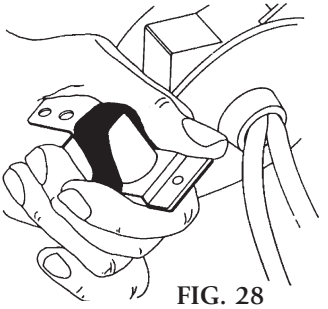


FIG. 28

Pinnacle Components

Most components listed earlier in this manual are also found in Pinnacle heaters. There are, however, a couple of other components that are worth mentioning that are found mostly in Pinnacle heaters and not any other brands.

Circuit Board

Pinnacle heaters are equipped with a circuit board. The board sends power to the motor and transformer. The board sends power to the transformer initially for 5 seconds. After five seconds, the board sends power to the motor. The rotation of the motor builds pump pressure which siphons kerosene from the fuel tank. The correct fuel to air mixture creates a fine mist out of the nozzle. The kerosene mist from the nozzle is ignited by the spark generated from the electrodes or spark plug. If the heater doesn't light or lights for a short period of time, the circuit board will indicate an error code. The error code will help you troubleshoot the symptoms of your heater.

Room Sensor

The sensor works hand in hand with the thermostat; it indicates the ambient temperature in the room. When the room temperature meets the desired thermostat setting the heater will shut down into standby mode. As the room cools, the room sensor calls for heat according to the thermostat setting and the heater will begin to cycle through its ignition process.

L.B. White Components & Maintenance (45,000 & 75,000 BTU)

Fuel Tank

Flush every 200 hours of operation or as needed.

Air Intake Filter (Figure 1)

WASH AND DRY WITH SOAP AND WATER EVERY 500 HOURS OF OPERATION, OR AS NEEDED.

- Remove screws along each side of heater using medium Phillips screwdriver
- Lift off upper shell
- Remove fan guard
- Wash or replace air intake filter
- Reinstall fan guard and upper shell

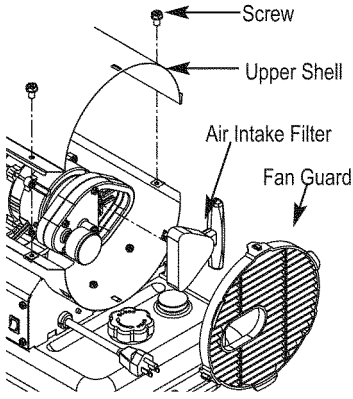


Figure 1

Air Output Filter, Lint Filter (Figure 2)

REPLACE EVERY 500 HOURS OF OPERATION OR ONCE A YEAR

- Remove upper shell and fan guard
- Turn air pressure gauge counter-clockwise and remove
- Remove end filter cover screws using medium Phillips screwdriver
- Remove end filter cover
- Replace air output and lint filter
- Reinstall end filter cover and air pressure gauge
- Reinstall fan guard and upper shell

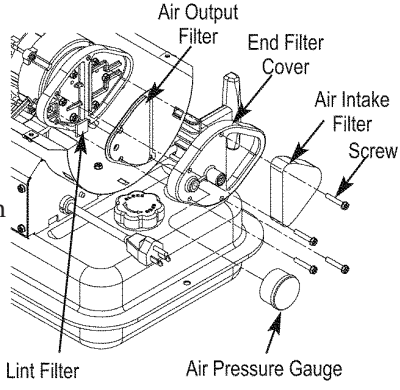


Figure 2

Fan Blades (Figure 3)

CLEAN EVERY SEASON OR AS NEEDED

- Remove upper shell (See Air Intake Filter)
- Use M6 Allen wrench to loosen set screw which holds fan blade to motor shaft
- Slip fan blade off motor shaft
- Clean fan blade using soft cloth moistened with kerosene or solvent
- Dry fan blade thoroughly
- Reinstall fan blade to motor shaft
- Place fan blade hub flush with end of motor shaft
- Place set screw on flat of shaft
- Tighten screw firmly (40-50 inch-pounds/4.5-5.6 N-m)
- Reinstall upper shell

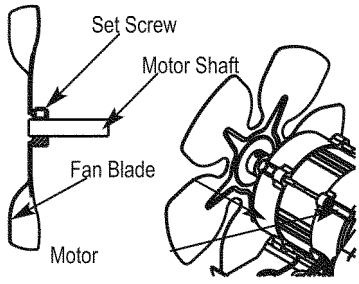


Figure 3

Nozzle (Figure 4)

CLEAN NOZZLE AS NEEDED

- Remove upper shell (See Air Intake Filter)
- Remove fan blade (See Fan Blades)
- Remove fuel and air line hoses from burner head
- Remove ignitor wire from spark plug
- Remove three screws using medium Phillips screwdriver and remove burner head from combustion chamber
- Remove spark plug from burner head using medium Phillips screwdriver
- Carefully remove nozzle from burner head using 5/8″ socket wrench
- Blow compressed air through face of nozzle (This will remove any dirt)
- Reinstall nozzle into burner head and tighten firmly (80-100 inch-pounds)
- Reinstall spark plug into burner head
- Attach burner head to combustion chamber
- Attach ignitor wire to spark plug. Attach fuel and air line hoses to burner head
- Reinstall fan blade and upper shell

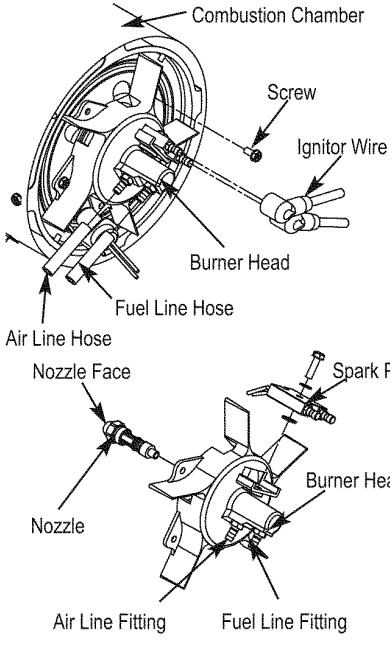


Figure 4

Spark Plug (Figure 5)

CLEAN AND REGAP EVERY 600 HOURS OF OPERATION OR REPLACE AS NEEDED.

- Remove upper shell (See Air Intake Filter)
- Remove fan (See Fan Blades)
- Remove ignitor wire from spark plug
- Remove spark plug from burner head using medium Phillips screwdriver
- Clean and regap spark plug electrodes to .140″ (3.5 mm) gap
- Reinstall spark plug into burner head
- Attach ignitor wire to spark plug
- Reinstall fan and upper shell

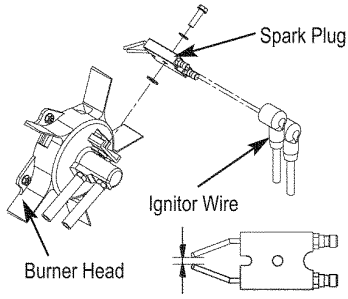


Figure 5

Fuel Filter (Figure 6)

CLEAN OR REPLACE TWICE PER HEATING SEASON OR AS NEEDED.

- Remove side cover screws using medium Phillips screwdriver
- Disconnect switch wires from power switch (CP075AK)
- Remove side cover
- Pull fuel line off fuel filter neck
- Turn fuel filter clockwise 90 degrees and pull to remove
- Wash fuel filter with clean fuel and replace in tank
- Attach fuel line to fuel filter neck
- Reinstall side cover

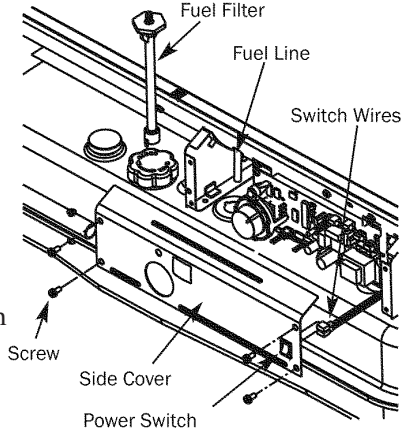


Figure 6

Photocell (Figure 7 & 8)

CLEAN PHOTOCELL ANNUALLY OR AS NEEDED.

(For Model CP045AK only)

- Remove upper shell (See Air Intake Filter)
- Remove fan (See Fan Blades)
- Remove photocell from its mounting bracket
- Clean photocell lens with cotton swab TO REPLACE: Remove side cover near power switch
- Disconnect wires from power switch and remove side cover
- Disconnect wires from circuit board and remove photocell
- Install new photocell and attach wires to circuit board
- Reinstall fan and upper shell

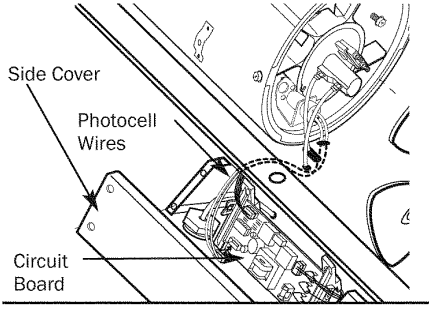


Fig. 7 - Photocell replacement for CP045AK

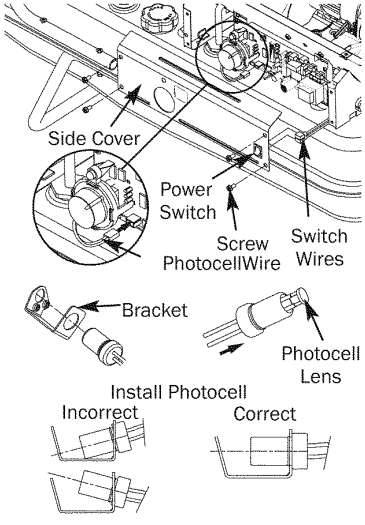


Fig. 8 - Photocell replacement for CP045AK

(For Model CP075AK only)

- Remove upper shell (See Air Intake Filter)
- Remove fan (See Fan Blades)
- Remove photocell from its mounting bracket
- Clean photocell lens with cotton swab TO REPLACE: Remove side cover near power switch
- Disconnect wires from power switch and remove side cover
- Disconnect wires from circuit board and remove photocell
- Install new photocell and attach wires to circuit board

Pump Pressure Adjustment (Figure 9)

- Start heater
- Allow motor to reach full speed
- Adjust pressure (using flat blade screwdriver)
- Turn relief valve clockwise to increase pressure
- Turn relief valve counterclockwise to decrease pressure
- Set pump pressure to correct pressure for each model
- Stop heater

Model	Pump Pressure
CP045AK	2.8 PSI
CP075AK	3.8 PSI

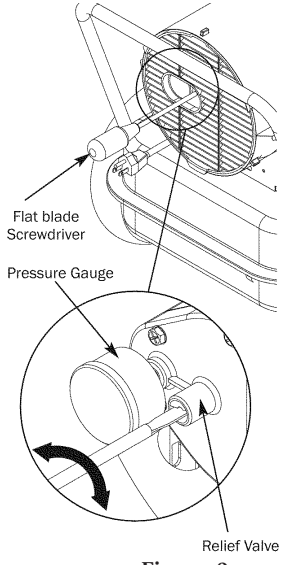


Figure 9

Replacing Fuse (Figure 10)

NOTE: The heater is fuse protected. If your heater fails to ignite, DO NOT RETURN YOUR HEATER TO THE STORE. Please follow the simple instructions below to inspect and change the fuse.

- Unplug heater
- Remove side cover screws using medium Phillips screwdriver
- Disconnect switch wires from power switch (CP075AK Only)
- Remove fuse from fuse holder (See Figure 10)
- Replace fuse with enclosed fuse
- Replace switch wires to power switch (CP075AK Only)
- Replace side cover

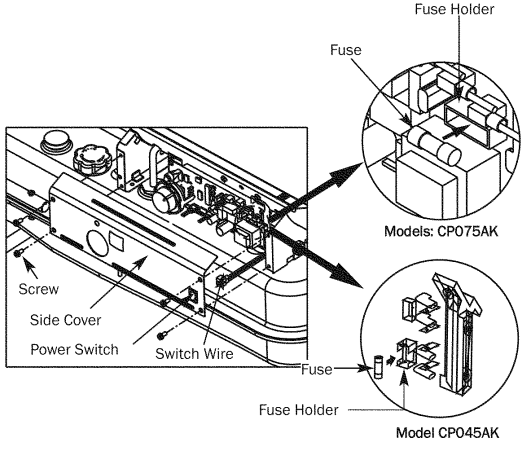


Figure 10

NOTE: Specified fuse rating: AC 125/8A, part number 572447

L.B. White Components & Maintenance (125,000-210,000 BTU)

Nozzle (Figure 1 & 2)

CLEAN NOZZLE AS NEEDED

(For Models CP125BK and CP170BK only)

- Remove upper shell (See Air Intake Filter)
- Remove fan blade (See Fan Blades)
- Remove fuel and air line hoses from burner head
- Remove ignitor wire from spark plug
- Remove three screws using medium Phillips screwdriver and remove burner head from combustion chamber
- Remove spark plug from burner head using medium Phillips screwdriver
- Carefully remove nozzle from burner head using 5/8″ socket wrench
- Blow compressed air through face of nozzle (This will remove any dirt)
- Reinstall nozzle into burner head and tighten firmly (80-100 inch-pounds)
- Reinstall spark plug into burner head
- Attach burner head to combustion chamber
- Attach ignitor wire to spark plug. Attach fuel and air line hoses to burner head.
- Reinstall fan blade and upper shell

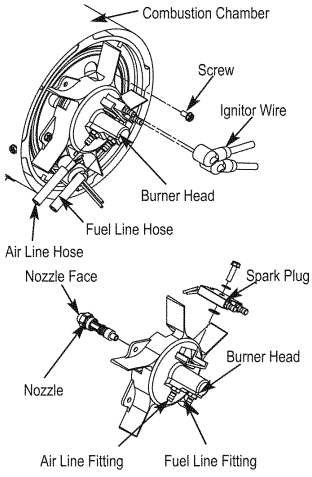


Fig. 1 - Nozzle replacement for models CP125BK and CP170BK

(For Model CP210BK only)

- Remove upper shell (See Air Intake Filter)
- Remove fan blade (See Fan Blades)
- Remove fuel and air line hoses from adapter nozzle
- Remove ignitor wire from spark plug
- Remove four screws using medium Phillips screw driver and remove bracket burner from combustion chamber
- Remove spark plug from bracket spark using medium Phillips screwdriver
- Carefully remove nozzle from adaptor nozzle using 5/8″ socket wrench
- Blow compressed air through the face of nozzle (this will remove any dirt)
- Reinstall nozzle into adaptor-nozzle and tighten firmly (80-110 inch-pounds)
- Reinstall spark plug in bracket spark
- Attach bracket burner to combustion chamber
- Attach ignitor wire to spark plug
- Attach fuel and air line hoses to adaptor nozzle
- Reinstall fan blade and upper shell

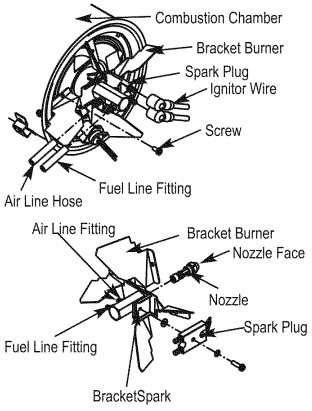


Fig. 2 - Nozzle replacement for model CP210BK

L.B. White Components & Maintenance (125,000-210,000 BTU)

Spark Plug (Figure 3 & 4)

CLEAN AND REGAP EVERY 600 HOURS OF OPERATION OR REPLACE AS NEEDED. CLEAN AND REGAP EVERY 600 HOURS OF OPERATION OR REPLACE AS NEEDED.

(For Models CP125BK and CP170BK only)

- Remove upper shell (See Air Intake Filter)
- Remove fan (See Fan Blades)
- Remove ignitor wire from spark plug
- Remove spark plug from burner head using medium Phillips screwdriver
- Clean and regap spark plug electrodes to .140″ (3.5 mm) gap
- Reinstall spark plug into burner head
- Attach ignitor wire to spark plug
- Reinstall fan and upper shell

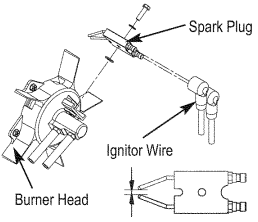


Fig. 3 - Spark plug replacement for models CP125BK and CP170BK

(For Model CP210BK only)

- Remove upper shell (See Air Intake Filter)
- Remove fan (See Fan Blades)
- Remove ignitor wire from spark plug
- Remove spark plug from bracket spark using medium Phillips screwdriver
- Clean and regap spark plug electrodes to .140″ (3.5 mm) gap
- Reinstall spark plug into bracket spark
- Attach ignitor wire to spark plug
- Reinstall fan and upper shell

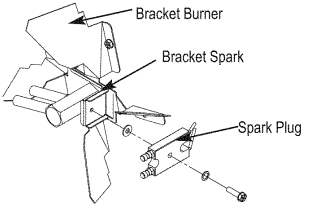


Fig. 4 - Spark plug replacement for model CP210BK

Photocell (Figure 5)

CLEAN PHOTOCELL ANNUALLY OR AS NEEDED

- Remove upper shell (See Air Intake Filter)
- Remove fan (See Fan Blades)
- Remove photocell from its mounting bracket
- Clean photocell lens with cotton swab

TO REPLACE: Remove side cover near power switch

- Disconnect wires from power switch and remove side cover
- Disconnect wires from circuit board and remove photocell
- Install new photocell and attach wires to circuit board
- Replace switch wires to power switch and side cover
- Replace fan and upper shell

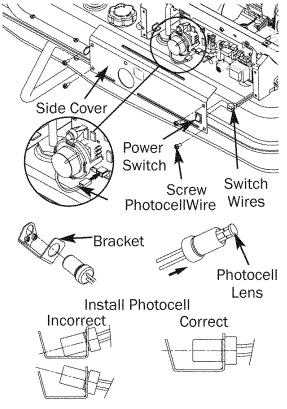


Fig. 5

L.B. White Components & Maintenance (125,000-210,000 BTU)

Fuel Filter (Figure 6)

CLEAN OR REPLACE TWICE PER HEATING SEASON OR AS NEEDED.

PUMP PRESSURE ADJUSTMENT

- Remove side cover screws using medium Phillips screwdriver
- Disconnect switch wires from power switch and remove side cover
- Pull fuel line off fuel filter neck
- Turn fuel filter clockwise 90 degrees and pull to remove
- Wash fuel filter with clean fuel and replace in tank
- Attach fuel line to fuel filter neck
- Reinstall side cover

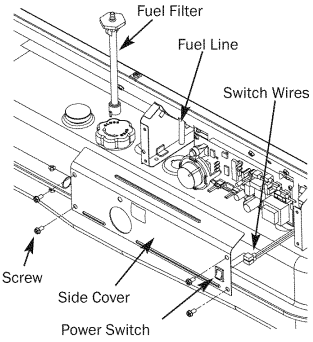


Fig. 6

Pump Pressure Adjustment (Figure 7)

- Start heater
- Allow motor to reach full speed
- Adjust pressure (using flat blade screwdriver)
- Turn relief valve clockwise to increase pressure
- Turn relief valve counterclockwise to decrease pressure
- Set pump pressure to correct pressure for each model
- Stop heater

Model	Pump Pressure
CP125BK	5.5 PSI
CP170BK	6.5 PSI
CP210BK	8.5 PSI

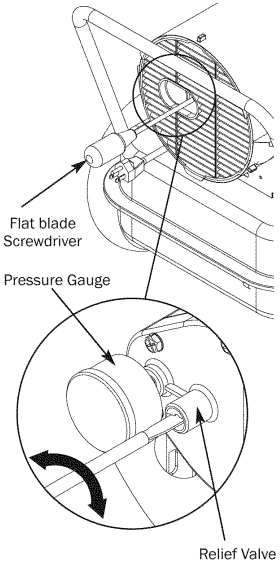


Fig. 7

Fig. 5

Enerco Maintenance & Storage

WARNING. To prevent personal injury, unplug the heater from the wall outlet before servicing.

For maximum efficiency and trouble-free service, make the following periodic maintenance, cleaning and inspections.

Daily Schedule

1. GENERAL. Make general visual inspection of heater for loose or damaged parts. Check nuts and bolts to insure against looseness caused by vibration or rough handling. Damaged parts should be repaired or replaced before using heater again. Check heater operation to be sure it is operating normally (See "Servicing" section for description of normal operation).
2. FILTERS. Dirty air or fuel filters will cause an imbalance in the air-fuel mixture. The best indication that this condition exists is an increase in odors or difficulty getting your heater to ignite. This heater should never be operated without the filters in place. If required, clean filters as described under "500 Hours" and "Annual Schedules".

500 Hour Schedule

1. AIR INTAKE FILTER. Remove and wash the filter element with a mild detergent, dry thoroughly and replace. Do not oil the filter element. If your heater is used where there is considerable dust or dirt, clean as often as necessary (approximately every 50 hrs.).
2. REMOVE DUST. Clean heater twice a season (more often under dusty conditions). Remove accumulated dust from the transformer, burner, motor and fan blades with compressed air. Wipe area clean with a clean dry cloth. Inspect area to insure all foreign materials are removed, especially around the burner and combustion area.
3. CAD CELL. Clean the glass portion of the cad cell with a soft dry cloth.
4. NOZZLE. Accumulation of dirt from fuel and carbon from the compressor vanes will eventually fill up the passages in the nozzle, resulting in reduction of fuel and air flow. Pressure will gradually increase giving improper fuel-air mixture and excess odor and smoke. If this occurs, replace the fuel nozzle.
5. FUEL TANK. Clean twice a season (during frequently used periods, clean twice a month). Drain and flush the fuel tank with clean fuel oil.

Annual Schedule

1. AIR OUTPUT FILTER. Remove the air output filter and tap the contaminated side gently on a solid object to remove contaminates. Compressed air or liquids should not be used to clean this filter. Reinstall cleaned filter in filter body in the same position as it was when removed. If the filter appears extremely dirty, replace it with a new filter of the same type. When replacing the filter cover, be sure the gasket is firmly in place and the screws in the filter cover are tight to prevent air leaks.
2. FUEL FILTER. Remove the fuel filter from fuel line and direct compressed air through the filter in the opposite direction of fuel flow. Safety glasses should be

worn when using compressed air.

3. AIR AND FUEL LINES. If the air or fuel lines are removed during cleaning, be sure all connections are tight before operating unit.
4. AIR PRESSURE SETTING. The air pressure has been properly set at the factory. If the air pressure is out of adjustment, it will most likely be caused by dirty air filters, a partially plugged nozzle, an air leak in the system or improperly set pressure. If adjustment becomes necessary, first determine the proper pressure setting for your heater which is printed on the serial label located on the fuel tank. With a full fuel tank, remove the plug from the air filter cover and attach a 0 - 15 PSI pressure guage. Start the heater and note the pressure reading. If the pressure is low, slowly turn the pressure adjusting screw in (Clockwise) until the correct pressure is obtained. If the air pressure is high, turn the adjusting screw out (counterclockwise) until the pressure is correct. When correct pressure is reached, unplug the heater, remove the gauge and replace the plug.

Storage

Store the heater in a dry location free from fumes or dust.
At the end of each heating season, clean the heater as described in the MAINTENANCE section. Drain and flush the fuel tank with clean fuel. The manufacturer recommends completely filling the tank with fuel for extended storage to minimize condensation inside the tank.

Servicing

A hazardous condition may result if a heater is used that has been modified or is not functioning properly.

When the heater is working normally:

- The flame is contained within the heater.
- The flame is essentially yellow.
- There is no strong disagreeable odor, eye burning or other physical discomfort.
- There is no smoke or soot internal or external to the heater.
- There are no unplanned or unexplained shut downs of the heater.

