SECTION 22: HEATING AND AIR CONDITIONING

CONTENTS

LIST OF ILLUSTRATIONS

1. HEATING AND AIR CONDITIONING

1.1 Description

The coach's interior is pressurized by its **H**eating, **V**entilation, **A**ir **C**onditioning (**HVAC**) units. Air flow and controls divide the vehicle in two sections: driver's and Central (passengers) sections.

The interior of vehicle should always be slightly pressurized to prevent dust and moisture from entering vehicle. Each section has its own fresh air, returning air and discharge air ducting. The exhaust is mainly done through the lavatory ventilator and through normal air-tightness losses.

2. AIR CIRCULATION

2.1 Driver's Area

Fresh air is taken from a plenum behind the front bumper and enters the mixing box through an adjustable damper. Returning air is taken through a front dash panel into the mixing box. The *"Driver A/C-Heating Recirc.-Fresh Air"* control is located on the R.H. dashboard control panel. Mixed air goes through cooling and heating coils, fans and discharge ducts.

Both right and left discharge ducts defrost one half of the windshield. The driver can also, with the *"Main Windshield Defroster"* control divert his air flow to the console, from which he can direct vent to his knees and/or upper body with adjustable HVAC register and to his feet with the lever (Fig. 1).

Two additional air outlets are installed on the HVAC ducting system. One is located in the stepwell, the air flow can be regulated by pressing the marked fin. The flow can be shut-off or increased for maximum ventilation. The other air outlets is located behind the driver, on its L.H. side. The air outlet can be rotated to direct air flow.

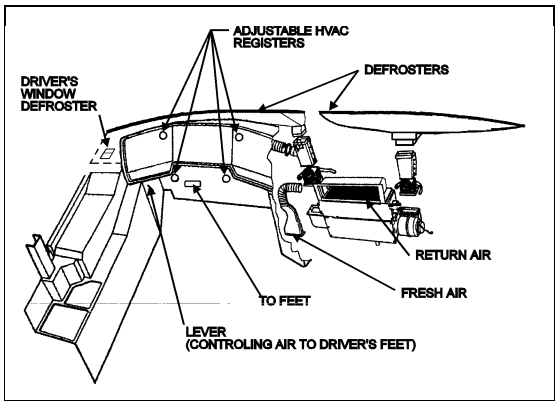


FIGURE 1: DRIVER'S AIR CIRCULATION 2202

2.2 Central Section (Passengers)

Fresh air is taken from the left side of vehicle through a two-position damper located at the left of the HVAC compartment. The pneumatic control damper can be fully opened for normal operation or partially closed for extreme weather or highly polluted areas. The *"Fresh Air Damper"* switch is located on the R.H. side lower control panel. Push down the rocker switch to partially close the fresh air damper. Refer to the H3 Operator's Manual for details.

Return air is drawn through the last entrance step riser and from the lower section of the floor ducts in two locations: one in the rear section of vehicle and the other in the front section of vehicle on the L.H. side (Fig. 2).

A double blower fan unit, which is activated by the evaporator motor, draws mixed air through an air filter, cooling and heating coils, then forces this air in the ventilation ducts (upper section) along the walls, and finally exhausts it at the bottom of the windows.

The HVAC system includes two adjustable registers to control air flow for the rear L.H. passenger seats. Air flow can be directed by adjusting the ball-socket nozzle. To adjust air flow volume, rotate the nozzle. Air flow can be increased to full-open and decreased to shut-off.

The lavatory ventilator acts as the main exhaust for the whole vehicle, eliminates odors, and finally heats or cools the lavatory with the vehicle's ambient air.

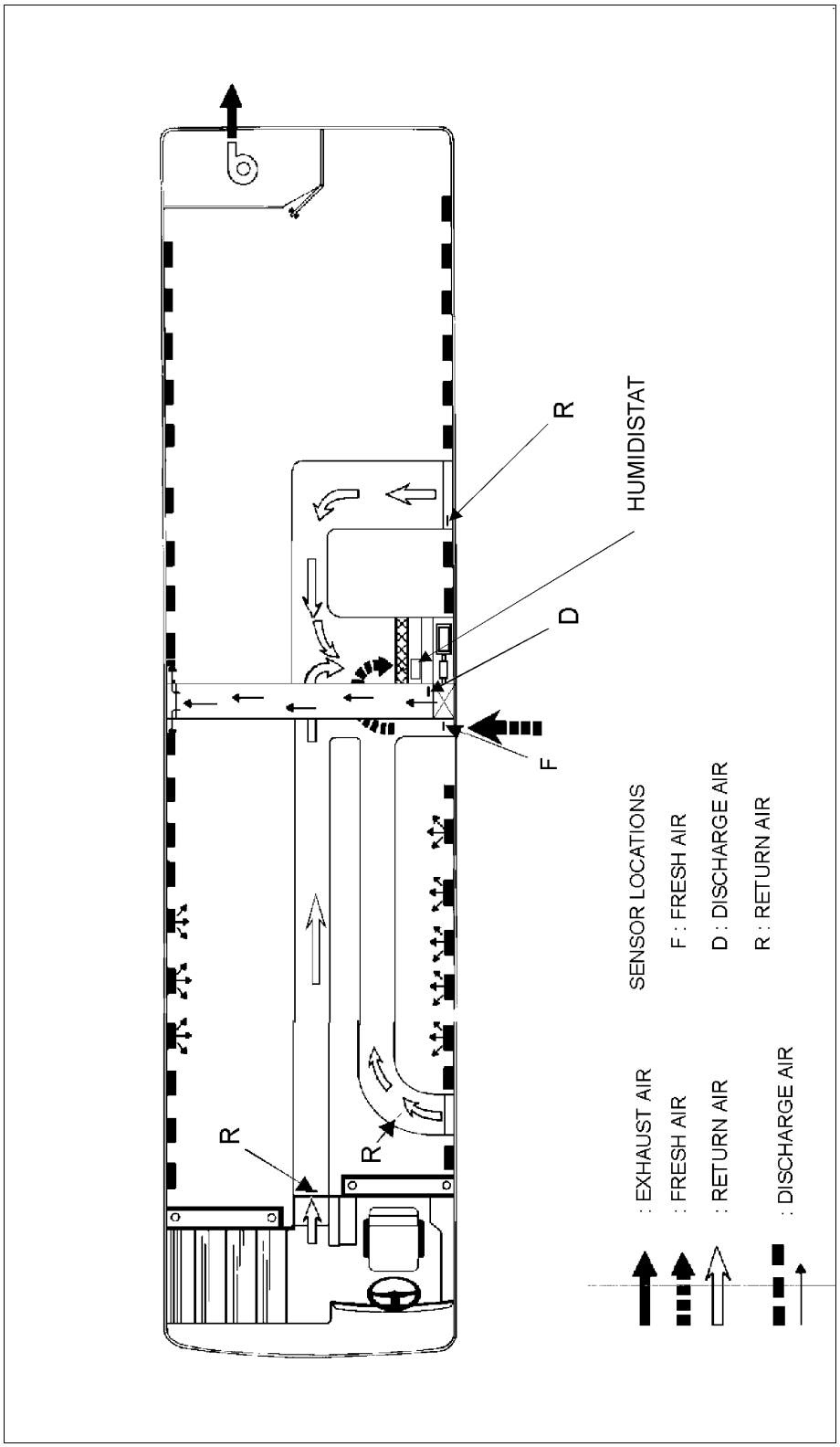


FIGURE 2: MAIN HVAC SYSTEM AIR CIRCULATION 22021

3. DRIVER'S HVAC SYSTEM OPERATION

The temperature control in the driver's area is provided by the *"Driver's A/C - Heating Temperature"* control mounted on the R.H. dashboard control panel, which is in fact a potentiometer, and by a thermistor sensor located under the dashboard close to the accelerator pedal. At extreme clockwise position, the temperature control will deliver full heat without any control.

The fan speed will be set by the position of the *"Driver's A/C - Heating Ventilation Speed"* control, also mounted on the R.H. dashboard control panel which has two functions. Th clicking noise produced while turning the control activates the heating or A/C system according to the *"Driver's A/C - Heating Temperature"* control position. This control also acts as a potentiometer. Consequently, it is possible to gradually increase speed of fan motor from 25% to maximum speed. An electronic module, mounted on the driver's HVAC unit, analyzes the value sent to the potentiometer, and thus sets the motor speed. This installation ensures economical operation, and a wide range of speeds.

The driver's HVAC unit piping is paralleled with the main HVAC unit piping. Both units use the same refrigerant and coolant, and are linked to the same condenser and compressor, even if they are individually controlled. It requires the main HVAC unit to engage the A/C compressor magnetic clutch. Consequently, the driver's unit cannot be operated in the A/C mode alone.

4. MAIN HVAC SYSTEM OPERATION

The *"Main A/C - Heating"* switch, located on the R.H. side lower control panel, operates the A/C-heating and ventilation system (HVAC) in the Main section. The *"Main A/C - Heating Temperature"* control, located on the R.H. side dashboard control panel, enables the selection of the temperature in the main section (refer to the H3 Operator's Manual for details). The evaporator motor installed in HVAC compartment on the L.H. side of vehicle is protected by a 150 amp, manually-resettable (CB8) circuit breaker mounted in the main power compartment (refer to Section 06, *"Electrical System"* in this manual for details).

The condenser mounted on the opposite side of the evaporator is ventilated by two axial fans. Each axial fan motor is protected by a manually-resettable 40 amp circuit breaker mounted on the L.H. side wall of the A/C and heating junction box (Fig. 3). Furthermore, the feeding circuit of these two breakers is protected by a 150 amp manually resettable (CB9) circuit breaker mounted in main power compartment (Fig. 4).

To operate air conditioning system when coach is stationary, engine should run at fast idle. During operation of air conditioning system, windows should be kept closed and door not left open longer than necessary. In order to prevent battery discharge, A/C-heating system will not operate if vehicle charging system is not working properly.

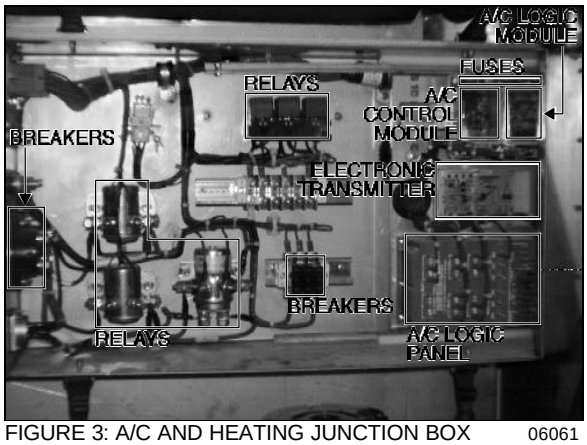
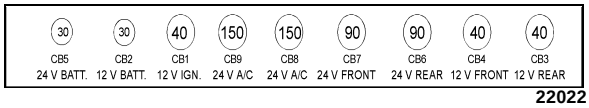


FIGURE 3: A/C AND HEATING JUNCTION BOX 06061



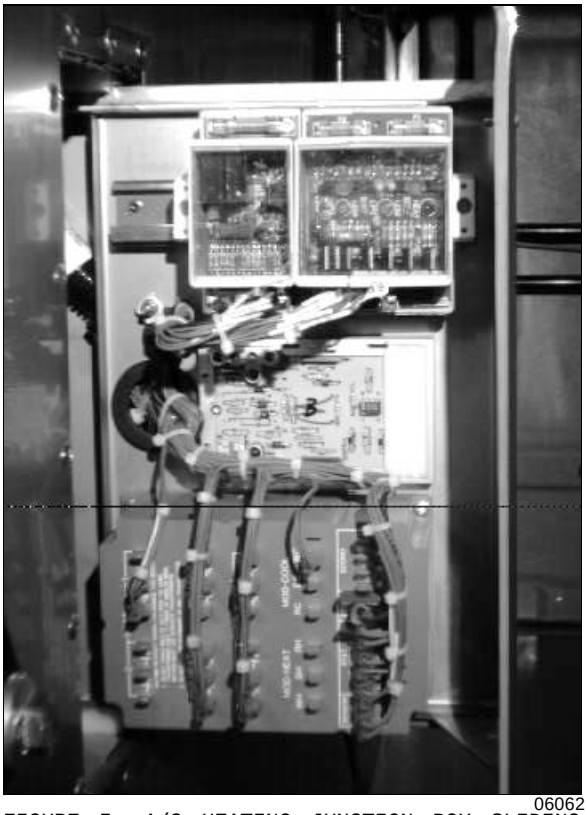
22022

FIGURE 4: VIEW FROM THE MAIN POWER COMPARTMENT

The heating and cooling components (water recirculating pump, main hot water valve actuator, A/C compressor clutch and unloaders, etc) are connected to the HVAC logic panel mounted on the A/C and heating junction box sliding drawer (Fig. 5).

Air temperature is picked up by three identical sensors, each one located in one of the three returning air ducts, and by another sensor located in the discharging air duct (Fig. 2). As shown in Figure 6, the sensors are series parallel connected. The electronic transmitter (see Fig. 5 and 6) detects the sensor signal and then compares it with the driver's setpoint (*"Main A/C - Heating Temperature"* control, which is mounted in R.H. dashboard control panel).

This will result in a voltage range (Fig. 7) for the HVAC logic panel. At this point, a fresh air sensor located in the fresh air damper on L.H. side of vehicle, can modify this range to anticipate any major change in the outside temperature. Afterwards, the HVAC logic panel will select the appropriate heat or cooling contact and staging according to the actual conditions. On the HVAC logic panel, there are three heat and three cooling contacts (Fig. 6).



06062

FIGURE 5: A/C HEATING JUNCTION BOX SLIDING DRAWER

In the Heat Mode

Heat in the system varies with the restricted opening of the linear main hot water valve actuator, the bypass solenoid valve and the action of the water recirculating pump.

If the preheater is switched "ON", the bypass solenoid water valve opens and the main hot water valve actuator should be fully "CLOSE", except if **heat contact 3** is "ON" the main hot water valve actuator should be fully "OPEN".

The main hot water valve actuator is controlled by the heat voltage ramp (Fig. 7).

The **heat contact 1** starts the water recirculating pump and turn "ON" LEDs for diagnosis (see paragraph "5. DIAGNOSIS OF MAIN HVAC UNIT PROBLEMS").

The **heat contact 2** controls nothing.

In the Cooling Mode

Contact will vary with the number of active cylinders in the compressor by means of electric unloaders. Staging will be defined as follows:

No cooling contact: Compressor clutch is disengaged.

Cooling contact 1: Compressor clutch is engaged and 2 compressor active cylinders.

Cooling contact 2: Compressor clutch is engaged and 4 compressor active cylinders.

Cooling contact 3: Compressor clutch is engaged and 6 compressor active cylinders.

