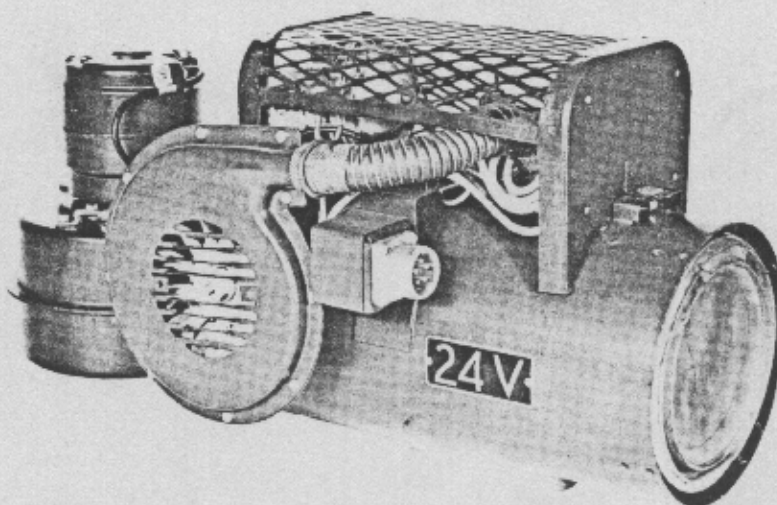


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# *South Wind*

## **MODEL 978 PERSONNEL HEATER**



# **SERVICE MANUAL**

**KEEP MANUAL WITH VEHICLE**

**SOUTH WIND DIVISION OF STEWART-WARNER CORPORATION**

1514 DROVER STREET

INDIANAPOLIS 7, INDIANA

PRINTED IN U. S. A.

FORM No. PM 6348 (12-56)

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# *South Wind*

## MODEL 978 PERSONNEL HEATER

# SERVICE MANUAL

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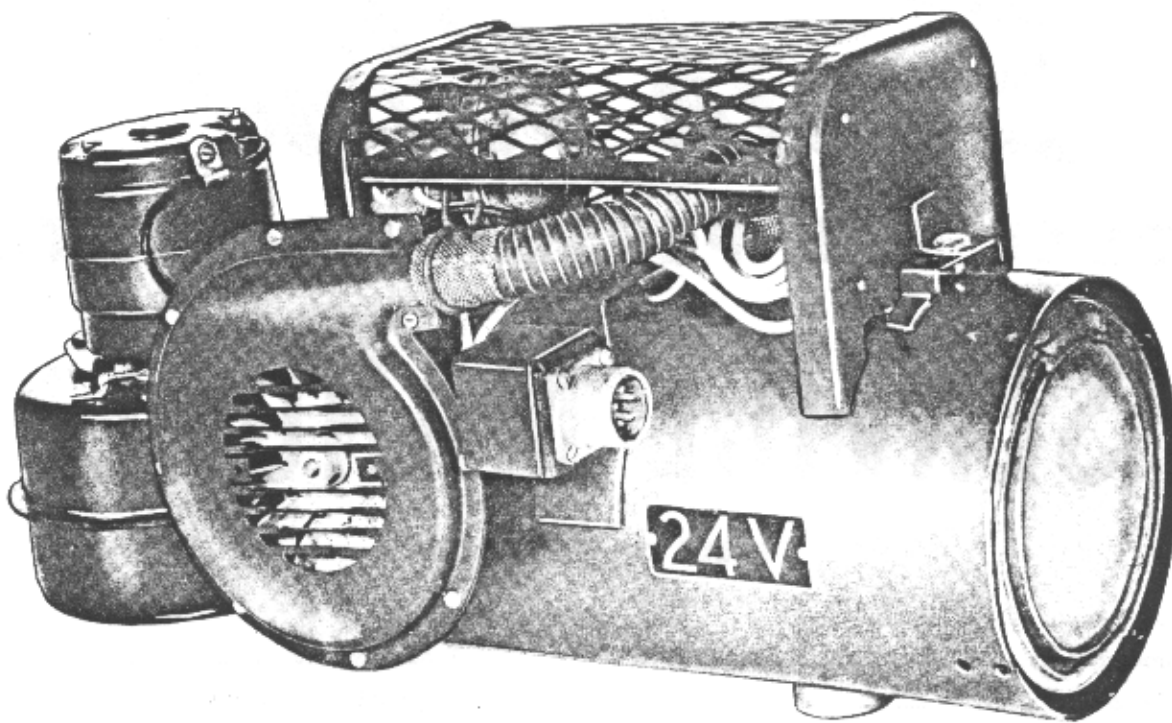
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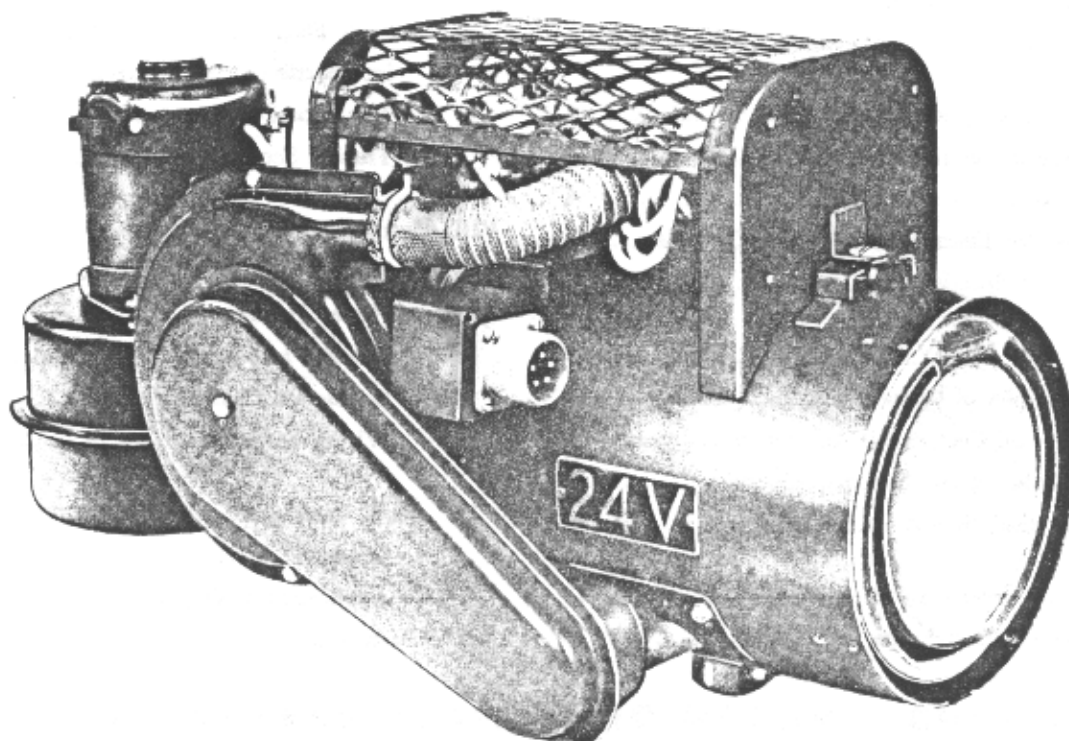
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*Figure 1—Model 978-M-H Heater*



*Figure 2—Model 978-M-R Heater*

# Section I

## INTRODUCTION

### GENERAL

1. The South Wind Model 978 Personnel Heater (Figures 1 and 2) is an extremely compact, light-weight heating unit, designed to produce a maximum heat output of more than 20,000 BTU per hour quickly, and with the utmost safety and serviceability.

2. This heater has been developed out of our wartime aircraft and postwar automotive heating experience and utilizes the famous South Wind "sealed flame" principle which has been fully proved and tested for safety under all conditions. In this heater, combustion occurs within a sealed, all-welded, stainless-steel heat exchanger.

### MODELS

1. The Model 978 heater is produced at present in three models: the 978-M-B, 978-M-E, and 978-M-H. The Model 978-M-H is produced in 6, 12, and 24-volt models for use on vehicles having electrical systems of these voltages. The 978-M-B and 978-M-E heaters are produced only in the 24-volt models. All of these heaters are electrically suppressed to prevent radio interference. A previous model heater, the Model 978-M-R, is no longer in production, but many of these heaters are in service, and it is fully covered in this manual. The Model 978-M heater is now considered obsolete and has been out of production for some time. If service parts for this heater are required, use parts of the Model 978-M-C heater (see Page 13).

2. The Model 978-M-H heater is completely interchangeable, as a unit, with any older model heater of the same voltage. It can be used to replace the Model 978-M, 978-M-C, or 978-M-R. When used in this manner, the heater will fit any mounting bracket or box and can be used with any wiring harness and control box on older systems. The reverse may not be true, however, of newer installations, since the MH heater is somewhat smaller in overall dimensions and will tolerate greater back pressure in the exhaust system.

3. The changes in the Model MH heater consist of complete internal suppression of the motors (which eliminates the condenser inside the housing) and redesign of the internal parts of the heat exchanger. With the new heat exchanger, the recirculating adapter used on the 978-M-R is no longer required, and the heat exchanger and combustion air inlet have been greatly simplified (Figure 1). These changes simplify service operations and reduce the overall dimension of the heater from side to side. Wiring connections are also simplified by the elimination of the condenser used on the 978-M-R heater (Figure 23).

4. All Model 978 heaters are similar in basic principle, the difference in heaters being adaptations to various heating requirements. The Models 978-M-C and 978-M-R are similar except that the MR heater has a recirculating exhaust system which adapts it to use with long exhaust tubes which are required in many installations.

5. The Models 978-M-B and 978-M-E heaters are similar to the MC and MR models respectively except that they are equipped with high-speed ventilating air blowers for installations which require this feature, and the MB heater also has provision for a high-temperature outlet adapter to permit high ventilating air temperatures for engine pre-heating, etc. Application of the various model heaters is more fully explained in Section VIII of this manual.

6. The combination of heater models and differing voltages results in a series of five different heaters, as listed below:

*978-M-B24	*978-M-E24	978-M-H6
		978-M-H12
		978-M-H24

\*Used by U. S. Air Force.

The heater described and illustrated in this manual is the Model 978-M-H24 in most cases; however, the information applies to all models except in those instances where specific models are indicated.

## Section II

### OPERATING INSTRUCTIONS

#### TO OBTAIN HEAT

##### New-Style Control Box

1. To start the heater, turn the HI-LO switch to HI position and hold the heater switch in START position until the pilot lamp comes on. This switch is spring loaded and must be held in position.

2. After the pilot lights, snap the switch to RUN. Warm air should be felt at the heat outlet within three minutes.

3. After the heater has been started, the temperature may be regulated by snapping the HI-LO switch from HI to LO according to the heating requirements of the space being heated.

#### Old-Style Control Box

1. To start heaters equipped with the old-style control box, proceed as follows:

a. Turn the thermostat or HI-LO switch to high position.

b. Hold the safety valve switch in RESET position for about 30 seconds. This switch is spring loaded and will return to its normal position when released.

c. Snap the heater switch to ON. Warm air should be felt at the heat outlet within three minutes.

d. On heater installations equipped with a thermostat, the temperature may be regulated by adjustment of the thermostat knob and the heater will automatically maintain



the desired temperature. If the control box is equipped with a HI-LO switch, the temperature is regulated by snapping the switch from HI to LO as required.

#### FAILURE TO START

1. If a heater equipped with a new style control box fails to start (pilot lamp fails to come on), push in on the jewel of the pilot lamp. If the lamp lights, it is an indication that there is voltage at the hot terminal of the heater and a second attempt may be made to start the heater. If the lamp fails to light, it indicates that there is a defect in the heater wiring, and the installation should be checked before attempting another start.

2. If the heater does not ignite on the third attempted start, service is required, and no further attempts should be made until the cause of failure has been corrected.

3. If heaters equipped with the old-style control boxes fail to start, proceed as follows:

- a. Turn the heater switch off.
- b. If the control box is equipped with a red circuit breaker reset button, push the button to reset the circuit breaker. If the control box does not have the red button,

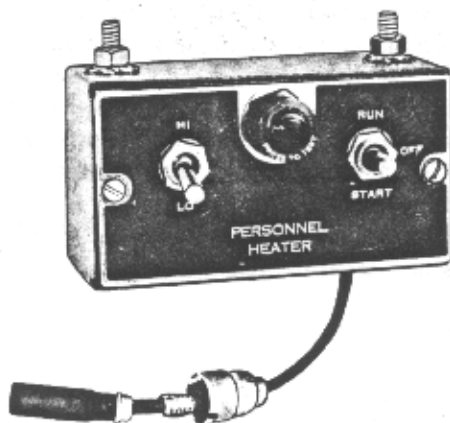


Figure 3—New Style Control Box

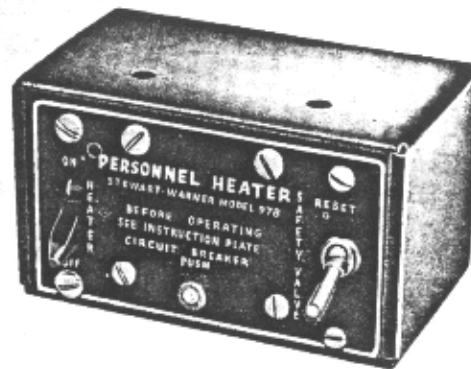


Figure 4—Old Style Control Box

the circuit breaker is automatic and does not require re-setting.

- c. Hold the safety valve reset lever in PRIME position for about 30 seconds.

- d. Restart the heater by turning the heater switch to ON position.

- e. If the heater does not start on the third attempt, correct the cause of failure before making another attempt at starting.

#### TURNING HEATER OFF

1. Turn the heater switch to the OFF position. Burning in the heater will stop within a few seconds, but the blowers will continue to run for two or three minutes to cool and "purge" the heater of unburned gases. When the heater cools sufficiently, the blowers will automatically stop.

2. If the heater switch is placed in the ON position while the heater is purging, it will not start until the purge period is over.

#### SERVICE

1. The fuel filter must be cleaned frequently to prevent the formation of ice during cold weather operation.

2. Clean out the igniter pocket of the heater after every 300 hours of heater operation, using the igniter housing scraper tool.

## Section III HEATER DESCRIPTION

#### GENERAL DESCRIPTION

1. The Model 978 heater has a rated heat output of 20,000 BTU per hour and is of the fuel metering type.

2. For operation, the heater requires fuel under pressure of 1 to 15 pounds per square inch, electric current for ignition and a flow of combustion and ventilating air.

3. The heater is of sealed, all welded, stainless steel construction. The combustion air, ventilating air and exhaust passages are completely separated so that products of combustion cannot enter the ventilating air stream. The necessary connections for fuel and electric current are outside the heater case.

4. Principal components of the heater are: The heat exchanger, heater case, flame detector switch, fuel control valve, standpipe and vaporizer pad, igniter, overheat switch, combustion air blower assembly, ventilating air blower assembly and terminal strip (Figure 6). The Model 978-M-R also has a recirculating combustion air inlet adapter not shown in Figure 6.

#### DETAILED DESCRIPTION

##### Heat Exchanger

1. The heat exchanger (Figure 5) is made of stainless steel and consists of a cylinder-shaped central chamber and an outer chamber which encases the central chamber. The

two chambers are connected at the top by a slot that extends the full length of the exchange and at the bottom by a small opening which serves as a drain tube in the event any gasoline should accumulate in the exchanger.

2. One end of the exchanger contains the igniter pocket which has openings for the igniter and fuel standpipe. Two tubes extend from the exchanger and provide passage for the combustion air at the top and exhaust gases at the bottom. The exhaust tube is connected to the outer chamber while the combustion air tube extends into the portion of the central chamber, known as the "combustion chamber."

3. The combustion chamber is located inside the central chamber near the igniter pocket. It consists of a stainless steel cone with a semi-circular baffle welded inside.

4. A steel baffle,  $\frac{3}{4}$  inch wide, is welded at the top of the heat exchanger between the combustion chamber and the rod of the flame detector switch. This baffle prevents the direct flame from striking the flame detector rod and prolongs the service life of this component.

5. The heat exchanger of the Model 978-M-R heaters differs from the other heaters in that it has an auxiliary exhaust outlet at right angles to the regular outlet on the bottom of the heat exchanger. This is an oval tube which

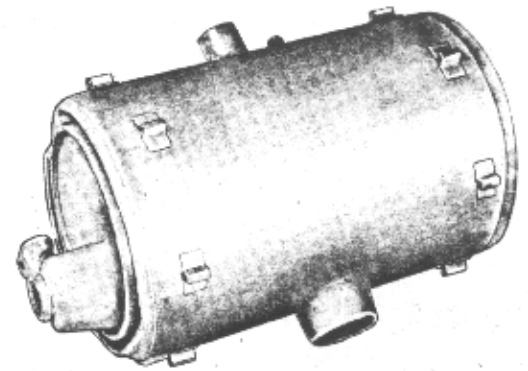


Figure 5—Heat Exchanger

is welded into the side of the heat exchanger for use with the recirculating combustion air intake adapter (see Figure 2).

#### Igniter

1. The igniter (Figure 7), which screws into the igniter well, is a resistance coil of the "glow plug" type that heats red hot when current is passed through it.

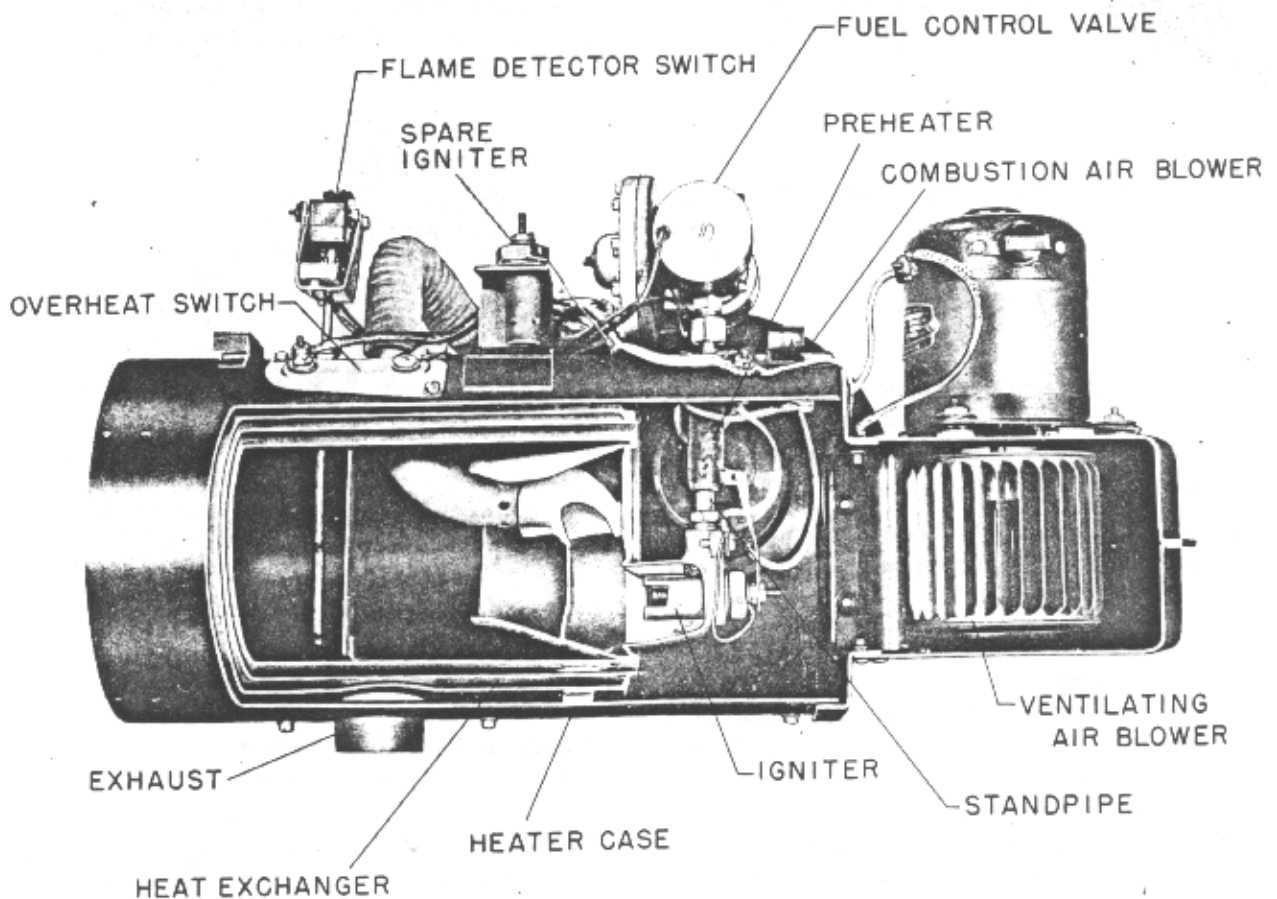


Figure 6—Cutaway View of Model 978 Heater

2. The igniter is designed to operate on 6 volts DC. On 12 and 24 volt heaters, a series dropping resistor is used to reduce the voltage to the proper value. In this way, the igniter is interchangeable on all models.

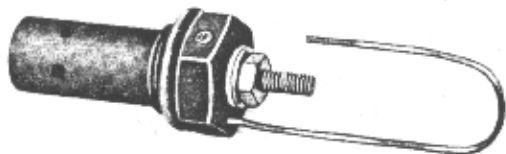


Figure 7—Igniter

On the 12 and 24-volt heaters, the voltage dropping resistor also serves to preheat the fuel in the standpipe, thereby providing a quicker start at low temperatures (see Figure 6).

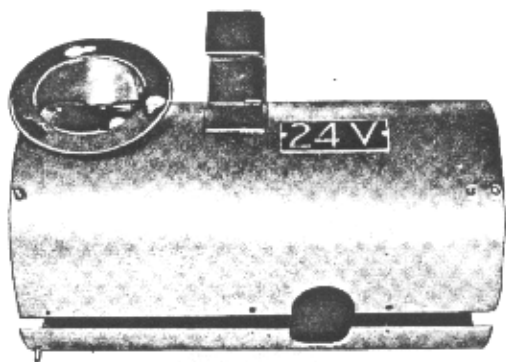


Figure 8—Heater Case

#### Heater Case

1. The one-piece heater case (Figure 8) fits around the heat exchanger. A formed edge extends the full length of the case, at the center line of the exhaust tube to simplify removal and replacement.

2. The case used on the 978-M-R heaters has an additional opening for the recirculating exhaust outlet but is otherwise similar.

