



**MV60S-1, MV60X-1, MV60T-1, MV60XT-1,
MV125-DND**

SHELTER HEATER
60,000 BTU Multi-fuel Shelter Heater

Operation and Maintenance Manual



HDT –Tactical Systems Business Unit
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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.



WARNING!

FIRE, EXPLOSION

Use only Kerosene, Diesel or Number 2 Fuel Oil, 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. Always keep vent on fuel tank cap open during transport and operation.



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.

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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 120 volts, 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. 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 thermostat assembly also has a CO detector that sounds an audible alarm and flashes an LED.

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.

THE INSTALLATION OF THE UNIT SHALL BE IN ACCORDANCE WITH THE REGULATION OF THE AUTHORITIES HAVING JURISDICTION

1.2 Description of Major Components

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



Fuel Tank, Fuel Selector Switch, and Sediment Strainer Assembly – Internal fuel tank is located on underside of heater. The fuel selector switch permits the operator to choose between the internal tank and a remote external fuel source. The sediment strainer screens out any large particles that may be in the fuel supply. (NOTE: fuel selector switch and sediment strainer only on MV60X-1 AND MV60XT-1)



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 power cable and the optional remote room thermostat/CO detector assembly.



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.



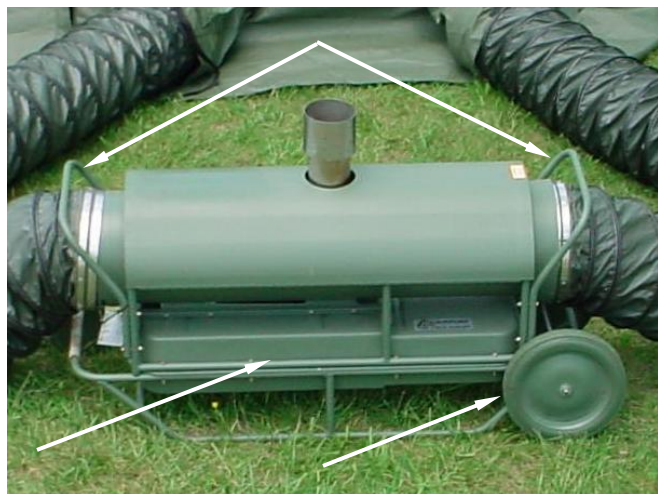
Power cable – A 6-foot long AC power cable that connects the heater with a 120 VAC power source.



Remote room thermostat/CO detector assembly – Permits automatic temperature control inside a shelter. The remote room thermostat/CO detector assembly 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 setpoint is reached. The integral CO detector continuously monitors the air quality in the shelter. If CO is detected, it will sound an audible alarm and shut down the heater (in thermostat mode only; in manual mode, the alarm will sound but the heater will continue to run).



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.*

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	Turns heater power on and off
3	Thermostat Switch	Activates the remote thermostat
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	Power cable input connection	Permits the connection of external 120 VAC power via the included power cord

2

3

4

1

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/CO detector assembly, monitors the temperature of the shelter.
3	CO Detector	Monitors air inside shelter for carbon monoxide gas

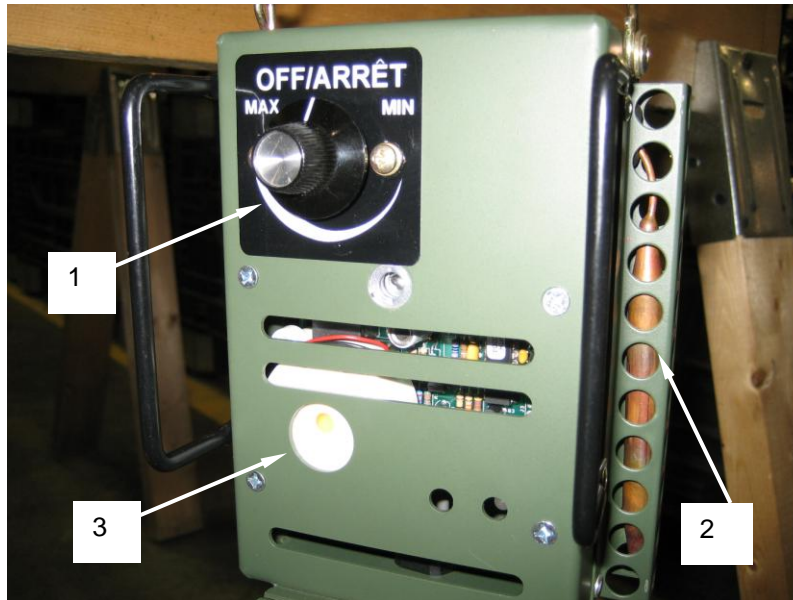
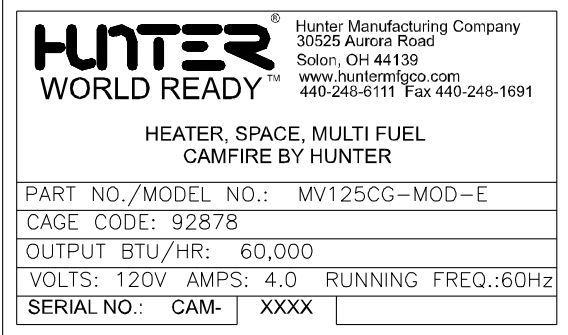
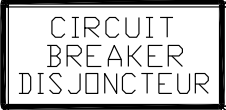

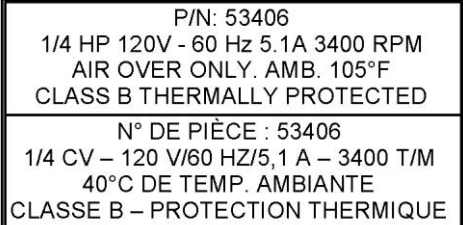


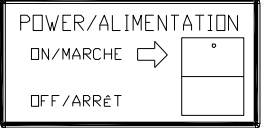



Figure 1-2. Remote room thermostat/CO detector assembly

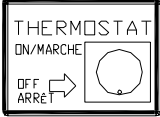



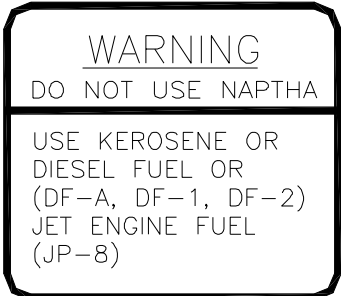

1.4 Labels and Data Plates


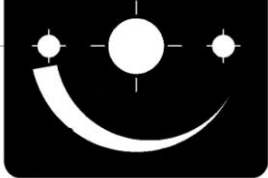
The following section contains a description of all WARNING labels and data plates associated with the Camfire Heater.

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

Label or Data Plate	Location/Description
 <p>HUNTER[®] Hunter Manufacturing Company 30525 Aurora Road Solon, OH 44139 www.huntermfgco.com 440-248-6111 Fax 440-248-1691</p> <p>WORLD READY[™]</p> <p>HEATER, SPACE, MULTI FUEL CAMFIRE BY HUNTER</p> <p>PART NO./MODEL NO.: MV125CG-MOD-E CAGE CODE: 92878 OUTPUT BTU/HR: 60,000 VOLTS: 120V AMPS: 4.0 RUNNING FREQ.:60Hz 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 DISJONCTEUR</p>	<p>Located on the control panel, identifies the circuit breaker. See section on controls and indicators.</p>
 <p>DANGER FAN COMPARTMENT DISCONNECT POWER BEFORE OPENING COMPARTIMENT DE VENTILATEUR COUPER LE SECTEUR AVANT D'OUVRIR</p>	<p>Located near the fan compartment, warns user of electrical shock potential inside fan compartment.</p>
 <p>P/N: 53406 1/4 HP 120V - 60 Hz 5.1A 3400 RPM AIR OVER ONLY. AMB. 105°F CLASS B THERMALLY PROTECTED N° DE PIÈCE : 53406 1/4 CV - 120 V/60 HZ/5,1 A - 3400 T/M 40°C DE TEMP. AMBIANTE CLASSE B - PROTECTION THERMIQUE</p>	<p>Located on fan assembly, label identifies part number and performance specs of fan.</p>

Label or Data Plate	Location/Description
<p style="text-align: center;">SPACE HEATER</p> <p>RECOMMENDATIONS OF LOCAL AUTHORITIES HAVING JURISDICTION SHOULD BE FOLLOWED</p> <p style="text-align: center;"><u>OPERATION INSTRUCTIONS</u></p> <p>FUEL — USE ONLY KEROSENE, DIESEL, NO. 1 FUEL OIL OR JP8</p> <p>TO START: 1. FILL FUEL TANK. 2. PLUG INTO PROPER VOLTAGE 3. SWITCH ON</p> <p>TO STOP: 1. SWITCH OFF 2. REMOVE PLUG</p> <p>IF MOTOR DOES NOT START: 1. PRESS CONTROL RESET 2. CONSULT MANUAL</p> <p style="text-align: center;"><u>MAINTENANCE</u></p> <p>FUEL TANK — DRAIN TANK COMPLETELY EVERY 150 HOURS FOR STORAGE — DRAIN TANK COMPLETELY DRY</p> <p>AIR INTAKE FILTER — EVERY 500 HOURS REMOVE FILTER ELEMENT, WASH IN WARM WATER & MILD DETERGENT, DRY AND REPLACE IN UNIT.</p> <p>FUEL INTAKE: REMOVE ASSEMBLY AND WASH IN KEROSENE OR BLOW OUT IN REVERSE</p> <p>FUEL & AIR LINES — ENSURE THAT ALL CONNECTIONS ARE TIGHT</p> <p>MOTOR & FAN — CONSULT MANUAL</p> <p>AIR OUTPUT — REPLACE ONCE A YEAR</p> <p style="text-align: center;"><u>CAUTION</u></p> <ol style="list-style-type: none"> 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. 	<p>Located on side of heater, label lists the operating procedures for the heater in abbreviated form.</p>
	<p>Located on the control panel, identifies power switch.</p>
	<p>Located inside heater near air pump, identifies pressure adjustment screw.</p>
	<p>Located inside heater near burner assembly, identifies pressure gauge.</p>
	<p>Located on control panel, identifies Reset switch.</p>
<p style="text-align: center;"><u>START UP PROCEDURE</u></p> <ol style="list-style-type: none"> 1. TURN HEATER ON (SET TO THERMOSTAT OR CONTINUOUS). 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 (THERMOSTAT). 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.) <p>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</p> <ol style="list-style-type: none"> 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. 	<p>Located on side of heater, details heater start-up procedures.</p>

Label or Data Plate	Location/Description
	<p>Located on control panel, identifies remote room thermostat/CO detector assembly control switch.</p>
	<p>Located on control panel, identifies remote room thermostat/CO detector assembly jack.</p>
	<p>Parts ID tag located on the ignition transformer.</p>
	<p>Located on control panel, alerts user that only 120VAC power should be used.</p>
	<p>Located near fuel filler cap on side of heater, warns user against the use of naphtha and identifies all approved fuels.</p>
	<p>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.</p>

Label or Data Plate	Location/Description
<div data-bbox="196 281 794 787">  <p>WARNING</p> <p>POSSIBLE CARBON MONOXIDE POISONING</p> <p>Open CO sensor door during in tent operation. Failure to allow for detection of CO may cause serious illness or death.</p> <p>AVERTISSEMENT</p> <p>POSSIBILITÉ D'EMPOISONNEMENT AU MONOXYDE DE CARBONE</p> <p>Ouvrir la porte du détecteur de CO en cas de fonctionnement dans la tente. Ne pas activer la détection de CO peut causer des troubles graves ou mortels.</p> </div> <div data-bbox="274 808 717 1396"> <p>REMOTE OPERATION</p> <ul style="list-style-type: none"> * Connect remote to unit and hang inside shelter near return duct * Remote should be hung at least five foot from floor * Deploy CO detector by opening door on the front of remote * Place unit selector switch to the AUTO position * If unit does not start, check that remote thermostat is at on position * Adjust thermostat for desired temperature * Unit will shut off after post purge cycle and shelter temperature is reached * When temperature drops in shelter, thermostat will cycle until back on and begin to heat shelter until thermostat is satisfied </div> <div data-bbox="363 1413 628 1677"> <p>OFF/ARRÊT</p> <p>MAX MIN</p>  </div>	<p>Located on remote thermostat/CO detector, alerts user to proper operation of the CO detector.</p> <p>Located on back of thermostat/CO detector, details operation of thermostat/CO detector.</p> <p>Located on thermostat/CO detector, indicates a higher or lower thermostat setting.</p>

Label or Data Plate	Location/Description
<div data-bbox="259 283 730 483"><p data-bbox="289 331 701 399">REMOVE THIS CAP BEFORE OPERATING THIS HEATER</p><p data-bbox="341 420 649 441">THERMOSTAT IS STORED INSIDE</p></div>	<p data-bbox="831 277 1396 394">Located on the accessory plug which covers heater outlet for transportation and storage purposes. Cover must be removed before using the heater.</p>

1.5 CAMFIRE Heater Specifications

Table 1-2. Camfire Heater Specifications

	MV60S-1, MV60X-1, MV60T-1, MV60XT-1	MV125-DND
Input Heat Rating BTU/Hour	90,000 btu/h	87,000 btu/h
Output Ratings		
Volume, CFM (Approximate)	600	850
Other Ratings		
Current, starting	6.5 AMPS	6.5 AMPS
Current, running	3.2 AMPS	3.2 AMPS
Voltage	120 VAC	120 VAC
Frequency	60 Cycle	60 Cycle
Fan/Pump Motor	1/4 HP	1/4 HP
Air Pump Pressure	5.5 PSI	5.5 PSI
Fuel Nozzle		
Meter Size	0.65 GPH	.74-.80 GPH
Spray Angle	80 DEGREES	30 DEGREES
Fuel	Kerosene, DF1, DF2, Fuel Oil, JP8 Only	Kerosene, DF1, DF2, Number 2 Fuel Oil, JP8 Only
Tank Capacity	8.5 GAL	13.5 GAL
Flexible Ducts (2)	12 inch diameter 15 ft Length	12 inch diameter 15 ft Length
Dimensions (Without Stack Extension)	W15" L46" H25"	W16.5" L51" H25"
Weight (Without Fuel)	105 LBS	115 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 (MV60X-1 AND MV60XT-1 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 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 assembly may be used during the normal course of operating the heater. The thermostat can be set to any desired temperature between 35 degrees 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.

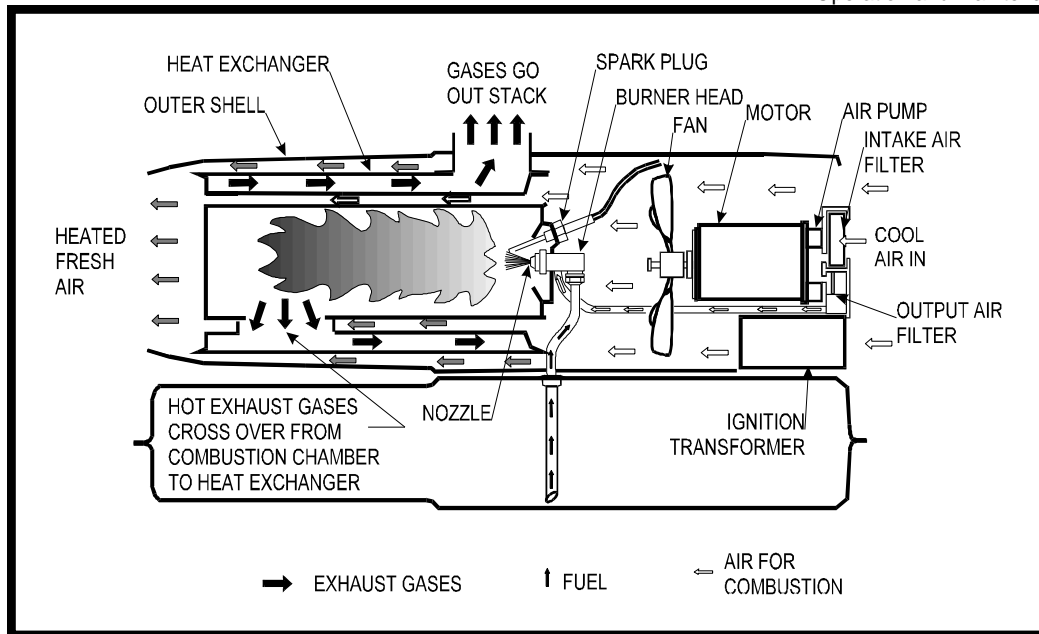


Figure 1-3. System Operational Diagram.

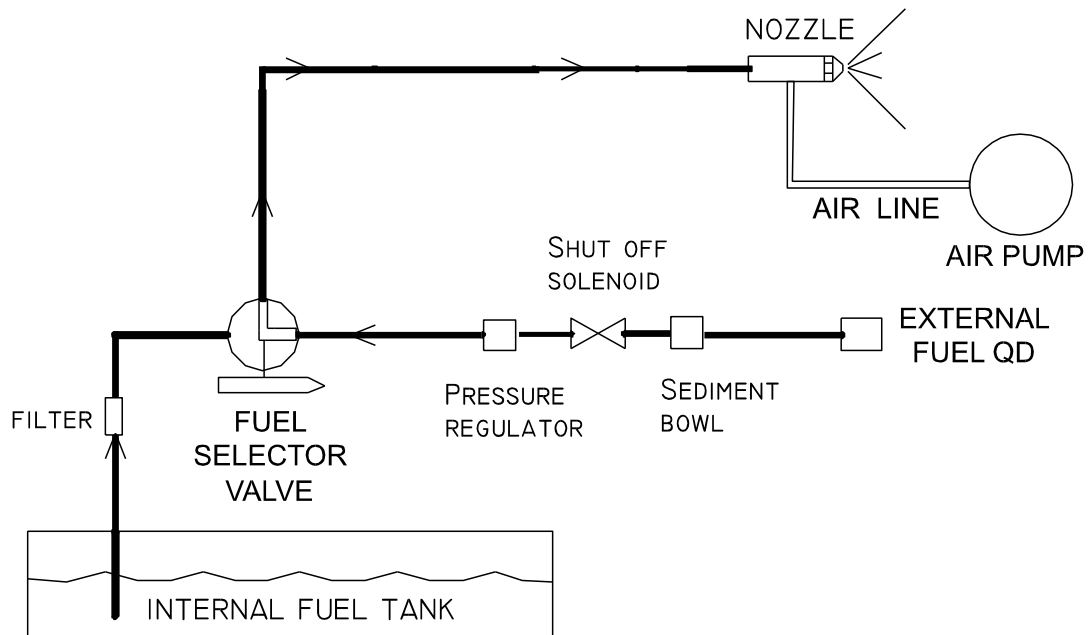


Figure 1-4. MV60X-1 AND MV60XT-1 Fuel Flow Diagram.

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 power cable and remote room thermostat/CO detector assembly. Set the power cable and thermostat aside.

2.2 Site 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)**.

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 4 feet (122 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 return 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°F	Above 32°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. 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.

