



**MV60-EU Series Heaters, 220 VAC, 50-60 Hz**

**SHELTER HEATER**  
**60,000 BTU Multi-fuel Shelter Heater**

**Operation and Maintenance Manual**



**HDT –Tactical Systems Business Unit**  
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MANUAL PART NUMBER: 53858  
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## Warning Summary



Be sure to read and understand this operation and maintenance manual before starting or servicing this heater.



**WARNING!**

### **FIRE, EXPLOSION, CARBON MONOXIDE POISONING**

Improper use of this heater can result in serious bodily injury due to hazards of fire and explosion, carbon monoxide poisoning, burn and electrical shock. Do not adjust the pump pressure higher than the recommended amount. Failure to do so can result in higher than normal heat exchanger temperatures, which can cause the heat exchanger to fail allowing dangerous Carbon Monoxide gas to enter the shelter. Failure to follow these instructions could cause serious injury or death.



**WARNING!**

### **FIRE, EXPLOSION**

Use only Kerosene, Diesel or Number 1 Fuel Oil, or JP8 can be used for extreme cold conditions. Never burn gasoline, naphtha, paint thinners, alcohol or other volatile fuels. Fill fuel tank or move heater only when heater is shut off.



**WARNING!**

### **FIRE, EXPLOSION**

Use only in areas free of flammable vapor or high dust content. Never use heater where gasoline, paint thinner or other highly flammable vapors are present.



**WARNING!**

### **EXPLOSION**

Fully drain and ventilate fuel tank before transporting.



**WARNING!**  
**ROTATING MACHINERY**

When used with thermostat, heater may start at any time. Do not open access door while heater is running or plugged in. Remove all power prior to service.



**WARNING!**  
**SHOCK HAZARD**

Use only with electrical voltage and frequency specified on model plate. Do not perform any service with heater plugged in.



**WARNING!**  
**HIGH VOLTAGE**

The ignition transformer develops 10,000 volts. Serious injury or death may occur if personnel come in contact with high voltage lead.



**WARNING!**  
**FIRE, EXPLOSION**

Do not operate heater without output duct, P/N CAH-1015, properly installed. Ensure hot air outlet is at least 1.5 meters from combustible materials. Ensure ducts (outlet and inlet) are free from obstructions and sharp bends. ALWAYS REMOVE STORAGE PLUG CAH-126-1 BEFORE OPERATING HEATER.



**WARNING!**  
**HOT SURFACES**

Parts of the heater become very hot when operating and immediately after operating. The exhaust can reach temperatures in excess of 1000 degrees Fahrenheit. Severe burns may occur if the heater is not allowed to cool down properly before servicing.



**WARNING!**

**CARBON MONOXIDE POISONING**

The heat exchanger must be inspected annually by qualified service personnel for leaks which could allow dangerous carbon monoxide gas to enter the shelter. Failure to do so, could cause severe injury or death.

## Table of Contents

Operation and Maintenance Manual .....	1
<b>1. System Overview, Description and Principles of Operation .....</b>	<b>10</b>
1.1 System Overview .....	10
1.2 Description of Major Components .....	11
1.3 Controls and Indicators .....	14
1.4 WARNING Labels and Data Plates .....	16
1.5 CAMFIRE Heater Specifications .....	19
1.6 Principles of Operation .....	20
<b>2. Setup and Operation of the CAMFIRE Heater .....</b>	<b>25</b>
2.1 Preparing the Heater for Operation .....	25
2.1.1 Unpacking .....	25
2.1.2 Installing the Exhaust Stack Extension .....	25
2.1.3 Removing the Accessories .....	26
2.2 Siting Considerations .....	26
2.3 Setup .....	27
2.3.1 Attaching the Flexible Ducts .....	27
2.4 Before Operation Preventative Maintenance Checks and Services (PMCS) .....	30
2.5 Fueling .....	30
2.5.1 Fueling the Internal Tank (MV60S-EU, MV60T-EU) .....	30
2.5.2 Connecting and operating the Remote Room Thermostat .....	31
2.5.3 Connecting the Power Cable .....	32
2.6 Final Checks Before Operation .....	33
2.7 Starting and Operating the Heater .....	33
2.7.1 Starting the Heater .....	33
2.8 Refueling During Operation .....	34
2.9 Shutting Down the Heater .....	34
2.10 Preparing for Movement or Storage .....	34
2.10.1 Preparing for Movement .....	34
2.10.2 Preparing the Heater for Storage .....	35
<b>3. CAMFIRE Troubleshooting .....</b>	<b>38</b>
3.1 Introduction .....	38
3.2 <i>Operator Level</i> Troubleshooting .....	38
3.3 Safety Control Operation and Diagnostics .....	38
3.3.1 Operator Level Malfunction Symptom Index .....	39
3.3.2 Examining the Heater .....	39
3.3.3 Test Firing the Heater .....	40
3.3.4 Operator Level Troubleshooting Procedures .....	40
3.4 Maintainer Level Troubleshooting .....	45
3.4.1 Test Firing .....	45
3.4.2 Maintainer Level Safety Control Operation and Diagnostics .....	45
3.4.3 Maintainer Level Malfunction Symptom Index .....	46
3.4.4 Maintainer Level Troubleshooting Procedures .....	47
<b>4. CAMFIRE Maintenance .....</b>	<b>54</b>
4.1 Introduction .....	54
4.2 Preventive Maintenance Checks and Services .....	54
4.2.1 Introduction .....	54
4.2.2 Removing Upper Shell .....	56
4.2.3 Preventive Maintenance Checks and Services .....	57
4.3 Special Tools, Equipment and Supplies .....	61

- 4.4 System Maintenance Procedures..... 61
  - 4.4.1 General..... 61
  - 4.4.2 Remote Room Thermostat (Inspect/Test)..... 62
  - 4.4.3 Ignition Transformer (Inspect/Test)..... 63
  - 4.4.4 Checking Motor Starting Circuits (Test)..... 65
  - 4.4.5 Fan Service ..... 67
  - 4.4.6 Sediment strainer Service ..... 68
  - 4.4.7 Burner Head Service (Clean) ..... 69
  - 4.4.8 Air Pump Repair (Inspect, Test, Repair) ..... 73
  - 4.4.9 Safety Control Circuit Testing (Test, Clean)..... 81
  - 4.4.10 Photocell (Test) ..... 85
- 5. Illustrated Parts Listing..... 88
- 6. Schematics and Wiring Diagrams..... 106
- 7. Alphabetical Index..... 108

## Table of Figures

Figure 1-1. CAMFIRE Control Panel.....	14
Figure 1-2. Remote Room Thermostat .....	15
Figure 1-3. System Operational Diagram (simplified for clarity) .....	21
Figure 4-1. Camfire Maintenance Locations .....	56
Figure 4-2. Wiring Diagram .....	66
Figure 4-3. Location of Fan on Shaft .....	67
Figure 4-4. Checking clearance of air pump rotor.....	78
Figure 5-1. MV60-EU Labels and Accessories.....	88
Figure 5-2. MV60-EU FULL ASSEMBLY .....	90
Figure 5-3. COMBUSTION CHAMBER ASSEMBLY.....	92
Figure 5-4. BURNER HEAD ASSEMBLY 53649 .....	94
Figure 5-5. MV60 CONTROL BOX-FUEL BRACKET ASSEMBLY .....	96
Figure 5-6B. CONTROL BOX ASSEMBLY.....	98
Figure 5-7. MOTOR/PUMP/BRACKET ASSEMBLY (53745) .....	100
Figure 5-8. MOTOR AND PUMP ASSEMBLY(53485) .....	102
Figure 6-1. Camfire Heater Wiring Diagram .....	106
Figure 6-2. Camfire (MV60) Fuel Schematic .....	107

## Table of Tables

Table 1-1. CAMFIRE Heater Warning Labels and Data Plates .....	16
Table 1-2. Camfire Heater Specifications .....	19
Table 2-1. Flexible Duct Usage vs. Outside Temperature .....	27
Table 2-2. Extension Cord Size Requirements.....	32
Table 3-1. Operator Level Malfunction Symptom Index .....	39
Table 3-2. Operator Level Troubleshooting Procedure .....	40
Table 3-3. Maintainer Level Malfunction Symptom Index.....	46
Table 3-4. Maintainer Level Troubleshooting Procedures .....	47
Table 4-1. Camfire Heater Preventive Maintenance Checks and Services.....	57
Table 5-1. MV60 Labels and Accessories .....	89
Table 5-2. Combustion Chamber Assembly .....	93
Table 5-3. Burner Head Assembly 53649.....	95
Table 5-4. Control Box-Fuel Bracket Assembly .....	97
Table 5-5. Control Box Assembly .....	99
Table 5-6. Motor/Pump/Bracket Assembly .....	101
Table 5-7. Motor and Pump Assembly P/N 53485.....	103

Chapter 1  
System Overview,  
Description and  
Principles of Operation

## **1. System Overview, Description and Principles of Operation**

### **1.1 System Overview**

The CAMFIRE Heaters are portable, clean-air space heaters that rely on an external input of 220 VAC, 50/60 Hz, single phase power.

The heart of the heater is a heat exchanger that is supplied with air from a fan driven by a 1/4 horsepower motor. Part of the air from the fan enters the combustion chamber where it mixes with the atomized fuel to become a combustible mixture. The exhaust gases circulate within the heat exchanger; warming its inner surfaces, then escape from the heater through a flue pipe adapted to the top of the heater.

The remaining air from the fan passes over and around the combustion chamber and through the heat exchanger where it is heated, and emerges from the heater as a powerful stream of heated clean air.

The heater is provided with duct connectors at the outlet and inlet ends, allowing use either in a 100% fresh air mode or 100% recirculation air mode.

The fuel system consists of an air pump mounted on one end of the motor shaft that forces air through the nozzle. The moving air in the nozzle lifts the fuel from the tank by siphon action and carries it into the combustion chamber.

Filters protect the fuel system prior to the fuel entering into the spray nozzle. The electrical control system is protected by a push button type circuit breaker.

A safety control unit, connected to a photoelectric cell, shuts down the heater if a flame is not detected in the combustion chamber after start up. It also has two diagnostic LEDs to help troubleshoot problems. A "Duct Over-Heat" switch is installed as a safety measure. In the event that the outlet duct becomes blocked, the switch will shut the heater down.

A thermostat accessory, which plugs into the electrical system of the heater, may be set to any desired temperature. When the temperature of the surrounding air reaches the pre-set temperature, the thermostat contacts open and cause the heater to shut down. When the air cools, the thermostat contacts close and the heater recycles.

The heater is designed for hard use in rough environments resulting in a minimum of down time for repair and maintenance. It is protected by roll bars to prevent damage by upset or rollover and shrouded to protect the working portion of the heater against falling objects.

The heater can be fitted with added accessories such as wheels, skis or toboggan. A spares kit is also available that includes filters, spark plug, and fuel regulating components.

## 1.2 Description of Major Components

**Control Panel** – Contains all operation controls for heater including power input connector, optional remote room thermostat connector, and hour meter.



**Exhaust Stack Extension**– The exhaust stack extension is installed in the exhaust outlet on the top of the heater and acts to direct the combustion gases away from the heater.

An internal screen in the exhaust stack extension acts as a spark arrester.



**Inlet and outlet ducts** – 15 foot flexible ducts connect to the shelter duct tunnels and circulate heated and unheated air through the shelter.



**End plug** – Installs into the inlet end of the heater and is used to house accessory items such as the remote room thermostat.



**Burner assembly** – The burner assembly is where all combustion occurs within the Camfire heater. Atomized fuel is mixed with air and ignited by the spark plug to create the heat circulated through the shelter.



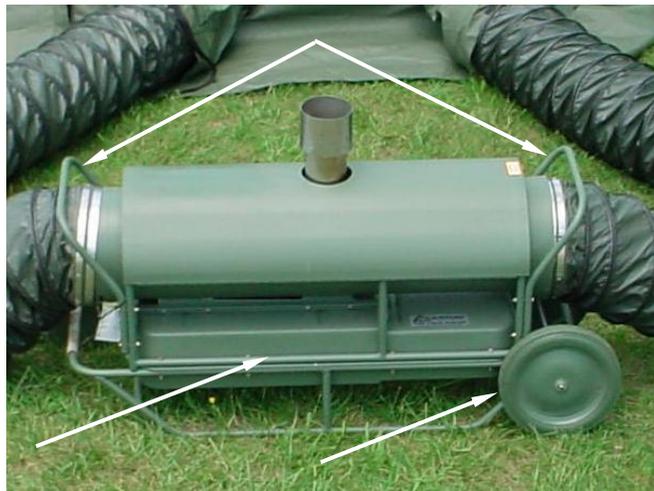
**Power cable** – A 6-foot long AC power cable that connects the heater with a 220` VAC power source. The power cable is wrapped around the inlet duct adapter.



**Remote Room Thermostat** – Permits automatic temperature control inside a shelter. The remote room thermostat hangs inside the shelter and monitors the shelter temperature. If the shelter temperature falls below the set point on the thermostat, the heater will start and begin supplying heat until the set point is reached.



**Roll bars, handles, and local transport wheels\*** – Handles are located at either end of the heater and permit the heater to easily be moved into position. Roll bars are located around the heater and act to protect the heater from damage. Local transport wheels (optional accessory) permit the heater to be rolled into position.



*\* Local transport wheels are an optional accessory.*

**Sediment strainer assembly.** Allows for visual inspection of fuel for dirt and water. Is able to be easily removed and cleaned.



### 1.3 Controls and Indicators

No.	Control	Description
1	Reset	Resets the heater in the event a problem shuts the heater down or a fault condition occurs
2	Power ON AUTO/ ON MANUAL	Turns heater power on and selects AUTO or MANUAL heat mode
3	Pilot Light	Indicates that power is supplied to the heater.
4	Thermostat Jack	Permits the connection of the remote thermostat assembly.
5	Hour meter	Displays the total number of operating hours for the heater.
6	Circuit Breaker	Protects the heater against circuit overload
7	View Port	Allows the user to view the diagnostic LEDs, for troubleshooting and repair

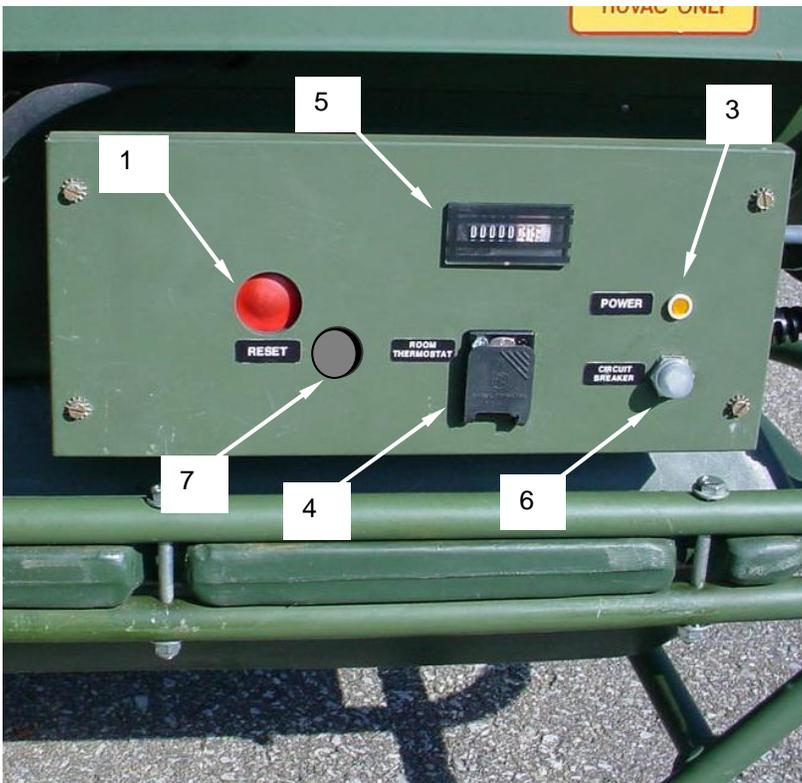


Figure 1-1. CAMFIRE Control Panel

No.	Control	Description
1	Variable Temperature Control	Placed inside the shelter being heated, permits the operator to set the desired temperature of the shelter.
2	Temperature Sensing Coil	Located on the top of the remote room thermostat, monitors the temperature of the shelter.

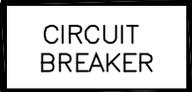
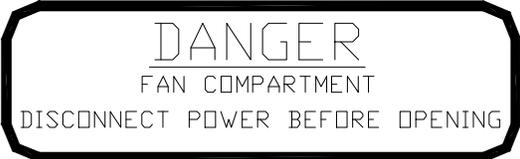
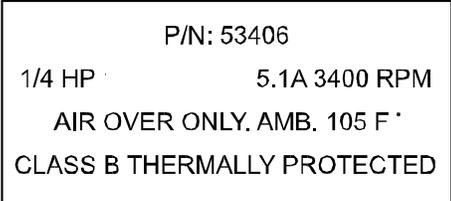


Figure 1-2. Remote Room Thermostat

### 1.4 WARNING Labels and Data Plates

The following section contains a description of all WARNING labels and data plates associated with the Camfire Heater.

Table 1-1. CAMFIRE Heater Warning Labels and Data Plates

WARNING Label or Data Plate	Location/Description
 <p><b>HUNTER</b> WORLD READY™</p> <p>Hunter Manufacturing Company 30525 Aurora Road Solon, OH 44139 www.huntermfgco.com 440-248-6111 Fax 440-248-1691</p> <p>HEATER, SPACE, MULTI FUEL CAMFIRE BY HUNTER</p> <p>PART NO./MODEL NO.:</p> <p>CAGE CODE: 92878</p> <p>OUTPUT BTU/HR: 60,000</p> <p>VOLTS:            AMPS: 4.0    RUNNING FREQ.</p> <p>SERIAL NO.: CAM-    XXXX    _____</p>	<p>Located on the side of the heater, the data plate provides pertinent data including Model Number and Serial Number</p>
 <p>CIRCUIT BREAKER</p>	<p>Located on the control panel, identifies the circuit breaker. See section on controls and indicators.</p>
 <p><b>DANGER</b> FAN COMPARTMENT DISCONNECT POWER BEFORE OPENING</p>	<p>Located near the fan compartment, warns user of electrical shock potential inside fan compartment.</p>
 <p>P/N: 53406</p> <p>1/4 HP                    5.1A 3400 RPM</p> <p>AIR OVER ONLY. AMB. 105 F °</p> <p>CLASS B THERMALLY PROTECTED</p>	<p>Located on fan assembly, label identifies part number and performance specs of fan.</p>

**SPACE HEATER**  
 RECOMMENDATIONS OF LOCAL AUTHORITIES HAVING JURISDICTION SHOULD BE FOLLOWED

OPERATION INSTRUCTIONS

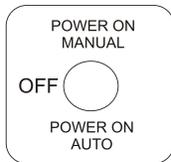
FUEL — USE ONLY KEROSENE, DIESEL, NO. 1 FUEL OIL OR JP8  
 TO START: 1. FILL FUEL TANK. 2. PLUG INTO PROPER VOLTAGE 3. SWITCH ON  
 TO STOP: 1. SWITCH OFF 2. REMOVE PLUG  
 IF MOTOR DOES NOT START: 1.PRESS CONTROL RESET 2. CONSULT MANUAL

MAINTENANCE

FUEL TANK — DRAIN TANK COMPLETELY EVERY 150 HOURS  
 FOR STORAGE — DRAIN TANK COMPLETELY DRY  
 AIR INTAKE FILTER — EVERY 500 HOURS REMOVE FILTER ELEMENT, WASH IN WARM  
 WATER & MILD DETERGENT, DRY AND REPLACE IN UNIT.  
 FUEL INTAKE: REMOVE ASSEMBLY AND WASH IN KEROSENE OR BLOW OUT IN REVERSE  
 FUEL & AIR LINES — ENSURE THAT ALL CONNECTIONS ARE TIGHT  
 MOTOR & FAN — CONSULT MANUAL  
 AIR OUTPUT — REPLACE ONCE A YEAR

CAUTION

1. READ MANUAL CAREFULLY BEFORE OPERATION OR SERVICING
2. DO NOT START THE HEATER WHEN CHAMBER IS HOT
3. DO NOT START THE HEATER WHEN EXCESS OIL HAS ACCUMULATED IN THE BURNER
4. DO NOT USE GASOLINE OR CRANKCASE OIL
5. DO NOT FILL TANK WHILE UNIT IS IN OPERATION
6. DO NOT TAMPER WITH UNIT. HAVE AUTHORIZED SERVICEMAN MAKE ADJUSTMENTS
7. THIS HEATER MUST BE ELECTRICALLY GROUNDED, THREE (3) CONDUCTOR ATTACHMENT PLUG RECEPTACLE MUST BE USED
8. DO NOT OPERATE UNIT IN CLOSED QUARTERS OR IN POORLY VENTILATED QUARTERS
9. WHEN HEATER IS USED IN CLOSED ROOM, PROVIDE GOOD VENTILATION BY OPENING DOOR OR WINDOW
10. DO NOT USE HEATER WITHIN FOUR (4) FEET OF COMBUSTIBLE MATERIALS
11. NOT SUITABLE FOR USE WITH EXTERNAL TANKS.



REMOVE THIS CAP BEFORE  
 OPERATING THIS HEATER  
 ACCESSORIES ARE STORED INSIDE

- MAINTENANCE/ PARTS MANUAL
- STACK EXTENSION
- POWER CORD
- THERMOSTAT



Located on side of heater, label lists the operating procedures for the heater in abbreviated form.

Located on the control panel, identifies power switch.

Located inside heater near air pump, identifies pressure adjustment screw.

Located inside heater near burner assembly, identifies pressure gauge.

Located on end plug at end of heater, identifies the fact that the cap must be removed before operation. Also informs user of accessories stored inside end plug.

Located on control panel, identifies Reset switch.

**START UP PROCEDURE**

1. TURN HEATER ON (SET TO POWER ON AUTO OR POWER ON MANUAL).
2. IGNITER AND MOTOR SHOULD START IMMEDIATELY.
3. SAFETY SWITCH LOCKOUT WILL OCCUR IF FLAME IS NOT ESTABLISHED DURING THE START UP 30 SECOND "TRIAL FOR IGNITION" PERIOD.
4. CONTROL WILL PROVIDE A 5 TO 10 SECOND IGNITION OVERRUN TIME AFTER THE "TRIAL FOR IGNITION" PERIOD TO PREVENT LOCKOUTS.
5. HEATER WILL SHUT DOWN WHEN CALL FOR HEAT IS SATISFIED (AUTO MODE).
6. IF FLAME FAILURE OCCURS DURING A RUN, THE MOTOR WILL IMMEDIATELY SHUT OFF. A 90 SECOND "RECYCLE" PERIOD WILL BEGIN FOLLOWED BY A NEW "TRIAL FOR IGNITION" PERIOD. (NOTE: PLEASE ALLOW 60 TO 120 SECONDS FOR RECYCLE PERIOD.)

NOTE: IF "TRIAL FOR IGNITION" CYCLES 3 TIMES, CONTROL UNIT WILL LOCK OUT. TO RESTART, HOLD RESET IN FOR 120 SECONDS OR UNTIL UNIT STARTS

7. POWER LOSS DURING A RUN WILL CAUSE THE HEATER TO SAFELY SHUT DOWN AND BEGIN A NORMAL "TRIAL FOR IGNITION" UPON RESTORATION OF POWER.