#### Flame Detector Switch

1. The flame detector switch (Figure 9) consists of a quartz rod encased in a metal tube with a mounting bracket which supports a microswitch and adjusting spring.

2. The quartz rod and tube extend into the central chamber of the heat exchanger where they are subjected to the heat of the flame. The heat causes the tube to expand and allows the quartz rod, which does not expand, to move downward and release the pressure on the microswitch button.

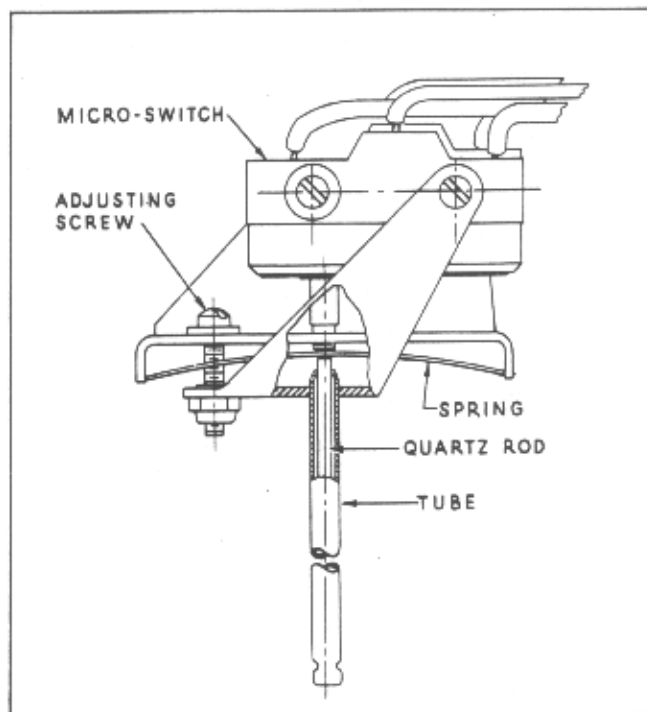


Figure 9—Flame Detector Switch

#### Fuel Control Valve

1. The fuel control valve (Figure 10) consists of a valve body, pressure regulator, two solenoid-operated valves and an orifice or metering plate. Its purpose is to control and meter the quantity of fuel flowing into the heat exchanger. For a more complete description see Section IV, OPERATION.

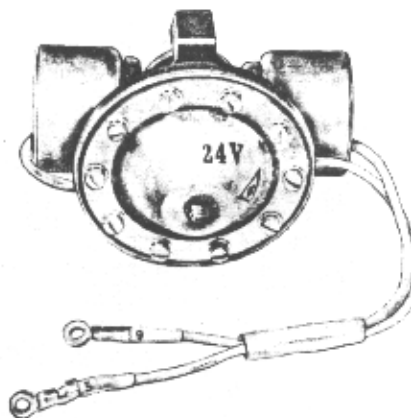


Figure 10—Fuel Control Valve

#### Standpipe and Vaporizer Pad

1. The fuel valve standpipe (Figure 11) connects the fuel valve to the igniter pocket in the heat exchanger. The vaporizer pad is a stainless steel wire mesh wick, and is partially threaded into the heat exchanger end of the standpipe. When the standpipe is screwed into the igniter pocket, the pad extends inside where it is saturated by the fuel flowing from the valve to the exchanger.

2. On 12 and 24-volt heaters the igniter voltage dropping resistor is mounted on the standpipe. In this way, the heat from the resistor is used to preheat the fuel in the standpipe when starting the heater.

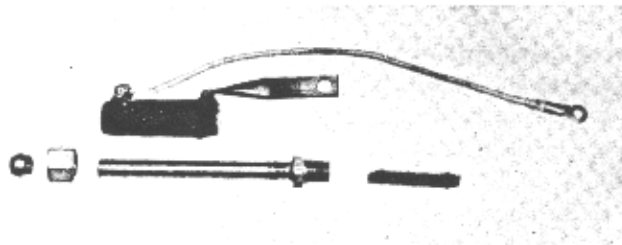


Figure 11—Standpipe and Vaporizer Pad

#### Overheat Switch

1. The overheat switch (Figure 12) will automatically close the shut-off solenoid of the fuel control valve and stop the fuel flow in the event the heater becomes overheated. It consists of a fixed contact point and a bi-metal blade which is mounted directly in the ventilating air stream.

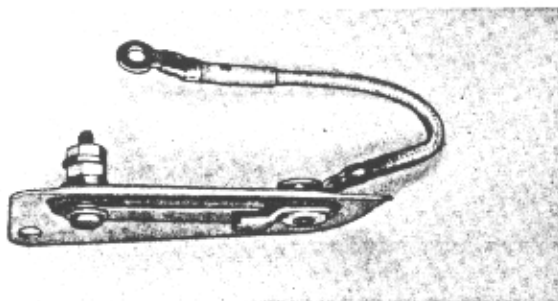


Figure 12—Overheat Switch

#### Combustion Air Blower Assembly

1. The combustion air blower assembly consists of a motor, blower wheel and housing. It is designed to supply the proper amount of air to maintain the correct fuel-air ratio. The blower assembly can be removed from the heater case in one piece due to the type of mounting provided.

2. When used with the 978-M-R heater, an adapter is used to effect recirculation of exhaust gases.

#### Ventilating Air Blower Assembly

1. The ventilating air blower assembly (Figure 14) which consists of a heavy duty, ball bearing, 1/40 H. P. motor, "squirrel cage" type blower and housing, is mounted on the upstream end of the heater by means of four studs on the heater case. This blower assembly provides a ventilating air flow of approximately 6 pounds per minute. The blower is suppressed to prevent interference with radio equipment.

#### Terminal Strip

1. A terminal strip, consisting of 6 terminals, is provided on top of the heater case to facilitate disassembly.

#### Protective Cover

1. A heavy mesh protective cover (Figure 15) is secured to the top of the heater case by means of two Dzus fasteners. This cover protects the heater components located

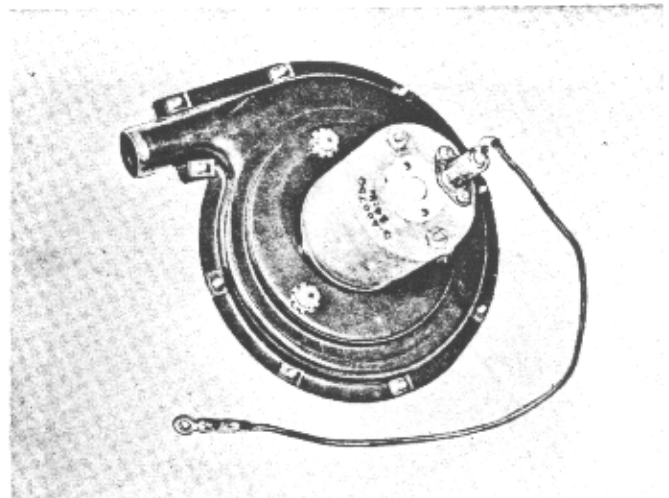


Figure 13—Combustion Air Blower

on the top of the case. The heater wiring diagram is mounted inside the cover.

#### DETAILED DESCRIPTION OF HEATER CONTROLS Control Box

1. The control box contains a heater switch, HI-LO switch, and a circuit breaker to protect the heater assembly. In installations which contains a safety valve, a safety valve prime switch is used in addition to the other switches. The HI-LO switch is omitted if a thermostat is used to regulate temperature. If an electric fuel pump is used, the prime switch also starts the fuel pump when placed in the prime position.

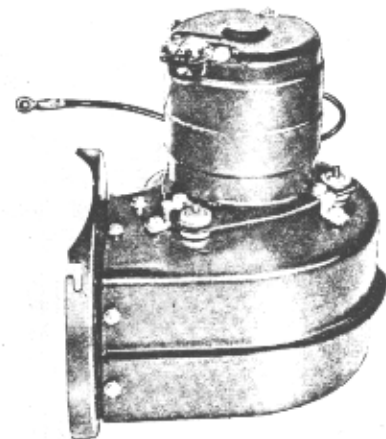


Figure 14—Ventilating Air Blower

2. This box is designed so that the electrical receptacle can be mounted on the back or on the bottom of the box by relocating the mounting screws and grommet without unsoldering wires.

#### Safety Valve

1. The safety valve (Figure 17) consists of a shut-off solenoid and a casting, which houses a large diaphragm and spring. The safety valve provides just the initial flow of fuel for ignition. Additional fuel to sustain combustion is received only after the shut-off solenoid of the safety valve is energized when the ventilating air blower comes on.



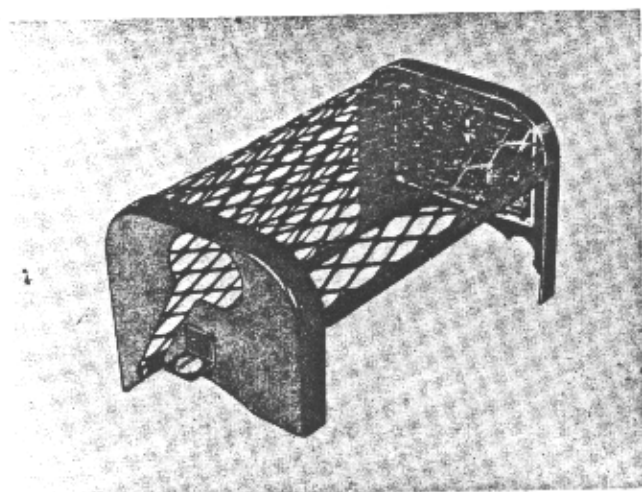


Figure 15—Protective Cover

### HEATER SPECIFICATIONS

Weight.....approx. 23 lbs.

#### Dimensions

1. Width .....approx. 8¼ inches
2. Length .....approx. 18½ inches
3. Height .....approx. 9¾ inches

### Electrical Supply

M-C6, M-H6, M-R6..... 6 volts D.C.  
M-C12, M-H12, M-R12.....12 volts D.C.  
M-B24, M-C24, M-E24, M-H24, M-R24.....24 volts D.C.

### Current Consumption

M-C6, M-H6, M-R6:

- a. Starting Load .....13.5 amps.
- b. Operating Load .....10 amps.

M-C12, M-H12, M-R12:

- a. Starting Load .....12 amps.
- b. Operating Load ..... 5 amps.

M-B24, M-C24, M-E24, M-H24, M-R24:

- a. Starting Load .....11 amps.
- b. Operating Load ..... 2.5 amps.

### Fuel

Any automotive or aviation gasoline.

Fuel Pressure.....1 to 15 lb./sq. in.

### Fuel Consumption

1. High heat .....1 gal./4 hrs.
2. Low heat .....1 gal./8 hrs.

### Heat Output

1. High heat .....20,000 B.T.U./hr.
2. Low heat .....10,000 B.T.U./hr.

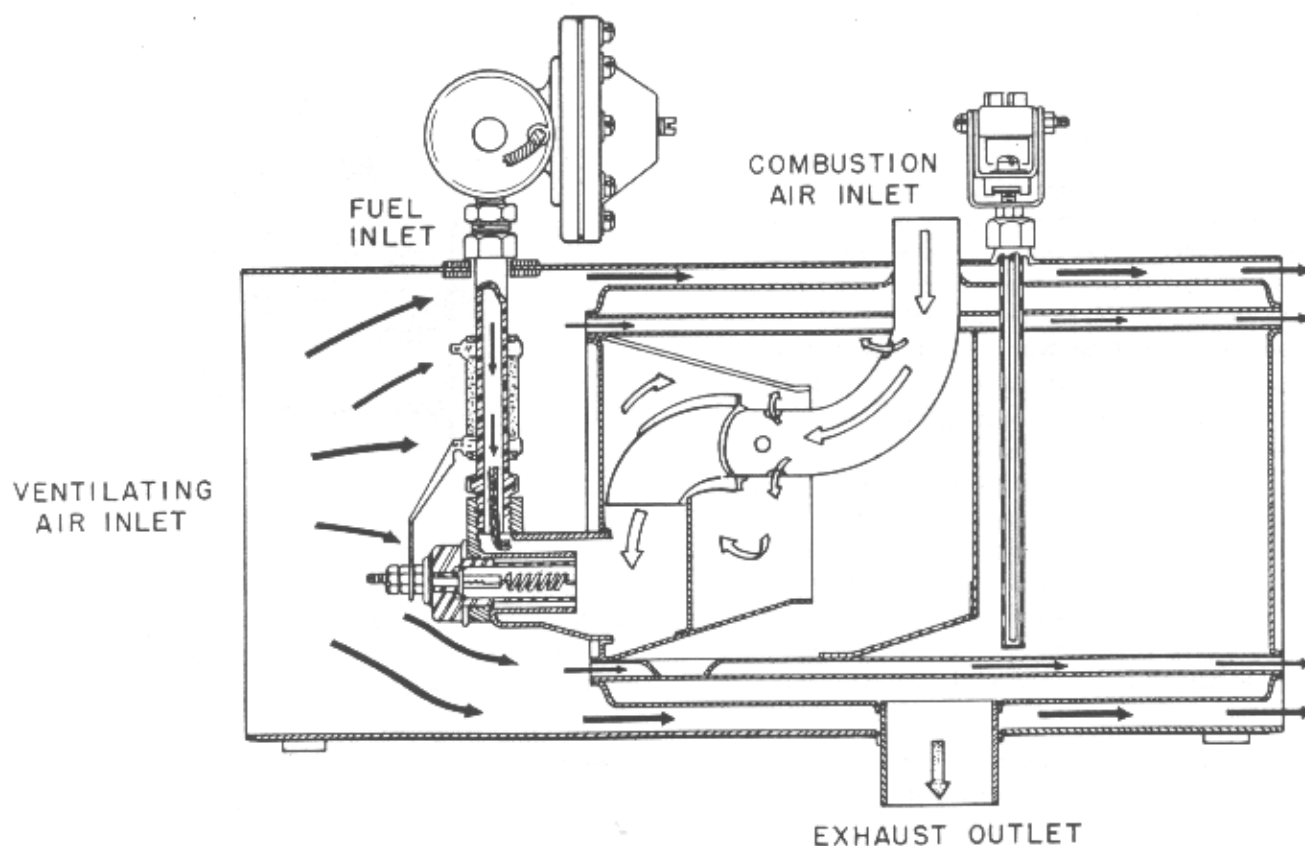


Figure 16—Flow System through Heater

## Section IV OPERATION

### PRINCIPLES OF OPERATIONS

#### General

1. The Model 978 Heater produces heat by burning a gasoline and air mixture inside a sealed, all welded, stainless steel combustion chamber.

2. When the heater is turned ON, three things occur simultaneously: Fuel is allowed to flow into the heater; the combustion air motor is energized and air is forced into the heater for combustion; and the electric "glow plug" igniter is energized. Within 20 seconds, the gasoline and air mixture will ignite. The burning of this mixture creates a large volume of hot gases which flow through the heat exchanger passages to the exhaust. As the hot gases flow through these passages, they dissipate their heat through the stainless steel walls to the ventilating air, which is forced across the heat exchanger by the ventilating air blower (Figure 16).

#### Systems

1. It becomes apparent from the above explanation that the heater consists of three systems, namely, fuel and combustion air system, ventilating air system, and electrical system. Each of these systems will now be considered in greater detail.

#### FUEL AND COMBUSTION AIR SYSTEM

##### Safety Valve

1. When the heater switch is snapped ON, fuel enters the safety valve (Figure 17) at the inlet port and exerts a pressure against the diaphragm. This pressure overcomes the spring tension against the diaphragm, causing it to move and force the gasoline in the chamber through the outlet port to the fuel control valve. This chamber holds only sufficient fuel to allow ignition to take place within the heater. After ignition occurs, the flame detector switch energizes the safety valve shut-off solenoid and this provides additional fuel to sustain combustion. When the shut-off solenoid opens, fuel also enters the chamber and equalizes

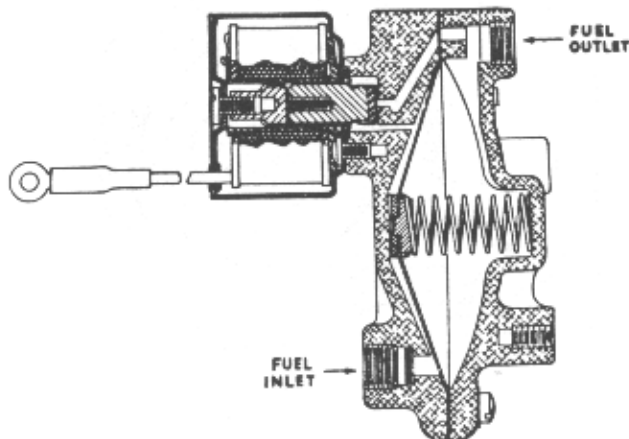


Figure 17—Safety Valve (Sectional View)

the pressure on the diaphragm. With the pressure on both sides of the diaphragm equal, the spring tension forces the diaphragm back slowly, allowing the chamber to refill, and it is then ready for the next "start."

2. If ignition does not occur, the shut-off solenoid will not open and only one minute's supply of fuel will enter the heater. Thus, when ignition does not occur, the heater cannot possibly be restarted without refilling the chamber. This is accomplished by opening the shut-off solenoid by placing the reset lever in the closed position.

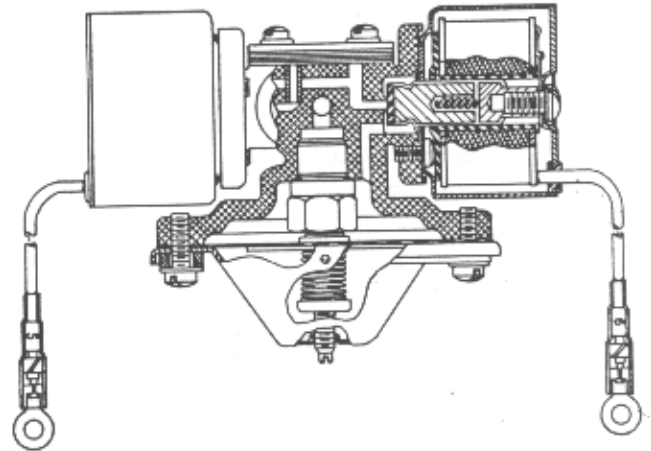


Figure 18—Fuel Control Valve (Sectional View)

##### Fuel Control Valve

1. Fuel flows from the safety valve to the fuel control valve (Figure 18) where it enters the pressure regulator. A diaphragm in the regulator maintains a one pound per square inch fuel pressure within the valve for any given inlet pressure between the limits of 1 to 15 pounds per square inch.

2. The fuel leaves the pressure regulator and flows through the shut-off solenoid (Figure 19) provided the valve has been unseated by the solenoid around the valve.

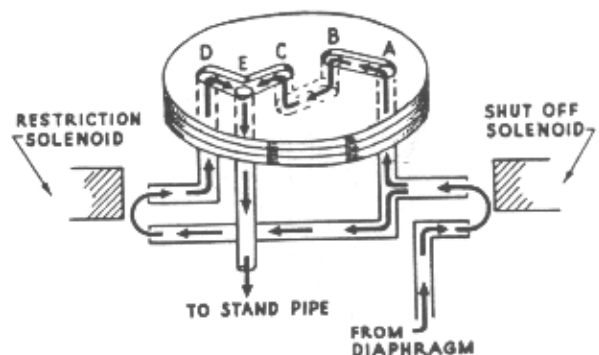


Figure 19—Orifice Plate

If the restriction solenoid is closed, the fuel flows into the orifice plate at hole "A," across the passage, down hole "B," across the lower passage, up hole "C," and out hole "E" to the standpipe. Holes "A," "B," and "C" are very small and restrict the amount of fuel which is allowed to pass on to the heater. This is actually low heat fuel flow.

3. The restriction solenoid is identical in construction to the shut-off solenoid. When it is opened by the HI-LO switch, the fuel takes the path of the least resistance and flows through the restriction solenoid and into the orifice plate at hole "D," across the passage and out hole "E" to the standpipe. Hole "E" actually meters the fuel flow on high heat.

4. From the control valve, the gasoline drips down the fuel standpipe, where it collects and saturates the vaporizing pad that extends into the igniter pocket (Figure 16).

#### Combustion Air Blower

1. Air is forced into the combustion chamber by the combustion air blower. Inside this chamber the air mixes with the fuel vapors and forms a highly combustible mixture which is ignited initially by the electric "glow plug" igniter (Figure 16).

#### Heat Exchanger

1. The resultant gases from the burning in the combustion chamber pass through the central chamber and around the outer chamber to the exhaust tube, where they are deflected away. As the hot gases flow through these passages, they dissipate their heat through the stainless steel walls of the heat exchanger (Figure 20).

2. The heat exchanger of the Model 978-M-R has an auxiliary exhaust outlet which passes through the bottom of the heat exchanger at right angles to the regular outlet (Figure 21). The combustion air inlet is an oversize fit-

ting which draws the combustion air into the blower from around the recirculating exhaust outlet. When the heater is in operation, a part of the exhaust gases pass through the side outlet of the heat exchanger and are drawn into the combustion air blower. Fresh combustion air is also drawn in through the oversize air inlet of the blower and is mixed with the exhaust gases to provide the oxygen necessary for combustion. This flow system has advantages for some types of installations because it maintains the proper pressure differential for heater operation while eliminating any possibility of back pressure in the exhaust tube which could cause exhaust gases to leak into the interior of the vehicle. This arrangement also prevents cavity resonance in the exhaust system in installation, such as tanks, which require an unusually long exhaust tube.

3. The Model 978-M-H heater has internal design changes which eliminate the need for the recirculating exhaust feature

#### VENTILATING AIR SYSTEM

##### Ventilating Air Fan

1. Air is drawn in and forced through the air passages around the heat exchanger by the ventilating air fan. The air, in passing across the exchanger between the inner and outer chamber, and between the outer chamber and the heater case, absorbs the heat that is being dissipated through the walls by the hot combustion gases (Figures 16 and 20). The heated air is then conducted to the desired heat outlets.

#### ELECTRICAL SYSTEM

##### General

1. The electrical system of the 978 heater is designed to operate on 6, 12 or 24 volts, depending on the heater model. All heater model numbers terminate in a number which indicates the operating voltage of the heater.