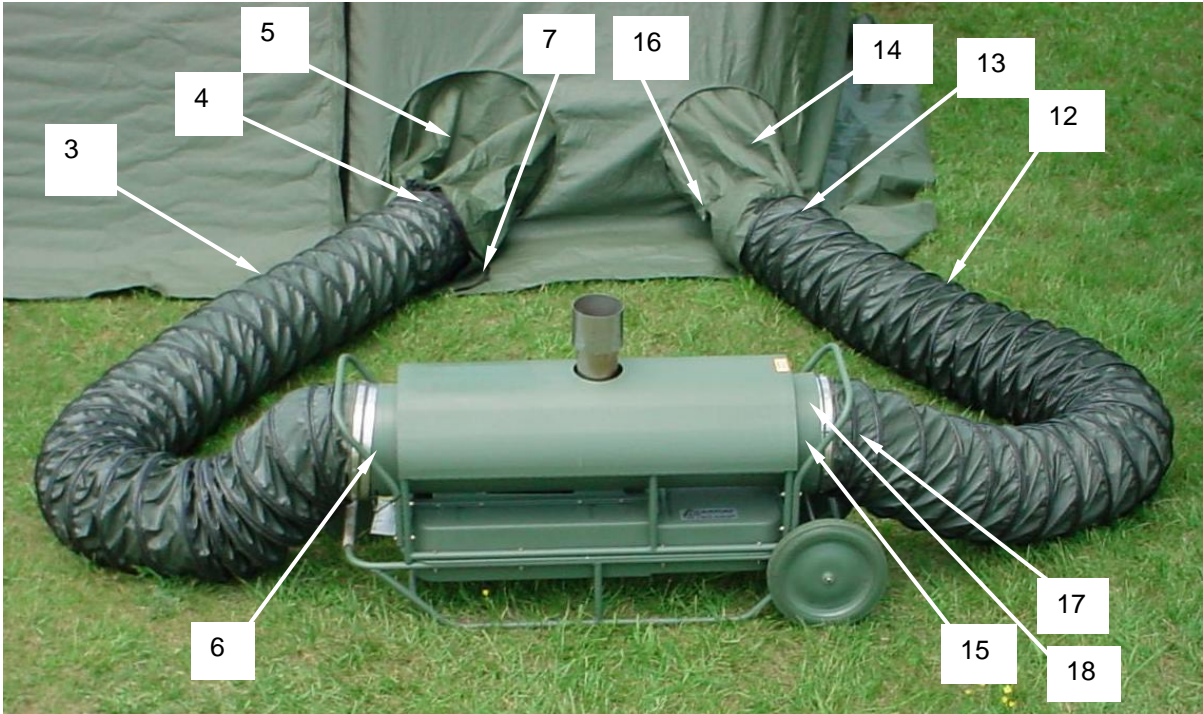
Locate the heated air supply duct (3). Make sure inside and outside of duct are free of damage, dirt, and obstructions prior to attachment to the heater assembly. Insert the end (4) of the duct without the J-slot mounting bracket into the shelter duct tunnel (5) closest to the heated air outlet end (6) of the heater as indicated by the label "Heated Air Outlet" on the upper housing assembly. Secure the shelter duct tunnel tie straps (7). 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 (10) onto the protruding pins (11) 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. Release the duct.

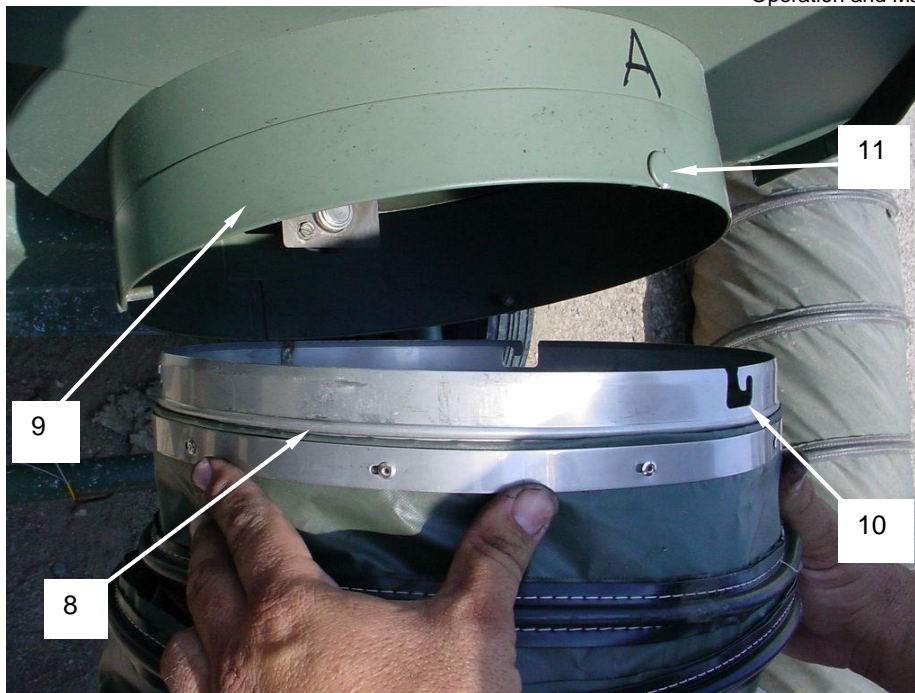
If outside temperatures are above freezing, the air supply duct (12) should be located outside the shelter in accordance with Table 2-1. Make sure inside and outside of duct and the grill are free of damage, dirt, and obstructions prior to attachment to the heater assembly.

NOTE

If using a shelter with a plenum, be sure that the heated air duct is not inserted so far into the duct tunnel as to restrict the air flow.

Insert the end (13) 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 J-slot bracket (17) to the duct adapter (18) on the air inlet end of the heater. Engage the J-slot (10) onto the protruding pins (11) on the inside of the duct adapter and push in fully. While pushing the duct in, rotate the duct clockwise until it locks in place. Release the duct.







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 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-1, MV60T-1, and MV125-DND)

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 handtighten securely.

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

2.5.2 Fueling the Internal Tank (MV60X-1 and MV60XT-1)

In order to operate the CAMFIRE heater from the internal fuel tank, the turn the fuel selector switch **(1)** to the INTERNAL position.

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 handtighten securely.

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



2.5.3 Using a Remote Fuel Source (MV60X-1 and MV60XT-1only)

2.5.3.1 Preparing A Fuel Supply Site

Select a fuel supply site that is level, free of debris and open flame, at least seven feet (2.13 meters) from the shelter, and a minimum of five feet from heater.

NOTE

A piece of petroleum absorbent material should be placed where the fuel can and fuel can stand will be installed as well as under the fuel quick disconnect connector in order to catch any fuel that may spill. Additional commercial products are available to contain large spills. Soiled absorbent material should be discarded in accordance with local environmental regulations.

Route the fuel supply hose from the heater to the fuel supply location to gauge where the fuel supply site is best located. Place a petroleum absorbent mat where the fuel can stand will be set up.

2.5.3.2 Fill Fuel Can With Fuel And Install Fuel Can Adapter

Heater Assembly Fuel Selection



WARNING

Gasoline, JP-4, Used Motor Oil, Solvents or other unauthorized fuels should **NOT** be used with the CAMFIRE Heater under any circumstance. Using unauthorized fuels will create a fire danger and potential for explosion.

Refer to Table 2-2. Fuel Selection vs. Outside Temperature to determine the appropriate fuel for the ambient temperature.

Table 2-2. Fuel Selection vs. Outside Temperature

Ambient Temperature	Specification	Military Symbol
Above -60 °F (-51.1 °C)	MIL-T-83133	JP-8
Above -60 °F (-51.1 °C)	VV-F-800	DF-A
Above -25 °F (-31.7 °C)	MIL-T-83133	JP-5
Above -25 °F (-31.7 °C)	VV-F-800	DF-1
Above +20 °F (-6.7 °C)	VV-F-800	DF-2

Install Fuel Can Adapter. At the fuel supply site, install a fuel can adapter on a full fuel can as follows:



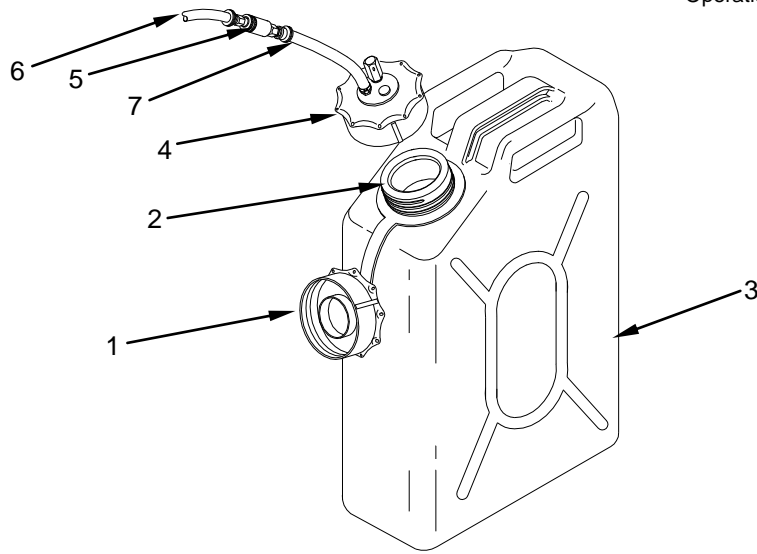
WARNING

Fuel can adapter kit must be fully seated to prevent fuel leakage and fire.

Remove cap **(1)** from mouth **(2)** of fuel can **(3)**, and replace with gravity feed adapter **(4)**. Screw the adapter into the fuel can securely.

Attach male end **(5)** of fuel supply hose **(6)** to gravity feed adapter fitting **(7)**. Set the assembled fuel can aside.

At the fuel supply site, set up fuel can stand with fuel can **(3)** level or slightly above heater as detailed in the next section.



Assemble Fuel Can Stand. Select a site for the fuel can stand that is a minimum of 5 feet (1.5 m) but no more than 8 feet (2.4m) from the fuel quick disconnect connector on the heater.

No heat or flame sources, other than the heater, shall be within 8 feet (2.4 m) of fuel can stand. Set up the fuel can stand in accordance with the instructions detailed below. For convenience in the field, an instruction card is attached to the fuel can stand.

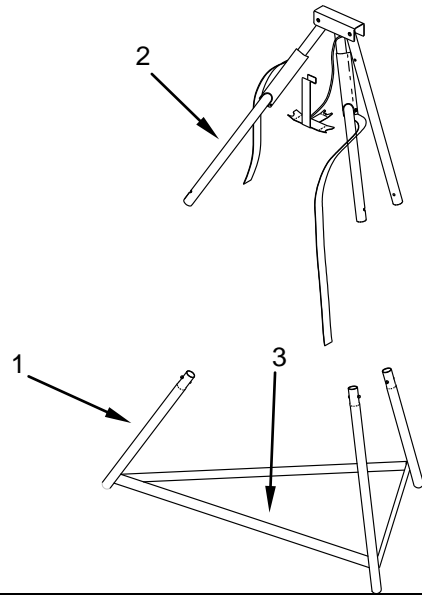


WARNING

Death or serious injury may occur if fuel is not handled carefully. Always place fuel can and stand in well-ventilated area as far away from open flames and other potential ignition sources as possible. Fuel spills shall be cleaned up in accordance with local requirements.

STEP 1

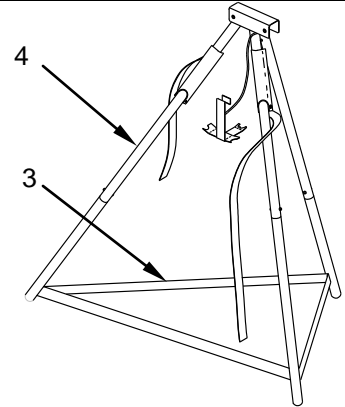
Insert the bottom leg assembly **(1)** into the top leg assembly **(2)** until each leg is locked in place. Be sure to orient each bottom leg so that the stabilizing straps **(3)** are positioned toward the inside of the stand. Ensure that the straps are not twisted.



STEP 2

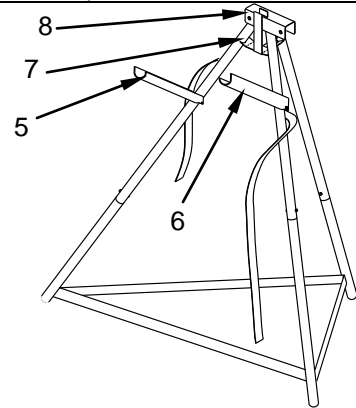
Spread the assembled leg assembly **(4)** until the stabilizing straps **(3)** are fully extended and the stand is stable.

The leg assembly straps are designed to ensure the stand is stable, but are also designed to prevent the stand from sinking into snow.



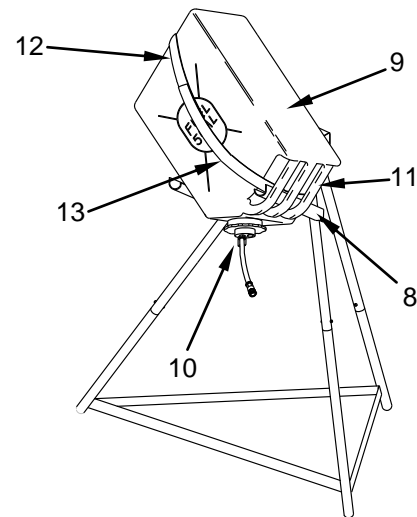
STEP 3

Lower the left **(5)** and right **(6)** support arms so that each is at a right angle to its attached leg. Place the tripod brace **(7)** under the top bracket **(8)** of the stand and clip into position over the front of the top bracket.

**STEP 4****NOTE**

Make sure that the gravity feed adapter is fully seated and secured to avoid leaking.

Invert the fuel can with installed fuel can adapter **(9)** and mount on the assembled fuel can stand so that the gravity feed adapter **(10)** faces the ground. Slide the right support arm **(8)** through the handle **(11)** of the fuel can. Wrap the left support strap **(12)** over the bottom of the fuel can **(9)**. Feed the right support strap **(13)** through the fuel can handle **(11)**, up across the front of the fuel can body, and over the left support strap **(12)**. Secure the right strap **(13)** to the left strap. The strap helps secure a partially filled fuel can to the fuel stand during windy conditions.



If any fuel leaks occur, refer to the section of this manual entitled "Troubleshooting".

2.5.4 Connecting the CAMFIRE Heater To Remote Fuel Supply

To operate the Camfire Heater from a remote fuel supply, set up an approved supply as detailed in the previous section.

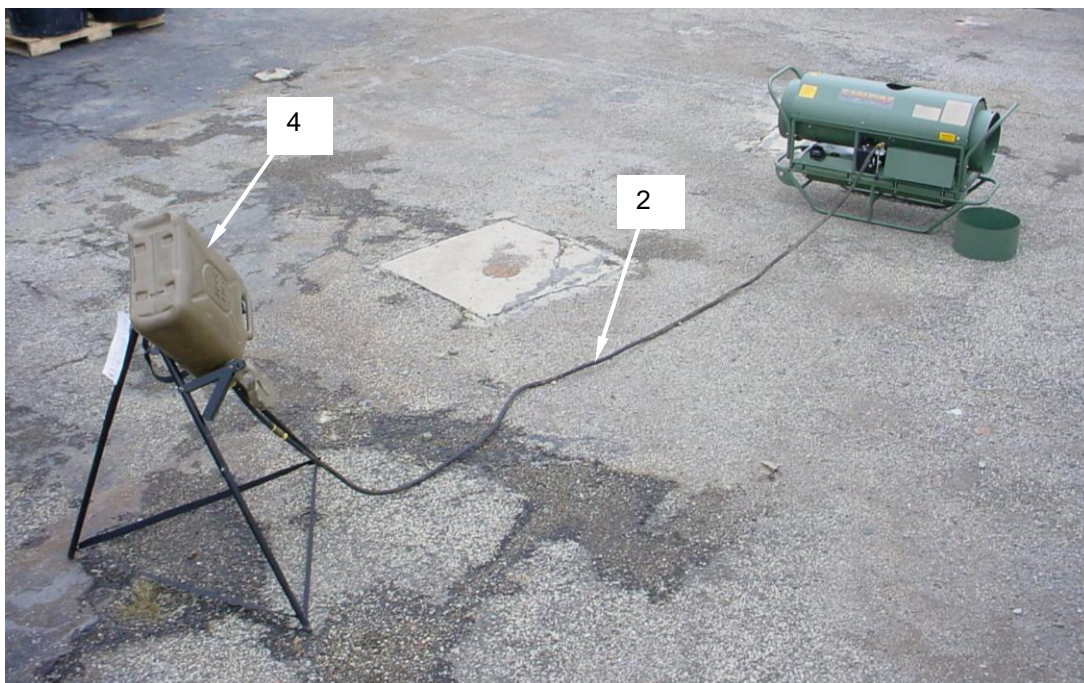
Flip the fuel selector switch **(1)** to the EXTERNAL position.

Layout the fuel line in a straight line from the remote fuel supply to the heater taking care to not have any kinks or sharp bends in the hose.

Connect the fuel line **(2)** to external fuel quick disconnect **(3)** by pulling back on the outer collar and fully engaging on the external fuel quick disconnect. Release the outer collar and tug on the hose to ensure that it is connected securely.

Connect fuel line **(2)** to the remote fuel source **(4)** by pulling back on the outer collar of the quick disconnect located on the fuel can adapter and inserting the quick disconnect connector of the fuel line.

Insert the fitting of the fuel line securely and release the outer collar of the fuel can adapter quick disconnect. Tug on the connection and ensure that the connection is secure.



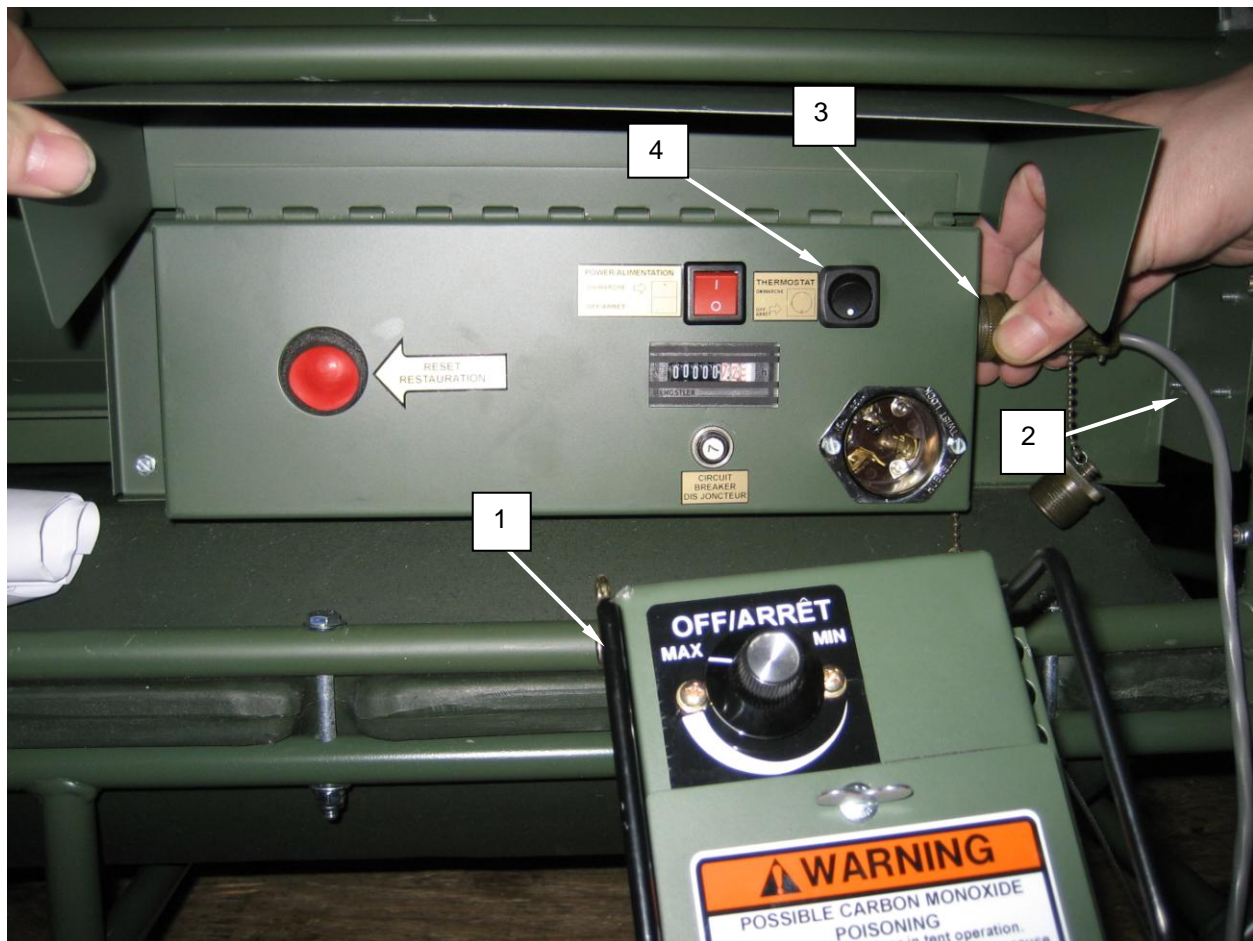
2.5.5 Connecting the Remote Room Thermostat/CO Detector Assembly

The remote room thermostat/CO detector assembly (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.