ROOM  
THERMOSTAT

TRANSFORMER  
CAH-107-1  
CAMFIRE BY HUNTER  
[www.huntermfgco.com](http://www.huntermfgco.com)

**WARNING**  
220 VAC ONLY

**WARNING**  
DO NOT USE NAPHTHA

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USE KEROSENE OR  
DIESEL FUEL OR  
(DF-A, DF-1, DF-2)  
JET ENGINE FUEL  
(JP-8)

**WARNING**  
USE DUCTING RATED FOR  
TEMPERATURES OF  
300° F OR HIGHER

Located on side of heater, details heater start-up procedures.

Located on control panel, identifies remote ROOM THERMOSTAT.

Parts ID tag located on the ignition transformer.

Located on control panel, alerts user that only 220VAC power should be used.

Located near fuel filler cap on side of heater, warns user against the use of naphtha and identifies all approved fuels.

Located near duct connections at end of heater. Warns user that only approved flexible ducts rated for temperatures of 300 degrees F or higher can be used.

## 1.5 CAMFIRE Heater Specifications

Table 1-2. Camfire Heater Specifications

	<b>MV60S-EU, MV60T-EU,</b>
Input Heat Rating BTU/Hour	90,000
Output Ratings Clean-air Output, BTU/Hour	60,000
Volume, CFM (Approximate)	600
Other Ratings	
Current, starting	3.5 AMPS
Current, running	2.2 AMPS
Voltage	220 VAC
Frequency	50/60 Cycles
Fan/Pump Motor	1/4 HP
Air Pump Pressure	5.0 PSI
Fuel Nozzle Meter Size	0.65 GPH
Spray Angle	80 DEGREES
Fuel	Kerosene, DF1, DF2, Fuel Oil, JP8 Only
Tank Capacity	8.5 GAL
Flexible Ducts (2)	12 inch diameter 15 ft Length
Dimensions (Without Stack Extension)	W15" L46" H25"
Weight (Without Fuel)	105 LBS

## 1.6 Principles of Operation

### Fuel System

An air pump on one end of the motor shaft forces the air through the nozzle. The moving air lifts fuel from the tank or from the remote fuel source ( AND version) by a siphon action and carries it into the combustion chamber in a fine spray.

### Air System

The air system is divided into two parts, both are supplied with air from a fan that is attached to the other end of the motor.

Part of the air from the fan enters the combustion chamber where it mixes with the atomized fuel to become a combustible mixture, and also mixes with the burning gases to complete the process of combustion.

The exhaust gases from the combustion chamber circulate within the inner surfaces of the heat exchanger. They are then ducted out of the heater through the stack adapter on its' top and out of the heater space through a flue pipe.

The rest of the air from the fan passes over and around the combustion chamber and through the heat exchanger where it is heated and emerges from the front of the heater as a powerful stream of heated fresh air, without being mixed with the products of combustion.

### Ignition System

The ignition system consists of a transformer and spark plug. The transformer increases the input voltage to a very high potential that causes an arc to be drawn between the electrodes of the spark plug. The arc is used to ignite the fuel and air mixture within the combustion chamber.

### Control System

The safety control circuit consists of a duct over heat switch, a light sensitive photocell, and a safety control. The safety control will trip if the heater fails to ignite or the flame goes out, thereby causing the heater to shut down. The safety control has two diagnostic LEDs which can be seen through a hole in the front of the control panel.

The photocell is used to sense the presence of light due to the flame inside the combustion chamber. It varies its' electrical resistance in relation to light rays. When under the influence of light, the cell has very low resistance. The resistance is high when little or no light strikes the light sensitive surface. The flame sensor's function is to control the safety control.

A "duct over-heat" switch is located at the outlet end of the heater. This switch will shut down the heater if the duct temperature exceeds approximately 275 deg. F.

A thermostat accessory, Part No. CAH-134-1, may be incorporated into the electrical circuit of the heater. The thermostat can be set to any desired temperature between 35 deg. F and 95 degrees F. When the

temperature of the surrounding air reaches the pre-set temperature, the thermostat contacts open and cause the heater to shut down. When the air cools, the thermostat contacts close and the heater recycles. A "duct over-heat" switch is located at the outlet end of the heater. This switch will shut down the heater if the duct temperature exceeds approximately 275 degrees F.

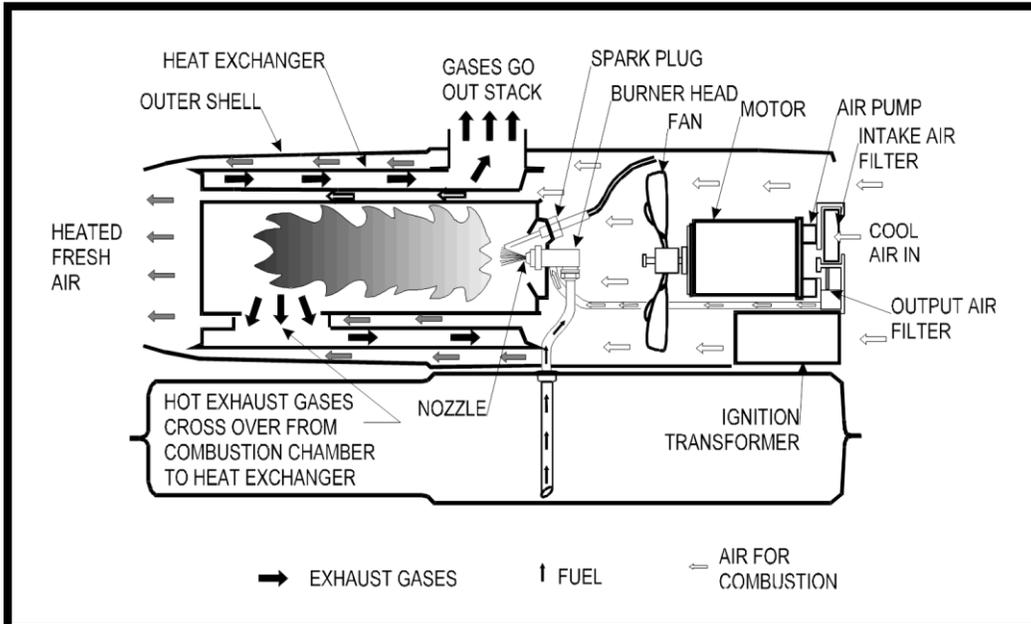


Figure 1-3. System Operational Diagram (simplified for clarity)



## Chapter 2

# Setup and Operation of the CAMFIRE Heater



## 2. Setup and Operation of the CAMFIRE Heater

### 2.1 Preparing the Heater for Operation

#### 2.1.1 Unpacking

The Camfire heater is shipped mounted to a shipping pallet and wrapped in a plastic wrap material. When unpacking the heater, remove all protective material covering the heater and remove the unit from the shipping pallet.



#### 2.1.2 Installing the Exhaust Stack Extension

The exhaust stack extension is wrapped in foam and packaged to the side of the heater. Unwrap the exhaust stack extension and install on the top of the heater by engaging the exhaust stack extension into the exhaust port at the top of the heater. Push down and seat securely.



### 2.1.3 Removing the Accessories

Remove the end plug by pushing in and rotating counterclockwise to release from the J-slot. Pull the end plug to disengage it from the heater and remove the remote room thermostat. Set the thermostat aside.

## 2.2 Siting Considerations



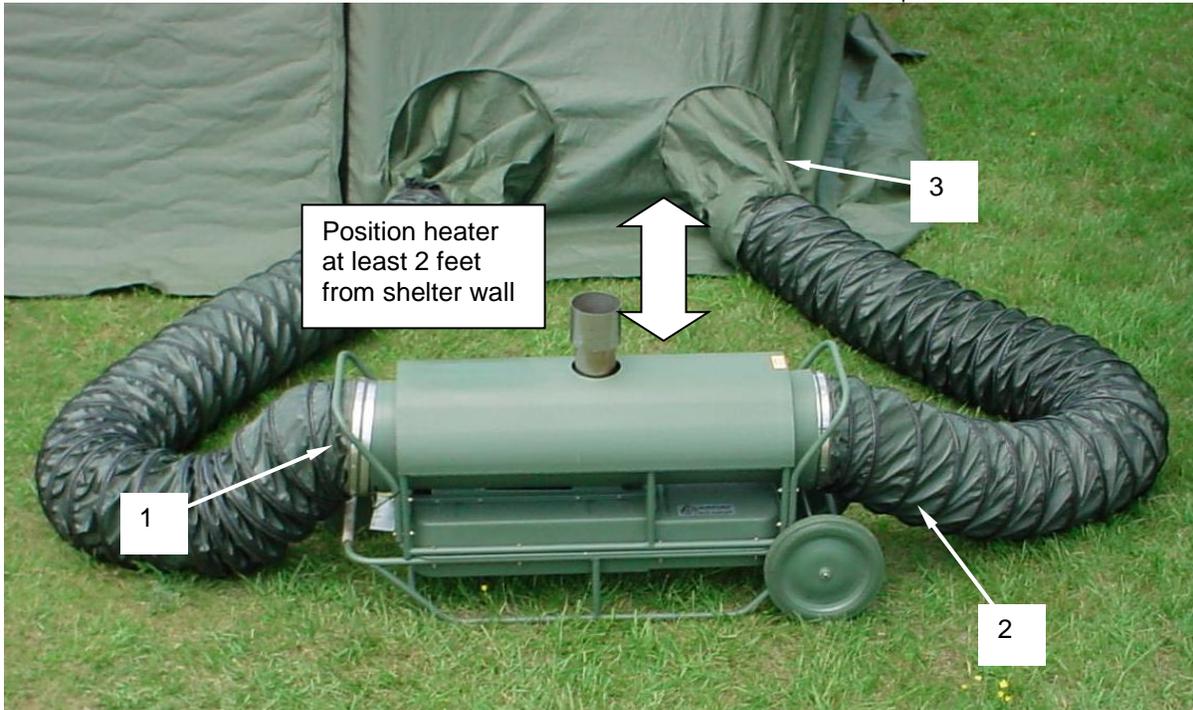
### **WARNING**

The CAMFIRE heater weighs approximately 105 pounds dry weight (48 kg). A fully fueled heater weighs 165 pounds (74.8 kg). Two persons must carry the CAMFIRE heater when lifting or lowering the unit. Be sure to lift with legs, not back, to prevent injury.

The CAMFIRE heater site location will be dictated by the location of the shelter since the heater inlet **(1)** and outlet **(2)** ducts must be able to reach the shelter duct tunnels **(3)**. (see photo next page)

The heater site must be as level as possible and free of combustible material (e.g. dried twigs, leaves, etc.). If snow is present, it should be removed from the area immediately beneath and around the heater.

The site should be selected so that the heater will be positioned at least 2 feet (61 cm) from combustibles, including the shelter wall.



**Positioning the Heater Outside Shelter.** Place heater on the side of the shelter that has the shelter duct tunnels. The heater should be a minimum of 2 feet (61 cm) from shelter walls. If possible, position the heater so that the control panel faces away from the shelter wall. Position the heater so that the two supplied 15-foot flexible ducts can be connected to the heater and the shelter duct tunnels.

## 2.3 Setup

### 2.3.1 Attaching the Flexible Ducts

**General.** Two air ducts, 15 feet in length and 12 inches in diameter, connect to the inlet and outlet ends of the heater and move air from the interior of the shelter, through the heater, and back to the interior of the shelter. In conditions where the outside ambient temperature is above freezing, only the heated air supply duct is used. In this way, the heater draws unheated air from the outside. Operating the heater without input ducting in warmer temperatures allows the heater to run cooler, thus preventing safety overheat shutdown.

	Below 32 <sup>0</sup> F	Above 32 <sup>0</sup> F
Use Heated Air Outlet Duct Only		X
Use Air Inlet Duct and Heated Air Outlet Duct	X	

Table 2-1. Flexible Duct Usage vs. Outside Temperature

**Installing the Air Supply and Return Ducts (re-circulation mode).** To install the heated air return and air supply ducts (NOTE: air return duct to be installed only if outside temperatures are below freezing), remove end plug **(1)** from the heater duct adapter **(2)** on the air inlet end of the heater by pushing in and rotating clockwise to disengage the protruding pins on the end plug from the J-slots in the heater duct adapter. Remove the power cable stowed inside the end plug and set aside.



### WARNING

During heater operation, air leaving the heated air outlet of the heater and passing through the heated air return duct may exceed 220°F (104°C). Make sure shelter personnel are aware of burn hazards and equipment hazards presented by the heated air exiting the heated air duct.



### CAUTION

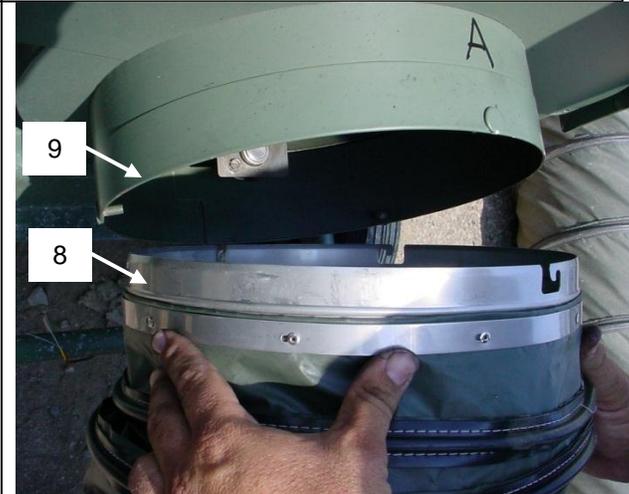
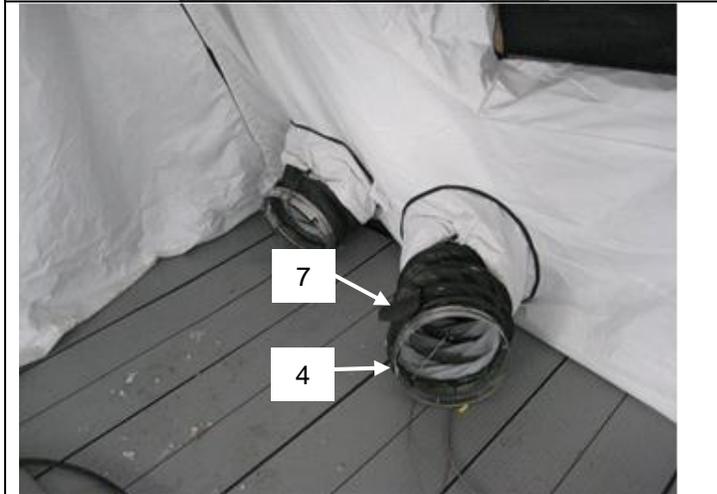
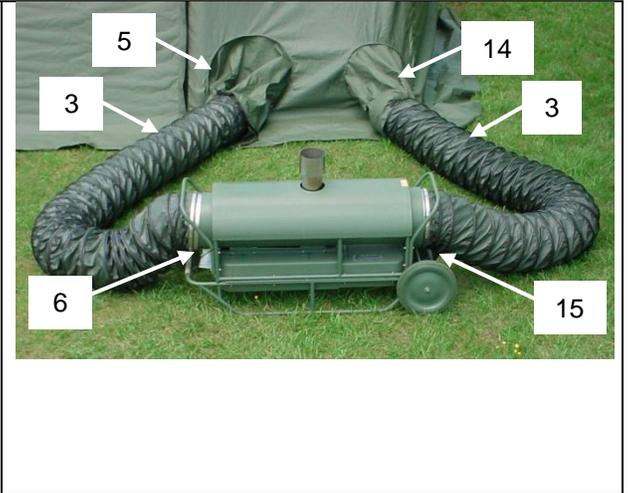
Wear gloves while handling ducts. There may be sharp metal edges or burrs that could cut you.

**NOTE:** The heater ducts are outfitted with J-slot, twist lock bands on each end. They can only be attached one way. Make sure to match up the ends before attaching to the shelter. Locate the heated air supply duct **(3)**. Make sure inside and outside of duct are free of damage, dirt, and obstructions prior to attachment to the heater assembly. Insert the outlet end **(4)** of the duct into the shelter duct tunnel **(5)** closest to the heated air outlet end **(6)** of the heater as indicated by the label "Heated Air Outlet" on the upper housing assembly. Make sure about 12 inches of the outlet end **(4)** protrude into the shelter **(7)** so that the air can be directed away from the inlet properly. Secure the shelter duct tunnel tie straps. Do not secure the straps so tightly that the air flow within the duct is restricted. Attach the end of the duct with the J-slot bracket **(8)** to the duct adapter **(9)** on the heated air outlet end **(6)** of the heater. Engage the J-slot onto the protruding pins on the inside of the duct adapter and push in fully. While pushing the duct in, rotate the duct counterclockwise until it locks in place.

### IMPORTANT

If using the heater on a shelter with a plenum, move the plenum to the side so it does not obstruct the airflow. **DO NOT ATTACH THE HEATER TO THE SHELTER PLENUM.** The heater will do a much better job of heating by blowing the heat on the floor.

Insert the end of the duct without the J-slot mounting bracket into the shelter duct tunnel **(14)** closest to the air inlet end **(15)** of the heater as indicated by the label "Air Inlet" on the upper housing assembly. Secure the shelter duct tunnel tie straps **(16)**. Do not secure the straps so tightly that the air flow within the duct is restricted. Attach the end of the duct with the pins onto the J-slots **(17)** to the duct adapter **(18)** on the air inlet end of the heater. Engage the protruding pins onto the J-slots on the duct adapter and push in fully. While pushing the duct in, rotate the duct counterclockwise until it locks in place.



Re-circulation mode

Outside air mode (see next section)

**Installing the Air Supply and Return Ducts (outside air mode)** If outside temperatures are above freezing, the inlet of the air supply duct **(12)** should be located outside the shelter, drawing outside air, in accordance with Table 2-1. This helps to keep the heater from shutting down on overheat unexpectedly. Make sure the duct is still attached to the heater as this keeps rain and snow from being drawn into the fan compartment. Also, make sure inside and outside of duct and the grill are free of damage, dirt, and obstructions prior to attachment to the heater assembly.



**WARNING**

Never use gasoline in this heater. Never use JP-4. The heater is designed to run only on DF-1, DF-2, DF.A, JP-5, and JP.8. Failure to use only authorized fuels may result in fire or explosion.

**2.4 Before Operation Preventative Maintenance Checks and Services (PMCS)**

Perform the “Before Operation PMCS” on all CAMFIRE heater components as outlined in section 4.2, prior to preparing the heater for use. All scheduled maintenance must be performed on the heater and its associated equipment prior to use.

**2.5 Fueling**

**2.5.1 Fueling the Internal Tank (MV60S-EU, MV60T-EU)**

Remove the internal fuel tank cap **(2)** and fill the internal tank with an approved fuel as detailed in section 1.5 of this manual.

Install the internal fuel tank cap **(2)** and hand tighten securely.

Open the vent on the top of the fuel tank cap **(2)**.

**CAUTION:** For fuel tanks with a manual vent. The fuel tank vent should always be open to prevent pressure from building up in the fuel tank. Only close the vent when the heat is tilted, such as when moving the heater on its optional wheels.

The fuel level in the tank is displayed on the fuel gauge to the right of the fuel tank cap **(3)**.



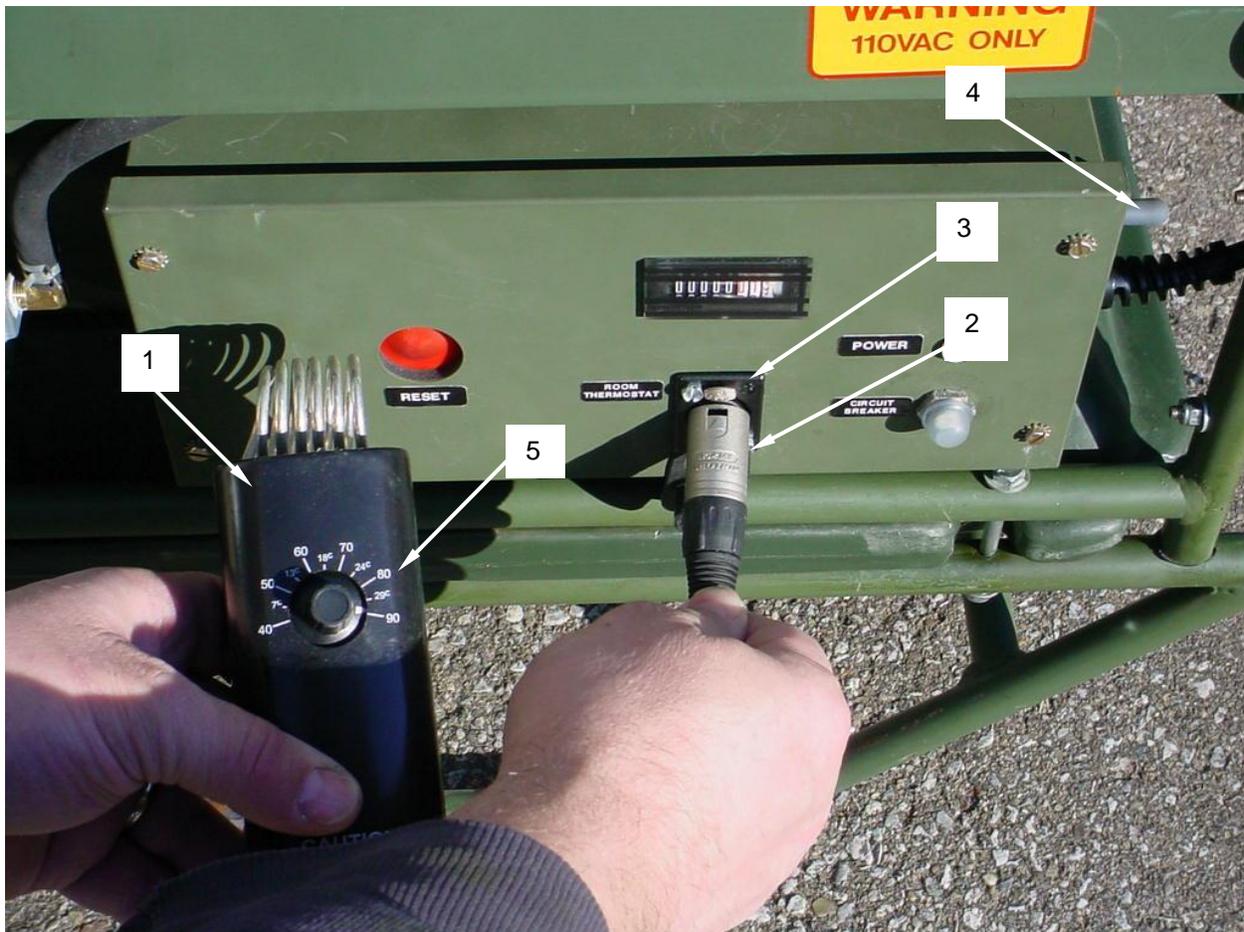
## 2.5.2 Connecting and operating the Remote Room Thermostat

The optional remote room thermostat (1) allows the operator to control the environment inside the shelter automatically by monitoring the temperature and subsequently controlling the heat output of the Camfire heater. (see photo next page)

To connect the remote room thermostat (1), engage the plug (2) on the end of the cable into the connector (3) on the control panel of the heater labeled "ROOM THERMOSTAT". Push the plug in securely until it clicks in position. Rotate the dial on the room thermostat fully counter clockwise so that it does not turn on unexpectedly while setting up.

Route the thermostat control into the shelter and hang from a convenient location. Be sure to position the control so that it is not in the direct path of the heated air outlet or the cold air at the entrance to the shelter. You may need to try several locations in the shelter before a suitable location is found.

To use the room thermostat move the control panel switch (4) to the ON AUTO position. Adjust the dial until the heater comes on. If the room temperature is not satisfactory, adjust the room thermostat as necessary. **NOTE:** The numbers (5) on the room thermostat are for reference only. You should remember that if the shelter temperature is too cold (or hot) simply adjust the room thermostat.