2. The electrical system is explained in three phases of operation, i.e., Start-up, Running, and Purging.

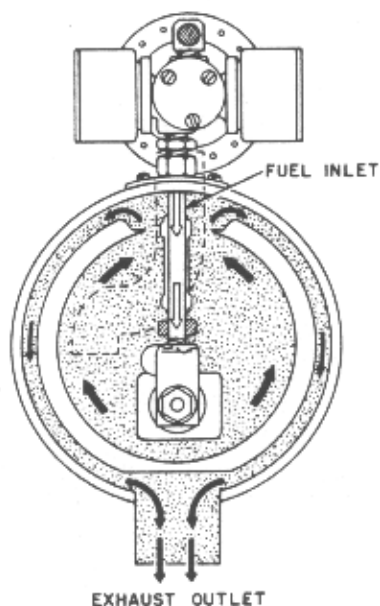


Figure 20—Flow System (End View)

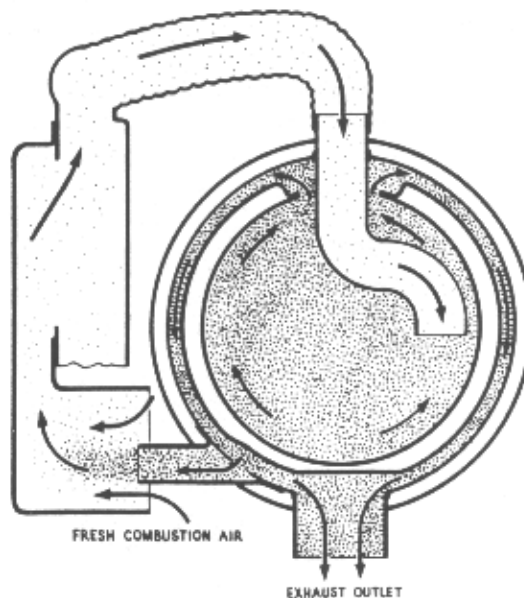


Figure 21—Flow System, Recirculating Exhaust (End View)

### Start-Up

1. When the heater switch is snapped "ON" several things occur simultaneously (see Figures 22 and 23)

a. The igniter is energized through the "A" and "B" contacts of the flame detector switch.

b. The combustion air motor is energized through the contact plate of the flame detector switch. On the Model 978-M-R6, the normally closed relay is also energized from terminal No. 7 of the terminal strip. This causes the relay contacts to open, placing the resistor in the combustion air motor circuit and causing the motor to start at slow speed (see Figure 23).

c. In the 12 and 24-volt heaters, the heating action of the igniter circuit resistor is transmitted through the standpipe and heats the gasoline as it drips into the igniter well. The preheated gasoline is easier to ignite, and it is not necessary to start with the combustion air blower operating at low speed. For this reason, the relay and resistor assembly is no longer used on these heaters.

d. The shut off solenoid is energized from terminal No. 4 of the terminal strip and through the overheat switch. This allows the initial fuel flow from the safety valve to reach the combustion chamber.

e. The restriction solenoid is energized from the closed contacts of the thermostat through terminal No. 5 of the terminal strip. This assures high heat fuel flow for start up.

2. With fuel and air provided and the igniter on, all requirements for combustion are fulfilled and burning starts.

### Running

1. Within twenty seconds after combustion starts, the metal tube of the flame detector switch expands and allows the quartz rod to move downward, releasing the pressure on the micro switch button, causing the contact plate to make contact with terminals "C" and "D." When this takes place, several things again occur simultaneously:

a. The igniter is shut off since the contact plate of the flame detector switch no longer makes contact with terminals "A" and "B."

b. On the 978-M-R6 heater, the normally closed relay

is de-energized, causing the relay to short out the combustion air motor resistor and the motor speeds up to normal operating speed. The igniter circuit resistor is turned off in the 12 and 24-volt heaters when the flame detector switch transfers since preheating is no longer required.

c. The shut-off solenoid of the safety valve is energized through the "C" and "D" contacts of the flame detector switch. This allows fuel to flow to the fuel control valve to sustain combustion and also refills the chamber of the safety valve with fuel in preparation for the next "start."

d. The motor of the ventilating air fan is energized through the "C" and "D" contacts of the flame detector switch.

2. The heater is now in full running operation.

3. When the space being heated reaches the desired temperature, the HI-LO switch is used to break the circuit to the restriction solenoid. This closes the restriction valve and the heater receives only low heat fuel flow. As soon as the temperature drops below the desired setting, the HI-LO switch is closed to reopen the restriction valve.

### Purging

When the heater switch is snapped OFF, the circuit to the fuel control valve is broken, shutting off the fuel supply. The burning in the heater stops in a few seconds but the combustion air fan and ventilating air fan continue to operate. As the heater becomes cool, the metal tube of the flame detector switch starts contracting and forces the quartz rod up until it moves the contact plate to terminals "A" and "B." This cuts off the current to the two motors and the heater is completely shut off.

### Failure to Start

1. If the heater fails to start, it is necessary to turn off the control switch and push the circuit breaker button on heaters which have this type of control box. This will manually reset the two circuit breakers. Hold the safety valve reset lever in the closed position for about 30 seconds. The safety valve reset lever manually energizes the safety valve shut-off solenoid, allowing the chamber to refill with fuel. Turn the control switch back ON and heater should ignite.

NOTE: *The ventilating air motor will run while the safety valve reset lever is held in the closed position, as the two electrical circuits are connected.*



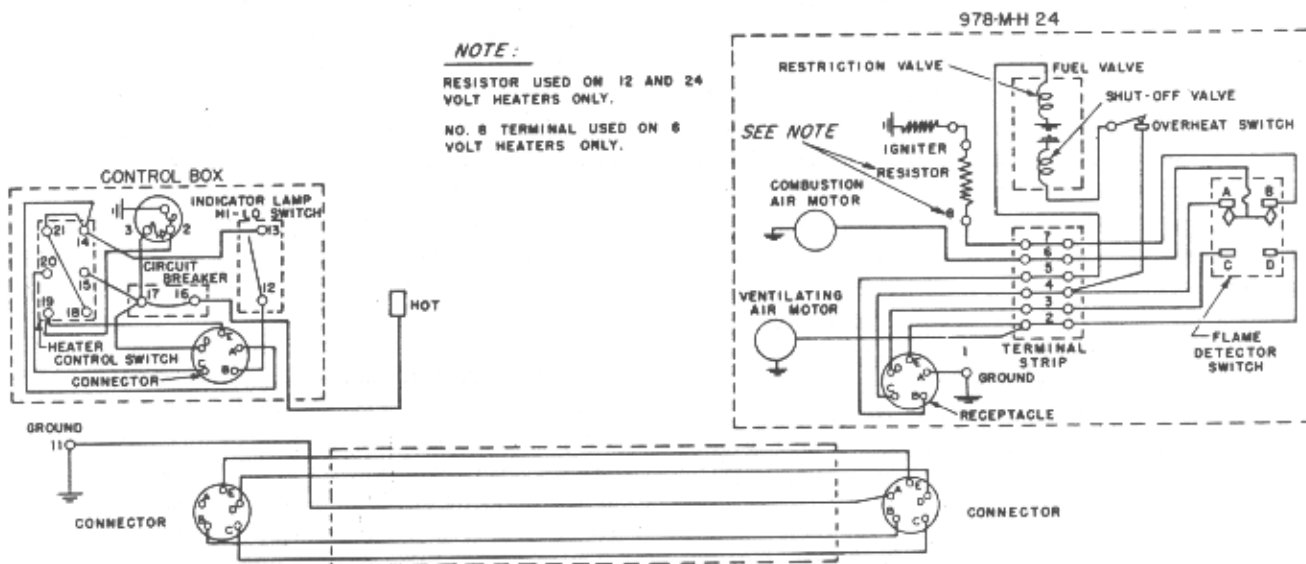


Figure 22—Typical Installation Wiring Diagram, Showing 978-M-H24 Heater

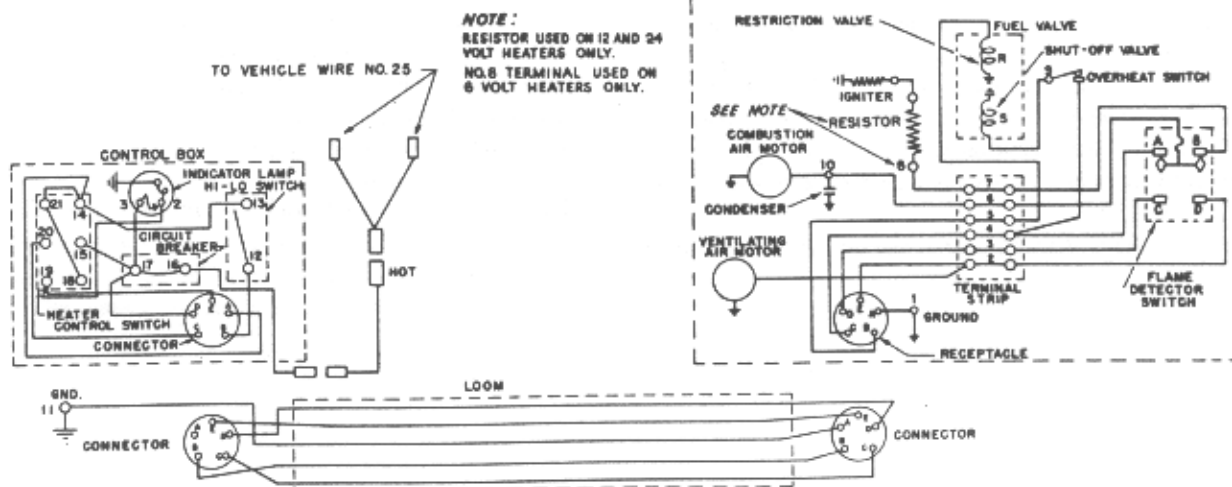


Figure 23—Typical Installation Wiring Diagram, Showing Model 978-M-C6, C12, C24 or 978-M-R12 or R24 Heaters

## Section V

### HEATER OVERHAUL AND REPAIR

#### GENERAL DESCRIPTION

1. This section consists of a description of the factory recommended procedure for overhaul and repair of the 978 Personnel Heater. The sequence of operations may be varied, depending upon which of the component parts are being repaired or replaced.

#### READ CAREFULLY

2. The Model 978 heater is designed to operate on 6, 12 or 24 volts, depending on the heater model. The number at the end of the heater model number indicates the voltage of the electrical circuit into which the heater is to be connected. There are two large model number plates on each heater, one on the ventilating air blower housing and the other on the heater case. These plates are marked 6 V., 12 V., or 24 V., and clearly indicate the voltage and model number of the heater in question.

2. It is extremely important that these model numbers be noted during overhaul and repair and especial care should be taken to see that replacement parts correspond in voltage to the heater upon which they will be reassembled. THE COMBUSTION AIR MOTOR, THE VENTILATING AIR FAN MOTOR, THE FUEL VALVE AND THE SAFETY VALVE ARE NOT INTERCHANGEABLE AMONG THE THREE MODELS AND THE HEATER CAN NOT FUNCTION PROPERLY IF A REPLACEMENT PART OF THE WRONG VOLTAGE IS USED.

#### Previous Model Heaters

1. The Model 978-M6, -M12, and -M24 heaters are no longer in production and are now regarded as obsolete since they are not suppressed for radio interference. However, these heaters may be encountered in the field, and if repairs are required, the defective parts should be replaced with parts of the 978-MC series, using parts of the proper voltage in all cases. The 978-MC parts are interchangeable by making minor changes in wiring connections using Figure 22 as a guide.

#### TOOLS REQUIRED

##### 1. Special Tools

1. Fuel valve screen tool, Part No. 488270 (Ord. No. 7355871).
2. Igniter housing scraper, Part No. 488269 (Ord. No. 7355872).

##### 2. Standard Tools

1. 5/16" open end wrench
2. 11/32" open end wrench
3. 3/8" open end wrench
4. 1/2" open end wrench
5. 9/16" open end wrench
6. 6" pipe wrench
7. 6" screw driver
8. 13/16" deep socket

#### DISASSEMBLY OF HEATER

##### Cover

1. Turn the two Dzus fasteners, located at each end of cover, counter-clockwise with screwdriver (Figure 24); and remove cover (Figure 25).

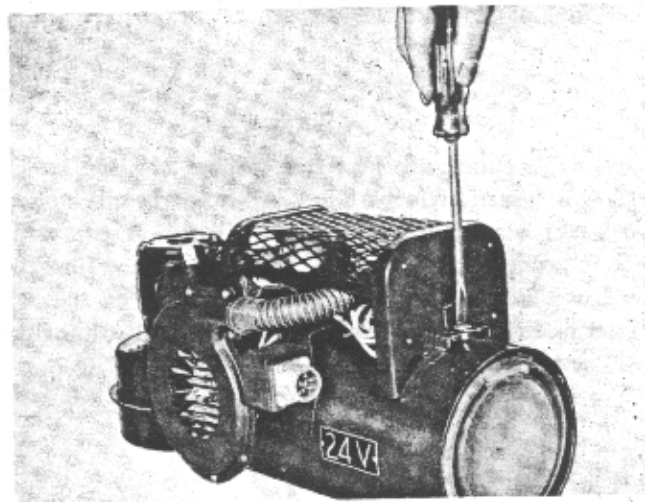


Figure 24

##### Ventilating Air Blower

1. Disconnect the ventilating air motor lead from terminal No. 2 of the terminal strip. Also disconnect the motor ground lead from the heater case.
2. Loosen the four nuts which hold blower to heater case.

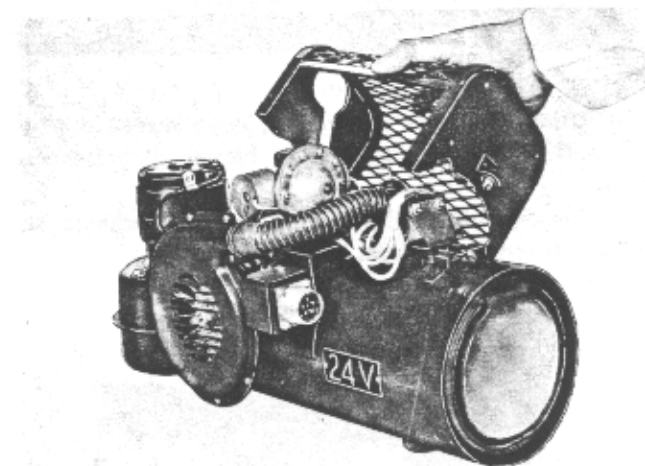


Figure 25

3. Remove blower housing by turning counter-clockwise on heater case until studs in case line up with slots in blower housing and pull free (Figure 26).

##### Combustion Air Blower

1. Remove combustion air hose and clamps. The clamps can be removed by compressing the ends with hose clamp

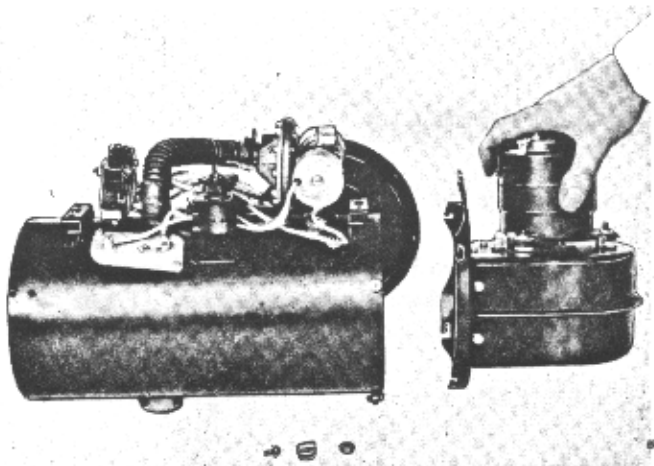


Figure 26

pliers while pulling the hose free (Figure 27). On Model 978-M-R heaters, remove the screw from the combustion air intake adapter and remove the adapter (Figure 28).

2. Disconnect combustion air motor lead No. 6 from the condenser inside the heater case (Figure 29) on the MR heater or from terminal No. 6 on the terminal strip of the MH heater.

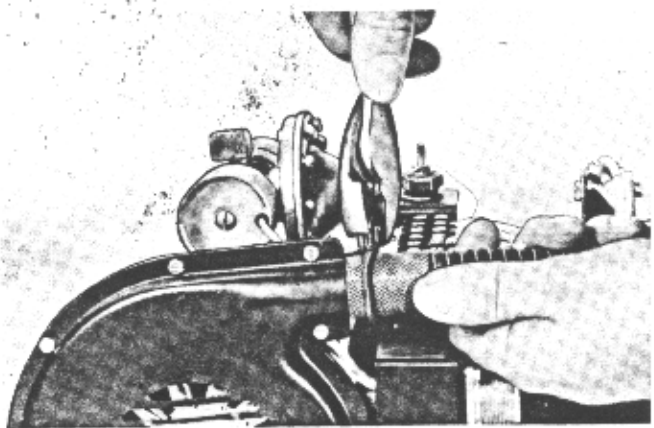


Figure 27

3. Using a  $\frac{3}{8}$ " open end wrench, loosen three No. 10-32 hex nuts which hold combustion blower to heater case flange.

4. Remove blower by turning counter-clockwise and pulling directly away from heater (Figure 30).

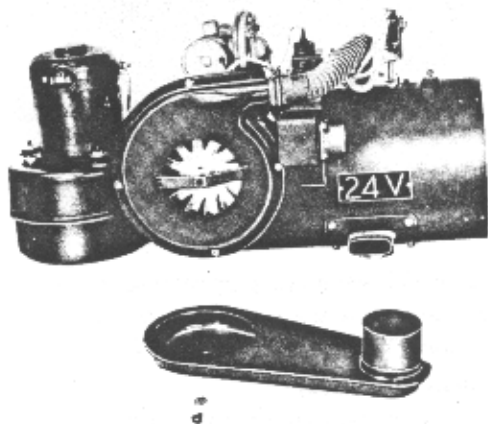


Figure 28

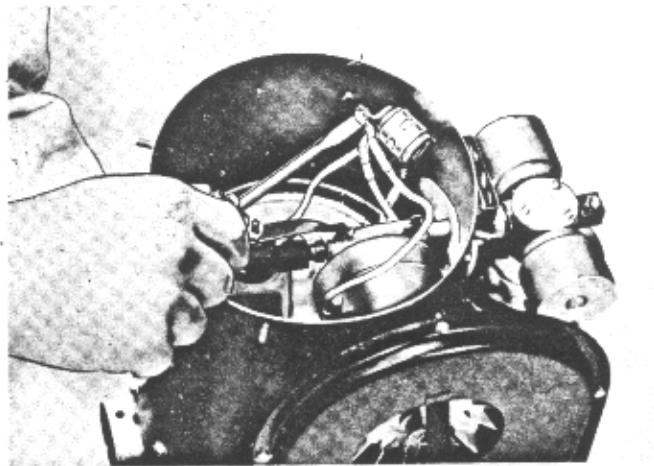


Figure 29

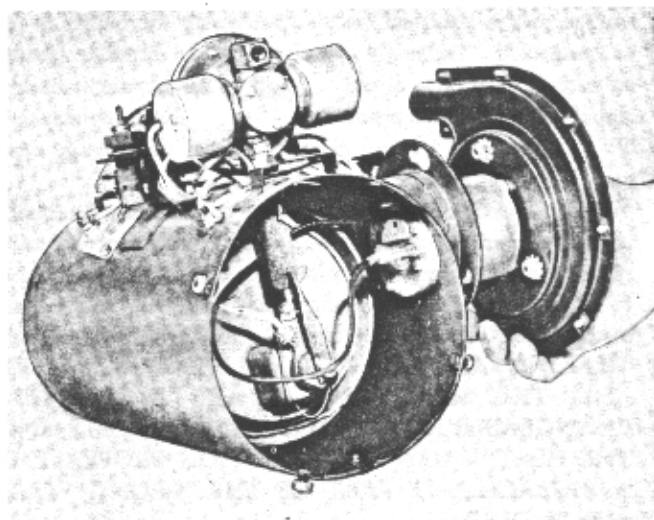


Figure 30

#### Flame Detector Switch

1. Disconnect the five flame detector switch leads from terminal strip screws Nos. 2, 3, 4, 6, 7 (Figure 31).

2. Loosen jam nut on expansion tube (Figure 32).

3. Remove flame detector switch by lifting straight up from heater until the expansion tube clears the heater port (Figure 33).

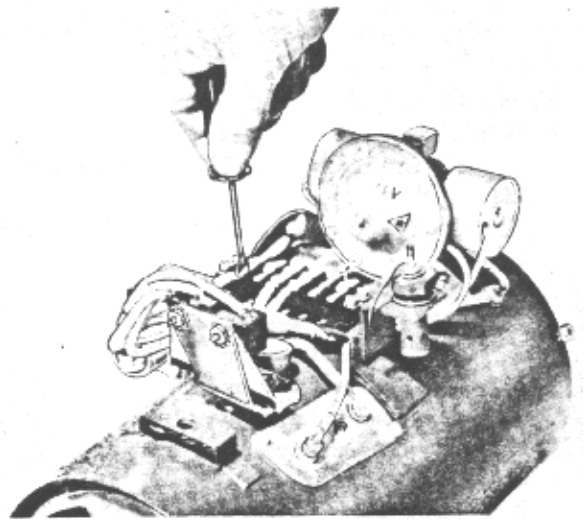


Figure 31

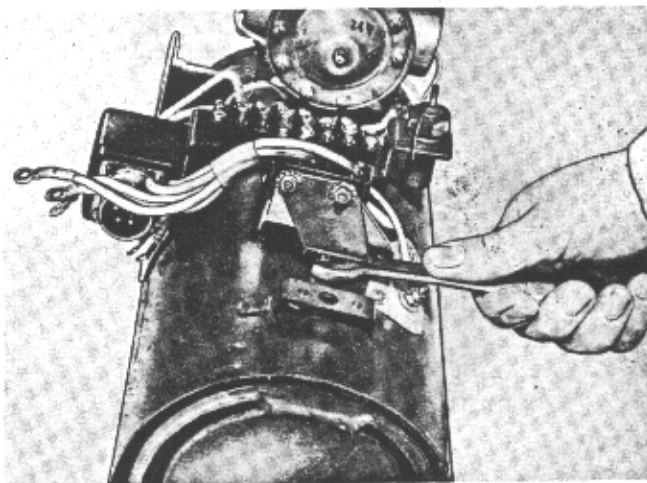


Figure 32

### CAUTION

Use care in removing this switch since the quartz rod encased in the expansion tube may be easily broken by twisting or excessive lateral pressure. When reassembling switch, be sure that expansion tube does not "bottom" inside heat exchanger. If expansion tube touches bottom, it should be raised approximately  $\frac{1}{8}$ " before tightening jam nut.