To connect the remote room thermostat/CO detector assembly (1), engage the plug (2) on the end of the cable into the connector (3) on the control panel of the heater labeled "THERMOSTAT JACK". Push the plug in securely until it clicks in position.

Move the control panel switch (4) labeled "THERMOSTAT" to the ON position.

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.



2.5.6 Operating the CO Detector

NOTE

The detector is only rated for operation above 32°F. The carbon monoxide detector will survive -65°F cold storage.



WARNING

Actuation of the carbon monoxide detector indicates the presence of CO which can be FATAL.



WARNING

The CO detector cannot monitor air quality if it is not placed inside the shelter.

If the alarm sounds:

1. Immediately move to a location which has fresh air, outdoors or by an open door/window.

DO A HEAD COUNT TO CHECK THAT ALL PERSONS ARE ACCOUNTED FOR. DO NOT REENTER PREMISES UNTIL THE MEDICAL PERSONNEL HAVE ARRIVED, THE PREMISES HAS BEEN AIRED OUT, AND THE ALARM REMAINS IN ITS NORMAL CONDITION.

2. Call for medical support personnel.
3. Press the reset button **(1)**. After following steps 1 and 2, if your alarm reactivates within a 24-hour period, repeat steps 1 and 2 and contact unit maintenance to examine and/or replace the detector.

When the power switch on the operator control box is turned on, the status light **(2)** on the front of the carbon monoxide detector **(3)** will alternately switch between RED and GREEN, as the unit performs a two and a half minute warm-up and self-test procedure.

The audible tones on the detector will cycle twice, emitting two sets of four tones. At the end of this 2-1/2 minute cycle, the status light **(2)** will turn GREEN to indicate normal operation and good, safe air. The alarm relay is energized during the 2-1/2 minute warm up cycle.

The CO detector continuously monitors the air in the shelter. If the detector measures levels of CO greater than the danger level, the RED light will turn on, the Alarm Relay will switch to actuate the alarm circuits in the operator control box, the buzzer will sound, and the heater will shut down. The detector is programmed to alarm if the danger level of carbon monoxide is exceeded, which are time and concentration related. The alarm points are 70 ppm of carbon monoxide after 60 to 240 minutes, 150 ppm of CO after 10 to 50 minutes, and 400 ppm of CO after 4 to 15 minutes, per UL Standard 2034.

2.5.7 Connecting the Power Cable

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

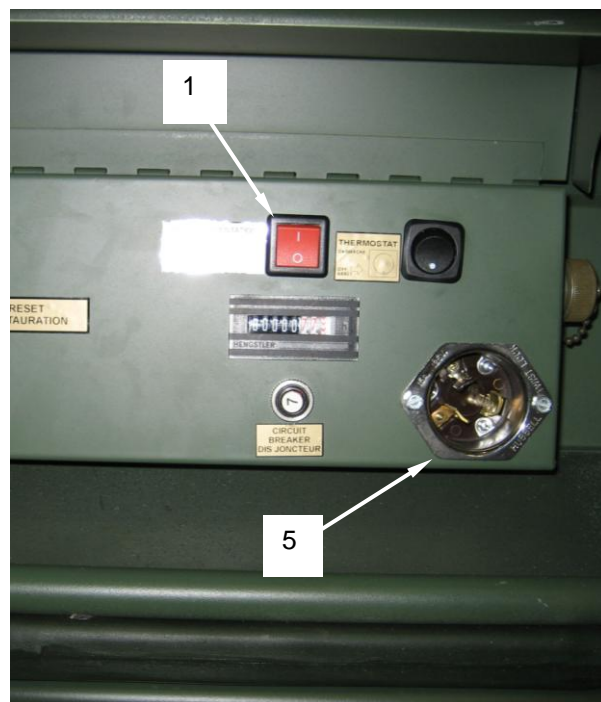
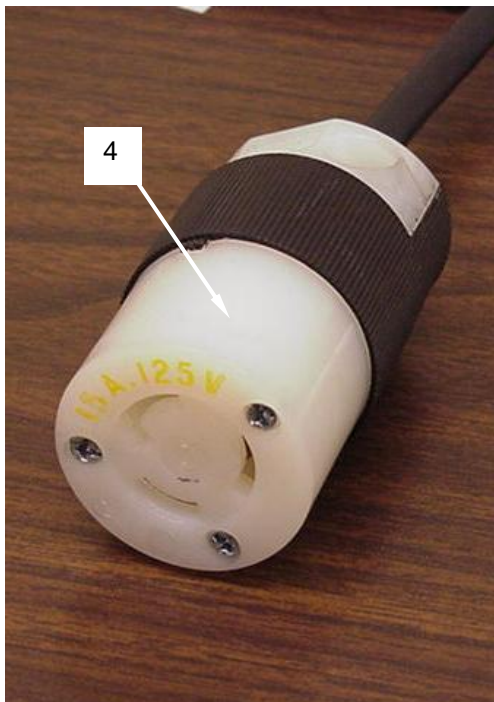
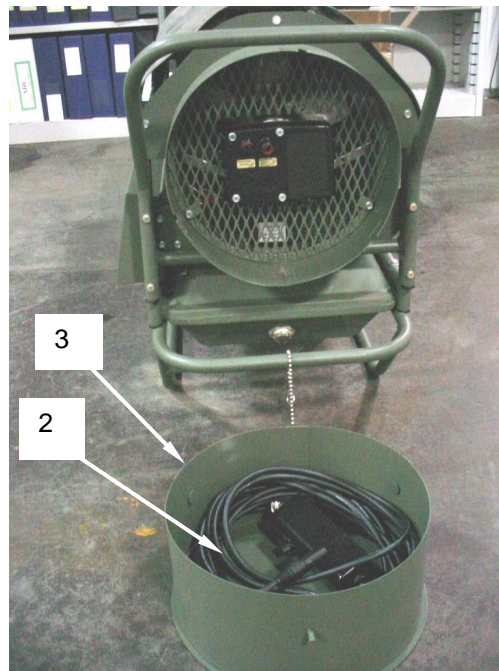
Connect the male end of the power cable **(2)** that was stowed inside the end plug **(3)** to a 120 volt, 60 cycle single phase VAC power source.

Connect the female twist lock end **(4)** of the power cable to the power entry connector **(5)** located on the right side of the control panel of the heater. Push the female twist lock end **(4)** into the power entry connector **(5)** and then rotate clockwise to lock.

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 2-3. 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 the fuel hose leading from the fuel can to the heater is not kinked or looped and lies flat on the ground (applies only to MV60X-1). Make sure all fuel connections are correct, secure, and do not leak at the gravity feed adapter or fuel quick disconnect connector at the heater.

2. Open internal fuel tank cap and check for an adequate fuel supply. If an external fuel source is being used, ensure that there is sufficient fuel in the external source. Ensure that fuel tank vent on cap 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, 120VAC 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 thermostat toggle switch to the OFF position if the heater is not being operated with the room thermostat control. If the room thermostat accessory is being used, set the thermostat toggle switch to the ON position and set the dial to the desired temperature. 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. Set Thermostat to call for heat.
3. Set power switch to the "ON" position; igniter and motor should start immediately.
4. Safety switch lockout will occur if flame is not established during the start up 30 second "trial for ignition" period. To restart, the safety switch must be manually reset.
5. Control will provide a 5 to 10 second ignition overrun time after the "trial ignition period" to prevent lockouts.
6. Burner will turn off when call for heat is satisfied.
7. 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 cycles three times, control will lock out. To reset, hold reset in for 5 seconds or until unit starts.

8. 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. If operating from the internal fuel tank, refuel in accordance with the section entitled "Fueling the Internal Fuel Tank".

If operating from an external fuel supply, replenish the supply and restart the heater in accordance with the section entitled "Starting the Heater".

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.

NOTE

If the heater should fail to ignite, or the fire goes out during operation, the safety control will shut off all power to the heater and render the heater inoperable. The heater will automatically try to restart in 120 seconds. If unsuccessful on 3 attempts, the safety control will lockout. If this occurs, hold reset for 5 seconds.

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 and stow inside the end plug.
3. Remove the remote room thermostat/CO detector assembly from the shelter (if used) and disconnect from the thermostat connector on the control panel. Coil the remote room thermostat/CO detector assembly cable and stow it in the end plug along with the power cable.
4. If operating from an external fuel supply, remove the fuel can from the fuel can stand and place on ground.
5. Disconnect the fuel hose from the Camfire heater and raise the end of the fuel hose so that it is higher than the level of the fuel can. Drain the fuel in the fuel hose back into the fuel supply.
6. Coil the fuel hose back to the fuel can and disconnect the fuel hose from the fuel can adapter fitting.
7. Connect the ends of the fuel hose together in order to prevent dirt or debris from entering the fuel hose connections.
8. Strike the fuel can stand and stow in a protected location.
9. 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.
10. 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.
11. Ensure that the power cable and remote room thermostat/CO detector assembly are 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.

12. 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 rinse with an approved agent. Start the heater and run out all residual fuel left in the system. Ensure that the vent on the fuel tank cap is open.

Lubricate all hinges.

Fog the entire heater with a thin layer of WD-40 or equivalent 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 "remedy" 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

3.2.1 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 training 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;	3
Heater Burns With Odor; Heater Smokes Continuously	
Flames And/Or Black Smoke Come Out Of Stack	4
Heater Cycles Intermittently	5
Heater Ignites But Safety Control Trips	6

3.2.2 Examining the Heater

1. Check the fuel tank for sludge and water. If you find it, expect to find a dirty nozzle and/or fuel filter.
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.

3.2.3 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.

3.2.4 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.	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 thermostat switch on the heater control box to the "OFF" 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 for further troubleshooting.

No.	Malfunction	Possible Cause	Corrective Action To Take
2.	Heater will not ignite, but motor runs for a short time.	G. Broken rotor or carbon blades. Pump rotor binding.	1. Refer the unit to maintenance for further troubleshooting.
		A. Fuel tank empty, wrong fuel, water in fuel.	1. Check level of fuel in tank. A minimum of 1 gallon is required for proper operation. 2. Ensure fuel is of a type indicated on the heater or listed in the Specifications, Section 1.5. 3. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank. 4. If water is found, refer the unit to maintenance.
		B. Air leak at fuel filter.	1. Check fuel filter for air leaks and tightness of fittings where filter joins fuel line.
		C. Defective or damaged spark plug.	1. Refer the unit to maintenance for further troubleshooting.
3.	Heater burns but puffs of smoke can be seen; heater will not burn steady; heater burns with odor; heater smokes continuously.	D. Defective transformer.	1. Refer the unit to maintenance for further troubleshooting.
		A. Heater running out of fuel, wrong fuel, water in fuel.	1. Check level of fuel in tank. A minimum of 1 gallon is required for proper operation. 2. Ensure fuel is of a type indicated on the heater or listed in the Specifications, Section 1.5. 3. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank. 4. If water is found, refer the unit to maintenance for repair.
		B. Dirty air filters causing reduced air pressure through nozzle resulting in low fuel flow.	1. Ensure air intake is not blocked. 2. Remove and clean air filters (see Section 4.4.8).

No.	Malfunction	Possible Cause	Corrective Action To Take
4.	Flames and/or black smoke come out of stack.	C. Dirty fuel filter.	1. Refer the unit to maintenance for further troubleshooting.
		D. Fuel filter loose.	1. Check fuel filter for air leaks and for tightness of fittings where filter joins fuel line.
		E. Dirty fuel nozzle.	1. Refer the unit to maintenance for further troubleshooting.
		F. Low pump output pressure (low motor speed, worn pump, pump out of adjustment).	<p>CAUTION</p> <p>Never use a drill, wire or other tool to open nozzle passage</p> <p>1. Ensure that no mechanical damage to the fan blades could be causing low motor speed.</p> <p>2. If mechanical damage is observed, refer the unit to maintenance for further troubleshooting.</p>
		G. Loose output airline between pump and burner head.	1. Tug airline at both connections to ensure that they are tight.
		A. Dirty fan or air passageway through heater blocked.	<p>1. Ensure that debris grill is clear. Ensure that fan is operating properly in accordance with Section 4.4.5.</p> <p>2. Ensure air passageway through heater is clear.</p>
		B. Pump output too high causing too much fuel to be supplied.	1. Refer the unit to maintenance for further troubleshooting.
5.	Heater cycles intermittently.	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.
		A. Thermostat (if used) set too low.	1. Set thermostat to a higher temperature for more even

No.	Malfunction	Possible Cause	Corrective Action To Take
			operation.
		B. Defective thermostat (if used).	<ol style="list-style-type: none"> 1. Set thermostat power switch on heater control box to "OFF" position. 2. If heater runs evenly, replace thermostat.
		C. Defective electrical supply or defective electrical connections.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. Refer the unit to maintenance for further troubleshooting.
		E. Unit is over heating.	<ol style="list-style-type: none"> 1. Check ducts for obstructions, or kinks. Straighten ducts to promote good airflow. 2. Remove inlet duct from heater.
6.	Heater ignites but safety control trips.	A. Dirty or defective photocell.	<ol style="list-style-type: none"> 1. Lift top cover. Open access hatch. Remove photocell from bracket attached to burner head. 2. Inspect glass face of photocell. If dirty, wipe with clean soft cloth. 3. Replace photocell and close access hatch. Start heater. If problem persists, notify maintenance.

3.3 Maintainer Level Troubleshooting

3.3.1 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.

3.3.2 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;	3
Heater Burns With Odor; Heater Smokes Continuously	
Flames And/Or Black Smoke Come Out Of Stack	4
Heater Cycles Intermittently	5
Heater Ignites But Safety Control Trips	6

3.3.3 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.	1. Lift top cover. Open access hatch. Remove photocell from bracket attached to burner head. 2. Disconnect blue and white photocell leads. 3. Connect ohmmeter test leads to photocell leads. 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. 5. Block off light completely by covering the open end of the photocell. Within 10 seconds the resistance indicated should be high. 6. Replace photocell if there is no change in resistance during this procedure.
		C. Defective CO detector	1. put the CO detector in self test mode as described in 2.5.6. if the CO detector does not calibrate replace it.
		D. Defective safety control.	1. Remove 4 screws holding the control box. Pull away from the electrical panel but do not disconnect any electrical connections. 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

No.	Malfunction	Possible Cause	Corrective Action To Take
			wire on the left side of the distribution bar.
			3. If one or both wires do not read 120 volts (approximately) replace the safety control.
			NOTE After replacing the safety control, check the ignition transformer as follows before starting the heater.
			4. Remove screen from inlet end of heater. Disconnect the red and white transformer leads.
			5. Attach ohmmeter test leads to the red and white transformer leads. The ohmmeter should indicate an open line (no conductance).
		E. Broken rotor or carbon blades. Pump rotor binding.	1. Remove pump end cover and pump front cover.
			2. Visually inspect rotor and blades for breakage.
			3. Ensure that the rotor and blades are free of any lubricant or debris.
			4. Check rotor with feeler gauge for proper clearance between rotor and pump body (see Section 4.4.4).
2.	Heater will not ignite, but motor runs for a short time.	A. Fuel tank empty, wrong fuel, water in fuel.	1. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of the fuel tank.
			2. If water is found, drain and clean tank and filter. Fill with fresh, clean fuel.
		B. Defective or damaged spark plug.	1. Remove spark plug from burner head. Visually inspect spark plug for cracks or worn

No.	Malfunction	Possible Cause	Corrective Action To Take
			electrodes.
			2. Adjust spark plug gap (see Section 4.4.3).
			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.
			4. Start heater; observe the spark between the plug's electrodes. If the ground is good and spark does not jump between the electrodes, replace spark plug.
		C. Defective transformer.	<p><u>WARNING</u></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.</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>
3.	Heater burns but puffs of smoke can be seen; heater will not burn steady; heater	A. Heater running out of fuel, wrong fuel, water in fuel.	1. Check for water in the fuel tank. Water in the fuel will form visible globules in the bottom of

No.	Malfunction	Possible Cause	Corrective Action To Take
	burns with odor; heater smokes continuously.		the fuel tank. 2. If water is found, drain and clean tank and filter. Fill with fresh, clean fuel.
		B. Dirty fuel filter.	1. Remove and clean fuel filter (see Section 4.4.6). 2. Replace a blocked filter.
		C. Low pump output pressure (low motor speed, worn pump, pump out of adjustment).	CAUTION Never use a drill, wire or other tool to open nozzle passage. 1. Check and adjust pump output pressure (see Section 4.4.8). 2. Repair or replace pump if adjustment cannot be made (see Section 4.4.8).
4.	Flames and/or black smoke come out of stack.	A. Pump output too high causing too much fuel to be supplied.	1. Check and adjust pump output pressure.
		B. Fan loose or improperly located on shaft.	1. Check and tighten hex screw located on rear of fan hub. 2. Ensure fan is in correct location (see Section 4.4.5).
		C. Bent or damaged fan.	1. Replace a damaged fan. DO NOT ATTEMPT TO REPAIR A DAMAGED FAN.
5.	Heater cycles intermittently.	A. Defective overheat switch.	1. Remove leads from overheat switch (located at output end of heater). 2. Using a test lead with 2 alligator clips, jump overheat leads (white wires are low voltage). 3. Start heater. If heater runs properly, replace overheat switch.
6.	Heater ignites but safety	A. Dirty or defective photocell.	1. Disconnect blue and white

No.	Malfunction	Possible Cause	Corrective Action To Take
	control trips.		<p>photocell leads.</p> <p>2. Connect ohmmeter test leads to photocell leads.</p> <p>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.</p> <p>4. Block off light completely by covering the open end of the photocell. Within 10 seconds the resistance indicated should be high.</p> <p>5. Replace photocell if there is no change in resistance during this procedure.</p>
		B. Defective overheat switch.	<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 low voltage).</p> <p>3. Start heater. If heater runs properly, replace overheat switch.</p>

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.

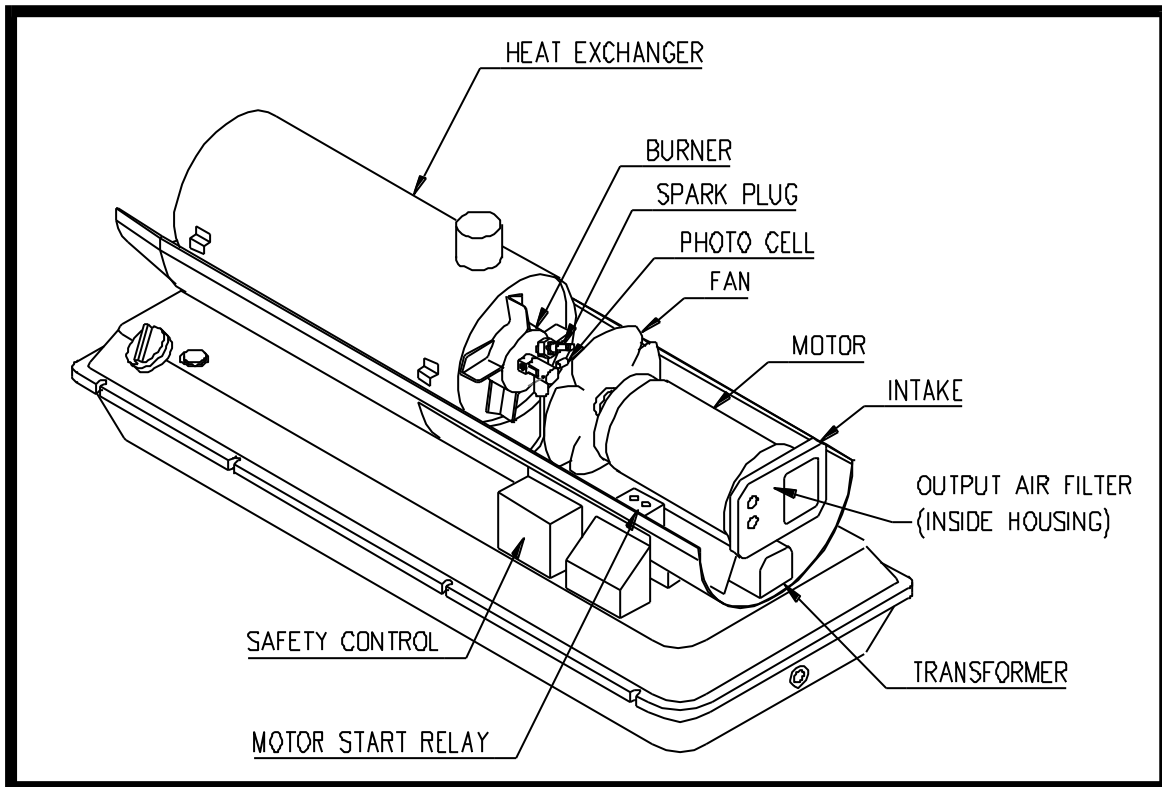


Figure 4-1. Camfire Maintenance Locations

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.