### 2.5.3 Connecting the Power Cable

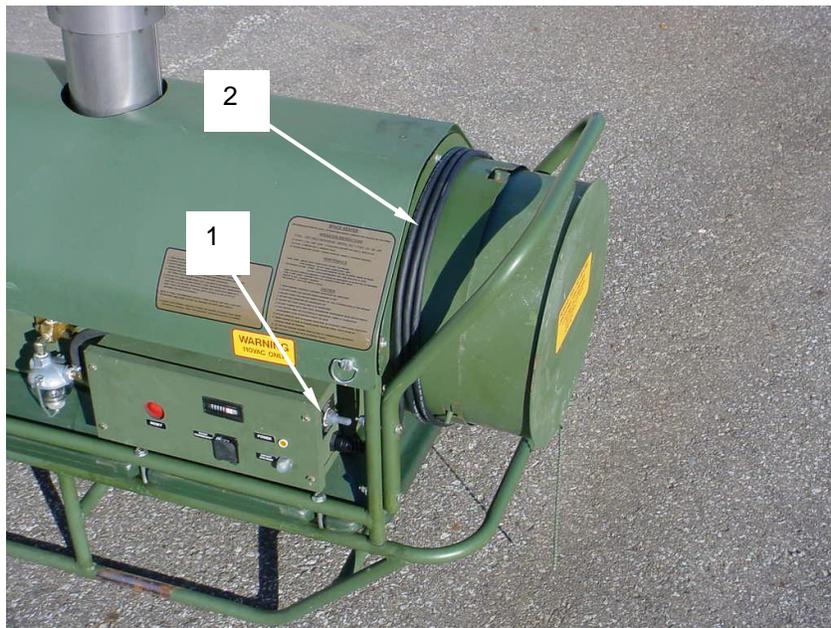
Ensure that the main power switch (1) on the Camfire heater control panel is in the OFF position.

Uncoil the power cable (2) and connect the male end of the power cable to a 220 VAC, 50/60 cycle single phase power source with GFCI.

If an extension cord is required, ensure that it is a three wire cord and of adequate size, as listed in the following table.

Table 2-2. Extension Cord Size Requirements

LENGTH OF CORD	WIRE SIZE (AWG)
100 ft	NO. 14
200 ft	NO. 12
300 ft	NO. 10
400 ft	NO. 8
450 ft	NO. 6



## 2.6 Final Checks Before Operation

1. Make sure that all the connections are secure, power, room thermostat, ducts, etc.
2. Open internal fuel tank cap and check for an adequate fuel supply. Make sure the fuel tank cap vent is open.
3. Ensure that the power switch on the control panel is in the OFF position.
4. Plug the Camfire heater power cord into a grounded, 220 VAC power supply outlet.
5. The heater assembly is now ready for operation.

## 2.7 Starting and Operating the Heater

### 2.7.1 Starting the Heater

1. Set the toggle switch to the ON MANUAL position if the heater is not being operated with the room thermostat control. If the room thermostat accessory is being used, set the toggle switch to the ON AUTO position and set the dial on the room thermostat to the desired temperature. This will initiate a “call for heat”. The heater will start immediately provided that the surrounding air is cooler than the setting of the dial. The heater will continue to operate until the temperature of the surrounding air reaches the dial setting. It will then shut down and cycle on when the temperature drops.
2. Safety control lockout will occur if flame is not established during the startup 15 second “trial for ignition” period. To restart, the safety switch must be manually reset. See section 3 for details.
3. Control will provide a 5 to 10 second ignition overrun time after the “trial ignition period” to prevent lockouts.
4. Burner will turn off when call for heat is satisfied. **CAUTION:** There is no post purge on this heater so surfaces will remain hot for some time after shut down.
5. If flame failure occurs during a run, the motor will immediately shut off. A 90 second “recycle” period will begin followed by a new “trial for ignition” period. (Please allow 60 to 120 seconds for recycle period). Flame failure may occur due to a heater failure or, if the heater runs out of fuel.

### NOTE

If trial for ignition locks out three times, control will “latch-up”. To reset, refer to section 3.



### WARNING

**Only a qualified technician should attempt to reset the control after latch-up. The problem that caused the malfunction must be corrected before returning the burner to normal operation. Failure to do so may lead to fire and or damage to equipment or personnel. (see troubleshooting)**

6. Power loss during a run will cause the burner to safely shut down and begin a normal trial for ignition upon power restoration.

## **2.8 Refueling During Operation**

The heater must not be refueled while it is operating. To refuel the heater, turn the power switch to the OFF position. Refuel in accordance with the section entitled "Fueling the Internal Fuel Tank".

## **2.9 Shutting Down the Heater**

1. Move the heater switch to the OFF position.
2. If the heater is equipped with a thermostat accessory, turn the dial to the "No Heat" position.

## **2.10 Preparing for Movement or Storage**

### **2.10.1 Preparing for Movement**

1. To prepare the Camfire heater for movement, ensure that the heater has been shutdown in accordance with section 2.9 and that it is completely cool.
2. Unplug the power cord from the power source as well as the Camfire control panel. Coil the power cord around the inlet adapter.
3. Remove the remote room thermostat from the shelter (if used) and disconnect from the thermostat connector on the control panel. Coil the remote room thermostat cable and stow it in the end plug along with the power cable.
4. Remove the heated air outlet duct from the shelter duct tunnel. Stow the duct in a location that will protect it from weather extremes, cuts, tears, or other damage.
5. Remove the air inlet duct (if used) from the remaining shelter duct tunnel. Stow the duct in a location that will protect it from weather extremes, cuts, tears, or other damage.
6. Ensure that the remote room thermostat is neatly coiled inside the end plug as previously discussed. Install the end plug in the end of the heater by aligning the pins on the end plug with the J-slots on the heater duct housing. Push the end plug in place and rotate clockwise to lock in place. Release the end plug.
7. Remove the stack extension and stow in a protected location along with the ducts.



### 2.10.2 Preparing the Heater for Storage

To prepare the heater for storage, follow all procedures detailed in the previous section to prepare the heater for movement.

In addition, drain the fuel tank and purge with an approved agent. Start the heater and run out all residual fuel left in the system. Make sure the fuel tank vent is open. Empty the sediment strainer.

**CAUTION:** The fuel tank vent should always be open to prevent pressure from building up in the fuel tank. Only close the vent when the heater is tilted, such as when moving the heater on its optional wheels.

Lubricate all hinges.

Fog the entire heater with a thin layer of WD-40 or equivalent light oil spray to protect all metal surfaces.

Store the heater in a location protected from moisture and sand.



# Chapter 3

## Troubleshooting

### 3. CAMFIRE Troubleshooting

#### 3.1 Introduction

Should you encounter any problems with the operation of a heater, the chart on the following pages may help. For each problem there is a list of "possible causes". The corrective action column tells you how to correct the problem or tells you by means of a section and paragraph number where to find detailed instructions for correcting it.

In troubleshooting, remember that the air pump is part of the fuel system because the air it supplies lifts the fuel from the tank and pushes it through the nozzle.

#### NOTE

Be sure to follow all cautions and warnings. They will help you prevent damage to the heater or injury to yourself.

#### 3.2 Operator Level Troubleshooting

#### 3.3 Safety Control Operation and Diagnostics

During the start-up and operation of the heater the safety control goes through several steps where it is evaluating the controls and inputs from other safety devices such as the photocell and overheat thermostat. On the control there are two LEDs, one amber (A) and one red (R), which are visible through a small view port on the front of the control panel. During operations the LEDs may come on and/or blink. The table below shows various stages of operation after the heater is switched on, and the resultant LED status. The LED status is as follows: I=ON, O=OFF

Step	LED Status		Description
	A	R	
1	O	O	<b>Power ON/Standby</b> , Control waits for Room Thermostat circuit to close or Manual ON
2	I	O	<b>Call for heat</b> , Room Thermostat circuit closed. The amber LED turns ON. For the first 3 of 4 seconds, the control performs a self-test. If the photocell senses flame, the control repeats this test until flame is no longer detected. During this time the amber LED blinks off momentarily every 3 or 4 seconds
3	O	O	<b>Burner ON</b> . After the self-test, the amber LED turns OFF. The igniter starts, followed 1 second later by the motor.
4	O	O	<b>TFI (trial for ignition)</b> , the photocell must detect flame within 15 seconds. After flame is detected, the igniter stays on another 10 seconds for flame stabilization.
5	O	O	<b>RUN</b> , the burner continues firing as long as the photocell senses flame and the overheat does not trip.
6	O	I	<b>LOCKOUT</b> , if the photocell does not sense flame within 15 seconds after the burner starts, lockout occurs. The control turns the RED on constant. To RESET, push in and hold red button for 1 second, then release.
N/A	I	I	<b>LATCH-UP</b> , If the control locks out 3 times during a single call for heat, latch-up occurs. The control turns on both the amber and red LEDs constant. <b>Warning! Only a qualified technician should attempt to reset the control after latch-up. The problem that caused the malfunction must be corrected before returning the burner to normal operation. (see maintainer level troubleshooting)</b>

### 3.3.1 Operator Level Malfunction Symptom Index

The malfunction symptom index lists common malfunctions that may occur during the operation of the CAMFIRE Heater. Find the malfunction to be eliminated and go to the indicated troubleshooting procedure in the next section. This index cannot list all malfunctions that may occur, all tests or inspections needed to find the fault, or all actions required to correct the fault. If the existing malfunction is not listed, or cannot be corrected through this troubleshooting index, notify maintenance.

For purposes of this troubleshooting section, the term operator refers to someone who has been trained in the deployment and use of the heater but has not been trained or certified in the maintenance of the heater beyond operator level maintenance tasks.

Table 3-1. Operator Level Malfunction Symptom Index

Malfunction	Troubleshooting Procedure
Motor Does Not Start	1
Heater Will Not Ignite, But Motor Runs For A Short Time.	2
Heater Burns But Puffs Of Smoke Can Be Seen; Heater Will Not Burn Steady; Heater Burns With Odor; Heater Smokes Continuously	3
Flames and/or Black Smoke Come Out Of Stack	4
Heater Cycles Intermittently	5
Heater starts but will not stay running, RED light is flashing on control	5
Heater Ignites But Safety Control Trips, Red LED is on constant.	6
Heater will not start, amber light is flashing on the control	7

### 3.3.2 Examining the Heater

**WARNING!**

**REMOVE ALL POWER BEFORE SERVICING THE HEATER. SEVERE INJURY COULD OCCUR**

1. Check the fuel tank for sludge and water. If you find it, expect to find a dirty nozzle and/or sediment strainer.
2. Spin the fan to be sure it turns freely. If it is stiff, look for a worn or dry bearing on the fan end of the motor, or for binding pump rotor.
3. Check the heater for dirt and foreign materials around the pump, fan and air filters. Be sure the heater is reasonably clean before test-firing.
4. Check the heater cord for obvious breaks or other unsafe conditions. If the cord is doubtful repair it or replace with a new one before test firing.

### 3.3.3 Test Firing the Heater

1. Clean the fuel tank and fill it with at least 2 gal of fuel. A minimum of 1 gal of fuel must be in the tank in order to operate the heater.
2. Clean the air intake filter. See Section 4.4.8.

### 3.3.4 Operator Level Troubleshooting Procedures

Table 3-2. Operator Level Troubleshooting Procedure

No.	Malfunction	Possible Cause	Corrective Action To Take
1.	Motor does not start.	A. Safety control locked out. (see section 3.3)	1. Push and hold red reset button for 5 seconds.
		B. No power or low voltage at heater.	1. Check that heater is plugged in.  2. Ensure voltage at heater is the same as indicated on heater Data Plate located on electrical panel cover and as indicated in the Specifications, Section 1.5.  3. Use an extension cord of sufficient gauge to carry the electrical load of the heater (see Table 2-3).
		C. Thermostat (if used) improperly set or defective.	1. Adjust thermostat to a higher setting. If heater still does not start, continue with Step 2.  2. Place the toggle switch on the heater control box to the "ON MAUNAL" position. If heater functions properly, replace thermostat.
		D. Fan obstructed by mechanical damage or dirt.	1. Check for bent outer shell, damaged fan, or damaged motor mount.
		E. Defective photocell.	1. Refer the unit to maintenance for further troubleshooting.
		F. Defective safety control.	1. Refer the unit to maintenance

No.	Malfunction	Possible Cause	Corrective Action To Take
2.	Heater will not ignite, but motor runs for a short time.	<p>G. Broken rotor or carbon blades. Pump rotor binding.</p> <p>A. Fuel tank empty, wrong fuel, water in fuel.</p>	<p>for further troubleshooting.</p> <p>1. Refer the unit to maintenance for further troubleshooting.</p> <p>1. Check level of fuel in tank. A minimum of 1 gallon is required for proper operation.</p> <p>2. Ensure fuel is of a type indicated on the heater or listed in the Specifications, Section 1.5.</p> <p>3. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank.</p> <p>4. If water is found, refer the unit to maintenance.</p>
3.	Heater burns but puffs of smoke can be seen; heater will not burn steady; heater burns with odor; heater smokes continuously.	<p>B. Air leak at sediment strainer.</p> <p>C. Defective or damaged spark plug.</p> <p>D. Defective transformer.</p> <p>A. Heater running out of fuel, wrong fuel, water in fuel.</p> <p>B. Dirty air filters causing reduced air pressure through</p>	<p>1. Check sediment strainer and gasket for air leaks and tightness of thumb screw that holds the glass bowl on.</p> <p>1. Refer the unit to maintenance for further troubleshooting.</p> <p>1. Refer the unit to maintenance for further troubleshooting.</p> <p>1. Check level of fuel in tank. A minimum of 1 gallon is required for proper operation.</p> <p>2. Ensure fuel is of a type indicated on the heater or listed in the Specifications, Section 1.5.</p> <p>3. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank.</p> <p>4. If water is found, refer the unit to maintenance for repair.</p> <p>1. Ensure air intake is not blocked.</p>

No.	Malfunction	Possible Cause	Corrective Action To Take
		nozzle resulting in low fuel flow.	2. Remove and clean air filters (see Section 4.4.8).
		C. Dirty sediment strainer.	1. Remove sediment bowl and clean. 2. Refer the unit to maintenance for further troubleshooting.
		D. Sediment strainer loose.	1. Check sediment strainer and gasket for air leaks and tightness of thumb screw that holds the glass bowl on.
		E. Dirty fuel nozzle.	1. Refer the unit to maintenance for further troubleshooting.
			<b>CAUTION</b>
			Never use a drill, wire or other tool to open nozzle passage
		F. Low pump output pressure (low motor speed, worn pump, pump out of adjustment.	1. Ensure that no mechanical damage to the fan blades could be causing low motor speed.  2. If mechanical damage is observed, refer the unit to maintenance for further troubleshooting.
		G. Loose output airline between pump and burner head.	1. Tug airline at both connections to ensure that they are tight.
		H. Inlet duct is blocked	1. Check inlet duct and make sure it is clear. Make sure test fabric or other FOD are not blocking the airflow.
		I. Inlet screen blocked	1. Remove inlet duct and check debris screen for FOD. Clean as necessary.
4.	Flames and/or black smoke come out of stack.	A. Dirty fan or air passageway through heater blocked.	1. Ensure that debris grill is clear. Ensure that fan is operating properly in accordance with Section 4.4.5.  2. Ensure air passageway through heater is clear.

No.	Malfunction	Possible Cause	Corrective Action To Take
5.	Heater cycles intermittently.	B. Pump output too high causing too much fuel to be supplied.	1. Refer the unit to maintenance for further troubleshooting.
		C. Fan loose or improperly located on shaft.	1. Refer the unit to maintenance for further troubleshooting.
		D. Bent or damaged fan.	1. Inspect fan for damage. If damage to fan is observed, refer the unit to maintenance for repair. Make sure fan is not loose on the motor shaft.
		E. Inlet duct is blocked	1. Check inlet duct and make sure it is clear. Make sure test fabric or other FOD are not blocking the airflow.
		F. Inlet screen blocked	1. Remove inlet duct and check debris screen for FOD. Clean as necessary.
		G Access hatch is open	1. close access hatch
		A. Room Thermostat (if used) set too low.	1. Set thermostat to a higher temperature for more even operation.
		B. Defective thermostat (if used).	1. Set power switch on heater control box to "ON MAUNUAL" position.  2. If heater runs evenly, replace thermostat.
		C. Defective electrical supply or defective electrical connections.	1. Ensure extension cord is in good condition.  2. Check mechanical and electrical soundness of all wiring connections in the heater (see Schematic, Section 6).
		D. Defective overheat switch.	1. Refer the unit to maintenance for further troubleshooting.
E. Unit is overheating.	1. Check ducts for obstructions, or kinks. Straighten ducts to promote good airflow. 2. Remove inlet duct from shelter.		

No.	Malfunction	Possible Cause	Corrective Action To Take
6.	Heater ignites but safety control trips. Heater starts but will not stay running, The control turns the red LED on constant,	<p><i>If photocell does not sense flame within 15 seconds after burner starts, lockout occurs.</i></p> <p>A. Dirty or defective photocell.</p> <p>B. overheat switch open</p> <p>D. Sediment strainer loose.</p> <p>D. Sediment strainer dirty.</p>	<p>1. Lift top cover. Open access hatch. Remove photocell from bracket attached to burner head.</p> <p>2. Inspect glass face of photocell. If dirty, wipe with clean soft cloth</p> <p>3. Replace photocell and close access hatch. Start heater. If problem persists, notify maintenance.</p> <p>4. Overheat, (see 5, D and E)</p> <p>1. Let unit cool down and see if overheat resets.</p> <p>2. Check ducts and inlet screen for blockages</p> <p>1. Check sediment strainer and gasket for air leaks and tightness of thumb screw that holds the glass bowl on.</p> <p>1. Check sediment strainer for dirt and water. Empty bowl and clean screen.</p> <p>If problem persists notify unit maintenance</p>
7.	Heater will not start, Amber light flashes on control	A. photocell seeing light	<p>1. Make sure access cover is closed.</p> <p>2. Attach return duct</p> <p>3. Disconnect photocell. If heater starts then photocell is defective. Notify unit maintenance.</p>

### 3.4 Maintainer Level Troubleshooting

#### 3.4.1 Test Firing

1. Check and adjust the air pressure, as described in Section 4.4.8, except that fuel must be used for test-firing.

#### NOTE

It is not possible to test-fire a heater properly if this adjustment cannot be made.

2. Allow the heater to run for 15 minutes. Observe its operation during the test-run.
3. After making the pressure check, adjustment, and test firing, remove the gauge and re-install the plug. Tighten plug until sealed. Use soapy water to check for sealing. Do not tighten.
4. If any troubles show up during the test firing, refer to the troubleshooting chart to find out how to correct them.

#### 3.4.2 Maintainer Level Safety Control Operation and Diagnostics

During the start-up and operation of the heater the safety control goes through several steps where it is evaluating the controls and inputs from other safety devices such as the photocell and overheat thermostat. On the control there are two LEDs, one amber (A) and one red (R) which are visible through a small view port on the front of the control panel. During operations the LEDs may come on and/or blink. The table below, shows various stages of operation and the resultant LED status. The LED status is as follows: I=ON, O=OFF, B=BLINK, F=FLASHING

Step	LED Status		Description
	A	R	
1	O	O	<b>Power ON/Standby</b> , Control waits for Room Thermostat circuit to close or Manual ON
2	I	O	<b>Call for heat</b> , Room Thermostat circuit closed. The amber LED turns ON. For the first 3 of 4 seconds, the control performs a self-test. If the photocell senses flame, the control repeats this test until flame is no longer detected. During this time the amber LED blinks off momentarily every 3 or 4 seconds
3	O	O	<b>Burner ON</b> . After the self-test, the amber LED turns OFF. The ignitor starts, followed 1 second later by the motor.
4	O	O	<b>TFI (trial for ignition)</b> , the photocell must detect flame within 15 seconds. After flame is detected, the igniter stays on another 10 seconds for flame stabilization.
5	O	O	<b>RUN</b> , the burner continues firing as long as the photocell senses flame and the overheat does not trip.
6	O	I	<b>LOCKOUT</b> , if the photocell does not sense flame within 15 seconds after the burner starts, lockout occurs. The control turns the RED on constant. To RESET, push in and hold red button for 1 second, then release.
	I	I	<b>LATCH-UP</b> , If the control locks out 3 times during a single call for heat, latch-up occurs. The control turns on both the amber and red LEDs constant. <i>You must use the special procedure below to reset the control after latch-up.</i>  <b>Warning! Only a qualified technician should attempt to reset the control after latch-up. The problem that caused the malfunction must be corrected before returning the burner to normal operation.</b>

	<b>F</b>	<b>F</b>	<b>RESET from LATCH-UP</b> Push in and hold the reset button for about 10 seconds. The amber and red LED's will begin to flash alternately.
	<b>O</b>	<b>O</b>	After the LED's begin flashing, continue holding the reset button for about another 20 seconds. The LED's will turn off. Release the reset button and the control will restart. (Releasing the button before the LED's turn off will cause the control to remain in latch-up.) <b>Note:</b> The 50240 control will not reset from lockout or latch-up if power is interrupted.
	<b>O</b>	<b>F</b>	<b>FLAME FAILURE</b> If the photocell loses flame signal during operation (after the TFI), the red LED flashes. The burner shuts off within seconds. Recycle: Control waits for 65 seconds (with red LED flashing), then begins again at Self-test. Red LED goes off

### 3.4.3 Maintainer Level Malfunction Symptom Index

Table 3-3. Maintainer Level Malfunction Symptom Index

Malfunction	Troubleshooting Procedure
Motor Does Not Start	1
Heater Will Not Ignite, But Motor Runs For A Short Time.	2
Heater Burns But Puffs Of Smoke Can Be Seen; Heater Will Not Burn Steady; Heater Burns With Odor; Heater Smokes Continuously	3
Flames and/or Black Smoke Come Out Of Stack	4
Heater Cycles Intermittently	5
Heater starts but will not stay running, RED light is flashing on control	5
Heater Ignites But Safety Control Trips, Red LED is on constant.	6
Heater will not start, amber light is flashing on the control	7

### 3.4.4 Maintainer Level Troubleshooting Procedures

Table 3-4. Maintainer Level Troubleshooting Procedures

No.	Malfunction	Possible Cause	Corrective Action To Take
1	Motor does not start	A. Fan obstructed by mechanical damage or dirt.	1. Replace a damaged fan. Do not attempt to repair.
		B. Defective photocell. (see section 4.4.10)	<p>1. Lift top cover. Open access hatch. Remove photocell from bracket attached to burner head.</p> <p>2. Disconnect blue and white photocell leads.</p> <p>3. Connect ohmmeter test leads to photocell leads.</p> <p>4. Hold open end of photocell towards a light source (a 60-watt light bulb or direct sunlight). The resistance indicated on the ohmmeter should be low.</p> <p>5. Block off light completely by covering the open end of the photocell. Within 10 seconds the resistance indicated should be high.</p> <p>6. Replace photocell if there is no change in resistance during this procedure.</p>
		C. Defective safety control. (see section 4.4.9)	<p>1. Remove 4 screws holding the control box. Pull away from the electrical panel but do not disconnect any electrical connections.</p> <p>2. Attach one test lead of a voltmeter to one of the white leads on the distribution bar. Plug heater in and switch on. Touch the other test lead to first the orange wire on the left side of the distribution bar, then to the blue wire on the left side of the distribution bar.</p> <p>3. If one or both wires do not read 220 volts (approximately) replace</p>

No.	Malfunction	Possible Cause	Corrective Action To Take
			<p>the safety control.</p> <p style="text-align: center;">NOTE</p> <p>After replacing the safety control, check the ignition transformer as follows before starting the heater.</p> <p>4. Remove screen from inlet end of heater. Disconnect the red and white transformer leads.</p> <p>5. Attach ohmmeter test leads to the red and white transformer leads. The ohmmeter should indicate an open line (no conductance).</p>
		D. Broken rotor or carbon blades. Pump rotor binding. (see Section 4.4.4).	<p>1. Remove pump end cover and pump front cover.</p> <p>2. Visually inspect rotor and blades for breakage.</p> <p>3. Ensure that the rotor and blades are free of any lubricant or debris.</p> <p>4. Check rotor with feeler gauge for proper clearance between rotor and pump body (see Section 4.4.4).</p>
		E. Defective run capacitor	Check capacitor near motor in accordance with 4.4.4
2.	Heater will not ignite, but motor runs for a short time.	A. Fuel tank empty, wrong fuel, water in fuel.	<p>1. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank.</p> <p>2. If water is found, drain and clean tank and filter. Fill with fresh, clean fuel.</p>
		B. Defective or damaged spark plug.	1. Remove spark plug from burner head. Visually inspect spark plug for cracks or worn electrodes.