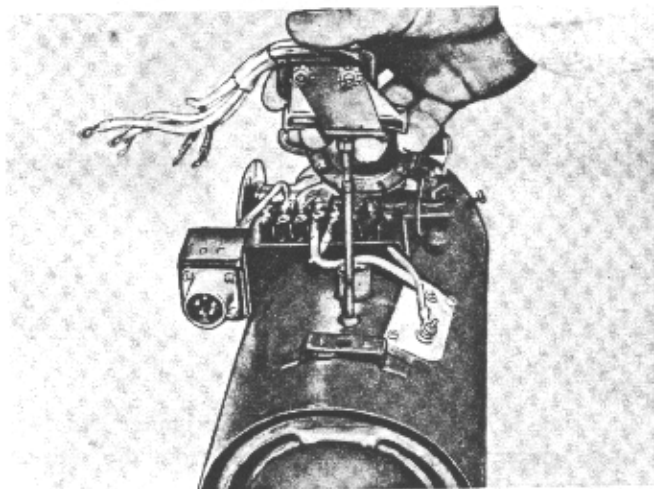


Figure 33

### Control Valve

1. Remove shut-off solenoid lead No. 9 from overhear switch terminal (Figure 34).

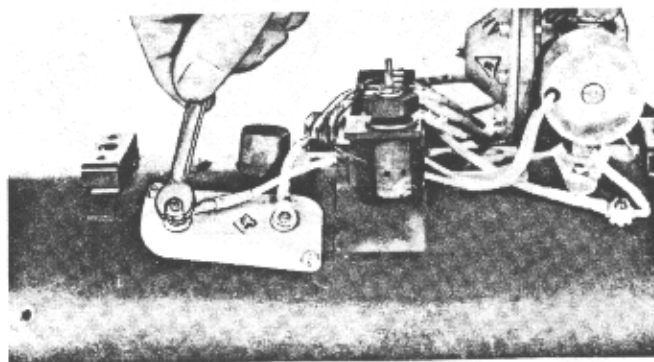


Figure 34

2. Disconnect restriction solenoid lead No. 5 from No. 5 terminal strip screw.

3. Loosen compression nut on standpipe (Figure 35) until fuel valve is free, and lift valve off.

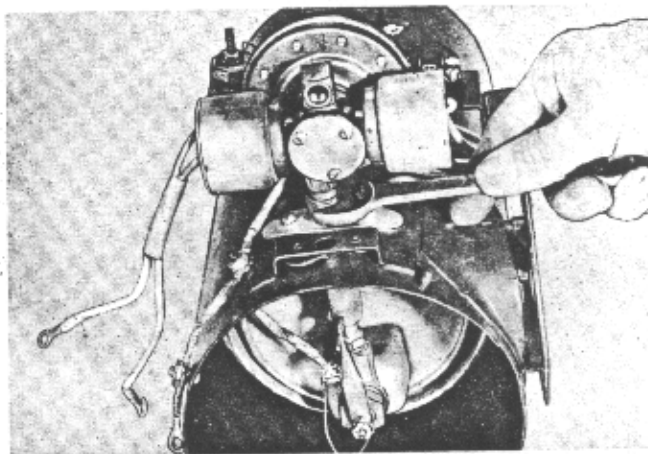


Figure 35

### Relay and Resistor (978-M-R6 Only)

1. Disconnect the relay leads from terminals No. 6 and 7 of the terminal strip and from the condenser terminal.
2. Remove the mounting screw and remove the relay from the mounting bracket (Figure 36).

The relay and resistor are now obsolete on the 978-M-R12 and M-R24 heaters. If the relay and resistor assembly are defective on any heater in the field, the entire assembly should be removed and the heater modified by installing the Fuel Pre-heater Kit, Part No. G-488330, on 24-volt heaters or No. 488369 on 12-volt heaters. This modification should not be made on the M-R6 heater, however.

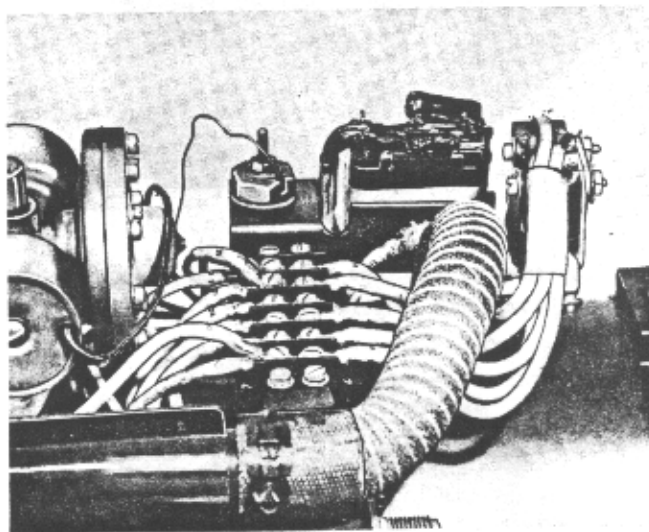


Figure 36

### Overheat Switch

1. Disconnect overheat switch lead No. 4 from terminal strip screw No. 4.
2. Using a screwdriver, remove two screws, holding overheat switch plate to heater case and remove switch (Figure 37).



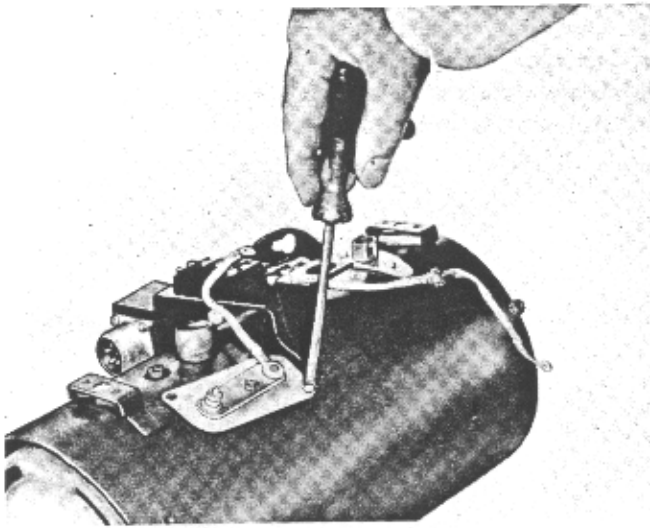


Figure 37

**Preheater and Standpipe (12 and 24-Volt Heaters Only)**

1. Remove the screws from the standpipe tapping plate and remove the slotted plate from inside the heater case (Figure 38), also disconnect resistor lead from igniter (Figure 39).

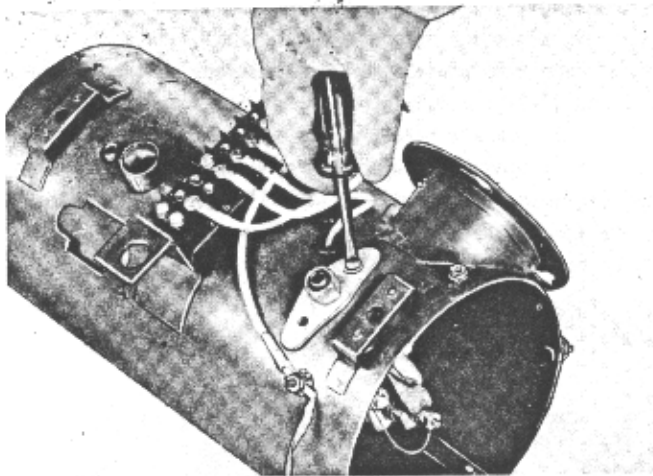


Figure 38

2. Unscrew the standpipe, using an end wrench on the hex at the lower end (Figure 40).

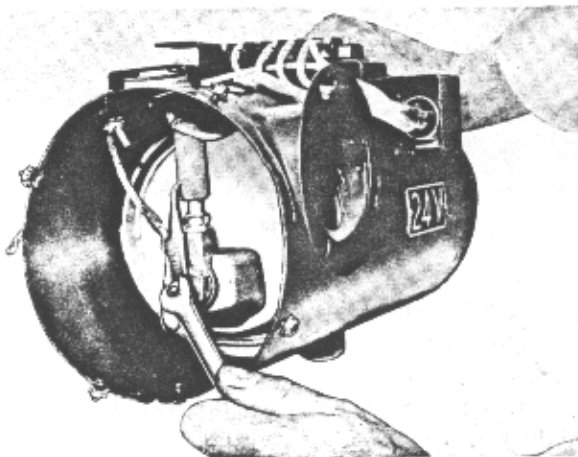


Figure 39

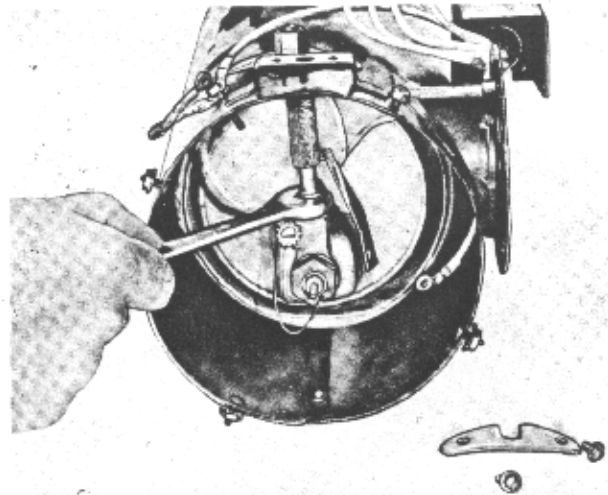


Figure 40

3. Lift the standpipe and resistor out through the top of the heater case (Figure 41).

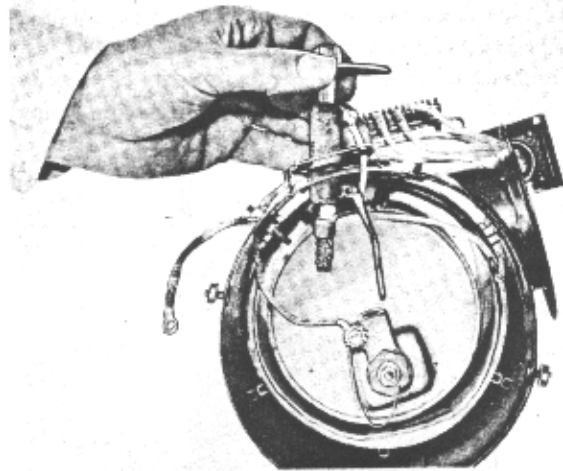


Figure 41

**Igniter**

1. Using 11/32" end wrench, remove igniter lead No. 7 from igniter. Also disconnect wires from the resistor assembly on 12-volt heaters.

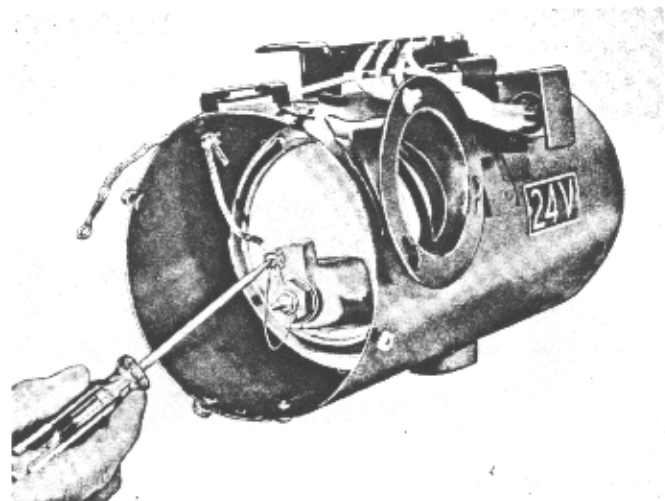


Figure 42

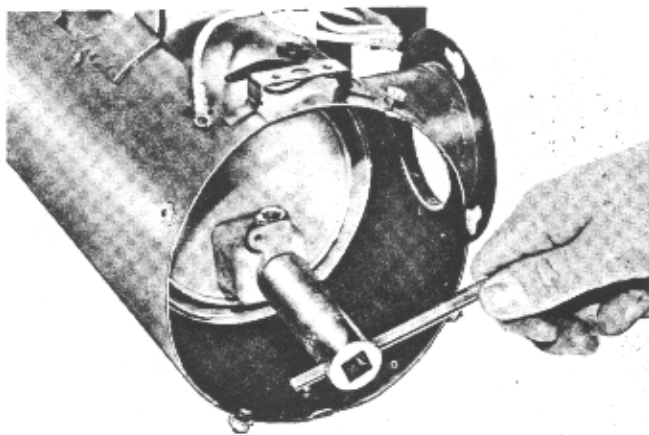


Figure 43

2. Disconnect igniter ground wire from screw on igniter pocket. This will also release the resistor on 12 or 24-volt heaters (Figure 42).

3. Using a 13/16" deep socket, remove igniter from housing (Figure 43).

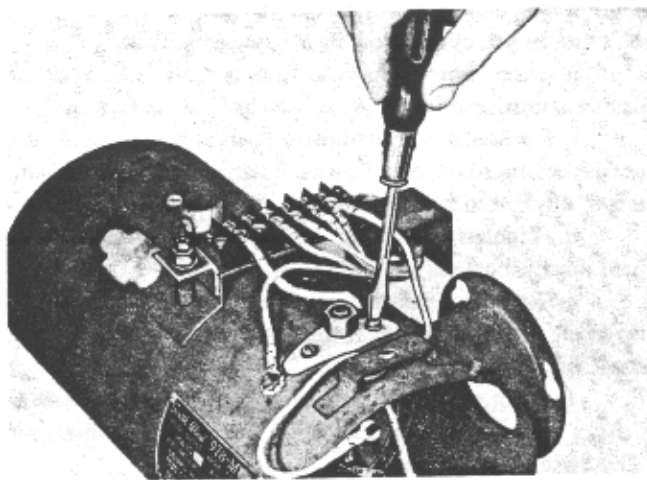


Figure 44

#### Standpipe (M-R6 Model)

1. Loosen two screws in standpipe collar (Figure 44).
2. Using a pipe wrench, loosen standpipe from igniter housing (Figure 45) and remove standpipe by lifting straight up through the heater case.

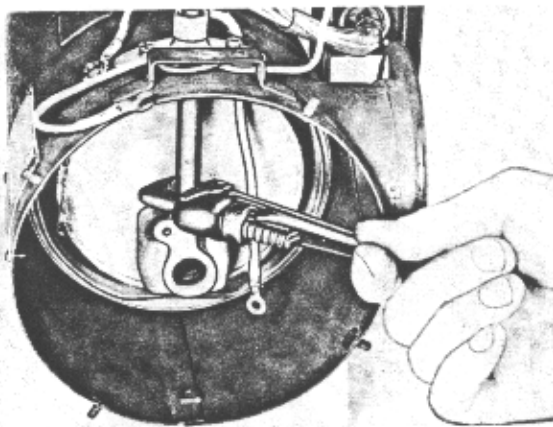


Figure 45

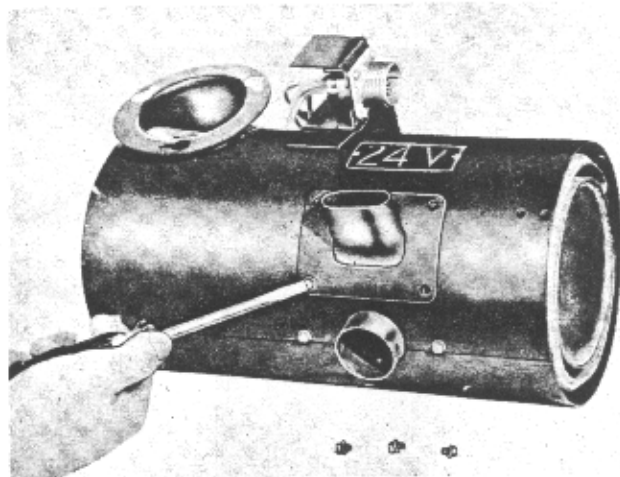


Figure 46

#### Heater Case

1. Remove plate from around recirculating exhaust outlet on MR series heaters (Figure 46).
2. Remove three screws on exhaust side of heater case (Figure 47).

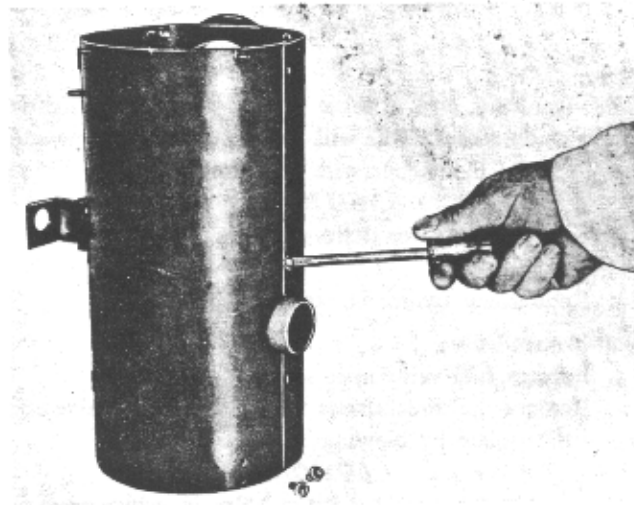


Figure 47

3. Spring heater case open with hands, enough to allow it to clear combustion air port on top of heat exchanger, and remove by sliding straight up until it is free of the heat exchanger (Figure 48).

#### INSPECTION, CLEANING AND REPAIR Heat Exchanger

1. Inspect the heat exchanger for possible damage or leaks.
2. Clean combustion residue from inside walls of igniter housing with igniter housing scraping tool.
3. Remove combustion residue from inside of heat exchanger by soaking heat exchanger in a 20% solution of ammonium acetate at a temperature of 180° F. for a period of 5 to 10 hours. This is the best method of cleaning exchanger and will noticeably increase efficiency if heater has been in use over extended period of time. Alternate method of cleaning is to pour *small* shot into heat exchanger and

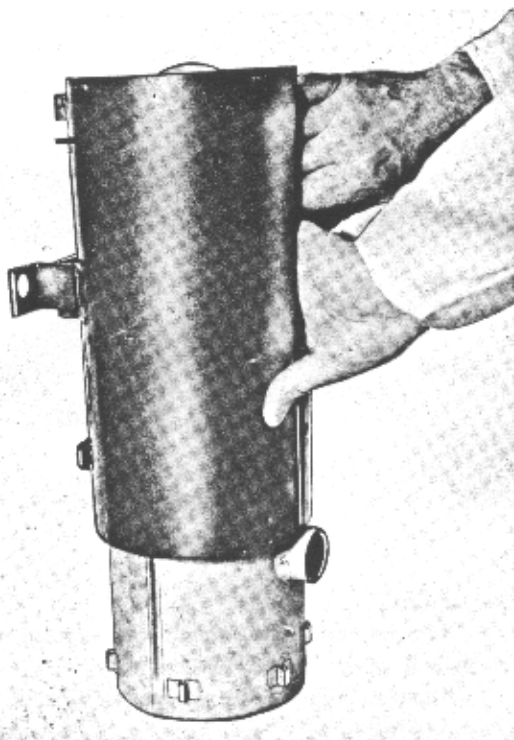


Figure 48

shake vigorously; and, at same time, tap exchanger lightly with rawhide mallet. This will loosen most of residue and allow it to be blown out with compressed air.

#### CAUTION

Remove *all* shot after performing this operation.

#### Igniter

1. Replace the igniter at each overhaul period.

#### Fuel Control Valve

1. Replace fuel valve inlet screen.
2. Remove the three screws from the back of valve and clean orifice plate by blowing on it.

#### CAUTION

Do not force anything through holes in orifice plate.

3. Inspect vaporizer wick, replace if necessary.
4. It is not advisable to attempt to repair any other part of the valve. If valve malfunctions, replace with new unit.

#### Blower and Fan Assemblies

1. Blower wheels and housings may be washed in gasoline, if dirty.
2. Inspect blades for possible damage.
3. Both motors are of ball bearing type and will require no lubrication since they are factory packed with special low temperature grease.

#### Heater Case

1. Inspect condition of rubber grommet.
2. Clean inside of case with wire brush or kerosene.

#### Flame Detector Switch

1. Disassemble switch and inspect quartz rod.
  - a. Loosen two switch mounting screws (Figure 50).
  - b. Remove adjusting screw (Figure 51).
  - c. Turn micro switch back on bracket and remove bow spring (Figure 49).

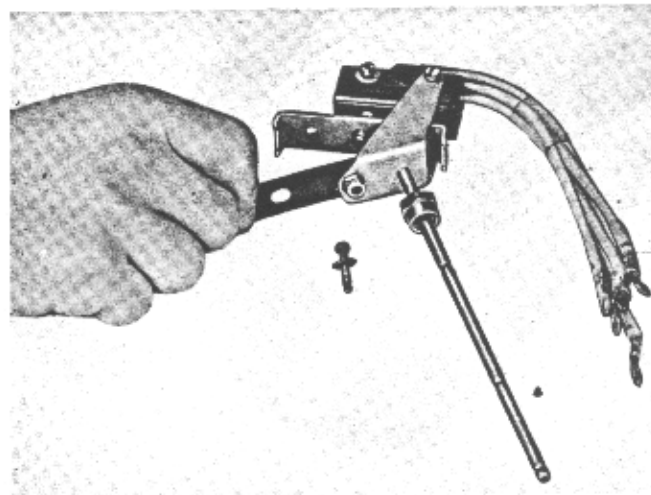


Figure 49

d. Turn assembly upside down and allow quartz rod to slide from expansion tube. Be sure that the switch is turned back far enough to give the quartz rod free passage. Replace quartz rod if broken.

2. Reassemble and adjust the switch.

a. Insert quartz rod into expansion tube.

b. Insert bow spring and turn micro switch back into position until the bow spring touches the quartz rod.

c. Reassemble the adjusting screw and turn it down until the micro switch "clicks"; then back the adjusting screw off approximately one turn.

d. Tighten mounting screws so that the switch is held firmly but *not* locked.

e. Remove tension from the bow spring by pressing up with fingers. This will allow the quartz rod to center itself on the switch button.

f. Turn the adjusting screw in slowly until the switch "clicks"; then, turn in exactly  $\frac{3}{4}$  turn beyond this point. The switch is now properly adjusted.

g. Tighten mounting screws to lock switch in proper position.