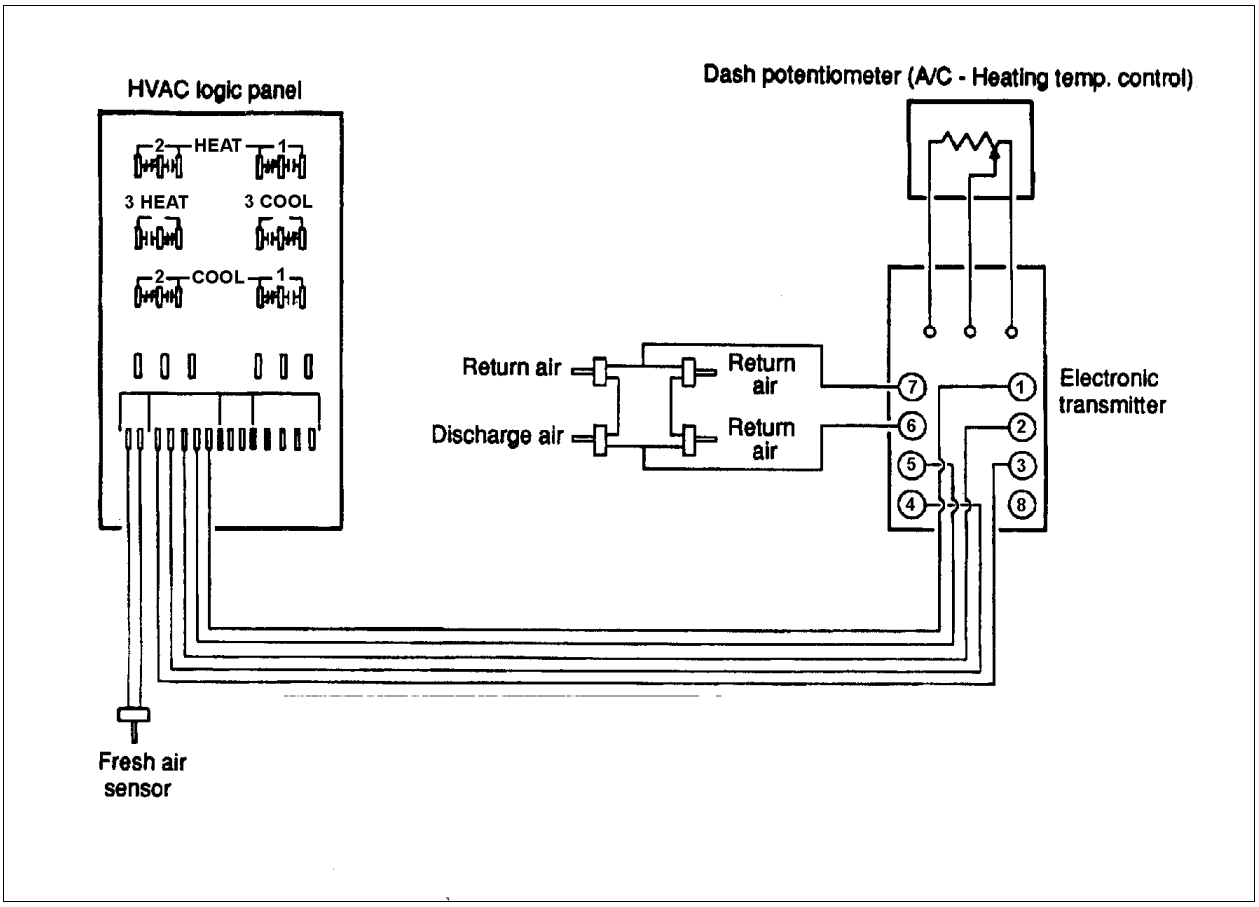


FIGURE 6: HVAC LOGIC PANEL AND ELECTRONIC TRANSMITTER 22023

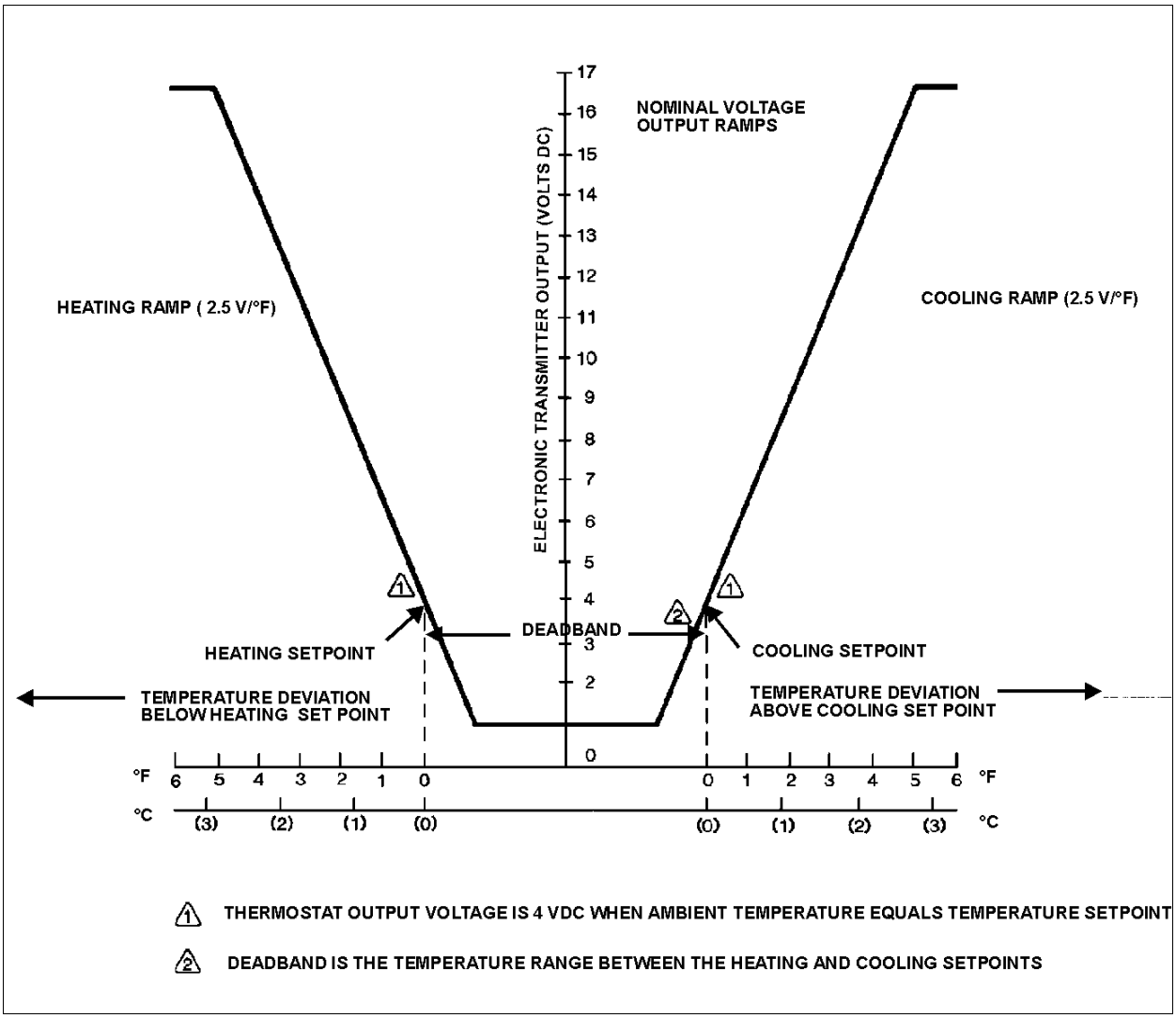


FIGURE 7: ELECTRONIC TRANSMITTER OUTPUT VOLTAGE RAMPS 22024

5. DIAGNOSIS OF MAIN HVAC UNIT PROBLEMS

Troubleshooting the HVAC system is made easier with the LEDs (light-emitting diodes) integrated in the system, and acting as indicator lights.

The main HVAC unit is equipped with three LEDs to indicate the heating mode and are located as follows:

One **red LED** is located on the **electronic transmitter** and identified *"Heat"* (Fig. 8). The electronic transmitter picks up the sensor signal and compares it with the setpoint established by the driver ("Main A/C - Heating Temperature" control). After analysis, a voltage signal, of which value is proportional to the analysis result (sensor vs driver's setpoint), is transmitted to the HVAC logic panel. The red LED on the electronic transmitter will be illuminated according to the voltage value, i.e. red LED may not be illuminated at first, and then will gradually reach its maximum brightness or vice versa.

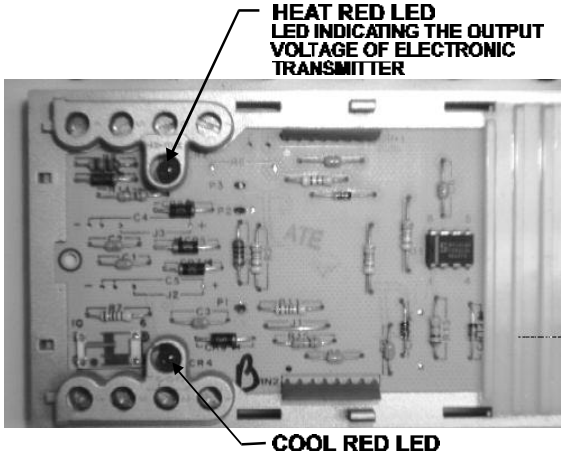


FIGURE 8: ELECTRONIC TRANSMITTER 22025

Two other red LEDs connected in parallel are located as follows:

One **red LED** is located in **driver's compartment**, on the lower console under the inside thermometer, while the other red LED is located on the HVAC logic module, which is mounted right over the electronic transmitter (Fig. 9). The two red LEDs operate simultaneously; unlike the LED mounted on the electronic transmitter, they may be illuminated or not (*"ON"* or *"OFF"*). Their function is to indicate the output of the HVAC logic panel.

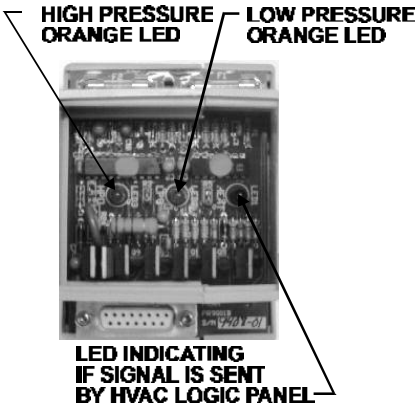


FIGURE 9: HVAC LOGIC MODULE 22026

The HVAC logic panel reads the voltage from the electronic transmitter. As soon as the voltage reaches 4.6 volts, the HVAC logic panel opens the normally-closed **heat contact 1**.

At this stage, the two red LEDs will illuminate to indicate that the HVAC logic panel has sent a signal to activate the heating system. If the other stages are activated, the two LEDs will remain illuminated.

The red LED on the lower console advises the driver that the heating system is operating. The red LED mounted on the HVAC logic module enables the technician to quickly diagnose the problem.

As for the A/C mode, it is almost the same installation, except that the red LED on the electronic transmitter is identified *"Cool"*. Its operation is, however, identical.

The significant difference lies in the fact that the two other LEDs connected in parallel are

green. One green LED is located in the driver's compartment on the lower console under the inside thermometer, while the other one is located on the HVAC control module. These two LEDs indicate the operation of the A/C system.

When the humidistat requests the operation of the A/C system to dry ambient air inside the vehicle, the two green LEDs will illuminate to indicate the operation of this system. However, the *"Cool"* red LED on the electronic transmitter will not illuminate, because the humidistat control bypasses the electronic transmitter. Therefore it is normal for the driver who requests heat by means of the *"Main A/C - Heating Temperature"* control, that the red and green LEDs be illuminated simultaneously. This corresponds to the operation of the heating system to heat the vehicle, and to the operation of the A/C system to dry air (dehumidification).

Note: *The dehumidifying function will operate only when the humidistat requests dehumidification AND the ambient temperature inside vehicle is less than 4 F (2 C) from the selected temperature with "Main A/C - Temperature" control.*

In addition to the two LEDs on the electronic transmitter and to the four other ones used to indicate the output of HVAC logic panel, four other LEDs described hereafter have been added on the HVAC control module and HVAC logic module to help the technician to quickly diagnose the problem.

5.1 High Pressure Orange LED

This LED mounted on the HVAC logic module (Fig. 9), is designed to light up when the pressure inside the A/C system (high pressure side) is too high. If this occurs, perform the following checks:

1. Too high air inlet temperature to the condenser;
2. Dirty condenser;
3. Faulty condenser fans; or
4. Refrigerant overcharge.

Note*: Another indicator light, "High A/C Pressure Indicator", mounted in the dashboard will also illuminate in order to inform the driver of this abnormal situation.*

Note*: If the A/C pressure is too high, the compressor clutch is disengaged, but the fan remains active.*

5.2 Low Pressure Orange Led

This LED, also mounted on the HVAC logic module (Fig. 9), is designed to light up when the pressure inside the A/C system (low pressure side) is too low. If this occurs, perform the following checks:

1. Too low air inlet temperature to condenser and/or evaporator;
2. Dirty evaporator air filter;
3. Dirty evaporator;
4. Low refrigerant charge; or
5. Expansion valve freeze up.

Note*: Another indicator light "Low Conditionning A/C Pressure Indicator", mounted in the dashboard will also illuminate in order to inform the driver of this abnormal situation.*

Note: *If the A/C pressure is too low, the compressor clutch is disengaged and the fan is deactivated.*

5.3 Driver's Red LED

This LED, mounted on the HVAC control module (Fig. 10), will turn on to indicate the energization of the driver's liquid refrigerant solenoid valve, each time there is a cooling request by the *"Main A/C - Heating Temperature"* control and the driver's system fan is on.

Note: *Cooling mode in driver's compartment will remain inoperative as long as central A/C system has not been turned on. Furthermore, central A/C system must be in cooling mode and not in dehumidifying mode, to allow cooling of the driver's compartment as driver's evaporator unit never operates in the dehumidifying mode.*

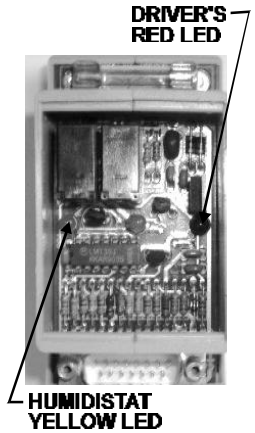


FIGURE 10: HVAC CONTROL MODULE 22027

5.4 Humidistat Yellow LED

This LED, mounted on the HVAC control module (Fig. 10), will be turned on (full intensity) during a dehumidifying request. It can also be half illuminated during a heat request.

Note: *Even if the dehumidifying function is requested, the cooling contact 1 on the HVAC logic panel will not turn on as long as the ambient temperature inside the vehicle will be over than 4 F (2 C) from the selected temperature with "Main A/C - Temperature" control.*

6. MAIN HVAC UNIT TROUBLESHOOTING GUIDE

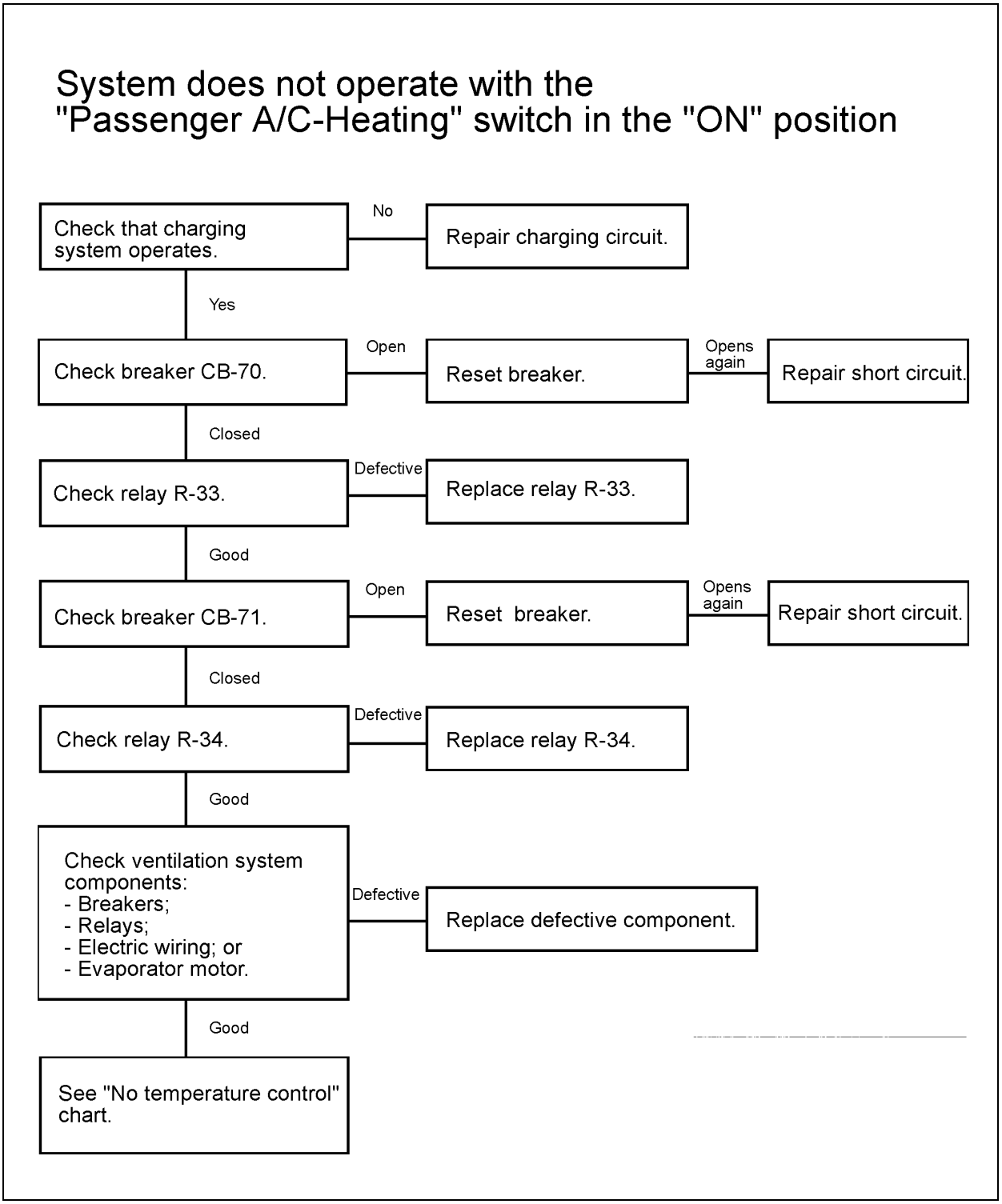


DIAGRAM 1: TROUBLESHOOTING CHART - MAIN HVAC UNIT 22028

6.1 CONTROL TEMPERATURE CHART

Ventilation operates, but there is "no temperature control".

Turn "Passenger A/C-Heating Temperature" control to extreme clockwise or counterclockwise position (cold or warm).

Set humidistat (located in HVAC compartment over evaporator motor) to its maximum position to inhibit operation of A/C system which could alter data.