No.	Malfunction	Possible Cause	Corrective Action To Take
			<p>2. Adjust spark plug gap (see Section 4.4.3).</p> <p>3. Establish a good ground between the spark plug and the heater. Be careful not to let any part of your person become a portion of the grounded circuit. See 4.4.3</p> <p>4. Start heater; observe the spark between the plug's electrodes. If the ground is good and spark does not jump between see next troubleshooting section.</p>
		C. Defective transformer.	<p><b><u>WARNING</u></b></p> <p>To begin the transformer test, first ensure the heater is not plugged in. Then, when power is required, be EXTREMELY careful when checking the transformer. A transformer in good condition produces VERY HIGH VOLTAGE at the output terminal. See 4.2.3</p> <p>1. Connect the transformer lead to a properly gapped spark plug. The gap should be 0.050 inch, plus or minus 0.005 inch.</p> <p>2. Establish a good ground between the spark plug and the heater. Be careful not to let any part of your person become a portion of the grounded circuit.</p> <p>3. Start heater; observe the spark between the plug's electrodes. If the ground is good and spark does not jump between the electrodes, the transformer is defective and must be replaced.</p>

No.	Malfunction	Possible Cause	Corrective Action To Take
3.	Heater burns but puffs of smoke can be seen; heater will not burn steady; heater burns with odor; heater smokes continuously.	<p>A. Heater running out of fuel, wrong fuel, water in fuel.</p> <p>B. Dirty sediment strainer.</p> <p>C. Low pump output pressure (low motor speed, worn pump, pump out of adjustment).</p>	<p>1. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank.</p> <p>2. If water is found, drain and clean tank and filter. Fill with fresh, clean fuel.</p> <p>3. Check fuel tank for dirt or water</p> <p>1. Remove and clean sediment strainer (see Section 4.4.6).</p> <p>2. Replace a blocked filter screen.</p> <p>1. Check and adjust pump output pressure (see Section 4.4.8).</p> <p>2. Repair or replace pump if adjustment cannot be made (see Section 4.4.8).</p>
4.	Flames and/or black smoke come out of stack.	<p>A. Pump output too high causing too much fuel to be supplied.</p> <p>B. Fan loose or improperly located on shaft.</p> <p>C. Bent or damaged fan.</p>	<p>1. Check and adjust pump output pressure.</p> <p>1. Check and tighten hex screw located on rear of fan hub.</p> <p>2. Ensure fan is in correct location (see Section 4.4.5).</p> <p>1. Replace a damaged fan. DO NOT ATTEMPT TO REPAIR A DAMAGED FAN.</p>
5.	Heater cycles intermittently. Red LED flashes on the control.	<p><b>NOTE:</b> <i>If the photocell loses flame signal during operation (after the TFI), the red LED flashes. The burner shuts off and the Control waits for 65 seconds (with red LED flashing), then begins again at Selftest. Red LED goes off</i></p> <p>A. Defective overheat switch.</p>	<p>1. Remove leads from overheat switch (located at output end of heater).</p> <p>2. Using a test lead with 2 alligator clips, jump overheat leads (white wires are low voltage).</p> <p>3. Start heater. If heater runs properly, replace overheat switch.</p>

No.	Malfunction	Possible Cause	Corrective Action To Take
6.	Heater ignites but safety control trips. Heater starts but will not stay running, The control turns the red LED on constant,	<p><i>If photocell does not sense flame within 15 seconds after burner starts, lockout occurs.</i></p> <p>A. Dirty or defective photocell.</p> <p>B. Defective overheat switch.</p> <p>C. Dirty nozzle</p> <p>B. Dirty sediment strainer.</p> <p>D. Low pump output pressure (low motor speed, worn pump, pump out of adjustment).</p>	<p><b>Note:</b> <i>make sure photocell is aligned properly so it is pointing towards the view port in the burner head</i></p> <ol style="list-style-type: none"> <li>1. Disconnect blue and white photocell leads.</li> <li>2. Connect ohmmeter test leads to photocell leads.</li> <li>3. Hold open end of photocell towards a light source (a 60-watt light bulb or direct sunlight). The resistance indicated on the ohmmeter should be low.</li> <li>4. Block off light completely by covering the open end of the photocell. Within 10 seconds the resistance indicated should be high.</li> <li>5. Replace photocell if there is no change in resistance during this procedure.</li> </ol> <ol style="list-style-type: none"> <li>1. Remove leads from overheat switch (located at output end of heater).</li> <li>2. Using a test lead with 2 alligator clips, jump overheat leads (white wires low voltage).</li> <li>3. Start heater. If heater runs properly, replace overheat switch.</li> </ol> <ol style="list-style-type: none"> <li>1. clean or replace nozzle in accordance with section 4.4.7</li> </ol> <ol style="list-style-type: none"> <li>1. Remove and clean sediment strainer (see Section 4.4.6).</li> <li>2. Replace a blocked filter screen.</li> </ol> <ol style="list-style-type: none"> <li>1. Check and adjust pump output pressure (see Section 4.4.8).</li> <li>2. Repair or replace pump if adjustment cannot be made (see Section 4.4.8).</li> </ol>

No.	Malfunction	Possible Cause	Corrective Action To Take
7.	Heater will not start, Amber light flashes on control	A. photocell seeing light	<ol style="list-style-type: none"><li>1. Make sure access cover is closed.</li><li>2. Attach return duct</li><li>3. Disconnect photocell. If heater starts then photocell is defective. (see section 4.4.10)</li></ol>

# Chapter 4

## Maintenance

## 4. CAMFIRE Maintenance

### 4.1 Introduction

Maintenance consists of simple operations the user of the heater can perform to keep the heater running and in good condition. If ordinary maintenance fails to return the heater to good operating condition, refer to Section 3 in this manual for checking and troubleshooting. See Figure 4-1 for maintenance points.

### 4.2 Preventive Maintenance Checks and Services

#### 4.2.1 Introduction

Preventive Maintenance Checks and Services (PMCS) are performed to keep the Camfire Heater in good operating condition and ready for its primary mission. The checks are used to find, correct, and report problems. PMCS is performed every day the Camfire Heater is in operation, and is done according to the PMCS table provided. Pay attention to **WARNING**, **CAUTION**, and **NOTE** statements. A **WARNING** indicates that someone could be hurt or killed. A **CAUTION** indicates that equipment could be damaged. A **NOTE** may make your maintenance or repair task easier.

Be sure to perform scheduled PMCS. Always perform PMCS in the same order so it becomes habit. With practice, you will quickly recognize problems with the equipment.

Use DA Form 2404, Equipment Inspection and Maintenance Worksheet, to record any discovered faults. Do not record faults that you fix!

#### PMCS PROCEDURES

Table 4-1 lists inspections and care required to keep your equipment in good operating condition. It is arranged so that you can perform before operation checks as you walk around the equipment.

#### Explanation of Table 1 Columns

##### Item Number

Indicates the reference number. When completing DA Form 2404, Equipment Inspection and Maintenance Worksheet, include the item number for the item to check/service indicating a fault. Item numbers appear in the order you must perform the checks/services listed.

##### Interval

Indicates when you must perform the procedure in the procedure column.

- before** - perform before equipment operation
- during** - perform during equipment operation
- after** - perform after equipment has been operated
- weekly** - perform every week
- monthly** - perform each month
- hours** - perform at the noted hourly interval

##### Item to Check/Service

Indicates the item to be checked or serviced.

##### Procedure

Indicates the procedure you must perform on the item listed in Item to Check/Service column. You must perform the procedure at the time specified in the Interval column.

**Not Fully Mission Capable If:**

Indicates faults which will prevent your equipment from performing its primary mission. If you perform procedures listed in Procedure column which show faults listed in this column, do not operate the equipment. Follow standard procedures for maintaining the equipment or reporting equipment failure. If you are not authorized to perform a task, notify unit maintenance.

**Other special entries**

Observe all special information and notes that appear in Table 4-1.

When a check/service procedure is required for both weekly and before intervals, it is not necessary to perform the procedure twice if the equipment is operated during the weekly period.

**COMMON CHECKS AND CLEANING****Cleaning**

Always keep the equipment clean. Remove dirt, sand, and debris from all circuit breakers and hose connections.

**Bolts, nuts, and screws**

Check them for obvious looseness, missing, bent, or broken condition on equipment. If you find a bolt, nut, or screw you think is loose, tighten it or report it to your supervisor.

**Hoses**

Look for wear, damage, and leaks. Ensure clamps are tight. Wet spots show leaks, but a stain around a fitting or connector can also mean a leak. If a leak comes from a loose fitting or coupling, tighten it. If something is broken or worn out, report it to your supervisor.

**LEAKAGE DEFINITION FOR PERFORMING PMCS**

It is necessary for you to know how fluid leakage affects the status of the equipment. The following are the types/classes of leakage an operator needs to know to be able to determine the status of the water system. Learn these leakage definitions and remember - when in doubt, notify your supervisor.

**CAUTION**

Equipment operation is allowable with minor leakages (Class I or II). Of course, consideration must be given to fluid capacity in the system, when in doubt, notify your supervisor.

When operating with Class I or II leaks, continue to check fluid levels as required in your PMCS.

Class III leaks should be reported immediately to your supervisor.

**Class I** - Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

**Class II** - Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.

**Class III** - Leakage of fluid great enough to form drops that fall from items being checked/inspected.

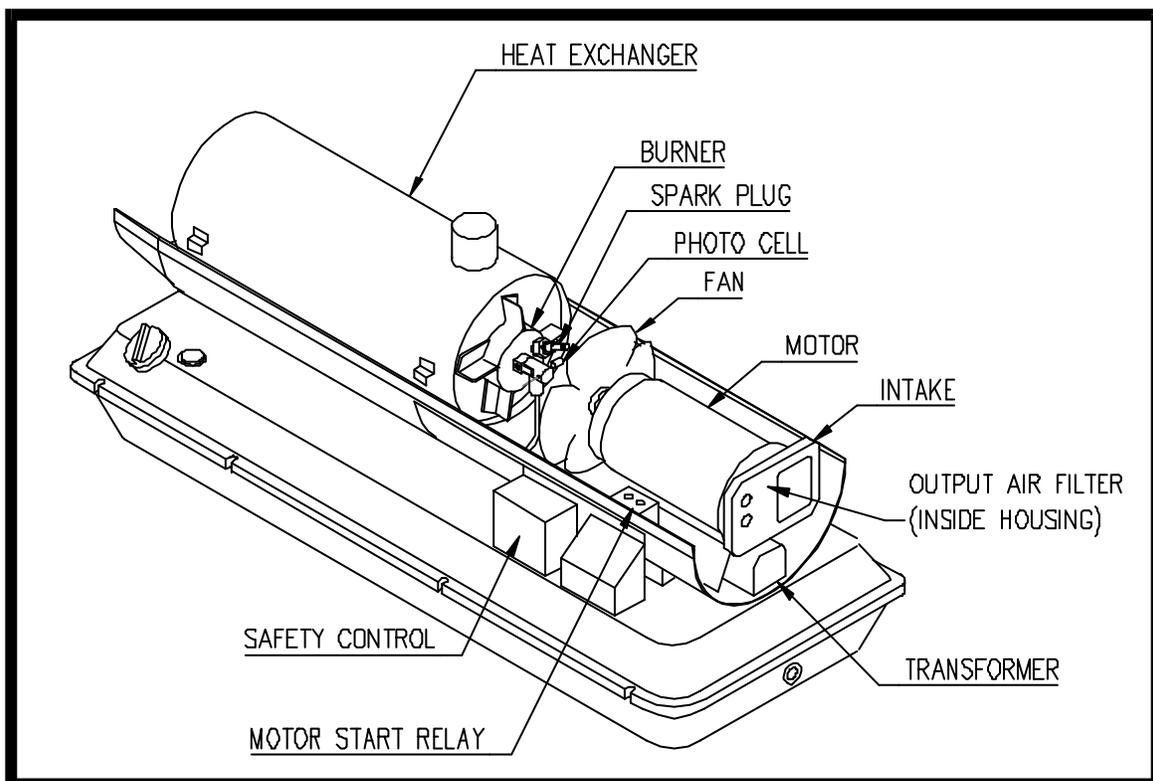


Figure 4-1. Camfire Maintenance Locations

#### 4.2.2 Removing Upper Shell

##### **WARNING**

When necessary to work on the heater with the upper shell removed, be sure to unplug the power source from the heater. If power is required to perform any maintenance procedure, keep away from the fan and spark plug lead to prevent injury or serious electrical shock.

DO NOT operate the heater for extended periods of time with the upper shell removed. If you do, the combustion chamber may be permanently damaged due to overheating.

1. To remove upper shell of the heater, first remove top shroud, inlet and outlet duct adapters and eight screws from split seam of upper and lower shells. Slide upper shell out of frame.

2. To replace the upper shell, align the eight holes located along its lower edge over the eight speed nuts on the lower shell and install the screws. Replace top shroud and duct adapters in the reverse order.

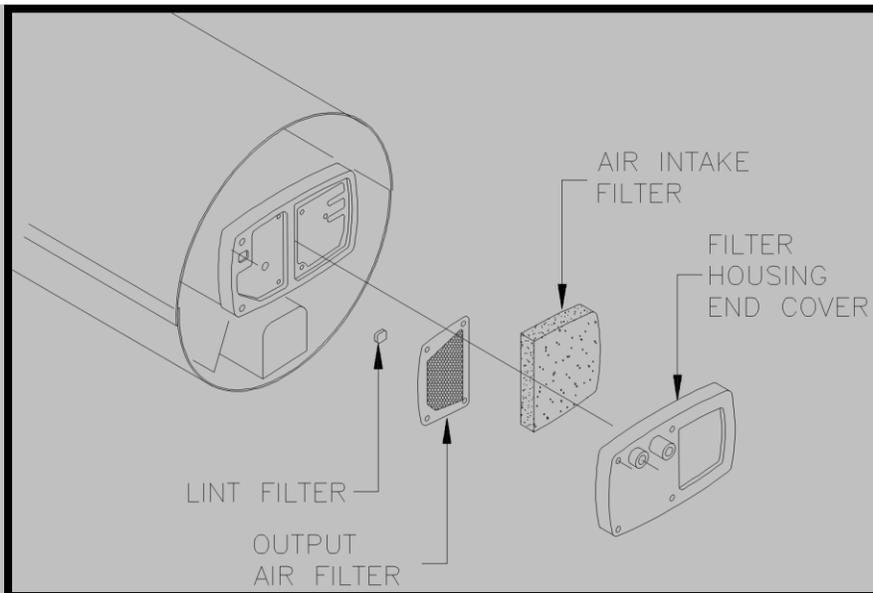
### 4.2.3 Preventive Maintenance Checks and Services

Table 4-1. Camfire Heater Preventive Maintenance Checks and Services

ITEM NO.	INTERVAL	LOCATION  ITEM TO CHECK/SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
1	Every 150 hours	Fuel Tank	Drain the fuel tank after every 150 hours of operation and flush it out with clean fuel. Refill with new, clean fuel.	Fuel tank dirty or fuel contaminated.
2	Before	Air ducts and inlet screen	Check ducts to make sure they are not kinked or obstructed. Remove inlet duct and check inlet screen for debris.	Ducts are blocked, inlet screen has debris
3	Every 40 hours or as conditions dictate	Air Filter	<p>1. Check and clean the intake air filter often. The filter needs cleaning more often if the heater is operated in dusty conditions (see figure).</p> <p>2. To clean the intake air filter, simply pull it out of the housing, wash with mild detergent and hot or cold water, dry thoroughly, and replace in the housing.</p> <p style="text-align: center;"><b>CAUTION</b> Do not oil the filter element</p> <p>3. Replace the output air filter once each heating season.</p> <p>4. To reach the output air filter, remove the five screws that attach the filter housing end cover. Lift the output air filter out (see figure).</p> <p style="text-align: center;"><b>NOTE</b> Cleaning the output air filter may cause a change in the air pump output pressure. If the heater burns improperly after cleaning, have the air pump pressure checked. See Section 4.4.8.</p> <p>5. Replace the output air filter, the filter housing end cover, and the screws and washers.</p>	Air filter dirty or in need of replacement.

ITEM NO.	INTERVAL	LOCATION	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
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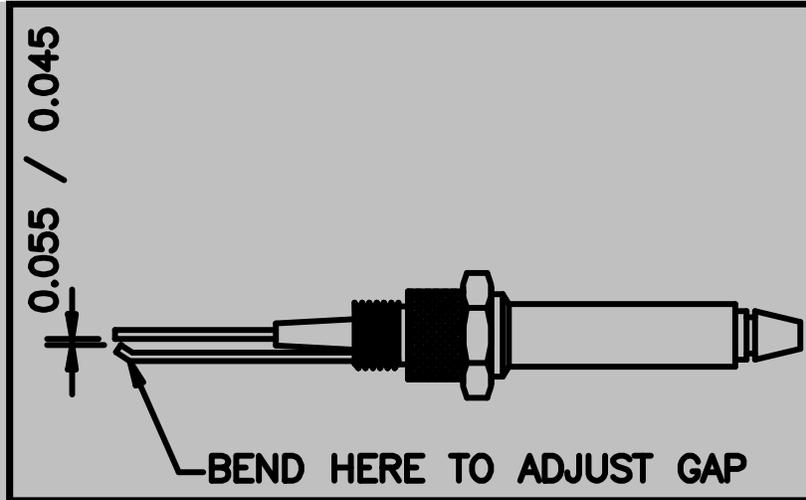
ITEM TO CHECK/SERVICE



4	Every 500 hours	Fan	<p>1. Clean the fan blades after every 500 hours of operation, or whenever you see that they are getting dirty. A build-up of dirt will reduce the air supply and cause faulty operation.</p> <p>2. To clean, wipe the blades with a cloth moistened with kerosene or solvent. Be careful not to bend the blades. Dry the fan thoroughly.</p>	Fan blades dirty or damaged.
5	Every 1000 hours or at beginning of new heating season	Spark Plug	<p><b>WARNING</b> Be sure the heater is not plugged into the outlet. The spark plug wire carries high voltage during heater operation.</p> <p>1. Disconnect the spark plug wire and remove the spark plug (see figure).</p> <p>2. Adjust the gap by bending the outside electrode (see figure).</p> <p>3. Reinstall the spark plug.</p>	Spark plug gap out of adjustment.

ITEM NO.	INTERVAL	LOCATION	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
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ITEM TO CHECK/SERVICE



6	Every day and at beginning of new heating season	Sediment strainer	<ol style="list-style-type: none"> <li>The sediment strainer is located on the heater next to the control panel. Check it daily for dirt and water, or if the trouble-shooting chart indicates.</li> <li>To remove the sediment strainer, loosen the thumb screw at the bottom of the glass bowl.</li> <li>Wipe out the bowl with a lint free cloth.</li> <li>Check the screen for dirt and debris. Shake dirt from screen or clean with diesel fuel or solvent.</li> </ol>	Sediment strainer dirty or damaged.
7	Every 1000 hours or at beginning of new heating season	Burner	<ol style="list-style-type: none"> <li>Be sure the heater is disconnected from the power source, then remove the lead wire from the spark plug. Remove fuel line assembly from burner head. Disconnect the air line from the fitting in the right side of the nozzle adapter.</li> <li>Remove the photocell assembly from its bracket. Then remove the screws that fasten the burner head to the combustion chamber and remove the burner head.</li> </ol>	Burner nozzle clogged, dirty, or otherwise damaged. Photocell dirty or damaged.

ITEM NO.	INTERVAL	LOCATION  ITEM TO CHECK/SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
----------	----------	---------------------------------------	-----------	-------------------------------

3. Remove the nozzle carefully, using a socket wrench. Hold the nozzle adapter with another wrench while removing the nozzle.

**CAUTION**

Do not attempt to open the nozzle passage with a steel drill, a wire, or any other tool. Any change in the nozzle opening will alter the flow characteristics that will affect the heater's performance. If solvent and reverse air flow through the nozzle cannot remove the contamination, replace the nozzle. Always protect the nozzle face whenever the burner head is removed from the heater.

4. Soak the remaining parts of the burner head assembly for one hour in non-flammable liquid cleaning agent. (Do not use kerosene or fuel oil.) Blow dry air through fittings in rear of burner. Blow the nozzle dry through the face (outlet) end only.

5. When reinstalling the burner, place it on the back of the combustion chamber so the fitting for the fuel filter is down, and the spark plug is just above center, on the right. Install the attaching screws and hardware.

6. Connect the fuel line and the air line from the filter housing to its respective fittings on the nozzle adapter.

7. Reinstall the photocell, then install the spark plug and snap the spark plug lead onto the terminal. It must snap, or it may not be tight enough to prevent loosening as the heater is moved.

**CAUTION**

Do not attempt to repair the nozzle. If the nozzle is defective, replace it.

ITEM NO.	INTERVAL	LOCATION ITEM TO CHECK/SERVICE	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
8	Annually	Heat exchanger	<p style="text-align: center;"><b>WARNING!</b> <b>CARBON MONOXIDE POISONING</b></p> <p>The heat exchanger must be inspected annually by qualified service personnel for leaks which could allow dangerous carbon monoxide gas to enter the shelter. Failure to do so, could cause severe injury or death.</p> <p>1. Inspect the heated air out end of the heat exchanger using a good quality light source. Look in the areas where the heat exchanger has turned dark due to the intense heat. Look for cracks or pin holes. If heat exchanger has cracks or pin holes replace immediately.</p>	Heater exchanger has cracks or pin holes.

### 4.3 Special Tools, Equipment and Supplies

The following tools, equipment and supplies should be available for complete servicing of the heater.

1. Air gauge, Part Number CAH-146 (supplied with heater), or any gauge with a 15 PSI pressure range and 1/4 PSI divisions, able to indicate 4 PSI accurately, plus fittings for installation into a 1/8 inch standard pipe-threaded hole.
2. Oil burner nozzle wrench, or any deep 5/8 inch socket wrench.
3. Clean fuel, either kerosene or No. 1 fuel oil.
4. Non-flammable, non-toxic liquid cleaning solvent.

#### **CAUTION**

Fumes of most solvents are poisonous. Use solvent in a well ventilated area.

5. Compressed air is advisable, but not absolutely necessary.

### 4.4 System Maintenance Procedures

#### 4.4.1 General

This section covers replacement of parts, repair and rebuilding of heater components and the making of adjustments. Check to be sure the maintenance of the heater has been done before going into the more extensive service operations. This work should only be carried out by a skilled technician.