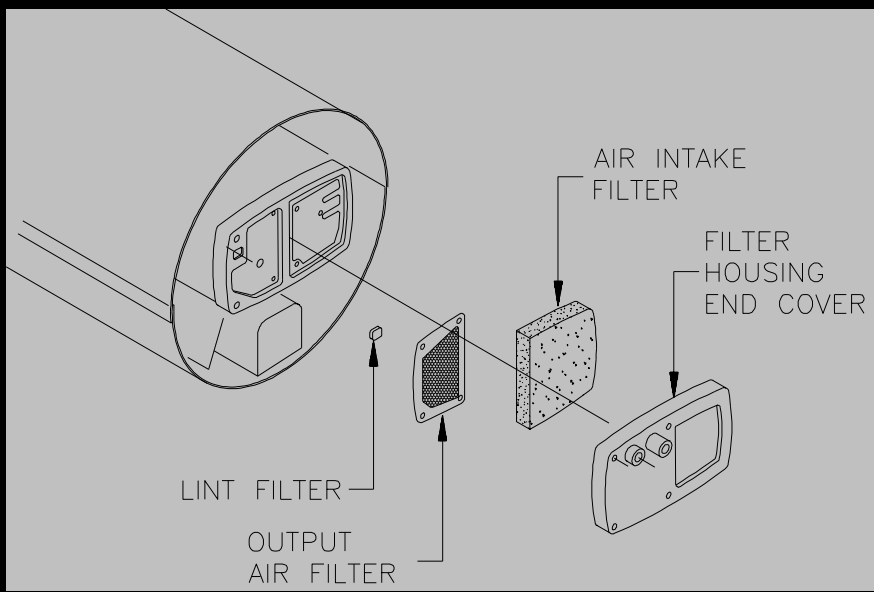
1. To remove upper shell of the heater, first remove top shroud, inlet and outlet duct adapters and eight screws from split seam of upper and lower shells. Slide upper shroud out of frame.

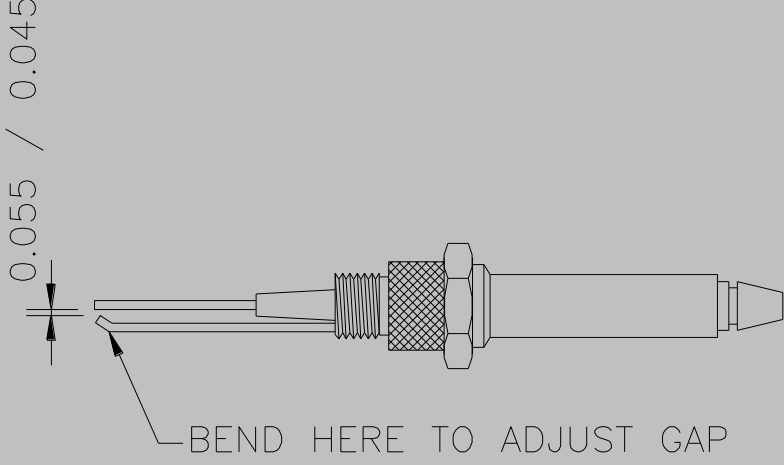
2. To replace the upper shell, align the eight holes located along its lower edge over the eight speed nuts on the lower shell and install the screws. Replace top shroud and duct adapters in the reverse order.

4.2.3 Operator 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	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;"><u>CAUTION</u></p> <p style="text-align: center;">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;"><u>NOTE</u></p> <p>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:
		ITEM TO CHECK/SERVICE		
				
3	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.
4	Every 1000 hours or at beginning of new heating season	Spark Plug	<p><u>WARNING</u></p> <p>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:
		ITEM TO CHECK/SERVICE		
				
5	Every 1000 hours or at beginning of new heating season	Fuel Filter	<ol style="list-style-type: none"> 1. The fuel filter is located on the fuel line assembly, which leads up from the fuel tank to the burner. Change it twice each season, or if the trouble-shooting chart indicates. 2. To remove the fuel filter, gently pull both male ends out of the gas line. 3. Replace dirty filter with new. 4. When re-installing the filter, moisten the male ends and simply insert into gas line. Be sure to position filter according to arrow on side. <p style="text-align: center;">NOTE</p> <p>If the burner head is to be removed for maintenance, do not re-install the fuel filter until ready to re-install the burner.</p>	Fuel filter dirty or damaged.
6	Every 1000 hours or at beginning of new heating season	Burner	<ol style="list-style-type: none"> 1. 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. 2. Remove the photocell assembly from its bracket. Then remove the screws that 	Burner nozzle clogged, dirty, or otherwise damaged. Photocell dirty or damaged.

ITEM NO.	INTERVAL	LOCATION	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
		ITEM TO CHECK/SERVICE	<p>fasten the burner head to the combustion chamber and remove the burner head.</p> <p>3. Remove the nozzle carefully, using a socket wrench. Hold the nozzle adapter with another wrench while removing the nozzle.</p> <p style="text-align: center;">CAUTION</p> <p>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.</p> <p>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 through fittings in rear of burner. Blow the nozzle dry through the face (outlet) end only.</p> <p>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.</p> <p>6. Connect the fuel filter assembly and the air line from the filter housing to its respective fittings on the nozzle adapter.</p> <p>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.</p>	

ITEM NO.	INTERVAL	LOCATION	PROCEDURE	NOT FULLY MISSION CAPABLE IF:
		ITEM TO CHECK/SERVICE		
			CAUTION Do not attempt to repair the nozzle. If the nozzle is defective, replace it.	

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, 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/CO detector assembly (Inspect/Test)

INITIAL SETUP

Tools:

Multimeter

Personnel Required:

One

Materials/Parts:

None required

Equipment Condition:

Heater shut down and cool, Remote room thermostat/CO detector assembly 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.

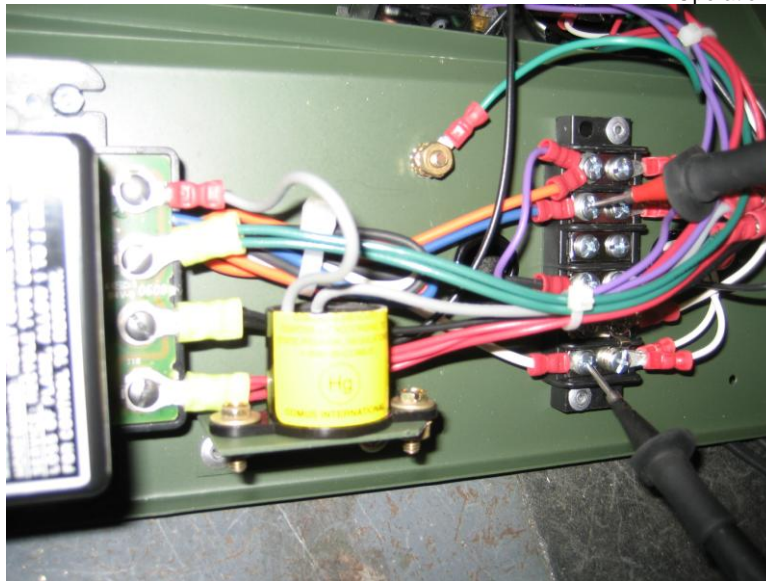


4. Remove the control panel.

WARNING

120VAC is present in the following steps. Take proper precaution against electrical shock before proceeding.

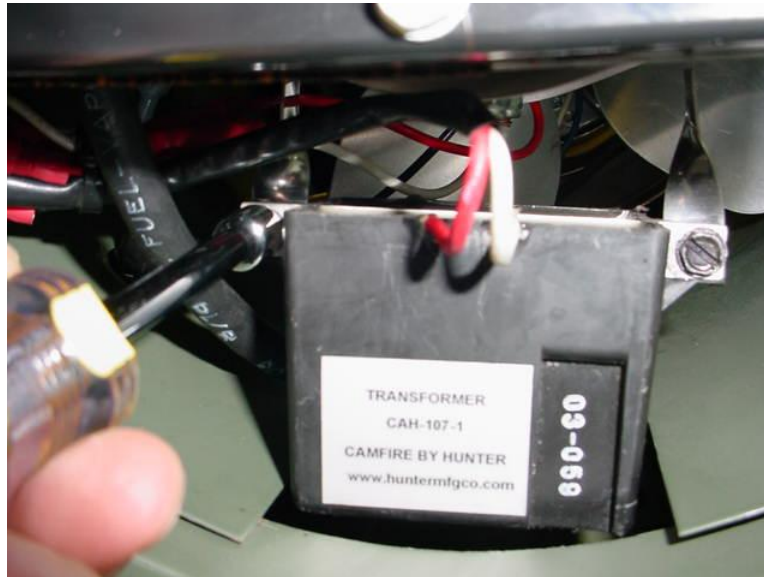
5. Plug the heater in and turn power switch to on.
6. Place probes on (top to bottom) #2 blue and #6 white.
7. When the heater starts there should be 120vac. If not replace the safety control.



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 grommet around ignition wire.
11. Remove the spark plug boot and attach a piece of wire or cable to the end of the ignition wire and pull ignition wire through heater.
12. Attach wire or cable to new ignition wire and pull back through heater. Replace grommet and spark plug boot.



13. Reinstall the attaching screws, and make wiring connections in accordance with step 11.
14. Snap the spark plug lead tightly onto the plug terminal to prevent its coming loose when the heater is moved.



4.4.4 Checking Motor Starting Circuits (Test)

INITIAL SETUP

Tools:

Multimeter

Personnel Required:

One

Materials/Parts:

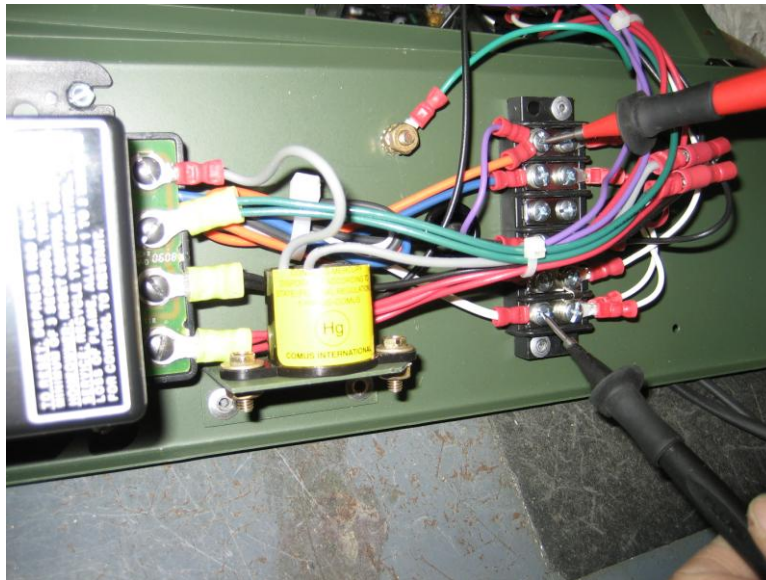
None required

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 120 VAC.



5. The heaters have ¼ horsepower motors and separate starting relays. See the wiring diagram, Figure 4-2.

NOTE

The starting relay is "position sensitive" and must be tested in the same position as when installed in the heater (with the contacts on the bottom).

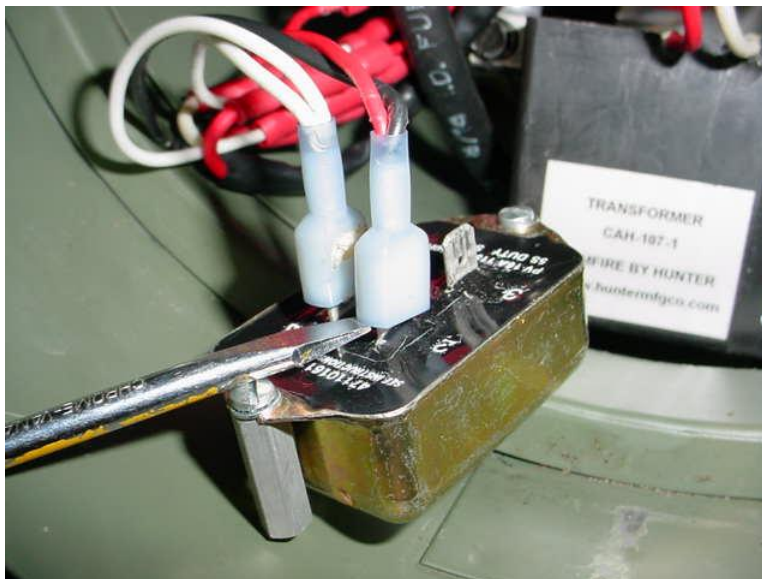
6. Take the relay out of the heater by taking out the screw that holds its bracket to the left side of the lower shell near the motor.

CAUTION

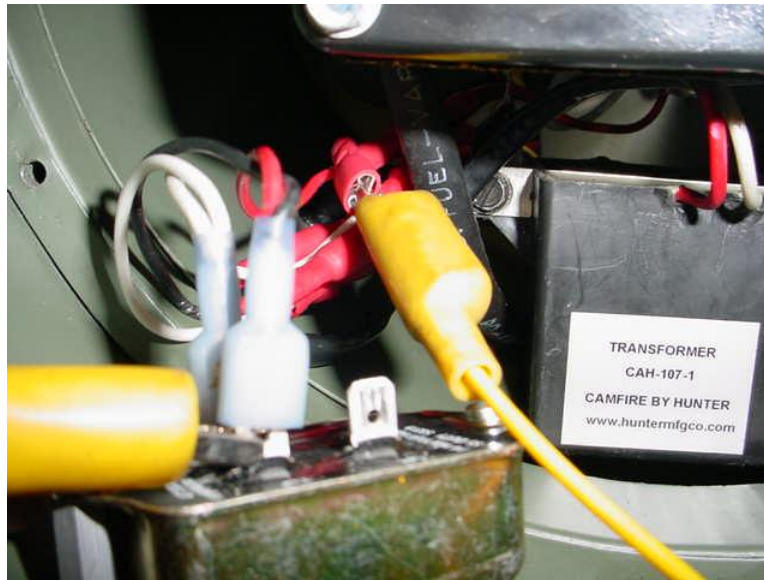
Avoid touching the bare wires or the exposed wire terminals.



7. Lift the terminal partially so that you can attach a jumper to the terminal.



8. Take the black motor wire off its terminal (3) of the starting relay. Attach the jumper to the terminal (2) of the red lead and plug in the heater. The motor should start. As soon as the motor reaches operating speed, remove the jumper from terminal (2). The motor should continue to run.
9. If the motor starts and continues to run install a new relay. Disconnect the power cord and re-connect the wiring according to the wiring diagram. See Figure 4-2.
10. If the motor fails to start and the relay is found not to be the cause of failure, disconnect the power cord and remove the motor. Install a new motor.



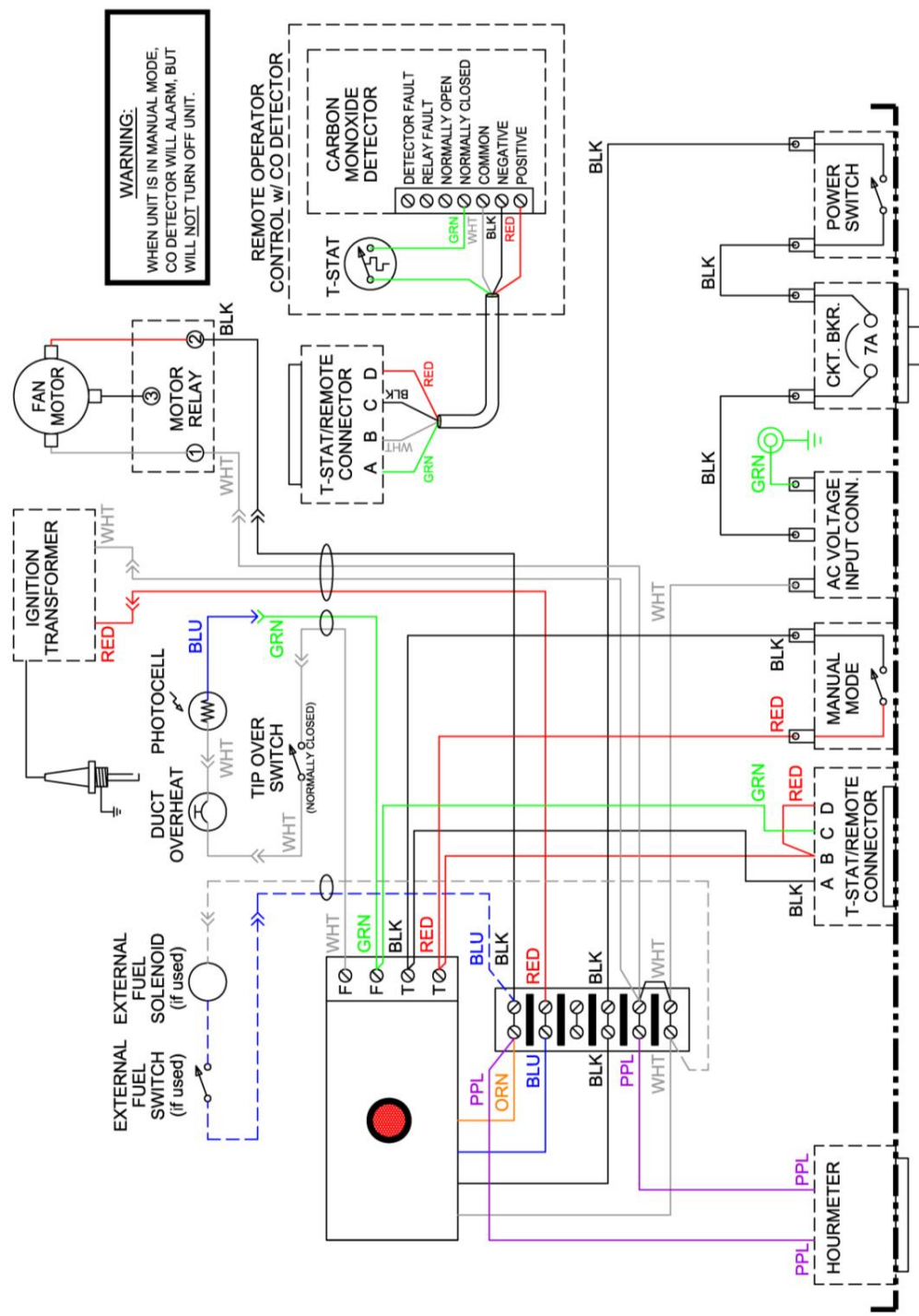


Figure 4-2. Wiring Diagram

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 of the motor shaft. Make sure the fan is in the same position and location as before it was removed. See Figure 4-3.