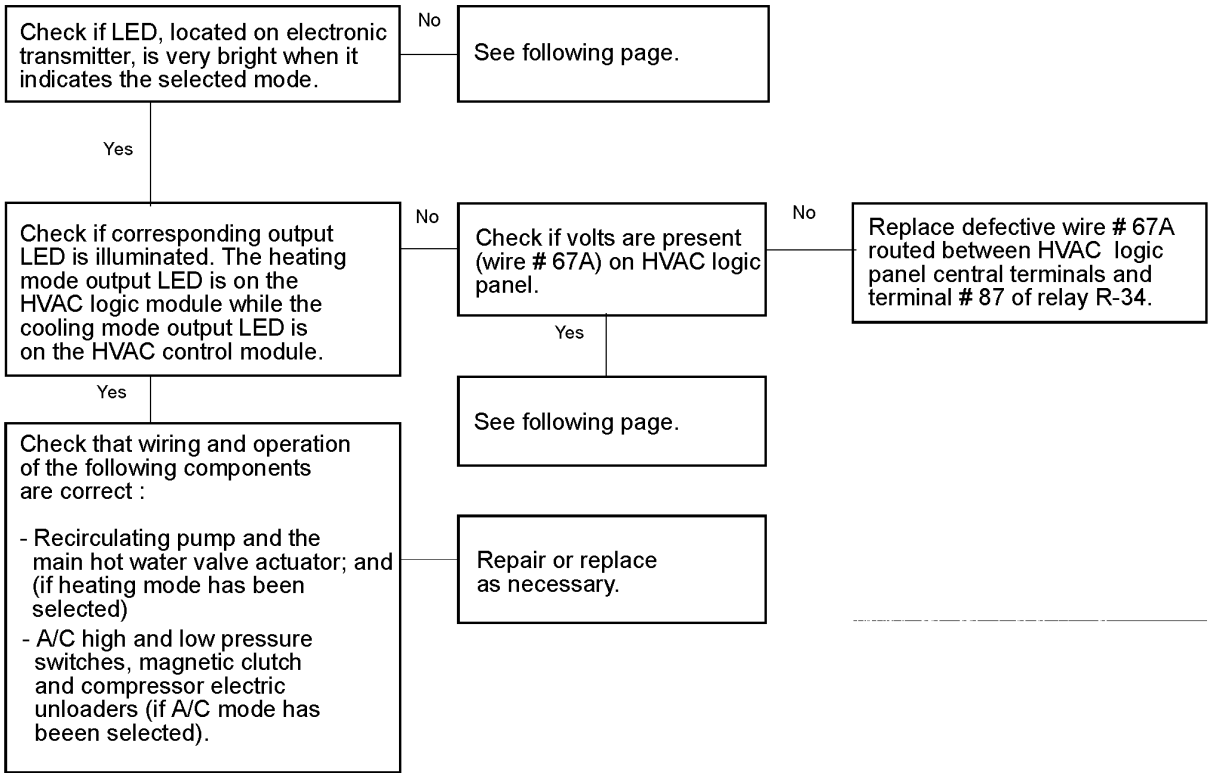


DIAGRAM 2: TROUBLESHOOTING CHART - TEMPERATURE 22029

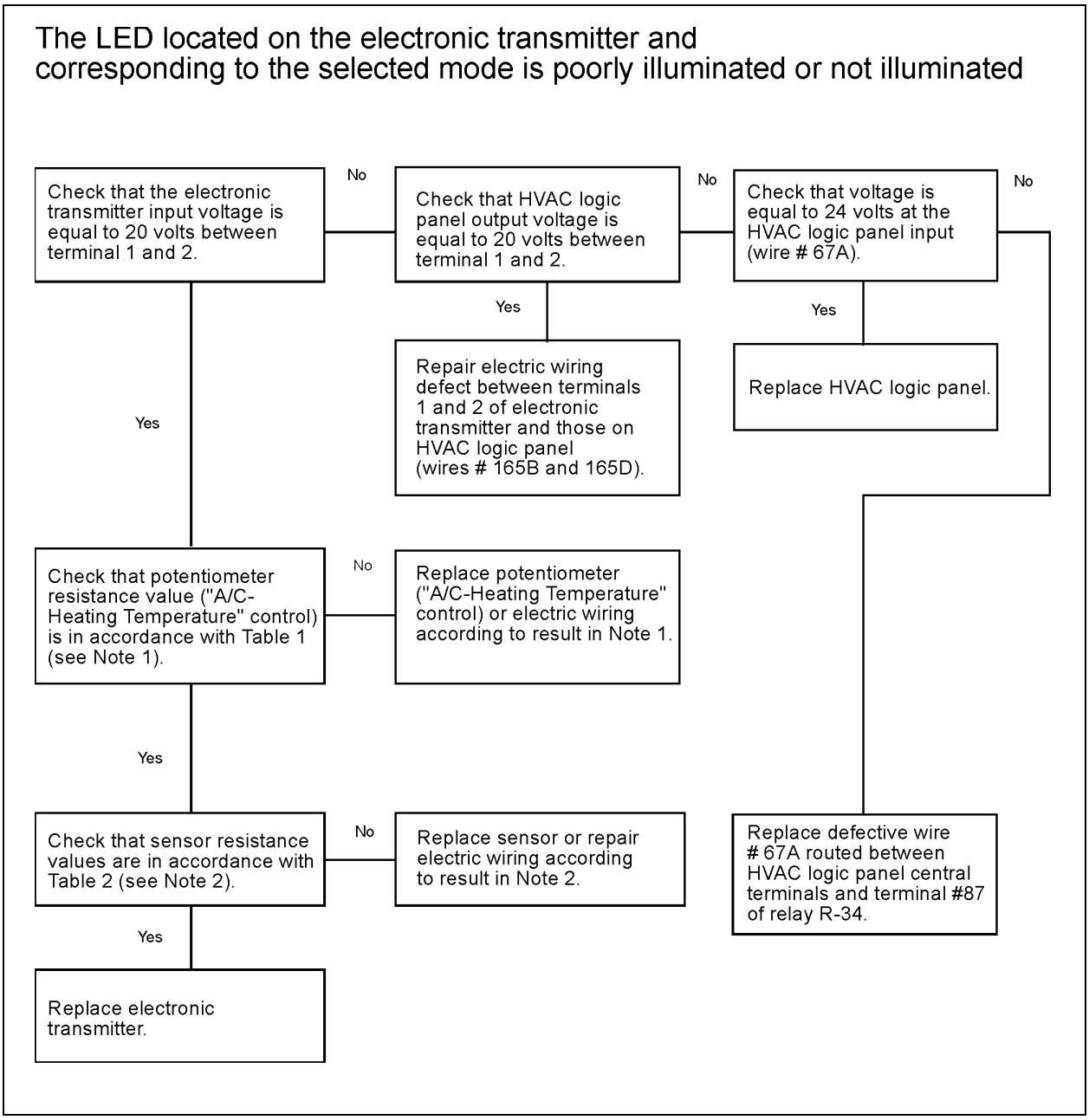


DIAGRAM 3: TROUBLESHOOTING CHART - ELECTRONIC TRANSMITTER 22030

6.2 Checking Potentiometer Resistance Values

Disconnect the 2-pin connector C-137 located on the A/C and heating junction box sliding drawer in back of the electronic transmitter. Locate the corresponding female contact pins for wires #167 and #167A, and using an ohmmeter connected according to the indications given in Table 1, check if readings match with data of Table 1. At location #165D, place the ohmmeter probe on head of screw #1 of electronic transmitter.

***Note**: Readings may be slightly higher than those in Table 1 due to the length of the wires routed between the electronic transmitter and the potentiometer.*

If reading does not match, proceed as follows to check if potentiometer or wiring between potentiometer and electronic transmitter is defective:

Disconnect the 3-pin connector C-355 located under the dashboard, right behind the potentiometer. Identify male contact pins corresponding to the green, brown or black, and pink or red wires from potentiometer. Using an ohmmeter connected according to the indications given in Table 1 (refer to the following cross-reference between wire color and wire number), check if readings match with data of Table 1.

If readings match, trouble is located in wiring between connector C-355 and electronic transmitter. If reading does not match, potentiometer is defective.

WIRE COLOR & NUMBER CROSS REFERENCES	
Between connector C-355 and potentiometer	Between connector C-355 and electronic transmitter
Green	165D
Brown or black	167A
Pink or red	167

6.3 Checking the Sensor Resistance Values

Remove the eight screws (#1 to #8) on the electronic transmitter and move it away from its support which holds the junction terminals. Locate terminals #6 and #7 on support, and using an ohmmeter, note the reading between these two terminals. (The board is moved away from its support to isolate the sensor electric circuit from the electronic transmitter. Compare reading with data of Table 2 given in the *"Recirculated Air Sensor"* curve. Temperature at the bottom of Table 2 is the temperature picked up by the sensor at the time of verification.

Reading between terminals 6 and 7 corresponds to the total resistance of the four paralleled series sensors. Thus, if reading does not match with Table 2, check if problem is located at sensors or wiring.

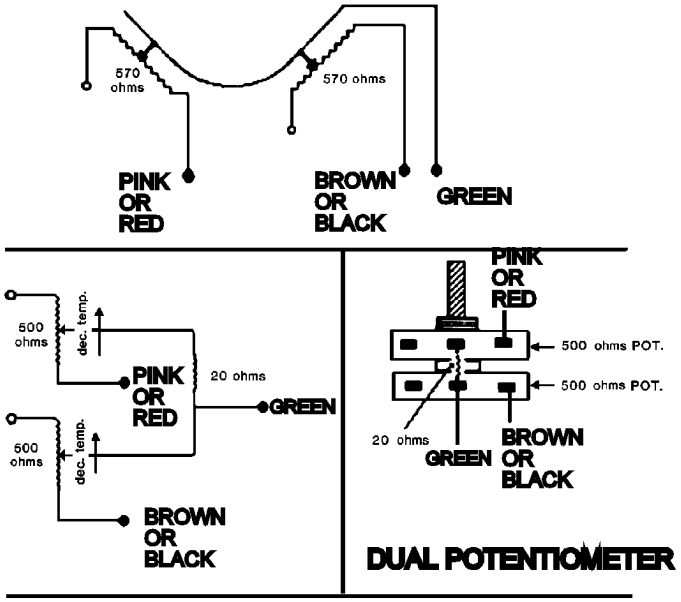
6.4 Testing Each Sensor

Disconnect each connector from its respective sensor (refer to Fig. 2 for sensor location), then with an ohmmeter, note each sensor reading.

***Note**: To gain access to the sensor connector located in the last entrance step riser, remove the six screws retaining grill, the grill, the four bolts securing the sensor mounting plate to the air return duct, then lift the sensor mounting plate.*

Compare each reading with data of Table 2 given in the *"Recirculated Air Sensor"* curve. The four-sensor curves are used again, since each sensor, taken individually, has the same resistance as the four paralleled series sensors taken together. If all sensors check good, the problem is located in wiring between terminals 6 and 7 and the sensors.

CIRCUIT DIAGRAM OF DUAL POTENTIOMETER (A/C-HEATING TEMPERATURE CONTROL)



WIRE CONNECTIONS / SELECTED TEMPERATURE		POTENTIOMETER RESISTANCE						
		GREEN	PINK OR RED		GREEN	BROWN OR BLACK	BROWN OR BLACK	PINK OR RED
heating	cooling	165D	167		165D	167A	167A	167
Min.	Max.	534 ohms		19 ohms	515 ohms		1046 ohms	
		493		20	473		964	
		426		24	402		825	
		352 ohms		27 ohms	325 ohms		673 ohms	
		284		32	252		532	
		210		34	176		383	
		143 ohms		39 ohms	104 ohms		243 ohms	
Max.	Min.	76		45	31		103	

TABLE 1

22031

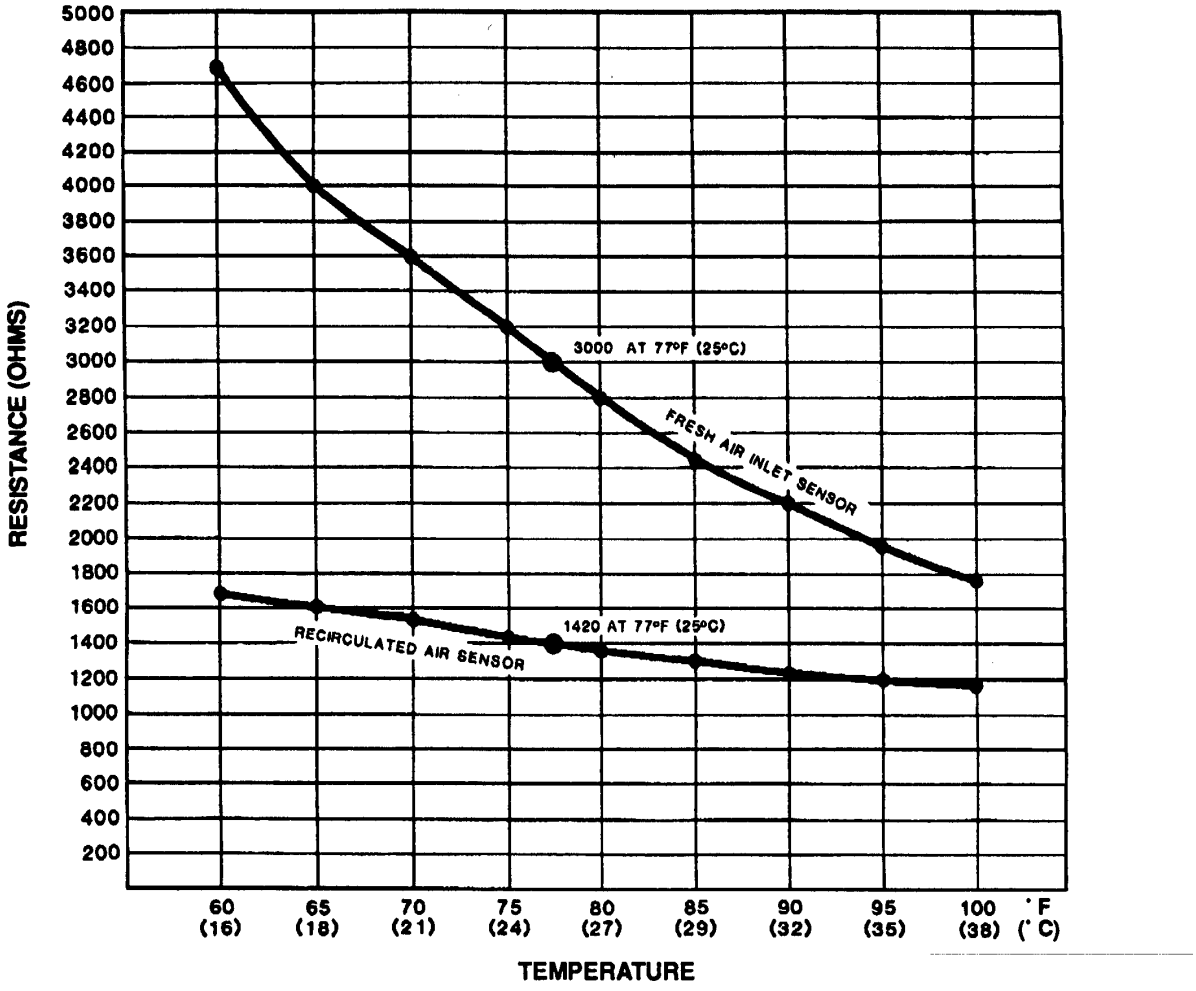


TABLE 2: RESISTANCE RANGE ACCORDING TO AMBIENT TEMPERATURE SENSORS 22032

6.5 Fresh Air Inlet Sensor

6.5.1 Description

The main HVAC is provided with a fresh air sensor located in the fresh air damper. The fresh air sensor consists of a thermistor sensing element mounted in a tubular probe. The negative temperature coefficient characteristic of the thermistor element causes its resistance to decrease as the sampled air temperature increases. The fresh air sensor provides heating and cooling anticipation to the system at a sensitivity ratio of 25:1. In other words, a 25°F (14°C) increase in fresh air inlet temperature corresponds to a 1°F (0,6°C) decrease in set temperature. Thus, if sensor is short-circuited or in an open circuit condition, the control system will be slightly affected, i.e. the temperature inside of vehicle will be about 2 or 3 °F (1 or 2 °C) lower or higher than the temperature selected by the driver with the *"Main A/C - Heating Temperature* " control.

6.5.2 Checkout

1. Set the ohmmeter scale to R X 1000.

2. At the HVAC logic panel located on the A/C and heating junction box sliding drawer, disconnect wiring terminal "T1" from sensor outlet.

3. Connect a wire of the ohmmeter to terminal "T" of HVAC logic panel, and the other wire of the ohmmeter to the loose wire of sensor.