#### 4.4.2 Remote Room Thermostat (Inspect/Test)

---

##### INITIAL SETUP

**Tools:**  
Multimeter

**Personnel Required:**  
One

**Materials/Parts:**  
None required

**Equipment Condition:**  
Heater shut down and cool, Remote Room  
Thermostat disconnected from heater

---

##### Inspect

Inspect the thermostat assembly for signs of damage such as nicks, cuts, abrasions. Check coil on top for damage.

##### Test

1. Using a volt ohmmeter, set the meter to the lowest ohm setting or continuity.
2. Place the probes on pin 1 and pin 2. At room temperature, with the dial turned to the lowest setting, the circuit should be open.
3. Turn the dial to maximum setting there should be continuity. If not replace the thermostat assembly.



4. If you suspect that the thermostat is preventing the heater from starting when it is set to call for heat, unplug thermostat. Set thermostat switch to continuous.

### 4.4.3 Ignition Transformer (Inspect/Test)

---

#### INITIAL SETUP

**Tools:**  
None required

**Personnel Required:**  
One

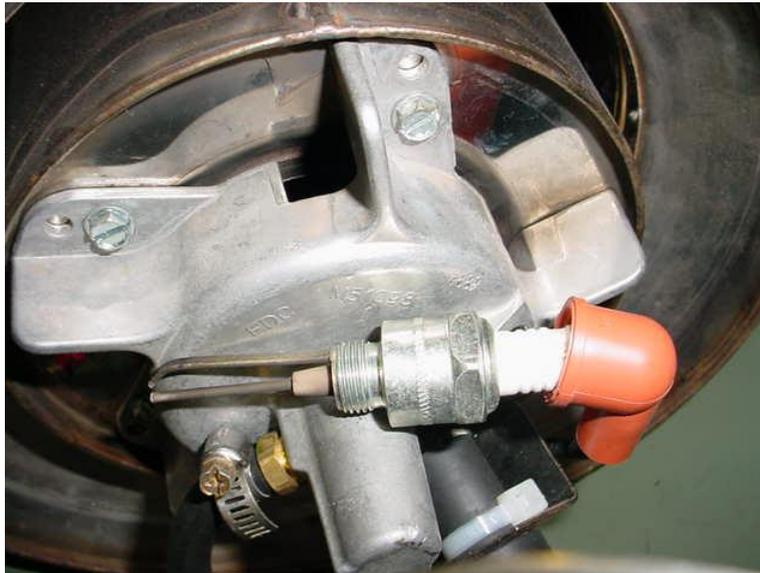
**Materials/Parts:**  
None required

**Equipment Condition:**  
Heater shut down and cool, heater unplugged

---

#### TEST

1. Connect the transformer lead to a properly gapped spark plug. The gap should be 0.050 inch, plus or minus 0.005 inch.
2. Establish a good ground between the spark plug and the heater. Be careful not to let any part of your person become a portion of the ground circuit.
3. Move the ON/OFF switch; observe the spark between the plug's electrodes. If the ground is good and spark does not jump between the electrodes, check the voltage to the transformer in the next step.



4. Remove the control panel.

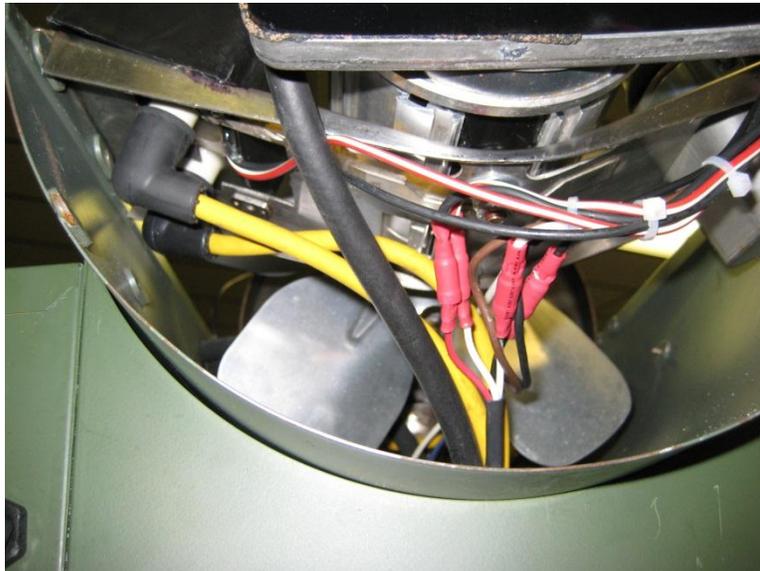
#### **WARNING**

220 VAC is present in the following steps. Take proper precaution against electrical shock before proceeding.

5. Plug the heater in and turn power switch to on.
6. Place probes on (top to bottom) #2 blue and #6 white as shown in the photo below.
7. When the heater starts there should be 220 VAC. If not see section 4.4.9 test and/or replace.



8. To replace the transformer, unplug the heater, remove three screws that attach the inlet screen.
9. Remove two screws that attach the transformer to the motor mounting bracket.



10. Remove ignition wires from the transformer.
11. Attach ignition wires to new transformer
12. Reinstall the attaching screws.

#### 4.4.4 Checking Motor Starting Circuits (Test)

---

##### INITIAL SETUP

**Tools:**  
Multimeter

**Personnel Required:**  
One

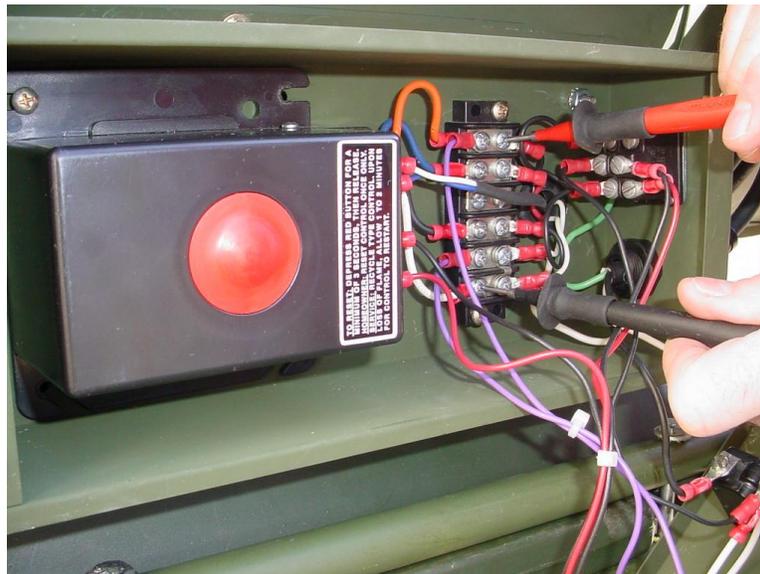
**Materials/Parts:**  
None required

**Equipment Condition:**  
Heater shut down and cool, power cable disconnected

---

##### TEST

1. Remove control panel as detailed in the transformer section.
2. Turn main switch on.
3. Place test probes on terminals #1 (white) and #6 (orange).
4. Verify that measured voltage is 220 VAC.



5. The heaters have  $\frac{1}{4}$  horsepower motors and separate starting capacitor. See the wiring diagram, Figure 4-2.
6. Remove the terminals from the top of the capacitor. Using a volt ohm meter check the resistance across the capacitor terminals. If it is shorted or open replace it.

#### CAUTION

Avoid touching the bare wires or the exposed wire terminals.

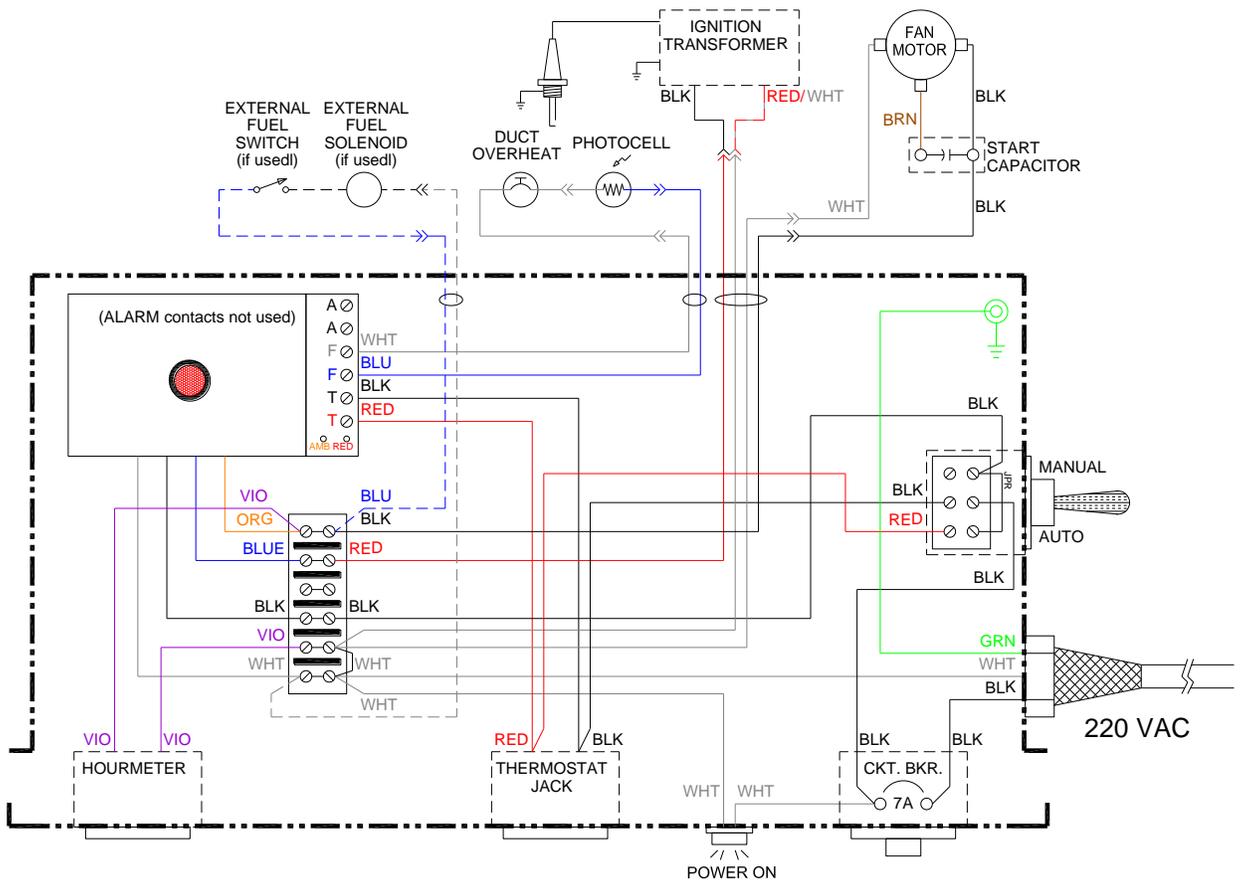


Figure 4-2. Wiring Diagram

#### 4.4.5 Fan Service

---

##### INITIAL SETUP

**Tools:**

Phillips screwdriver

**Personnel Required:**

One

**Materials/Parts:**

None required

**Equipment Condition:**

Heater shut down and cool. Power disconnected.

---

Replace a damaged or bent fan. Do not attempt repair except as a temporary emergency measure. Loosen the two setscrews to remove the fan from the motor shaft. Only use replacement fan P/N CAH-EUR-113. This is important in order to retain the air flow and combustion characteristics of the heater. Check for proper fan location on the motor shaft. Make sure the fan is in the same position and location as before it was removed. See Figure 4-3.

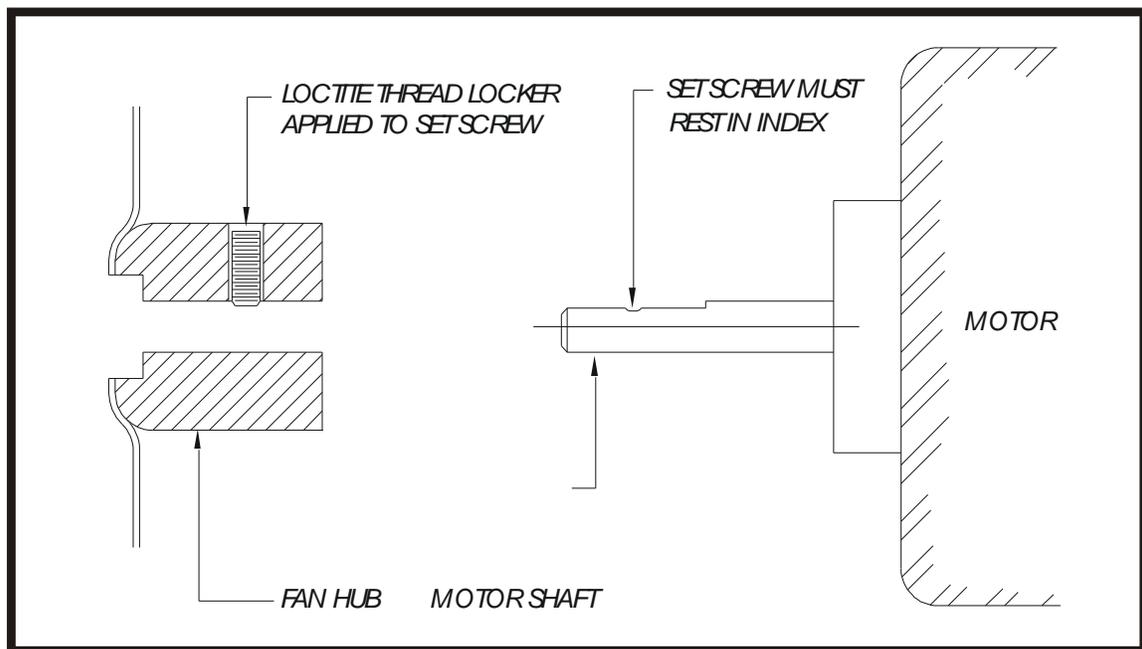


Figure 4-3. Location of Fan on Shaft

#### 4.4.6 Sediment strainer Service

---

##### INITIAL SETUP

**Tools:**  
None required

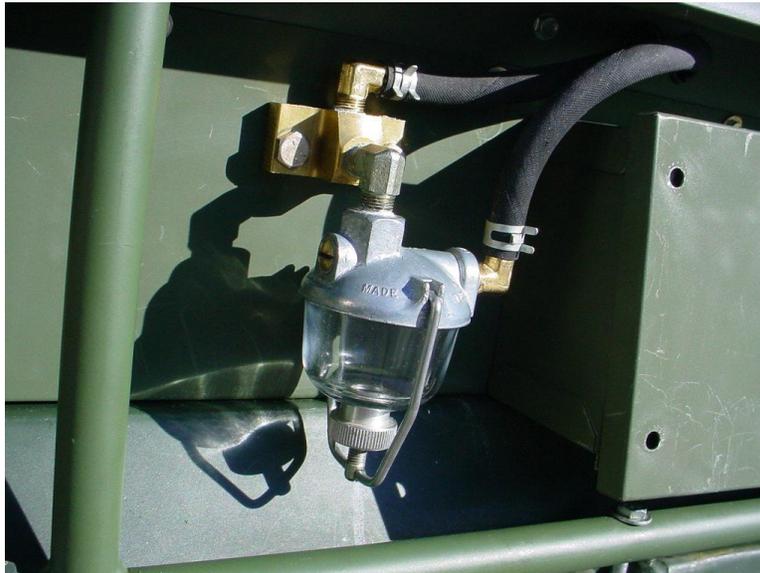
**Personnel Required:**  
One

**Materials/Parts:**  
None required

**Equipment Condition:**  
Heater shut down and cool. Power disconnected.

---

1. Remove the sediment strainer from the heater and clean it as described in Section 4.2.3.
2. Before reinstalling the sediment bowl check the gasket and screen. Be sure the gasket is in good condition, not cut or cracked. Replace a damaged gasket.
3. Reinstall the sediment strainer according to Section 4.2.3.



#### 4.4.7 Burner Head Service (Clean)

---

##### INITIAL SETUP

**Tools:**

3/8" open wrench  
5/8" socket

**Materials/Parts:**

Dry cleaning fluid

**Personnel Required:**

One

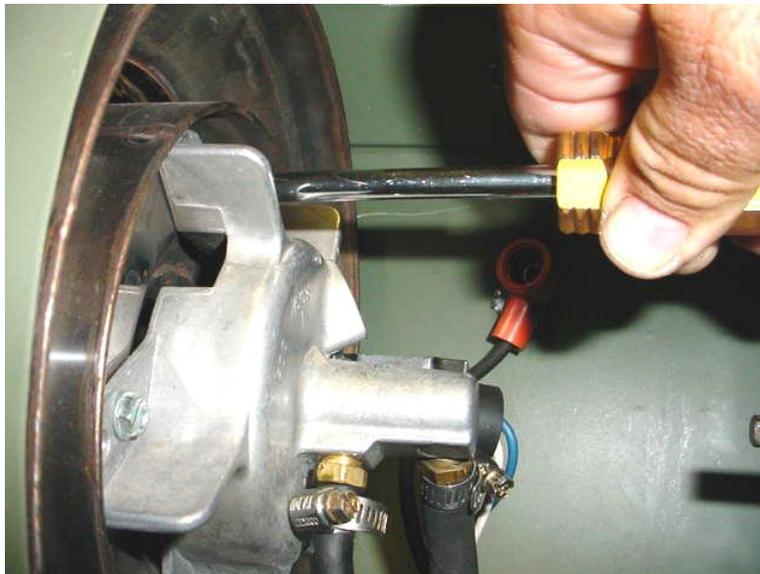
**Equipment Condition:**

Heater shutdown and cool. Power cable disconnected. Upper cover removed.

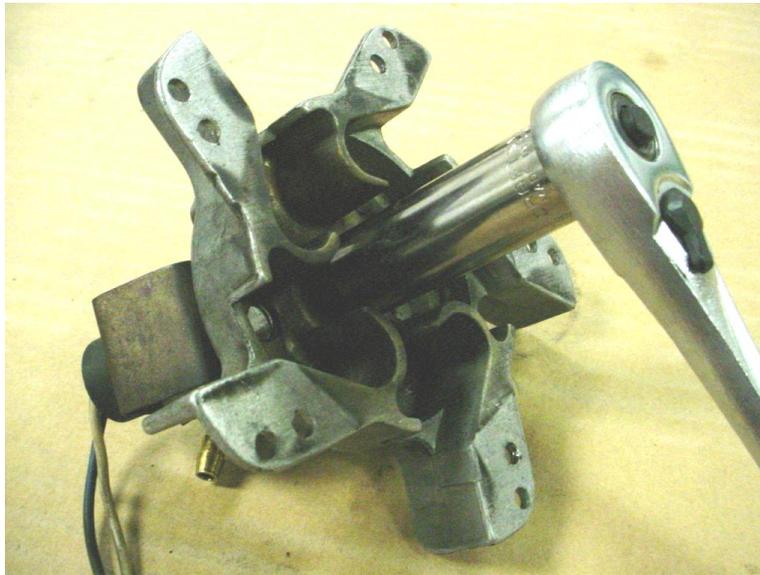
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##### CLEAN

1. Take out the spark plug and remove the burner head. Clean the entire burner head as described in Section 4.2.3. Remove burner head.



2. Remove the nozzle with a 5/8" socket. Blow out fuel and air passages in the burner head



3. Remove the rubber gasket, two washers and spring from nozzle.



4. Using a 3/8" open wrench and 5/8" socket remove nozzle center section.



### **CAUTION**

Do not use metal picks or abrasives, they will damage the nozzle. Do not use a drill to open up the passages.

5. Clean internal components with dry cleaning fluid.
6. Left to right, stem, swirler, cap.



## REASSEMBLE

### CAUTION

Do not over tighten. Apply no more than 10 in/lbs.

1. Put swirler on stem then into cap.



#### 4.4.8 Air Pump Repair (Inspect, Test, Repair)

---

##### INITIAL SETUP

**Tools:**

General Mechanics Tool Kit  
Pressure gauge

**Materials/Parts:**

None required

**Personnel Required:**

One

**Equipment Condition:**

Heater shutdown and cool. Power cable disconnected. Upper cover removed.

---

##### GENERAL

##### NOTE

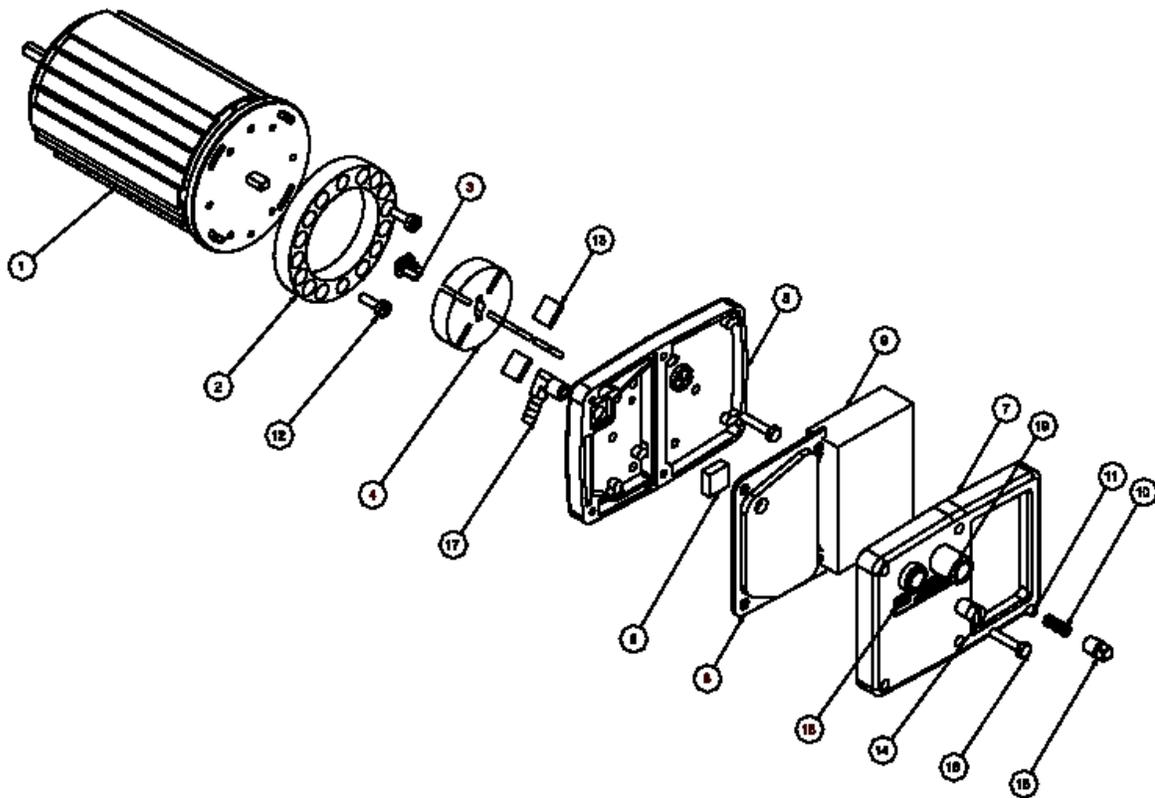
Because of the close tolerance and critical positioning of the parts, we recommend that only skilled technician attempt any repair of the air pump.

1. Handle all pump parts with care and keep them clean. The pump parts are made with close tolerances. Dirt and oil on the pump parts will hinder the performance of the pump.

##### INSPECT

The heater air pump consists of a rotor with four carbon blades, rotating inside a pump body. The rotor is directly driven by the motor, and is supported by the ball-bearing end of the motor.

One of the pump end plates is the motor's back plate. The other pump end plate is a part of the housing for the air intake and outlet filters.