NOTE: When it is desired to adjust the switch without removing it from the heater, the following procedure may be used:

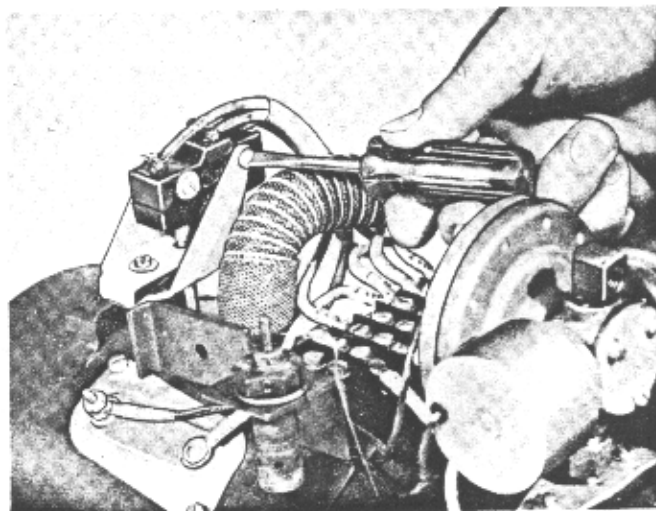


Figure 50

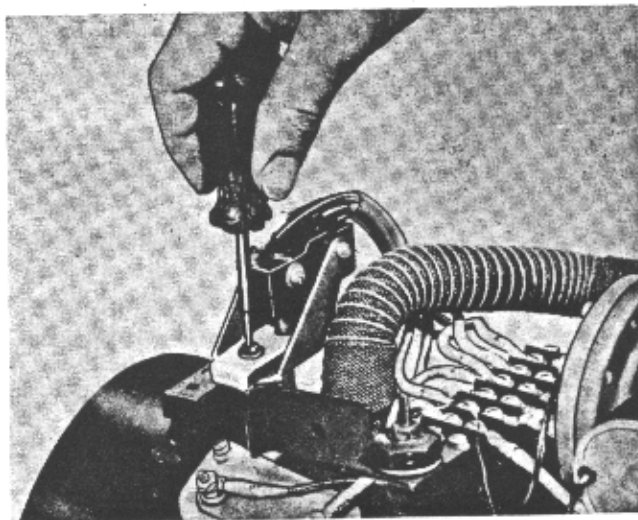


Figure 51

a. Check bow spring to see if tension of quartz rod is causing it to bow up toward the top of the switch. If the spring is not bowed but is in a straight position, it may be assumed that the quartz rod is broken. If so, remove and inspect as in paragraph "1" above.

b. If the quartz rod is not broken, loosen two switch mounting screws (Figure 50).

c. Back off adjusting screw until the switch "clicks" (Figure 51).

d. Turn adjusting screw in until the switch "clicks" again and then turn in an additional  $\frac{3}{4}$  turn from the click point. Switch is now correctly adjusted.

NOTE: Click is very faint and close attention must be paid while attempting this adjustment.

e. Tighten two switch mounting screws to hold switch in proper position.

#### Overheat Switch

1. Visually inspect for damage and clean by sliding piece of plain paper between the contacts. Do not attempt to bend blade or contact arm.

#### Combustion Air Hose

1. Inspect for damage, air leaks, frayed ends, etc.  
2. Clean inside of hose by blowing out with compressed air.

#### Safety Valve and Filter

1. To clean fuel filter, remove bowl by unscrewing and clean inside of bowl. Filter elements may be cleaned by washing in gasoline.

When reassembling, be sure gasket is in place between bowl and filter body.

2. If safety valve malfunctions, do not attempt to repair it. Replace the unit.

#### Wiring

1. Inspect for cracks and worn insulation.  
2. Inspect terminal strip for possible damage.

#### REASSEMBLY

1. For sequence of reassembly, reverse the procedure under disassembly.

## Section VI

### TESTING

#### TEST STAND (Part No. G-488367)

The G-488367 (Ord. No. 7950038) test stand is a highly portable test unit enclosed in a case which includes a compartment for accessories. It makes available complete facilities for testing all of the Model 978 Series Heaters in 6, 12, or 24-volt models. (See Figure 52.)

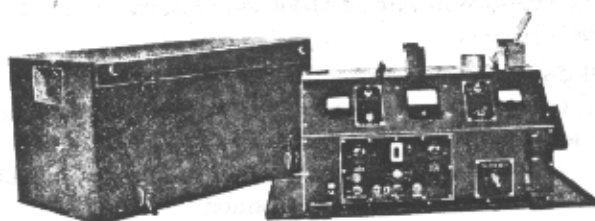


Figure 52—G-488367 Test Stand and Accessories

The test stand incorporates a cradle for mounting the heater, a fuel tank and electric fuel pump to supply fuel to the heater, a voltmeter and ammeter to measure the current and voltage to the heater, and a velometer to measure the combustion and ventilating air fan blower output, as well as a fuel flow meter to determine the rate of fuel flow through the heater fuel control valve.

An internal power supply, which supplies voltage for the 6, 12, or 24-volt model heaters is incorporated into the test stand for use when 120-volt line current is available.

The test stand is equipped with complete controls and switches for the operation of the test equipment and also includes provision for a storage battery power source in the event that 120-volt, 60-cycle, A. C. current is not available.

#### Test Stand Accessories

The following accessories are supplied with each test stand and are found in the accessory compartment of the test stand cover:

1. One set of storage battery leads for external power connections when 120 A. C., 60-cycle voltage is not available.



2. One tubing adapter for connecting the velometer hose to the ventilating and combustion air blower of the heater assembly.

3. Two and one-half feet of rubber tubing for connecting the velometer to the blowers.

4. One fuel line for attaching heater to the fuel pump of test stand.

#### Assembly of Test Equipment

1. Connect the free end of the flexible test stand fuel line to the inlet of the fuel control valve on heater to be tested.

2. Remove the green plug found at the upper left corner of the test stand and pour fuel through the filler tube.

#### TESTING PROCEDURE

1. In order to test the Model 978-M Heater intelligently, the test stand operator should have a thorough understanding of the normal heater operation. The trouble-shooting procedure outlined in Section VII will greatly aid in locating the source of most heater complaints when the proper testing procedure is followed.

2. A complete heater test includes the following:

a. Checking general heater performance, using chart found on Pages 21, 22, and 23 of the manual.

b. Measuring fuel flow through control valve by means of fuel flow meter on the test stand.

c. Checking output of combustion air blower.

d. Checking output of ventilating air blower.

#### Connecting Heater to Test Stand

1. Turn all test stand switches to OFF position.

2. Place Model 978 Heater on the test stand cradle with ventilating air blower to the left (Figure 53).



Figure 53—G-488367 Test Stand with Heater in Place

3. Place the connector of the test stand wiring harness in the receptacle on the heater.

4. Connect the test stand fuel line to the elbow on the heater fuel control valve.

5. If heater to be tested is a 6-volt model, connect the loose red wire protruding from the power panel and terminating in a plug to the 6-volt female socket and set the

internal voltage selector switch to the 6-volt position. Then set voltage regulator to LOW, MED., or HI as required, so that the correct voltage is indicated on the D. C. voltmeter of the control panel.

6. If the heater to be tested is a 12-volt model, place the loose red wire protruding from the power panel, in the 12-volt-24-volt socket and set the internal voltage selector to the 12-volt position. Then set the voltage regulator to LOW, MED., or HI as required so that the correct voltage is indicated on the D. C. voltmeter of the control panel.

7. If the heater to be tested is a 24-volt model, place the loose red wire terminating in a male plug in the 12-volt-24-volt female socket and set the internal voltage selector in the 24-volt position. Then set the voltage regulator to LOW, MED., or HI as required so that the correct voltage is indicated on the D. C. voltmeter of the control panel.

#### Testing Heater Operation

**NOTE:** If heater does not operate as specified below, refer to the Trouble-Shooting Procedure on Pages 24, 25, and 26, and use the service analyzer, part number G-487890 (Ord. No. 7951950) to isolate the trouble.

1. Place the ammeter switch in the AMMETER IN CIRCUIT position.

2. Place the "High-Low" switch in the HI position.

3. Place the fuel pump switch on the ON position.

4. Place the heater switch in the HEAT position.

a. The combustion air fan, igniter, and fuel valve should operate immediately and the ammeter should read as follows:

13 amps. for the 6-volt heaters

12 amps. for the 12-volt heaters

11 amps. for the 24-volt heaters

b. Within 40 seconds, the igniter should be turned off by the flame detector switch, the ventilating air fan should run, and the ammeter should then read as follows:

10 amps. for the 6-volt heaters

5 amps. for the 12-volt heaters

2½ amps. for the 24-volt heaters

5. Place the "High-Low" switch in LOW position.

a. The sound of burning in the heater will be heard to decrease in intensity as the heater output should be reduced.

6. Place the heater switch in the OFF position.

a. Burning should stop within 45 seconds.

b. The combustion air fan and the ventilating air fan should continue to run for about two minutes to cool and purge the heater.

#### Fuel Control Valve Test

1. Check the fuel control valve for On-Off operation and leaks as follows:

a. With heater connected to fuel source of test stand, turn the heater switch to OFF position.

b. Turn the fuel pump switch to ON, which will allow fuel pressure to be applied to the fuel control valve.

c. Turn the FUEL FLOW METER control valve to FUEL FLOW TEST.

d. Observe on the "Fuel Flow Meter" whether the level of gas drops as observed through the lucite tubing,

which will indicate whether the fuel control valve is leaking in the OFF position.

2. Check the fuel control valve for correct fuel flow as follows:

a. Install heater on test stand and adjust the test stand controls as follows:

Turn the fuel pump switch to ON

Turn the thermostat switch to HI

Turn the ammeter switch to IN CIRCUIT

Turn the heater switch on HEAT

b. Then, with the heater burning and the thermostat in HI position, turn the control valve of the "Fuel Flow Meter" to FUEL FLOW TEST, and, with a watch or stopwatch, measure the time it takes for fuel flow level to drop from the FULL position to the EMPTY position.

With the thermostat in HI position, the fuel level on the "Fuel Flow Meter" should drop from FULL to EMPTY in 1 minute.

c. Turn the control valve of the "Fuel Flow Meter" to ON position and allow the "Fuel Flow Meter" to refill.

d. Turn the thermostat switch to the LOW position and again set the control valve of the "Fuel Flow Meter" to FUEL FLOW TEST and measure the time it takes for the fuel level to drop from the full position to the EMPTY position.

With the thermostat in LOW position, the fuel level on the "Fuel Flow Meter" should drop from FULL to EMPTY in 2 minutes.

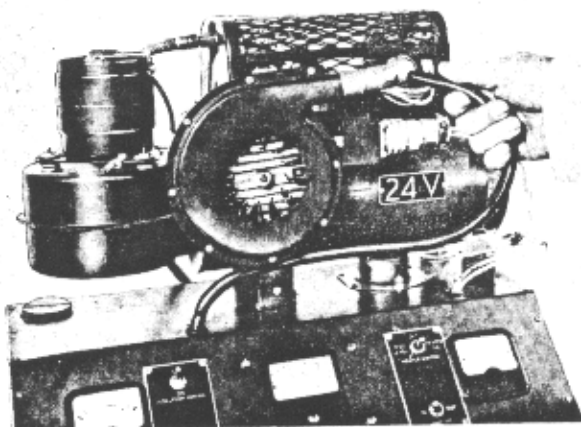


Figure 54—Combustion Air Blower Test

#### Combustion Air Blower Test

**NOTE:** Before making this test, make sure the voltage indicated on the voltmeter reads 6, 12, or 24 volts, depending on the model being tested. If the voltage is below or above this figure, adjust the voltage regulator control (which is found at the upper left corner of the power panel) until the voltmeter indicates the correct voltage since the following test is greatly affected by variations in voltage.

1. Remove the end of the flexible tubing from combustion air blower outlet of the heater and attach the steel test elbow which is supplied with the test stand. Then reconnect the flexible combustion air tubing to the elbow. With the heater ON, insert orifice tip of the rubber tube from

velometer into the small hole in the steel elbow (see Figure 54). Turn the heater switch to ON.

2. The velometer so connected should read between 1.0" and 1.75" on the high range for the 978-M-R heater or 0.7" to 1.0" for the 978-M-H.

**NOTE:** Read the velometer on the upper scale only, as this unit has been calibrated for the high range exclusively. Also, when testing the Model 978-M-R6, wait until the flame detector switch transfers and the combustion air blower goes into high-speed operation before taking the reading.

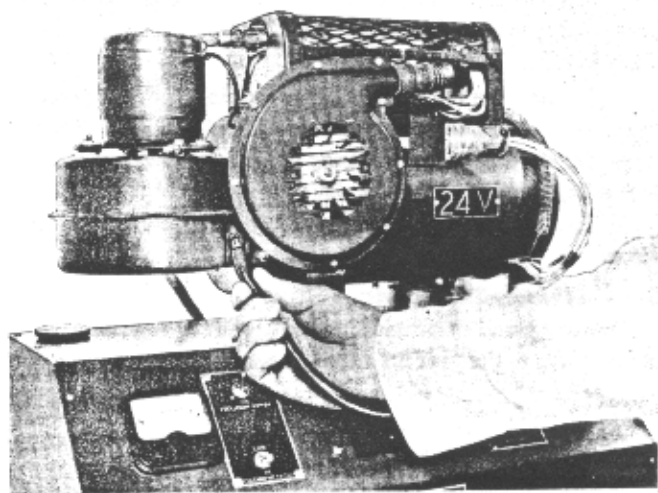


Figure 55—Ventilating Air Blower Test

#### Ventilating Air Blower Test

**NOTE:** Before making this test, make sure the voltage indicated on the voltmeter is 6, 12, or 24 volts, depending on the model being tested. If the voltage is below or above this figure, adjust the voltage regulator control (which is found at the upper left corner of the power panel) until the voltmeter reads the correct voltage since the following test is greatly affected by variations in voltage.

In order to make this test:

1. Remove screw from the side of the ventilating air blower housing and insert the tubing adapter in this hole, connecting the velometer into the ventilating air stream (see Figure 55). Turn the heater switch to ON.

2. In this position, the velometer so connected should read between 0.3" and 0.7" H<sub>2</sub>O on the high range.

#### Overheat Switch Test

1. Make sure that all switches are OFF with exception of ammeter switch.

2. Disconnect ventilating air fan motor lead #2 from terminal strip #2.

3. Using the amber and black leads from the service analyzer, part number G-487890, ground the black lead to the heater case and connect the amber lead to the screw post of the overheat switch.

4. Place fuel pump switch ON, thermostat switch to HI, and the heater switch ON.

5. At instant ignition occurs, start timing action of overheat switch by observing the amber light.

6. At normal room temperature, the overheat switch should open, at which time the amber light of the service analyzer (part number G-487890, Ord. No. 7951950) with go out, within 25 to 60 seconds after ignition takes place.

#### **Storage Battery Operation**

If 110-volt A. C., 60-cycle, current is not available for internal power unit, this test stand may be operated on 6, 12, or 24-volt storage batteries. To connect storage batteries to test stand, proceed as follows:

1. Turn all switches on the test stand to OFF.
2. Connect the storage battery leads to the storage battery terminals found at the extreme left of the power panel, observing polarity of the large battery clips (one is marked POSITIVE).
3. Connect the red wire which protrudes from the power panel to the female plug marked STORAGE BATTERY.
4. Set storage battery selector switch on power panel to the voltage of the heater model under test.
5. Proceed with test as covered in the preceding instructions.

#### **Sub-Assembly Test Leads**

The test stand is provided with a pair of test leads extending from the rear of cabinet, which allow testing of

individual sub-assemblies of the personnel heater. These test leads are color-coded to indicate polarity (red insulator sleeve, positive; black insulator sleeve, negative).

In order to check sub-assemblies of the heater, proceed as follows:

1. Determine the operating voltage of the part to be tested and set the INTERNAL VOLTAGE SELECTOR SWITCH to the proper setting and place the red wire and plug assembly in the correct voltage socket.
2. Connect the test leads to the device to be tested, making sure that leads are well insulated to prevent a short at the point where they connect to the part under test.
3. Set the voltage regulator switch to LOW, MEDIUM, OR HIGH so that the correct voltage for operation of the part is indicated on the D. C. voltmeter of the control panel.
4. Place the ammeter switch in AMMETER IN CIRCUIT position.
5. Place the heater switch in TEST position, which will apply voltage to the part under test and the operating current of the device will be indicated on the D. C. ammeter of the control panel.

## Section VII

### TROUBLE SHOOTING

#### INTRODUCTION

1. The South Wind Model 978 Heater Circuit Analyzer (G-487890, Ord. No. 7951950) is a multiple test light unit, designed for checking operation of the electrical circuit of the South Wind Model 978 Heater.

2. By using this instrument, it is possible to completely check the operation of a heater while it is installed in the vehicle, making it unnecessary to remove the heater except for major repairs. The circuit analyzer, when used as directed below, gives a constant visual indication of the electrical conditions existing in the heater, either in the shop or while making a road test.

3. As shown in Figure 56, the Model 978 Heater Circuit Analyzer consists of a metal case, in which are mounted four jewel lights. These lights are colored red, amber, white and green. Five test leads extend from the metal case, two equipped with alligator clips and the other three attached to a connecting strip, for connecting them to the various circuit elements in the heater.

A selector switch is provided on the top of the analyzer to set the instrument for use on 6, 12, or 24-volt heaters as required.

4. The leads are made long enough for the analyzer to be brought through an open window into the interior of the vehicle while the leads are connected in place on the heater. In this way, the heater may be tested under actual driving conditions on the road.

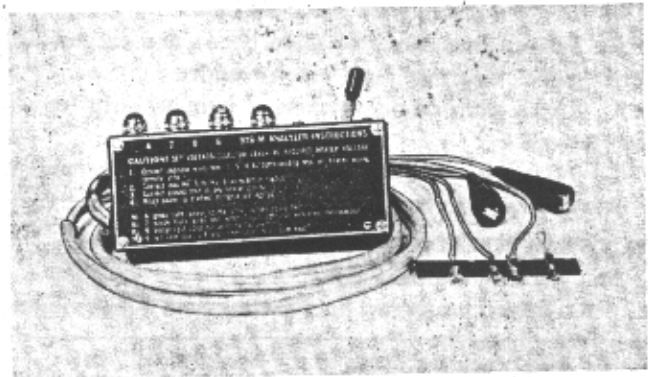


Figure 56—G-487890 Circuit Analyzer

#### TEST PROCEDURE

1. The following test procedure, using the circuit analyzer, is recommended for checking either a newly installed heater or for trouble shooting on an older installation brought in for repair. The procedure should be followed through in the order listed below. If operation is satisfactory at each stage of the check, the heater is operating in a normal manner. If operation is unsatisfactory at any stage, consult the section referred to in **UNSATISFACTORY** column at the right hand side of the page.

**CAUTION:** Make sure the voltage selector switch is set to the voltage of the heater which is being tested. Failure to do so may burn out the lamps in the jewel lights.

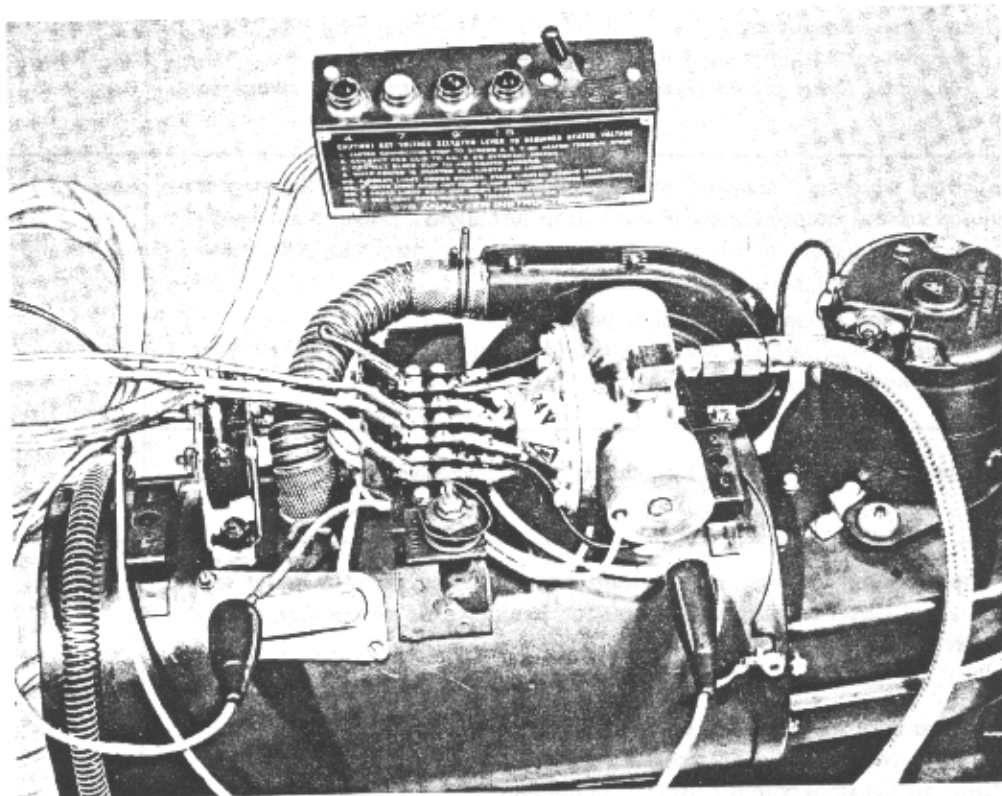


Figure 57—Circuit Analyzer Connections

## TROUBLE SHOOTING PROCEDURE

<p><b>I. PRELIMINARY VISUAL CHECK</b></p> <p>A. Remove protective cover from heater.</p> <p>B. Exhaust line is free of sharp bends, and exhaust deflector, if so equipped, has at least 1/2-inch clearance from exhaust outlet.</p> <p>C. Check electrical connections at terminal strip for wiring code matching and firm connections.</p> <p>D. Heater is mounted securely and horizontally with the fuel control valve on top.</p>	<p><i>If Unsatisfactory See Paragraph Referred to Below Under Trouble Shooting Procedure</i></p>
<p><b>II. OPERATIONAL CHECK</b></p> <p>A. With the engine running:</p> <ol style="list-style-type: none"> <li>1. Inspect heater fuel lines for leaks and 4-inch vibration loop.</li> </ol>	
<p>B. Attach analyzer leads to the heater as follows:</p> <ol style="list-style-type: none"> <li>1. Loosen screws holding connecting strip to the heater terminal strip. Insert analyzer connecting strip under terminal screw leads 2, 4, 5 and 7 and tighten down screws (see Figure 57).</li> <li>2. Connect the red alligator clip to the screw terminal of the overheat switch. Connect the black (ground) to the fuel inlet elbow or any convenient ground (see Figure 57).</li> <li>3. Lights may be observed either on the outside of the vehicle or, during a road test, by running the leads through a side window in the vehicle.</li> <li>4. Check ventilating air fan by snapping heater switch to RESET for a few seconds. If fan operates properly, turn switch off and proceed with operation procedure.</li> </ol>	<p>A, B</p>
<p>C. Turn the HI-LO switch to HI heat position; turn heater switch to ON or START position. Speed up engine slightly and leave at that speed for 3 minutes.</p> <ol style="list-style-type: none"> <li>1. Red lamp lights immediately.</li> <li>2. Green lamp lights immediately.</li> <li>3. Amber lamp lights immediately.</li> <li>4. White lamp lights immediately.</li> <li>5. White lamp goes out within 30 seconds after ignition.</li> </ol> <p>NOTE: <i>Green and amber lights should remain on continuously until heater switch is turned off.</i></p>	<p>C D E F G</p>
<p>D. On installations which are equipped with a thermostat, when the red lamp goes out, turn thermostat control counterclockwise until lamp just lights. Leave in this position until lamp goes out again. In this manner, keep turning control clockwise until lamp just lights, until the full high heat position is reached.</p> <ol style="list-style-type: none"> <li>1. Lamp goes on and off in extreme high position.</li> </ol> <p>NOTE: <i>When making a road test, the red lamp should go on and off intermittently to indicate proper thermostatic action.</i></p>	<p>H</p>
<p>E. If white lamp relights any time during check, it will be necessary to attempt to restart heater.</p>	<p>G</p>
<p>F. To check operation on low heat, remove lead from restriction valve or heater terminal No. 5 and allow heater to burn on low heat for 2 minutes. If satisfactory, reconnect lead to heater terminal No. 5.</p>	<p>J</p>
<p>G. Allow heater to burn for 2 minutes and turn heater switch to OFF position.</p> <ol style="list-style-type: none"> <li>1. Burning stops completely in 45 seconds.</li> <li>2. Ventilating air fan stops within 1:10 to 2:35 minutes.</li> </ol>	<p>K L</p>



## TROUBLE SHOOTING PROCEDURE

### A. Ventilating Fan Fails to Operate

1. With motor off, heater switch in PRIME position, ground black alligator clip and touch red alligator clip to:

a. Reset terminal No. 17 of control box. If lamps fails to light, it is:

- (1) Faulty wire battery to No. 16 control box or
- (2) Open circuit breaker, or
- (3) Defective circuit breaker.

b. No. 2 terminal strip. If lamp fails to light, it is:

- (1) Faulty wire No. 18 in control box to safety valve, or
- (2) Faulty wire safety valve to "E" of AN connector, or
- (3) Bad solder connection in AN connector, or
- (4) Faulty wire "E" in AN connector to No. 2 terminal strip.

c. Check motor ground wire, fan connection to No. 2 heater terminal strip. If these are good, fan motor is bad and must be replaced.