4. The ohmmeter reading will vary according to the temperature picked up by the sensor. The fresh air inlet sensor resistance must vary between 1600 and 4800 ohms. Refer to Table 2 for the resistance readings at different temperatures. If reading does not match with the data of Table 2, disconnect wiring connector directly from fresh air sensor which is accessible from the evaporator compartment, then measure resistance of the fresh air sensor to determine if sensor or its wiring between sensor and HVAC logic panel are defective.

7. HVAC UNIT MAINTENANCE

No special maintenance is required on the main and driver's units, with the exception of cleaning their respective coil air filters.

Note: *Squeeze rubber hose located under the concerned compartment, to eliminate water and dirt when you make routine maintenance.*

7.1 Coil Cleaning

Check the external surface of the coil at regular intervals for dirt or any foreign matter.

For the driver's HVAC unit, flush the coil from inside (Fig. 13) , and for the evaporator, back flush the coil (Fig. 11) every 12,500 miles (20 000 km) or once a year, whichever comes first.

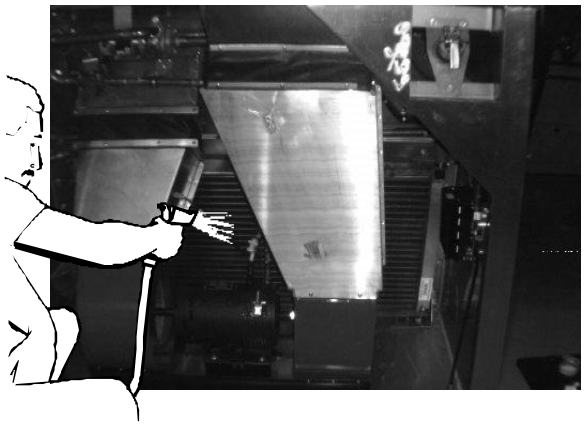


FIGURE 11: EVAPORATOR COIL 22033

For the condenser coil, back flush the coil (Fig. 12) every 6,250 miles (10 000 km) or twice a year, whichever comes first.

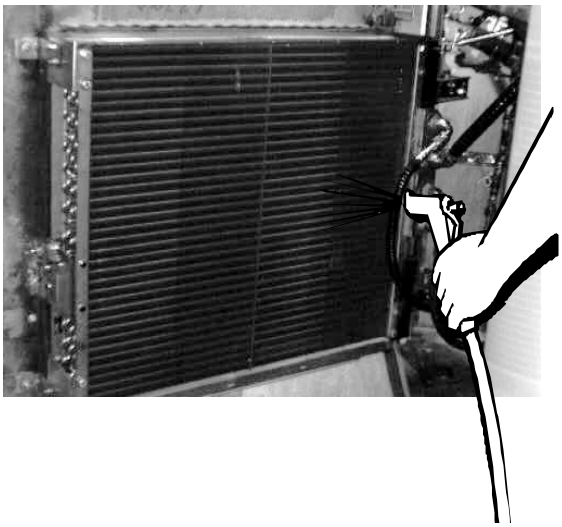


FIGURE 12: CONDENSER COIL 22034

Use a water jet or water mixed with air pressure to clean the coil.

Caution: *Direct the pressure straight through the coil to prevent bending of fins and do not use extremely high pressure. Do not use hot water, steam or caustic soap.*

7.2 Driver's HVAC Unit Air Filter

The air filter is located under the dashboard (Fig. 13). To gain access, unscrew both 3/4 turn knurled fasteners of A/C & heating units access panel located over entrance door steps counterclockwise. Remove panel and filter. To clean filter, back flush with water, then dry with air, every 12,000 miles (20 000 km) or once a year, whichever comes first.

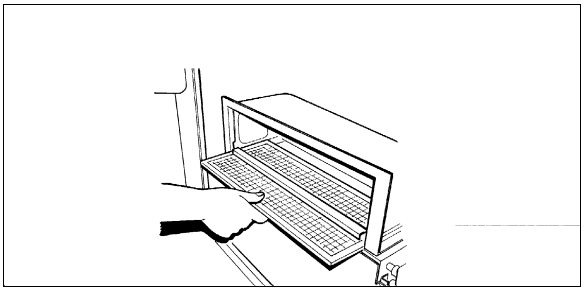


FIGURE 13: DRIVER'S HVAC UNIT AIR FILTER MAXE2209

7.3 Main HVAC Unit Air Filter

The main air filter is located in the HVAC compartment (Fig. 14). To access the filter, locate access panels in one of the baggage compartments adjacent to the HVAC compartments (L.H. side). Open panels by unscrewing the three screws of either panel 1/4 of a turn, unsnap both fasteners on top of filter, and slide out filter. To clean filter, back flush with water or soapy water, then dry with air every 12,000 miles (20 000 km) or once a year, whichever comes first.

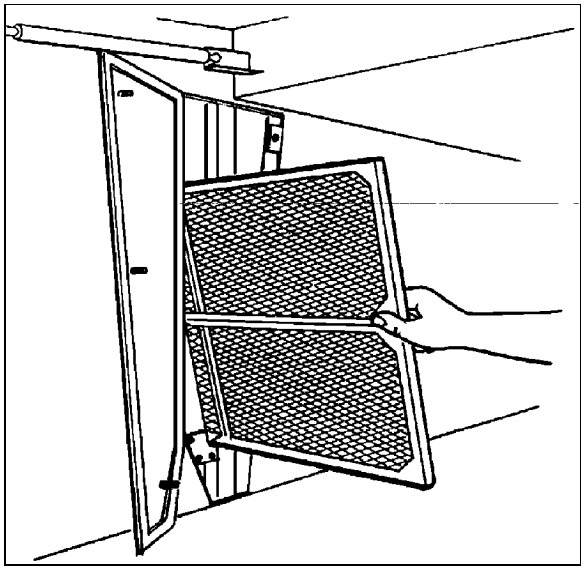


FIGURE 14: MAIN HVAC UNIT AIR FILTER **22100**

Caution: *Do not use high pressure water jet to avoid damaging filter.*

Caution: *Be sure not to reverse filter upon installation.*

8. EVAPORATOR MOTOR

The evaporator motor is installed in the HVAC compartment (L.H. side of vehicle) (Fig. 15). It is a 27.5 volt, 2 HP (1,5 kW) motor which activates a double blower fan unit. An evaporator motor speed controller is installed in the HVAC compartment as standard equipment.

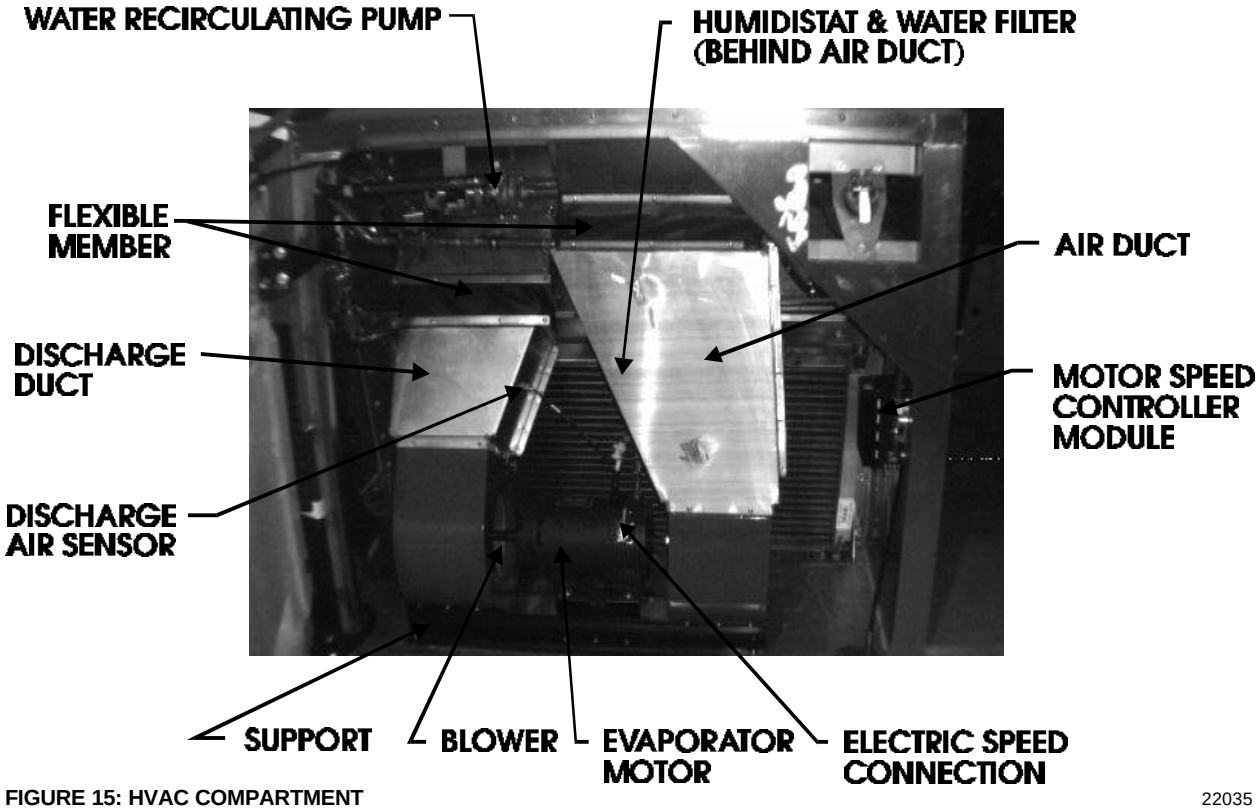


FIGURE 15: HVAC COMPARTMENT 22035

8.1 Removal

1. Set the main battery disconnect switch to the *"OFF"* position.
2. Open the last L.H. side baggage compartment door. Pull the black release button located on the L.H. side in order to unlock and open the HVAC compartment door.
3. Identify the L.H. side discharge duct inside compartment and remove the Phillips head screws retaining the flexible member to duct. Separate the adhesive tape (680453) on the duct.
4. Repeat step 3 for the R.H. side discharge duct.
5. Disconnect the discharge air sensor connector. Remove the cable tie securing wire.
6. Disconnect electrical speed connection control on the motor plate.
7. From under the vehicle, remove the eight bolts retaining the evaporator fan motor support. Remove the complete unit from the HVAC compartment (Fig. 16).
8. On a work bench, unscrew the fan square head set screws, the Phillips head screws retaining cages to support and slide out the assemblies from the evaporator motor output shaft.

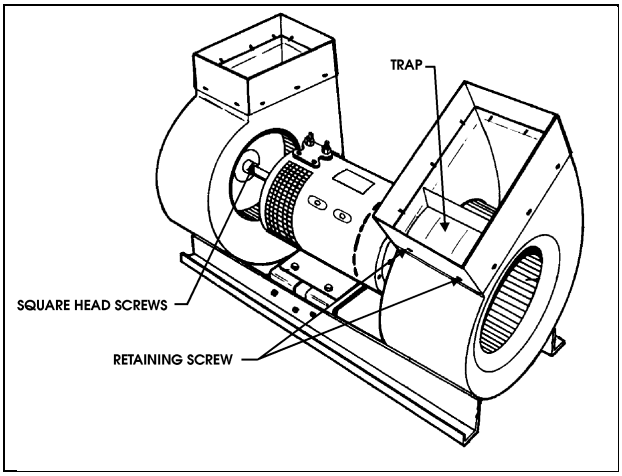


FIGURE 16: EVAPORATOR MOTOR ASSEMBLY 22036

Caution: *Never support evaporator motor by its output shafts while moving it.*

8.2 Installation

To reinstall the evaporator motor, reverse "Evaporator Motor Removal" procedure.

8.3 Maintenance

8.3.1 Checking Operation of Brush in Holder

Lift brush slightly 1/8 inch (3 mm) and release it. Brush must produce a dry noise.

8.3.2 Brush Wear Inspection and Replacement

Replace the brushes if less than ¾ inch (19 mm). New brush length is 1-¼ inch. Clean brushes with a clean cloth impregnated with gasoline or alcohol.

Warning: *Cleaning products are flammable and may explode under certain conditions. Always handle in a well ventilated area.*

To replace brushes, proceed as follows:

1. Set main battery disconnect switch(es) to the "OFF" position.
2. Remove the protective screen band from the motor housing by pulling down the spring loaded fastener.
3. Remove and replace brushes as per the standard procedure.
4. Reverse installation procedure.

8.3.3 Checking Commutator

The surface must be polished. A brown-black colored surface is normal and indicates a good switching. Ensure there is no evidence of arcing or metal chips.

8.4 Speed Controller Module

The optional evaporator motor speed controller module is mounted on the R.H. side wall inside the HVAC compartment (Fig. 15). The purpose of this electronic module is to limit the evaporator motor speed to 75% of its full rated speed throughout the heating mode and during the first stage of the cooling mode. The module will then gradually increase the motor speed as the cooling demand increases.

8.4.1 Troubleshooting

Check that evaporator motor is in good condition. Perform the following test in order to determine if speed controller module is defective, or if HVAC logic panel is sending a bad signal to the module.

1. Locate the HVAC logic panel mounted on the A/C and heating junction box sliding drawer compartment as illustrated in Figure 3.
2. Disconnect the "WC" wire from the HVAC logic panel "WC" terminal.
3. Connect an ammeter between the "WC" terminal on the HVAC logic panel and "WC" wire previously disconnected.
4. The ammeter should indicate 0 mA when *"A/C & Heating temperature"* control is turned to the maximum heating position, and approximately 4.85 mA when it is turned to the maximum cooling position. If not, check ground continuity on speed controller module as follows.

5. Set the *"A/C & Heating"* switch to the *"OFF"* position. Connect an ohmmeter between the large and small "--" (ground) terminals on speed controller module.

6. The ohmmeter should indicate less than 5 ohms. If more, the internal ground circuit is defective and can be corrected by installing a jumper wire (18 AWG) between the two "--" (ground) terminals.

7. With the *"A/C & Heating"* switch set to the "ON" position, repeat steps 3 and 4. If readings still do not check within tolerance, replace speed controller module.

8. Connect a voltmeter between the *"Motor"* and "--" (ground) large terminals on speed controller module.

9. The voltmeter should indicate approximately 7.5 V when *"A/C & Heating Temperature"* control is turned to the maximum heating position, and approximately 0.5 V when it is turned to the maximum cooling position. If not, the speed controller module is defective and must be replaced as a unit.

9. AIR CONDITIONING SYSTEM

9.1 Description

The schematic of Figure 17 shows the A/C system and its components. The system is equipped with a 6 cylinder, 05G-134A Carrier compressor. The air conditioning capacity is 9 tons. The receiver and filter dryer are mounted inside the A/C condenser compartment. The fuel filler door is a small door located at left of A/C condenser compartment door, allowing viewing of the filter dryer and the moisture indicator.

***Note**: For opening of the A/C condenser door, close the baggage compartment door at the left of the A/C condenser compartment door, but do not close the fuel filler door.*

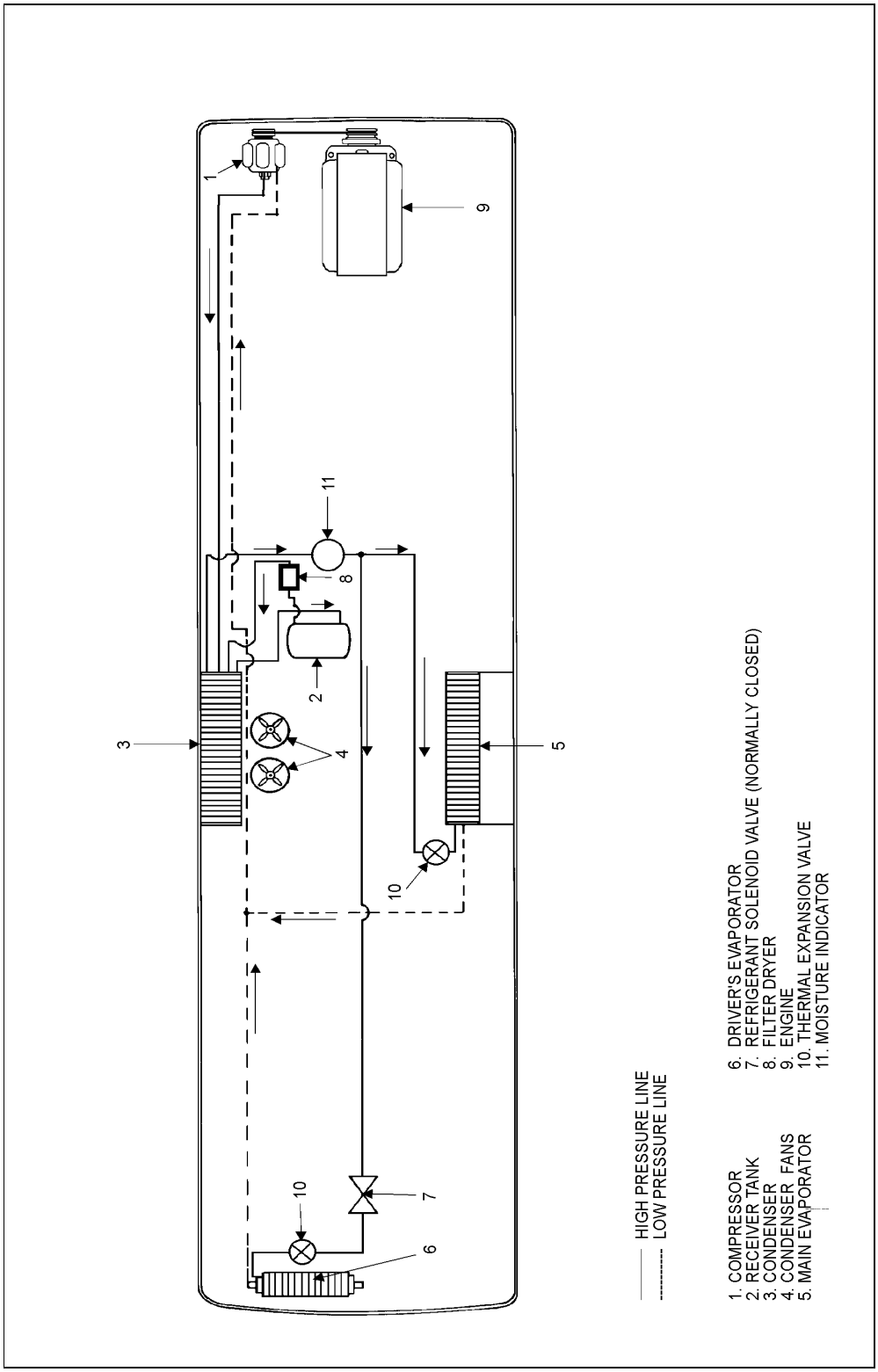


FIGURE 17: A/C SYSTEM COMPONENTS 22037

9.2 A/C Cycle

Refrigeration may be defined as "the transfer of heat from a place where it is not wanted to a place where it is unobjectionable". Components required for a closed circuit refrigeration system are shown in Figure 17 .