1. Remove the end cover and take out the intake and outlet air filters and the lint filter.



2. Remove output filter, and clean by tapping lightly and brushing with a soft bristle brush.



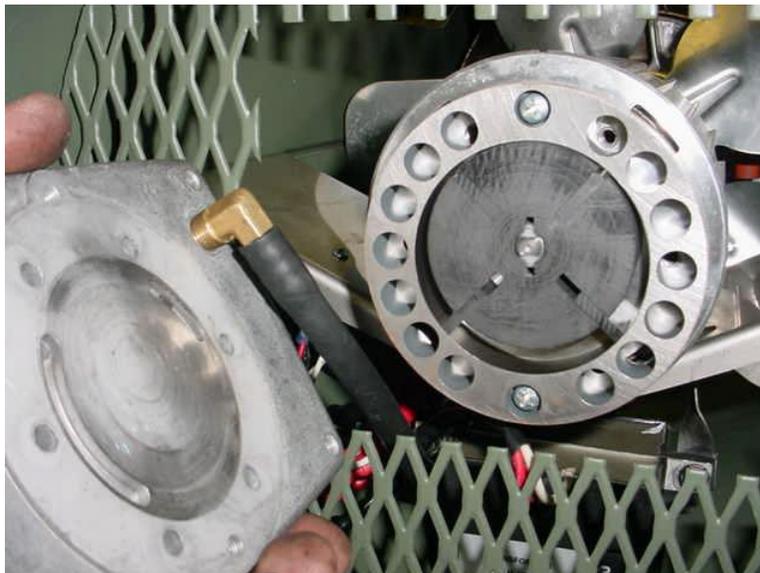
3. Remove lint filter and clean by flicking back and forth with a finger to remove any debris.



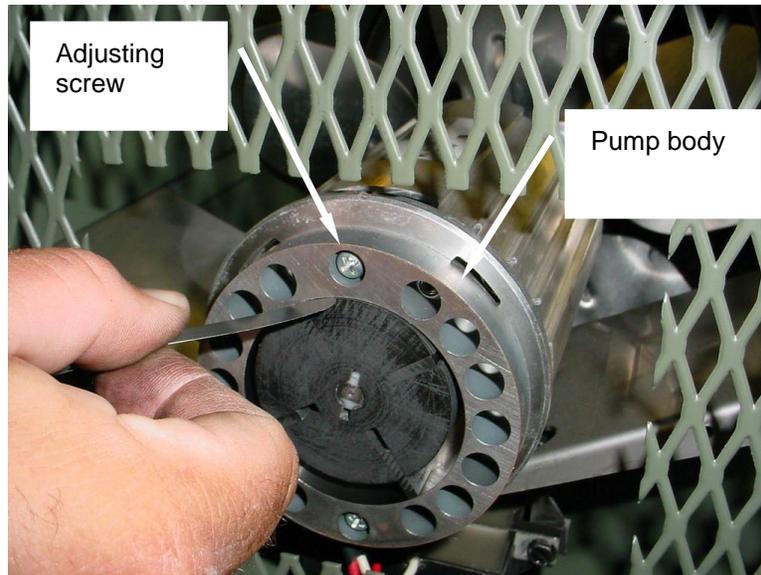
4. Remove the six screws that hold down the front cover to the pump body.



5. Inspect carbon blades, and rotor for signs of wear, chipping or broken or missing blades.
6. Inspect outer cover for deep grooves or gouges.
7. Worn out or sticking carbon blades cause loss of air pressure. If the blades are worn or are sticking in the rotor slots, replace them. (It is not necessary to remove the rotor or the pump body to replace the carbon blades.)



8. Measure the clearance with a feeler gauge. It should be 0.005 to 0.006 inch. If the clearance is not within this range, adjust by loosening the two adjusting screws and moving the pump body.
9. Use a new rotor only if deep grooves or uneven wear appear on the surfaces. Check the insert for wear, and replace if worn or loose.



### REASSEMBLING THE AIR PUMP

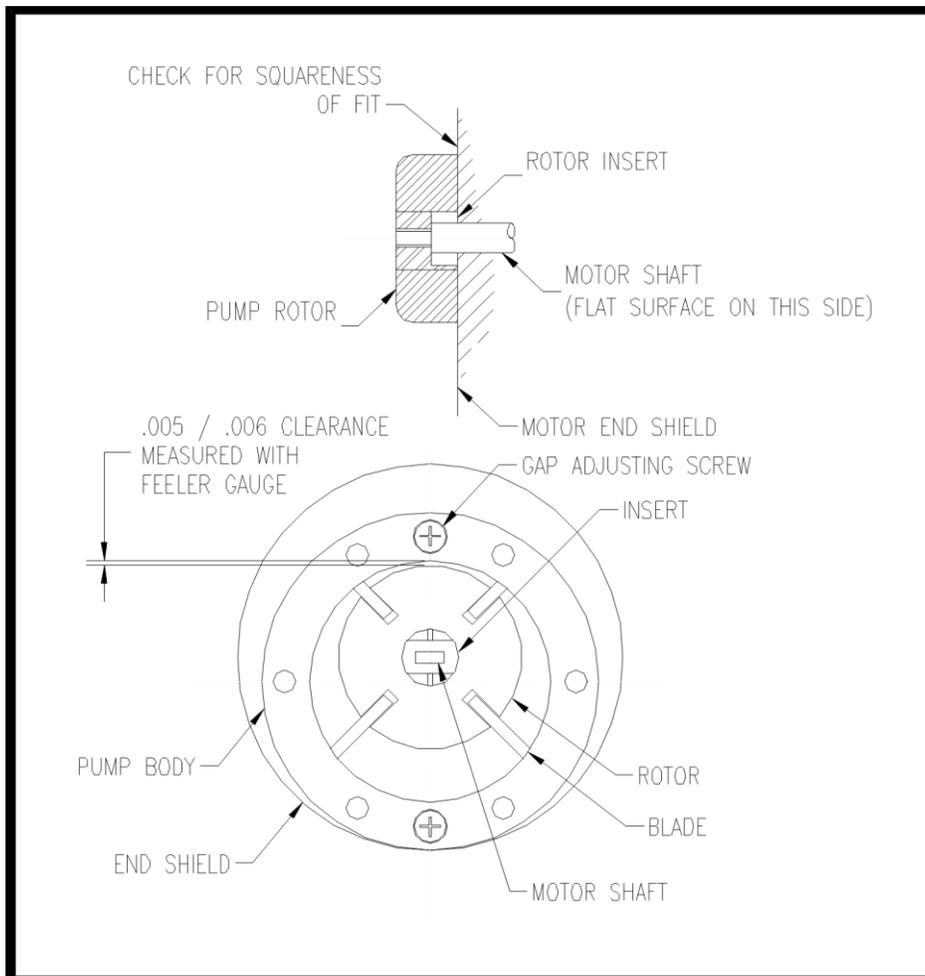
1. Install the insert in the pump rotor as shown in Fig. 4-4, the assemble rotor on the motor shaft. When installing the rotor, take care to keep it perpendicular to the motor shaft. Attach the pump body to the motor with the two recessed screws that were removed to take it off.

2. Adjust the pump body to provide 0.005 to 0.006 inch clearance at the point shown in the figure 4-4. Measure the clearance with a feeler gauge. Spin the motor by hand to be sure the rotor does not rub on the pump body. The proper clearance must be maintained. Be sure the recessed screws are tight after adjusting.
3. Insert carbon blades as described previously.
4. Install the end cover, using the six screws that were removed. Reconnect the air line.

**CAUTION**

Do not over tighten the valve stem or you may crack the pump housing.

Remove the gauge and replace the plug.



*Figure 4-4. Checking clearance of air pump rotor*

## TEST

1. Remove the plug from the air filter housing, and install the pressure gauge into the hole. (NOTE: some heater models come with a pressure gauge installed)
2. Start the heater. (NOTE: fuel does not have to be present in the tank for this pressure check and adjustment.)



3. Pump pressure must be 5.0 PSI plus or minus 1/4 pound for most efficient performance. If the pressure is not within this range, adjust the pressure relief valve.

**WARNING! Do not adjust the pump pressure higher than the recommended amount. Failure to do so can result in higher than normal heat exchanger temperatures, which can cause the heat exchanger to fail allowing dangerous Carbon Monoxide gas to enter the shelter. Failure to follow these instructions could cause serious injury or death.**

**Note: Adjusting the air pressure higher than the recommended amount will void your warranty.**

4. To adjust pump pressure, use a large flat blade screwdriver, large enough to span the slot in the valve stem, screw the valve stem in CW to raise the pressure, out CCW to lower.

## **REASSEMBLING THE HEATER**

1. Put the heater back together in the reverse order of disassembly.
2. Check all wiring to be sure it agrees with the wiring diagram. Be sure all electrical connections are tight.
3. Tighten the connections at both ends of the air line, and tighten the connection where the sediment strainer is assembled to the burner head.
4. Make sure the electrode lead is snapped on to the spark plug and the transformer output terminal.
5. Be sure all parts are in place and the screws are tight before attempting to use the heater.

#### 4.4.9 Safety Control Circuit Testing (Test, Clean)

---

##### INITIAL SETUP

**Tools:**

General Mechanics Tool Kit

**Personnel Required:**

One

**Materials/Parts:**

None required

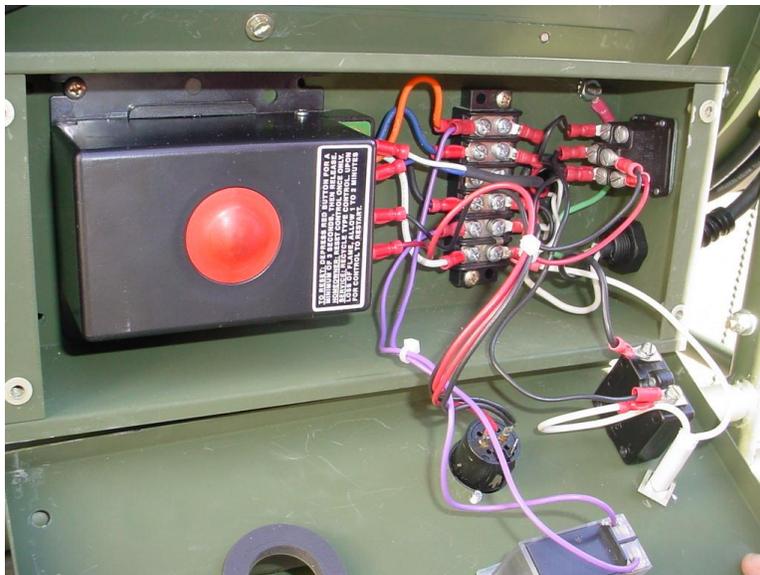
**Equipment Condition:**

Heater shutdown and cool. Power cable disconnected. Upper cover removed.

---

##### TEST

1. Remove 4 screws holding the control box. Pull away from the electrical panel but do not disconnect any electrical connections. Make sure thermostat switch is in off position.

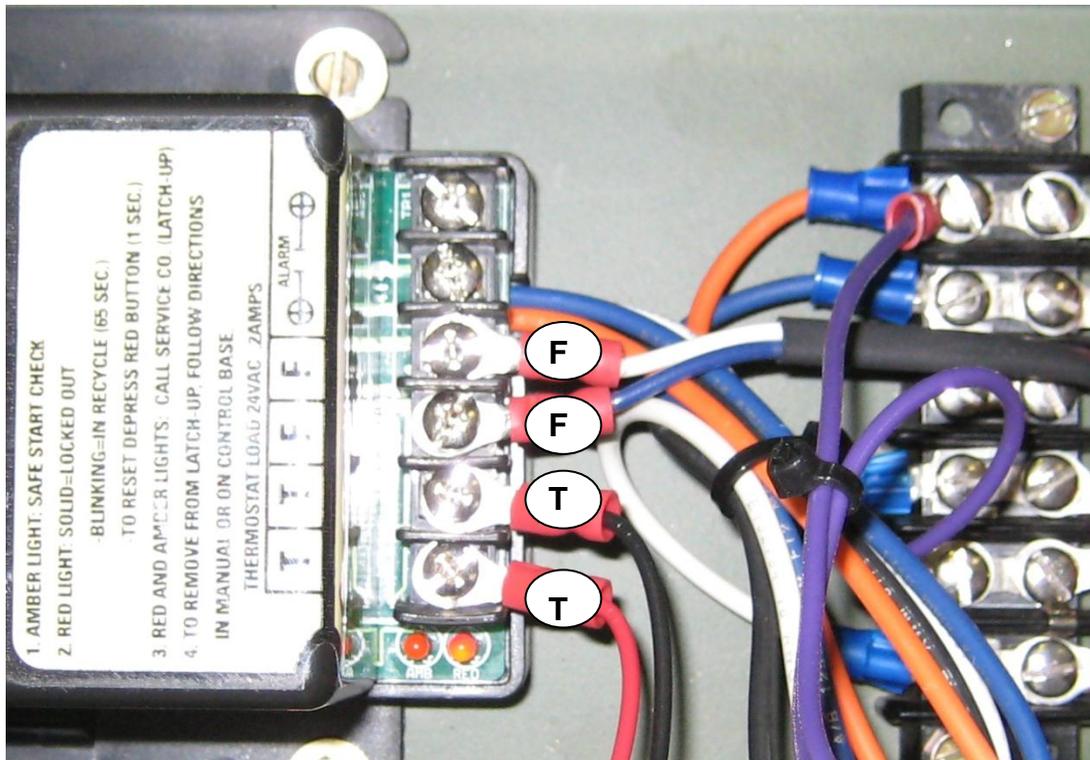


2. **Power Circuits.** Attach one test lead of a voltmeter to #1 (white) on the terminal block. Plug heater in and switch on. Touch the other test lead to #3 black wire. Verify that 220 VAC is present. This is the power to the safety control.
3. The safety control has two circuits that send power to systems in the heater. The orange wire is for the motor and the blue wire is the ignition transformer.
4. Attach one test lead of a voltmeter to #1 (white) on the terminal block. Plug heater in and switch on. Touch the other test lead to #6 orange wire on the left side of the terminal block. This is the power to the motor. Then to the #5 blue wire on the left side of the terminal block. This is the power to the ignition transformer.

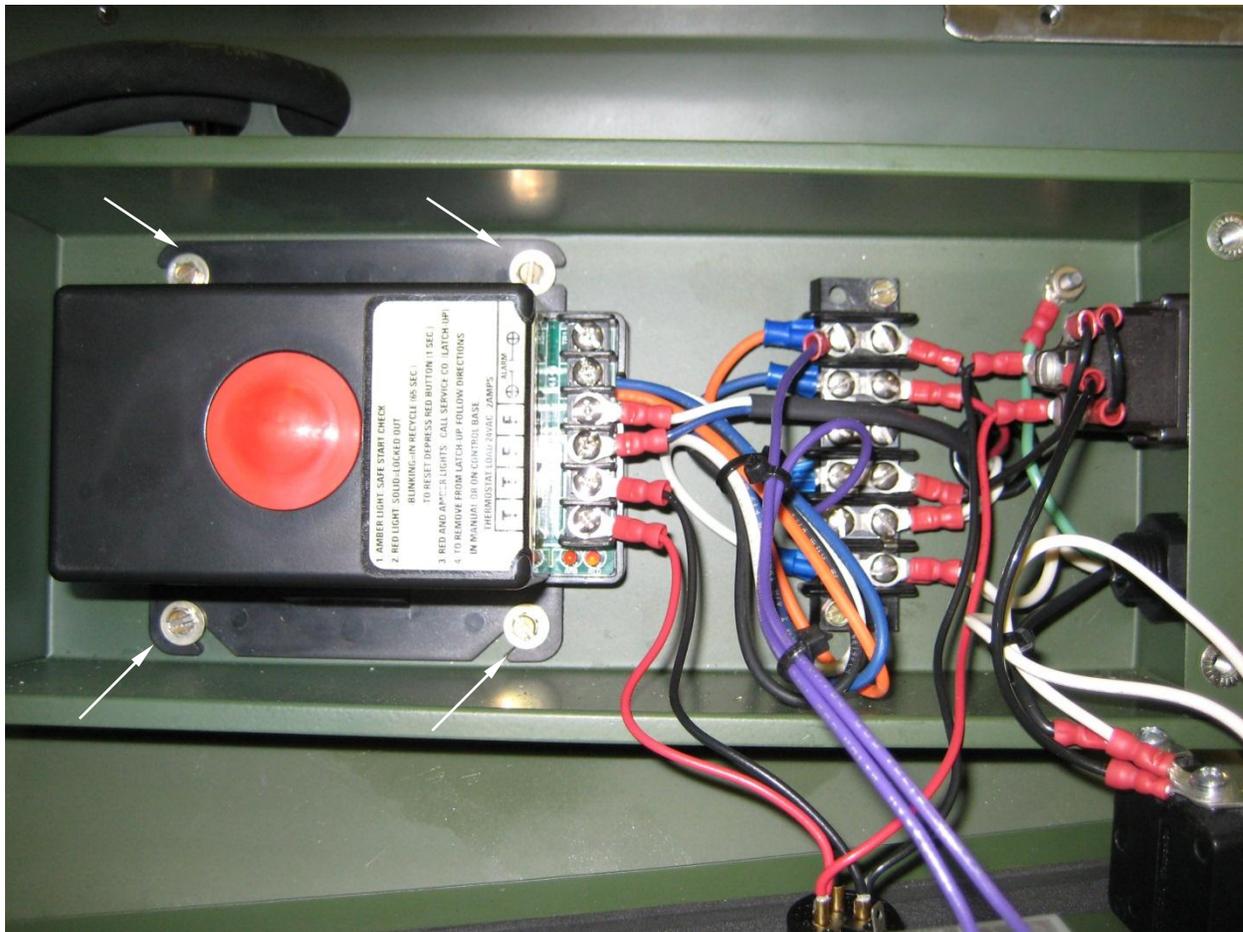


5. If you have power on #6 but not #5, replace the safety control.
  6. **Control Circuits.** If there is no power on #5 and #6 check the control circuits as follows:
    - “T” Circuit, this the thermostat circuit. (see photo below) Jumper T and T. Start heater. If Heater starts, check wires and connections going to the safety control from the thermostat circuit.
    - “F” Circuit, this is the flame failure/overheat circuit. Remove one of the wires from the F terminal. If the heater starts, check the photocell and over heat switch.
- If the heater does not start after checking both circuits, replace the safety control.

**Note:** The “Alarm” terminals on the safety control are not used in this application.



7. Replace the safety control by loosening the screws attaching its base to the mounting box assembly only enough to disconnect the 4 electrical leads (black, white, blue and orange.) from the remainder of the electrical circuit.
8. After disconnecting the electrical leads, withdraw the safety control and make the electrical connections as shown in the wiring diagram shown in section 6-1.
9. Test-fire the heater to make sure it will function properly. If it does not, check all wiring connections according to the wiring diagram.



## CLEANING

1. Clean the safety control flame sensor by wiping the face of the photo cell with a soft cloth.
2. Replace the safety control flame sensor by disconnecting the wires. Loosen the flame sensor clamping screws, then remove the one screw attaching the flame sensor to the mounting bracket. Slide out the flame sensor. Install the new unit in the reverse order of removal.
3. Replace the safety control by loosening the 4 screws attaching its base to the mounting box assembly only enough to disconnect the 4 electrical leads (black, white, blue and orange.) from the remainder of the electrical circuit.
4. After disconnecting the electrical leads, withdraw the safety control and make the electrical connections as shown in the wiring diagram found in section 6-1.
5. Test-fire the heater to make sure it will function properly. If it does not, check all wiring connections according to the wiring diagram.

#### 4.4.10 Photocell (Test)

---

##### INITIAL SETUP

**Tools:**  
General Mechanics Tool Kit

**Personnel Required:**  
One

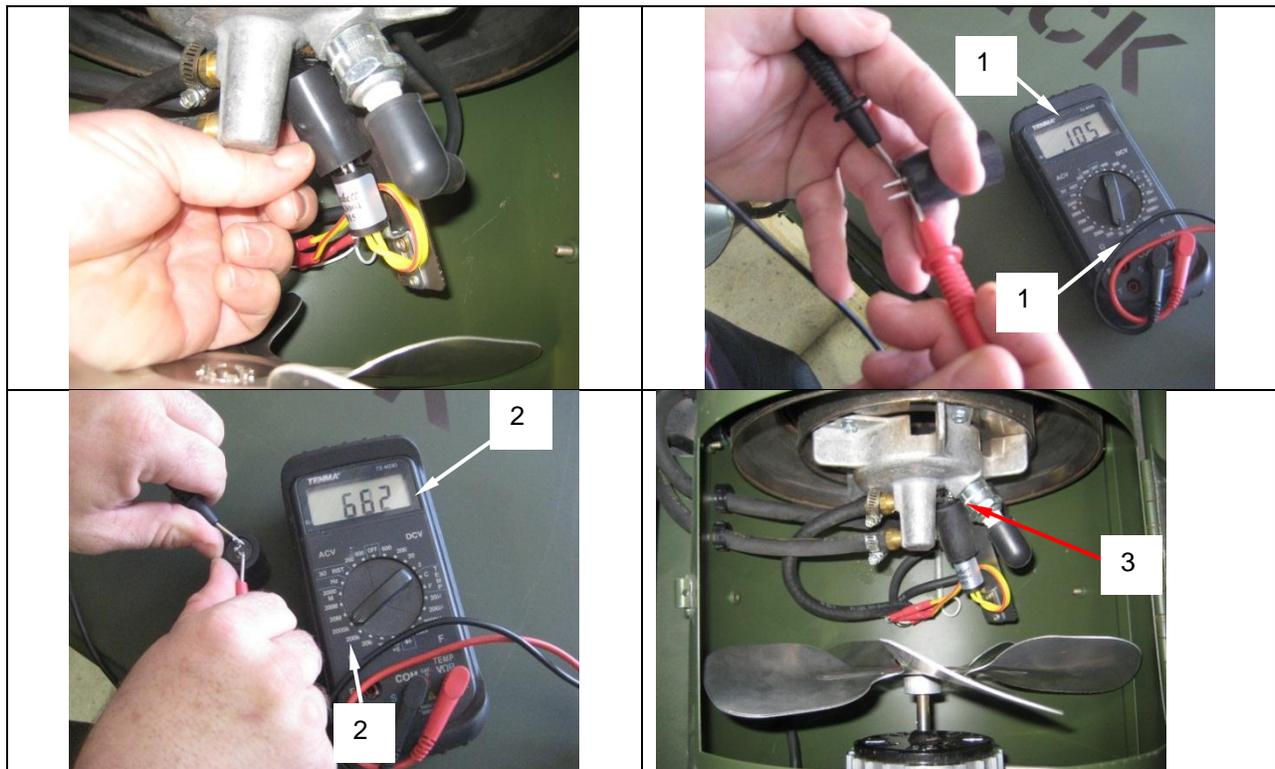
**Materials/Parts:**  
None required

**Equipment Condition:**  
Heater shutdown and cool. Power cable disconnected. Access hatch open.

---

##### TEST

1. Remove photocell from the photocell holder.
2. Connect ohmmeter test leads to photocell pins.
3. Hold open end of photocell towards a light source (a 60-watt light bulb or direct sunlight). The resistance indicated on the ohmmeter should be low (**1**). (K ohms)
4. Block off light completely by covering the open end of the photocell. Within 10 seconds the resistance indicated should be high (**2**). (Meg Ohms)
5. Replace photocell if there is no change in resistance during this procedure. **Note:** make sure photocell is aligned properly so it is pointing towards the view port (**3**) in the burner head