Desa® International
Troubleshooting, Repair Procedures

Start by visually checking all parts. (Cleaning the heater will help in uncovering trouble spots.) Make sure all parts are present.

Power Cord. Check power cord for continuity and shorts (with ohm meter). Make sure cord is equipped with a grounded plug.

Electrical Connections. Make sure all connections are in the proper position and are connected tight.

OBSERVED FAULT

Motor Starts - Unit will not ignite

Check for Spark at Plug or Glow in Glowbar

No Spark/Or Glow Observed

1. Check Spark Plug for proper gap

2. Defective Transformer Electronic Igniter
   A. Ignition Transformer Test

3. Cracked Spark Plug or Glowbar
   A. Resistance Test
   B. Thump Test

Spark/Or Glow is Observed

4. Check for Proper Pump Pressure

5. Check for restricted Fuel Flow Due To:
   A. Seal Leak
   B. Filter Blocked
   C. Restriction in Nozzle of Burner Head
   D. Fuel Filter Restriction

Test Procedure

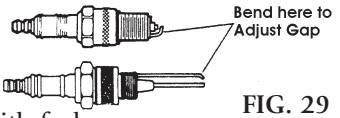


FIG. 29

1. Check Spark Plug for Proper Gap
See *Heater Performance Specifications* "Spark Plug Gap" for proper gap. Reset gap with feeler gauge.

2. Defective Transformer or Electronic Igniter

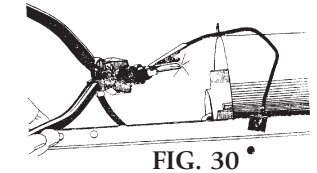


FIG. 30

Connect the transformer or electronic igniter to a properly gapped spark plug. Establish a good ground between the spark plug and heater. Plug in the heater cord and observe for spark between electrodes.If the ground is good and a spark does not jump the gap, the transformer or spark plug is defective. If spark is observed at any portion of the plug, except at the electrodes, the porcelain insulator is cracked and the plug must be replaced.

Caution: Do not let any portion of your body touch electrodes or plug, due to high voltage.

A. Ignition Transformer

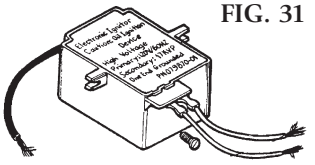


FIG. 31

The transformer needs to arc back to its own ground. Make sure the trans former is mounted tightly and properly. This will insure a good ground from the transformer to the spark plug. Remove fan blade. Remove wire from spark plug and hold it with a good pair of insulated pliers. Check the electrical performance by connecting the transformer to the 110 volt power cord by itself. Touch the end of the wire to the ground on the transformer. Pull the spark plug wire away from the transformer slowly, the electrical arc created needs to exceed more than 1/2" long before the arc breaks, and the arc needs to be rainbow in color.

**See page 21 for explanation Ignition Control Hot Surface System*
**See page 59 for Ignition Control Board Troubleshooting.*

3. Glowbar Troubleshooting:
The primary job for a glowbar is to ignite the atomized fuel coming form the nozzle. When a glowbar works properly, it will heat up to over 2,500 degrees Fahrenheit. The radiant heat generated from the glowbar will ignite the fuel from the nozzle. The glowbar will only glow for ten seconds, which is all that is needed to ignite the fuel. When proper air pressure is maintained, the fuel should continue to burn without the added help of a glowbar.

A. Resistance Test

1. Unplug the heater from the 120 volt source.
2. Remove the two wires from the ICB board that are labeled "Igniter."
3. Set your Ohm meter to the 0 – 200 scale.
4. Connect the leads from the Ohm meter to the two wires on the glowbar.
5. Glowbar should show a reading of 30 – 175 Ohms of resistance.
6. If glowbar does not pass the Ohm test, you should replace it with a glowbar that shows proper resistance.

B. Thump Test

If the glowbar passes the Resistance Test, check for hairline cracks by doing a "Thump Test."

1. Remove top shell of heater, exposing the combustion chamber.
2. Connect two wires from glowbar to an Ohm meter set on a 0-200 setting.
3. Ohm meter should maintain a steady reading.
4. Gently flick the ceramic mounting block of the glowbar using your thumb and index finger.
5. Observe for a change in the Ohm meter for an increase in resistance.
6. If there is an increase in resistance, the glowbar has a hairline crack in the ceramic mounting block or in the heating element and should be replaced.

The glowbar may not pass these tests due to the heating element being broken or absent. If the heating element is broken, you will see infinite resistance on both tests. If the glowbar passes these two tests and still fails to glow, there may be a problem with the ICB Board. You should refer to the Ignition Control Board Troubleshooting Section for proper test procedures.

4. Check for Proper Pump Pressure

Install HA1180 Pressure Gauge or equivalent to rear of air filter housing (FIG 32). Start heater and adjust air pressure to specified pressure. Turning adjustment screw clock wise increases pressure, counterclockwise decreases pressure. The screwdriver must be removed from the slot after any adjustment before taking a reading on the gauge.

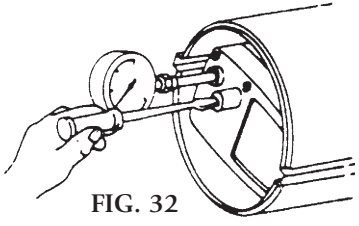


FIG. 32

Note: Pressure gauge must be scaled in 1/4 pound increments for accurate measurement.

5. Check For Restricted Fuel Flow

Remove the burner head from heater. Using a socket wrench, carefully remove the nozzle from burner head. (Be extremely careful not to scratch or score the face of the nozzle).

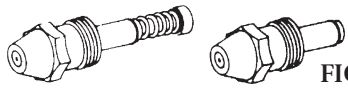


FIG. 33

A. Seal Leak

Remove the rubber seal washer from stem of nozzle and discard. (To be safe, always replace nozzle sleeve during servicing of burner head.) Even the smallest air leak in this area can reduce flow rates and result in problems.

NOTE: On smaller heaters (30,000,35,000, and 50,000 BTU), inspect "O" ring, do not remove, if air leak persists replace the nozzle adapter.

Install a new rubber seal to stem of nozzle. Make sure the seal washer, spring and second seal washer are in place before reinstalling nozzle in the burner head.

B. Filter Blocked

On certain models, a drop-in fuel filter is located in the copper or aluminum line that attaches to the fuel fitting on the back side of the burner head. Lift the filter out of the copper or aluminum fuel line and clean or replace, if necessary.

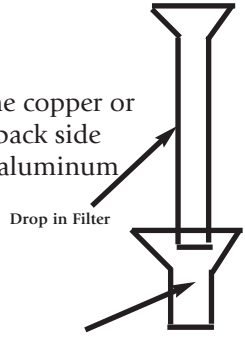


FIG. 34

C. Restriction in Nozzle or Burner Head

Using a compressed air source, blow the compressed air through the outlet end of nozzle to dislodge any possible restriction (FIG. 35). Using compressed air, also blow through passages in burner head. The air should be directed from input fitting at rear of head to the center of burner head. Many times the restriction to the flow is due to metal chips, etc.

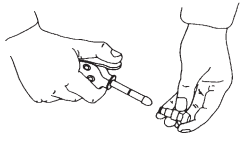
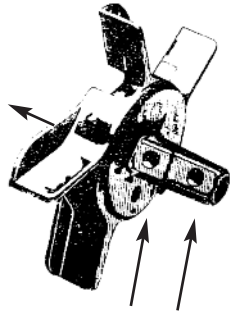
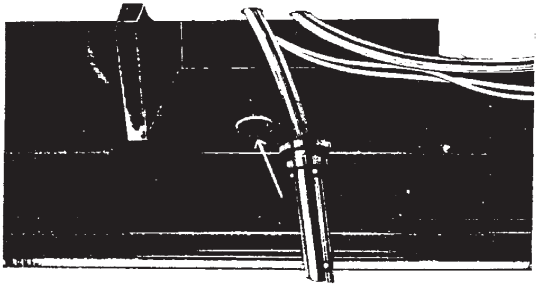


FIG. 35



D. Fuel Filter Restriction

The fuel filter should be inspected and cleaned. The filters are located in the fuel line either at tank location, in the copper or aluminum tubing or in line with the fuel line at access cover.



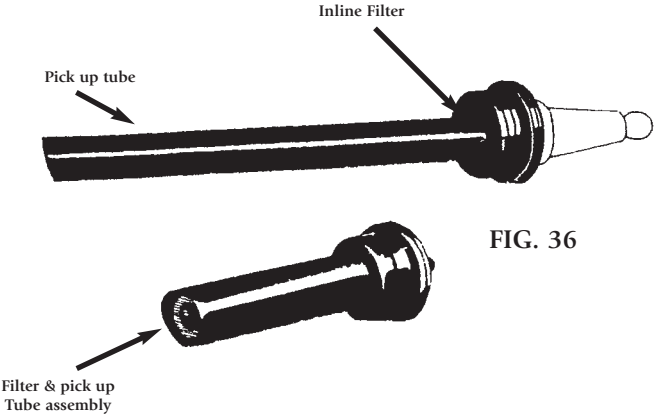


FIG. 36

OBSERVED FAULT

Motor Does Not Run or Runs at Slow Speeds.
Spark is Observed at Plug

Rotate Fan by Hand to Determine if Fan Rotates Easily

Fan is Difficult to Rotate

1. Broken rotor or blades
2. Improper rotor clearance
3. Oversized rotor
4. Dry motor bearing

Fan Rotates Easily by Hand

5. Open motor winding
   - A. Shaded pole motors
   - B. Motors with relays
   - C. HSI heater motors
6. Defective motor start relay
7. Defective capacitor
8. Low voltage

Test Procedure

1. Broken Rotor or Blades

Disassemble the end cover filter and end pump cover from rear of motor. Visually inspect the rotor and blades for breakage. Make sure that the rotor and blades are free of any type of lubricant. Rotor and blades must be clean and dry for proper operation (FIG. 37).

2. Improper Rotor Clearance

Check rotor with feeler gauge for proper clearance between rotor and pump body. Rotate rotor and make sure all four quadrants of rotor have adequate clearance.

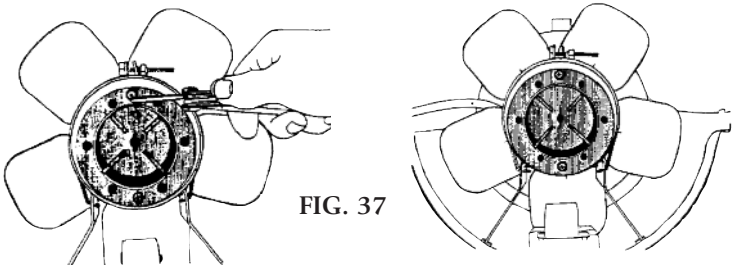


FIG. 37

3. Oversized Rotor

If the fan is hard to turn when the rotor end cover is installed, but easy to turn when loosened, the rotor should be removed and lightly sanded. Remove the rotor and lightly sand by placing rotor in the palm of hand and sanding on a flat surface making figure eight rotations. (Use the finest grade of sandpaper available).

Be sure that rotor, blades and pump body ring are exactly the same width.

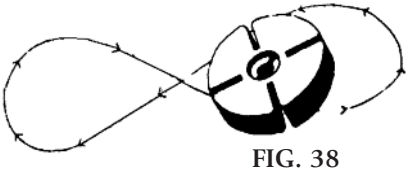


FIG. 38

4. Dry Motor Bearing

If the fan is difficult to turn with the air pump parts removed, apply 10 to 20 drops of a nondetergent oil to the sleeve bearing on the fan of the motor (FIG. 39). The bearing located at the pump end is of the ball bearing type and should be lubricated.

Note: Motors manufactured after 1978 have permanently lubricated sleeve bearing and cannot be oiled.

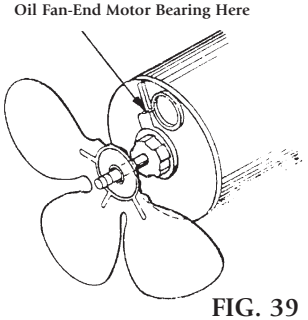


FIG. 39

5. **Open Motor Windings**

A. Shaded Pole Motors—Motors without Relay: (30,000, 35,000 & 50,000)

With the heater disconnected from AC plug, connect he ohmmeter on the RX1 scale to the wires coming from motor. On smaller heaters, the leads from the motor should indicate a resistance of 6 to 8 ohms. Actual resistance varies between motor types. Refer to motor resistance chart on next page.

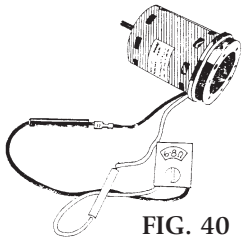
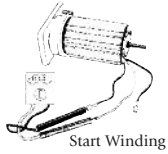


FIG. 40

Note: Resistances may vary due to motor temperature.

B. Motors with Relays: (63,000, 66,000, 70,000,100,00 & 150,000 BTU)

Start Winding: Connect the ohmmeter on the RX1 scale to the white and black wires coming from motor. This procedure allows you to determine the condition of the start winding. If the meter indicates infinity (open circuit) or the meter goes full scale (zero ohms) the winding is defective and the motor must be replaced. Actual resistance aries between motor types. Refer to motor resistance chart on next page.



Start Winding

FIG. 41

Main Winding: Connect the ohmmeter on the RX2 scale to the red and white wires coming from motor. If the needle does not move again or goes to full scale, the motor must be replaced. Actual resistance varies between motor types. Refer to motor resistance chart on next page.

Main Winding

FIG. 42

C. HSI Heater Motors

The motor in a Hot Surface Heater is relatively the same as one from a Solid State heater. The main difference is that all HSI heaters 70,000BTU's and higher have a start capacitor instead of a motor start relay. The start capacitor is a non-serviceable and non-replaceable part. Therefore, if you suspect you have a bad motor, you may perform a split phase motor test or a shaded pole motor test. Which test you will run will depend on what kind of motor you have. If you have a three-wire motor and a start capacitor, you will need to perform the split phase motor test. If you have a two-wire motor and no start capacitor, you can perform a shaded pole motor test. Replace the motor if it is found to be defective.

Motor Resistance Chart

Part No.	Crosses To	Red to White Main+/- 7%	Black to White Auxiliary +/- 7%
078894-01	M51415-01 M23107-3	3.0	11.2
097300-02	078894-06 097127-06 097134-01 097134-02 097300-01 M51131-01	4.14-5.06	N/A
097308-02	M50882-01 078894-02 097130-01 097130-02 097308-01	9.5	16.7
097308-04	097126-01 079210-01 079994-01 097307-01	2.76	9.09
102001-01	097073-01 100088-01 M50843-01	5.57-6.81	N/A
102001-20	103609-01	6.03-7.37	N/A
102001-21	103493-01	4.14-5.06	N/A
102001-27	-	3.96-4.84	N/A
102001-14	M25022-1	7.81	15.6
105336-01	M51575-01 099131-01 103404-01	N/A	9.0
M31316	M30718-01 M17941-7 M17941-7 M23107-1 M23107-4	3.65	17.0

6. **Defective Motor Start Relay or Solid State Relay**

Motor Start Relay: Prepare a jumper wire approximately 8" long with a male quick disconnect terminal at one end and a test probe at the other end. Disconnect the black wire coming from the motor that is connected to the "S" terminal of relay. Connect this black wire to the male connection of jumper wire. Touch the test probe to the "M" terminal of the start relay and plug in the heater(FIG. 43). As soon as the motor reaches speed, remove the test probe from terminal "M". The motor should continue to run.If the motor operates correctly, the relay should be replaced.

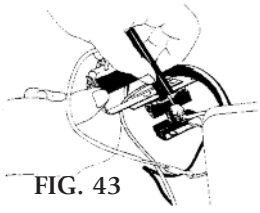


FIG. 43

Caution: Do not touch electrical connections or allow them to touch metal parts of heater.

Defective Solid State Relay: Disconnect the black wire coming from the motor that is connected to the solid state relay terminal. Connect this black wire to the male connection of jumper wire. Touch the test probe to the opposite terminal of the solid state relay and plug in the heater(FIG. 44). As soon as the motor reaches speed, remove the jumper wire from terminal. The motor should continue to run. If the motor operates correctly, the solid state relay should be replaced.

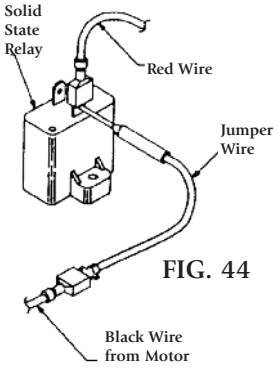


FIG. 44

Note: Solid state relays need a period of approximately 1 min. without current flow to discharge built up resistance before unit can be restarted.

8. **Defective Capacitor**

A capacitor is used on certain models to increase the starting capabilities. The most accurate method of determining if a capacitor is defective is by replacing it with a known functional capacitor(FIG. 45). However, you can check the capacitor with an ohmmeter, if you follow this procedure. Set the ohmmeter on RX1K scale. Momentarily short the outside terminals of the capacitor together. Connect the leads of the ohmmeter to the outside terminals of the capacitor. The meter should deflect to the right of the scale initially and slowly come back to the left side. If meter movement is not observed, the capacitor should be replaced.

FIG. 45

Note: Motors that require a start capacitor have <u>Blue</u>, Red & White wires, rather than <u>Black</u>, Red & White wires.

9. Low Voltage

In certain circumstances, a heater may operate correctly when being tested in the service shop, but the customer complains that it does not start at times on the job site. It is important that the customer is made aware that if the heater is operated on an incorrectly sized extension cord or a low voltage outlet, the heater's motor will not start due to low voltage. If the customer has the availability of a volt-meter, have the customer check the voltage at the heater(FIG. 46). A minimum of 108 volts, while the heater is running, is necessary for proper operation.

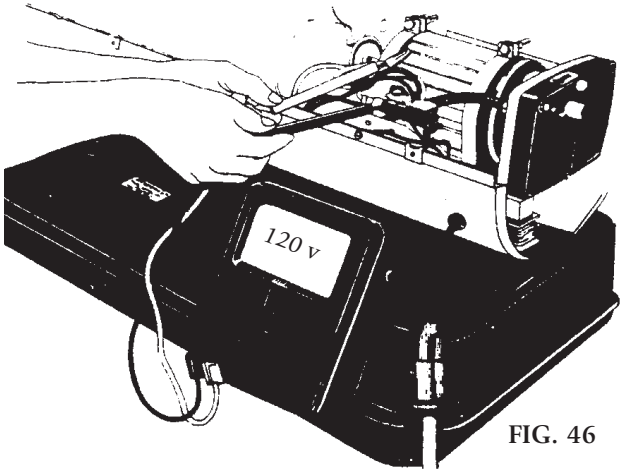


FIG. 46

OBSERVED FAULT

Heater Does Not Start/Motor and Transformer/Igniter Do Not Operate

Possible Causes External to Heater

1. Check for broken or frayed wires on cord
2. If external thermostat is used, plug heater directly into AC source

Possible Causes Internal to Heater

1. Check that reset button on safety control is fully depressed
2. Check wiring connections at safety control and wire nuts for proper fit.
3. Check for continuity of circuit breaker.
4. Visually inspect back side of printed circuit boards for cracks in solder.
5. (HSI units) check for defective ignition control board

Possible Causes Internal To Heater

Test Procedure

1. **Check that Reset Button on Safety Control is fully depressed.** Visually inspect the black reset button on safety control(FIG. 47) The button must be fully depressed in for oper ation.

FIG. 47

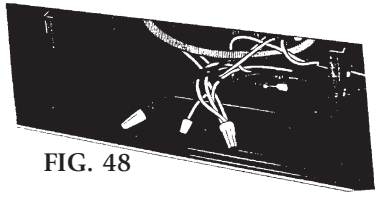


FIG. 48

2. **Check Wiring Connections at Safety Control and Wire Nuts for Proper Fit.** Physically check electrical connections at wire nuts(FIG. 48) and safety control for proper fit. Check for continuity between male prongs of power cord to safety control.

3. **Check for Continuity of Circuit Breaker**
   A. **Standard Safety Control** (M50671-03) With the heater disconnected from AC source, disconnect the red and black wires connected to the safety control. With the ohmmeter on the RX1 scale, check for continuity across terminals where wires were removed(FIG. 49). Meter should indicate "O".

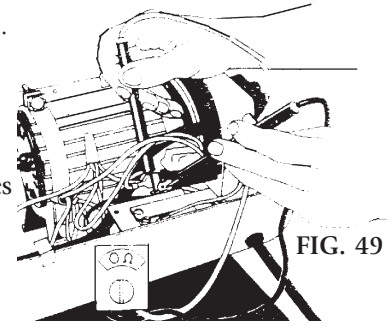


FIG. 49

   B. **Printed Circuit Board** (M50671-02) Disconnect the wires that are connected to terminals marked **LINE-120VOLTS** and **XFMR-neutral.** Connect meter on RX1 scale to these terminals and check for continuity(FIG. 50). Meter should indicate "O".

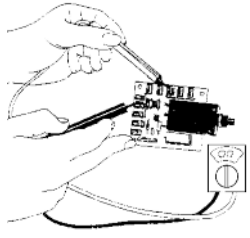


FIG. 50

4. **Visually Inspect Back Side of Printed Circuit Boards for Cracks in Solder (R100, K100A, Sears 356030)** Visually inspect back side of printed circuit board for cracks in solder tracks(FIG. 51). Replace if cracks are observed

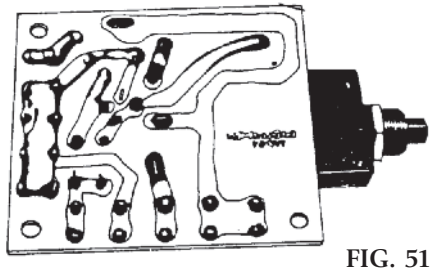


FIG. 51

(5) Hot Surface Ignition Control Board Troubleshooting

Voltage Test

1. Unplug the heater from the 120 volt source.
2. Remove the access cover on the side of the heater to reveal the Ignition Control Board.
3. Disconnect the two wires from the terminals marked "igniter" and the two wires marked "motor." Some older motors may have three motor wire connections. Note: Newer heaters with a digital LED display on the boards require that you leave the igniter wires connected for this test.
4. Set your multi-meter on the 200 volt AC scale.
5. Connect the leads for the multi-meter to the terminals marked "igniter."
6. Plug heater into 120 volt source and observe multi-meter: Multi-meter should register 120 volts and hold it for ten seconds then immediately drop to 0 volts. Note: In older models, (If they have a motor start relay) you should read 85 volts for ten seconds.
7. Unplug heater from 120 volt source and let it sit for 1 minute.
8. Connect multi-meter to the terminals marked "motor." Note: In older models, connect the multi-meter to the motor terminals marked "Motor Main" and "Motor Common."
9. Plug heater into 120 volt source and observe multi-meter: Multi-meter should register 0 volts for five seconds, climb to 120volts and maintain for 3 - 4 seconds, then drop back to 0 volts.

The reason you should see brief voltage activity in the motor terminals is because there is no flame, thus, the board will lock out and cease activity. If the ICB puts out any different reading on the voltage test, the problem will be probably be found to be defective motor or glowbar. See the *Motor Troubleshooting Section* and *Glowbar Troubleshooting* for more information.

Visual Inspection

Visually inspect the front and back of the board for burn marks (for hot spots) or cracks in solder tracks. Replace the board if cracks or hot spots are observed. Since the photocell and the ICB works hand-in-hand, you will want to test the photocell to further troubleshoot an ICB. By running the appropriate tests on a photocell, you can determine if you have a faulty board. Please refer to the Photocell Troubleshooting Section of this manual for the proper testing procedure on a photocell.