The air conditioning system in the H3 series vehicles is the "Closed" type system using R-134a.

1. The refrigerant flowing to the compressor, is compressed to high pressure and reaches a temperature higher than the surrounding air. It is passed through the air-cooled fins and tubes of the condenser coil causing the hot, high pressure gas to be condensed into a liquid form.

2. The liquid refrigerant flows to the receiver tank, then through a filter dryer where all moisture, acids and dirt are removed. It is passed again into the condenser sub-cooling and through a moisture indicator which indicates if any moisture is present in the system.

3. By its own pressure, the liquid refrigerant flows through a thermal expansion valve where the pressure drop vaporizes in a vapor-liquid state at a low temperature pressure.

4. The cold low pressure refrigerant passes through the main and the driver's evaporator absorbs heat from the air passing over the fins and tubes, and changes into gas. In this form, the refrigerant is drawn into the compressor to repeat the air conditioning cycle.

   The success of the air conditioning system depends on retaining the conditioned air within the coach. All windows and intake vents should be closed. An opening of approximately 8 in^2 (5162 mm^2) could easily neutralize the total capacity of the system.

   Other causes of inadequate cooling are dirty coils or filter. Dirt acts as an insulation and is also serves as a restriction to the air flow.

   The refrigeration load is not constant and varies. It is also affected by outside temperature, relative humidity, passenger load, compressor speed, the number of stops, etc.

   The compressor will load depending on operating conditions.

9.3 Refrigerant

The A/C system of this vehicle has been designed to use Refrigerant 134a as a medium. Regardless of the brand, only R-134a must be used in this system. The chemical name for this refrigerant is
Ethane, 1, 1, 1, 2-Tetrafluoro.

Warning: *Refrigerant in itself is nonflammable, but if it comes in contact with an open flame, it will decompose.*

9.3.1 Procurement

Refrigerant is shipped and stored in metal cylinders. It is serviced in 30 and 100 pound (13,6 and 45 kg) cylinders. Approximately 25 pounds (11,4 kg) are used in the system.

It will be impossible to draw all the refrigerant out of the cylinder. However, the use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the cylinder.

9.3.2 Precautions in Handling Refrigerant

1. Do not leave a cylinder of refrigerant uncapped.

2. Do not subject the cylinder to high temperatures.

3. Do not weld or steam clean on or near the system.

4. Do not fill a cylinder completely.

5. Do not discharge vapor into an area where a flame is exposed.

6. Do not expose the eyes to liquid refrigerant.

All refrigerant cylinders are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is a good practice to replace the cap after each use of the cylinder for the same reason. If the cylinder is exposed to the sun's radiant heat, pressure increase resulting may cause release of the safety plug or the cylinder may burst.

For the same reason, the refrigerant cylinder should never be subjected to excessive temperature when charging a system. The refrigerant cylinder should be heated for charging purposes by placing it in 125°F (52°C) water. Never heat above 125°F (52°C) or use a blowtorch, radiator, or stove to heat the cylinder.

Welding or steam cleaning on or near any refrigerant line or components of the A/C system could build up dangerous and damaging pressures in the system.

If a small cylinder is ever filled from a large one, never fill the cylinder completely. Space should always be allowed above the liquid for expansion. Weighing cylinders before and during the transfer will determine the fullness of the cylinders.

Warning: *One of the most important precautions when handling refrigerant consists in protecting the eyes. Any liquid refrigerant which may accidentally escape is approximately -40 F (-40 C). If refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when opening refrigerant connections.*

9.3.3 Treatment in Case of Injury

If liquid refrigerant comes in contact with the skin, treat the injury as if the skin was frost-bitten or frozen.

If liquid refrigerant comes in contact with the eyes, consult an eye specialist or doctor immediately. Give the following first aid treatment:

1. Do not rub the eyes. Splash eyes with cold water to gradually bring the temperature above the freezing point.

2. Apply drops of sterile mineral oil (found at any drugstore) in the eyes to reduce the possibility of infection. The mineral oil will also help in absorbing the refrigerant.

9.3.4 Precautions in Handling Refrigerant Lines

1. All metal tubing lines should be free of kinks, because of the restriction that kinks will give to the flow of refrigerant. The refrigeration capacity of the entire system can be greatly reduced by a single kink.

2. The flexible hose lines should never be allowed to come within a distance of 2-1/2 inches (6,3 cm) of the exhaust manifold.

3. Use only sealed lines from parts stock.

4. When disconnecting any fitting in the refrigeration system, the system must first be discharged of all refrigerant. However, proceed very cautiously, regardless of gauge readings. If there happens to be liquid refrigerant in the line, disconnect fittings very slowly, keeping face and hands away so that no injury can occur. If pressure is noticed when fitting is loosened, allow it to bleed off very slowly.

Warning: *Always wear safety goggles when opening refrigerant lines.*

5. In the event that any line is opened to the atmosphere, it should be immediately capped to prevent entrance of moisture and dirt.

6. The use of the proper wrenches when making connections on O-ring fittings is important. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connection lines or components. When connecting the flexible hose connections, it is important that the swaged fitting and the flare nut, as well as the coupling to which it is attached, be held at the same time using three different wrenches to prevent turning the fitting and damaging the ground seat.

7. The O-rings and seats must be in perfect condition. The slightest burr or piece of dirt may cause a leak.

8. O-rings should be coated with refrigeration oil and installed on the line before the line is inserted into the fitting to prevent damaging the O-ringIf leaks are encountered at the couplings or connectors, no attempt should be made to correct the leaks by tightening the connections beyond the recommended torque. The O-rings are designed to seal at the specified torque and overtightening the connection does not result in a satisfactory and permanently sealed connection. The connection must be disassembled and the cause of the leak (damaged O-ring, defective lines, etc.) corrected. Use new O-ring.

9.4 Pumping Down

This procedure is intended to reduce refrigerant loss by isolating it in the compressor and the receiver tank, as well as in their connecting line, in order to carry out repairs on other sections of the air conditioning system (lines and components).

Note: *Before attempting any repair between compressor and receiver tank, use a recovery unit to remove refrigerant from the system.*

Warning: *When air conditioning system must be opened, refer to previous paragraph "PRECAUTIONS IN HANDLING REFRIGERANT" to prevent any injury.*

Procedure

1. Close the receiver tank outlet valve by turning it clockwise, backseat the suction service valve on the compressor, install an appropriate pressure gauge set, and turn the valve forward 1/4 turn to enable a visual check of the suction pressure.

2. Disconnect the *"Low Pressure Switch"* connector (mounted near the A/C compressor), and install a jumper wire.

Note: *This jumper wire will allow the clutch to remain engaged after pressure drops below 15 psi (103,5 kPa).*

3. Open the baggage compartment located at the right of the HVAC compartment door, unscrew the retaining screw on back wall of the compartment a quarter of a turn. Slide the “A/C and Heating Junction Box Sliding Drawer”. Locate the **cooling contact *3*** on the HVAC logic panel. Install a jumper wire between the central terminal of this stage and its normally-closed contact terminal as illustrated in Fig. 18. Locate the **cooling contact *2***. Install a jumper wire between the central terminal of this stage and its normally-closed contact terminal as illustrated in Fig. 18.

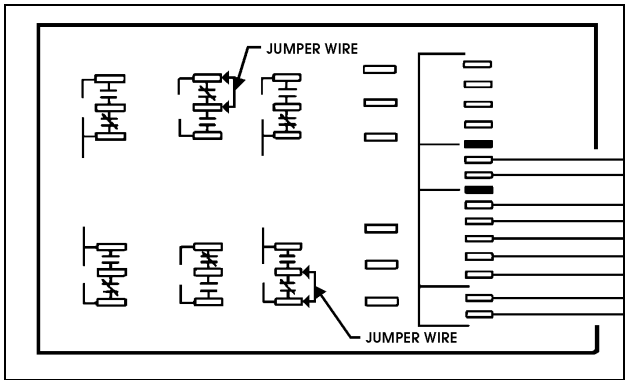


FIGURE 18: HVAC LOGIC PANEL 22038

Note: *No wire has to be disconnected. In fact, wires #31A and 31B will be connected to wire #67A. This temporary connection will restrict compressor operation to two cylinders.*

4. Start the engine, turn on the *"Main A/C-Heating"* switch, and adjust *"A/C-Heating Temperature"* controls to maximum A/C position.

5. Run the compressor until pressure reaches 1-2 psi (7-14 kPa).

Note*: During this operation, care must be taken not to fill the receiver tank over the upper sight glass. If so, stop process immediately. Always allow refrigerant piping and units to warm up to the ambient air temperature before opening system or sweating will take place inside the lines.*

6. Stop engine, and close compressor outlet valve by turning it clockwise until valve is properly seated.

7. Close compressor suction valve by turning it clockwise until it is properly seated.

9.5 Adding Refrigerant (Vapor State)

Use the suction service valve on the compressor to add a small quantity of refrigerant to the system. Backseat the valve and connect a charging line from the refrigerant cylinder to the valve loosely. Tighten connection at level of refrigerant cylinder and open tank end slightly to purge air from the charging line. Tighten the charging line at the compressor. Screw in the stem of suction valve approximately two turns. Start the engine and run at fast idle. Add sufficient refrigerant to bring the level in lower sight glass of receiver tank to mid-point. Always charge the system with the cylinder upright and the valve on top to avoid drawing liquid out of the cylinder.

Fill liquid refrigerant at the receiver tank and completely charge, if necessary, using previous procedure.

9.6 Evacuating System

1. Open both receiver valves by turning "out" (normal position).

2. Remove the caps from the two 90° adapters on the suction, discharge valves and connect two hoses to the vacuum hose.

3. Place the two compressor valves, suction and discharge, in neutral position by turning each one 3 to 4 turns "in" from the "out" position.

4. Start the vacuum pump. Open the large (suction) shutoff valve and close the small vacuum gauge valve.

5. The pressure will drop to approximately 29 inches vacuum (14.2 psi or 97,9 kPa) (the dial gauge only gives a general idea of the absolute system pressure).

6. Backseat the compressor valves by turning "out" all the way.

7. Shut down the vacuum pump.

8. Remove the hoses.

9. Reinstall the caps at the suction valve take-off points.

9.7 Charging System

When a system has been opened or if there are any questions about the air or moisture in the system, evacuate the system. Charging of an evacuated system may be accomplished by forcing liquid R-134a directly into the receiver tank.

When charging an empty system, weigh the amount of refrigerant put into the system. This will eliminate any possibility of overfilling. A fulll charge requires 24 pounds (10,9 kg).

1. Backseat the two compressor shutoff valves ("out").
2. Install the test gauges at the shutoff valves noting that the 400 psi (2758 kPa) gauge is connected to the discharge.
3. Turn in the two shutoff valves 3 to 4 turns.
4. Open the lower receiver valve by turning "out" all the way.
5. Backseat the upper receiver valve by turning out all the way.
6. Remove the cover cap from the service fitting in the top receiver valve.
7. Attach a charging hose to the R-134a tank. Open the tank valve slightly permitting R-134a to escape thus purging the hose of air.
8. Connect the charging hose to the service fitting.
9. Open the R-134a tank valve.
10. To build up pressure in the receiver tank, heat the receiver tank with a heating blanket.
11. Turn in the upper receiver valve several turns. The R-134a will now enter the system.
12. The proper charge of R-134a is 24 lbs (10.89 kg). When the scale indicates this amount of charge, backseat the receiver valve and close the R-134a tank valve.
13. Disconnect the charging hose. Replace the cover caps.
14. The system is now ready for operation.

Caution: *The evacuation of the system must be made by authorized and qualified personnel only. Refer to local laws for R-134a recuperation.*

9.8 Refrigerant System Cleanout After Compressor Failure

Although the vast majority of reciprocating refrigerant compressors manufactured today are extremely reliable, a small percentage do fail. These failures usually result in minor or extensive system contamination depending on the severity of the failure. When an open type compressor becomes damaged internally, this provokes small particles of bearings, steel, brass, copper, and aluminium and, in severe cases, carbonized oil, which could contaminate the system. To prevent repeated failures, the problem which caused the failure should be corrected, and depending upon the severity of the failure, the system should be thoroughly cleaned out using one of the cleanout procedures mentioned.

9.8.1 Determining Severity of Failure

The severity of compressor failure can be categorized as minor or major. A failure is considered minor when the contamination is limited to the compressor with little or no system contamination. A major failure, or burnout, results in extensive system contamination as well as compressor damage. Extensive system contamination can be determined by withdrawing a small sample of compressor oil and checking its color, odor and acidity. A Virginia Chemical "TKO" one step acid test kit is one of several compressor oil test kits that may be used. A high acid content would indicate a major failure or burnout. A small amount of refrigerant gas may be discharged. A characteristic burned odor would also indicate severe system contamination.

9.8.2 Cleanout after Minor Compressor Failure

1. Be sure to correct the problem which caused the failure.
2. Change liquid line filter dryer.

3. Run the unit for 2 hours on high speed cool only. If a unit with a hot gas heating system is allowed to operate in heat or defrost, the refrigerant will not all flow through the liquid line filter dryer for cleaning and some parts of the system which were not previously contaminated, may become contamined.

4. Check compressor oil level to ensure compressor is not overcharged with oil. Sometimes a significant amount of oil is pumped out of the compressor to other parts of the system when a compressor fails. This oil will return to the replacement compressor when it is started, causing an overcharge of oil in the sump of the replacement compressor. In this case, it is important that the oil level be adjusted to the proper level.

5. Withdraw a sample of the compressor oil and check its color, odor, and acidity, using instructions supplied above. If the oil is contamined, change the oil and filter dryer, and repeat the procedure until the system is clean.

9.8.3 Cleanout After Major Compressor Failure

1. Reclaim the refrigerant into a refrigerant bottle through a filter dryer to filter out contaminants.

2. Remove the failed compressor and repair it if possible.
3. Install new or repaired compressor.

4. Change the filter dryer.

5. Circulate clean R-134a with the reclaimer to clean out many of the contaminants collected in the coil valves, TXV (Thermal Expansion Valve), solenoid valves, check valves, and any other mechanical component that may have collected contaminants.

6. Evacuate and charge the system normally

7. Run the unit for 8 hours and monitor the pressure drop across the filter dryer. Also check the liquid line dryer for signs of restriction. If the pressure drop across the filter dryer exceeds 12 to 14 psig (82,75 to 96,5 kPa) with a 40°F (5°C) evaporator coil temperature, stop the unit and change the liquid line and suction line filter dryer. After 4 or 5 hours of operation, stop the unit and replace the filter dryer.

8. After 8 hours of operation, stop the unit and remove a sample of the compressor oil and check its color, odor, and acidity, using instructions supplied above. If the oil is contaminated, replace the oil and repeat step 7. If the oil is not contaminated, change the filter dryer again and replace the moisture-liquid indicator.
9. After approximately 7 days of operation, recheck the compressor oil for cleanliness and acidity.