Chapter 5  
Illustrated Parts Listing

## 5. Illustrated Parts Listing

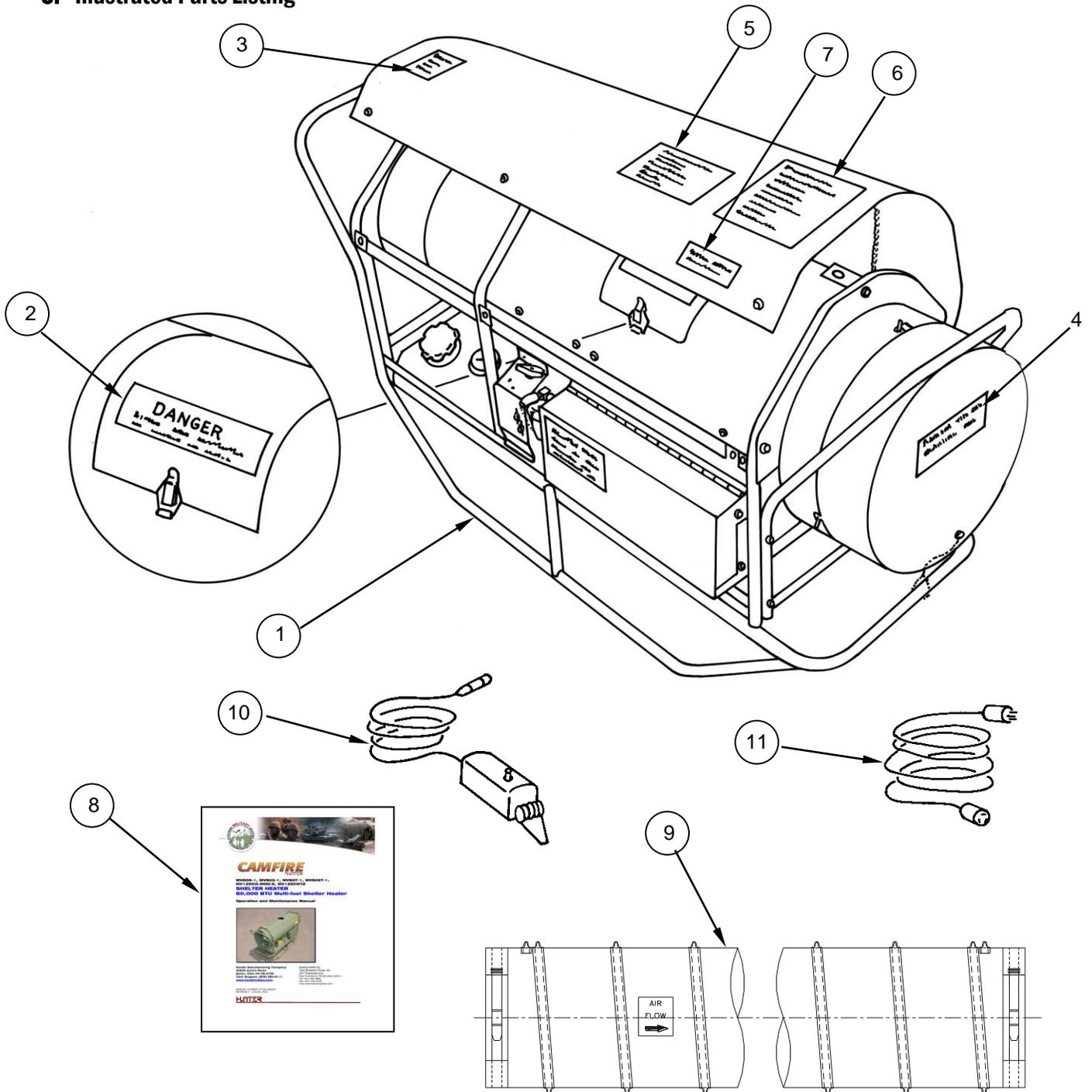


Figure 5-1. MV60-EU Labels and Accessories

Table 5-1. MV60 Labels and Accessories

**PARTS LIST**  
**MV60-EU LABELS AND ACCESSORIES**

ITEM	QTY	PART NO	DESCRIPTION
1	1	53313	I.D. PLATE
2	1	53328	DECAL, FAN COMPARTMENT
3	1	53330	DECAL, DUCT TEMP
4	1	53331	DECAL, STORAGE CAP
5	1	53332	DECAL, START UP PROCEDURE
6	1	53334	DECAL, OPERATING INSTRUCTIONS
7	1	53340	DECAL, VOLTAGE
8	1	53644	TECHNICAL MANUAL
9	1	CAH-1015	DUCT, 12' X 15' (OPTIONAL)
10	1	CAH-134-1	ROOM THERMOSTAT
11	1	CAH-133-3	POWER CABLE

**Service Kits and Accessories (not shown)**

ITEM	QTY	PART NO	DESCRIPTION
		CAH-1081	MV SERIES SPARE PARTS KIT
		CAH-151	12" INLET "Y" ADAPTER
		CAH-150	12" OUTLET "Y" ADAPTER
		CAH-153	12"X6"X6"X6" THREE WAY ADAPTER
		CAH-146	PRESSURE GAUGE



## MV60-2 FULL ASSEMBLY

			PARTS LIST	
ITEM	QTY	PART NO		DESCRIPTION
1	1	53613		FUEL TANK BRACKET
2	1	COMBUSTION CHAMBER ASSEMBLY		COMBUSTION CHAMBER ASSEMBLY
3	1	CAH-132		STACK EXTENSION
4	1	53477		ACCESSORY PLUG
5	1	53653		CONTROL BOX ASSEMBLY
6	1	53471		TOP COVER
7	1	53463		FUEL TANK
8	1	53464		LOWER FRAME
9	1	53465		UPPER FRAME
10	2	53470		HANDLE
11	1	53468		OUTPUT ADAPTER
12	1	53469		INPUT ADAPTER
13	1	53443		INPUT ADAPTER WIRE SCREEN
14	1	53455		OVERHEAT SWITCH BRACKET ASSEMBLY
15	10	CAH-103-2		PRESS-FIT GLIDE, ROUND, FITS .58" TO .68" ID & 3/4" OD TUBE
16	4	CAH-103-1B		WOODEN INSERT (FRAME) 5/8 DIA X 6-1/2" LONG
17	4	CAH-103-1A		WOODEN INSERT (HANDLE) 5/8 DIA X 5" LONG
18	1	CAH-124-6		OVERHEAT SWITCH
19	3	53479		RUBBER BUMPER
20	21	MS51849-54		#8-32 UNC X 1/2 LG HEX HD SLOTTED MACHINE SCREW
21	21	MS27183-41		3/16 ID X 7/16 OD FLAT WASHER
22	3	CAH-131-7		1/4 TURN RECEPTACLE
23	1	CAH-102-2 (D)		RUBBER GROMMET
24	1	MIL-H-13444-.19-12		HOSE, RUBBER, FUEL & OIL TYPE I, 3/16 ID
25	1	MIL-H-13444-.19-21		HOSE, RUBBER, FUEL & OIL TYPE I, 3/16 ID
26	1	53650		SEDIMENT BOWL ASSEMBLY
27	3	170607		CLAMP HOSE MICRO GEAR
28	3	CAH-131-6		PUSH-ON RETAINER
29	8	CAH-142		#10-16 X 1/2 LG HEX HD SLOTTED TAPPING SCREW
30	8	CAH-139(D)		1/4-20 UNC HEX LOCKNUT W/NYLON INSERT
31	16	CAH-138(D)		1/4 FLAT WASHER
32	8	CAH-137(D)		1/4-20 UNC HEX HD BOLT X 3 LG
33	8	CAH-137-1		#10-32 UNF HEX HD SLOTTED MACHINE SCREW X 1-7/8 LG
34	20	CAH-138-1		#10 FLAT WASHER
35	12	CAH-139		#10-32 UNF HEX LOCKNUT W/NYLON INSERT
36	3	CAH-131-5		1/4 TURN STUD
37	6	CV-102-3		WASHER 1/4 LOCKING EXTERNAL TOOTH
38	4	CV-102-2		1/4-20 UNC HEX HD BOLT X 3/8 LG
39	2	53315		DECAL SMALL CAMFIRE BY HUNTER
40	1	53329		DECAL WARNING FUEL USE
41	1	53340		DECAL WARNING 110VAC ONLY
42	1	53330		DECAL WARNING OUTLET RING
43	1	53651		DECAL START UP PROCEDURE
44	1	CAH-136		SPLIT RING
45	1	53334		DECAL OPERATING INSTRUCTIONS
46	1	53655		EXTERNAL FUEL SUPPLY ASSEMBLY
47	1	CAH-105-2		WIRING GROMMET (MEDIUM)
48	1	3777		PLUG BUTTON (FITS 1/2" DIA. HOLE)
49	1	53331		DECAL STORAGE CAP
50	4	MS35335-32		WASHER, LOCK, EXT TOOTH, #10, CARBON STEEL

\*ITEM #46 = 53655 ~ EXTERNAL FUEL SUPPLY ASSEMBLY TO BE USED ON MV60X-2 (53457-10) ONLY  
 \*ITEM #48 = 3777 ~ PLUG BUTTON (FITS 1/2" DIA. HOLE) TO BE USED ON MV60S-2 (53457-8) ONLY  
 REPLACEMENT PART NO. 53507 ~ ACCESSORY PLUG ASSEMBLY (TO INCLUDE ITEMS 4, 44 AND 49)  
 REPLACEMENT PART NO. 53508 ~ TOP COVER ASSEMBLY (TO INCLUDE ITEMS 6, 40 THRU 43 AND 45)

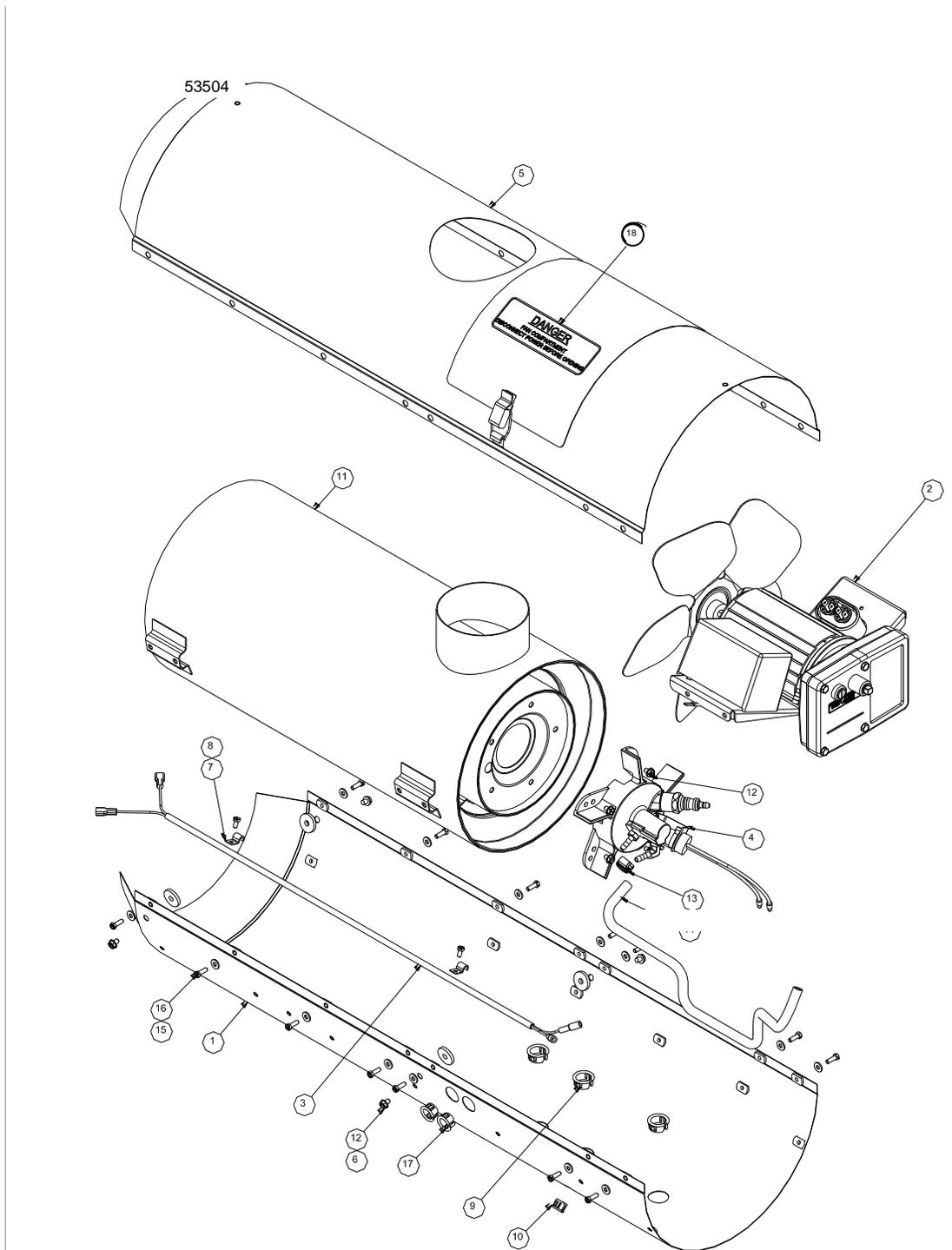


Figure 5-3. COMBUSTION CHAMBER ASSEMBLY

Table 5-2. Combustion Chamber Assembly

**PARTS LIST  
COMBUSTION CHAMBER ASSEMBLY**

ITEM	QTY	PART NO	DESCRIPTION
1	1	53466	LOWER SHELL
2	1	53745	MOTOR/PUMP & BRACKET ASSEMBLY
3	1	CAH-109-3	ELECTRICAL CONDUIT ASSEMBLY
4	1	53649	BURNER HEAD ASSEMBLY
5	1	53467	UPPER SHELL
6	4	CAH-101(D)	SPACER
7	2	CAH-109-1	CONDUIT CLAMP
8	2	CAH-141	#8-18 X 5/16 LG HEX HD SLOTTED TAPPING SCREW
9	3	CAH-105-1	WIRING GROMMET (LARGE)
10	1	CAH-105	WIRING GROMMET (SMALL)
11	1	CAH-111-2	COMBUSTION CHAMBER
12	9	CAH-142	#10-16 X 1/2 LG HEX HD SLOTTED TAPPING SCREW
13	1	170607	CLAMP HOSE MICRO GEAR
14	1	51965-24	HOSE RUBBER REINFORCED 3/16" I.D.
15	14	MS27183-41	3/16 ID X 7/16 OD FLAT WASHER
16	14	MS51849-54	#8-32 UNC X 1/2 LG HEX HD SLOTTED MACHINE SCREW
17	2	CAH-105-2	WIRING GROMMET (MEDIUM)
18	1	53328	DECAL DANGER FAN COMPARTMENT

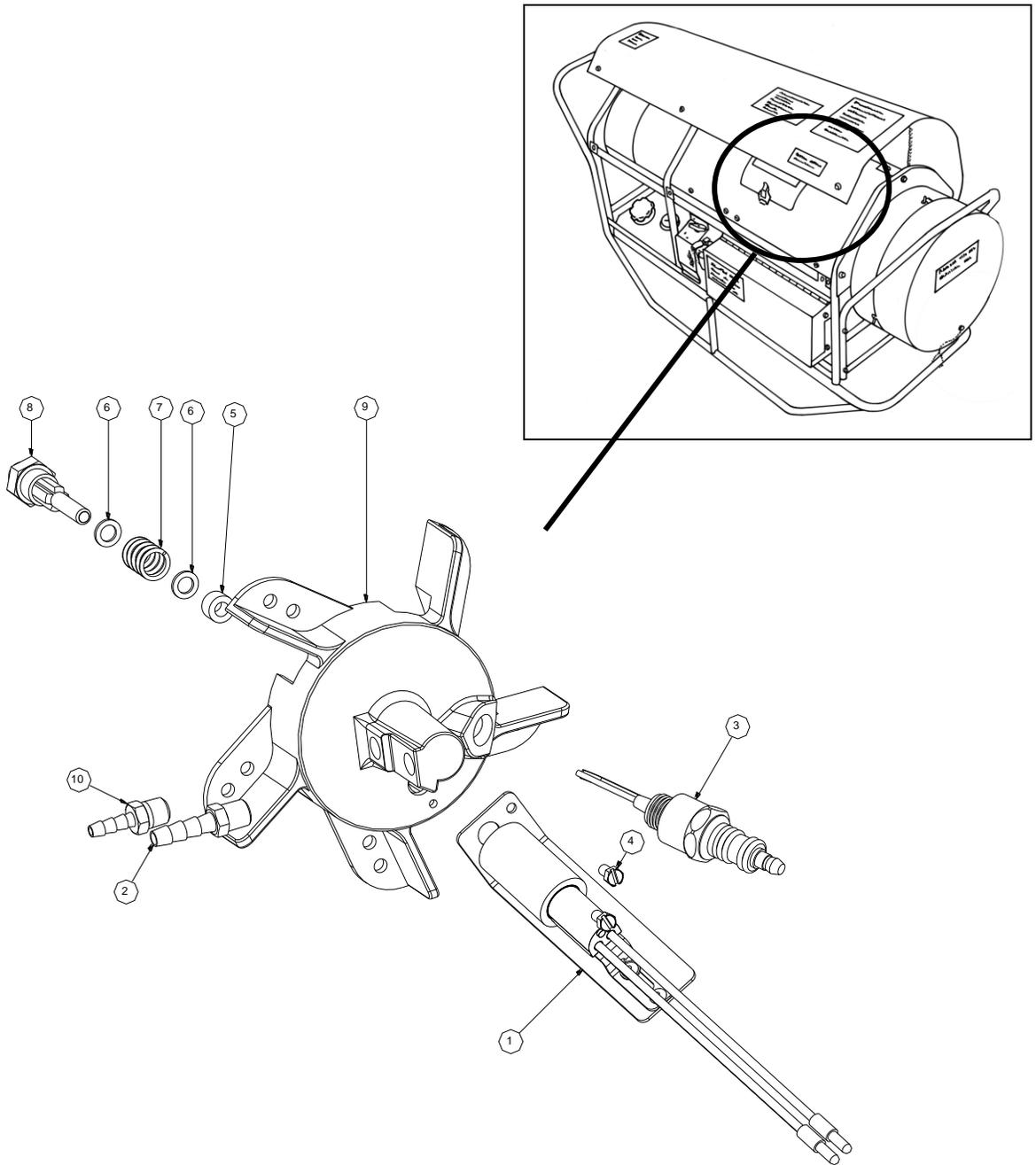


Figure 5-4. BURNER HEAD ASSEMBLY

Table 5-3. Burner Head Assembly

**PARTS LIST  
BURNER HEAD ASSEMBLY**

**BURNER HEAD ASSEMBLY B-200**

PARTS LIST			
ITEM	QTY	PART NO	DESCRIPTION
1	1	CAH-112-2	ASSEMBLY, PHOTOCELL
2	1	106515	FITTING HOSE BARB 3/16" X 1/8" NPT
3	1	B-207	SPARK PLUG
4	2	CAH-141	#8-32 UNF X 5/16 LG HEX HD SLOTTED TAPPING SCREW
5	1	B-201 SEAL	NOZZLE SEAL
6	2	B-202	NOZZLE SEAL WASHER
7	1	B-203	NOZZLE SEAL SPRING
8	1	B-201 NOZZLE	NOZZLE
9	1	B-205	BURNER HEAD
10	1	107262	FITTING, BRASS, HOSE BARB, 3/16" I.D. HOSE X 1/8" NPTF

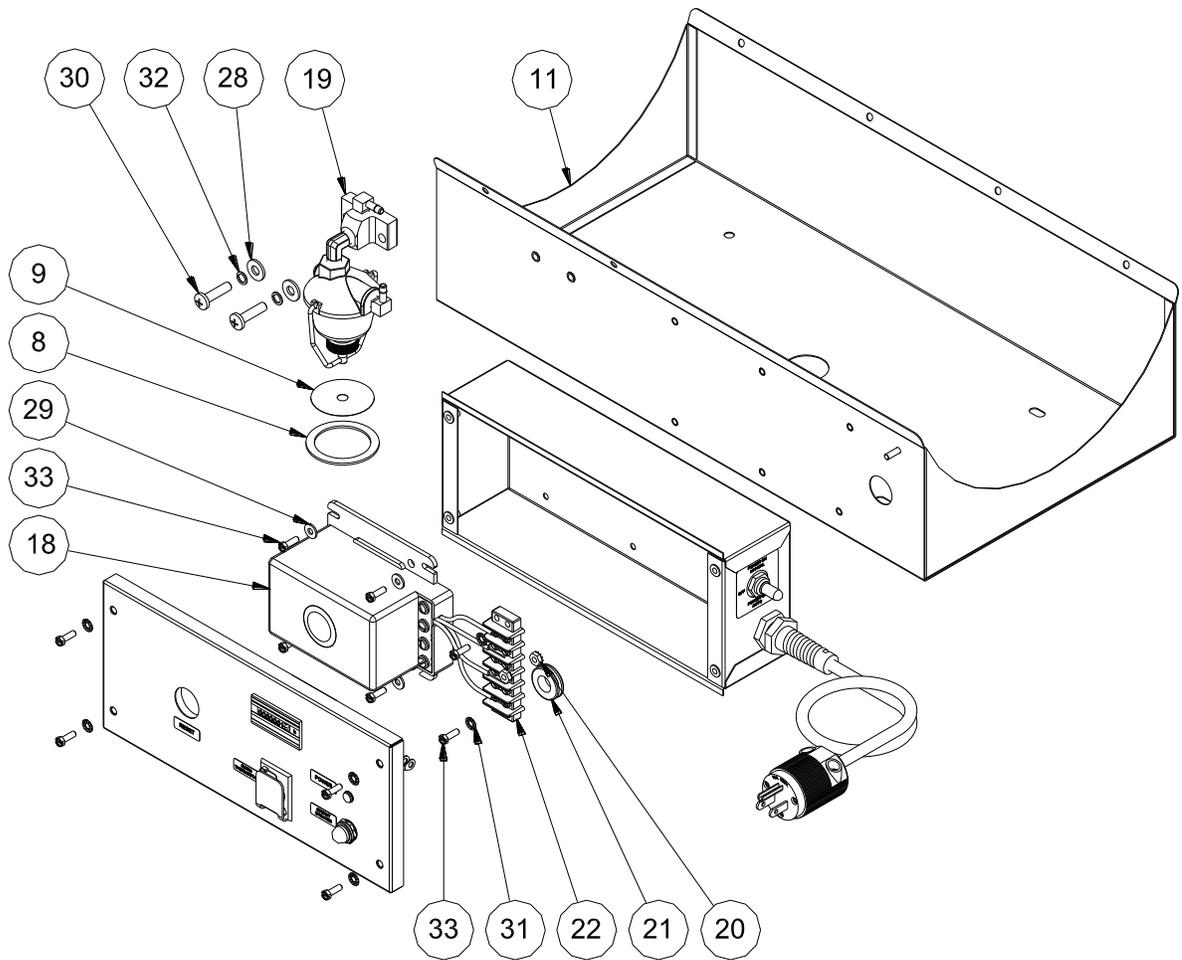
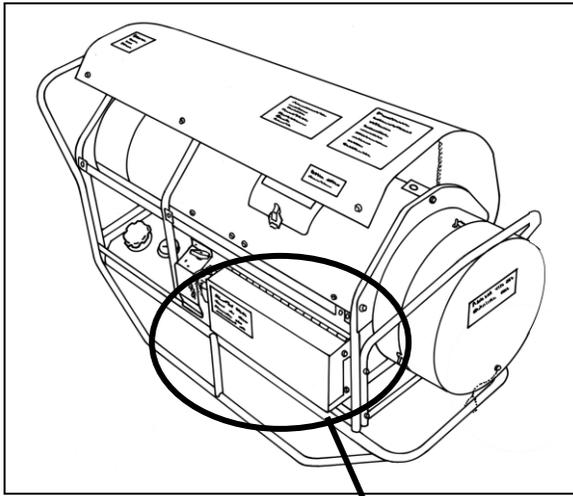