OBSERVED FAULT

Heater Ignites and Burns; However, Safety Control Trips and Heater Shuts Off

Safety Control Trips within the First Minute of Operation

1. Defective Safety Control
2. Defective Photocell
3. Loose Wire

Safety Control Trips After Several Minutes of Operation

4. Dirty Photocell
5. Improper Pump Pressure
6. Check for Restricted Fuel Flow Due To:
   A. Seal Leak
   B. Filter Blocked
   C. Restriction in Nozzle or Burner Head
7. Fuel Filter Restriction
8. Fuel Cap Not Vented

Test Procedure

1. **Defective Safety Control (M50671-03)**
   Make sure unit is disconnected from AC source. Disconnect the blue wiring coming from safety control that is connected to blue wire at photocell (connection is made in smaller wire nut connection)(FIG. 52). Connect the blue wire from control under the wire nut connection where the white wires are con nected. Plug unit into AC supply. If the reset button on the safety control pops out and unit shuts off, the control is defective and must be replaced.

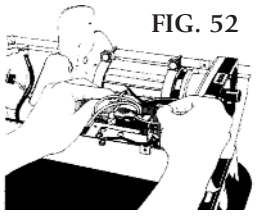


FIG. 52

(M50671-02) Disconnect the blue and white wires connected to photocell connections on printed circuit board. Fabricate a jumper with two spade connections where blue & white wires were removed(FIG. 53).

Plug unit into AC supply. If the reset button of the P.C. board pops out and the unit shuts off, the P.C. board must be replaced. Replace with 097528-01 Kit.

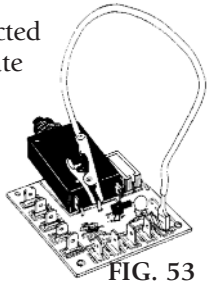


FIG. 53

Note: If control is good, the unit will continue to run even if out of fuel. **Never allow heater to leave service area with safety control bypassed.**

2. **Bypassing Photocell using HA1170 Tester**
   1. Unplug the heater from the 120 volt source.
   2. Disconnect the two wires from the Ignition Control Board (ICB) on the terminals marked "photocell."
   3. Using the HA1170 Tester, connect the alligator clips to the terminals on the ICB marked "photocell" and leave the LED selector switch in the OFF position.
   4. Plug the heater into a 120 volt source and allow heater to cycle.
   5. As soon as the motor engages, move the LED selector switch to the "Flashing" position. The flashing LED sends a signal to the board, causing the board to believe there is sufficient flame and the flame is the right color. If unit still shuts down, it has a bad board.
   6. At this time, use an HA1180 0-15 pressure gauge to check the pump pressure for the proper PSI. Using the HA1170, you will be able to have enough time to work with pump pressure.

If you had to adjust the pump pressure to the recommended setting, you may have solved the problem. Re-connect the photocell and try to run the heater again. If you still have the same symptom, you have a problem with the photocell. Clean the photocell with a soft cloth and rubbing alcohol(FIG. 54). It is important that the electronic eye is clean of soot or dust. After you clean the photocell, you can test it using your HA1170 Tester.

2A. Testing Photocell using HA1170 Tester

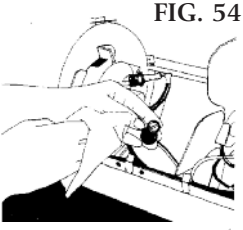
1. Unplug the heater from the 120 volt source.
2. Disconnect photocell leads from Ignition Control Board (ICB.)
3. Connect a multi-meter to the two leads on the photocell.
4. Set multi-meter to Ohms, on the 1xRK scale.
5. Set position switch on the HA1170 to the "solid" position.
6. Place the photocell boot over the red LED on the tester.
7. Resistance should measure 11,000 Ohms or less.
8. Remove photocell form HA1170 and cover the boot with your thumb.
9. Resistance should climb quickly to 50,000 Ohms or more.

If photocell does not perform as indicated in the HA1170 test, you should replace it with one with proper resistance. Always replace a defective Hot Surface Photocell with a Hot Surface Photocell. It is a common mistake to put a Solid State photocell into a Hot Surface heater. Because of the different technology in the two photocells, they are not interchangeable. If you try to test the HSI photocell using a flashlight as your light source, you will get a false reading. The light coming from a flashlight is too intense for an HSI photocell.

2B. Testing a Photocell or ICB Without an HA1170

The best way to troubleshoot and test a heater that you suspect has a defective photocell or ICB is to use an HA1170 Tester. If you do not have this tool, the only thing you can do is replace the parts with known working ones. Note: Never assume that a new part is a good part.

FIG. 54



2C. Defective Photocell

Inspect the lens of the photocell for soot/dirt, etc.. If dirty, wipe off with a clean, damp cloth (FIG. 54). Remove photocell from heater and connect ohmme ter on the 1000 Ohm (RX1K) scale. Hold the lens up to a light source (60 watt light bulb, direct sunlight, etc.) with the lens of the photocell pointed towards the light source (FIG. 55). The resistance of the meter should be low. By blocking off the light source by putting thumb over opening of photocell, the resistance on meter should be high (FIG. 56). Replace the photo cell if a change in resistance is not observed during the above test.

FIG. 55

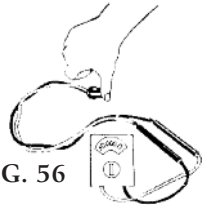


FIG. 56

3. **Loose Wire Nut Connection**
Physically check that all electrical connections are secure and making electrical contact.

4. **Dirty Photocell**-See Step 2C above

5. **Check for Proper Pump Pressure**
Install HA1180 Pressure Gauge or equivalent to rear of air filter housing. Start heater and adjust air pressure to specified pressure. Turning adjustment screw clockwise increases pressure, counterclockwise decreases pressure (FIG. 57). The screwdriver must be removed from the slot after any adjustment before taking a reading on the gauge.

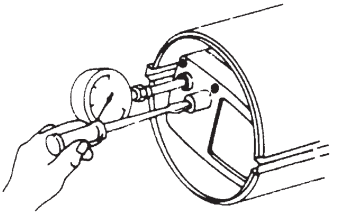


FIG. 57

5A. Adjusting Air Pressure Without an HA1170
If you cannot keep your motor running long enough to adjust your pump pressure, and you do not have an HA1170, you can bypass the board. If you have a single pole motor, you can connect your motor to a 120 volt source. As soon as you plug in your power test cord, your motor should come up to full RPM. If you have a split phase motor, you will need to run a split phase motor test to get your motor to come to full RPM. The split phase motor test can be found on page 30. Start your motor based on your motor type and adjust the pump pressure accordingly.

Note: Pressure gauge must be scaled in 1/4 pound increments for accurate measurement.

6. **Check for Restricted Fuel Flow**
Remove the burner head from heater. Using a socket wrench, carefully remove the nozzle from burner head (FIG. 58). (Be extremely careful not to scratch or score the face of the nozzle.)

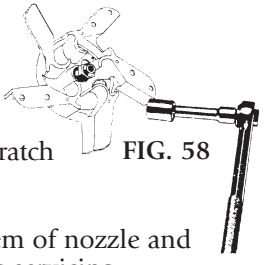


FIG. 58

A. Seal Leak-Remove the rubber seal washer from stem of nozzle and discard. (To be safe, always replace nozzle seal during servicing of burner head.) Even the smallest air leak in this area can reduce flow rates and results in problems.

NOTE: On small heaters (30,000,35,000 & 50,000 BTU), inspect "O" ring, do not remove.

Install a new rubber seal to stem of nozzle. Make sure the seal washer, spring and second seal washer are in place before reinstalling nozzle in the burner head.

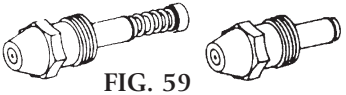


FIG. 59

B. Filter Blocked-On certain models, a drop-in fuel filter is located in the copper or aluminum line that attaches to the fuel fitting on the back side of the burner head. Lift the filter out of the copper or aluminum fuel line and clean, if necessary.

C. Restriction in Nozzle or Burner Head
Using a compressed air source, blow the compressed air through the outlet end of nozzle to dislodge any possible restriction (FIG. 60).

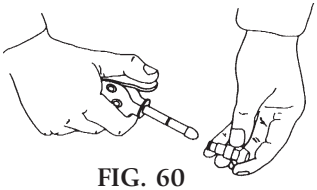


FIG. 60

Caution: Never drill out or try to increase nozzle size.

Using compressed air, also blow through passages in burner head. The air should be directed from input fitting at rear of head to the center of burner head. Many times the restriction to the flow is due to metal chips, etc. being present in the burner head assembly.

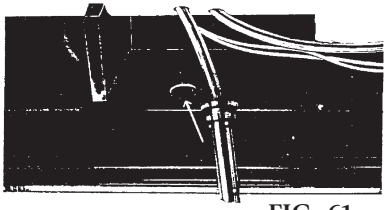


FIG. 61

7. **Fuel Filter Restriction**
The fuel filter should be inspected and cleaned. The filters are located in the fuel line either at tank location, in the copper or aluminum tubbing or in line with the fuel line at access cover.

8. **Fuel Cap Not Vented**
Inspect the vent hole and gasket under the fuel cap to make sure the passage is open. Remember that since the fuel is being drawn from the tank, the tank must be vented for proper operation (FIG. 62).

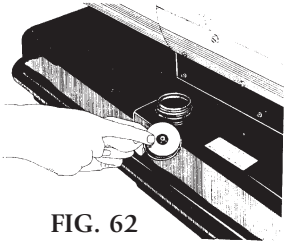


FIG. 62

OBSERVED FAULT

Frequent Plug Fouling/
Delayed Ignition

1. Spark plug too close to spray pattern of nozzle
2. Wrong fuel

1. Spark Plug Too Close to Spray Pattern of Nozzle

It may be necessary in some cases to move the spark plug back from spray pattern of nozzle. The best method is to shim the plug back by placing a standard spark plug washer under the flat of the plug at threaded area. This moves the plug back approximately .1 inch and reduces the possibility of the plug fouling with carbon or the plug becoming wet during the ignition cycle.

2. Wrong Fuel

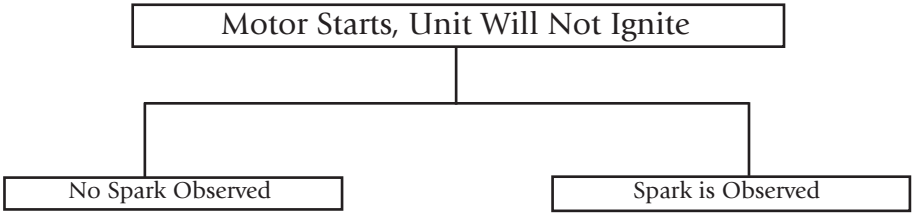
Recommended fuels are Kerosene, Fuel Oil No. 1, and Jet "A". They have the best overall results.,minimum odor & minimum maintenance.No additives necessary for cold weather operation. Alternative fuels are Fuel Oil No.2, Diesel No.1, & Diesel No.2. They have noticeable increase in odor. They require frequent maintenance of fuel filter, nozzle & spark plug. Requires a winterizing additive at temps below 20˚F.

National Riverside
Specific Troubleshooting Guide

If the General Troubleshooting Guide does not resolve the problem, specific guidance for each heater model or group of models is given here. To use this section find the specific heater model of interest and follow the guidance and troubleshooting charts which are appropriate. Be sure to obtain the proper exploded view, parts list and wiring diagram for your heater.

- All repairs must be made by a trained experienced service person.
- Before servicing, disconnect the heater from the electrical power source by removing the electrical plug from the wall receptacle. **NOTE:** When certain tests require electrical power to be applied, connect electrical power only for the time necessary to complete the test.
- Do not bypass safety devices.
- If replacement parts are necessary, do not substitute with non-factory parts (use only factory authorized replacement parts).
- Make sure all electrical connections are secure and all harness leads are in place prior to connection to electrical power source.

OBSERVED FAULT



1. Improper spark plug gap
2. Faulty transformer
3. Faulty spark plug/ignition electrode (cracked)
4. Improper pump pressure
5. Restricted fuel flow due to
   A. Seal leak
   B. Filter blocked
   C. Restriction in nozzle or burner head
   D. Fuel filter restriction

Correction Procedure

Improper Spark Plug Gap

1. Check gap at tip of electrodes for .050/.055 (1.3-1.4 mm) inch spark plug gap. Reset gap as required.

   Note: If feeler gauge is not available, set plug gap to thickness of a dime.

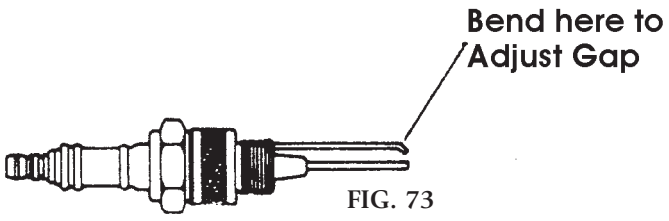


FIG. 73

Faulty Transformer

2. Connect the transformer lead to a new spark plug. Establish a good ground between the spark plug and the heater. Plug in the heater cord and observe for spark between electrodes. If the ground is good and a spark does not jump the gap, the transformer is faulty.

   Caution: Do not let any portion of your body touch electrodes or plug due to high voltage.

Faulty Spark Plug (Cracked)

3. Conduct the above test, using the original spark plug, if spark is observed at any portion of the plug, except at the electrodes, the porcelain insulator is cracked and the plug must be replaced.

Improper Pump Pressure

4. Install Pressure Gauge to rear of air filter housing as shown.

   Start heater and adjust air pressure to specific pressure. Turning adjustment screw clockwise increases pressure, counterclockwise decreases pressure (see Page 102).

   Note: Pressure gauge must be scales in 1/4 pound increments for accurate measurement.

Restricted Fuel Flow

5. Remove the burner head from heater. Using a socket wrench, carefully remove the nozzle from burner head. (Be extremely careful not to scratch or score the face of the nozzle.)

5A. Inspect the rubber "O Ring" seal on the stem of nozzle. Replace if worn or damaged. Even the smallest air leak in this area can reduce flow rates and result in pulsating or improper combustion.

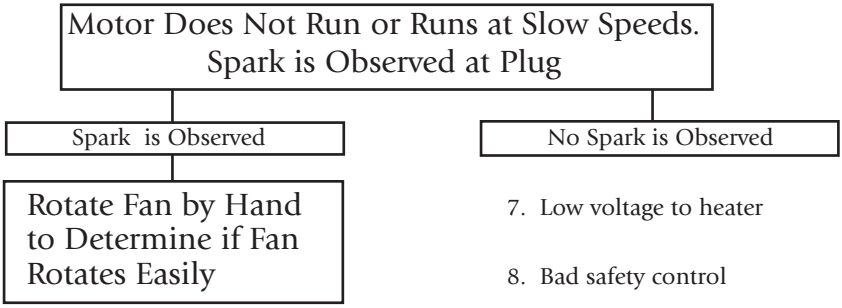
5B. Using a compressed air source, blow the compressed air through the outlet end of the nozzle to dislodge any possible restriction.

Caution: Never drill out or try to increase a nozzle size.

5C. Using compressed air, also blow through passages in burner head. The air should be directed from input fitting at rear of head to the center of burner head. The restriction to the flow may be due to metal chips, etc. being present in the burner head assembly.

5D. The fuel filter should be inspected and replaced. The filters are located in the fuel line at the tank location.

OBSERVED FAULT



1. Broken rotor or blades
2. Improper rotor clearance
3. Dirt on rotor face
4. Faulty motor bearing
5. Open motor winding
6. Faulty relay

7. Low voltage to heater
8. Bad safety control

Correction Procedure

Broken Rotor or Blades

1. Disassemble the end cover filter and end pump cover from rear of motor. Visually inspect the rotor and blades for breakage. Make sure that the rotor and blades are free of any type of lubricant. Rotor and blades must be clean and dry for proper operation.

Improper Rotor Clearance

2. Check rotor with feeler gauge for proper clearance between rotor and pump body (.004-.005). Rotate rotor and make sure all four quadrants of rotor have adequate clearance.

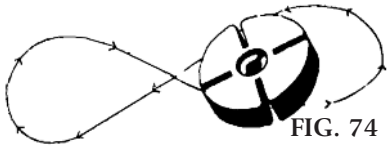


FIG. 74

Dirt on Rotor Face

3. If the fan is hard to turn when the motor end cover is installed, but easy to turn when loosened, the rotor should be removed and lightly sanded. Remove the rotor and lightly sand by placing rotor in the palm of hand and sanding on a flat surface making figure eight rotations(FIG. 74). (Use the finest grade of sandpaper available.)

Faulty Motor Bearing

4. If the fan is difficult to turn with the air pump parts removed, replace the motor.

Open Motor Windings

5. **Motors Without Relay** (50,000 BTU/hr Heaters) — With the heater disconnected from the air pump connect the motor to a 115V, 60 Hz electrical outlet. If the motor fails to rotate replace the motor.

5A. **Motors with Relays** (100,000 and 150,000 BTU/hr Heaters
Start winding. Connect an ohmmeter to the white and black wires coming from motor. This procedure allows you to determine the condition of the start winding. If the meter indicated infinity (open circuit) or the meter goes full scale (zero ohms), the winding is faulty and the motor must be replaced. The actual resistance varies among different motors. Do not be concerned about actual resistance values.

5B. **Main Winding**
Connect the ohmmeter to the red and white wires coming from motor. If the needle does not move again or goes to full scale , the motor must be replaced.

Faulty Relay (100,000 and 150,000 BTU/hr Heaters)

6. Prepare a jumper wire approximately 8" long with a male quick disconnect terminal at one end and a test probe at the other end. Disconnect the black wire coming from the motor that is connected to the "S" terminal of relay. Connect this black wire to the male connection of the jumper wire. Touch the test probe to the "M" terminal of the start relay and plug in the heater. As soon as the motor reaches speed, remove the test probe from terminal "M". The motor should continue to run. If the motor operates correctly, the relay should be replaced.

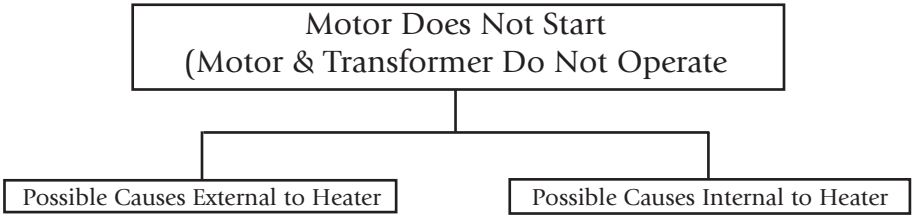
   Note: Relay is position sensitive. Make sure it is properly positioned.

   Caution: Do not touch electrical connections or allow them to touch metal parts of the heater.

Low Voltage to Heater

7. In certain circumstances, a heater may operate correctly when being tested in the service shop, but the customer complains that it does not start at times on the job site. It is important that the customer is made aware that if the heater is operated on an incorrectly sized extension cord or a low voltage outlet, the heater's motor will not start due to low voltage. If the customer has the availability of a voltmeter, have the customer check the voltage at the heater. A minimum of 105 volts, while the heater is running, is necessary for proper operation. Refer to the operators manual for proper extension cord sizing.

OBSERVED FAULT



1. Broken or frayed wires on cord
2. Faulty in-line thermostat

3. Faulty high limit switch
4. Reset button on safety control not fully depressed
5. Poor wiring at safety control
6. Faulty safety control

Correction Procedure

1. **Broken or Frayed Wires on Cord –** Inspect all wires on power cord. Check for any broken or frayed wires. Check for continuity between male prongs of power cord to safety control. If continuity does not exist, replace the power cord.

2. **Faulty In-Line Thermostat –** If an in-line thermostat is being used, be sure that it is working. To do that, disconnect the heater power cord from the thermostat. Plug the heater power cord directly into a 115v 60hz source. If the heater still does not come on, move to step#3 if your heater has a hi-limit switch. If no hi-limit switch exists and the heater works when bypassing the thermostat, replace the thermostat.

3. **Faulty High-Limit Switch –** Some of the newer heaters contain a hi-limit switch inline between the power cord and the circuit breaker. With the heater disconnected from the power source, use an ohm meter set on Rx1 and place leads on the two male terminals on the hi-limit switch. If meter reads "0" resistance and the heater has an in-line thermostat, replace the thermostat. If meter reads high resistance or infinity, replace the hi-limit switch.

4. **Reset Button on Safety Control Not Fully Depressed –** Make sure that the reset button on the safety control is fully depressed. If you are not able to keep the button from popping out, replace the safety control.

5. **Poor Wiring at Safety Control –** Gently tug on all wires on safety control to make sure that the connections are all snug. Install new wire ends if any connections seem to be loose or the wires pull away from their connectors.

6A. **Faulty Safety Control –** With heater disconnected from power supply, check for continuity between the #1 terminal on reset button and the #1 and #2 terminals on the printed circuit board. If continuity does not exist, replace the safety control.

6B. **Faulty Printed Circuit Board –** Connect heater to a 115v 60hz source. Using a volt meter, check for 115 volts between #1 or #2 on printed circuit board and #4, #5, #6 or #7 on printed circuit board. If no or low voltage exists, replace safety control.

OBSERVED FAULT

Heater Ignites and Burns; However, Safety Control Trips and Heater Shuts Off

Safety Control Trips Out Within First Minute of Operation

1. Faulty safety control/printed circuit board
2. Faulty photocell

Safety Control Trips Out After Several Minutes of Operation

3. Dirty photocell
4. Improper pump pressure
5. Check for restricted fuel flow due to:
   A. Seal leak
   B. Filter blocked
   C. Restriction in nozzle or burner head
6. Fuel filter
7. Fuel cap not vented

Test Procedure

Faulty Safety Control/Printed Circuit Board

1. Physically check that all electrical connections are secure and making electrical contact. Disconnect the blue and white wires connected to PHOTOCELL connections on printed circuit board. Fabricate a jumper wire with two spade connections and place where blue and white wires were removed.

Plug unit into AC supply. If the reset button on this P.C. board pops out and the unit shuts off, the P.C. board must be replaced.

Note: If control is good, the unit will continue to run even if out of fuel. Never allow heater to leave service area with safety control bypassed.

Faulty Photocell

2. Inspect the lens of the photocell for soot/dirt, etc. If dirty, wipe off with a clean, damp cloth.

Remove photocell from heater and connect ohmmeter on the 1000 ohm scale. Hold the lens up to a light source (60 watt light bulb, direct sunlight, etc.) with the lens of the photocell pointed toward the light source. The resistance of the meter should be low.

By blocking off the light source by putting thumb over opening of photocell, the resistance on meter should be high. Replace the photocell if no change in resistance is observed.

Dirty Photocell

3. See item #2 above.

Improper Pump Pressure

4. Install a 0-15 psig Pressure Gauge or equivalent to rear of air filter housing. Start heater and adjust air pressure to specified pressure. Turning adjustment screw clockwise increases pressure, counterclockwise decreases pressure (see Table on page 84 for specified pressures).

Note: Pressure gauge must be scaled in 1/4 pound increments for accurate measurements

Restriced Air Flow

5. Remove the burner head from heater. Using a socket wrench, carefully remove the nozzle from burner head. **(Be extremely careful not to scratch or score the face of nozzle.)**

5A. Inspect the rubber "O-Ring" seal washer on the stem of nozzle. Replace if weak or damaged. Even the smallest air leak in this area can reduce flow rates and result in pulsating or improper combustion.