### B. Fan Runs But Air Flow Inadequate

1. Turn heater switch to OFF position and check intake and outlet ducts for restrictions.

### C. Red Lamp Does Not Light

1. Turn the thermostat, if used, to full counterclockwise position. With motor running, heater switch in ON position, ground black wire test lead and touch amber test lead to:

a. Both thermostat terminals, one at time. If the lamp lights on one but not on the other, replace the thermostat. (Thermostat must be in full high heat position for this check.)

### D. Green Lamp Does Not Light

1. Before making any further inspections, check the voltage at the No. 3 terminal of the terminal strip. A minimum of 5½ volts is required for heater operation. (978-M-C6)

2. With motor running, heater switch in heat position, ground black test lead and touch red test lead to:

a. No. 14 heater switch terminal. If lamp fails to light, it is:

- (1) Faulty wire No. 15 control box to circuit breaker, or
- (2) Defective switch or open circuit breaker.

b. No. 4 heater terminal strip. If the lamp fails to light, it is:

- (1) Faulty wire No. 4 terminal strip to "C" of AN connector, or
- (2) Bad solder connection in AN connector, or
- (3) Faulty wire "C" of AN connector to control box.

### E. Amber Light Does Not Light

1. Defective overheat switch. Replace complete assembly.

### F. White Lamp Does Not Light

1. With motor running, heater switch in ON position, ground black test lead and touch amber test lead to:

- a. No. 4 heater terminal strip. If lamp lights, it is:
  - (1) Flame detector switch inoperative or out of adjustment (broken quartz rod or bow spring).

### G. White Lamp Remains On

1. To restart heater, proceed as follows:

a. Snap heater switch to RESET position for 30 seconds.

b. Restart heater by snapping heater switch to ON position.

c. If heater still fails to start, proceed with the following check procedure.

2. Heater does not ignite.

a. With motor running, heater switch in heat position, ground black test lead and touch amber test lead to:

(1) No. 6 heater terminal strip. If lamp fails to light, it is:

- (a) Inoperative flame detector switch.

NOTE: If lamp lights at No. 6 heater terminal, and blower is not operating, check combustion air motor.

(2) No. 3 heater terminal. If lamp fails to light, it is:

(a) Faulty wire No. 3 heater terminal to "D" AN connector, or

- (b) Bad solder connections in AN connector, or

(c) Faulty wire "D" AN connector to No. 17 circuit breaker, or

- (d) Open or defective circuit breaker.

b. Turn heater switch to off position. Connect black test lead to No. 3 heater terminal strip and touch red alligator clip to:

(1) Bolt terminal of overheat switch. If "S" valve does not click, the shut off solenoid is defective.

(2) No. 5 heater terminal strip. If "R" valve does not click, the restriction solenoid is defective.

(3) No. 7 heater terminal. If spark does not jump, the igniter or resistor is defective.

NOTE: If the above checks are satisfactory and heater still does not ignite, replace safety valve.

3. Heater ignites but fan does not come on.

a. Disconnect lead wire from bolt terminal on overheat switch. Turn heater switch to heat position. Ground black test lead and touch amber test lead to:

(1) No. 3 heater terminal. If lamp fails to light, it is:

(a) Faulty wire No. 3 heater terminal to "D" AN connector, or

(b) Bad solder connections in AN connector, or

(c) Faulty wire "D" AN connector to No. 17 circuit breaker, or

- (d) Open or defective circuit breaker.

(2) The flame detector switch is defective or out of adjustment.

#### H. Thermostatic Action Not Obtained

1. The thermostat is either defective or is set low and should be replaced. However, before replacing, check thermostat for location in a hot pocket.

**NOTE:** *Outside temperature must be cold for proper thermostatic action. Testing in a warm shop will give false indications.*

#### J. Heater Goes Out in Low Heat

1. Remove fuel valve and check low heat fuel flow through the shut off valve.

2. Check length of wick protruding from standpipe; should be 1/2-inch.

3. If flow rate and wick are satisfactory, check heater fuel line for "hot spots" which would cause vapor lock.

#### K. Heater Does Not Stop Burning

1. Defective shut-off valve. Replace complete fuel control valve assembly.

#### L. Fan Stops Too Soon or Too Late

1. Flame detector switch out of adjustment or defective.

a. When it is desired to adjust the flame detector switch without removing it from the heater, the following procedure may be used.

(1) Check bow spring to see if tension of quartz rod is causing it to bow up toward the top of the switch. If the spring is not bowed but is in a straight position, it may be assumed that the quartz rod is broken and the switch should be replaced.

(2) If the quartz rod is not broken, loosen the two switch mounting screws.

(3) Back off adjusting screw until the switch clicks.

(4) Turn adjusting screw in until the switch clicks again and then turn in an additional 3/4 turn. Switch is now correctly adjusted.

(5) Tighten the two switch mounting screws to hold the switch in proper position.

## Section VIII INSTALLATION

### INSTALLATION KITS

To facilitate installation of the Model 978 Heater, an extensive series of complete installation kits have been designed. These kits include the heater, or heaters, required for each vehicle plus all the additional equipment required for a complete installation. Complete illustrated installation instructions are packed in each kit, and the instruction booklet should always be used as a reference when making a specific installation. Since there may be variations due to engineering changes in individual kits, even though designed for the same vehicle and bearing the same Ordnance number, the instructions packed in the individual kit should always be used rather than depending upon previous experience with similar vehicles, and the *installation instructions should always be saved and kept in the vehicle after the installation is completed.* In this way, an accurate list of spare parts will always be available for every installation.

A list of Ordnance heater kits, showing part numbers of the various major components is included in this manual (see Page 28). Since new kits are continuously being developed, new kits not listed in the manual may appear in the field.

### HEATER PACKAGES

In addition to the complete kits listed on Page 28, Stewart-Warner has available a number of "Heater Package" kits which include the heater assembly, control box, safety valve, etc., but do not include accessory items such as distribution ducts, fuel fittings, and mounting brackets. These heater kits are designed to be used when making pilot installations in new vehicles, for making installations not on a production basis, and for factory installation in certain

vehicles where the distribution system and other components are built into the vehicle. The table on Page 29 lists these kits by Stewart-Warner part number and shows the major components of each package.

### WIRING DIAGRAMS

Heater wiring diagrams are mounted inside the protective cover of the heater assemblies and overall wiring diagrams of each kit are supplied on etched plates to be mounted in each vehicle. In addition, a detailed wiring diagram appears in every installation manual. However, for reference purposes, the overall wiring diagram of the 2 1/2 Ton Shop-type vehicles and the wiring diagram for the 37-Passenger Bus installation are included in this manual since these diagrams are too large to be shown in detail on the etched plates.

### GENERAL INSTALLATION INSTRUCTIONS

The following instructions are provided as an aid in making pilot installations on new vehicles or for making any installation not covered by a specific installation kit.

#### Heater Models

1. The choice of heater model will depend upon the individual requirements of each installation. For all Ordnance installation, the Model 978-M-H series heaters should be used to promote standardization. This heater should also be used in any installation where the exhaust tube will exceed a maximum length of approximately 6 inches. The recirculating feature of the Model 978-M-H series heaters permits the use of exhaust tubes of a length equivalent to 25 feet of straight 1 1/2 I. D. flexible tubing. However, shorter exhaust tubes should be used wherever possible.

2. In addition to the consideration of exhaust tube length, the outlet temperature of the ventilating air and the speed of the ventilating air blowers will determine the type of heater to use. The Model 978-M-B heater has provision for attaching a high-heat outlet adapter which permits the use of air at temperatures up to 400° F. This heater is suitable for engine preheating or other applications which require high-temperature air. The 978-M-B heater also has a high-speed ventilating air blower which adapts the heater to use with distribution systems where higher than normal pressure drops are encountered or where a larger volume of air is required than can be obtained from the other model heaters.

3. The Model 978-M-E heater is similar to the 978-M-R series except that it is equipped with a high-speed blower without the high-temperature outlet feature. This heater is suitable for installations which have an unusually high pressure drop in the distribution system.

#### Heater Location

1. The heater should be located in an accessible place so that it can be removed for servicing from time to time. The heater may be located within the space to be heated, but should not be located in a space so confined that radiated heat from the heater could affect the overheat switch or fuel line and cause erratic operation.

2. The heater should be firmly mounted in an upright position with the exhaust outlet at the bottom. The heater mounting should be able to withstand vibration on the order of 20 cps at  $\frac{1}{8}$  in amplitude.

#### Heater Exhaust

1. The heater should be located so as to use the shortest possible exhaust tube. The exhaust tube for the 978-M-C heater should not exceed 6 inches in length, but the 978-M-R heater can be used with tubes equivalent in length to 25 feet of  $1\frac{1}{2}$ -inch I. D. flexible tubing.

2. For the Model 978-M-R heaters, the static pressure at the exhaust outlet must not be more than 0.16 in.  $H_2O$  greater than the pressure at the combustion air blower inlet. This limitation does not apply to the Model 978-M-H heaters, since they will operate satisfactorily with back pressures up to  $1\frac{1}{2}$  in.  $H_2O$ , which is more than is likely to be encountered in an actual installation. When used with the 978-M-H heaters, 25 feet of flexible  $1\frac{1}{2}$  in. I.D. exhaust tube is equal to 0.2 in.  $H_2O$  back pressure. One sharp 90° exhaust elbow is equal to 10 feet of flexible exhaust tube. All of these heaters will operate with up to 8 in.  $H_2O$  vacuum at the exhaust outlet. The table below, which refers to the 978-M-R series heaters only, shows the pressure drop in different types of exhaust tubing for these heaters.

**PRESSURE DROP IN EXHAUST DUCTS  
(978-M-R Heater Only)**

Type of Duct	Pressure Drop Per Linear Foot	Drop Across Fitting
$1\frac{1}{2}$ " I. D. Flexible Duct	0.004 in. $H_2O$	—
$1\frac{1}{2}$ " O. D. x 0.35 Wall Solid Tubing	0.006 in. $H_2O$	—
Sharp Right Angle in $1\frac{1}{2}$ " I. D. Tube	—	.020 in. $H_2O$

#### Air Distribution System

1. The duct used to conduct the heated air from the heater outlet should have a cross-sectional area equivalent to 12 square inches and this area should be maintained throughout the system unless the heater is equipped with a high-speed ventilating air blower, in which case, ducts of smaller area may be used.

2. If a duct is used on the fresh air inlet of the heater, it, too, should have a cross-sectional area of 12 or more square inches.

3. In applications such as engine preheating, where higher outlet temperatures can be tolerated, smaller ducts may be used.

4. The heating system may be designed to recirculate heated air or may take in fresh air at the ventilating air inlet of the heater. When small spaces occupied by personnel are being heated the fresh air system is preferred, and where windshield defrosting is a heater function, fresh air should also be introduced into the heating system to prevent condensation.

#### Fuel Supply

A source of fuel at a pressure of 1-15 lb./sq. in. must be available for the heater. If this fuel cannot be obtained from the engine fuel pump of a vehicle, an auxiliary electric fuel pump may be used to supply the required pressure. Suitable fuel pumps are listed in the Parts Catalog, Section IX.

#### Factory Engineering Service

Stewart-Warner has produced more than 70 personnel heater kits which have been tested and accepted by the Armed Forces for use at temperatures of -65° F. These kits encompass a wide variety of standard mounting brackets, defrosting equipment, distribution systems, and wiring harness assemblies, many of which have wide applications in the field of heating. Upon request, Stewart-Warner Corporation will furnish engineering assistance in the design and development of kits for new installations and investigate the possibility that equipment already in production may be suitable for use without the necessity for extensive development work.

# INSTALLATION KITS

Personnel Installation Heater Kit Instruction S. W. No. S. W.-P. M.		Vehicle	Personnel Heater Kit No.	Heater Set No.	Defroster Set No.	Radiator Cover Set No.	Primer Set No.	Installation Instruction No.
G-486926	7030	Truck, 1/4 Ton 4x4 (6V).....	7354051	7354052	7354053	7720530	7720531	7354054
G-488180	9098	Carriage Motor Comb. Gun M15A1.....	7354195	7354196	7354197	.....	7354198	7951763
G-488180	9098	Carriage Motor Comb. Gun M16.....	7354195	7354196	7354197	.....	7354198	7951763
G-487223	7393	Truck, 1 1/2 Ton 4x4 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 1 1/2 Ton 4x4 Tel. Const. Maint. K43 (6V)....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton Mach. L. D. AM16A2 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton Sig. Corps. Rep. M30 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton S. Arms Rep. M7A2 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton Art. Rep. M9A1 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton Inst. Rep. M10A1 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton 6x6 LWB (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton 6x6 SWB (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton 6x6 Dump (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487223	7393	Truck, 2 1/2 Ton 6x6 Bomb Service M27 (6V).....	7354240	7354296	7354239	7720766	7354295	7951158
G-487640	7757	Truck, 1/4 Ton Amb. US Marine Corps.....	7354271	.....	.....	.....	.....	7951647
G-487634	7725	Truck, 2 1/2 Ton 6x6 US Marine Corps.....	7354272	.....	.....	.....	.....	7951647
G-486399	7755	Shelter, Personnel Arctic (24V) (Reo).....	7354601	.....	.....	.....	.....	7951462
G-487611	7802	Truck, 5 Ton 6x6 Cargo M41-24V (Inter).....	7355525	7355713	7351618	7355715	.....	7951484
G-487075	7879	Truck, 2 1/2 Ton 6x6 Cargo M133 Series (24V).....	7355576	7355710	7355711	7355712	.....	7951718
G-488502	9360	Shop Van—2 1/2 Ton 6x6 (Trucks) M109.....	7355885	.....	.....	.....	.....	7951967
G-488019	8696	Tank, Medium, M46-24V.....	7355999	.....	.....	.....	.....	7951624
G-488926	2694	Vehicle, Recovery Med. M74 (24V).....	7358663	.....	.....	.....	.....	8359710
G-488620	1571	Truck, 1/4 Ton 4x4, M38A1 (24V).....	7358725	7358727	7358728	7358730	7358729	8359666
G-486143	6939	Truck, 1/4 Ton 4x4, Utility, M38 24V.....	7387261	7387262	7387263	7387264	.....	7700332
G-486144	6938	Truck, 3/4 Ton, 4x4 Cargo, M37 24V.....	7387271	7387272	7387273	7387274	.....	7700334
G-486144	6938	Truck, 3/4 Ton, 4x4 Command M42 24V.....	7387271	7387272	7387273	7387274	.....	7700334
G-486144	6938	Truck, 3/4 Ton, 4x4 Maint. M201 24V.....	7387271	7387272	7387273	7387274	.....	7700334
G-487945	9226	Van, 2 1/2 Ton Elec. Rep. M18A2 Truck 6V.....	7389285	.....	.....	.....	.....	7951838
G-487945	9226	Van, 2 1/2 Ton Mach. LD AM16A2 6V.....	7389285	.....	.....	.....	.....	7951838
G-487945	9226	Van, 2 1/2 Ton Sig. Corps Rep. M30 6V.....	7389285	.....	.....	.....	.....	7951838
G-487945	9226	Van, 2 1/2 Ton S. Arms Rep. M7A2 6V.....	7389285	.....	.....	.....	.....	7951838
G-487945	9226	Van, 2 1/2 Ton Art Rep. M9A1 6V.....	7389285	.....	.....	.....	.....	7951838
G-487945	9226	Van, 2 1/2 Ton Inst. Rep. M10A1 6V.....	7389285	.....	.....	.....	.....	7951838
G-486145	6806	Truck, 2 1/2 Ton 6x6 Cargo M34 24V (Reo).....	7390744	7386862	7351618	7386178	.....	7700231
G-486194	6936	Automobile, Sedan, Light 5-Pass. 1949 Chev. 6V.....	7390746	7386861	7386858	7730937	7730938	7700333
G-486472	6940	Tank, Med. M26 24V.....	7399564	7399565	.....	.....	.....	7408597
G-486472	6940	Tank, Med. M45 24V.....	7399564	7399565	.....	.....	.....	7408597
G-486183	6686	Tractor, 18 Ton High-Speed, M4 12V.....	7524407	7389485	7389486	.....	.....	7700202
G-486152	6391	Truck, 1/4 Ton 4x4 6V.....	7720467	7720528	7720529	7720530	7720531	7700203
G-486153	6385	Truck, 3/4 Ton 4x4 W/C 6V.....	7720633	7720725	7720748	7720763	7720778	7700204
G-486153	6385	Truck, 1 1/2 Ton 6x6 (6V).....	7720633	7720725	7720748	7720763	7720778	7700204
G-486154	6384	Truck, 3/4 Ton 4x4 W/C 12V.....	7720634	7720726	7720748	7720763	7720778	7390558
G-486189	6389	Truck, 3/4 Ton 4x4 Amb.....	7720635	7720725	7720748	7720763	7720778	7399264
G-486189	6389	Truck, 3/4 Ton 4x4 Amb. (Van).....	7720635	7720727	.....	.....	.....	7399264
G-486638	6387	Truck, 1 1/2 Ton 4x4 (6V).....	7720636	7720728	7720749	7720764	7720779	7700207
G-486638	6387	Truck, 1 1/2 Ton 4x4 (6V).....	7720636	7720728	7720749	7720764	7720779	7700207
G-486155	6383	Truck, 2 1/2 Ton 6x6 LWB (6V).....	7720638	7720730	7720751	7720766	7720781	7700208
G-486155	6383	Truck, 2 1/2 Ton 6x6 SWB (6V).....	7720638	7720730	7720751	7720766	7720781	7700208
G-486155	6383	Truck, 2 1/2 Ton 6x6 Dump (6V).....	7720638	7720730	7720751	7720766	7720781	7700208
G-486155	6383	Truck, 2 1/2 Ton 6x6 M27 (6V).....	7720638	7720730	7720751	7720766	7720781	7700208
G-486191	6390	Truck, 4 Ton 6x6 Wrecker (6V).....	7720645	7720737	7720752	7720767	7720782	7700209
G-486191	6390	Truck, 4 Ton 6x6 Dump (6V).....	7720645	7720737	7720752	7720767	7720782	7700209
G-486192	6388	Truck, 4-5 Ton Tract. Autocar U71447 (6V).....	7720646	7720738	7720753	7720768	7720783	7700210
G-486639	5547	Truck, 5 Ton 4x2 Tractor (6V).....	7720647	7720739	7720754	7720769	7720784	7700211
G-486193	6377	Truck, 6 Ton 6x6 PM White 666 (6V).....	7720648	7720740	7720755	7720770	7720785	7700212
G-486193	6377	Truck, Tractor 6 Ton 6x6 (6V).....	7720648	7720740	7720755	7720770	7720785	7700212
G-486465	6867	Truck, 7 1/2 Ton 6x6 PM Mack (6V).....	7720649	7720741	7720756	7720771	7720786	7700213
G-486188	6393	Truck, Wrecking Heavy M1A1 (12V).....	7720650	7720742	7720757	7720772	7720787	7700214
G-486466	6398	Truck, Tractor M26A1 (12V).....	7720651	7720743	7720758	7720773	7720788	7700232
G-486195	5549	Automobile, Sedan, Light 21A3 Ford (6V).....	7720652	7720744	7720759	7720774	7720789	7700215
G-486197	5550	Automobile, 1942 BG-1503 Chev. (6V).....	7720653	7720745	7720760	7720775	7720790	7700216
.....	5551	Automobile, 1942 P11 Plymouth (6V).....	7720654	7720746	7720761	7720776	7720791	7700217
G-486196	5552	Buss, 37 Pass. International K7 (6V).....	7720655	7720747	7720762	7720777	7720792	7700218
G-486187	5827	Truck, 4-5 Ton Tractor, Federal (6V).....	7721080	7721086	7721089	7721092	7721095	7700219
G-486184	6378	Carrier, Cargo M29C (12V).....	7721081	7721087	7721090	7721093	.....	7390720
.....	5826	Snowmobile, Penguin Mark 11 (12V).....	7721082	7721088	7721091	.....	7721096	7700221