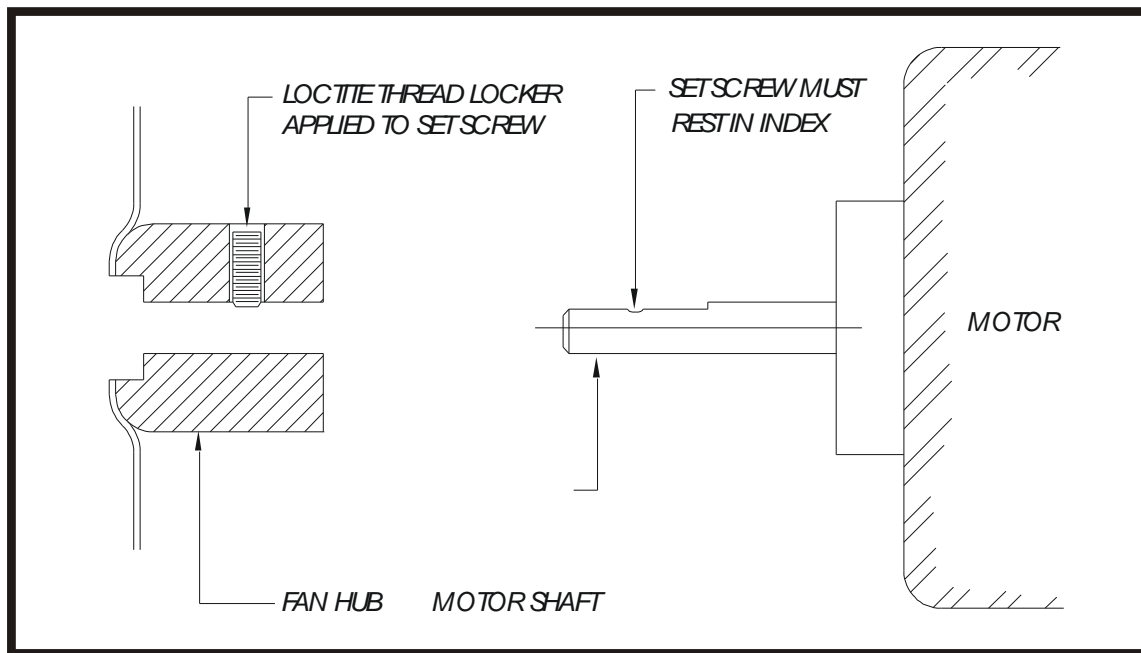


Figure 4-3. Location of Fan on Shaft

4.4.6 Fuel Filter Service

INITIAL SETUP

Tools:

Flat blade screwdriver

Personnel Required:

One

Materials/Parts:

None required

Equipment Condition:

Heater shut down and cool. Power disconnected.

-
1. Remove the fuel filter from the heater and clean it as described in Section 4.2.3.
 2. Before reinstalling the fuel filter check the rubber bushing where it enters the fuel tank. Be sure the bushing is in good condition, not cut or cracked. Replace a damaged bushing.
 3. Reinstall the fuel filter according to Section 4.2.3. Replace with a new filter if the connecting parts are damaged thus preventing a tight connection.

4.4.7 Burner Head Service (Clean)

INITIAL SETUP

Tools:

3/8" open wrench
5/8" socket

Materials/Parts:

Dry cleaning fluid

Personnel Required:

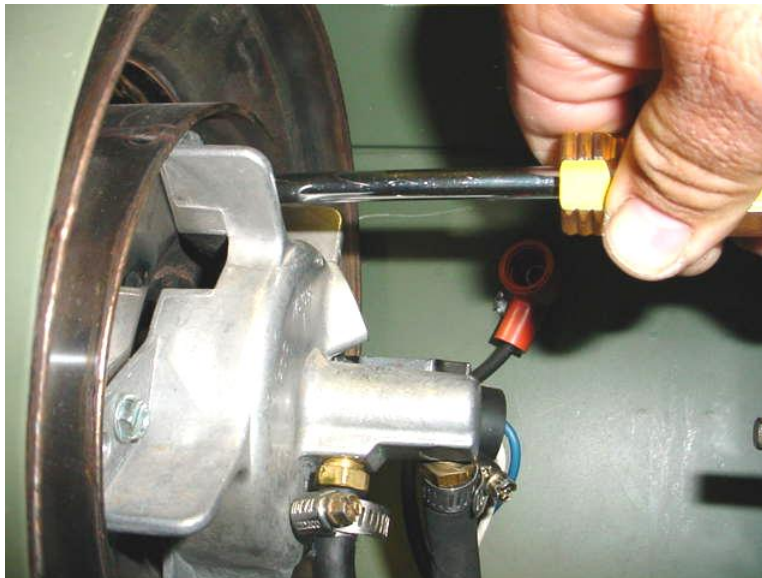
One

Equipment Condition:

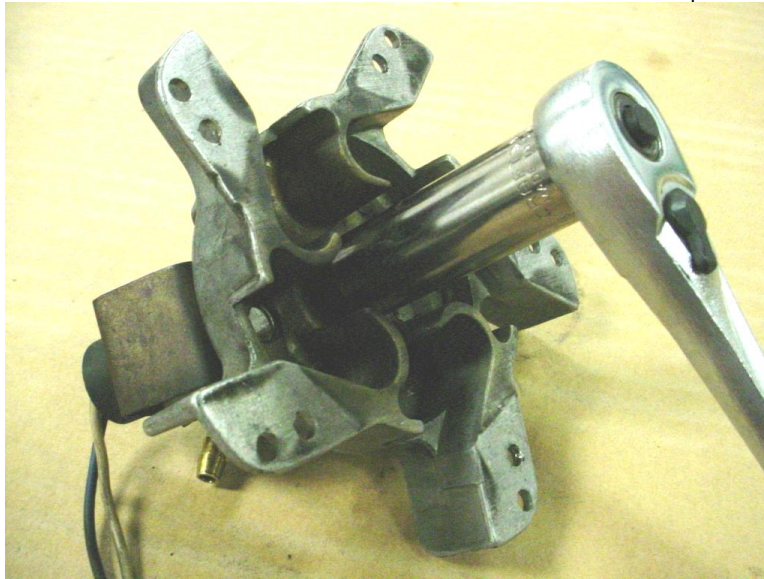
Heater shutdown and cool. Power cable disconnected. Upper cover removed.

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

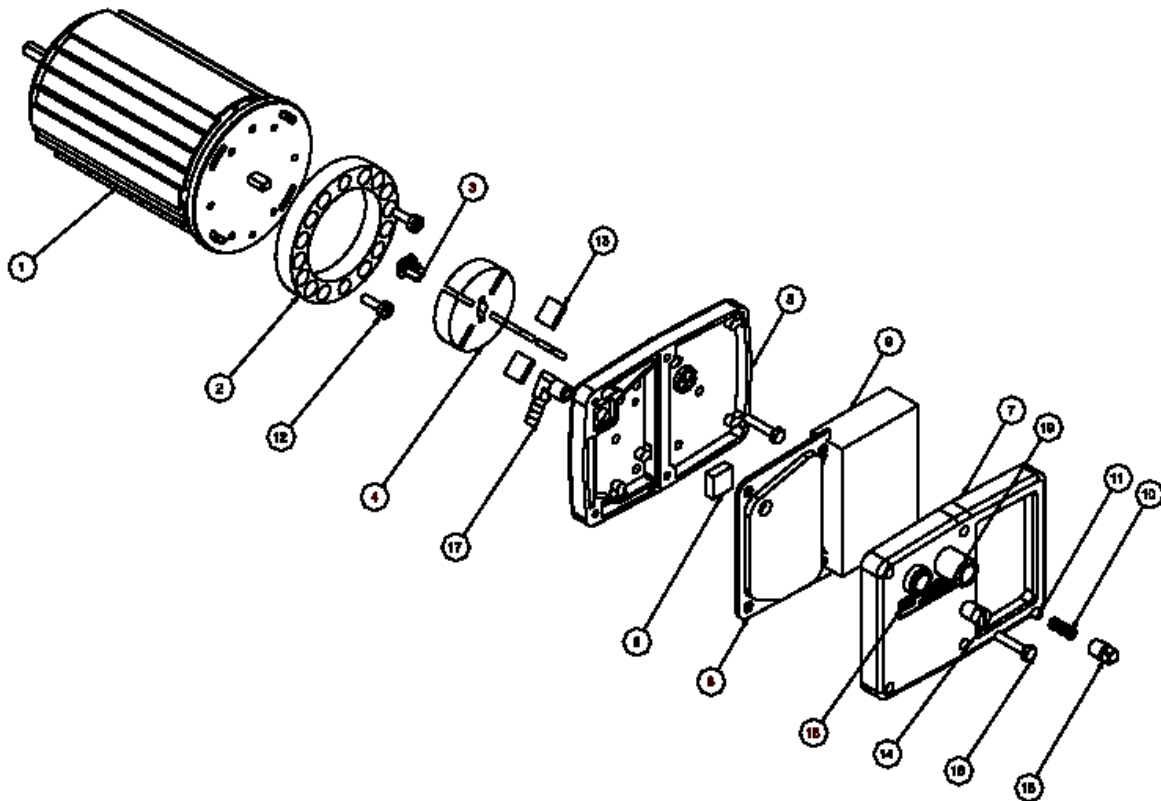
Because of the close tolerance and critical positioning of the parts, we recommend that only skilled technician attempt any repair of the air pump.

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.



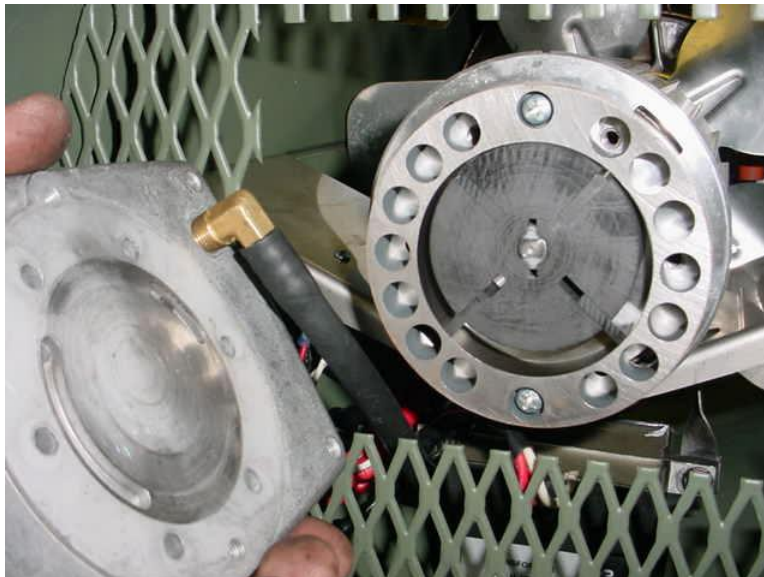
3. Remove lint filter and clean by flicking back and forth with a finger to remove any debris.



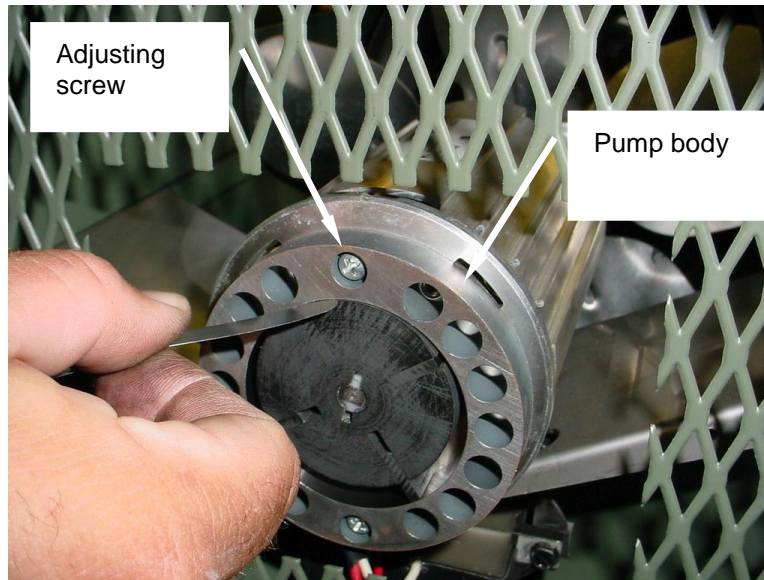
4. Remove the six screws that hold down the front cover to the pump body.



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.



TEST

1. Remove the plug from the air filter housing, and install the pressure gauge into the hole.
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 5.5 PSI plus or minus 1/4 pound for most efficient performance. If the pressure is not within this range, adjust the pressure relief valve.
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.

CAUTION

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

5. Remove the gauge and replace the plug.



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.

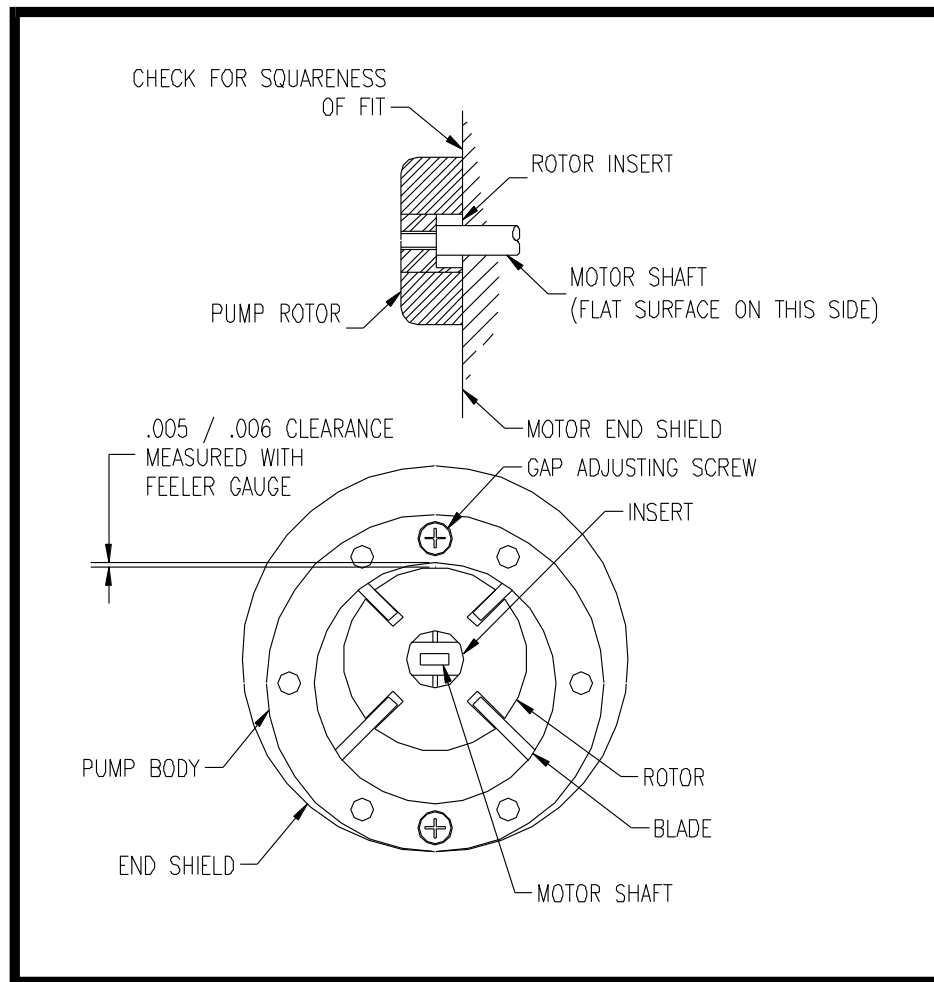


Figure 4-4. Checking clearance of air pump rotor

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 fuel filter 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:

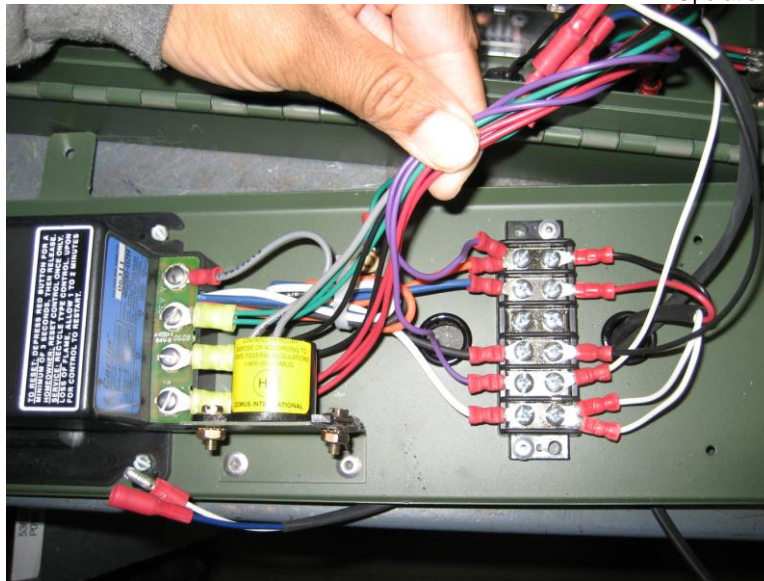
Heater shutdown and cool. Power cable disconnected. Upper cover removed.

TEST

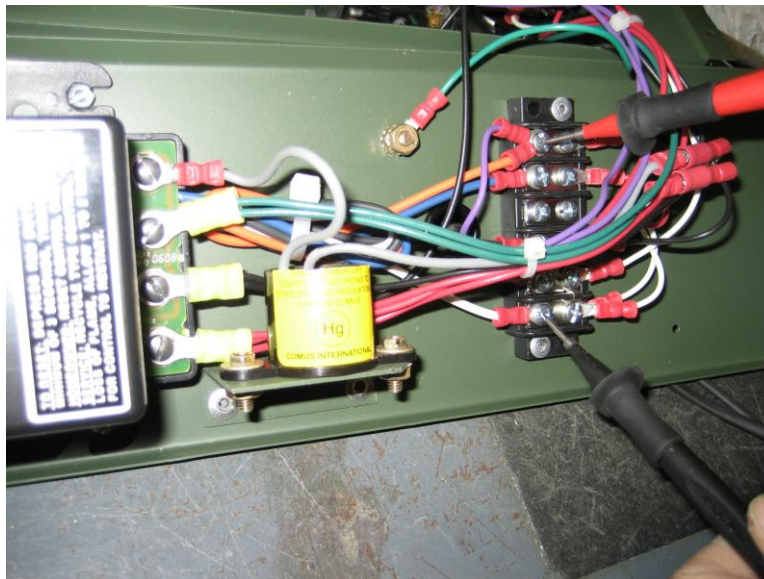
1. Remove 4 screws holding the control box. Pull away from the electrical panel but do not disconnect any electrical connections. Make sure thermostat switch is in off position.



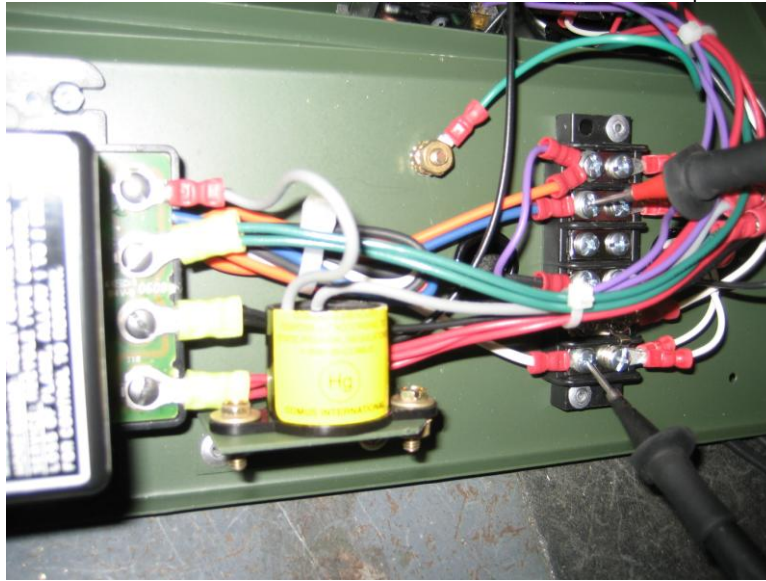
2. **Power Circuits.** Attach one test lead of a voltmeter to #1 (white) on the terminal block. Plug heater in and switch on. Touch the other test lead to #3 black wire. Verify that 120VAC is present. This is the power to the safety control.



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.



5. Then to the #5 blue wire on the left side of the terminal block. This is the power to the ignition transformer.
6. If you have power on #6 but not #5, replace the safety control.

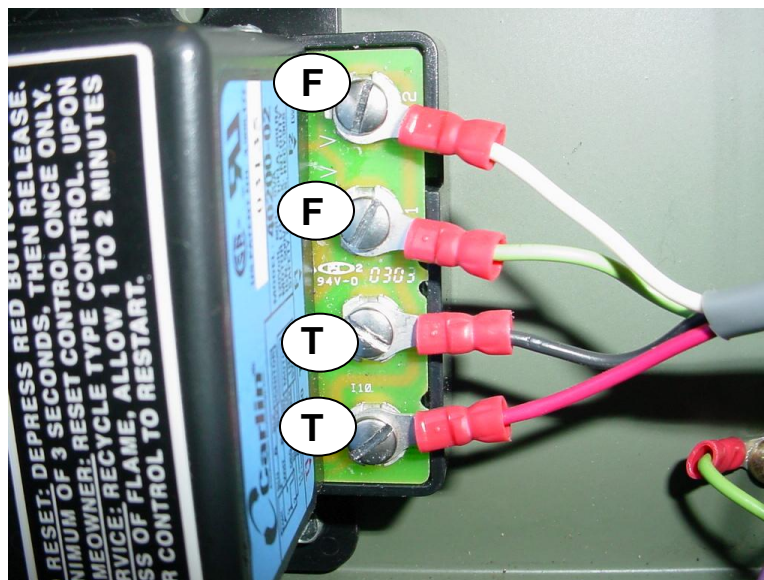


7. **Control Circuits.** If there is no power on #5 and #6 check the control circuits as follows:

“T” Circuit, this the thermostat circuit. Jumper T and T. Start heater. If Heater starts, check wires and connections going to the safety control.