5B. Using a compressed air source, blow compressed air through the outlet end of the nozzle to dislodge any possible restriction.

Caution: Never drill out or try to increase nozzle size.

5C. Using compressed air, blow through passages in the burner head. The air should be directed from the input fitting at the rear of head to the center of the burner head. The restriction to the flow may be due to metal chips, etc. being present in the burner head assembly.

Fuel Filter

6. The fuel filter should be inspected and replaced if needed. The filters are located in the fuel line at the tank location.

Vented Fuel Cap

7. Inspect the vent hole and gasket under the fuel cap to make sure the passage is open. Since the fuel is being drawn from the tank, the tank must be vented for proper operation.

OBSERVED FAULT

Frequent Plug Fouling or Delayed Ignition

1. Spark plug or electrode location
2. Wrong fuel
3. Worn out nozzle

Correction Procedure

1. Spark Plug or Electrode Location

It may be necessary in some cases to move the spark plug back from spray pattern of nozzle. The best method is to shim the plug back by placing standard spark plug washer under the flat of the plug at threaded area. This moves the plug back approximately .1 inch and reduces the possibility of the plug becoming wet during the ignition cycle.
Note: Electrode ingited heaters have stationary electrodes and cannot be moved. Consider Step #3.

2A. Wrong Fuel – Empty the fuel tank.

2B. **Fuel Selection**

One of the most critical specifications for trouble-free operation is the use of a clean, acceptable fuel. Listed below are guidelines and comments concerning operation of heaters with different fuels.

RECOMMENDED FUELS	COMMENTS
Kerosene	Best overall results.
Fuel Oil No. 1	Minimum odor and minimum maintenance.
Jet "A"	No additives necessary for cold weather operation.

ALTERNATIVE FUELS	COMMENTS
Fuel Oil No. 2	Noticeable increase in odor.
Diesel No. 1	Requires frequent maintenance of fuel filter, nozzle and spark plug. Requires a winterizing additive at temperature below 20˚F.
Diesel No. 2	

3. Worn Out Nozzle

If moving the spark plug does not solve the problem or if you have an electrode and it is getting wet, you may have a worn out nozzle. Replace the nozzle with the correct part number.

Mr. Heater
Diagnostic Safety Shutdown and Troubleshooting

These instructions are applicable for MH75KT / HS75KT, MH125KT / HS125KT, MH175KT / HS175KT, and MH210KT / HS210KT.

This heater is equipped with a diagnostic control board and flashing LED error indicator. This flashing LED signals when there is a malfunction of a monitored component. See the following dianostic guide for error signal and brief description of the error.

PLEASE NOTE: The HS50K is not equipped with a diagnostic control board, but the same causes and solutions do apply.

To use the troubleshooting section, look up the symptom you observe for the possible causes. This section is based on the Heat Star and Mr. Heater product manufactured by Mr. Heater and Enerco.

Symptoms:

LED 1 flash

Causes:
System Lockout (High limit switch Open Circuit)

Solutions:
1) Make sure heater is cooled off, press reset switch and retry.

LED gives 2 flashes

Causes:
System Lockout (Sparks, calling for flame, but no or slow motor operation)

Solutions:
1) Check wiring to motor (per wiring schematic in manual).
2) Make sure that the gauge plug is in place and not damaged.
3) Adjust pressure for proper heater operation per manual.
4) With heater disconnected from AC source, rotate fan clockwise to verify motor is free.
5) Remove air filter housing from motor and inspect the pump rotor for damage. If damaged, replace rotor assembly.
6) If wiring is correct, pump rotor is okay, and motor is not rotating freely, replace motor or power-pack assembly.
7) If problem persists, replace oil flame control assembly.
8) Check for spark arching from the electrode assembly, to the combustion cylinder.
9) Check the cad cell for continuity.
10) Check length and gage of extension cord for proper amp. draw.

LED gives 3 flashes

Causes:
System Lockout (No Spark)

Solutions:
1) Check wiring to igniter (per wiring schematic in manual).
2) Check gap between electrode probes (2.3 - 3 mm).
3) Still no spark, replace igniter assembly.
4) Replace oil flame control assembly.

LED gives 4 flashes

Causes:
System Lockout (Abnormal Motor Operation - Motor overheats or Stops)

Solutions:
1) Motor speed too low (Motor should operate at 3450rpm) - Replace motor.
2) With heater disconnected from AC source, rotate fan clockwise to verify motor is free.
3) Remove air filter housing from motor and inspect the pump rotor for damage. If damaged, replace rotor assembly.
4) If wiring is correct, pump rotor is okay, and motor is not rotating freely, replace motor or power-pack assembly.
5) Replace oil flame control assembly.

LED gives 5 flashes

Causes:
System Lockout (Reset button Error)

Solutions:
1) Check wiring to reset button.
2) Replace reset button.
3) Replace oil flame control assembly.

LED gives 6 flashes

Causes:
System Lockout (Unable to Detect Flame)

Solutions:
1) Check wiring to Cad Cell (per wiring schematic in manual).
2) Clean Cad Cell photo cell.
    a) Slide Cad Cell out of Cad Cell holder.
    b) Push the photo cell out of the white rubber Cad Cell housing by pushing on the blue and white wires.
    c) Clean the photo cell with a soft cloth and rubbing alcohol.
    d) Pull the photo cell back into the Cad Cell housing and reinstall into holder.
    e) Test heater.
3) If the heater still does not operate, replace Cad Cell.
4) Replace oil flame control assembly.

LED is steady on (no flashes)

Causes:
Flame Control Failure

Solutions:
1) Check wiring in heater (per wiring schematic in manual).
2) Replace oil flame control assembly.

Abnormal motor operation, Motor overheats and stops (LED gives 4 flashes)

Causes:
1. Broken Rotor or Blades
2. Improper Rotor Clearance
3. Oversized Rotor
4. Low Voltage to Heater
5. Defective Oil Flame Control Assembly

Solutions:
1. Broken Rotor or Blades
Disassemble the end cover filter and end pump cover from rear of motor. Visually inspect the rotor and blades for breakage. Make sure that the rotor and blades are free of any type of lubricant. Rotor and blades must be clean and dry for proper operation.

2. Improper Rotor Clearance
Check rotor with feeler gauge for proper clearance between rotor and pump body. The proper gap should be .003″ or .004″ at the twelve o'clock position. Rotate rotor and make sure all four quadrants of rotor have adequate clearance. If rotor catches on a "high spot", re-gap rotor at the high spot.

3. Oversized Rotor
If the fan is hard to turn when the motor end cover is installed, but easy to turn when loosened, the rotor should be removed and lightly sanded. Remove the rotor and lightly sand by placing rotor in the palm of hand and sanding on a flat surface making figure eight rotations. (Use the finest grade of sandpaper available). Re-install rotor using guidelines as detailed in #2.

4. Low Voltage to Heater
Check for voltage using a voltmeter a minimum of 108 volts while the heater is running for normal operations.

5. Defective Oil Flame Control Assembly
After doing all the tests in this section and the problem persists, replace oil flame control assembly.

No heater operation when connected to power source
LED gives 5 flashes

Note: Make sure that the thermostat is turned up and calling for heat.
Causes:
1. Check that reset button on Safety Control is fully depressed
2. Check wiring connections at the reset button
3. Check for Continuity of Reset Button
4. Oil Flame Control Assembly

Solutions:
1. Check that reset button on Safety Control is fully depressed
Visually inspect the black reset button on safety control. The button must be fully depressed and latched in for operation.

2. Check wiring connections at the reset button
Make sure connections on the reset button are secure. Check with wiring schematic for proper wiring.

3. Check for Continuity of Reset Button
With the heater disconnected from AC source, disconnect the two wires connected to the safety control. Push reset button in. With the ohmmeter on the 0 to 200 OHM scale, check for continuity across terminals where wires were removed. Meter should indicate "0".

4. Oil Flame Control Assembly
After doing all the tests if the problem persists, replace oil flame control assembly.

Heater ignites but Main PCB Assembly shuts heater off after a short period of time. (LED gives 6 flashes)

Causes:
1. Dirty or faulty Cad Cell (photocell)
2. Oil Flame Control Assembly

Solutions:
1. Dirty or faulty Cad Cell (photocell)
Defective Photocell inspects the lens of the photocell for soot/dirt, etc. If dirty, wipe off with a clean, dry cloth.
Remove photocell from heater and connect ohmmeter on the 1000 Ohm (RX1K) scale. Hold the lens up to a light source (60 watt light bulb, direct sunlight, etc.) with the lens of the photocell pointed toward the light source. The resistance of the meter should be low (less than 500 ohms).
By blocking off the light source by putting thumb over opening of photocell, the resistance on meter should be high. Replace the photocell if a change in resistance is not observed during the above test.

2. Oil Flame Control Assembly
After doing all the tests if the problem persists, replace oil flame control assembly.

LED is steady on (no flashes)

Causes:
1. Wiring
2. Flame Control Failure

Solutions:
1. Wiring
Check Wiring in heater (per wiring schematic in manual).

2. Flame Control Failure
Replace Oil Flame Control Assembly

Toro
Troubleshooting

SERVICE TROUBLE SHOOTING

The first step in problem solving is TROUBLE SHOOTING. To assist the technician, the following troubleshooting chart should be referenced as an aid in locating the source of the problem.

Problem	Possible Cause	Remedy
Pulsating or uneven firing	1. Low fuel level or unit not level	1. Level unit. Keep tank filled
	2. Air leak	2. Check air & fuel lines for leaks. Filter not tight. No filter gasket.
	3. Water in fuel.	3. Drain, flush & refill with clean, water-free fuel.
	4. Low air pressure	4. Adjust air pressure. Clean air filters.
	5. Nozzle leaking air into oil passage.	5. Replace nozzle seal.
	6. Restricted fuel filter	6. Replace fuel filter.
	7. Dirty nozzle.	7. Clean/or replace nozzle.
Motor does not start	1. No power to unit.	1. Check outlet and fuse Check power cord for good contact.
	2. Defective motor	2. Bench test motor, if bench testing indicates good, replace motor start relay.
	3. Circuit breaker tripped	3. Depress reset (button near power cord)
	4. Loose circuit breaker connections.	4. Check terminals on circuit breaker for good, tight contact.
	5. Defective PCB breaker	5. Replace P.C. breaker.
Motor runs slowly/Does not turn	1. Fan obstructed	1. Adjust as required.
	2. Low voltage.	2. Check length and size of extension cord.
	3. Tight compressor	3. With unit unplugged, turn fan by hand. If fan does not turn freely, perform Compressor Servicing as needed.

Problem	Possible Cause	Remedy
Cannot adjust air pressure	1. Air leak.	1. A) Check air line, replace if necessary. No "O" ring between filter body & compressor plate. Filter gasket not in place.
	2. Air line fitting or filter body loose	2. Tighten
	3. Compressor ring out of adjustment	3. Adjust gap between rotor and compressor ring. Gap too wide (.005).
	4. Plugged nozzle.	4. Clean or replace
	5. Defective nozzle seal/O-ring	5. Replace
	6. Dirty output filter	6. Replace
	7. Dirty seat for ball in relief valve or dirty relief valve ball.	7. Clean relief valve and seat.
	8. Spring in relief valve stuck or defective	8. Replace spring
	9. Worn or broken compressor vanes.	9. Replace all vanes as a set.
	10. Rotor warn.	10. Replace worn rotor.
Runs indoors, not outdoors in cold weather	1. Water in fuel	1. Drain, flush and refill with clean, water-free fuel.
	2. Improper fuel	2. If weather is below 0°F (-18 C), kerosene should be used as fuel. It may also be necessary to add a de-icer.
	3. Low air pressure	3. Adjust pressure. Clean or replace air filters. Check for air leaks or restriction in fuel and air lines.
	4. Incorrect nozzle or spark plug adjustment	4. Adjust nozzle spacing. Check spark plug alignment.

Pinnacle
Specific Troubleshooting Guide

To use the troubleshooting section, look up the symptom you observe for the possible causes. This section is based on the Pro-Temp, Heat Hog and Dayton models manufactured by Pinnacle Products International.

Symptoms:
1. Heater ignites but Main PCB Assembly shuts heater off after a short period of time. (Lamp is flickering) (E1) Page 91.
2. Heater will not ignite, but motor runs for a short period of time. (Lamp is flickering) (E1) Page 91.
3. Fan does not turn when heater is plugged in and Power Switch is in the ON position. (Lamp is on or Flickering) (E1 or E2) Page 91-93.
4. Lamp is flickering, and LED display shows "E2" Page 93.
5. Lamp is flickering, and LED display shows "E3" Page 93.
6. Heater does not turn on and the lamp is not lit. Page 94.

Heater ignites but Main PCB Assembly shuts heater off after a short period of time.

Causes:
1. Wrong pump pressure
2. Dirty Air Output, Air Intake or Lint Filter
3. Dirty Fuel Filter
4. Dirt in Nozzle
5. Dirty Photocell Lens
6. Photocell Assembly not properly installed (not seeing flame)
7. Bad electrical connection between photocell and Main PCB Assembly
8. Bad Photocell
9. Bad PCB Assembly

Solutions:
1. Wrong pump pressure
If model is not equipped with a built-in air pressure gauge, remove pressure gauge plug (solid plug) from end of filter cover and install a low pressure gauge. Start heater and allow motor to reach full speed. With a flat head screw driver, adjust the relief valve clockwise to increase pressure and counter clockwise to decrease pressure. Set pump pressure to correct pressure for each model. Stop heater. If accessory pressure gauge is being used, remove pressure gauge. Install plug in end of filter cover (solid plug).

Intake filter should be removed and washed with soap and water every 500 hours of operation, or as needed. Be sure that filter is completely dry prior to putting back in filter cover. Remove screws along side of heater using medium Phillips screwdriver. Lift off upper shell, remove fan guard. Wash or replace air intake filter, reinstall fan guard and upper shell.
The air output filter and lint filter should be replaced every 500 hours of operation or once a year. Remove upper shell and fan guard, remove end filter cover screws using medium Phillips screwdriver. Remove filter end cover replace air output and lint filter. Reinstall end filter cover, fan guard and upper shell.

3. Dirty Fuel Filter
It is suggested that you clean or replace the fuel filter twice per heating season or as needed. To take fuel filter out, turn counterclockwise 90 degrees, pull and move. Wash fuel filter with clean fuel and compressed air and replace in tank.

4. Dirt in Nozzle
Blow compressed air through the outlet end of nozzle to dislodge any possible restriction. Also blow compressed air through passages in burner head. The air should be directed from input fitting at rear of head to the center of burner head. Many times the restriction to the flow of fuel is due to a metal chip, a piece of carbon dust, etc. To prevent this from happening in the future, use clean kerosene.

5. Clean/replace Photocell
Inspect the lens of the photocell for soot/dirt, etc.. If dirty, wipe off with a clean, damp cloth. Remove photocell from heater and connect ohmmeter on the 1000 Ohm (TX1K) scale. Hold the lens up to a light source (60 watt light bulb, direct sunlight, etc.) With the lens of the photocell pointed towards the light source, the resistance of the meter should be under 500 ohms. Block off the light source by putting your thumb over opening of photocell; the resistance on meter should be high. Replace the photocell if a change in resistance is not observed during the above test.

6. Adjust Photocell position
Make sure that the photocell is properly seated in the bracket. The photocell needs to be properly seated in the bracket to observe flame in combustion chamber.

7. Replace Photocell
(See number 5.)

8. Check wiring connections
Check the wiring diagrams to make sure the heater is wired properly. Also check to see if the wires are tight and not loose.

9. Bad PCB Assembly
Bypass the photocell to check the PCB for proper operation. Remove the photocell wires from the board. Connect a jumper wire to the two terminals where the photocell connects to the board. Run the heater and if it shuts off you have a bad PCB. If the heater continues to run, see number 5 above.

Heater will not operate, or motor runs for short time. Lamp flickers and LED display shows "E1".

Causes:
1. No kerosene in fuel tank
2. Incorrect pump pressure
3. Corroded Spark Plug or incorrect plug gap.
4. Dirty Fuel Filter
5. Dirty Nozzle
6. Moisture in Fuel/Fuel Tank
7. Improper electrical connection between Transformer and Circuit Board.
8. Transformer Wire not connected to Spark Plug.
9. Defective Transformer
10. Defective Fuel Valve

Solutions:
1. No kerosene in fuel tank.
Fill tank with fresh, clean kerosene.

2. Incorrect pump pressure.
If model is not equipped with a built-in air pressure gauge, remove pressure gauge plug (solid plug) from end of filter cover and install a low pressure gauge. Start heater and allow motor to reach full speed. With a flat head screw driver, adjust the relief valve clockwise to increase pressure and counter clockwise to decrease pressure. Set pump pressure to correct pressure for each model. Stop heater. If accessory pressure gauge is being used, remove pressure gauge. Install plug in end of filter cover (solid plug).

3. Corroded Spark Plug or incorrect plug gap.
Clean and re-gap every 600 hours of operation, or replace as needed. After removing the Spark plug, clean the terminals with a wire Brush. Re-gap the terminals to 0.140" (3.5mm).

4. Dirty Fuel Filter
It is suggested you clean or replace fuel filter twice per heating season or as needed. To take fuel filter out turn counterclockwise 90 degrees, pull and move. Wash fuel filter with clean kerosene and compressed air and replace in tank.

5. Dirty Nozzle
Blow compressed air through the outlet end of nozzle to dislodge any possible restriction. Also blow compressed air through passages in burner head. The air should be directed from input fitting at rear of head to the center of burner head. Many times the restriction to the flow of fuel is due to a metal chip, a piece of carbon dust, etc. To prevent this from happening in the future, use clean kerosene.

6. Moisture in Fuel/Fuel Tank
Flush out fuel tank with clean fresh kerosene.

7. Improper electrical connection between Transformer and Circuit Board.
Inspect all electrical connections.

8. Transformer Wire not connected to Spark Plug.
Re-attach Transformer wire to Spark Plug.

9. Defective Transformer.
Connect the transformer or electronic igniter to a properly gapped spark plug. Establish a good ground between the spark plug and heater. Plug in the heater cord and observe for spark between electrodes. If the ground is good and a spark does not jump the gap, the transformer or spark plug is defective. If spark is observed at any portion of the plug, except at the electrodes, the porcelain insulator is cracked ant the plug must be replaced. The transformer needs to arc back to its own ground. Make sure the transformer is mounted tightly and properly. This will insure a good ground from the transformer to the spark plug.

To test transformer: Remove fan blade. Remove wire from spark plug and hold the wire with well insulated pair of insulated pliers. Check the electrical performance by connecting the transformer to the 110 volt power cord by itself. Touch the end of the wire to the ground on the transformer. Pull the spark plug wire away from the transformer slowly and observe an electrical arc to exceed more than 1/2" long before the arc breaks. Also observe that the arc is rainbow in color. If the transformer fails any part of this test, the transformer should be considered defective and replaced with an OEM transformer.

Fan does not operate when heater is plugged in and Power Switch is in the "ON" position. The lamp is flickering or the lamp remains steady.

Causes:
1. Thermostat is set too low
2. Broken electrical connection between Circuit Board and motor

Solutions:
1. Thermostat is set too low.
Rotate thermostat to a higher setting
2. Broken electrical connection between Circuit Board and motor.
Inspect all electrical connections. Wiring Diagrams (page 98)

Lamp is flickering, and LED display shows "E2".

Causes:
1. Disconnected room temperature sensor.
2. Room temperature sensor has failed.

Solutions:
1. Disconnected room temperature sensor.
Re-connect temperature sensor
2. Room temperature sensor has failed.
Replace temperature sensor.

Lamp is flickering, and LED display shows "E3".

Causes:
1. Thermostat Switch has failed

Solutions:
1. Thermostat Switch has failed
Using a multi-meter set to the lowest ohms setting, check for continuity when the thermostat is turned up to maximum heat. If it doesn't show continuity, replace Thermostat Switch.

Heater does not turn on and the lamp is not lit.

Causes:
1. Temperature limit sensor has over-heated.
2. No Electrical power
3. Fuse Blown
4. Improper electrical connection between Temperature Limit Sensor and Circuit Board.

Solutions:
1. Temperature limit sensor has over-heated.
Push Power Switch to "OFF" and allow heater to cool for 10 minutes. With the heater disconnected from the power source, use an ohm meter set on the Rx1 scale and place leads on the two male terminals on the hi-limit switch. If meter reads "0" resistance, the limit sensor is good. If meter reads high resistance or infinity, replace the limit sensor.
2. No electrical power
Check power cord and extension cord to insure of proper connection. Test power supply make sure source is at least 110 volts to heater.
3. Fuse Blown
Use an ohm meter set on the Rx1 scale and place leads on each end of the fuse. Check for continuity through the fuse. If the fuse shows no continuity, the fuse is defective and should be replaced.
4. Improper electrical connection between Temperature Limit Sensor and Circuit Board. Inspect all electrical connections. Wiring Diagrams on page 116.

L.B. White
Troubleshooting, Repair Procedures

Heater ignites but MAIN PCB assembly shuts heater off after a short period of time. (Indicator Lamp is flickering and room temp. display indicates "E1")

Causes:

1. Wrong pump pressure
2. Dirty Air Output, Air Intake or Lint Filter
3. Dirty Fuel Filter
4. Dirt in Nozzle
5. Dirt Photocell Lens
6. Photocell Assembly not Properly Installed (not seeing the flame)
7. Bad electrical connection between photocell and MAIN PCB Assembly
8. Defective photocell

Solutions:

1. See Pump Pressure Adjustment
2. See Air Output, Air Intake and Lint Filters
3. See Fuel Filter
4. See Nozzle
5. Clean Photocell Lens
6. Make sure photocell boot is properly seated in bracket
7. Check electrical components. See Wiring Diagrams
8. Replace Photocell

Heater will not turn-on (Indicator Lamp is off)

Causes:

1. Thermostat switch failure
2. Temperature limit safety device is overheated
3. No electrical power
4. Blown fuse
5. Bad electrical connection between temperature limit safety device and PCB board

Solutions:

1. Replace MAIN PCB
2. Turn power switch to "OFF" and allow to cool
3. Check to insure heater cord and extension cord are plugged in
4. Replace safety fuse in PCB board. See Replacing Fuse
5. Check electrical connections. See Wiring Diagrams

Heater will not ignite but motor runs for a short period of time. (Indicator Lamp is flickering and room temp. display indicates "E1")
Causes:
1. No fuel in tank
2. Wrong pump pressure
3. Carbon deposits on spark plug and/or improper gap
4. Dirty fuel filter
5. Dirt in Nozzle
6. Water in fuel tank
7. Bad electrical connection between igniter and MAIN PCB Assembly
8. Igniter wire is not attached to spark plug

Solutions:
1. Fill tank with kerosene
2. See Pump Pressure Adjustment
3. See Spark Plug
4. See Fuel Filter
5. See Nozzle
6. Flush fuel tank with clean kerosene
7. Check electrical components. See Wiring Diagram
8. Attach igniter to spark plug. See Spark Plug

Fan does not turn when heater is plugged in and power switch was in the "ON" position. (Indicator Lampison orflickering)
Causes:
1. Thermostat setting is too low
2. Bad electrical connection between motor and MAIN PCB Assembly

Solutions:
1. Turn thermostat control knob to a higher setting
2. Check electrical connections. See Wiring Diagram

(Indicator Lamp is flickering and room temp. display indicates "E2")
(Indicator Lamp is flickering and room temp. display indicates "E3")
Causes:
1. Room Temp. sensor disconnected
2. Sensor Failure

Solutions:
1. Reconnect sensor. See Wiring Diagrams
2. Replace sensor. See Wiring Diagram

DESA International Specifications

Model #	B50	B55	B70
Output Rating, BTU/hr	50,000	55,000	70,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, gal/hr	.37	.40	.52
Air Pump Pressure (PSI)	3.6	3.4	4.0
Fuel Tank Capacity, gals.	4	5	5
Electrical Requirements	120V, 60 Hz	120V, 60 Hz	120V, 60 Hz
Amperage	2.0	2.0	2.8
Motor RPM	1725 rpm	1725 rpm	3340 rpm
Hot Air Output	165 cfm	165 cfm	170 cfm
Net Weight	30 lbs.	37 lbs.	47 lbs.
Shipping Weight	35 lbs.	44 lbs.	56 lbs.