# INSTALLATION KITS (Cont.)

G-486190	6382	Truck (Van) 2½ Ton Elec. Rep. M18A2 (6V)	7721217	7721115	—	—	—	7700222
G-486190	6382	Truck (Van) 2½ Ton Sig. Corps Rep. M30 (6V)	7721217	7721115	—	—	—	7700222
G-486190	6382	Truck (Van) 2½ Ton S. Arms Rep. M7A2 (6V)	7721217	7721115	—	—	—	7700222
G-486190	6382	Truck (Van) 2½ Ton Art. Rep. M9A1 (6V)	7721217	7721115	—	—	—	7700222
G-486190	6382	Truck (Van) 2½ Ton Inst. Rep. M10A1 (6V)	7721217	7721115	—	—	—	7700222
G-486190	6382	Truck (Van) 2½ Ton Ord. Maint. (6V)	7721217	7721115	—	—	—	7700222
G-486190	6382	Truck (Van) 2½ Ton Mach. Ld. Am. 16A2 (6V)	7721217	7721115	—	—	—	7700222
G-486471	6941	Vehicle, Utility Armored M39 (24V)	7729826	7732000	—	—	—	7408584
G-486640	6652	Semi-Tr. Van, 6 Ton 2W Mob. Rec. (6) (110V)	7729828	—	—	—	—	7700223
G-486641	6651	Truck, 2½ Ton 6x6 Cargo COE 15'x17' Bod (6V)	7729830	7729832	7729833	7729834	7729835	7700224
G-486468	6396	Tank, Recovery Vehicle (M32B1 (24V)	7729841	7732004	—	—	—	7700225
G-486469	6392	Tank, Light M24 (24V)	7729844	7732009	—	—	—	7700233
G-486470	6401	Tank, Medium M4A3 (24V)	7729847	7732014	—	—	—	7700226
G-486470	6401	Tank, Howitzer 105 (24V)	7729847	7732014	—	—	—	7700226
G-486186	6397	Tractor 13 Ton High Speed M5A1 (12V)	7729850	7732029	7732030	—	7732032	7700227
G-486185	6395	Tractor 38 Ton High Speed M6 (12V)	7729853	7732037	7732038	—	—	7700228
G-486467	6702	Carriage, Motor Twin 40mm Gun M19A1 (24V)	7729859	7732050	7353203*	—	—	7700229
G-486642	6386	Shelter, Personnel Arctic (6V)	7730930	7732054	—	—	—	7700230
G-488503	9841	Auxiliary Heater, M109 Shop Van	7951952	—	—	—	—	8359583
G-489334	10056	Vehicle, Recovery, Medium M74 (24V)	8695920	—	—	—	—	8359846
G-489675	10068	Carrier, Cargo, Amphibious M76 (24V)	7977277	—	—	—	—	8359894

\*Turret heater canvas cover.

## HEATER PACKAGES

Package Assembly No.	Heater Assembly Model	Control Box Assembly	Outlet Adapter Assembly	Safety Valve and Filter Assembly	Filter	Thermostat	Fuel Pump	Wiring Harness Assembly
G-488521	978-M-H24	G-486321	G-484325 (Straight) G-484325 (45°)	G-484825 (24V)	—	G-484090	487059 (24V)	G-486390
G-488522	978-M-H12	G-486321	G-484324 (Straight) G-484325 (45°)	G-484824 (12V)	—	G-484090	487060 (12V)	G-486390
G-488523	978-M-H6	G-486321	G-484324 (Straight) G-484325 (45°)	G-484726 (6V)	—	G-484090	486779 (6V)	G-486390
G-488561	978-M-H24	G-488088	G-484324 (Straight) G-484325 (45°)	—	473441	—	487059 (24V)	G-488577
G-488562	978-M-H12	G-488088	G-484325 (Straight) G-484325 (45°)	—	473441	—	487060 (12V)	G-488577
G-488563	978-M-H6	G-488088	G-484324 (Straight) G-484325 (45°)	—	473441	—	486779 (6V)	G-488577
G-488591	978-M-H24	G-488088	G-484324 (Straight) G-484325 (45°)	—	473441	—	—	G-488590
G-488592	978-M-H12	G-488088	G-484324 (Straight) G-484325 (45°)	—	473441	—	—	G-488590
G-488593	978-M-H6	G-488088	G-484324 (Straight) G-484325 (45°)	—	473441	—	—	G-488590





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## Section IX

### PARTS CATALOG

#### General

This catalog consist of a numerical parts list of all Model 978 heater parts plus service parts for accessory items and a list of heater outlet adapters and fuel pumps. The heater assembly is illustrated by an exploded view (Figure 58) and control box service parts, fuel pumps, and outlet adapters are separately illustrated.

#### How to Use This Parts Catalog

1. To find the part number and nomenclature of any heater part, first find the illustration of the part in one of the exploded views. Note that the exploded views are composite illustrations of 978 heater parts and all these parts are not used in a single heater. Select the part number next to the part which is applicable to the heater model in question and locate this number in the Numerical Parts List. In the right-hand column of the parts list, an application coding is listed to show what heater the particular part is used on. The letters in the *Application Code* column are a condensed reference to heater models and should always be checked against the *Application Code* list on this page. For example, the application code for the M-R24 heater is "f"; Part No. 486229 shows "defh" in the *Application Code* column. This shows that the part is used on the Model 978-M-R24 heater and also on the M-R6, M-R12, and the M-E24 but is *not* used on other model heaters. Parts listed as "All" are used on all 978 heaters listed in *this catalog* but may not necessarily apply to older model heaters which are now regarded as obsolete.

2. To make a complete list of parts for any heater model, simply select all parts which are listed in the *Application Code* column as "All" plus all parts which include the code letter for the heater model in question.

3. Because of the great number of individual control boxes which have been manufactured, it is impractical to list each box separately in this manual. To find a replacement part for a control box, find the part in Figure 60 or 61 and then check the listing to make sure that nomenclature, voltage, etc., agree with the part in question. This same method applies to fuel pumps and outlet adapters. The illustration of outlet adapters (Figure 65) will prove helpful when selecting an outlet adapter for use in a new installation.

#### APPLICATION CODE

##### *Application Code Model Used On*

a.....	978-M-C6	(Ord. No. 7700173)
b.....	978-M-C12	(Ord. No. 7700174)
c.....	978-M-C24	(Ord. No. 7700175)
d.....	978-M-R6	(Ord. No. 7700192)
e.....	978-M-R12	(Ord. No. 7700193)
f.....	978-M-R24	(Ord. No. 7700160)
g.....	978-M-B24	
h.....	978-M-E24	
j.....	978-M-H6	(Ord. No. 8359776)
k.....	978-M-H12	(Ord. No. 8359775)
l.....	978-M-H24	(Ord. No. 8359774)

#### PARTS LIST—MODEL 978 SERIES PERSONNEL HEATER

<i>S-W Part No.</i>	<i>Army Ordnance No.</i>	<i>Ordnance Stock No.</i>	<i>Description</i>	<i>Qty. Per Unit</i>	<i>Application Code</i>
4208	114631	H006-0230535	Collar—Compression	1	All
4209	114629	H006-0213135	Union— $\frac{5}{16}$ solderless	1	All
7228	113103	H001-0716582	Nut—No. 8-32 hex	2	All
14526	446143	H101-0446143	Washer—Plain flat (for No. 8 screw)	3	g
18370	107316	H101-0107316	Screw—No. 8 x $\frac{1}{2}$ rd hd sheet-metal	1	abcdefgh
39337	114630	H006-0104052	Nut—Union hex	1	All
45569	120614	H001-4135681	Nut—No. 10-32 hex mach	1	d
76784	134530	H001-4135581	Nut—No. 8-32 hex mach	2	All
77837	121752	H001-7017561	Lockwasher—No. 8 external	1	abde
79003	131958	H001-5125821	Screw—No. 8-32 x $\frac{5}{16}$ fil h mach	3	g
79372	138526	H001-7021621	Lockwasher—No. 6 internal	6	All
118730			Rivet—Tubular	6	All
470394	142868	H006-0270005	Nipple— $\frac{1}{8}$ pipe	1	abcdeg
474695	7520348	G249-7520348	Screen—Inlet	1	All
474948	7520346	G249-7520346	Cable—Knit (fuel wick)	1	All
475005	178364	H001-7124581	Lockwasher—No. 8 int.-ext.	5	All
475067	7520358	G249-7520358	Gasket—Igniter	2	All
475127	117959	H102-0117959	Grommet	1	All

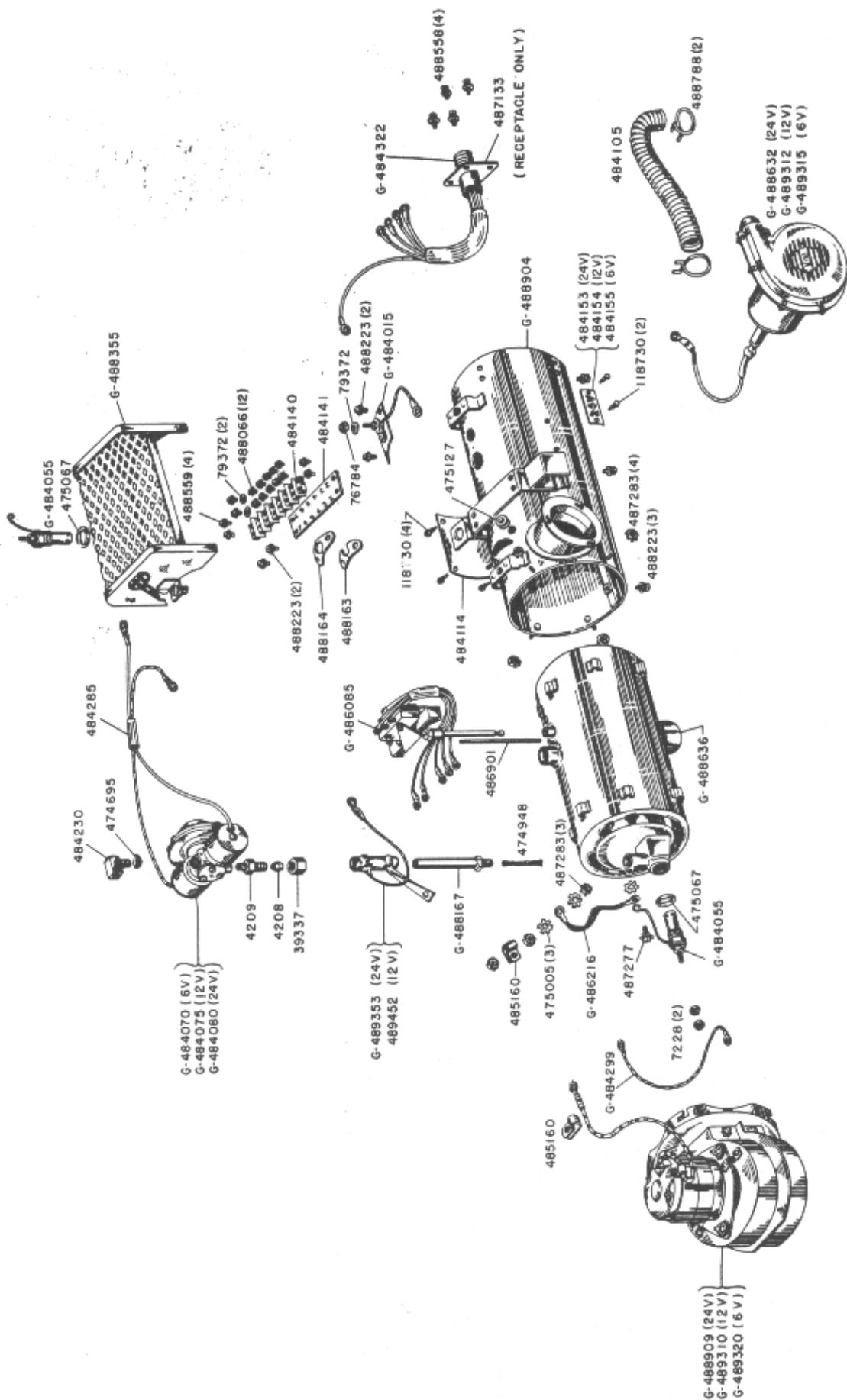


Figure 59—Exploded Parts View, Model 978-M-H Series Heaters

S-W Part No.	Army Ordnance No.	Ordnance Stock No.	Description	Qty. Per Unit	Application Code
476764	7520365	G249-7520365	Fitting—Connector	1	All
481074	178378	H001-7124621	Lockwasher	4	abcde fgh
484066	7058057	G226-7058057	Plug	1	All
484068	7399445	G249-7399445	Shield—Blower inlet	1	abcg
484105	7520366	G249-7520366	Duct—Flexible	1	All
484114			Nameplate	1	All
484120	7410326	G249-7410326	Nipple—Fuel standpipe	1	ad
484121	7410323	G249-7410323	Plate—Tapping	1	ad
484122	7410320	G249-7410320	Flange—Heater standpipe	1	ad
484140	7520372	G249-7520372	Strip—Terminal	1	abcde fghjkl
484141	7520373	G249-7520373	Strip—Double marker	1	abcde fghjkl
484153			Nameplate (24V)	1	cfghl
484154			Nameplate (12V)	1	bek
484155			Nameplate (6V)	1	adj
484230	444038	H106-0444038	Elbow— $\frac{1}{8}$ N.P.T. street	1	All
484233	7390046	G256-7390046	Connector— $\frac{3}{16}$ tube to $\frac{1}{8}$ pipe	1	abcdeg
484285	7390197		Sleeving— $1\frac{1}{2}$ in. transparent	1	All
484487	7390375	G249-7390375	Screen—Inlet	1	g
484671	7410321	G249-7410321	Washer—Insulating	1	abde
485160	572889	H004-0572889	Clamp—Support	1	All
486229	7410322	G249-7410322	Plate—Exhaust bleed cover	1	defh
486326	8359598		Strip—Terminal	1	g
486327	8359599		Strip—Double marker	1	g
486901	7416552	G249-7416552	Rod—Quartz ( $5\frac{1}{16}$ in. long)	1	All
487133	8359787		Receptacle—Connector	1	All
487274	454341		Screw—No. 8-32 x $\frac{1}{2}$ pan hd "Sems"	1	abde
487277	455230		Screw—Mach. No. 8-32 x $\frac{1}{2}$ pan hd "Sems"	1	All
487283	7951221	G249-7951221	Nut—No. 8-32 "Keps" lockwasher	7	All
487370	7951286		Nut—No. 10-32 "Keps" lockwasher	3	abcde fgh
488066	454735		Screw—No. 6-32 x $\frac{5}{16}$ pan hd "Sems"	14	abcde f
488067	454718		Screw—No. 8-32 x $\frac{5}{8}$ fil hd "Sems"	4	All
488163	7951958	G254-7951958	Plate—Tapping	1	bce fghjkl
488164	7951959	G254-7951959	Flange—Fuel line	1	bce fghjkl
488223	455229		Screw—No. 8-32 x $\frac{1}{4}$ fil hd "Sems"	11	All
488558	8359533		Screw—No. 6-32 x $\frac{3}{8}$ fil hd "Sems"	4	All
488559	8359534		Screw—No. 8-32 x $\frac{5}{8}$ fil hd "Sems"	4	ghkl
488788	8359683		Clamp—Hose	2	All
488907	502015		Capacitor—0.01 MFD 100V	1	abde
489452	8359824		Resistor Assy (12V)	1	bek
G-484009	7520369	G249-7520369	Exchanger Assy—Heat	1	abc
G-484015	7520340	G249-7520340	Switch Assy—Overheat	1	abcde fghjkl
G-484055	7700170	G249-7700170	Igniter Assy	2	All
G-484070	7520343	G249-7520343	Valve Assy—Fuel control (6V)	1	adj
G-484075	7520338	G249-7520338	Valve Assy—Fuel control (12V)	1	bek
G-484080	7520336	G249-7520336	Valve Assy—Fuel control (24V)	1	cfghl
G-484246	7520359	G249-7520359	Housing Assy	1	abc
G-484299	7413560	G249-7413560	Wire Assy—Terminal and	1	adj
G-484322	7410324	G249-7410324	Receptacle Assy	1	abcde fghjkl
G-486085	7539296	G249-7539296	Switch Assy—Flame detector	1	All
G-486094	7700172	G249-7700172	Guard Assy	1	d
G-486216	7413564	G249-7413564	Lead Assy—Ground	1	All
G-486226	7700167	G249-7700167	Adapter Assy—Combustion air	1	defh
G-486232	7700166	G249-7700166	Exchanger Assy—Heat	1	defh
G-486233	7700165	G249-7700165	Housing Assy	1	de

S-W Part No.	Army Ordnance No.	Ordnance Stock No.	Description	Qty. Per Unit	Application Code
G-486272	8359596	-----	Receptacle Assy .....	1	g
G-486279	7700164	G249-7700164	Guard Assy .....	1	abe
G-486294	-----	-----	Blower Assy—Combustion Air (24V) .....	1	fh
G-486318	8359597	-----	Housing Assy .....	1	g
G-486332	8359600	-----	Switch Assy—Overheat .....	1	g
G-486339	8359601	-----	Wire Assy—Terminal and .....	1	g
G-486340	8359631	-----	Wire Assy—Terminal and .....	1	g
G-486372	7700176	G249-7700176	Blower Assy—Vent. air (6V) .....	1	ad
G-486373	7700177	G249-7700177	Blower Assy—Vent. air (12V) .....	1	be
G-486392	7700181	G249-7700181	Blower Assy—Combustion air (6V) .....	1	a
G-486393	7700182	G249-7700182	Blower Assy—Combustion air (12V) .....	1	b
G-486431	7413563	G249-7413563	Wire Assy—Terminal and .....	1	abe
G-486660	7700198	G249-7700198	Relay Assy—Resistor and (6V) .....	1	d
G-486689	7700196	G249-7700196	Blower Assy—Combustion air (6V) .....	1	d
G-486695	7700197	G249-7700197	Blower Assy—Combustion air (12V) .....	1	e
G-486777	8359602	-----	Exchanger Assy—Heat .....	1	g
G-486861	8359603	-----	Guard Assy—Complete .....	1	g
G-488167	7951960	-----	Standpipe Assy .....	1	bcefhijkl
G-488355	7951964	G254-7951964	Guard Assy .....	1	cfhijkl
G-488560	8359516	-----	Housing Assy .....	1	fh
G-488632	8359779	G249-8359779	Blower Assy—Combustion air (24V) .....	1	l
G-488636	8359782	G249-8359782	Exchanger Assy—Heat .....	1	jkl
G-488904	8359783	G249-8359783	Housing Assy .....	1	jkl
G-488909	8359743	G249-8359743	Blower Assy—Ventilating air (24V) .....	1	cfl
G-489178	-----	-----	Blower Assy—Ventilating air (24V) .....	1	gh
G-489180	8359769	-----	Blower Assy—Combustion air (24V) .....	1	cg
G-489310	8359788	G249-8359788	Blower Assy—Ventilating air (12V) .....	1	k
G-489312	8359791	G249-8359791	Blower Assy—Combustion air (12V) .....	1	k
G-489315	8359796	G249-8359796	Blower Assy—Combustion air (6V) .....	1	j
G-489320	8359799	G249-8359799	Blower Assy—Ventilating air (6V) .....	1	j
G-489353	-----	-----	Resistor Assy (24V) .....	1	cfghl

*Application Code Model Used On*

a.....	978-M-C6	(Ord. No. 7700173)
b.....	978-M-C12	(Ord. No. 7700174)
c.....	978-M-C24	(Ord. No. 7700175)
d.....	978-M-R6	(Ord. No. 7700192)
e.....	978-M-R12	(Ord. No. 7700193)
f.....	978-M-R24	(Ord. No. 7700160)
g.....	978-M-B24	
h.....	978-M-E24	
j.....	978-M-H6	(Ord. No. 8359776)
k.....	978-M-H12	(Ord. No. 8359775)
l.....	978-M-H24	(Ord. No. 8359774)



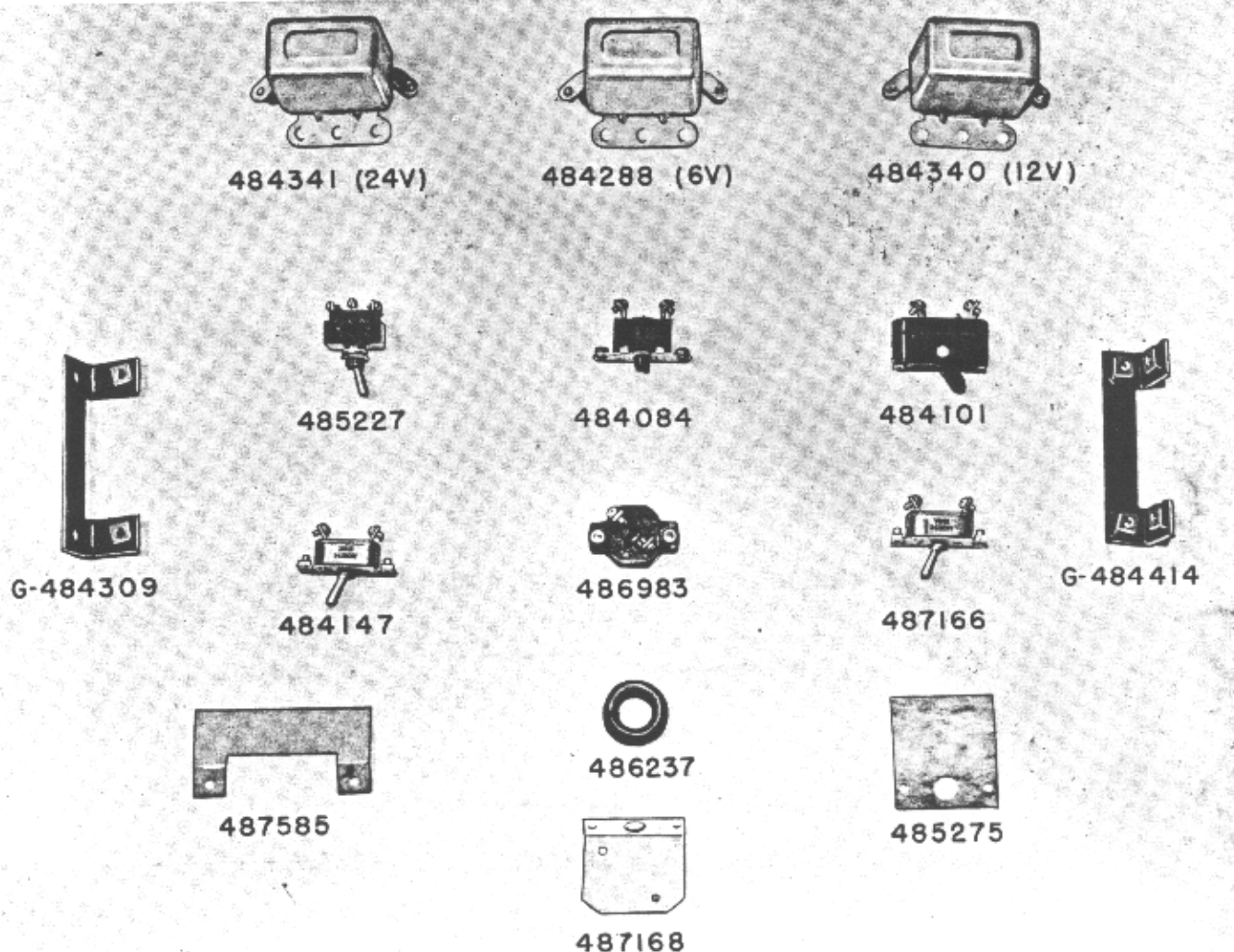


Figure 60—Control Box Parts

### CONTROL BOX PARTS

(For Old-Style Large and Small Control Boxes)

SW Part No.	Army Ordnance No.	Ordnance Stock No.	Description
484084	7520371	G249-7520371	Breaker—Circuit (12½ Amp. with reset button)
484101	7520347	G249-7520347	Switch—Breaker (Heater ON-OFF Switch)
484147	7520345	G249-7520345	Switch—Momentary Contact (Single-pole safety valve prime switch)
484288	7520370	G249-7520370	Relay—6-volt
484340	7520356	G249-7520356	Relay—12-volt
484341	7520352	G249-7520352	Relay—24-volt
485227	7399486	G262-7399486	Switch—D. P. D. T. (Safety valve prime switch for use with electric fuel pump)
485275	7399507	G249-7399507	Insulator—Switch (Used with 485227 switch)
486237	144229	H102-0144229	Grommet (for wiring harness)
486983	7016441	G503-0125901	Breaker—Circuit, 15 amp. (Automatic reset without button)
487166	7951124	H004-0502688	Switch—ON-OFF (HI-LO switch)
487168	8359555	.....	Bracket—Mounting
487585	8359611	.....	Insulator
G-484309	7390018	G249-7390018	Bracket Assy—Mtg.
G-484414	7524077	G249-7524077	Bracket Assy—Mtg.