“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.



8. 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.
9. 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.
10. 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.

Chapter 5

Illustrated Parts Listing

5. Illustrated Parts Listing

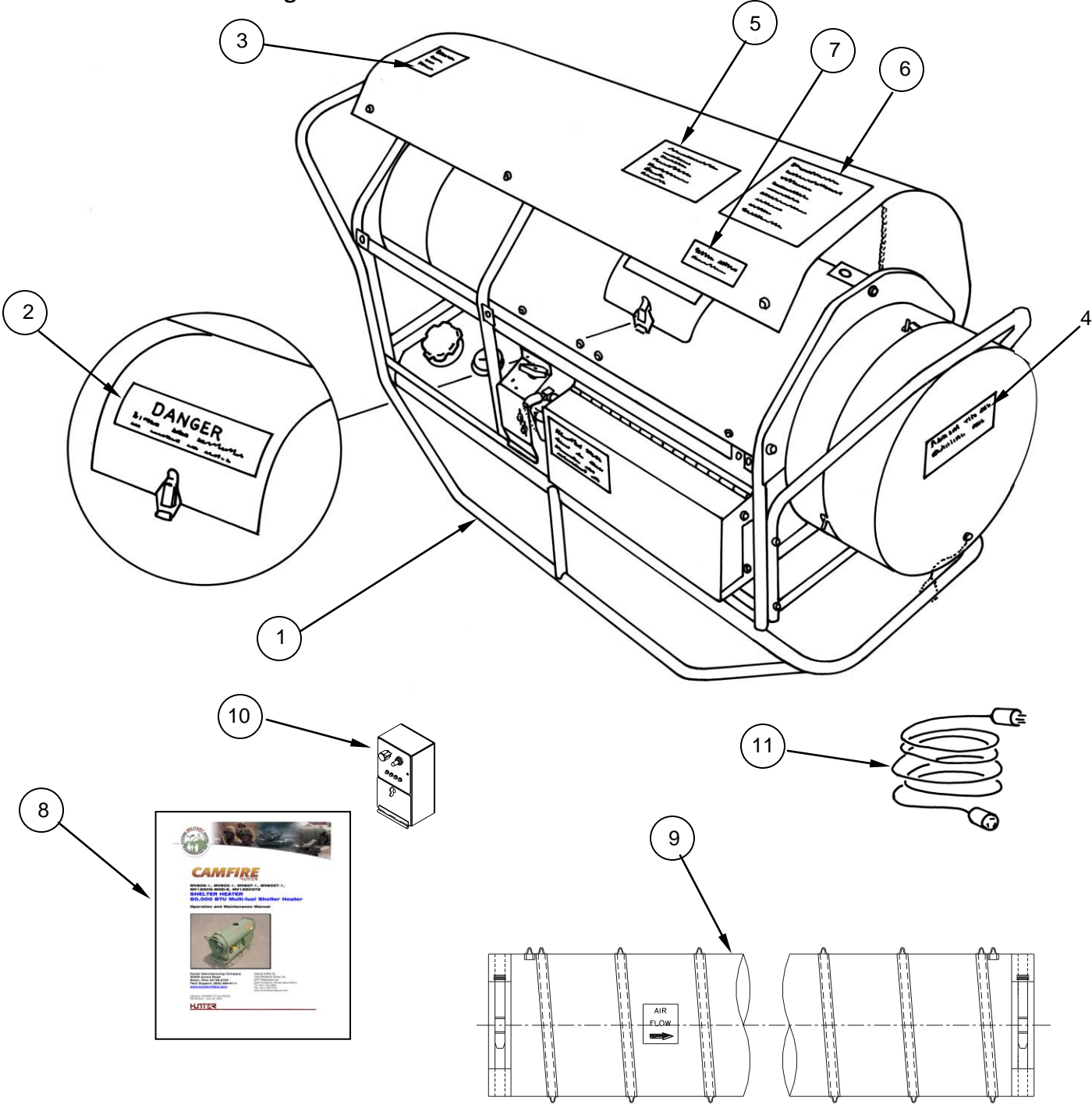


Figure 5-1. MV60 Labels and Accessories

Table 5-1. MV60 Labels and Accessories

PARTS LIST
MV60 LABELS AND ACCESSORIES

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO. (MV125-DND)	DESCRIPTION
1	1	53313	53313	I.D. PLATE
2	1	53328	53328	DECAL, FAN COMPARTMENT
3	1	53330	53330	DECAL, DUCT TEMP
4	1	53331	53331	DECAL, STORAGE CAP
5	1	53332	53332	DECAL, START UP PROCEDURE
6	1	53334	53334	DECAL, OPERATING INSTRUCTIONS
7	1	53340	53340	DECAL, VOLTAGE
8	1	53371	53371	TECHNICAL MANUAL
9	1	CAH-1015	CAH-1015	DUCT, 12' X 15' (OPTIONAL)
10	1	CAH-134-1	15005	ROOM THERMOSTAT
11	1	CAH-133-3	CAH-133-3	POWER CABLE

Table 5-2. Additional Authorized Items

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO. (MV125-DND)	DESCRIPTION
1		CAH-1081	CAH-1081	SPARE PARTS KIT
2		CAH-151	CAH-151	INPUT "Y" ADAPTER
3		CAH-150	CAH-150	OUTPUT "Y" ADAPTER
4		CAH-153	CAH-153	3 WAY ADAPTER 12"TO6"X6"X6"
5		CAH-146	CAH-146	PRESSURE GUAGE

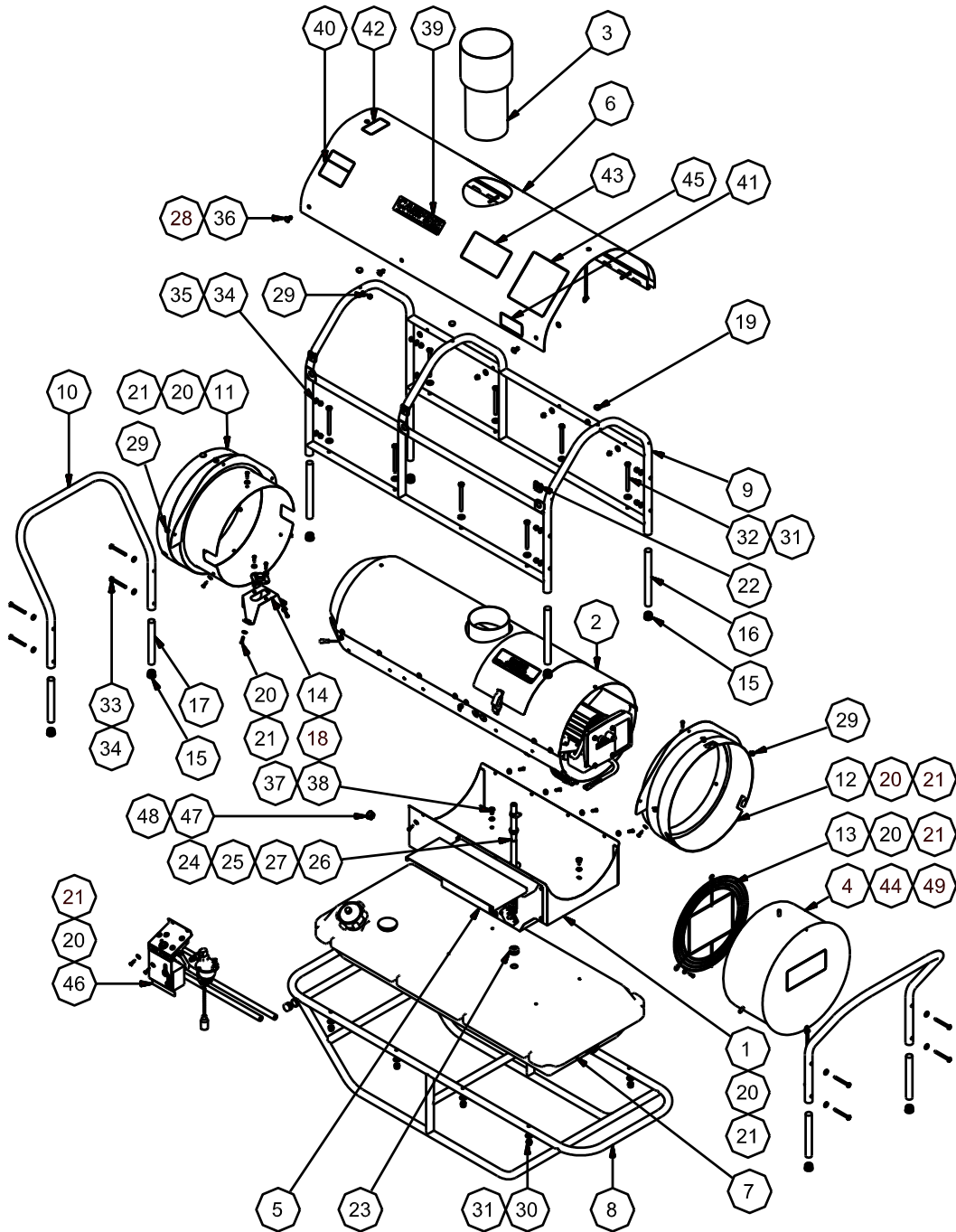


Figure 5-2. MV60 FULL ASSEMBLY

Table 5-3. MV60 Full Assembly

PARTS LIST
MV60 FULL ASSEMBLY

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO. (MV125-DND)	DESCRIPTION
1	1	53472	53472	FUEL TANK BRACKET
2	1	COMBUSTION CHAMBER ASSEMBLY	COMBUSTION CHAMBER ASSEMBLY	COMBUSTION CHAMBER ASSEMBLY
3	1	CAH-132	CAH-132	STACK EXTENSION
4	1	53477	CAH-126-1	ACCESSORY PLUG
5	1	53504	53504	CONTROL BOX ASSEMBLY
6	1	53471	CAH-131(D)	TOP COVER
7	1	53463	CAH-102(D)	FUEL TANK
8	1	53464	CAH-100(E)	LOWER FRAME
9	1	53465	CAH-103(C)	UPPER FRAME
10	2	53470	CAH-127	HANDLE
11	1	53468	CAH-123(D)	OUTPUT ADAPTER
12	1	53469	CAH-125	INPUT ADAPTER
13	1	53443	CAH-125-1	INPUT ADAPTER WIRE SCREEN
14	1	53455	CAH-124-1	OVERHEAT SWITCH BRACKET
15	10	CAH-103-2	CAH-103-2	PRESS-FIT GLIDE, ROUND, FITS .58" TO .68" ID & 3/4" OD TUBE
16	4	CAH-103-1B	CAH-103-1	WOODEN INSERT (FRAME) 5/8 DIA X 6-1/2" LONG
17	4	CAH-103-1A		WOODEN INSERT (FRAME) 5/8 DIA X 5" LONG
18	1	CAH-124-6	CAH-124	OVERHEAT SWITCH
19	3	53479	CAH-131-S	RUBBER BUMPER
20	23	MS51849-54	MS51849-54	#8-32 UNC X 1/2 LG HEX HD SLOTTED MACHINE SCREW
21	23	MS27183-41	MS27183-41	3/16 ID X 7/16 OD FLAT WASHER
22	3	CAH-131-7	CAH-131-7	1/4 TURN RECEPTACLE
23	1	CAH-102-2(D)	CAH-102-2(D)	RUBBER GROMMET
24	1	MIL-H-13444-3	MIL-H-13444-3	MIL-H-13444 LONG FUEL LINE
25	1	MIL-H-13444-8	MIL-H-13444-8	MIL-H-13444 SHORT FUEL LINE
26	1	CAH-108-2	CAH-108-2	FUEL LINE FILTER
27	1	170607	170607	CLAMP HOSE MICRO GEAR
28	3	CAH-131-6	CAH-131-6	PUSH-ON RETAINER
29	8	CAH-142	CAH-142	#10-16 UNC X 1/2 LG HEX HD SLOTTED TAPPING SCREW
30	8	CAH-139(D)	CAH-139(D)	1/4-20 UNC HEX LOCKNUT W/NYLON INSERT
31	16	CAH-138(D)	CAH-138(D)	1/4 FLAT WASHER
32	8	CAH-137(D)	CAH-137(D)	1/4-20 UNC HEX HD BOLT X 3 LG
33	8	CAH-137-1	CAH-137-1	#10-32 UNF HEX HD SLOTTED MACHINE SCREW X 1-7/8 LG
34	20	CAH-138-1	CAH-138-1	#10 FLAT WASHER
35	12	CAH-139	CAH-139	#10-32 UNF HEX LOCKNUT W/NYLON INSERT
36	13	CAH-131-5	CAH-131-5	1/4 TURN STUD
37	4	CV-102-3	CV-102-3	WASHER 1/4 LOCKING EXTERNAL TOOTH
38	4	CV-102-2	CV-102-2	1/4-20 UNC HEX HD BOLT X 3/8 LG
39	2	53315	53315	DECAL SMALL CAMPFIRE BY HUNTER
40	1	53329	53329	DECAL WARNING FUEL USE
41	1	53340	53340	DECAL WARNING 110VAC ONLY
42	1	53330	53330	DECAL WARNING OUTLET RING
43	1	53332	53332	DECAL START UP PROCEDURE
44	1	CAH-136	CAH-136	SPLIT RING
45	1	53334	53334	DECAL OPERATING INSTRUCTIONS
46	1	53511	53511	EXTERNAL FUEL SUPPLY ASSEMBLY
47	1	CAH-105-2	CAH-105-2	WIRING GROMMET (MEDIUM)
48	1	CAH-134-1	CAH-134-1	REMOTE THERMOSTAT
49	1	3777	3777	PLUG BOTTOM (FITS 1/2" DIA. HOLE)
50	1	53331	53331	DECAL STORAGE CAP

*ITEM #46 = 53511~EXTERNAL FUEL SUPPLY ASSEMBLY TO BE USED ON MV60X-1 (53457-2) ONLY

*ITEM #48 = 3777~PLUG BOTTOM (FITS 1/2" DIA. HOLE) TO BE USED ON MV60S-1 53457-1) ONLY

REPLACEMENT PART NO. 53507~ACCESSORY PLUG ASSEMBLY (TO INCLUDE ITEMS 4, 28, 36, 44, AND 49)

REPLACEMENT PART NO. 53508~TOP COVER ASSEMBLY (TO INCLUDE ITEMS 6, 40 THRU 43 AND 45)

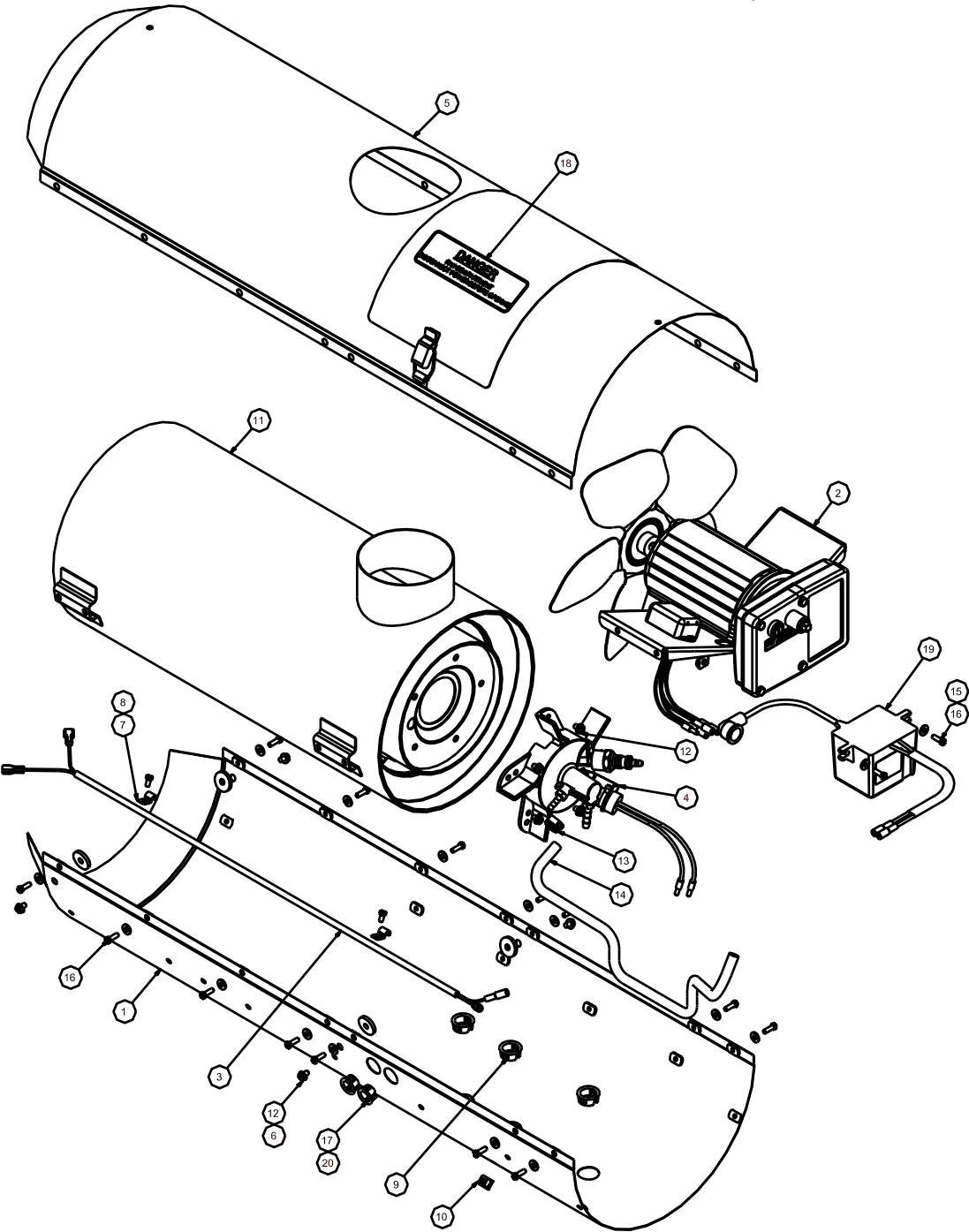


Figure 5-3. COMBUSTION CHAMBER ASSEMBLY

Table 5-4. Combustion Chamber Assembly

PARTS LIST
COMBUSTION CHAMBER ASSEMBLY

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	53466	CAH-104(D)	LOWER SHELL
2	1	53489	M-100	MOTOR/PUMP & BRACKET ASSEMBLY
3	1	CAH-109-3	CAH-109	ELECTRICAL CONDUIT ASSEMBLY
4	1	B-200	B-200	BURNER HEAD ASSEMBLY
5	1	53467	CAH-115	UPPER SHELL
6	4	CAH-101(D)	CAH-101(D)	SPACER
7	2	CAH-109-1	CAH-109	CONDUIT CLAMP
8	2	CAH-141	CAH-141	#8-32 UNF X 5/16 LG HEX HD SLOTTED TAPPING SCREW
9	3	CAH-105-1	CAH-105	WIRING GROMMET (LARGE)
10	1	CAH-105	CAH-105	WIRING GROMMET (SMALL)
11	1	CAH-111-2	CAH-111	COMBUSTION CHAMBER
12	9	CAH-142	CAH-142	#10-16 UNC X ½ LG HEX HD SLOTTED TAPPING SCREW
13	1	170607	170607	CLAMP HOSE MICRO GEAR
14	1	51965-24	CAH-110	HOSE RUBBER REINFORCED 3/16" I.D.
15	16	MS27183-41	MS27183-41	3/16 ID X 7/16 OD FLAT WASHER
16	16	MS51849-54	MS51849-54	#8-32 UNC X ½ LG HEX HD SLOTTED MACHINE SCREW
17	2	CAH-105-2	CAH-105-2	WIRING GROMMET (MEDIUM)
18	1	533228	533228	DECAL DANGER FAN COMPARTMENT
19	1	CAH-107-1	CAH-107-1	IGNITION TRANSFORMER ASSEMBLY
20	2	53500	53500	¾" DIA. PLUG (NOT TO BE USED WITH EXTERNAL FUEL SYSTEM)