DESA International Specifications

Model #	B100	B110	B150
Output Rating, BTU/hr	100,000	110,000	150,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, gal/hr	.74	.83	1.10
Air Pump Pressure (PSI)	4.0	4.5	5.0
Fuel Tank Capacity, gals.	9	9	13.5
Electrical Requirements	120V, 60 Hz	120V, 60 Hz	120V, 60 Hz
Operating Amperage	4.5	4.5	4.5
Starting Amperage	10	10	10
Motor RPM	3450 rpm	3450 rpm	3450 rpm
Hot Air Output	480 cfm	480 cfm	600 cfm
Net Weight	47 lbs.	47 lbs.	54 lbs.
Shipping Weight	56 lbs.	56 lbs.	65 lbs.

Hot Surface Ignition Model Specifications

Model #	R35D REM35C	R40 REM40	R55A REM55A	R60 REM60 RM60
Output Rating, BTU/hr	35,000	40,000	55,000	60,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, gal/hr	.3	.34	.4	.44
Air Pump Pressure (PSI)	3.0	3.0	3.6	3.4
Fuel Tank Capacity, gals.	3	3	5	5
Electrical Requirements	120V, 60Hz	120V, 60Hz	120V, 60Hz	120V, 60Hz
Operating Amperage	2.0	2.0	2.0	2.0
Motor RPM	1725 rpm	1725 rpm	1725 rpm	1725 rpm
Hot Air Output	165 cfm	170 cfm	175 cfm	180 cfm
Net Weight	31 lbs.	31 lbs.	31 lbs.	31 lbs.
Shipping Weight	36 lbs.	36 lbs.	36 lbs.	36 lbs.

Hot Surface Ignition Model Specifications

Model #	R70D R70DT	R110B R110BT	R115 REM115 RM115	REM150
Output Rating, BTU/hr	70,000	110,000	115,000	150,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, gal/hr	.5	.8	.8	1.1
Air Pump Pressure (PSI)	4.7	5.3	53	5.4
Fuel Tank Capacity, gals.	5	9	9	13.5
Electrical Requirements	120V, 60Hz	120V, 60Hz	120V, 60Hz	120V, 60Hz
Operating Amperage	2.8	3.6	3.6	3.6
Starting Amperage	6	8	8	8
Motor RPM	3450 rpm	3450 rpm	3450 rpm	3450 rpm
Hot Air Output	250 cfm	490 cfm	490 cfm	550 cfm
Net Weight	31 lbs.	48 lbs.	48 lbs.	55 lbs.
Shipping Weight	36 lbs.	57 lbs.	57 lbs.	66 lbs.

Hot Surface Ignition Model Specifications

Model #	R155B REM155B RM155	R165AT	R200A
Output Rating, BTU/hr	155,000	165,000	200,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, gal/hr	1.1	1.2	1.4
Air Pump Pressure (PSI)	5.4	5.6	6.2
Fuel Tank Capacity, gals.	13.5	13.5	13.5
Electrical Requirements	120V, 60Hz	120V, 60Hz	120V, 60Hz
Operating Amperage	3.6	3.6	3.6
Starting Amperage	8	8	8
Motor RPM	3450 rpm	3450 rpm	3400 rpm
Hot Air Output	550 cfm	575 cfm	600 cfm
Net Weight	55 lbs.	55 lbs.	66 lbs.
Shipping Weight	66 lbs.	66 lbs.	77 lbs.

National Riverside Specifications

Model #	50	100	150
Input Rating, BTU/hr	50,000	100,000	150,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, gal/hr	.38	.77	1.15
Air Supply Pressure, psig.	3.6	4.25	5.25
Fuel Tank Capacity, gals.	4	12	12
Electrical Input	115V, 60 Hz, 1Ø, 5.5a	115V, 60 Hz, 1Ø, 3.5a	115V, 60 Hz, 1Ø,5.5a
Minimum Operating	100V	100V	110V
Fan	1750 rpm 165 cfm	3000 rpm 275 cfm	3000 rpm 400 cfm
Ignition	Direct Spark, continuous	Direct Spark, continuous	Direct Spark, continuous
Spark Generator	Transformer, 5000V. sec. 10ma	Transformer, 5000V. sec. 20ma	Transformer, 5000V sec. 20ma
Spark Plug	1/16″ gap	1/16″ gap (.063) Post Electrode	1/16″ gap (.063) Post Electrode
Primary Flame Safety	Solid State Control	Solid State Control	Solid State Control
Control	25-second timing	25-second timing	25-second timing
Power Cord	1 ft.	1 ft.	1 ft.
Size (LxWxH)	33″x15″x15″	41″x20″x21″	41″x20″x21″
Net Weight		69 lbs.	76 lbs.
Shipping Weight	36 lbs.	74 lbs.	79 lbs.

Mr. Heater Specifications

Model	**50K**	**75KT**	**125KT**	**175KT**	**210KT**
Burn Rate	50,000	75,000	125,000	175,000	210,000
Fuel Rate Gal/Hr	0.37	0.55	0.96	1.3	1.6
Electrical Input	115V, 60Hz	115V, 60Hz	115V, 60Hz	115V, 60Hz	115V, 60Hz
Line Protection	10 amps	10 amps	20 amps	20 amps	20 amps
Pressure Setting	3.5	4.2	5.0	5.8	8.5
Max. Outlet Temperature	1300°F	1300°F	1300°F	1300°F	1300°F
Fuel Tank Capacity	4 gallons	6 gallons	14 gallons	14 gallons	14 gallons
Ignition	Direct Spark	Direct Spark	Direct Spark	Direct Spark	Direct Spark
Primary Safety Control	Solid State	Solid State	Solid State	Solid State	Solid State
Certification	**CSA**	**CSA**	**CSA**	**CSA**	**CSA**

Toro Specifications

Model #	**CH55**	**CH100**	**CH150**
Output (BTU's/HR)	55,000	100,000	150,000
Tank Capacity U.S. Gallons	4	11	11
Designed Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Electrical	115V, 60Hz	115V, 60Hz	115V, 60Hz
Approx. Hours Operation/Filling	10	15.1	10.1
Transport Wheels	Opt.	Std.	Std.
Air Flow (CFM)	180	385	560
Automatic Shut-off	Yes	Yes	Yes
Heated Area	10,300	18,800	28,200
Thermostat	Opt.	Opt.	Opt.
Net Weight (lbs.)	43	60	70
Ship Weight (lbs.)	48	67	78
Air Pressure Setting	4.1 PSI	5.5 PSI	6.25 PSI
Certification	ARL	ARL	ARL

Toro Specifications

Model #	I40	I60	CH220	CH225
Output (BTU's/HR)	40,000	60,000	220,000	175,000-225,000
Tank Capacity U.S. Gallons			20	20
Designed Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Electrical	-	115V 60Hz	115V 60Hz	115V 60Hz
Approx. Hours Operation/Filling	10	10	12.5	12.5
Transport Wheels	Std	Std	Std	Std
Air Flow (CFM)			560	560
Automatic Shut-off	Yes	Yes	Yes	Yes
Thermostat	Opt	Opt	Std	Std
Net Weight (lbs.)	35	50	90	90
Ship Weight (lbs.)	40	55	100	100
Air Press. Stng	3 PSI	4 PSI	6.25 PSI	5 PSI (1985) 6.25 PSI (1986 &Newer)
Certification	ARL	ARL	ARL	ARL

Pinnacle Specifications

Model	PT 45-KFA	PT 70T-KFA	PT125T-KFA	PT175T-KFA	PTH215T-KFA
Rating BTU/Hr	45,000	70,000	125,000	175,000	215,000
Fuel Rate Gal/Hr	0.35	0.53	0.95	1.33	1.63
Fuel Tank Capacity	5.0 gallons	5.0 gallons	10.0 gallons	13.0 gallons	13.0 gallons
Pump Pressure PSI	3.0	4.0	5.0	7.5	9.0
Volt/Hz	120V/60Hz	120V/60Hz	120V/60Hz	120V/60Hz	120V/60Hz
Amps	1.4	1.5	2.3	2.7	2.8
Phase	Single	Single	Single	Single	Single
Size (LxWxH)	30″x12″x15″	30″x12″x15″	38″x22″x25″	43″x24″x26″	43″x24″x26″
Weight (Lbs)	32	32	60	67	72

L.B. White Specifications

Model	**CP045AK**	**CP075AK**	**CP125BK**	**CP170BK**	**CP210BK**
Rating BTU/Hr	45,000	75,000	125,000	170,000	210,000
Fuel Rate Gal/Hr	0.35	0.57	0.95	1.3	1.6
Pump Pressure PSI	2.8	3.8	5.5	6.5	8.5
Volt/Hz	120V/60Hz	120V/60Hz	120V/60Hz	120V/60Hz	120V/60Hz
Amps	1.6	1.6	2.5	3.2	3.7
Phase	Single	Single	Single	Single	Single
Size (LxWxH)	32″x12″x17″	32″x12″x17″	38″x23″x24″	45″x24″x26″	43″x24″x26″
Weight (Lbs)	26	26	50	56	62

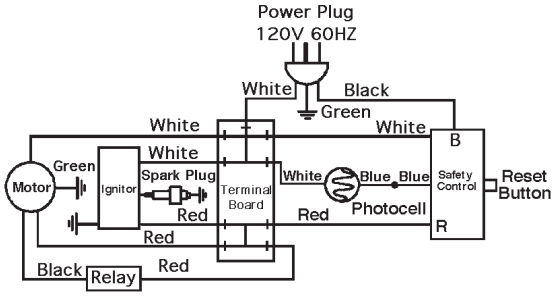


FIG. 68

70,000 - 150,000 BTU Heaters - Heaters equipped with Solid State Relay

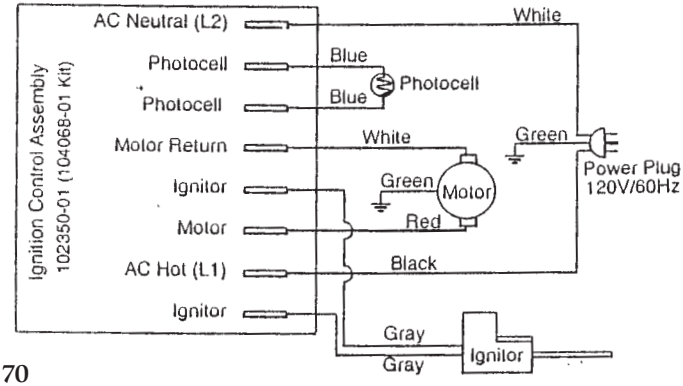


FIG. 70

55,000 BTu Model (R55A Model Only)

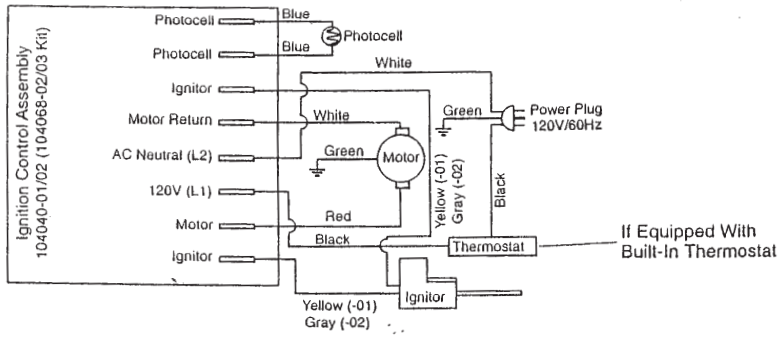


FIG. 71

35,000, 40,000, 50,000, 55,000, 60,000, 70,000, 110,000 115,000, 150,000 155,000, 165,000 BTU Models

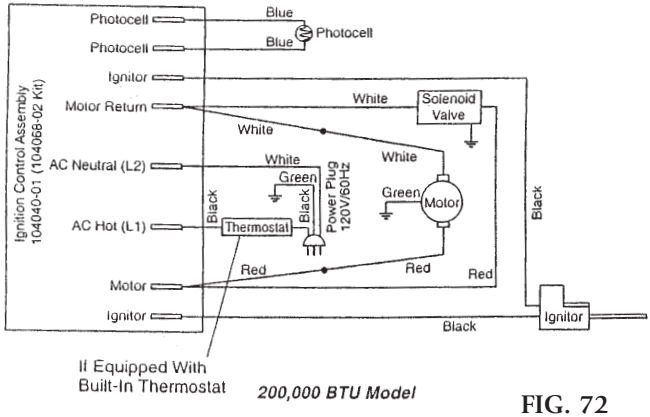


FIG. 72

200,000 BTU Model

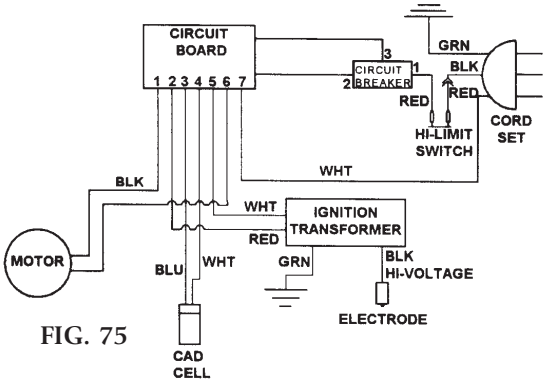


FIG. 75

Model K50

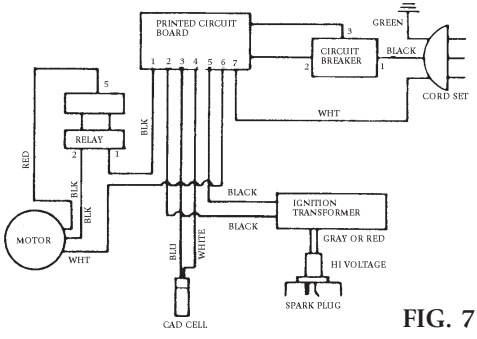


FIG. 77

Model K100/K150 Round Shell

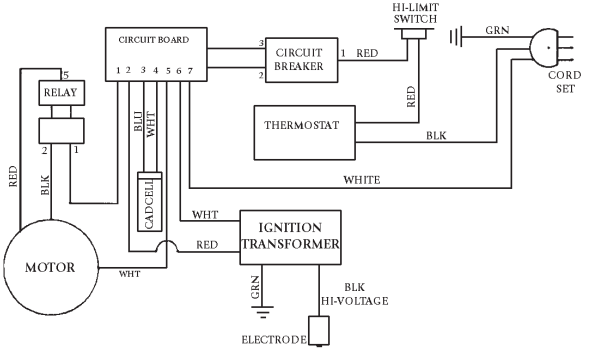
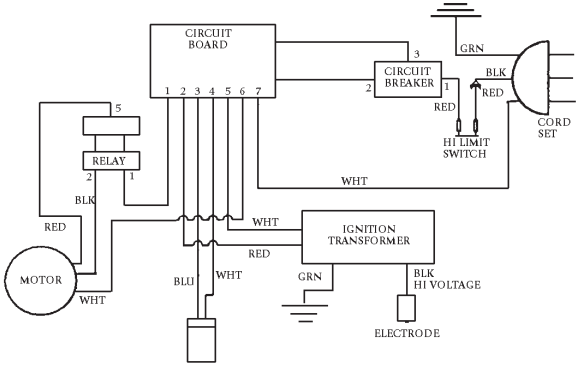


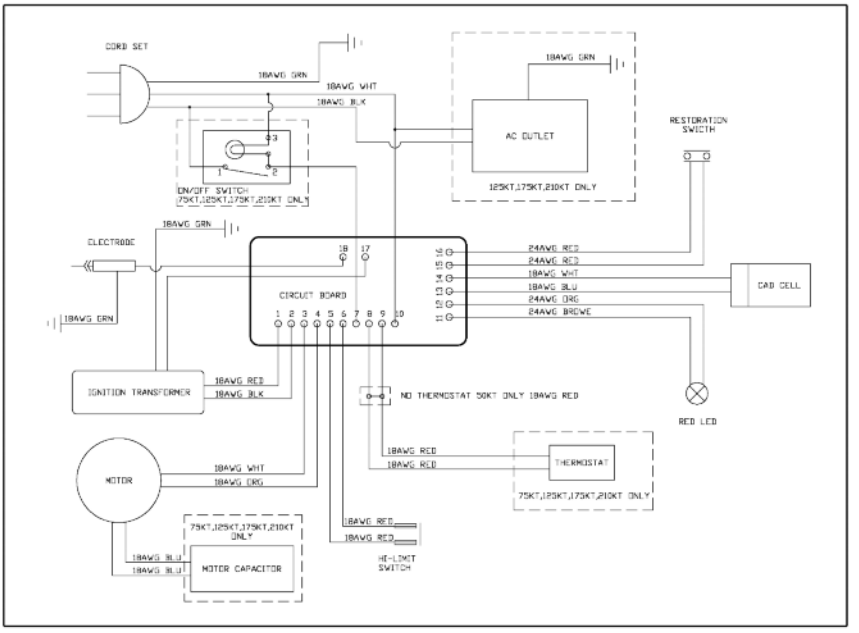
FIG. 76

Octagon heater with thermostat
Model K100/K150



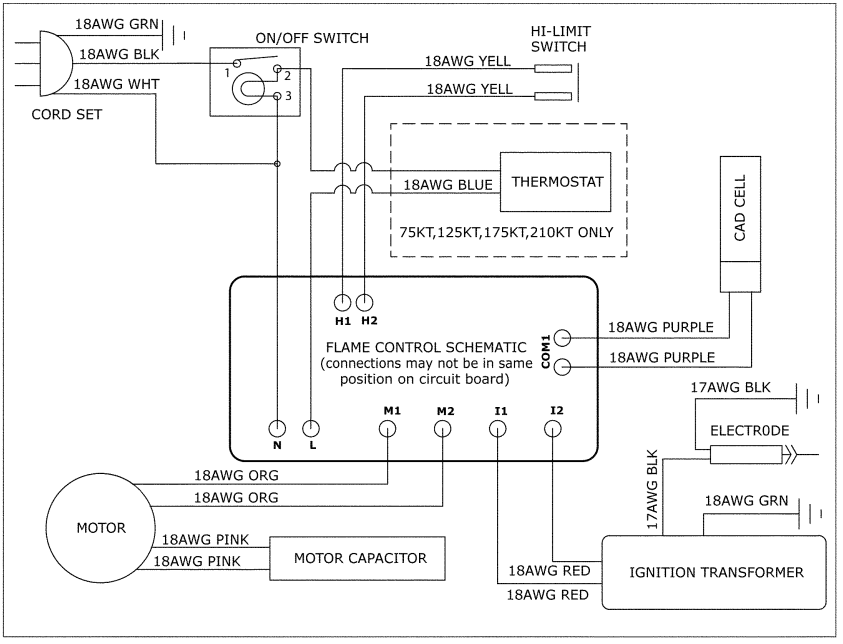
Octagon heater without thermostat
Model K100/K150

Mr. Heater/Heat Star Wiring Diagram



HS Series

Mr. Heater/Heat Star Wiring Diagram

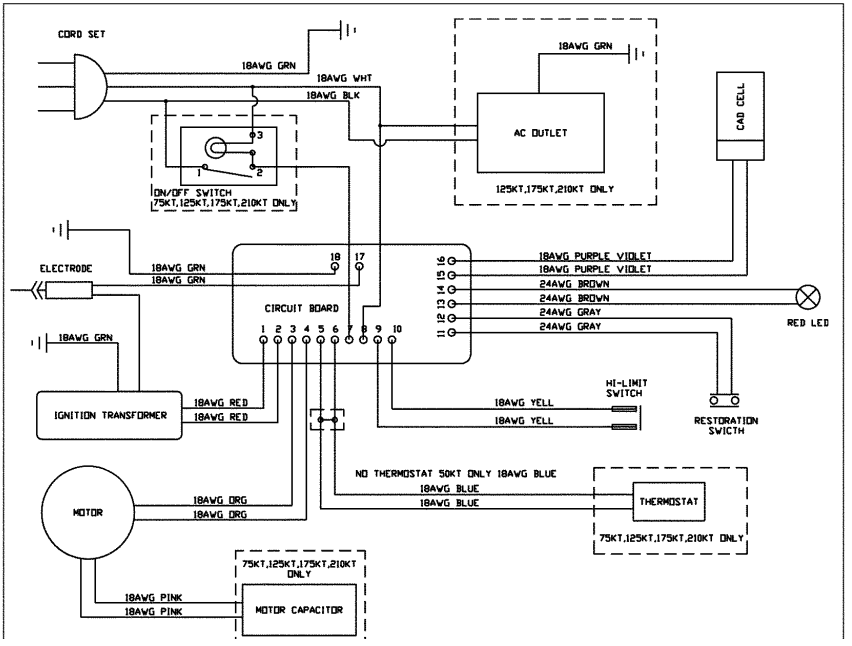


2009 to Present

Models:
HS50K
HS75KT
HS125KT
HS175KT
HS210KT

Enerco heaters with round style filter cover

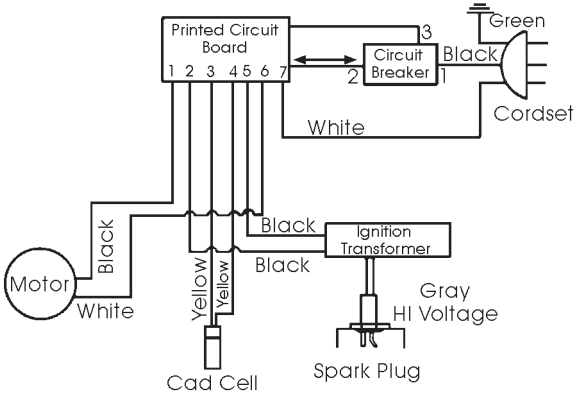
Mr. Heater/Heat Star Wiring Diagram



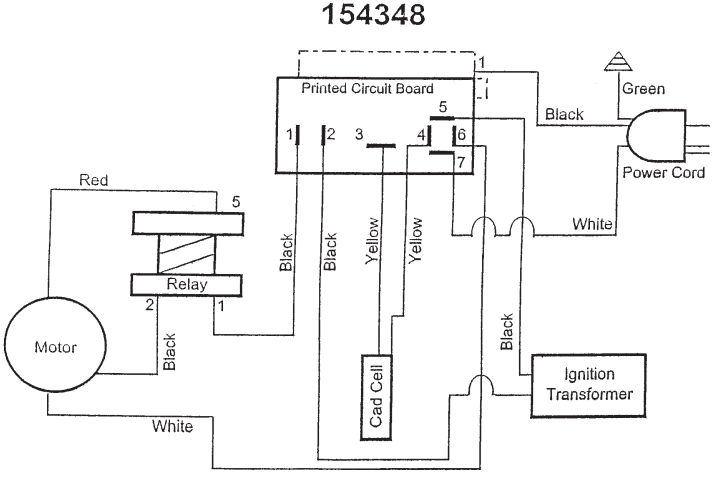
2005 to Present

Models:
HS/MH/TS50K
HS/MH/TS75KT
HS/MH/TS125KT
HS/MH/TS175KT
HS/MH/TS210KT

Enerco heaters with rectangular style filter cover



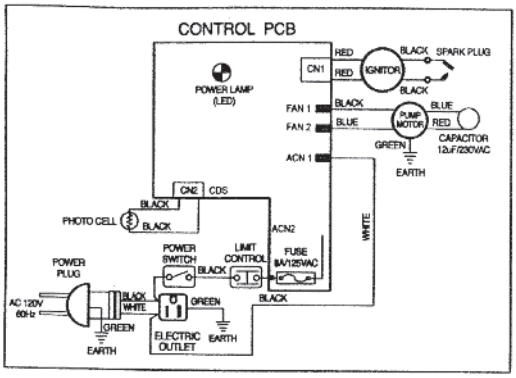
40/55,000 BTU 1983-1991



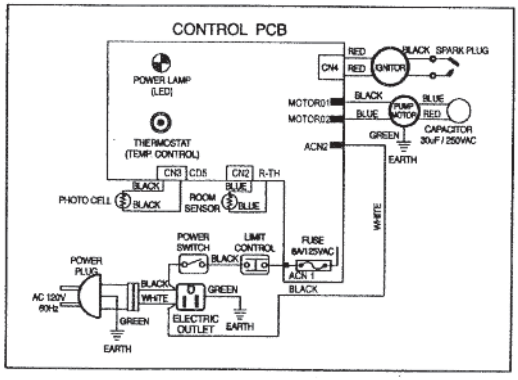
100/150,000 BTU 1986-1991

If no motor start relay, connect motor hot wire to terminal #1 on board.