10. A/C SYSTEM COMPONENTS

10.1 Compressor (Central System)

10.1.1 Belt Replacement

Warning: *Set the main battery disconnect switch to the "Off" position. For greater safety, set the engine starter selector switch in engine compartment to the "Off" position.*

FIGURE 19: ENGINE COMPARTMENT REAR DOOR 05035

1. Locate the belt tensioner two-way control valve (Fig. 19), and turn handle counterclockwise in order to release pressure and tension on belts.

2. Slip the old belts off and the new ones on.

Note: *Both belts must always be replaced simultaneously to ensure an equal distribution of load on each of them.*

3. Reset belt tensioning pressure control valve to 50 psi (345 kPa) to apply tension on the new belts as explained in Section 12.

10.1.2 Pulley Alignment

In order to avoid skipping, disengagement and a premature wear of compressor belt, it is necessary to align compressor pulley with the crankshaft pulley. Before performing the following procedure, release air from belt tensioners by means of the two-way control valve. After completing these procedures reset belt tensioning pressure control valve to 50 psi (345 kPa).

10.1.3 Longitudinal Compressor Alignment

1. Rest an extremity of a straight edge of approximately 46 inches (117 cm) against the upper part of the outer face of crankshaft pulley, positioning the other end close to the compressor clutch pulley (Fig. 20 and 21).

2. Check the distance between each extremity of straight edge (1. Fig. 21) and the first drive belt. If they are different, loosen the compressor support bolts and with a hammer, knock support to slide it in order to obtain the same distance, and tighten the bolts.

10.1.4 Horizontal Compressor Alignment

1. Rest an extremity of the straight edge against the upper part of the outer face of compressor pulley, positioning the other end close to the crankshaft pulley.

2. Check the distance between each extremity of straight edge (1, Fig. 21) and drive belt. If they are different, loosen the pillow block compressor bolts and with a hammer, knock compressor pillow block to slide it in order to obtain the same distance, and tighten the bolts.

10.1.5 Vertical Compressor Alignment

Rest a short "angle and level indicator" on the outer side face of the crankshaft pulley, adjust the level indicator inclination at 0° and check if the compressor pulley is at same angle (Fig. 20 & 21). If it is not the same, shim under the appropriate pillow block in order to obtain a correct angle.

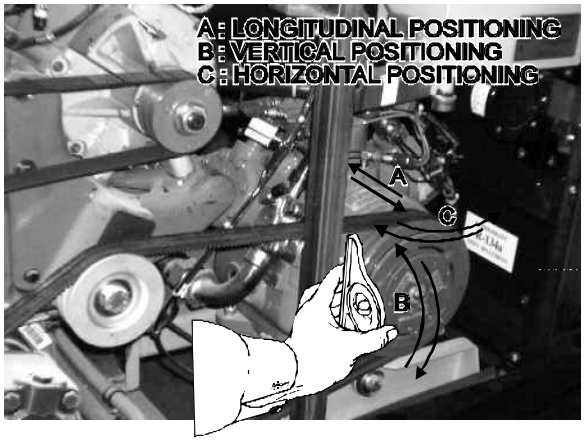


FIGURE 20: COMPRESSOR ALIGNMENT 22039

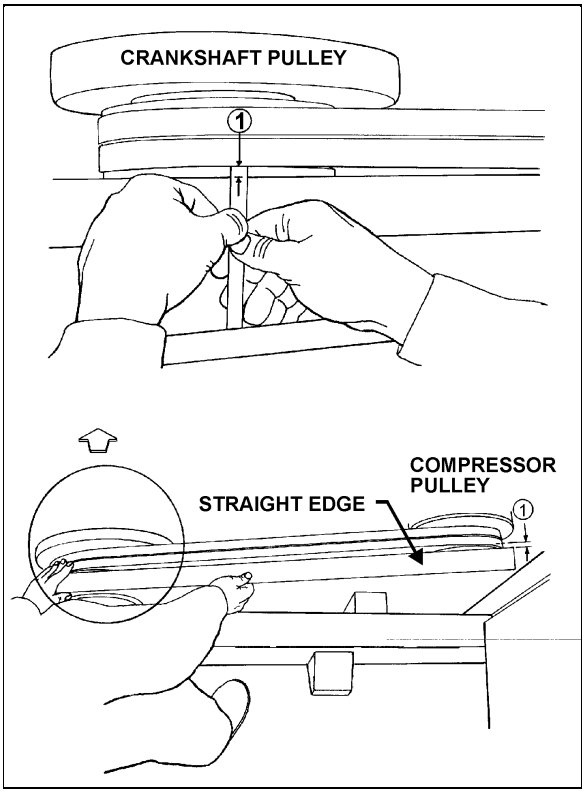


FIGURE 21: COMPRESSOR ALIGNMENT 22040

10.1.6 Compressor Maintenance

For the maintenance of the A/C compressor, see the *"Carrier Compressor Operation and Service Manual"* included at the end of this section.

Caution: *Use only Castrol SW 68 (POE) oils with refrigerant 134a.*

10.1.7 Troubleshooting Guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of 35°F (2°C) and over. The cylinder heads are internally divided into suction and discharge valves. The lower half of the cylinder head is the suction side, and it should be relatively cool to the touch, as opposed to the hot upper discharge side. If a valve plate or head gasket is blown, or a compressor unloader is stuck open, partially compressed refrigerant vapor will be circulated between the suction and discharge sides of the head. The affected cylinder head will then have a relatively even temperature across its surface and be neither as hot as the normal discharge temperature nor as cool as the normal suction temperature.

Broken suction valves are probably the most difficult items to detect without opening the compressor. Depending on the condition of the cylinder walls and piston rings, a compressor in good condition should be able to pull a vacuum of 20 inches Hg with the suction service valve frontseated. Failure to reach this value would require disassembly of the compressor to determine actual component conditions.

Blown Head Gaskets

Symptom:

- Loss of unit capacity at low temperature.
- Even cylinder head temperature.

Cause:

- Improperly torqued cylinder head bolts.
- Improperly positioned gasket at assembly.
- Warped cylinder head
- Severe liquid refrigerant floodback.

Blown Valve Plate Gaskets

Symptom:

- Loss of unit capacity at medium and low temperatures.
- Very hot cylinder head surface.
- Higher than normal suction pressure.

Cause:

- Improperly torqued cylinder head bolts.
- Severe liquid refrigerant floodback.
- Oil slugging caused by an overcharge of oil or flood starts.
- Discharge valves not seated properly (liquid drainback during shutdown) .

Broken Suction Valves

Symptom:

- Loss of unit capacity at all temperatures.

- Compressor unable to pull extremely low vacuum with suction service valve frontseated.

Cause:

- Repeated liquid refrigerant floodback.
- Flooded starts.
- Overcharge of oil.
- Discharge valves not seated properly (liquid drainback during shutdown).
- Expansion valve not controlling properly.

Unloader Valve Stuck Open

Symptom:

- Loss of unit capacity at all temperatures.
- Higher than normal suction pressure.
- Even cylinder head temperature.

Cause:

- Unloader body stem bent.
- Foreign material binding unloader piston or plunger.

10.2 Magnetic Clutch

Refer to Carrier service information entitled *"Housing-Mounted Electric Clutch"* at the end of this section for the description and maintenance of the magnetic clutch.

10.2.1 Time Delay Module

A time delay module integrated in the HVAC logic module is connected in series with the relay coil feeder circuit of the compressor magnetic clutch. This module allows approximately one minute delay following a compressor clutch request and its actual application, to avoid continuous engaging and disengaging (cycling) of clutch.
This time delay will be effective each time A/C system is actuated (Main A/C-Heating Switch), or upon restarting of compressor, when the latter has previously stopped due to an excessive high pressure (over 320 psi [2206,4 kPa]) or very low pressure (under 15 psi [103,5 kPa]) in the system.

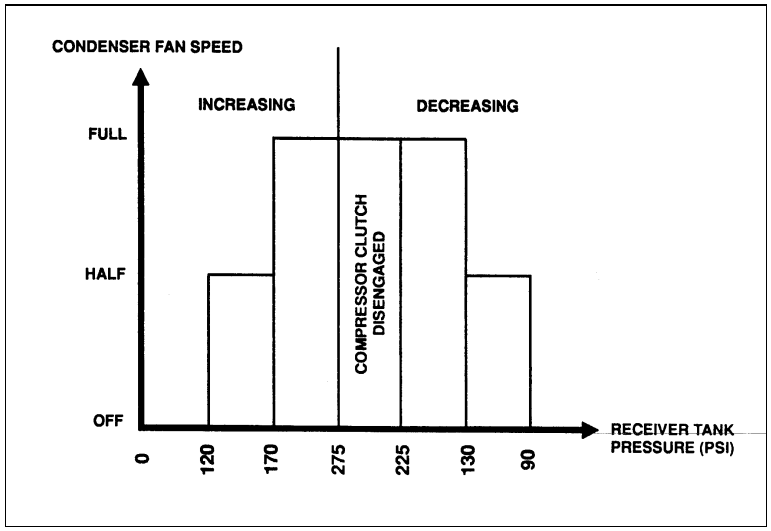
However, a time delay will be inoperative and restarting of the compressor will be immediate following a regulated interruption by the system, i.e. when temperature inside the coach is equal to the selected temperature.

10.3 Condenser

The condenser coil is hinge mounted on the R.H. side of the vehicle on the A/C condenser door. Since condenser's purpose is to dissipate heat from the hot refrigerant, it is important to keep the cooling coils and fins clean. A clogged coil will cause high discharge pressure and insufficient cooling.

10.3.1 Condenser Fan Motors

Two axial fan motors are installed in condenser compartment on R.H. side of vehicle in order to ventilate the condenser coil. The fans pull outside air through the condenser coil and discharge it through an opening at bottom of compartment. Depending on pressure in receiver tank (Fig. 22), the fan motors may be operated at full rpm, half rpm or not operated at all. With low pressure in receiver tank, both fan motors are connected in series and then operate at half rpm and, with a high pressure in receiver tank, both fan motors are connected in parallel and operate at full rpm. For details about electrical wiring, refer to *"A/C and Heat system"* in the master wiring diagram.



22041

FIGURE 22: CONDENSER FAN SPEED IN RELATION WITH RECEIVER TANK PRESSURE

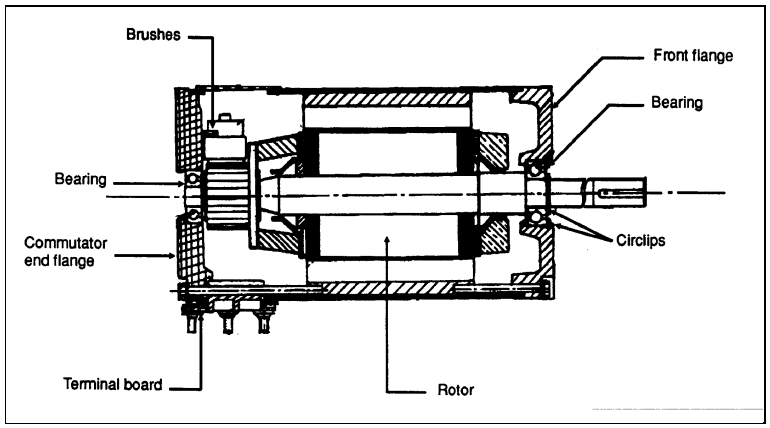


FIGURE 23: CONDENSER FAN MOTOR 22042

10.3.2 Condenser Fan Motor Removal

1. Set the main battery disconnect switch to the *"Off"* position.
2. Remove the two *"Phillips"* head screws retaining the fan motor protective cover to the square tubing.
3. Disconnect wiring from terminals on motor. Tag each wire to aid in identification at time of reconnection.
4. Support motor, and remove bolts which attach motor to mounting bracket. Remove the motor.

10.3.3 Preliminary Disassembly

1. Remove the brushes.
2. Unscrew the flange retaining screws on the shaft end side (opposite to the commutator end frame), and separate flange from frame (Fig. 23).
3. Remove flange and rotor assembly by pushing bearing shaft toward the commutator end frame.
4. Separate flange from rotor.

10.3.4 Disassembly

1. Perform preliminary disassembly.

2. Carefully note the position of the brush holder ring and the connections on the flange support.

3. Unscrew and remove the flange on the commutator end frame.

4. Remove the brush holder ring.

5. Finally, separate the following parts: brush holders, brush boxes, terminal board, bearings, etc...

10.4 Receiver tank

The receiver tank is located in the A/C condenser compartment (Fig. 24). The function of the receiver tank is to store the liquid refrigerant. During normal operation, the level of the refrigerant should be approximately at the midpoint of the lower sight glass.

In case of an extreme pressure there will be a rise in the liquid receiver tank. A pressure relief valve will break at 450 psi (3103 kPa) and relieve the receiver tank pressure.
The receiver tank incorporates an inlet valve on the inlet side (upper section) which allows the tank to be isolated or serviced. An outlet valve on the outlet side (lower section) permits complete isolation from the rest of the system.

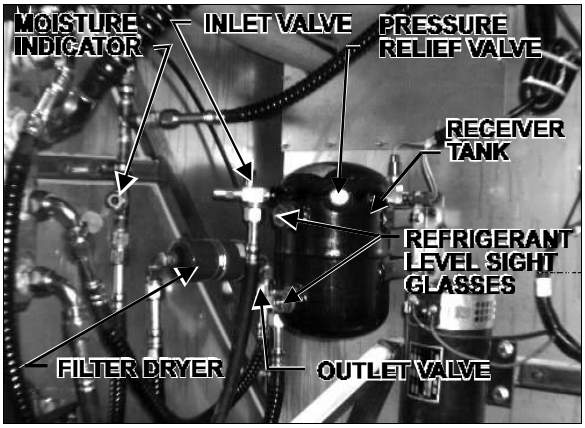


FIGURE 24: A/C CONDENSER COMPARTMENT 22043

10.5 Filter Dryer

10.5.1 Description

A filter dryer, also located in the A/C condenser compartment, is installed on the liquid refrigerant line (near the receiver tank). It is used to absorb moisture and foreign matter from refrigerant before it reaches the expansion valves.

The filter should be replaced if the system has been opened to prolonged exposure as shown by the moisture indicator sight glass.

10.5.2 Replacement

The filter is of the disposable type. When replacement is required, remove and discard the complete unit and replace with a new unit of the same type according to this procedure:

1. Isolate the refrigerant in the receiver tank by following the *"Pumping Down"* procedure stated previously.

2. Change the filter dryer as a unit.

3. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.

Caution: *Do not use carbon tetrachloride or similar solvents to clean parts. Do not use steam guns. Use mineral spirits or naphtha. All parts should be thoroughly cleaned. Use a stiff brush to wash dirt from grooves, holes, etc.*

Warning: *Cleaning products are flammable and may explode under certain conditions. Always handle in a well ventilated area.*

10.5.3 Moisture Indicator

The moisture sensitive element consists of a color changing ring which is reversible from pink to blue and vice versa as the moisture content in the refrigerant changes. Pink indicates a wet refrigerant, light violet (caution) and blue indicates a dry refrigerant.
Since temperature changes affect the solubility, color change will also vary with the refrigerant temperature. The following table shows the color change for R-134a at various moisture levels and liquid line refrigerant temperatures.

COLOR INDICATOR			
TEMPERATURE	BLUE (ppm)	LIGHT VIOLET (ppm)	PINK (ppm)
75°F (24°C)	Below 5	5-15	Above 15
100°F (38°C)	Below 10	10-30	Above 30
125°F (52°C)	Below 15	15-45	Above 45
p.p.m.= parts per million (moisture content)			

A moisture level of 15 p.p.m. for R-134a indicated in the blue color range of the above table is generally considered dry and safe. A color indication of light blue to light violet indicates the caution range of moisture level. For positive protection, the drying of the system should be continued until the color of the element turns to deep blue.
The liquid refrigerant is readily visible through the center opening of the moisture element where the presence of bubbles indicates a shortage of refrigerant or restriction in line.

Moisture is one of the main causes of chemical instability or contamination in air conditioning systems. If moisture is present, it can corrode the valves, condenser and evaporator coils, compressor and other components causing a malfunction and eventual failure of the system. Uncontrolled moisture in the system can result in very expensive multiple component replacements if not corrected at an early stage.
The moisture indicator permits an early detection of moisture in the system and when corrected by a desiccant charge, system contamination is greatly minimized.

10.6 Liquid Refrigerant Solenoid Valve

10.6.1 Description

The flow of liquid refrigerant to the driver's evaporator is controlled by a normally-closed solenoid valve located on the ceiling of the spare wheel and tire compartment and is accessible through the reclining bumper (Fig. 17).

10.6.2 Manual Bypass

This type of solenoid valve is equipped with a manual operating stem. The 3/16 inch square stem located on the bonnet is exposed when the seal cap is removed. To manually open valve, turn stem 1/2 turn counterclockwise. To manually close valve, turn stem clockwise until tight against seat. Manual stem must be in closed position for automatic electric operation.

10.6.3 Coil Replacement

1. Disconnect connector from the coil connector.

2. Take out the retaining screw at the top of the coil housing. The entire coil assembly can then be lifted off the enclosing tube.