*ITEM #17= CAH-105-2 ~ WIRING GROMMET (MEDIUM) TO BE USED ON MV60X-1 (534578-2) ONLY

*ITEM #20 = 53500 ~ ¾: DIA. PLUG TO BE USED ON MV60S-1 (53457-1) ONLY

*REPLACEMENT PART NO. 53506 ~ UPPER SHELL ASSEMBLY (TO INCLUDE ITEMS 5 AND 18)

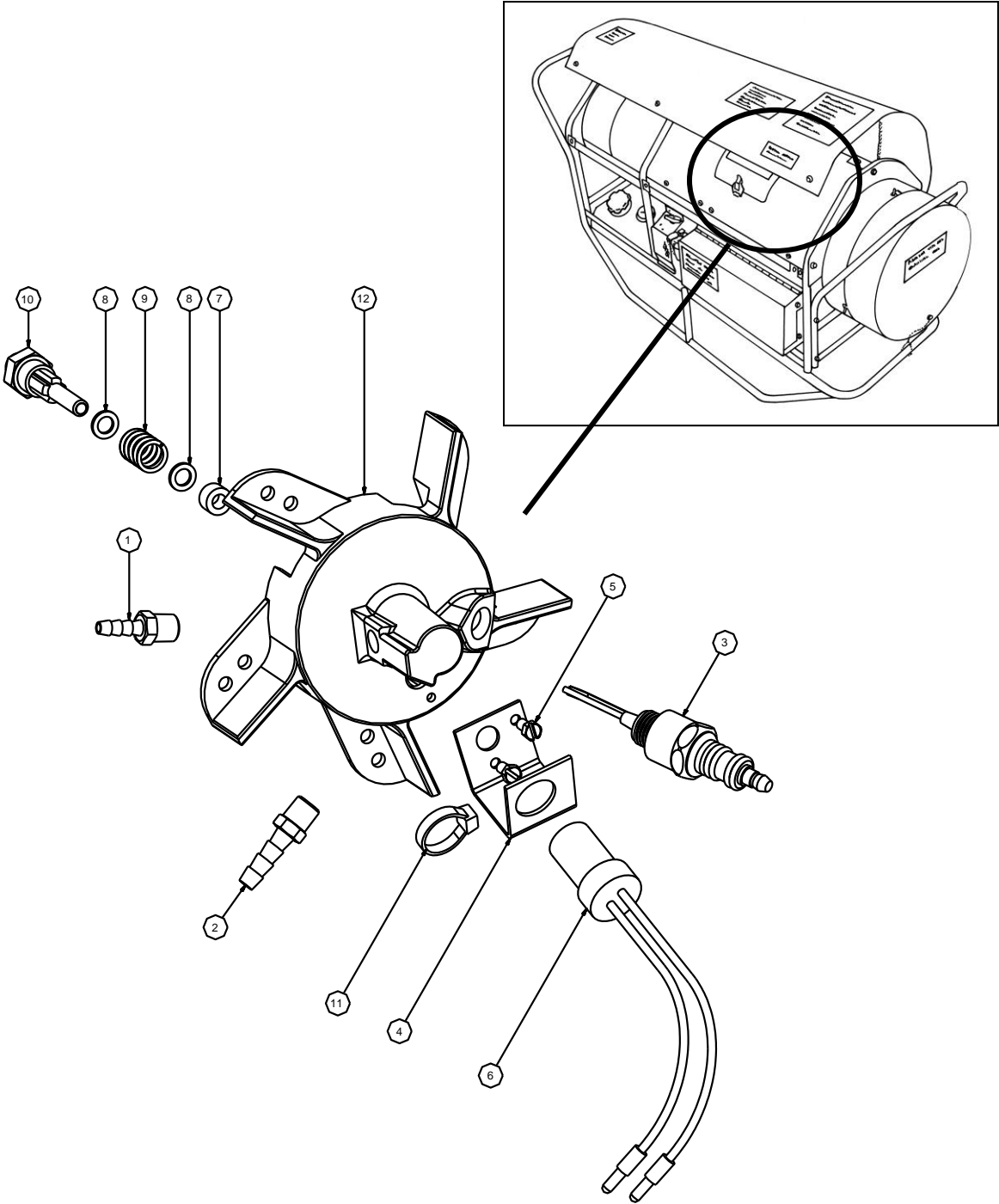


Figure 5-4. BURNER HEAD ASSEMBLY B-200

Table 5-5. Burner Head Assembly B-200

PARTS LIST
BURNER HEAD ASSEMBLY B-200

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	106515	106515	FITTING HOSE BARB 3/16" X 1/8" NPT
2	1	125HBL-4-2	125HBL-4-2	FITTING HOSE BARB 1/4" X 1/8" NPT
3	1	B-207	B-207	SPARK PLUG
4	1	CAH-112-1	CAH-112-1	PHOTOCELL BRACKET
5	2	CAH-141	CAH-141	#8-32 UNF X 5/16 LG HEX HD SLOTTED TAPPING SCREW
6	1	CAH-112-2	CAH-112	PHOTOCELL ASSEMBLY
7	1	B-201 SEAL	B-206	NOZZLE SEAL
8	2	B-202	B-202	NOZZLE SEAL WASHER
9	1	B-203	B-203	NOZZLE SEAL SPRING
10	1	B-201 NOZZLE	B-201	NOZZLE
11	1	170606	170606	TIE WRAP
12	1	B-205	B-205	BURNER HEAD

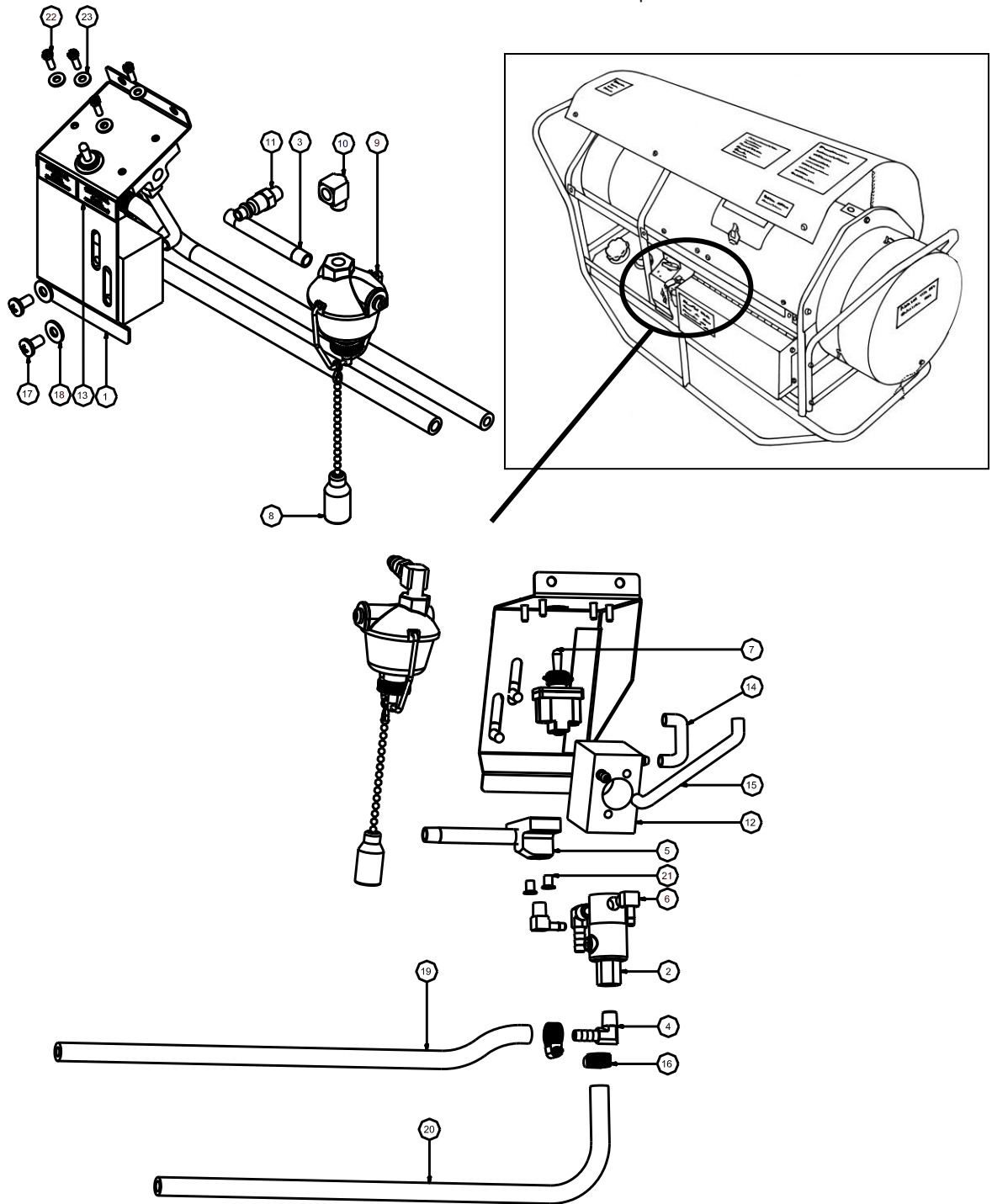


Figure 5-5. EXTERNAL FUEL SUPPLY KIT 53511

Table 5-6. External Fuel Supply Kit (53511)

PARTS LIST
EXTERNAL FUEL SUPPLY KIT 53511

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	106571	106571	EXTERNAL FUEL SUPPLY BRACKET
2	1	15112	15112	3 WAY SOLENOID
3	1	CAH-146-2	CAH-146-2	NIPPLE BRASS 3"
4	2	106522	106522	90 DEG. ELBOW HOSE BARB
5	1	53473	53473	DROP EAR 90 DEG. ELBOW
6	2	3034-10035	3034-10035	1/8 NPT 90 DEG TUBE ELBOW
7	1	MS24523-22	MS24523-22	SWITCH TOGGLE SEALED
8	1	5-13-5616	5-13-5616	DUST CAP ASSEMBLY
9	1	MS51086-2	MS51086-2	STRAINER SEDIMENT
10	1	4390	4390	FITTING, 1/8 MALE NPT TO 1/8 FEMALE NPT 90 DEG
11	1	HP2-4374	HP2-4374	PLUG QUICK CONNECT
12	1	53019	53019	FUEL REGULATOR ZERO PRESSURE
13	1	106579	106579	INTERNAL/EXTERNAL FUEL SUPPLY LABEL
14	1	106577	106577	TYGON TUBING 1/8 ID
15	1	106577	106577	TYGON TUBING 1/8 ID
16	2	170607	170607	CLAMP HOSE MICRO GEAR
17	2	MS24629-57	MS24629-57	¼ 20 X ½ LG PAN HEAD THREAD CUTTING SCREW
18	2	CAH-138(D)	CAH-138(D)	¼ FLAT WASHER
19	1	MIL-H-13444-9	MIL-H-13444-9	HOSE RUBBER FUEL & OIL TYPE I ¼ ID
20	1	MIL-H-13444-12	MIL-H-13444-12	HOSE RUBBER FUEL & OIL TYPE I ¼ ID
21	2	MS27130-S15	MS27130-S15	NUT BLIND RIVET .164-32
22	4	MS51849-54	MS51849-54	#8-32 UNC X ½ LG HEX HD SLOTTED MACHINE SCREW
23	4	MS27183-41	MS27183-41	3/16 ID X 7/16 OD FLAT WASHER

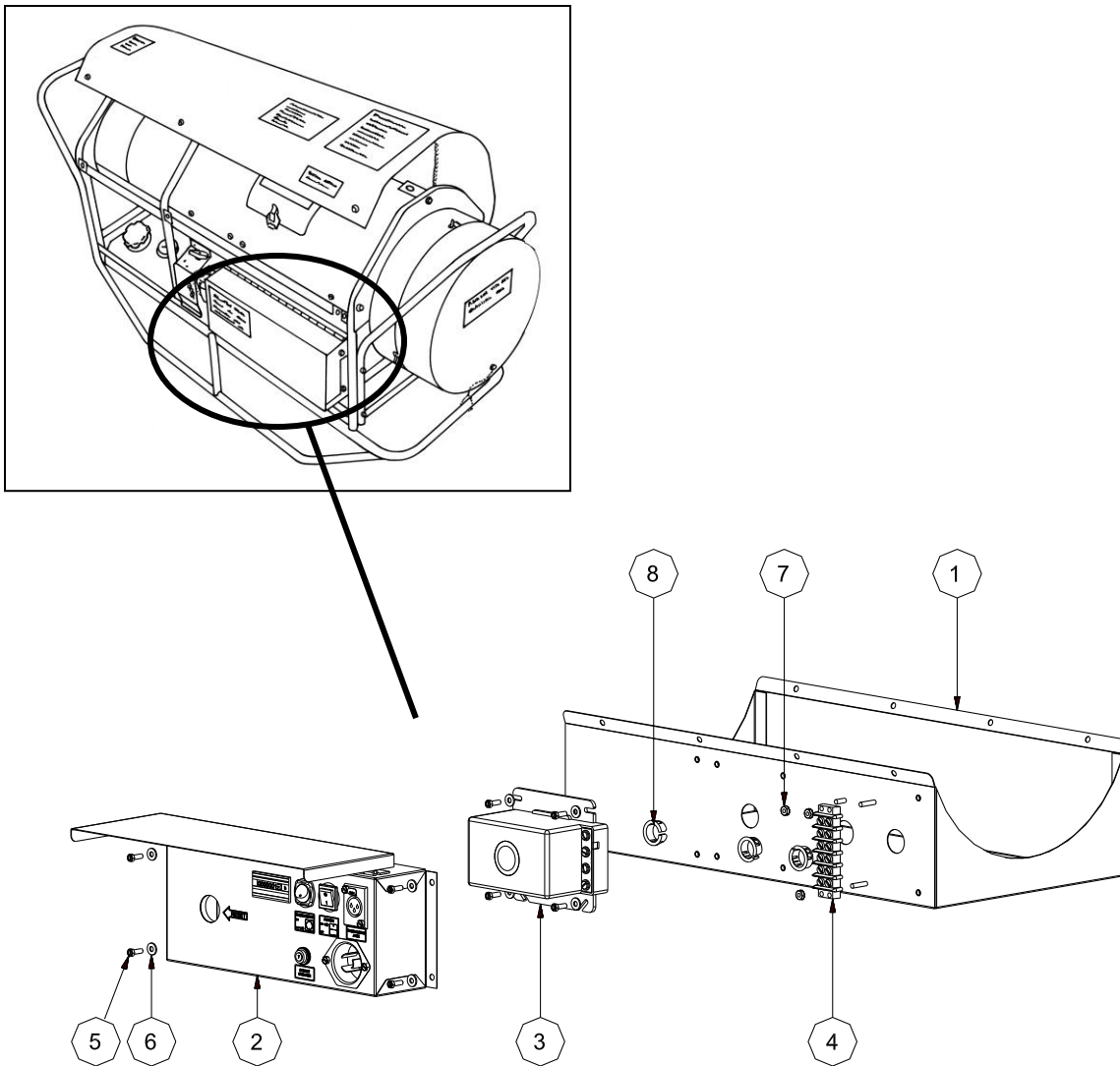


Figure 5-6. CONTROL BOX-FUEL BRACKET ASSEMBLY

Table 5-7. Control Box-Fuel Bracket Assembly

PARTS LIST
CONTROL BOX FUEL BRACKET ASSEMBLY

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	53472	N/A	FUEL TANK BRACKET
2	1	53504	53633	CONTROL BOX ASSEMBLY
3	1	53414	CAH-118-4	PRIMARY CONTROL
4	1	CAH-119-1	CAH-119-1	DISTRIBUTION WIRING BAR
5	8	MS-51849-53	MS-51849-53	#8-32 UNC X 5/16 LG HEX HD SLOTTED MACHINE SCREW
6	8	MS27183-41	MS27183-41	3/16 ID X 7/16 OD FLAT WASHER
7	3	53441	53441	#6-32 KEPS NUT
8	3	CAH-105-2	CAH-105-2	WIRING GROMMET (LARGE)

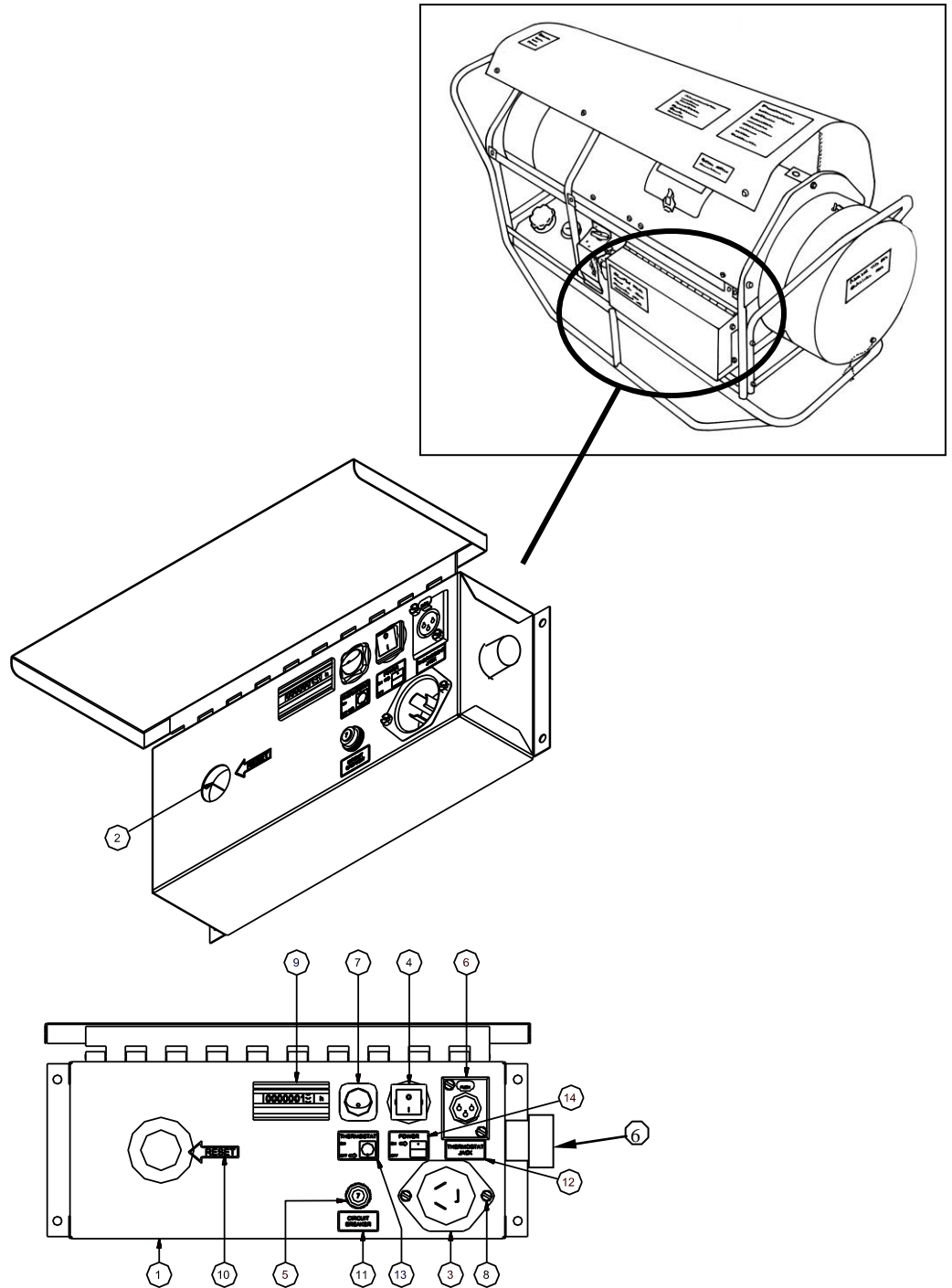


Figure 5-7. CONTROL BOX ASSEMBLY 53504

Table 5-8. Control Box Assembly 53504

PARTS LIST
CONTROL BOX ASSEMBLY 53504

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	53478	CAH-130(D)	CONTROL BOX
2	1	53420	53420	O-RING
3	1	CAH-120	CAH-120	TWIST SOCKET
4	1	CAH-121-4	CAH-121-3	ROCKER SWITCH ASSEMBLY
5	1	CAH-121-2	CAH-121-1	CIRCUIT BREAKER
6	1	CAH-122-2	53675	THERMOSTAT PLUG ASSEMBLY
7	1	CAH-122-1	CAH-122-1	BLACK ROCKER SWITCH
8	4	CAH-141	CAH-141	#8-32 UNF X 5/16 LG HEX HD SLOTTED TAPPING SCREW
9	1	CAH-140-1	CAH-140	ELAPSED TIME METER ASSEMBLY
10	1	53335	53335	DECAL RESET
11	1	53336	53336	DECAL CIRCUIT BREAKER
12	1	53337	53337	DECAL THERMOSTAT JACK
13	1	53338	53338	DECAL THERMOSTAT
14	1	53339	53339	DECAL POWER