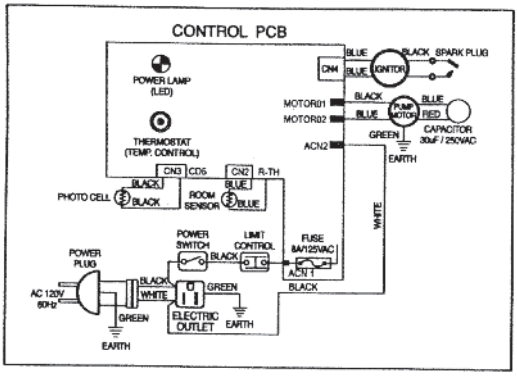
Pinnacle Wiring Diagram



Wiring Diagram A Models PT 45-KFA



Wiring Diagram B Models PT 70T-KFA



Wiring Diagram C Model PT 125/175/215T-KFA

L.B. White Wiring Diagrams

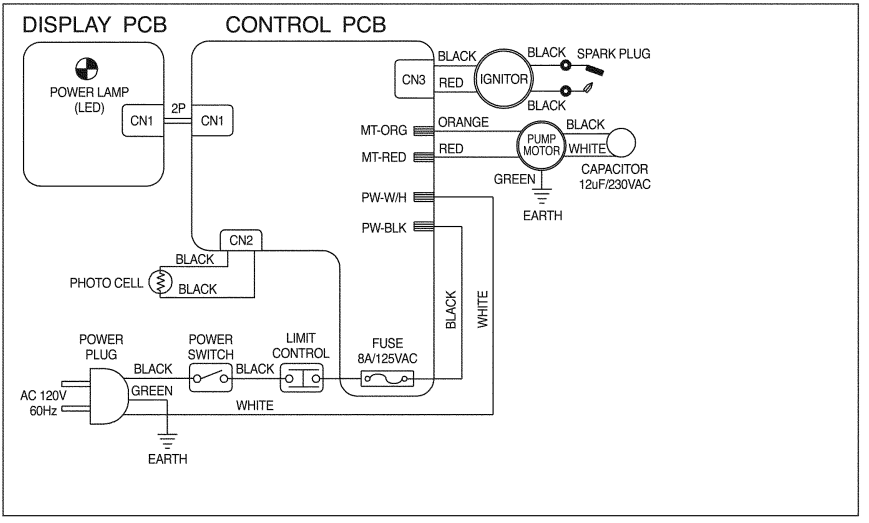


Figure 17 – Wiring Diagram Model CP045AK

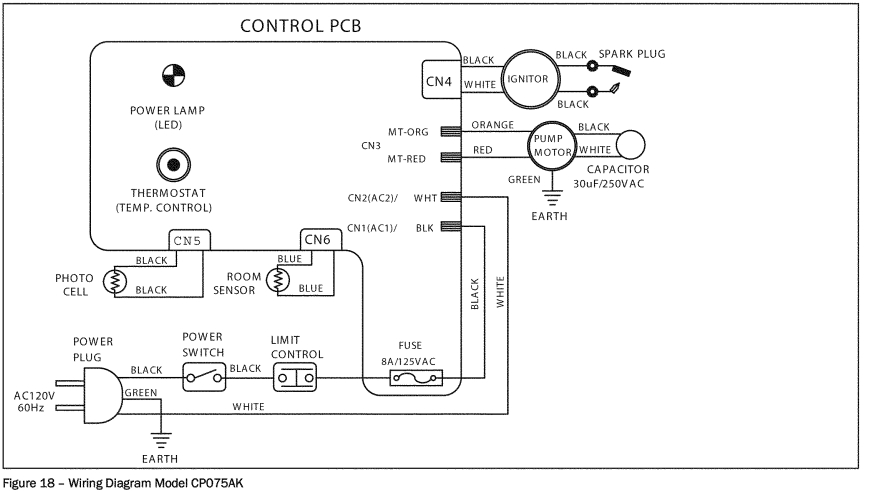


Figure 18 – Wiring Diagram Model CP075AK

L.B. White Wiring Diagram

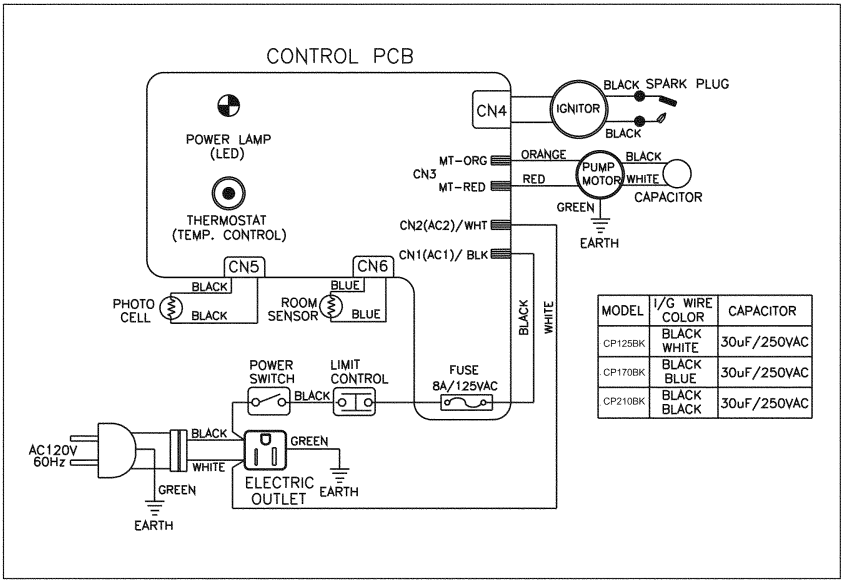


Figure 21 – Wiring Diagram Models CP125BK, CP170BK, CP210BK

High Pressure Theory of Operation

When the thermostat is turned up power is sent to the flame/safety control and to the fan switch. This brings power to the motor relay and the transformer. The transformer raises the voltage to a high level and sends the high voltage to a spark plug or electrode(s). When the coil in the motor relay is energized, a magnetic pull draws in the contacts in the motor relay and allows power to reach the motor.

When the motor reaches full speed, a centrifugal switch inside the motor allows power to open the solenoid valve located in the fuel line before the nozzle. The motor turns a fan blade at the front and drives a fuel pump attached to the rear of the motor. The pump draws fuel up from the tank thru an inlet port on the pump. A fuel filter is located in the draw line or inside the pump itself. The pump pressurizes the fuel and sends fuel to the nozzle. Another port returns excess fuel back to the tank. The pump has a pressure adjustment port with a screw in it to adjust the pump pressure. The pump also has a port that allows a pressure gauge to be attached to the pump. With spark and fuel spray the fuel ignites. A photocell detects the presence of flame in the combustion chamber. If flame is not detected within approximately 45 seconds, the flame/safety control trips and power to the motor and transformer is removed. When flame is established and the photocell senses the flame, the heater runs and heats the contacts in the fan switch so that power for the motor relay is now obtained from the power cord and not from the flame/safety control.

When the desired temperature is reached, the thermostat cuts power to the flame/safety control. This causes the transformer and solenoid valve to lose power, thereby cutting off the spark and fuel spray. The heater is now running the cool down phase. The motor will continue to run the fan blade to cool down the combustion chamber. The pump is still driven by the motor but the fuel blocked by the closed solenoid is returned to the tank by the pump's return line. When the fan cools the combustion chamber enough, the fan switch contacts also cool until power through the fan switch to the motor relay is cut and the motor stops. When the surrounding temperature drops enough, the thermostat control will send power to the flame/safety control and the cycle will begin again.

Always allow the cool down phase to run before turning off power to the heater. To start the cool down phase when the heater is burning simply turn the thermostat control down to its lowest setting.

Component Description and Operation

Fuel Pump
The fuel pump draws fuel from the fuel tank and pressurizes it to a high level. Pump pressures vary by manufacturer and model, but typically fall into a range of 80 to 160 pounds per square inch, or PSI.
The pump is driven by the heater motor. The motor rotates the pump by one of three means: direct motor shaft to pump shaft, a coupler to connect the shafts, or a belt drive.
The pump contains several "ports" or openings. The inlet port draws the fuel from the tank into the pump. The outlet port carries the pressurized fuel to the spray nozzle. The return or bypass port returns a portion of the fuel back to the fuel tank. The gauge port allows for the attachment of a high pressure fuel gauge to check and adjust pressure. The pressure adjustment port usually contains a screw to adjust pump pressure. The exact arrangement of these ports may vary from one manufacturer to another.

Fuel Filter
Several different types of fuel filters are found on high pressure oil heaters. They all remove impurities from the fuel before they can enter and damage the fuel pump.
Canister filters are located in the inlet line between the tank and the pump. Inside the canister is a removable filter cartridge that can be cleaned or replaced as needed.
Inlet line mesh filters use a metal mesh screen located at the end of the inlet line down in the fuel tank.
Most pumps contain an internal filter located where the inlet line enters the pump.

Motor
The motor powers the fuel pump and also turns the fan. Some motors contain an internal centrifugal switch. This switch allows current to flow to the fuel solenoid valve when the motor reaches full speed. Most motors have an internal thermal and current protector to prevent damage should the fan or pump lock up. These motors also contain a reset button which should only be activated with power removed from the heater.

Safety Control
The safety control monitors the presence of flame within the combustion chamber. A light sensing photocell is connected to the safety control. When flame is seen, power is allowed to continue thru the safety control to run the

solenoid valve, transformer and motor. If flame is not detected within approximately 45 seconds, power is removed from the solenoid valve and the transformer. Depending on the temperature of the fan switch, the heater will then run a cool down phase or totally shut down.

Photocell
The photocell contains a light sensitive cell and is aimed thru an opening in the combustion chamber to detect the presence of flame. The photocell then reports to the safety control and power is then continued or removed as described in the preceding "safety control" paragraph.

Solenoid Fuel Valve
The solenoid fuel valve acts as an on/off switch controlling the flow of fuel thru the spray nozzle. Usually the power for the solenoid valve must pass thru a centrifugal switch located within the motor. This ensures that the motor must be running before fuel spray can occur. This also allows fuel spray to be stopped in order to run the cool down phase of heater shutdown.

Fan Switch
The fan switch allows the motor to continue turning the fan after the thermostat shuts down combustion. This is done to properly cool the combustion chamber. The switch is a temperature-sensitive bi-metal type.
When the heater is first turned on, power to the motor is sent thru the thermostat, and then the safety/flame control and the normally closed contacts of the fan switch (usually one and three). After several minutes of operation the temperature of the combustion chamber increases. This causes the contacts to warp and closes contacts one and two. The heat also causes contacts one and three to open. Power for the motor is now routed thru contacts one and two, bypassing the thermostat and the safety/flame control. When the combustion chamber cools enough to allow the fan switch to open contacts one and two, the motor will shut off and the cool down phase will be complete.

Transformer
The transformer takes supply voltage and transforms this voltage up considerably. The output voltage varies from brand to brand, but typically falls within a range of about 7,000 to 15,000 volts. Most electrical multi-meters will be damaged trying to measure this output. The high voltage is then sent to a spark plug or electrode(s) to provide an ignition source for the fuel. Often the mounting points of the transformer serve as the ground connection to the heater.

Spark plug or electrode(s)
The high voltage sent by the transformer is received by the spark plug or electrode(s) and jumps across the gap to ignite the fuel spray. Consult the owner's manual of your heater for the recommended gap or position.

Thermostat
The setting of the thermostat decides whether power is sent to the safety/flame control. When the thermostat is turned higher than the surrounding temperature, power can reach the transformer and solenoid fuel valve. This results in spark and fuel spray so combustion can begin. When the desired thermostat temperature is reached, the contacts in the thermostat break the flow of power necessary for spark and spray. After the contacts cool enough, power is sent to the safety/flame control and the cycle begins again.

Motor Relay
Power for the motor must come from the motor relay. When the heater is first plugged in, power rests at the motor relay. In order for this power to be sent to the motor, a coil inside the motor relay must receive power from the fan switch.

High Pressure Troubleshooting

To use the troubleshooting section, look up the symptom you observe for the possible causes. This section is based on the Master brand models B350 and B600 manufactured by Desa. Other brands and models may differ somewhat, but the troubleshooting and tests are applicable in most cases.

Symptoms:

Motor will not start, but ignition spark is present.

Causes:

1. Defective fan switch.
2. Fuel pump seized.
3. Defective motor.
4. Defective relay.
5. Motor reset button tripped.

Solutions:

1. Defective fan switch.

The fan switch may be tested with a multimeter set to ohms to check for continuity.

Usually the fan switch has three male terminals. The terminals may be numbered 1, 2 and 3. If not numbered here is the layout: 1 is the terminal with the wire running to the motor relay, 2 is the terminal whose wire comes from a terminal block fed power from the power cord and 3 is the terminal whose wire comes from a terminal block fed by the flame/safety control. Remove the fan switch and place the multimeter probes on terminals 1 and 3. Continuity or zero ohms should be read. Next heat the "face" of the fan switch with a lighter or other heat source. Place the multimeter probes on terminals 1 and 2, and again continuity should be read. If either reading fails to show continuity, the fan switch is defective.

2. Fuel pump seized.
Unplug the heater and remove the top shell to access the fan blade. Standing behind the heater, attempt to turn the fan blade clockwise by hand. If the fan blade is difficult to turn, rock the fan blade back and forth (clockwise and counterclockwise) to loosen the pump. If the fan blade is still difficult to turn, undo the connection between the motor shaft and the pump shaft. Try turning the fan blade again. If the motor now turns freely the pump has seized up. If the pump cannot be repaired, it must be replaced. If the fan blade is still difficult to turn, the motor is defective.

3. Defective motor.
Follow the preceding instructions under " 2. Fuel pump seized" to determine if a seized pump is preventing the motor from turning. If the pump is not seized, disconnect the hot and neutral wires leading to the motor, and use a multimeter to check for voltage on these wires when the heater is turned on. If correct voltage is observed, and the motor's reset button is not tripped, the motor is defective. If voltage is not observed, refer to the fan switch and relay tests on pages 103 and 104.

4. Defective relay.
To test the relay, first remove it from the heater. Set a multimeter to read ohms. Use a power "pigtail" or remove the heater power cord and connect the hot and neutral wires to the appropriate terminals on the relay. The multimeter probes would be placed on the other two terminals that had wires. When power is applied, a reading of zero ohms or continuity should be read. If the test shows otherwise, the relay is defective.

5. Motor reset button tripped.
First follow the instructions under " 2. Fuel pump seized" to determine if a defective motor or seized fuel pump has tripped the motor reset button. Depress the motor reset button, then plug the heater in and attempt to start. If the motor reset button continues to trip, most likely the motor is defective.

Motor starts, but heater will not ignite.

Causes:
1. Defective transformer.
2. Defective spark plug or electrode(s).
3. Incorrect pump pressure.
4. Defective solenoid valve.
5. Dirty fuel filter.

6. Dirty or worn nozzle.
7. Drawing air in on fuel inlet line of pump.
8. Defective fuel pump.

Solutions:

1. Defective transformer.

If no spark is observed at the spark plug or electrode(s) check that the hot and neutral wires to the transformer are properly connected. Check to make sure the transformer output wire is connected to the spark plug or electrode(s). Also check that the transformer has an adequate ground connection. If the wiring and ground connection check ok, remove the transformer to perform a bench test. Use a power "pigtail" or remove the heater power cord so you can wire power direct to the transformer. Select a pair of well insulated pliers with no nicks or cuts in the insulation. Using the insulated pliers, hold the end the transformer's output wire against the grounding tab on the transformer. Plug the cord in to power up the transformer. Then using the insulated pliers, slowly draw the output wire away from the transformer's ground. Observe how far the arc "stretches" before breaking. If the arc will not stretch at least 1/2" or there is no arc, the transformer is defective.

2. Defective spark plug or electrode(s).

Inspect the spark plug or electrode(s) for proper gap and positioning. Refer to the owner's manual of your particular heater for the manufacturer's specifications and adjust as needed. Check the metal tip of the spark plug or electrode(s) for carbon buildup or melting. Inspect the porcelain area for cracks or chips and replace if necessary.

3. Incorrect pump pressure.

Use a high pressure fuel gauge inserted into the pump's gauge port to verify that the pump output pressure is within the manufacturer's specifications. Use the adjustment port to set the correct pressure.

4. Defective solenoid valve.

If no fuel spray is observed, the solenoid valve may be defective. Disconnect the hot and neutral wires to the solenoid valve and using a multimeter, check for proper voltage to the solenoid valve when the heater is turned on. Take care to maintain a safe distance from the rotating fan blade. If proper voltage is read then the valve is defective. If no voltage is present, the motor's internal centrifugal switch or wiring may be the cause.

5. Dirty fuel filter.
Inspect the fuel filter and clean or replace as needed. If your heater has a canister type filter remember to fill the canister with fuel before re-attaching the filter. This will help prime the fuel pump.

6. Dirty or worn nozzle.
Remove the nozzle and check that the orifice and filter on the backside of the nozzle are clean. To clean, blow out with compressed air. A solvent may be used if deposits are difficult to remove. Do not use anything metal to clean the nozzle orifice as this may enlarge the orifice hole. A worn nozzle cannot be detected with the naked eye. If the pump pressure, spark and fuel are all correct and the spray still will not ignite properly, a new nozzle may be needed, especially if the nozzle has a lot of use on it.

7. Drawing air in on the fuel inlet line of the pump.
If the pump cannot achieve and/or maintain its prime to pump a steady stream to the nozzle, there may be air entering the pump from the inlet line or fuel filter. If you suspect this, thoroughly tighten all fittings and check the condition of the gaskets in the fuel filter canister. If you still suspect air entering the inlet line, start eliminating the pieces in the draw line one by one starting with the draw tube down in the tank until you find the leak. It may be necessary to use a bucket or container to draw the fuel up.

8. Defective fuel pump.
If no fuel spray is observed, the pump may be defective. To check, slightly open the fitting on the output line of the pump, and run the heater briefly. If fuel is being pumped the solenoid valve may be defective or the nozzle plugged. See "4. Defective solenoid valve" on page 125. See "6. Dirty or worn nozzle" on page 126. If no fuel is being pumped, see "5. Dirty fuel filter" on page 126 and "7. Drawing air in on fuel inlet line of pump" on page 126. If none of the preceding are preventing the pump from working, the pump is defective.

Heater ignites, runs less than one minute and the flame/safety control trips.

Causes:
1. Photocell dirty or defective.
2. Flame/safety control defective.

Solutions:
1. Photocell dirty or defective.
If the photocell "eye" is dirty, it may be cleaned with a soft dry cloth. Should

a cleaner be necessary, use an alcohol based cleaner that will dry completely without leaving an oil residue. If the photocell is clean and this symptom continues, remove the photocell for testing. Place a flashlight or lamp shining directly at the photocell eye. Set a multimeter to read ohms and connect the two multimeter probes to the two photocell wires. The multimeter should read below 500 ohms, otherwise the photocell is defective. With all light blocked by covering the photocell completely, the multimeter should read over 250,000 ohms or the photocell is defective. An additional way to test a photocell is to locate the origin points of the two photocell wires and remove the wires. Next place a "jumper" wire across the same two origin points. If the heater will now continue running, the photocell is defective and must be replaced.

2. Flame/safety control defective.
The easiest way to test the flame/safety control is to prove the photocell is good or bad using one of the two preceding tests under "1. Photocell dirty or defective". If the jumper test will not run the heater or the photocell passes the ohm test, the flame/safety control is defective.

Heater ignites, runs several minutes and shuts down.

Causes:
1. Defective fan switch.
2. Photocell dirty or defective.
3. Dirty fuel filter.
4. Incorrect pump pressure.

Solutions:
1. Defective fan switch.
See "1. Defective fan switch" on page 123 for instructions on how to test the fan switch.

2. Photocell dirty or defective.
See "1. Photocell dirty or defective" on page 126 for instructions on cleaning and testing the photocell.

3. Dirty fuel filter.
See "5. Dirty fuel filter" on page 126.

4. Incorrect pump pressure.
See "3. Incorrect pump pressure" on page 125.

Heater ignites, but combustion is poor or uneven.

Causes:
1. Incorrect pump pressure.
2. Dirty or worn nozzle.
3. Dirty fuel filter.
4. Spark plug or electrode(s) not gapped or positioned properly.
5. Weak spark output from transformer.
6. Fuel contaminated by water or impurities.

Solutions:
1. Incorrect pump pressure.
See "3. Incorrect pump pressure" on page 125.

2. Dirty or worn nozzle.
See "6. Dirty or worn nozzle" on page 126.

3. Dirty fuel filter.
See "5. Dirty fuel filter" on page 126.

4. Spark plug or electrode(s) not gapped or positioned properly.
See "Defective spark plug or electrode(s)" on page 125.

5. Weak spark from transformer.
See "1. Defective transformer" on page 125.

6. Fuel contaminated by water or impurities.
Using a flashlight, inspect the fuel in the tank for water or impurities. Bubbles on the bottom of the tank indicate water in the fuel tank. Water can be removed from the tank by adding an additive to the tank that is designed to dry up moisture in fuel tanks. This type of additive can be purchased at most automotive supply stores. This is also advisable if the fuel filter contains water or impurities.

Motor and transformer do not operate.

Causes:
1. Flame/safety control is tripped.
2. Thermostat is defective.
3. Flame/safety control is defective.
4. Wiring disconnected, loose or incorrect.
5. No power at outlet.

Solutions:

1. Flame/safety control reset button is tripped.

Check to see if the flame/safety control reset button is tripped. If your heater is equipped with a thermostat, turn the thermostat up to its highest setting and press the reset button. If pressing the reset button does not power up the heater, either the thermostat or flame/safety control is defective. If the reset button continues to trip out, refer to the appropriate troubleshooting page.

2. Thermostat is defective.

The thermostat may be tested with a multimeter set to measure volts. Turn the thermostat to its highest setting and check for voltage on the hot wire coming out of the thermostat. If no voltage is read the thermostat is defective. Another way to test the thermostat is to bypass it. Connect the hot wire in to the thermostat to the thermostat's hot wire out. If the thermostat is defective, the heater will power up when plugged in.