Figure 5-5. MV60 CONTROL BOX-FUEL BRACKET ASSEMBLY

Table 5-4. Control Box-Fuel Bracket Assembly

**PARTS LIST  
CONTROL BOX FUEL BRACKET ASSEMBLY**

ITEM	QTY	PART NO	DESCRIPTION
8	1	5-13-5530	GSKT FUEL STRAINER
9	1	5-13-5531	SCREEN FUEL STRAINER
11	1	53613	FUEL TANK BRKT
18	1	53726	PRIMARY CONTROL
19	1	53650	SEDIMENT BOWL
20	2	7951221	#8-32 KEP NUT
21	1	3708	GROMMET
22	1	CAH-119-1	TERMINAL STRIP
28	2	MS27183-10	WASHER, 1/4"
29	4	MS27183-41	WASHER 3/16"
30	2	MS35296-283	SCREW, 1/4-20X1"
31	6	MS35335-31	#8 LOCK WASHER
32	2	MS35338-44	SPLIT WASHER, 1/4"
33	10	MS51849-54	SCREW, #8-32X 1/2"



Table 5-5. Control Box Assembly

**PARTS LIST  
CONTROL BOX ASSEMBLY**

<b>ITEM</b>	<b>QTY</b>	<b>PART NO</b>	<b>DESCRIPTION</b>
1	1	15097	SWITCH, TOGGLE 2P3P ON OFF ON
2	1	15177	LABEL, POWER, MANUAL AND AUTO
3	1	15179	LABEL, CIRCUIT BREAKER
4	1	15181	LABEL, ROOM THERMOSTAT
5	1	15182	LABEL, RESET
6	1	15183	LABEL, POWER
7	1	40462	BOOT, SWITCH, WATERPROOF
8	1	53420	O-RING
10	1	54369	CONTROL BOX WELDMENT
11	1	53634	GASKET, CONTROL BOX
12	1	53652	COVER, CONTROL BOX
13	1	53733	POWER CORD ASSEMBLY
14	1	53642	SEALING COVER, THERMOSTAT JACK
17	1	53638	INDICATOR LIGHT ASSEMBLY
21	1	CAH-121-2	CIRCUIT BREAKER
22	1	CAH-122	THERMOSTAT PLUG FEMALE
22	2	CAH-141	#8-18 X 5/16 LG HEX HD SLOTTED TAPPING SCREW
23	1	53722	ELAPSED TIME METER
25	1	M5423/07-11	BOOT, PUSHBUTTON, CLEAR, 15/32-32 X .281
29	6	MS35335-31	#8 EXTERNAL LOCK WASHER
31	10	MS51849-54	#8-32 UNC X 1/2 LG HEX HD SLOTTED MACHINE SCREW

Figure 5-7. MOTOR/PUMP/BRACKET ASSEMBLY (53745)

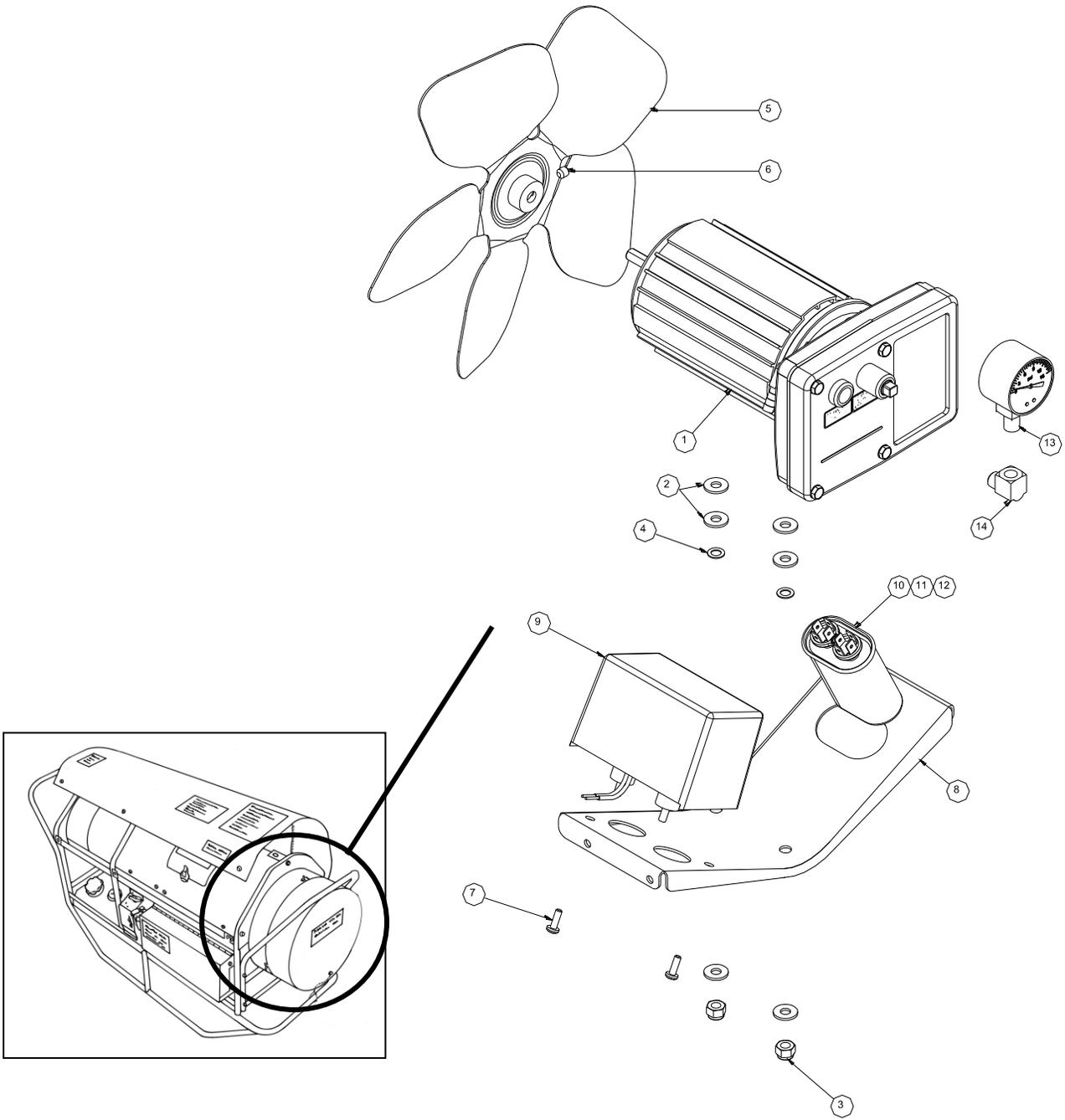


Table 5-6. Motor/Pump/Bracket Assembly

**PARTS LIST  
MOTOR/PUMP/BRACKET ASSEMBLY**

ITEM	QTY	PART NO	DESCRIPTION
1	1	54376-SV	MOTOR & PUMP ASSEMBLY
2	6	CAH-138(D)	1/4 FLAT WASHER
3	2	CAH-139(D)	1/4-20 UNC HEX LOCKNUT W/NYLON INSERT
4	2	47172	17/64 ID X 7/16 OD FLAT WASHER
5	1	CAH-EUR-113	PROP FAN
6	1		1/4-28 UNF SET SCREW X .25 LG (INCLUDED WITH PART #CAH-EUR-113)
7	2	CAH-142-1	#10- UNC X 3/4 LG HEX HD SLOTTED TAPPING SCREW TYPE AB
8	1	53720	BRACKET, MOTOR
9	1	53731	TRANSFORMER, IGNITION
10	1	53719	CAPACITOR, 10UF, +/-6%, 370VAC/B, 50/60 Hz
11	1	168314	CAPACITOR MOUNTING KIT
12	1	53743	ASSEMBLY, WIRE, CAPACITOR/CONTROL
13	1	53417	PRESSURE GAUGE
14	1	4390	ELBOW, STREET, 1/8" X 1/8"
		53745-SV	MOTOR PUMP AND BRACKET ASSEMBLY, INCLUDES ALL ITEMS ABOVE EXCEPT ITEM 5

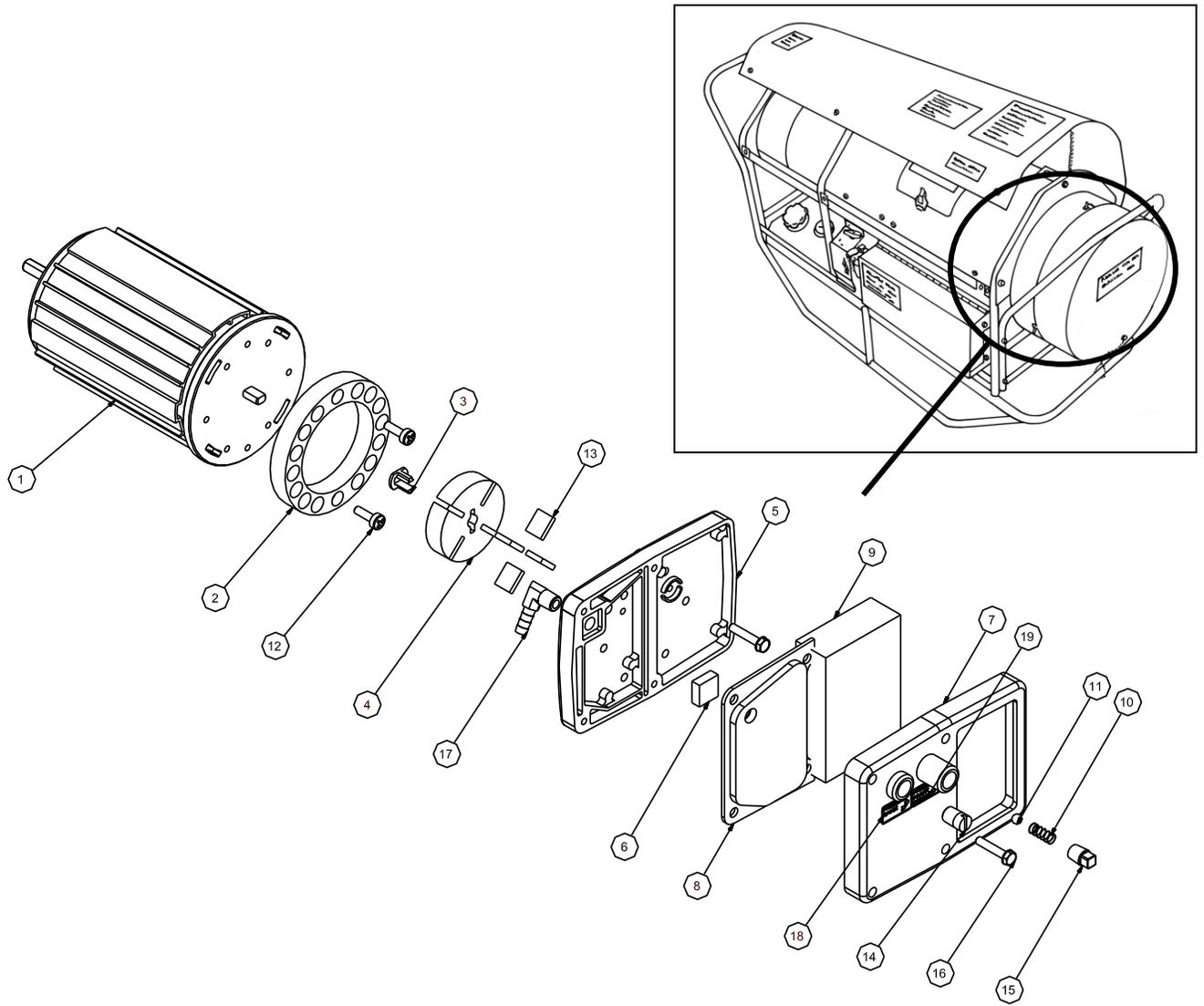


Figure 5-8. MOTOR AND PUMP ASSEMBLY(53485)

Table 5-7. Motor and Pump Assembly P/N 53485

**PARTS LIST  
MOTOR & PUMP ASSEMBLY 53485**

ITEM NO.	QTY	PART NO	DESCRIPTION
1	1	53716	¼ H.P. MOTOR ASSEMBLY (TO INCLUDE MOTOR AND TERMINALS)
2	1	M-113	PUMP BODY
3	1	M-112	ROTOR INSERT
4	1	M-111	PUMP ROTOR
5	1	M-109	FRONT COVER
6	1	M-101	LINT FILTER
7	1	M-102	END COVER
8	1	M-103	OUTPUT FILTER
9	1	M-104	INTAKE AIR FILTER
10	1	M-107	COMPRESSION SPRING
11	1	M-108	BALL BEARING
12	2	M-116	#10-32 UNF X .625 LG FILLISTER HD MACHINE SCREW
13	4	M-110	PUMP BLADE
15	1	M-106	PRESSURE ADJUSTING SCREW
16	10	M-117	#10-32 UNF X 1 LG HEX HD MACHINE SCREW
17	1	106522	90 DEG. ELBOW HOSE BARB
18	1	53321	DECAL PRESSURE GAUGE
19	1	53322	DECAL PRESSURE ADJUST SCREW



# Chapter 6

## Schematics and Wiring Diagrams

## 6. Schematics and Wiring Diagrams

Schematics and wiring diagrams for the Camfire Heater can be found on the accompanying pages.

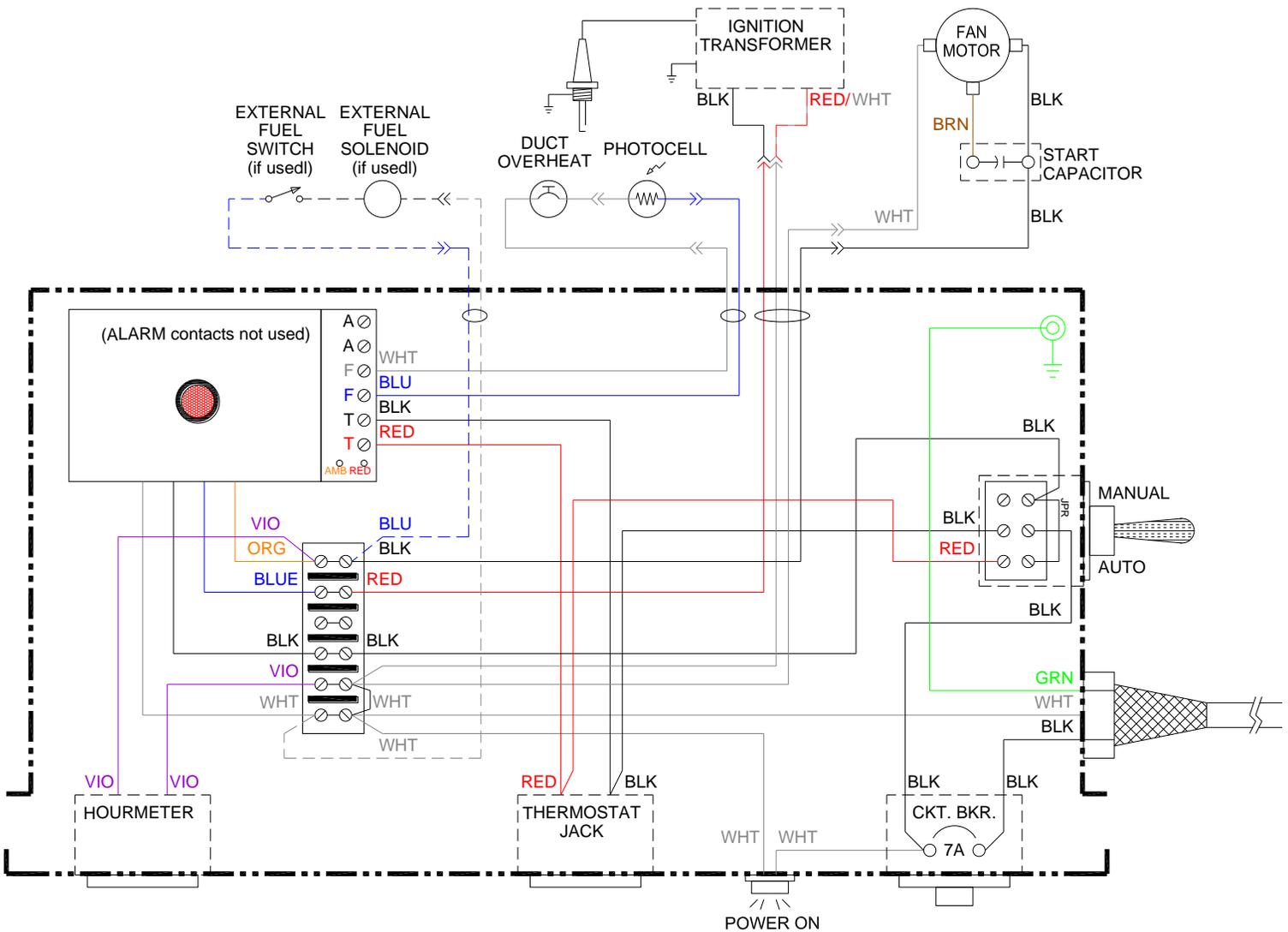
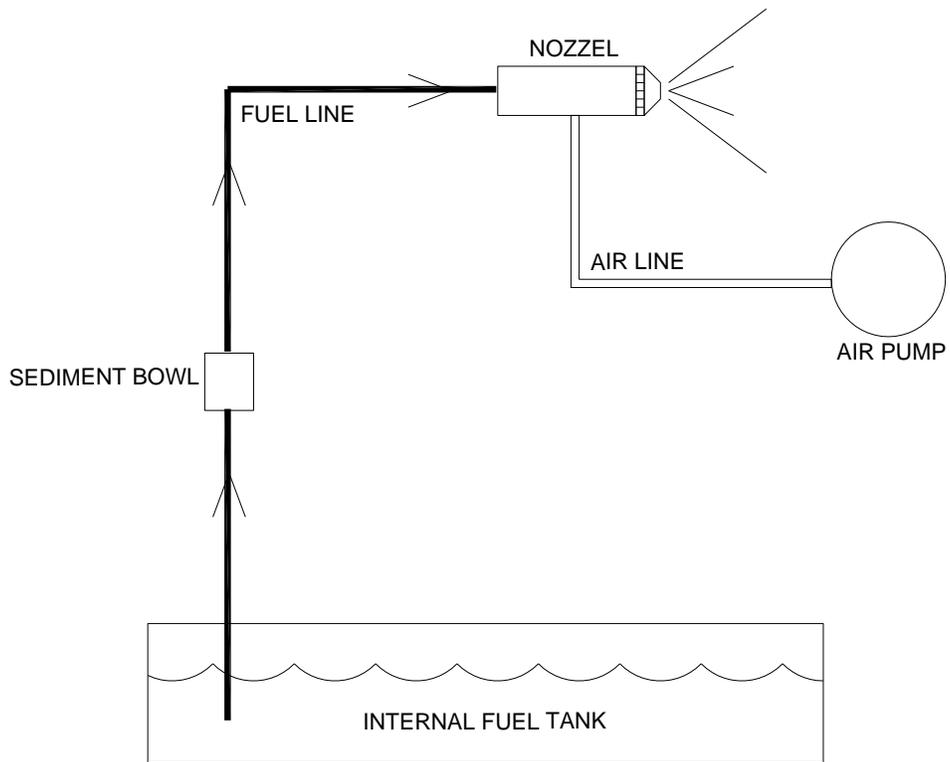


Figure 6-1. Camfire Heater Wiring Diagram



*Figure 6-2. Camfire (MV60) Fuel Schematic*

## 7. Alphabetical Index

### A

Air Pump Repair .....	73
<b>Air System</b> .....	21
Attaching the Flexible Ducts.....	26

### B

Before Operation PMCS .....	30
<b>Burner assembly</b> .....	12
<b>BURNER HEAD ASSEMBLY B-200</b> .....	93
Burner Head Service.....	69

### C

Camfire (MV60) Fuel Schematic.....	105
CAMFIRE Heater Specifications.....	20
Camfire Heater Wiring Diagram.....	104
CAMFIRE Maintenance .....	54
CAMFIRE Troubleshooting .....	38
Checking Motor Starting Circuits .....	65
Circuit Breaker .....	15
Cleaning .....	84
<b>COMBUSTION CHAMBER ASSEMBLY</b> .....	91
Connecting the Power Cable .....	32
Connecting the Remote Room Thermostat .....	31
<b>CONTROL BOX ASSEMBLY 53504</b> .....	97
<b>CONTROL BOX FUEL BRACKET ASSEMBLY</b> .....	95
<b>Control Panel</b> .....	11, 15
<b>Control System</b> .....	21
Controls and Indicators .....	15

### E

<b>End plug</b> .....	12
Examining the Heater.....	39
<b>Exhaust Stack Extension</b> .....	11, 24
Extension Cord Size Requirements .....	33

### F

Fan Service .....	67
Final Checks Before Operation .....	33
Flexible Duct Usage vs. Outside Temperature	26

Fuel Filter Service .....	68
<b>Fuel System</b> .....	21
<b>Fuel Tank</b> .....	34, 57
Fueling .....	30
Fueling the Internal Tank (MV60S-1 and MV60T-1) .....	30

### H

<b>handles</b> .....	14
Hour meter .....	15

### I

<b>Ignition System</b> .....	21
Illustrated Parts Listing .....	86
<b>Inlet and outlet ducts</b> .....	11
<b>Installing The Air Supply And Return Ducts</b> .....	27

### L

<b>LEAKAGE DEFINITION FOR PERFORMING PMCS</b> .....	55
<b>local transport wheels</b> .....	14

### M

Maintainer Level Malfunction Symptom Index	46
Maintainer Level Troubleshooting.....	44
Maintainer Level Troubleshooting Procedures	47
<b>MOTOR &amp; PUMP ASSEMBLY 53485</b> .....	101
<b>MOTOR/PUMP/BRACKET ASSEMBLY 53489</b> .....	99
<b>MV60 FULL ASSEMBLY</b> .....	87

### O

Operator Level Malfunction Symptom Index ...	39
Operator Level Troubleshooting .....	38, 44
Operator Level Troubleshooting Procedures...	40
Operator Preventive Maintenance Checks and Services.....	57

*P*

**Positioning the Heater Outside Shelter** .....26  
Power .....13, 15, 32, 34  
**Power cable** .....13  
Preparing for Movement.....35  
Preparing for Movement or Storage.....35  
Preparing the Heater for Operation.....24  
Preparing the Heater for Storage .....36  
Preventive Maintenance Checks and Services54  
Principles of Operation.....21

*R*

Reassembling the Air Pump.....77  
**Reassembling the Heater** .....80  
Refueling During Operation.....34  
**Remote Room Thermostat** .....13, 16, 31, 62  
Removing the Accessories.....25  
Removing Upper Shell .....56  
Reset .....15  
**Roll bars** .....14

*S*

Schematics and Wiring Diagrams.....104

Setup.....26  
**Setup and Operation of the CAMFIRE Heater**  
.....24  
Shutting Down the Heater.....34  
Siting Considerations .....25  
Special Tools, Equipment and Supplies .....61  
Starting and Operating the Heater .....34  
Starting the Heater.....34  
System Maintenance Procedures.....61  
System Operational Diagram.....22

*T*

Temperature Sensing Coil .....16  
Test Firing .....44  
Test Firing the Heater .....39  
Thermostat.....15, 40, 43  
Transformer .....63

*U*

Unpacking .....24

*V*

Variable Temperature Control .....16

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