3. Place the new coil and yoke assembly on the enclosing tube. Lay data identification plate in place.

4. Insert the coil retaining screw, rotate housing to proper position and tighten screw securely.

5. Connect connector from coil connector.

10.6.4 Valve Disassembly

1. Remove the coil as stated previously.

2. Pump down the system as stated earlier in this section.

3. Remove the four socket head screws which hold the body and bonnet together (Fig. 25).

4. Carefully lift off the bonnet assembly (upper part of the valve) so that plunger will not fall out. The diaphragm can now be lifted out.

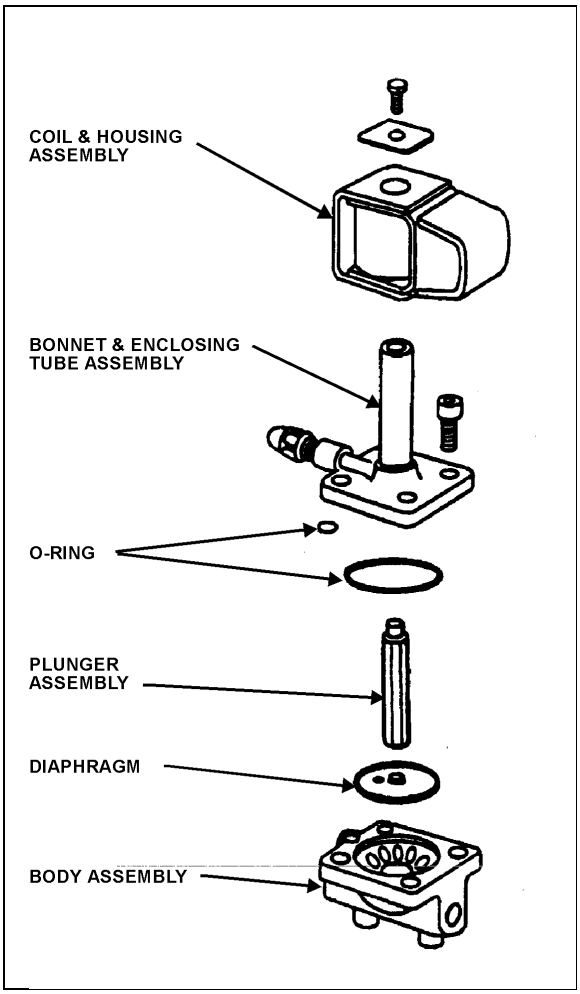


FIGURE 25: REFRIGERANT SOLENOID VALVE 22044

Note: *The above procedure must be followed before brazing solder-type bodies into the line.*

Caution: *Be careful not to damage the machined faces while the valve is apart.*

10.6.5 Valve Reassembly

1. Place the diaphragm in the body with the pilot port extension up.

2. Hold the plunger with the synthetic seat against the pilot port.

3. Make sure the bonnet O-rings are in place. Lower the bonnet assembly over the plunger, making sure that the locating sleeve in the bonnet enters the mating hole in the body.

4. Insert the four socket head screws and tighten evenly.

5. Replace the coil as stated previously.

6. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.

10.7 HUMIDISTAT

10.7.1 Description

This control, which is frequently used in houses, activates a humidifier in cases where the humidity rate of ambient air in the house is lower than the rate selected manually on the humidistat. The same control is used on this vehicle, with the exception that the inside ambient air of the vehicle must be dried when the humidity rate is too high. To do so, the signal transmitted by the humidistat is reversed by the use of the HVAC control module.

Air is dried by activating **Cooling contact 1** on the HVAC logic panel. Thus, the humidistat is a control which enables the bypass of the A/C system control to activate the A/C compressor. In practice, this means that when the heating system is operating, the A/C system can also operate simultaneously. A yellow LED mounted on the HVAC control module will be turned on to indicate a dehumidifying request (for location, refer to previous heading *"Humidistat Yellow LED"*). The humidistat is located in the HVAC compartment, in the center of the rear wall.

Air is dried by activating **Cooling contact 1** on the HVAC logic panel. Thus, the humidistat is a control which enables the bypass of the A/C system control to activate the A/C compressor. In practice, this means that when the heating system is operating, the A/C system can also operate simultaneously. A yellow LED mounted on the HVAC control module will be turned on to indicate a dehumidifying request (for location, refer to previous heading *"Humidistat Yellow LED"*). The humidistat is located in the HVAC compartment, in the center of the rear wall.

Note: Even if the dehumidifying function is requested, cooling contact 1 on the HVAC logic panel will not turn on as long as the ambient temperature inside the vehicle is over 4 F (2 C) from the selected temperature with "Main A/C - Heating Temperature" control.

10.7.2 Setting

As a reminder, the humidistat, which is mounted in center of rear wall of the HVAC compartment, should be set to 30%. This setting allows passengers to be comfortable and furthermore avoids unnecessary loading of A/C compressor.But, in areas where during transitional seasons, the temperature fluctates 23° and 50°F (-5° and 10°C) with a high degree of humidity, lower the the humidistat to 15% to prevent windshield fogging. Do not forget to reset humidistat to 30% once this period is over.

10.7.3 Checkout

1. Turn the control knob of the humidistat counterclockwise to the *"Off"* position.

2. Start engine, then switch on the *"Main A/C-Heating"* switch.

3. Turn the *"Main A/C - Heating Temperature"* control clockwise to its maximum heating position. The red LED located on the lower console should illuminate to indicate operation of the heating system.

4. Then, **slowly** turn the *"Main A/C - Heating Temperature"* control counterclockwise until the green LED located on the lower console also illuminates (red LED should remain illuminated) to indicate the dehumidifying request.

5. Turn the control knob of the humidistat to its maximum clockwise position; the green LED on the lower console should turn off.

6. Reset humidistat control.

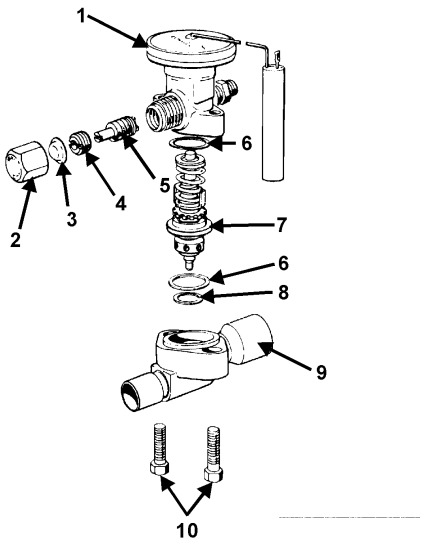
10.7.4 Maintenance

Do not apply oil to any part of the humidistat. To Ensure trouble-free performance, the nylon element should be inspected periodically. Dirt and grease will not damage the element, but may reduce its sensitivity. If necessary, remove accumulated dust and dirt with a soft bristled brush.

10.8 Expansion Valve

10.8.1 Main System

The expansion valve for the main system is a thermo-sensitive valve with a remote control bulb head attached to the evaporator outlet line and is accessible by the evaporator filter access door (Fig. 17 and 26). The valve regulates the flow of refrigerant liquid into the evaporator coils and is controlled by the suction gas temperature leaving the evaporator. The bulb head senses the refrigerant gas temperature as it leaves the evaporator. High temperature will cause expansion and pressure on the power head and spring. Such action causes the assembly valve to open, allowing a flow of refrigerant liquid into the evaporator.



1. POWER ELEMENT
2. CAP-SEAL NUT
3. BONNET-SEAL (FLARE)
4. PACKING NUT
5. ADJUSTING STEM & PACKING ASSY
6. BODY FLANGE GASKET
7. CAGE ASSY
8. SEAT GASKET
9. BODY FLANGE
10. CAPSCREWS

FIGURE 26: EXPANSION VALVE 22045

The remote bulb and power assembly is a closed system. The pressure within the remote bulb and power assembly corresponds to the saturation pressure of the refrigerant temperature leaving the evaporator and moves the valve pin in the opening direction.

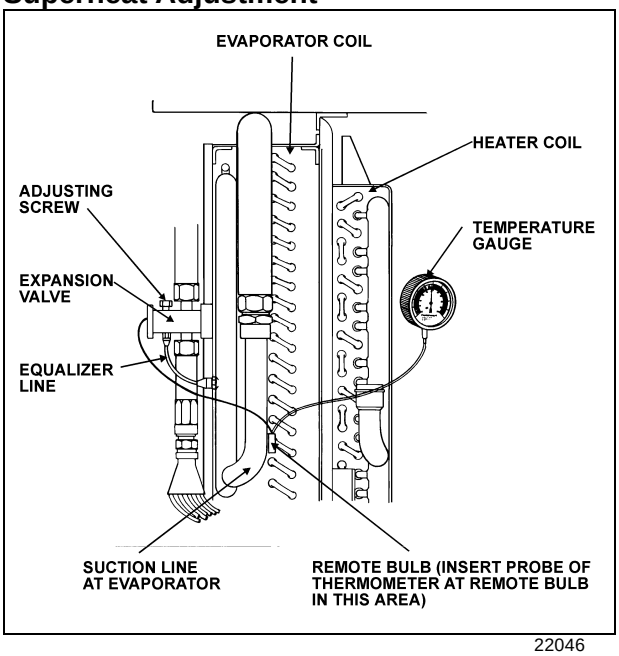
Opposed to this force, on the under side of the diaphragm and acting in the closing direction, is the force exerted by the superheat spring. As the temperature of the refrigerant gas at the evaporator outlet increases above the saturation temperature corresponding to the evaporator pressure, it becomes superheated. The pressure thus generated in the remote bulb and power assembly surpasses the combined pressures of the evaporator pressure and the superheat spring, causing the valve pin to move in the opening direction. Conversely, as the temperature of the refrigerant gas leaving the evaporator decreases, the pressure in the remote bulb and power assembly also decreases and the combined evaporator and spring pressures cause the valve pin to move in the closing position.

As the operating superheat is raised, the evaporator capacity decreases, since more of the evaporator surface is required to produce the superheat necessary to open the valve. It is obvious, then, that it is most important to adjust the operating superheat correctly and that a minimum change in superheat to move the valve pin to full open position, is of vital importance because it provides savings in both initial evaporator cost of operation. Accurate and sensitive control of the refrigerant liquid flowing to the evaporator is necessary to provide maximum evaporator capacity under load conditions. The spring is adjusted to give 8 to 12°F (-13,3 to -11,1°C) of superheat at the evaporator outlet. This ensures that the refrigerant leaving the evaporator is in a completely gaseous state when drawn into the suction side of the compressor. Liquid would damage the compressor valve, piston and heads if allowed to return in the suction line.

A vapor is said to be superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The amount of the superheat is, of course, the temperature increase above the saturation temperature at the existing pressure.

As the refrigerant moves along in the evaporator, the liquid boils off into a vapor and the amount of liquid decreases until all the liquid has evaporated due to the absorption of a quantity of heat from the surrounding atmosphere equal to the latent heat of vaporization of the refrigerant. The gas continues along in the evaporator and remains at the same pressure. However, its temperature increases due to the continued absorption of heat from the surrounding atmosphere. The degree to which the gas refrigerant is superheated is related to the amount of refrigerant being fed to the evaporator and the load to which the evaporator is exposed.

Superheat Adjustment



22046

FIGURE 27: SUPERHEAT ADJUSTMENT INSTALLATION

The easiest method of adjusting the superheat is to backseat the main evaporator expansion valve adjusting screw, and screw in 5-1/2 turns clockwise (refer to Fig. 27). If this method does not provide an accurate superheat, the following procedure should be followed:

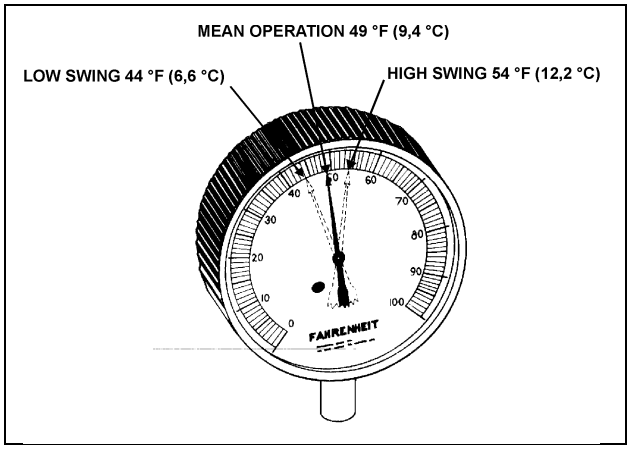
1. Operate coach for at least one-half hour at fast idle with temperature control set at 82°F (27,7°C).

2. Install pressure gauge at the evaporator suction header.

3. Install a remote reading thermometer to the evaporator outlet line near the existing remote bulb (refer to Fig. 27).

4. Apply thermostatic tape around the bulb and evaporator outlet line to get a true reading of the line temperature.

5. Check approximately 5 readings of pressure at 2-minute intervals and convert to temperature using the temperature pressure (page 43). Likewise check the temperature reading at the remote bulb at the same 2-minute intervals and record the low and high swing readings of the needle (refer to Fig. 28).



22047

FIGURE 28: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB

EXAMPLE OF READINGS TAKEN (Fig. 28):

A/C pressure gauge converted to temperature at expansion valve fitting	Temperature on remote bulb	
40°F(4,4°C)	Low swing 44°F (6,6°C)	High swing 54°F (12,2°C)
Formula for superheat 49°F-40°F=9°F (9,4°C-4,4°C=5°C)	Average of low and high swing is 49°F (9,4°C)	

Note: *The low swing of the superheat should be a minimum of 4 F (2,2 C) higher at the remote bulb and have an average of 8 to 12 F (4 to 6 C) higher range at the bulb than the fitting at the expansion valve.*

Note: *To lower evaporator temperature or reduce the superheat, flow of refrigerant is increased by turning adjusting screw of expansion valve counterclockwise. To increase temperature or increase superheat, flow of refrigerant is reduced by turning adjustment screw of expansion valve clockwise.*

6. Regulate suction pressure to temperature reading according to temperature chart or to the 134a temperature scale on the pressure gauge.

Example: Suction pressure 30 psi (207 kPa) converted to 32°F (0°C) on chart. If temperature reading is 40°F (4,4°C), subtract 32°F (0°C) and the result will be 8°F (4,4°C) of superheat.

Caution: *Before proceeding to the expansion valve adjustment, check for restriction on suction side for plugged filter dryer and partially open valves. These conditions will give a high superheat.*

Maintenance

1. Pump down the system as previously indicated in this section.

2. Disconnect the external equalizer line from the under side of the power head, and unclamp the remote control bulb from the evaporator coil outlet line.

3. Remove the two cap screws holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.

4. When reassembling, replace with the new gaskets in proper location. Make sure the two lugs on the cage assembly fit into grooves provided in the power assembly. Do not force the valves together. The cage must fit properly before tightening the body flange. Tighten bolts evenly.

5. Check for leaks.

Safety Intructions

1. Make sure the valve is installed with the flow arrow on the valve body corresponding to the flow direction through the piping system.

2. Before opening any system, make sure the pressure in the system is brought to and remains at the atmospheric pressure. Failure to comply may result in system damage and/or personal injury.

10.8.2 Driver's System

The function and operation of the expansion valve for the driver's system are similar to the main system, but no superheat adjustment is required (see fig. 17).

10.9 Torch Brazing

Use an electrode with 35% silver.

Caution: *When using heat near a valve, wrap with a water saturated rag to prevent overheating of vital parts.*

Warning: *Before welding any part of refrigeration system, make sure the area is well ventilated.*

10.10 Troubleshooting

10.10.1 Expansion Valve

PROBABLE CAUSE	PROBABLE REMEDY
LOW SUCTION PRESSURE-HIGH SUPERHEAT	
Expansion Valve Limiting Flow.	Adjust and/or test expansion valve.
Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of line flash and correct by use of any of the following methods. Add R-134a. Replace or clean filter dryer.
Inlet pressure too low from excessive vertical lift, undersize liquid line or excessive low condensing temperature. Resulting pressure difference across valve too small.	Increase head pressure. If liquid line is too small, replace with proper size.
Gas in liquid line due to pressure drop in line or insufficient refrigerant charge.	Locate cause of liquid line flash and correct by use of any of the following methods. Add R-134a. Replace or clean filter dryer. Check for proper line size.
Superheat adjustment too high.	Adjust superheat as outlined under "Superheat Adjustment".
Power assembly failure or partial loss of charge.	Replace power assembly or replace valve.
Air filter screen clogged.	Clean or replace air filter screen.
Plugged lines.	Clean, repair or replace lines.
Liquid line too small.	Install proper size liquid line.
Suction line too small.	Install proper size suction line.
LOW SUCTION PRESSURE-LOW SUPERHEAT	
Uneven or inadequate evaporator loading due to poor air distribution or liquid flow.	Balance evaporator load distribution by providing correct air or liquid distribution.
HIGH SUCTION PRESSURE-HIGH SUPERHEAT	
Compressor discharge valve leaking.	Replace or repair valve.
HIGH SUCTION PRESSURE-LOW SUPERHEAT (DEFECTIVE UNLOADER)	
Valve superheat setting too low.	Adjust superheat as outlined under "Superheat Adjustment".
Compressor discharge valves leaking.	Replace or repair discharge valve.
Incorrect superheat adjustment.	Superheat adjustment 8 to 12°F (4 to 6°C).