3. Flame/safety control is defective.

The flame /safety control receives power from the thermostat. First, prove the thermostat is passing power out when turned up by either testing for voltage or bypassing the thermostat. If the flame/safety control is receiving power from the thermostat, check for voltage out of the flame/safety control on its hot wire with a multimeter. If no voltage is read after pushing the reset button, the flame/safety control is defective.

4. Wiring disconnected, loose or incorrect.

With the heater unplugged, check the wiring from the cord to the terminal blocks, thermostat, and flame/safety control. Consult the wiring diagram of your heater to make sure all these wires are connected properly.

5. No power at outlet.

Use a multimeter to test the outlet, or plug in another item that uses the same voltage as the heater to verify the outlet has power.

Heater ignities, but flame is excessive.

Causes:

1. Pump pressure too high.
2. Incorrect fuel.
3. Worn nozzle.

Solutions:

1. Pump pressure too high.

Use a high pressure fuel gauge attached to the pump's gauge port to check the pump pressure. Use the pump's pressure adjustment if the pressure is higher than the manufacturer's recommended setting.

2. Incorrect fuel.

Only use fuels recommended by the specific manufacturer of the heater. Never use gasoline, thinners, solvents, or any other flammable fluid. If you suspect incorrect fuel, inspect carefully, then drain and replace if necessary.

3. Worn nozzle.

Over time, impurities in the fuel which are forced thru the nozzle under high pressure will enlarge the orifice and cause the heater to overfire or run "rich". Always check first for excessive pump pressure or incorrect fuel. If the pressure and fuel are both correct, a new nozzle is needed.

DESA High Pressure Specifications

Model#	**B350**	**B600**
Output Rating (BTU/Hr)	350,000	600,000
Fuel	Use only kerosene or No. 1 fuel oil	
Fuel Tank Capacity (U.S. Gallons)	30	36
Fuel Consumption (Gallons Per Hour)	2.5	4
Electric Requirements	120V/60Hz	120V/60Hz
Amperage (Normal Run)	7.1	11.5
Motor RPM	1725	1725
Fuel Pump Pressure (PSI)	100	110
Spark Plug Gap	.050/.060"	.050/.060"
Weight (Approx. Lbs.)		
Dry	180	285
With Full Fuel Tank	390	550

National Riverside High Pressure Specifications

Model	K350	K650
Input Rating BTU/hr	350,000	650,000
Type of Fuel	Kerosene or #1 Fuel Oil	
Fuel Consumption GPH	2.5	4.3
Pump Pressure PSIG	100	110
Fuel Tank Capacity Gals.	30	49
Electric Input	115V, 60Hz, 1Ø	
Amperage	9	11
Minimum Operating	100V	100V
Motor RPM	1725	1725
Ignition	Over Surface, Continuous	
Spark Generator	Ignitor, 13k secondary	
Electrode	Single Post Electrode	
Dry Weight lbs.	195	300
Wet Weight lbs.	405	643

Toro High Pressure Specifications

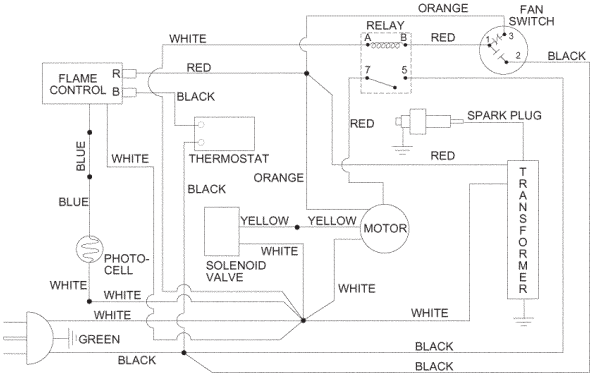
Toro High Pressure Specifications are not available.

Heat Wagon
High Pressure Specifications

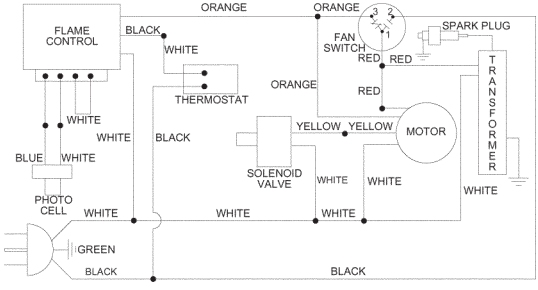
Model	**DF400**	**DF600**
Input Rating BTU/hr	400,000	600,000
Type of Fuel	Kerosene or #1 Fuel Oil	
Fuel Consumption GPH	2.83	4.32
Pump Pressure PSIG	165	190
Fuel Tank Capacity Gals.	35.7	35.7
Electric Input	120V, 60Hz, 1Ø	
Amperage	7.5	11.1
Minimum Operating	-	-
Motor RPM	-	-
Dry Weight lbs.	222.7	246.7

Desa® International Wiring Diagrams (High Pressure)

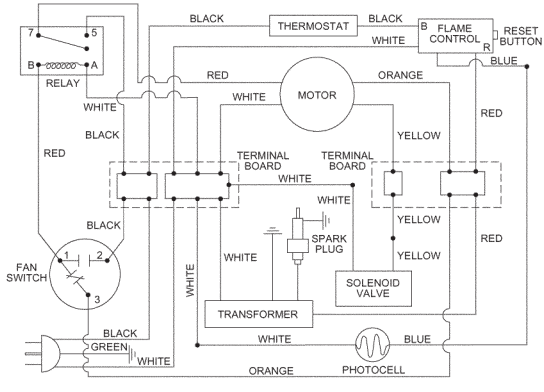
B350 and B600 Models



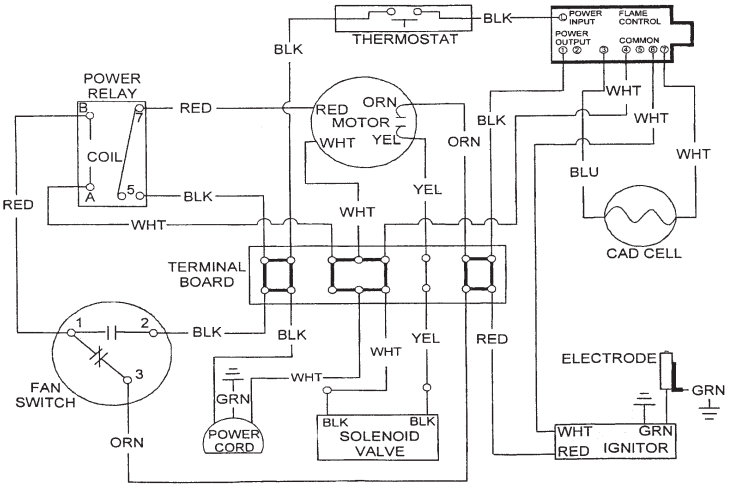
Wiring Diagram for Non-Terminal Block Heater with Standard Flame Control



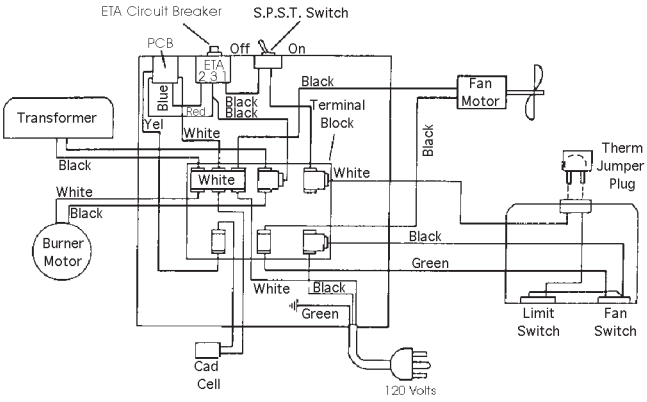
Wiring Diagram for Non-Terminal Block Heater with White-Rogers/Robert Shaw Flame Control



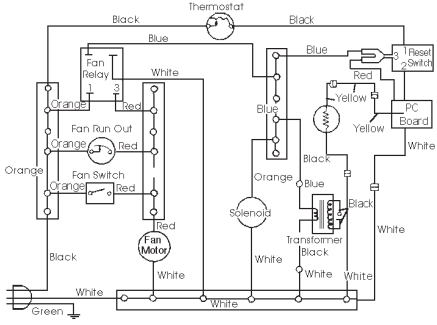
Wiring Diagram for Terminal Block Heater with Standard Flame Control



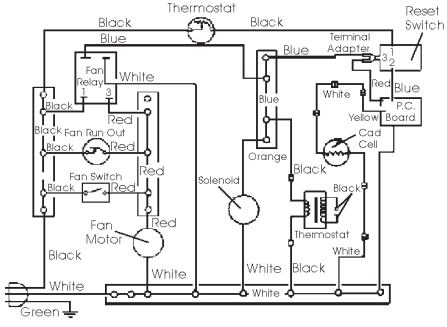
K350FA and K650FA Models



Toro Air Scoop Heater

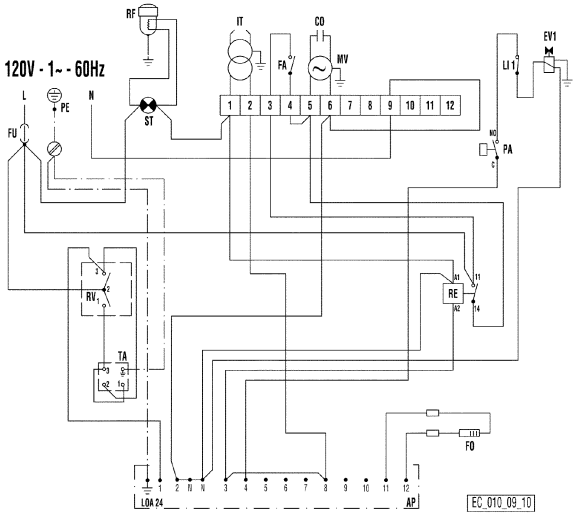


320,000 BTU Heater

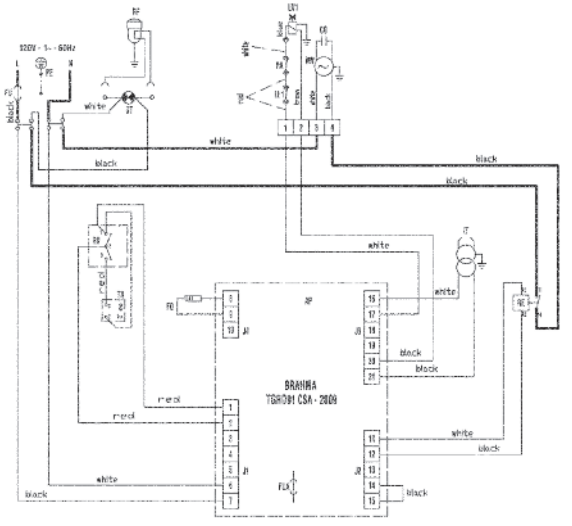


650,000 BTU Heater

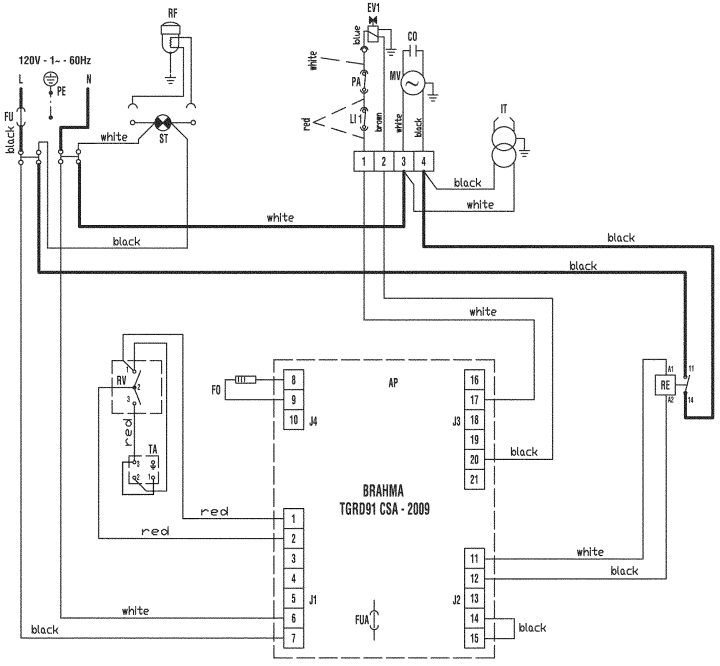
Heat Wagon Wiring Diagrams



DF400
SN 276000201 through 276000400



DF400
SN 276000401 and Beyond



FU FUSE 20A

IT TRANSFORMER H.V.

LI1 OVERHEAT THERMOSTAT

EV1 SOLENOID VALVE 1°

FO PHOTOCELL

CO CONDENSER

MV FAN MOTOR

ST ELECTRIC PILOT LAMP

RV CONTROL

TA ROOM THERMOSTAT PLUG

RE RELAY

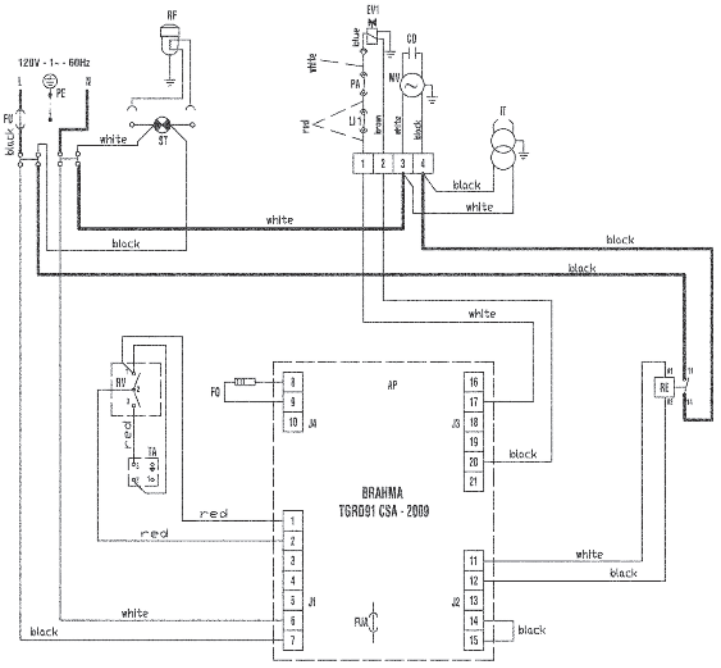
AP CONTROL BOX

RF HEATED FILTER **Optional**

PA AIR PRESSURE SWITCH

FUA FUSE 6,3A

DF600
SN 276000201 through 276000400



FU	FUSE 20A	**TA**	ROOM THERMOSTAT PLUG
IT	TRANSFORMER H.V.	**RE**	RELAY
LI1	OVERHEAT THERMOSTAT	**AP**	CONTROL BOX
EV1	SOLENOID VALVE 1°	**RF**	HEATED FILTER Optional
FO	PHOTOCELL	**PA**	AIR PRESSURE SWITCH
CO	CONDENSER	**FUA**	FUSE 6.3A
MV	FAN MOTOR		
ST	ELECTRIC PILOT LAMP		
RV	CONTROL		

DF600
SN 277000401 and Beyond

Indirect Oil Theory of Operation

The indirect oil theory of operation may differ slightly from one manufacturer or model to another. The following describes what steps a typical indirect oil heater will go thru during operation. If a more detailed description of operation is needed, consult the owner's manual of your particular heater. The majority of indirect oil heaters are of the high pressure type. To help understand the theory of indirect heaters, first read the "High Pressure Theory of Operation" on page 99 if you are not already familiar with how high pressure oil heaters operate.

When the on/off power switch is turned on, power is sent to a power indicator light on the control panel. Power is also received by the control board. On some heaters, power from the power cord must travel thru a thermostat before reaching the control board. The control board sends power out to a thermostat "socket". The socket must have a "jumper cap" or a remote thermostat plugged into the socket. If the heater has a heating element in the fuel filter, the element will now receive power from the control board, and begin pre-heating the fuel.

When the thermostat jumper cap is in place, or the remote thermostat is turned up to call for heat, the control board will begin the start up sequence. During the first step of start up called the purge cycle, the control board powers the motor and transformer for a short period of approximately ten seconds. The turning motor provides airflow and the transformer provides spark to light and burn off any residual fuel remaining from prior operation. At this time the fuel solenoid valve receives no power and remains closed. All fuel pumped is sent back to the fuel tank thru the fuel pump's return line. During this purge cycle the photocell which is connected to the control board looks for the presence of flame in the combustion chamber. If flame is detected during the purge cycle, the control board "locks out" or removes power from all components. If the heater is equipped with an air proving switch, air from the turning fan blade must close the switch, otherwise lock out will occur.

Once the purge cycle is completed successfully, the ignition cycle can begin. The control board now sends power to the fuel solenoid valve. The valve opens allowing fuel to flow thru to the nozzle. The photocell must now detect flame within several seconds or the control board will lock out. If flame is detected briefly and then lost, the purge and ignition cycles are repeated once more and if ignition is not achieved, lock out occurs. Some control boards remove power to the transformer a short time after ignition is achieved. If for any reason ignition is lost, the control board will remove power to the fuel

solenoid valve and the purge and ignition cycles will begin. Once ignition is established the thermostat will cycle the heater on and off as needed.

If lock out occurs the reset button will trip. Some heaters need a thirty second wait before the reset will function again. Other heaters may require removing power to the control board before the reset button will operate again.

To shut the heater off properly, a cool down cycle must be allowed to run. Depending on the make or model of the heater, the cool down cycle is initiated by turning the thermostat all the way down or turning the on/off switch to the off position. The control board will now remove power to the fuel solenoid valve. Some heaters will power the transformer to produce spark during the cool down cycle. This is done to ignite and burn off any remaining fuel. The cool down cycle is terminated by either a temperature sensitive fan switch or the control board will run the motor for a set period of time, usually under two minutes.

Indirect Heater Component Description and Operation

Most indirect heaters are high pressure and therefore share most of their components with the high pressure heaters. Please read the "High Pressure Oil Component and Description" section on pages 100-102 if you are not already familiar with high pressure oil components. The following components are found only on indirect oil heaters.

Control Board
The control board functions as the "brain" of the indirect oil heater and determines if and when the motor, transformer and fuel solenoid valve receive power. Some control boards receive power from the power cord thru a thermostat. Other control boards are wired to a thermostat "socket" which contains either a "jumper cap" for continuous running or a thermostat plugged into the socket for thermostatically controlled operation. The control board also is connected to a flame sensing photocell. This allows the control board to run the heater when combustion is established and shut the heater off if flame is not present. The control board may also be wired to an air proving switch. Air from the turning fan blade must close this switch for the heater to ignite or run. Some heaters have a overheat or limit switch wired to the control board to shut the heater off if it overheats.

Heat exchanger
The heat exchanger allows heat in the combustion chamber to transfer into the exchanger. The open flame in the combustion chamber never touches the heated output air. This keeps the products of combustion and moisture created by the flame separate from the clean, dry output air.

Air Damper
The air damper or air shutter setting controls how much air enters the combustion chamber. The correct amount of air is vital for ignition and combustion. Follow the manufacturer's specifications when setting or adjusting the air damper.

Thermostat / Jumper Cap
Most indirect heaters have a standard or optional thermostat. The thermostat may be wired in between the power cord and the control board or may have a "socket" for attaching a remote thermostat. The "socket" must have a "jumper cap" in place if the remote thermostat is not used or the heater will not operate. The thermostat functions as an on/off switch to cycle the heater to maintain a desired temperature.

Air Proving Switch
The air proving switch is wired between the control board and the fuel solenoid valve. Power for the fuel solenoid valve must pass thru the switch. The switch is normally "open". Air from the turning fan blade must close the switch to "prove" air flow or the heater will not start or continue running. Not all makes or models use an air proving switch.

Overheat / Limit Switch
Also called an overheat thermostat. The overheat / limit switch is normally closed. If the heater becomes too hot the switch will open and shut down the heater. Not all makes and models use a overheat switch.

Heated fuel filter
An electric heating element in the fuel filter receives power from the control board and pre-heats the fuel. Not all makes and models use a heated fuel filter.

Whirl disk
Also called a diffuser, or baffle. Some indirect oil heaters have a whirl disk located near the spray nozzle. The whirl disk helps blend air into the fuel mixture to achieve ignition and proper combustion.

Set Up of Indirect Heaters

The proper set-up of indirect oil fired heaters is one of the most important and usually overlooked aspects of utilizing indirect oil fired heaters. Proper set-up can help eliminate nuisance shut downs and untimely service calls. The most important set up requirements are the voltage to the heater, the proper manufacturer's required fuel(s), and the proper ducting of the heated air and/or the flue gases. It is important to note that this section in no way is to supersede set-up instructions listed in the original manufacturer owners manuals supplied with the heater.

Heat Ducting

Before attempting to duct an indirect-fired heater, refer to the owner's manual to ensure that the heater is eligible to be ducted. Ducting a heater that is not approved for duct can result in property damage, personal injury, or even death. There are a few things to keep in mind when ducting a heater. First, ensure that the duct is rated high enough for the heater's discharge temperature. Second, make sure that the duct I.D. is equal to the diameter of the heater discharge. A larger I.D. solid wall or wire duct (no lay-flat) duct can be used with some manufacturers. When dealing with duct length, remember that the owner's manual will list a MAXIMUM duct length and this length must be adhered to at all times! The owners manual assumes that the maximum duct length is the total length straight out from the nose of the heater. As a general rule of thumb, for every bend in the duct, it cuts the maximum length allowed in half. Also, to achieve the highest heating efficiency and to alleviate static pressure issues, keep the elbows and bends down to the absolute minimum.

Flue Pipe Ducting

Flue pipe ducting is the actual ducting of the byproducts of combustion. This is done with a flue collar usually located on top of the heater. Many times, improper flue pipe ducting leads to service issues. As stated earlier in the Heat Ducting section, the number one source of information about proper flue pipe ducting can be found in your owner's manual. The general rule about the flue pipe diameter is that the diameter of the flue pipe that comes with your heater is correct for that given length of the standard flue. If a longer flue pipe is needed, then an adjustment will have to be made to the make the flue pipe diameter larger. How large of an I.D. the flue pipe requires is a direct correlation of how many BTU's the heater is and how long the flue pipe run is needed. Draft hoods and adapters may be required to increase the flue pipe discharge size. Refer to the chart on page 121 for flue pipe sizing.

Indirect Heater Flue Pipe Sizing Chart

CAPACITY OF TYPE B DOUBLE-WALL VENTS SERVING A SINGLE DRAFT HOOD-HEATER x 1000 BTU'S								
VENT DIAMETER, D,INCHES								
		3	4	5	6	7	8	10
TOTAL VENT HEIGHT,H, FEET	LATERAL LENGTH, L, FEET							
6	0	46	86	141	205	285	370	570
	2	36	67	105	157	217	285	455
	6	32	61	100	149	205	273	435
	12	28	55	91	137	190	255	406
8	0	50	94	155	235	320	415	660
	2	40	75	120	180	247	322	515
	8	35	66	109	165	227	303	490
	16	28	58	96	148	206	281	458
10	0	53	100	166	255	345	450	720
	2	42	81	129	195	273	355	560
	10	36	70	115	175	245	330	525
	20	NR	60	100	154	217	300	486
15	0	58	112	187	285	390	525	840
	2	48	93	150	225	316	414	675
	15	37	76	128	198	275	373	610
	30	NR	60	107	169	243	328	553
20	0	61	119	202	307	430	575	930
	2	51	100	166	249	346	470	755
	10	44	89	150	228	321	443	710
	20	35	78	134	206	295	410	665
	30	NR	68	120	186	273	380	626

Indirect Oil Troubleshooting

Symptoms:

Motor and transformer do not operate.