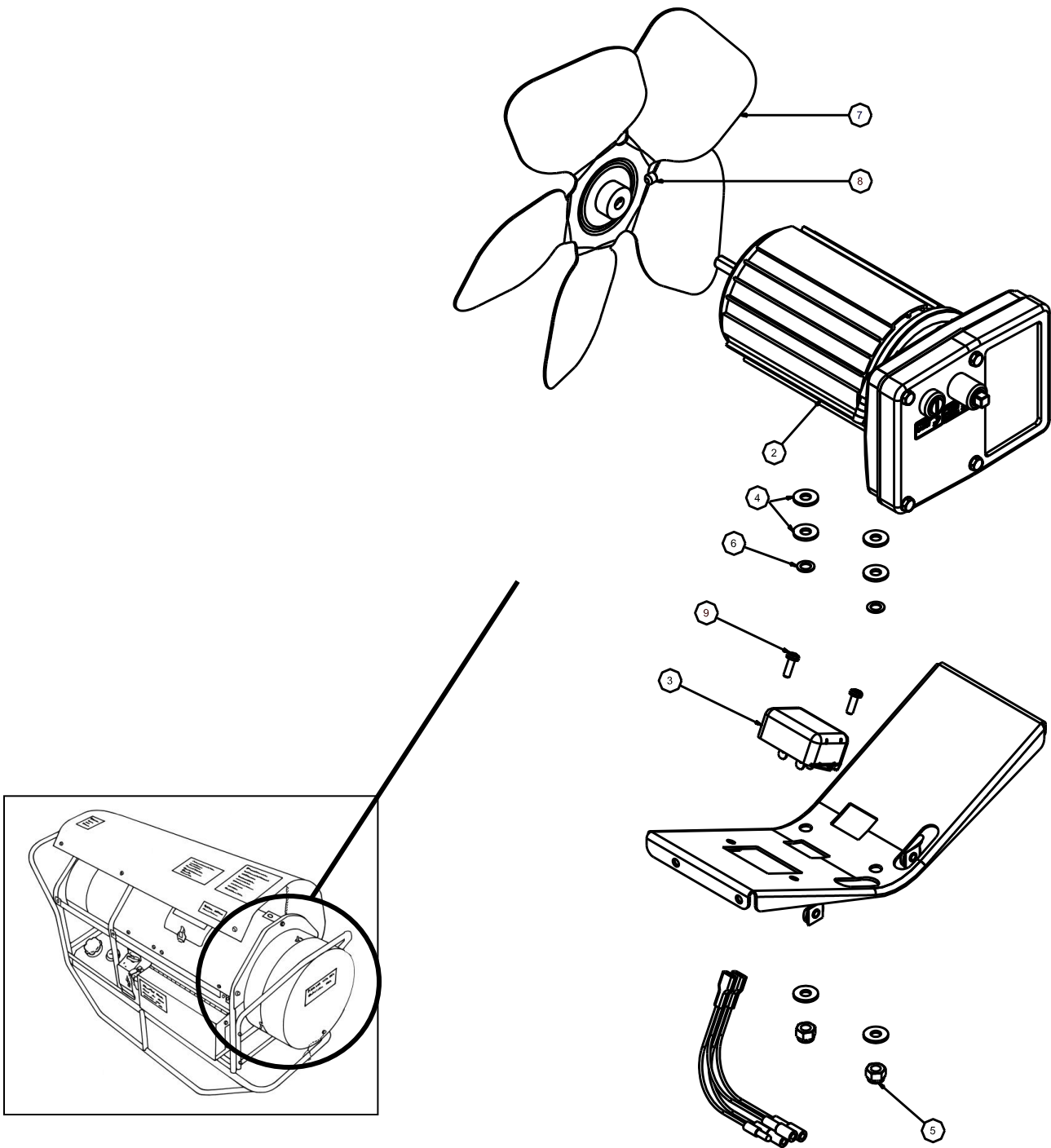


Figure 5-8. MOTOR/PUMP/BACKET ASSEMBLY (53489)

Table 5-9. Motor/Pump/Bracket Assembly (53489)

PARTS LIST
MOTOR/PUMP/BACKET ASSEMBLY 53489

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	CV-106	CAH-106 (D)	MOTOR BRACKET W/ TRANSFORMER SUPPORT
2	1	53485	M-100	MOTOR & PUMP ASSEMBLY
3	1	CAH-114-3(D)	CAH-114(D)	RELAY ASSEMBLY
4	6	CAH-138(D)	CAH-138(D)	¼ FLAT WASHER
5	2	CAH-139(D)	CAH-139(D)	¼-20 UNC HEX LOCKNUT W/NYLON INSERT
6	2	47172	47172	17/64 ID X 7/16 OD FLAT WASHER
7	1	CAH-EUR-113	CAH-EUR-113-2	PROP FAN
8	1			¼ UNF SET SCREW X .25 LG (INCLUDED WITH PART # CAH-EUR-113)
9	2	MS35206-244	MS35206-244	#8-32 UNC X 7/16 LG PAN HD CROSS RECESSED MACHINE SCREW

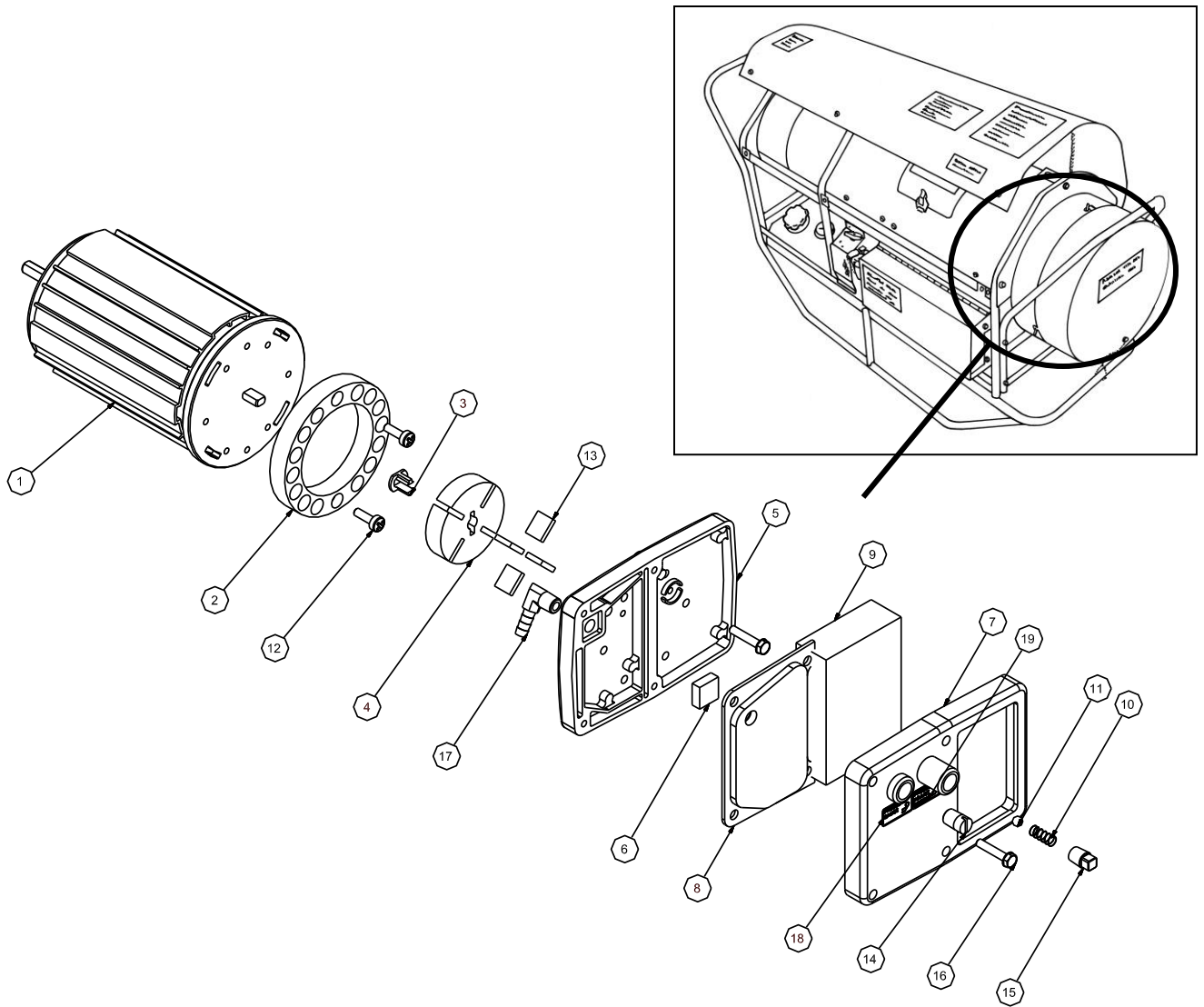


Figure 5-9. MOTOR AND PUMP ASSEMBLY(53485)

Table 5-10. Motor and Pump Assembly P/N 53485

PARTS LIST
MOTOR & PUMP ASSEMBLY 53485

ITEM NO.	QTY	PART NO (MV60S-1, MV60X-1, MV60T-1, MV60XT-1)	PART NO (MV125-DND)	DESCRIPTION
1	1	53488	53488	¼ H.P. MOTOR ASSEMBLY (TO INCLUDE MOTOR AND TERMINALS)
2	1	M-113	M-113	PUMP BODY
3	1	M-112	M-112	ROTOR INSERT
4	1	M-111	M-111	PUMP ROTOR
5	1	M-109	M-109	FRONT COVER
6	1	M-101	M-101	LINT FILTER
7	1	M-102	M-102	END COVER
8	1	M-103	M-103	OUTPUT FILTER
9	1	M-104	M-104	INTAKE AIR FILTER
10	1	M-107	M-107	COMPRESSION SPRING
11	1	M-108	M-108	BALL BEARING
12	2	M-116	M-116	#10-32 UNF X .625 LG FILLISTER HD MACHINE SCREW
13	4	M-110	M-110	PUMP BLADE
14	1	M-105	M-105	PIPE PLUG
15	1	M-106	M-106	PRESSURE ADJUSTING SCREW
16	10	M-117	M-117	#10-32 UNF X 1 LG HEX HD MACHINE SCREW
17	1	106522	106522	90 DEG. ELBOW HOSE BARB
18	1	53321	53321	DECAL PRESSURE GAUGE
19	1	53322	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.

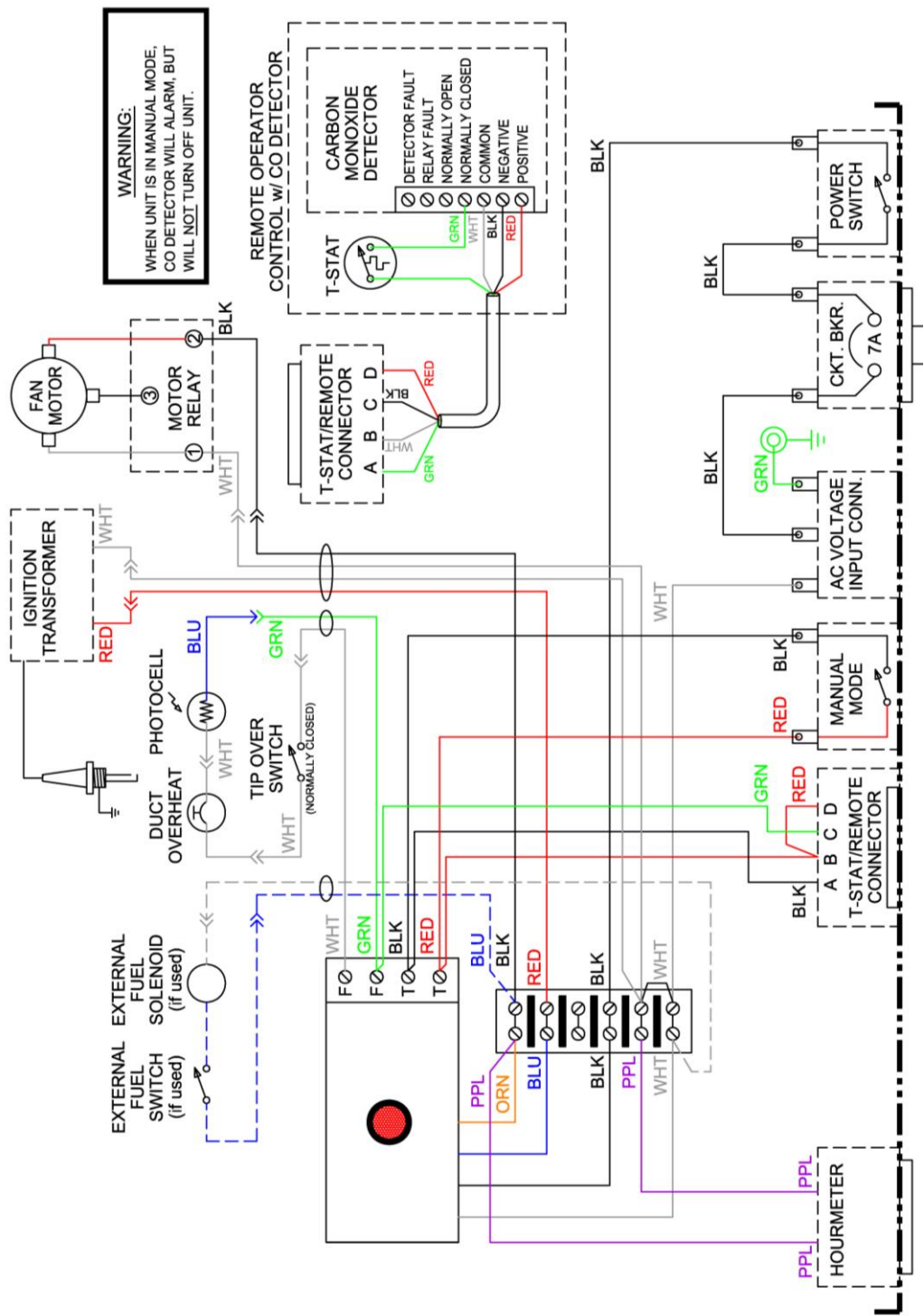


Figure 6-1. Camfire Heater Wiring Diagram

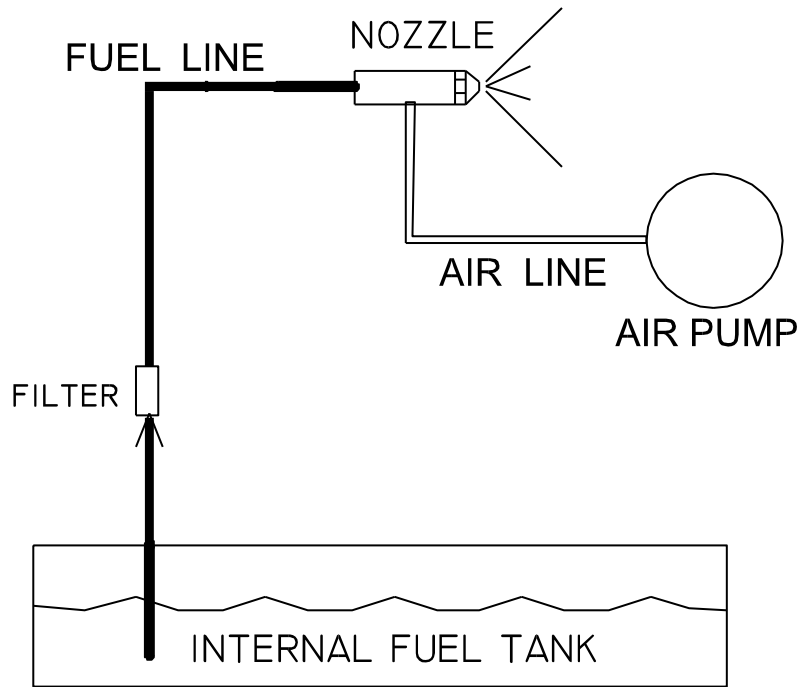


Figure 6-2. Camfire (MV60) Fuel Schematic

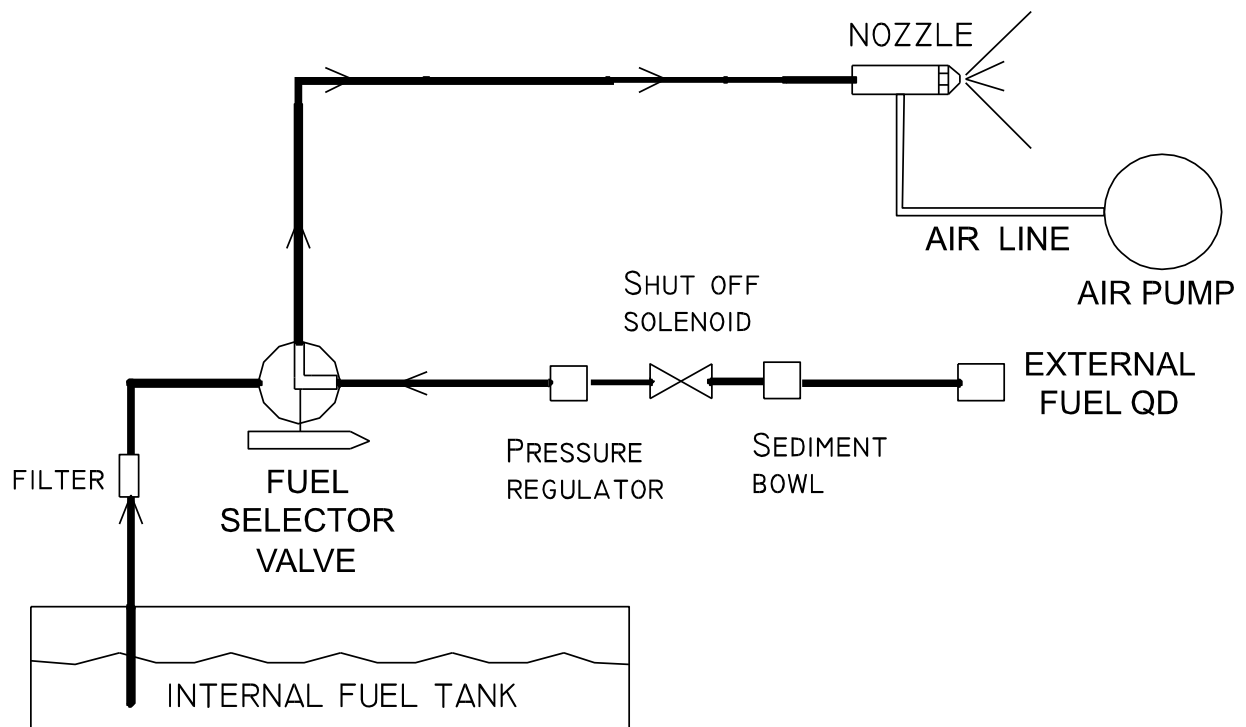


Figure 6-3. Camfire (MV60X-1 AND MV60XT-1) Fuel Schematic

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