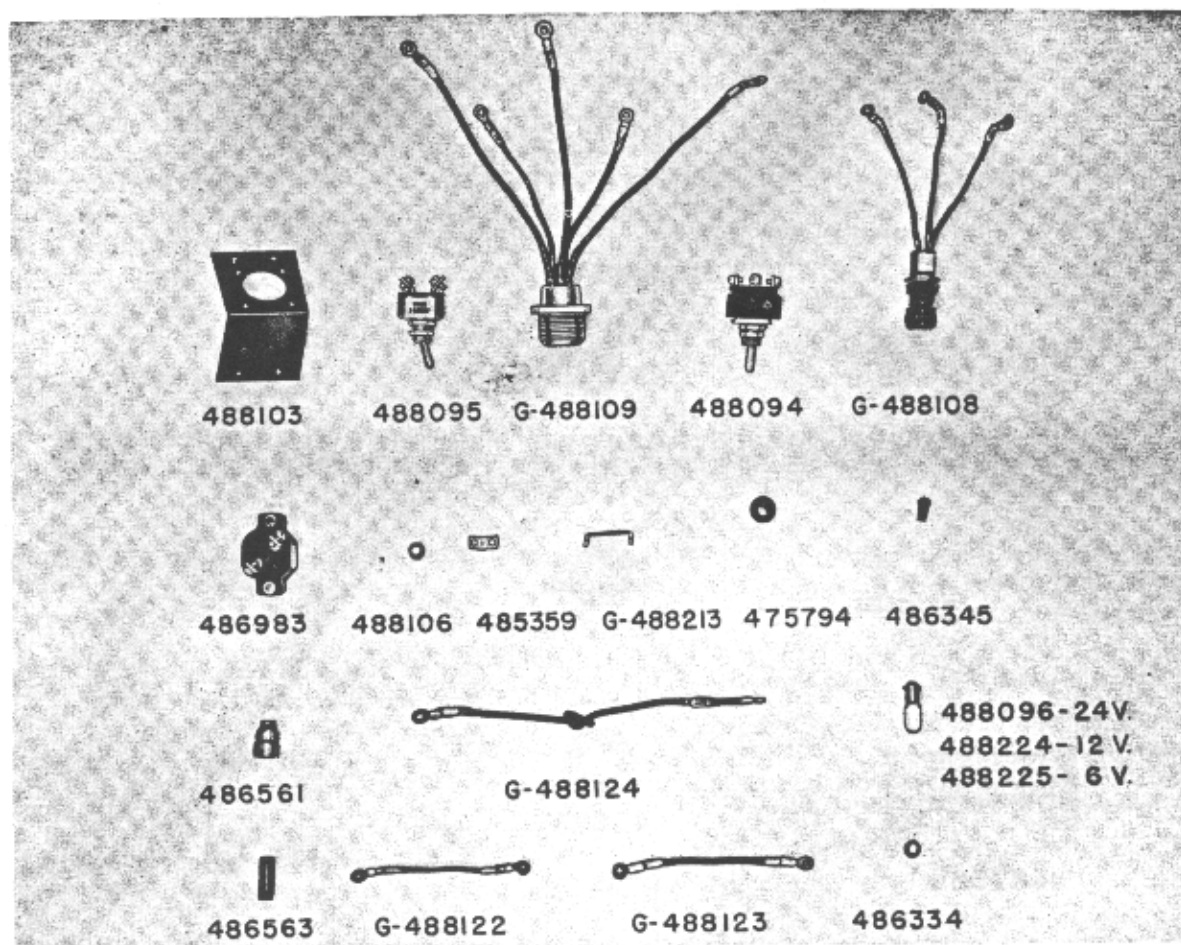


Figure 61—Control Box Parts  
**CONTROL BOX PARTS**  
 (For New Box with Receptacle)

SW Part No.	Army Ordnance No.	Ordnance Stock No.	Description	Qty. Per Unit
475794	7951754	G249-7951754	Grommet .....	1
485359	7951748	.....	Connector .....	1
486334	7765237	H004-0572999	Bushing, Terminal.....	1
486345	7762603	H004-0573005	Grommet .....	1
486561	7762628	H004-0573007	Shell, Female Connector.....	1
486563	7762624	H004-0573000	Connector, Inside.....	1
486983	7016441	G503-0125901	Breaker, Circuit (15 Amp.).....	1
488094	502703	H004-0502703	Switch—DPDT (On-Off-Start).....	1
488095	502673	H004-0502673	Switch—SPST (Hi-Lo) .....	1
488096	193067	H104-0193067	Bulb, Lamp (24V).....	1
488103	7951727	G249-7951727	Bracket .....	1
488106	7951730	G249-7951730	Spacer .....	2
488224	454626	.....	Bulb, Lamp (12V).....	1
488225	504521	H004-0504521	Bulb, Lamp (6V).....	1
G-488108	7951731	G249-7951731	Lamp, Assy., Indicator.....	1
G-488109	7951732	G249-7951732	Receptacle Assembly.....	1
G-488122	7951734	G249-7951734	Wire Assy., Terminal and.....	1
G-488123	7951735	.....	Wire Assy., Terminal and.....	1
G-488124	7951736	G249-7951736	Wire Assy., Terminal and.....	1
G-488213	7951737	G249-7951737	Jumper Assembly.....	1

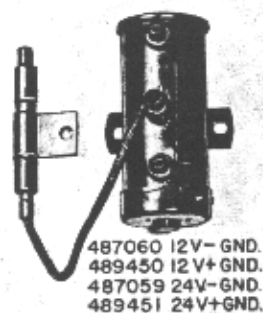


Figure 62—Electric Fuel Pumps

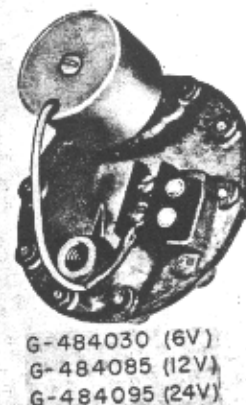


Figure 63—Safety Valves

### ACCESSORIES

SW Part No.	Army Ordnance No.	Ordnance Stock No.	Description
473441	7761059	G249-7761059	Filter—Fuel
486108	.....	.....	Pump—Fuel, #110-N 24-V
486779	.....	.....	Pump—Electric Fuel (6V) For Negative ground only
487059	.....	.....	Pump—Electric Fuel (24V) For Negative ground only
487060	.....	.....	Pump—Electric Fuel (12V) For Negative ground only
G-484030	A7727237	G249-7727237	Valve—Safety (6V)
G-484085	D7727238	G249-7727238	Valve—Safety (12V)
G-484095	D7761058	G249-7761058	Valve—Safety (24V)
484888	.....	.....	Power Converter (6V DC)
488567	.....	.....	Power Converter (12V DC)
485798	.....	.....	Power Converter (24V DC)
489449	.....	.....	Pump, Electric Fuel (6V) For positive ground only
489450	.....	.....	Pump, Electric Fuel (12V) For positive ground only
489451	.....	.....	Pump, Electric Fuel (24V) For positive ground only

### FUEL PREHEATER KIT

For 12- and 24-Volt Heaters

12V Kit G-489456 (Ord. No. 8359825)      24V Kit G-489374 (Ord. No. 8359820)

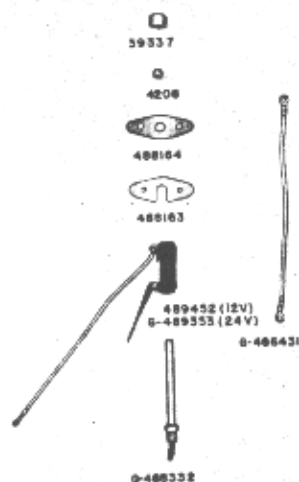


Figure 64—Preheater Kits

SW Part No.	Army Ordnance No.	Ordnance Stock No.	Description	Qty. Per Kit
4208	114631	.....	Collar, Compression (5/16 Tube) ..	1
39337	114630	.....	Nut, Compression (5/16 Tube) .....	1
488163	7951958	.....	Plate, Tapping .....	1
488164	7951959	.....	Flange, Fuel Line .....	1
489452	8359824	.....	Resistor Assy (12V) .....	1
G-488431	7413563	G-249-7413563	Wire Assy., Terminal and .....	1
G-488332	7951963	.....	Standpipe Assy., Wick and .....	1
G-489353	.....	.....	Resistor Assy. (24V) .....	1

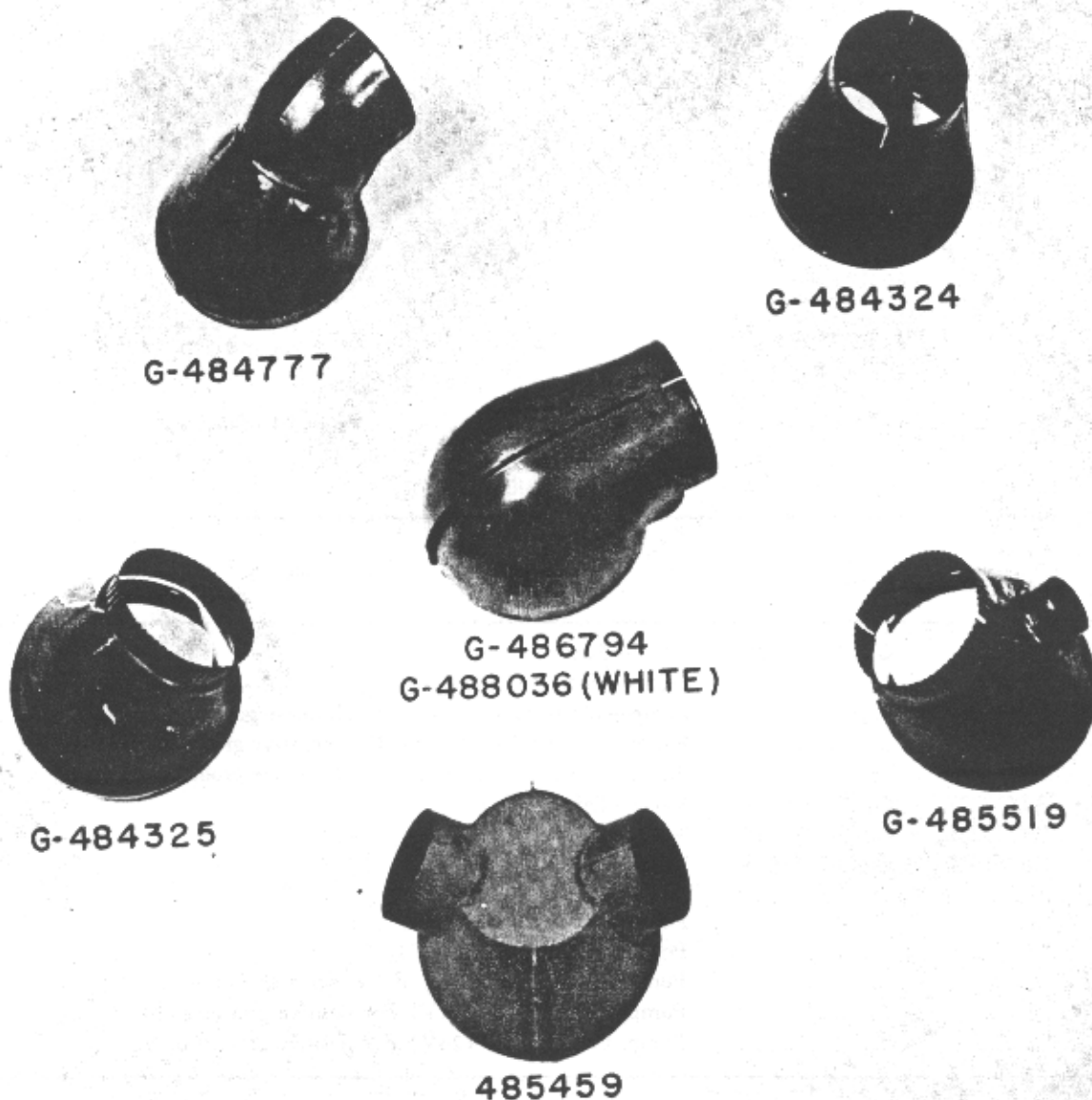


Figure 65—Outlet Adapters

#### OUTLET ADAPTERS FOR 978 PERSONNEL HEATER

SW Part No.	Army Ordnance No.	Ordnance Stock No.	Description
485459	7390625	.....	Outlet Adapter
G-484324	7524078	.....	Outlet Adapter Assembly
G-484325	7537537	.....	45° Outlet Adapter Assembly
G-484777	7401306	.....	Outlet Adapter Assembly
G-485519	7399623	.....	45° Outlet Adapter Assembly
G-486794	7951738	.....	90° Outlet Adapter Assembly
G-488036	7951597	.....	90° Outlet Adapter Assembly

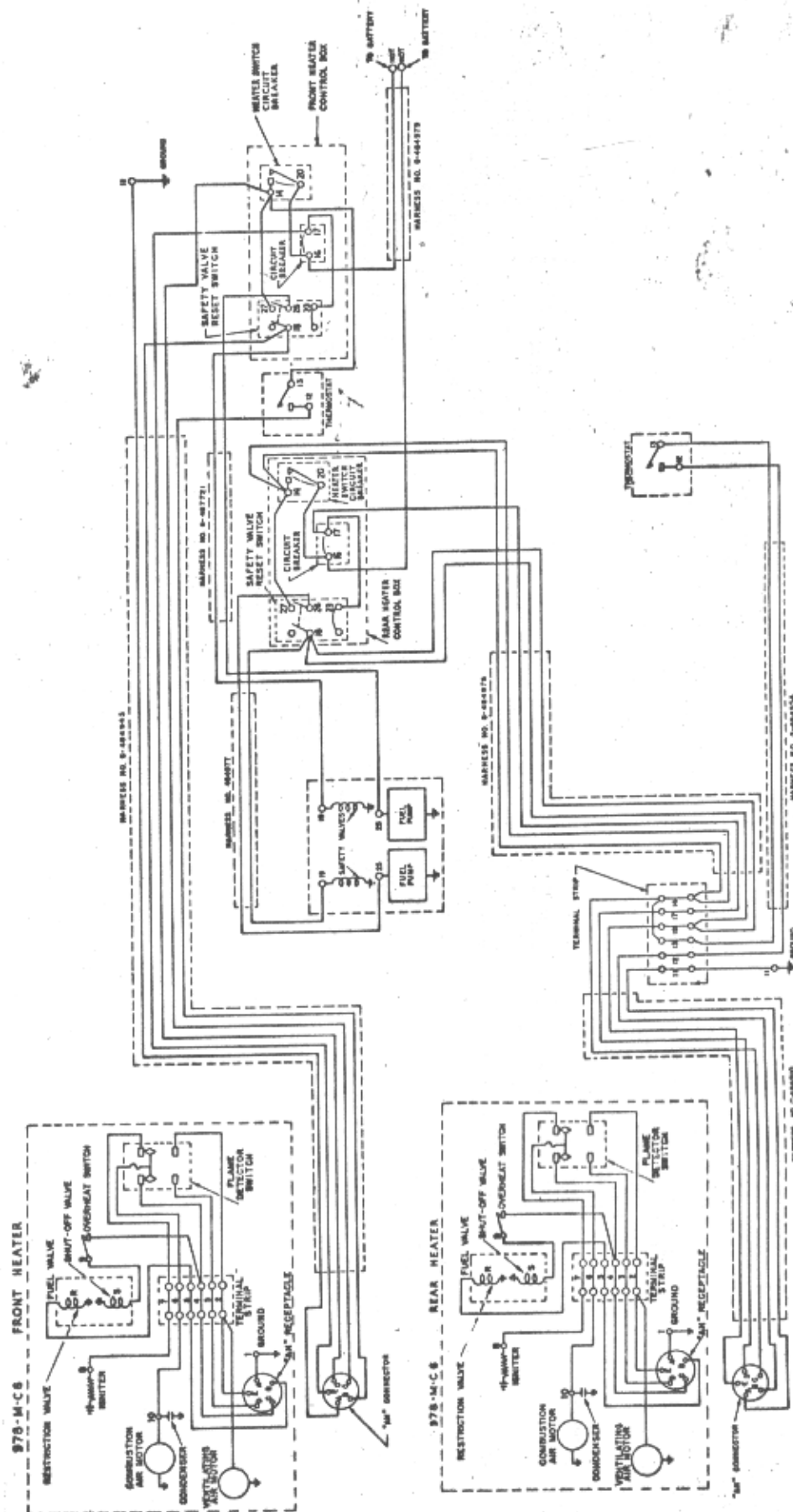


Figure 66—Wiring, 37-Passenger Bus



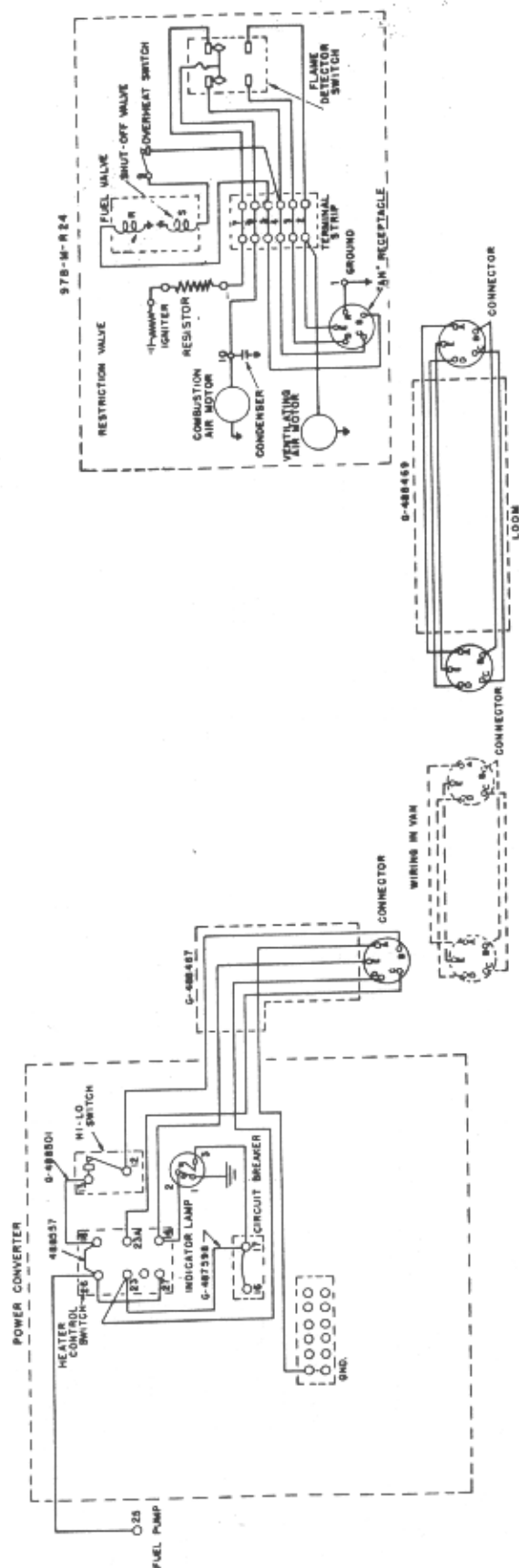


Figure 67—Wiring, Rear Compartment of 2 1/2 Ton Shop Truck M109