Causes:

1. Incorrect or low voltage supplied to the heater.
2. Fuse in heater is blown.
3. Thermostat defective, or not turned up to call for heat.
4. Thermostat jumper cap not in place.
5. Control board is defective.
6. Reset button has not been reset.

Solutions:

1. Incorrect or low voltage supplied to the heater. Most indirect oil heaters require a minimum of 108 volts to operate properly. A multi-meter set to measure volts can be used to check the amount of voltage at the end of the extension cord(s). If the measured voltage is too low, the length of the extension cord (s) must be shortened or a thicker gauge extension cord must be used. Refer to page 160 for guidelines on extension cord use.

2. Fuse in heater is blown. Locate and remove the in-line fuse of the heater. Set a multi-meter to measure ohms of resistance. Place a multi-meter probe on each end of the fuse. The multi-meter should read zero ohms (continuity) or the fuse is blown. If a new fuse blows immediately, check for possible causes. Check for incorrect voltage to the heater. Make sure the total amperage draw of all equipment running on the circuit is not too great. If the supplied voltage and total amperage draw are correct, check the wiring in the heater for correctness and possible shorts.

3. Thermostat is defective or not turned up to call for heat. Turn the thermostat up to the highest possible setting and try to start the heater. Next set a multi-meter to measure voltage coming out of the thermostat. If approximately 120 volts is not measured, the thermostat is defective.

4. Thermostat jumper cap not in place. Some indirect oil heaters have a female socket used to attach an optional remote thermostat. If the remote thermostat is not being used, a jumper cap or "plug" must be inserted into the female socket to complete a voltage circuit, or the heater will not run.

5. Control board is defective. Using a multi-meter set for volts, check the hot and neutral wires which bring voltage into the control board. If proper voltage is reaching the board then the control board is defective.

6. Reset button has not been reset. Push the reset button and try to start the heater.

Motor does not start, but ignition spark is present

Causes:
1. Control board is defective.
2. Motor is defective.
3. Motor start capacitor is defective.
4. Fuel pump seized.

Solutions:
1. Control board is defective.Locate the terminals of the control board that connect to the motor wires. Use a multi-meter set to read voltage and check for approximately 120 volts to the motor when the heater is turned on. If no voltage is observed the control board is defective.

2. Motor is defective. If the control board and the motor start capacitor check ok and the fuel pump is not seized, the motor is defective.

3. Motor start capacitor is defective. The capacitor may be tested using a multi-meter set to the lowest possible ohm range. First "short" the capacitor by momentarily placing a screwdriver across the two capacitor terminals. Then place the multi-meter probes on the two capacitor terminals. The multi-meter should read close to zero ohms (continuity) first, then slowly move to infinity on the multi-meter. If not then the capacitor is defective.

4. Fuel pump seized. With the heater unplugged, stand behind the heater and attempt to turn the fan blade clockwise by hand. If the fan blade is difficult to turn, undo the connection between the motor shaft and the pump shaft. Attempt turning the fan blade again. If the motor now turns freely, the pump has seized up. If the fan blade is still difficult to turn, the motor is defective.

Motor runs, spark is present, but there is no fuel spray

Causes:
1. Fuel pump is defective.
2. Air entering the fuel pump thru the inlet line.
3. Solenoid valve is defective.
4. Control board is defective.
5. Fuel filter is dirty.
6. Safety thermostat defective or tripped.
7. Air proving switch defective.
8. Spray nozzle clogged.

Solutions:
1. Fuel pump is defective. The output pressure of the fuel pump can be checked by placing a high pressure fuel gauge into the gauge port of the fuel pump. Use a gauge with enough capacity to measure the high pressure your particular heater can produce. Use the adjustment on the pump to set the pump pressure to the manufacturer's specification. If you do not have a fuel gauge, you may slightly loosen the pump's output line connection and place a rag there. Run the heater briefly and see if fuel reaches the rag. If no fuel is pumped, check the connection between the motor and the fuel pump to make sure the motor can turn the pump. Also check the external and internal fuel filters for blockage, and clean or replace if necessary. The fuel pumps internal filter is usually located where the fuel inlet line enters the pump.

2. Air entering the fuel pump thru the fuel inlet line. If air enters the pump it will lose its prime and will not maintain adequate pump pressure. First make sure all fittings, including the fuel filter on the inlet line are tight. If you still suspect air is entering the pump, start eliminating portions of the inlet line until the air leak is found. Start this process at the fuel tank end of the inlet line. It may be necessary to draw fuel from a small container rather than the fuel tank.

3. Solenoid valve is defective. Use a multi-meter set to measure volts. Check for approximately 120 volts at the ends of the two wires that carry voltage to the solenoid valve. If proper voltage is read, try cleaning the valve if it is dirty. If the valve will not open fully to allow fuel spray, the solenoid valve is defective. If proper voltage is not read, check for voltage on the control board terminals that the solenoid valve wires connect to. If proper voltage is read, the solenoid valve wires are defective. If voltage is not read on the board terminals, the control board is defective.

4. Control board is defective. Use a multi-meter set to measure voltage. Check for proper voltage on the two board terminals that the solenoid valve wires connect to. If proper voltage is read, the control board is ok. If proper voltage is not read, the control board is defective.

5. Fuel filter dirty. Check the external and internal fuel filters and clean or replace as necessary. Most fuel pumps contain an internal fuel filter located where the inlet line enters the fuel pump.

6. Safety thermostat defective or tripped. Also called overheat switch. Some indirect oil heaters have a safety thermostat wired between the control board and the solenoid valve. If the heater becomes too hot this normally closed switch will open and interrupt power to the solenoid valve. Use a multi-meter set to measure ohms. Place the multi-meter probes on the two male terminals of the safety thermostat. If the multi-meter shows infinity (no continuity) the safety thermostat is defective. If the switch opens up before the heater becomes hot, the safety thermostat is defective.

7. Air proving switch is defective. Some indirect oil heaters have an air proving switch wired between the control board and the solenoid valve. The air proving switch is normally open and requires air from the turning fan blade to close the switch and send power to the solenoid valve. Set a multi-meter to measure voltage. With the fan blade turning, check for voltage coming out of the air proving switch to the solenoid valve. If no voltage is read, next check for voltage at the control board terminals out to the air proving switch. If voltage at the control board is read, the air proving switch is defective. If no voltage is read at the board, the control board is defective.

8. Spray nozzle clogged. Remove and inspect the spray nozzle. Clean or replace as needed. Do not clean the nozzle orifice with anything metal as this may enlarge the orifice.

Motor runs, fuel sprays, but no spark is observed

Causes:
1. Electrodes damaged or gapped incorrectly.
2. Transformer defective.
3. Control board defective.

Solutions:
1. Electrodes damaged or gapped incorrectly. Inspect the electrode tips for melting. Make sure there are no cracks in the porcelain insulation. Check the electrodes with the manufacturer's specifications for gapping and spacing. Adjust or replace the electrodes as needed.

2. Transformer defective. Transformers require a ground connection to function properly. Check the transformer's ground wire or mounting tabs for a good ground connection. Use a multi-meter set to measure voltage. Check the voltage in to the transformer from the control board for approximately 120 volts. Do not attempt to measure the transformer's output voltage with an ordinary multi-meter. The transformer may also be bench tested for proper output arc. Remove the transformer and refer to page 125 for the transformer test.

3. Control board defective. Use a multi-meter set to measure voltage. Take a voltage reading on the control board terminals that send input power to the transformer. If proper voltage is not present, the control board is defective.

Motor runs, fuel sprays, spark is present, but heater will not ignite

Causes:
1. Pump pressure incorrect.
2. Electrodes damaged or gapped incorrectly.
3. Nozzle dirty or worn.
4. Air damper setting is incorrect.
5. Transformer output is weak.
6. Ducting is improper.
7. Venting is improper.
8. Fuel contains water or contaminants.

Solutions:
1. Pump pressure incorrect. Using a high pressure fuel gauge, check the output pressure of the fuel pump. If necessary, use the pump's adjustment to set

the pump pressure to the manufacturer's specifications.

2. Electrodes damaged or gapped incorrectly. Inspect the electrode tips for melting. Make sure there are no cracks in the porcelain insulation. Check the electrodes with the manufacturers specifications for gapping and spacing. Adjust or replace the electrodes as needed.

3. Nozzle dirty or worn. Clean the nozzle using compressed air. Never use anything metal to clean the nozzle as this may enlarge the orifice. With enough use, fuel traveling under high pressure thru the nozzle orifice can enlarge the orifice. This is especially true when diesel fuel is used. Clean or replace the nozzle as needed.

4. Air damper setting is incorrect. Use the manufacturers specifications for the air damper setting and adjust as needed.

5. Transformer output is weak. Remove the transformer and perform a bench test. Refer to page 125 for the transformer test.

6. Ducting is improper. Follow the manufacturer's recommendations concerning maximum duct length and diameter.

7. Venting is improper. Follow the manufacturer's guidelines for venting.

8. Fuel contains water or contaminants. Visually inspect the fuel in the tank for water bubbles or contaminants. Drain, flush, and re-fill tank as needed.

Heater ignites, runs less than one minute and shuts down

Causes:
1. Photocell is dirty, misaligned or defective.
2. Control board is defective.
3. Fuel pump defective.
4. Fuel filter dirty.

Solutions:
1. Photocell is dirty, misaligned or defective. Check that the photocell is aimed correctly and is free of dirt. If necessary, clean the photocell "eye" with a soft, dry cloth. Unfortunately no test exists for the photocell. Attempting to "jumper out" the photocell will not test the function. You must either replace

the photocell or borrow a known functioning photocell from an identical heater.

2. Control board is defective. If the heater's spray and spark are correct, the photocell and control board must work together to recognize the combustion flame has become established. Therefore if a new photocell does not correct this symptom, the control board is defective.

3. Fuel pump is defective. If the fuel pump will not achieve or maintain proper output pressure, the fuel pump is defective. Check the pump's output pressure with a gauge.

4. Fuel filter dirty. Inspect the internal and external fuel filters and clean or replace as needed.

Heater ignites, runs several minutes, then shuts down.

Causes:
1. Fuel pump is defective.
2. Solenoid valve is defective.
3. Overheat thermostat is defective.
4. Ducting is improper.
5. Venting is improper.
6. Nozzle is dirty.
7. Fuel filter is dirty.
8. Control board is defective.
9. Fuel contains water or contaminants.

Solutions:
1. Fuel pump is defective. If the fuel pump will not achieve or maintain proper output pressure, the pump is defective. Check the fuel pump output pressure with a gauge.

2. Solenoid valve is defective. Use a multi-meter set to measure voltage. Check for proper voltage at the solenoid valve. If proper voltage is read and the solenoid valve will not stay open and allow fuel spray, the solenoid valve is defective.

3. Overheat thermostat is defective. Also called a safety thermostat or limit switch. Some heaters are equipped with this. Set a multi-meter to measure ohms of resistance. Perform this test immediately after the heater shuts down

and the overheat thermostat is still hot. Place the multi-meter probes on the two male terminals of the safety thermostat. If the multi-meter reads infinity (no continuity) the safety thermostat is defective. Remember that if the heater is over firing due to high pump pressure, worn nozzle, or is improperly ducted or vented, the safety thermostat will heat enough to shut the heater off.

4. Ducting is improper. Always follow the manufacturer's recommendations regarding maximum duct length and diameter. Failure to do so can result in heat building up in the heater until the safety thermostat contacts open and shut the heater off.

5. Venting is improper. Follow the manufacturer's recommendations concerning proper venting. Failure to do so can result in heat building up in the heater until the safety thermostat contacts open and shut the heater off.

6. Nozzle is dirty. If dirt reaches the nozzle, the spray can be adversely affected and cause a shut down. If possible observe the spray pattern and clean the nozzle as needed.

7. Fuel filter dirty. Check the internal and external fuel filters. Clean or replace as needed.

8. Control board is defective. For the heater to function, the control board must send proper voltage to three components: motor, transformer and solenoid valve. Using a multi-meter set to measure voltage, check the appropriate control board terminals for proper voltage out to these three components. If proper voltage to any of these three components is not observed, the control board is defective.

9. Fuel contains water or contaminants. Visually inspect the fuel in the tank for water bubbles or contaminants. Drain, flush, and re-fill as needed.

Heater ignites, but combustion is poor or uneven

Causes:
1. Fuel pump pressure is incorrect.
2. Nozzle dirty or worn.
3. Electrodes damaged or gapped incorrectly.
4. Fuel filter is dirty.
5. Air damper setting incorrect.

6. Whirl disk dirty or mis-aligned.
7. Ducting is improper.
8. Venting is improper.
9. Fuel contains water or contaminants.

Solutions:

1. Fuel pump pressure is incorrect. The output pressure of the fuel pump can be checked by placing a high pressure fuel gauge into the gauge port of the fuel pump. Use a gauge with enough capacity to measure the high pressure your particular heater can produce. Use the adjustment on the pump to set the pump pressure to the manufacturer's specifications.

2. Nozzle dirty or worn. Clean the nozzle using compressed air. Never use anything metal to clean the nozzle as this may enlarge the orifice. With enough use, fuel traveling under high pressure thru the nozzle orifice can enlarge the orifice. This is especially true when diesel fuel is used. Clean or replace the nozzle as needed.

3. Electrodes damaged or gapped incorrectly. Inspect the electrode tips for melting. Make sure there are no cracks in the porcelain insulation. Check the electrodes with the manufacturer's specifications for gapping and spacing. Adjust or replace the electrodes as needed.

4. Fuel filter is dirty. Inspect the internal and external fuel filters and clean or replace as needed.

5. Air damper setting incorrect. Use the manufacturer's specifications for the air damper setting and adjust as needed.

6. Whirl disk dirty or mis-aligned. Inspect the whirl disk and clean if necessary. If the disk is warped or mis-aligned, replace or adjust as needed.

7. Ducting is improper. Follow the manufacturer's recommendations concerning maximum duct length and diameter.

8. Venting is improper. Follow the manufacturer's guidelines for venting.

9. Fuel contains water or contaminants. Visually inspect the fuel in the tank for water or contaminants. Drain, flush, and re-fill tank as needed.

Heater ignites but flame is excessive

Causes:
1. Fuel pump pressure is too high.
2. Nozzle is worn.
3. Incorrect fuel.

Solutions:
1. Fuel pump pressure is too high. Attach a high pressure fuel gauge to the fuel pump and check the pump pressure. Adjust the pressure to the manufacturer's specifications with the adjustment on the fuel pump.

2. Nozzle is worn. With enough use, the impurities in the fuel traveling under high pressure thru the nozzle orifice can enlarge the orifice. This is especially true when diesel fuel is used. A worn nozzle can cause the heater to run "rich" and possibly over fire the heater enough to activate the safety thermostat and cause a shutdown.

3. Incorrect fuel. Only use the manufacturer's recommended fuels. Never use gasoline, paint thinner, solvents, or other flammable liquids. If you suspect the fuel is incorrect, drain, flush and re-fill the tank with proper fuel.

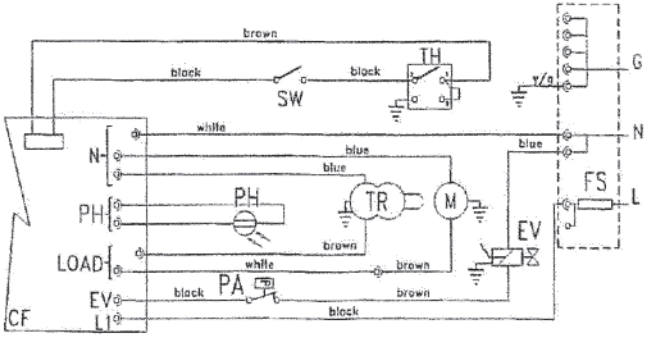
Heat Wagon Indirect Heater Specifications

Model #	**LVF90A**	**HVF180A**	**HVF300A**
Output Rating, BTU/hr	**90,000**	180,000	290,000
Type of Fuel	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil	Kerosene or #1 Fuel Oil
Fuel Consumption, (Gal/hr)	0.68	1.29	2.06
Efficiency (%)	80.0	87.1	88.5
Fuel Tank Capacity, gals.	12	14	26
Electrical Requirements	120V, 60 Hz	120V, 60 Hz	120V, 60 Hz
Amperage	4.0	7.0	12.5
Flue Diameter (in)	6	6	6
Noise Level (dB(A))	75	73	73
Net Weight	95 lbs.	167 lbs.	267 lbs.

Desa Indirect Heater Specifications

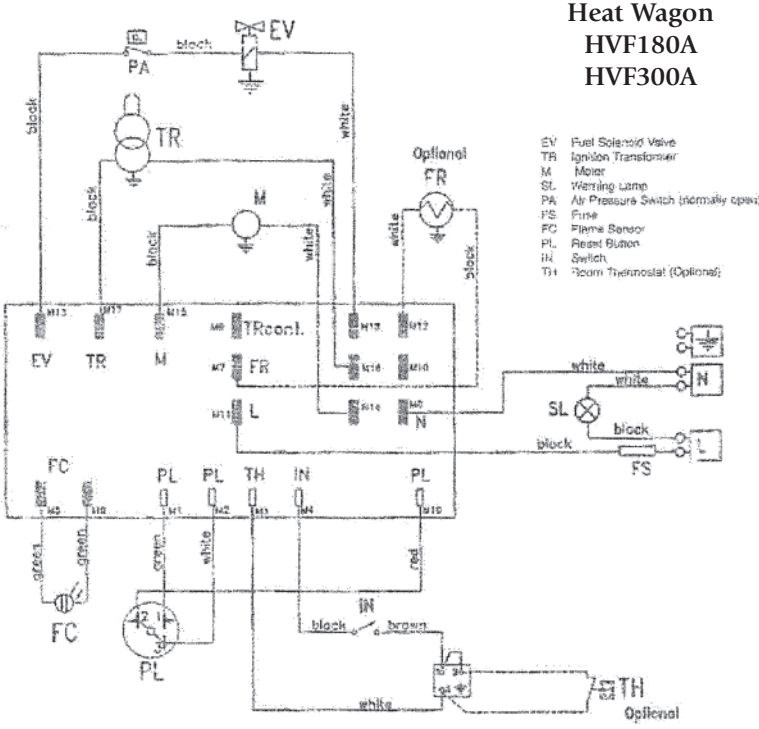
Model	**160-IF**	**280-IF**
Output Rating (Btu/Hr)	158,000	278,000
Fuel	Use only kerosene, #1/#2 diesel/fuel oil, JET A or JP-8 fuels*	
Fuel Tank Capacity (gal)	17	28
Fuel Consumption, (Gal/hr)	1.27	2.22
Pump Pressure (psi)	145	174
Electric Requirements	120 V/60 HZ	120 V/60 HZ
Amperage (Normal Run)	4.8	8.5
Motor RPM	2850	1750
Hot Air Output (CFM)	1,060	1,940
Shipping Weight	190 lbs	320 lbs
Heater Weight without Fuel	161 lbs	273 lbs

Heat Wagon
LVF90A



FS In-Line Fuse
IN ON/OFF Switch
M Motor
PA Air pressure switch
CF Flame Control
EV Solenoid valve
TH Remote Thermostat
PH Photocell
TR Transformer

Heat Wagon
HVF180A
HVF300A



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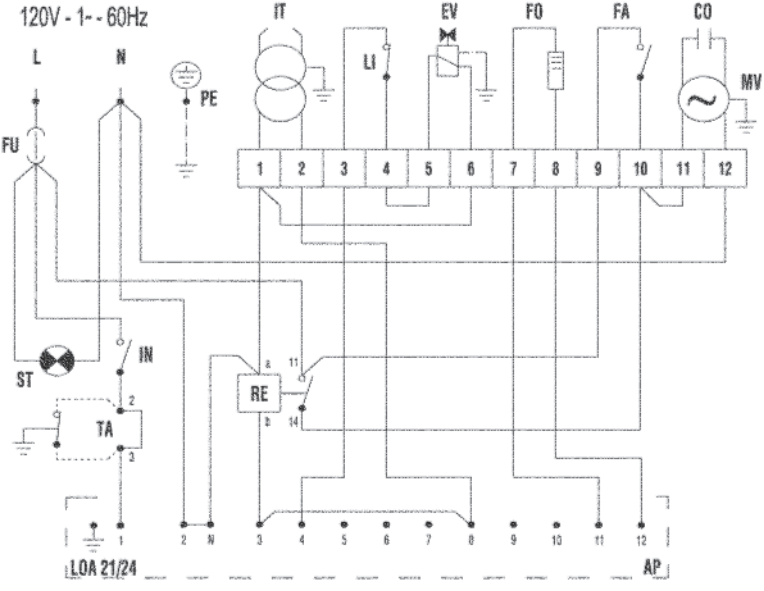

FU	Fuse 6A 160-IF 10A 280-IF	CO	Capacitor
		MV	Fan motor
		ST	Power light
IT	High voltage transformer	IN	Switch
LI	Safety thermostat	TA	Ambient thermostat socket
EV	Solenoid valve	RE	Relay
FO	Photocell	AP	Control box
FA	Fan thermostat		

Extension Cord Guidelines

Connect heater to a standard electrical outlet (120V/60Hz) to operate. For safety, all heaters have a three-prong, grounded power cord. Plug power cord of heater into threeprong, grounded extension cord. Extension cord must be at least six feet long. Make sure you use extension cord large enough to carry the voltage the heater requires. Use the following chart to determine the proper size extension cord for heater.

Length of Cord	Wire Size (AWG)		
100 ft.	No. 14	400 ft.	No. 8
200 ft.	No. 12	500 ft.	No. 6
300 ft.	No. 10		

Job Sizing Heat Requirements

This section deals with calculating how much heat or BTU's a given job needs. Usually a job requires the most heat at the beginning of construction when the building is open. As the construction proceeds the building becomes more closed and the heat requirement becomes less and less.

To calculate the BTU's needed you must first know three things:
1. The cubic feet of the area to be heated. Cubic feet is obtained by multiplying the length times the width, times the height.
2. The "design temperature" of the location. Design temperature may be thought of as the lowest possible temperature that will be encountered. This usually occurs at night. The design temperature will vary greatly from one part of the country to another. For example, the design temperature for Chicago Illinois is -10 degrees farenheight, compared to Tampa Florida of 36 degrees.
3. Temperature rise desired. The temperature rise is the difference between the design temperature and the temperature you wish to reach inside. Using Chicago Illinois as an example if we wish to reach 60 degrees we must go from -10 to 60 for a temperature rise of 70 degrees.

Once we know the cubic feet, the design temperature and the desired temperature rise, we can use the following formula:

Cubic feet x temperature rise, x .133 = BTU's required

Example:
Building size: 50 ft length x 25 ft width, x 12 ft height, = 15,000 cubic feet.
Chicago Illinois design temperature: -10 degrees.
Desired temperature: 60 degrees.
Temperature rise: from -10 to 60 degrees = rise of 70 degrees.

Using the formula we have:
15,000 x 70, x .133, = 139,650 BTU's required.

Placement of heaters.

Place your heaters so they are near the power supply. Because heaters add moisture and products of combustion to the air inside the building, they should be placed in a doorway, window, or opening, so the heater can draw fresh outside air into the building. In a multi-story building, place heaters in the lower levels because hot air rises.

This manual was written by:

Brad Lundgren

Chris Moore

Danny Murphy

Marc Smith

Sean Treece

800.362.6951

Toll free fax
800.255.7985

342 North 400 East
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