PROBABLE CAUSE	PROBABLE REMEDY
FLUCTUATING DISCHARGE PRESSURE	
Insufficient charge.	Add R-134a to system.
HIGH DISCHARGE PRESSURE	
Air or non-condensable gases in condenser.	Purge and recharge system.
Overcharge or refrigerant.	Bleed to proper charge.
Condenser dirty.	Clean condenser.
Insufficient cooling air distribution over air cooled condenser.	Properly locate condenser to freely dispel hot discharge air.

10.10.2 A/C

Use this A/C troubleshooting chart with paragraph "10.11 Temperature & Pressure".

TROUBLE	CAUSE
Low suction pressure and frosting at dryer outlet.	Clogged filter.
Low Oil Level.	Check for oil leaks and for leaking oil seal. Do not attempt to check oil level unless system has been stabilized at least 20 minutes.
Excessively cold suction line.	Loss of contact between the expansion valve bulb and the suction line or sticking of the expansion valve. Check for foreign matter and clean, repair or replace the valve.
Excessively cold suction line and noisy compressor.	Check superheat adjustment. Check remote bulb contact. Check expansion valve for sticking.
compressor squeaks or squeals when running.	Check oil level. Replace oil seal.
Noisy or knocking compressor.	Check for broken internal parts. Overhaul if required.
Compressor vibrates.	Check and tighten compressor mounting bolts.
Low refrigerant level	Check for refrigerant leaks and add refrigerant if required.
Suction pressure rises faster than 5 pounds per minute after shutdown.	Check compressor valve for breakage or damage.
Insufficient cooling.	Check for refrigerant leaks. Check condition of filter screens and motors.
Insufficient air flow.	Dirty or iced evaporator. Dirty air filter. Blowers inactive. Clogged ducts.
No flow of refrigerant through expansion valve.	Filter dryer is clogged. Remote bulb has lost charge or expansion valve is defective.
Expansion valve hisses. Bubbles in moisture and liquid indicator.	Gas in liquid line. Add refrigerant.

TROUBLE	CAUSE
Superheat too high.	Reset superheat adjustment. Check for clogged external equalizer line, or filter dryer.
Reduced air flow: a. Dirty or clogged air filter; b. Evaporator motor inoperative; or c. Plugged return air ducts.	Dirty or iced evaporator coil. Clean air filter screen. Check return ducts for obstructions. Check blower motor.
Frequent startings and stoppings on low pressure control switch.	Lack of refrigerant. Check for leaks. Recharge.
Compressor intermittently starts and stops.	Intermittent contact in electrical control circuit. Compressor valves not in operating position.
Non-condensable in the refrigeration system.	Leak on system, system in vacuum in low temp.. Specific symptom, pressure in system will not correspond to ambient temperature on shutdown. Only non-condensable will cause this. (Example: Pressure of idle R-134a system in 80°F (26,6°C) room should be 86.4 psi (595.7 kPa). See temperature chart in this section.) An evaporator just does a proper cooling job without sufficient air. Shortage of air can be caused by the following: • Dirty filters; or • Dirty coils.

Testing condenser pressure.

***Note*:** *R-134A pressure is function of the temperature variation.*

Example, for an exterior temperature of 100°F.
Exterior temperature (100°F) + 30°F = 130°F. Refer to paragraph "10.11 Temperature & Pressure".
Note the corresponding pressure for a temperature of 130°F, 199.8 psi.
Read the condenser pressure, example 171.9 psi.
171.9 psi ‹ 199.8 psi, the pressure in the condenser is inferior to the pressure corresponding to the exterior temperature, then condenser pressure may be to low. Check for refrigerant leaks and add refrigerant if necessary. If the pressure corresponding to the condenser temperature is superior to the pressure corresponding to the exterior temperature, then air cooled condenser pressure may be to high. Most frequent causes are:

Reduced air quantity. This may be due to:

- Non-condensable in system;
- Dirt on the coil;
- Restricted air inlet or outlet;
- Dirty fan blades;
- Incorrect rotation of fan;
- Fan speed too low;
- Fan motor going out on overload; or
- Prevailing winds.
- Too much refrigerant in system. Remove refrigerant if necessary.

10.11 Temperatures & Pressures

VAPOR-PRESSURE R134A			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
-100	-73.3	27.8	191.7
-90	-67.8	26.9	185.5
-80	-62.2	25.6	176.5
VAPOR-PRESSURE			
TEMPERATURE		**PRESSURE**	
°F	**°C**	**psi**	**kPa**
-70	-56.7	23.8	164.1
-60	-51.1	21.5	148.2
-50	-45.6	18.5	127.6
-40	-40.0	14.7	101.4
-30	-34.4	9.8	67.6
-20	-29	3.8	26.2
-10	-23	1.8	12.4
0	-18	6.3	43.4
10	-12	11.6	80
20	-7	18.0	124.1
30	-1	25.6	176.5
40	4	34.5	237.9
50	10	44.9	309.6
60	16	56.9	392.3
70	21.1	70.7	487.5
80	27	86.4	595.7
90	32.2	104.2	718.5
100	38	124.3	857.0
110	43.3	146.8	1012.2
120	49	171.9	1185.3
130	54.4	199.8	1377.6
140	60	230.5	1589.3
150	65.6	264.4	1823.0
160	71	301.5	2078.8
170	76.7	342.0	2358.1
180	82.2	385.9	2660.8
190	87.8	433.6	2989.7
200	93.3	485.0	3344.1
210	98.9	540.3	3725.4

10.12 Leak Testing

Some methods such as nitrogen pressure and soap, and electronic sniffer can be used for leak testing. However, the most common method used is a "Halide" torch consisting of an acetylene tank, a burner and a suction test hose. Proceed as follows:

Warning: *Do not inhale fumes from leak detector.*

The flow of acetylene to the burner causes a suction in the test line. Any gas refrigerant present will be drawn through the hose and into the burner where it decomposes into free acids.

These acids come in contact with the hot copper reaction plate in the burner, causing color reaction in the flame. A small concentration is indicated by a green tint and a large concentration by an intense blue. Do not confuse this change in color with the change caused by shutting off the air supply through the hose by holding the end too close to an object.

The procedure for testing is:

1. Adjust flame so that the top of the cone is approximately level or within one-half inch above the plate.

2. Probe end of suction test tube around all joints, valves, etc. When a leak has been found at a soldered joint, that section of the system must be pumped down. Do not solder as pressure will force hot solder out. If the system is empty, it is more economical to put in just enough R-134a to produce about 15 psi (103 kPa). The pressure can be raised to about 150 psi (1034 kPa) with dry nitrogen.

Note: *This gas is put into the suction and discharge shutoff valves at the compressor. The receiver valves must be opened. If no leaks are found, dump this mixture, evacuate the system and fill with refrigerant.*

11. HEATING SYSTEM

11.1 Description

The schematic of Figure 29 shows the heating system and its components.

In addition to the normal heating provided by the engine, an optional preheating system (40,000 Btu/hr or 80,000 Btu/hr) may have been installed in the rear electric compartment.

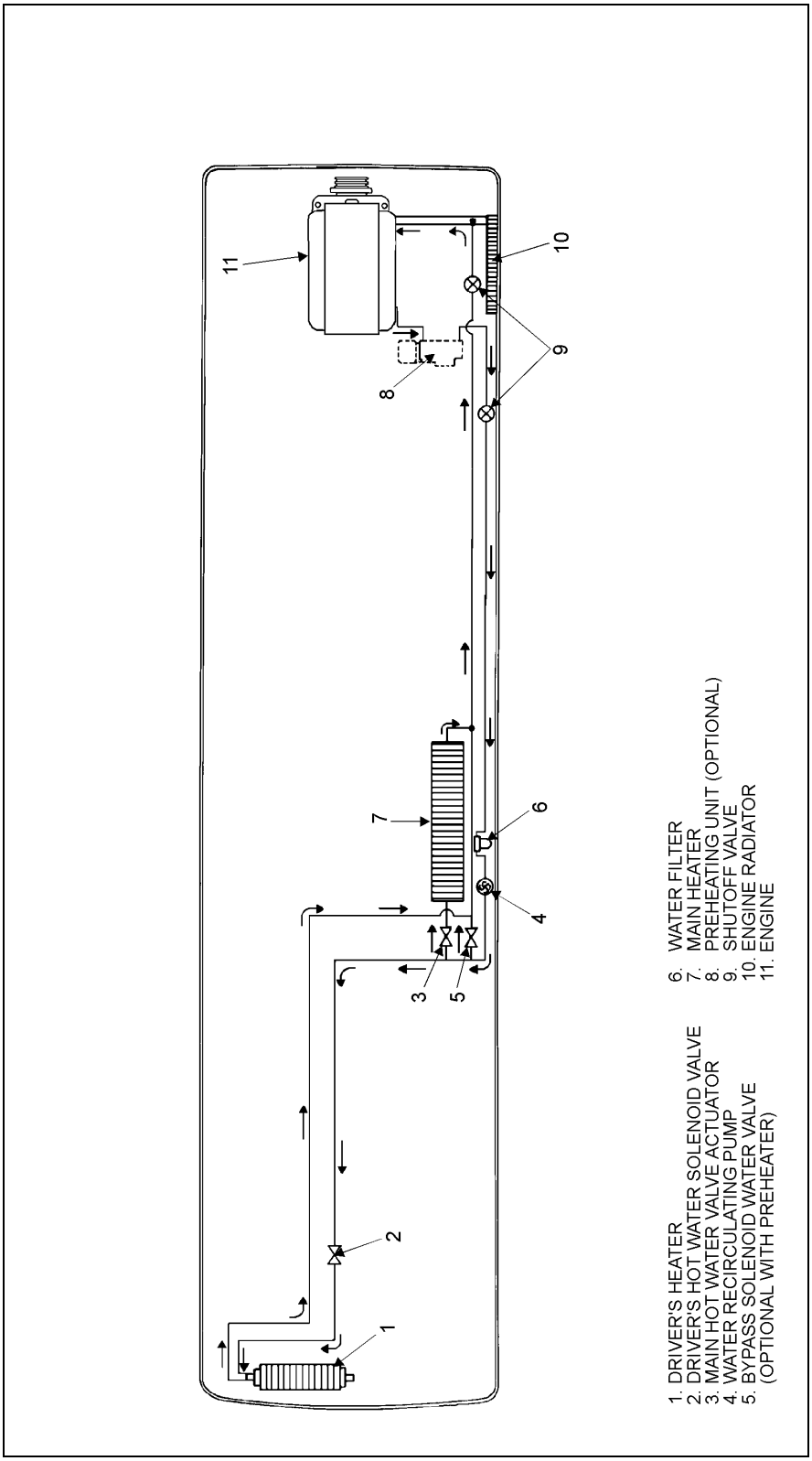


FIGURE 29: HEATING SYSTEM COMPONENTS 22048

11.2 Draining Heating System

To drain the entire system, refer to Section 05, *"Cooling"*. If only the driver's or main heater core must be drained, refer to the following instructions.

11.2.1 Driver's Heater Core

1. Stop engine and allow engine coolant to cool.

2. Locate the normally open water solenoid valve on the ceiling of the spare wheel compartment (Fig. 30), disconnect its wiring connector, then connect a 24-volt external power source, using jumper cables, to close valve.

Warning: *Before proceeding with the following steps, check that coolant has cooled down.*

3. Loosen hose clamp, install an appropriate container to recover coolant, and disconnect silicone hose from water solenoid valve.

4. From inside of vehicle, open the manual vent on the coolant inlet line near the driver's unit (Fig. 31) to ensure an efficient draining.

22049

FIGURE 30: CEILING OF THE SPARE WHEEL COMPARTMENT

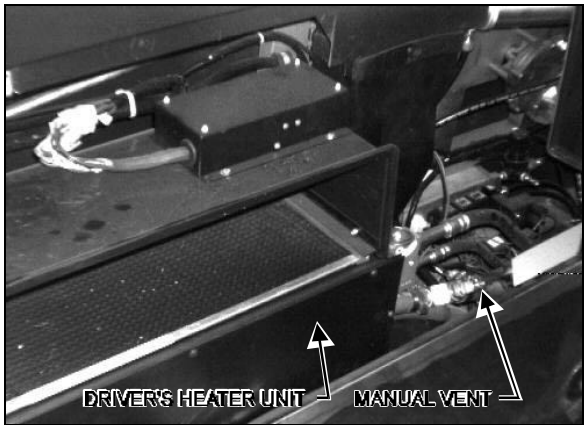


FIGURE 31: DRIVER'S HVAC UNIT 22050

11.2.2 Main Heater Core

1. Stop engine and allow engine coolant to cool.

2. Close both heater line shutoff valves. One is located in the engine compartment under the radiator fan gearbox, while the other one is located in the L.H. rear electric compartment near the preheater. Refer to 12.6 Preheater System of this section to gain access to the heater line shutoff valve.

3. Open the last L.H. side baggage compartment door, then pull the black release button located on the L.H. side in order to unlock and open the HVAC compartment door.

Warning: *Before proceeding with the following step, check that coolant has cooled down.*

4. Open drain cock in bottom of heater core, then open manual vent located on top of heater core (Fig. 32) in order to allow air to enter while draining.

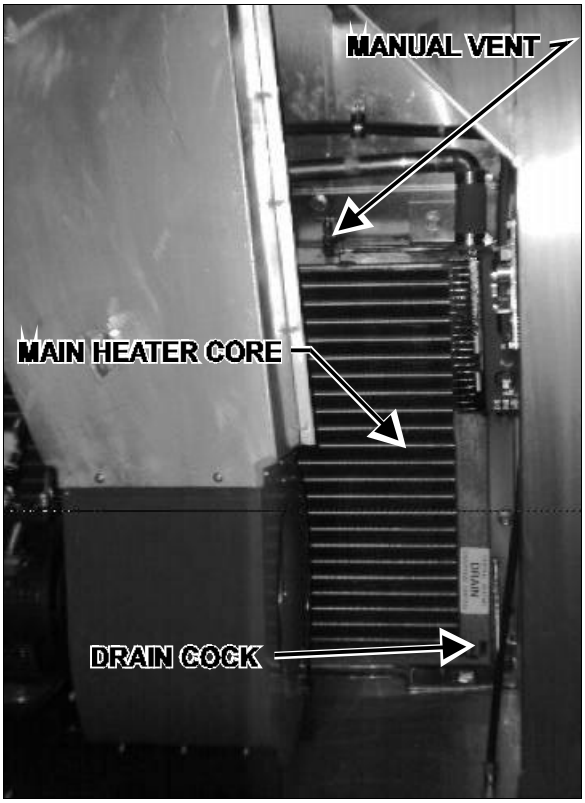


FIGURE 32: HVAC COMPARTMENT 22051

11.3 Filling Heating System

1. Ensure that the drain hose is reconnected and the manual vents and drain cock are closed.

2. Open the surge tank filler cap and slowly fill the system to level of filler neck.

3. After initial filling, the water valves should be open and the water recirculating pump should be energized to assist in circulating coolant through the heating system. To perform this operation, start the engine, switch on the *"Main A/C-Heating"* switch, and turn the *"Main and Driver's A/C-Heating Temperature"* controls clockwise to their maximum positions in order to request the heating mode in each of these sections.

4. When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.

5. Once the level has been stabilized, replace surge tank filler cap.

11.4 Bleeding Heating System

Whenever the heating system has been drained and refilled, or the system has run low on coolant and coolant has been added, it is necessary to bleed air from heating system. Locate the manual vents illustrated in Figures 31 and 32, and open them momentarily until no air escapes from the lines.

11.5 Soldering

Before soldering any part of the system, make sure the area is well ventilated. Use (stay clean) flux sparingly and apply solder (95-5 round wire 1/8 inch [3,1 mm]). After completing repairs, test for leaks.

When using heat at or near a valve, wrap with a water saturated rag to prevent overheating of vital parts.

12. HEATING SYSTEM COMPONENTS

12.1 Driver's Water valve

12.1.1 Description

A two-way normally open, internal pilot-operated solenoid valve designed for smooth closing is used to control the coolant flow through the driver's heating unit. It is mounted on the coolant inlet line of the driver's heating unit, and is accessible through the spare wheel compartment (see fig. 29). The valve cannot be manually bypassed.

12.1.2 Improper Operation

1. Faulty control circuit: Check the electric system by energizing the solenoid. A metallic clicking noise indicates that the solenoid is operating. Absence of clicking indicates a loss of power or a defective solenoid. Check for open breaker, open-circuited or grounded coil, broken lead wires.

2. Burned-out coil: Check for open-circuited coil. Replace coil if necessary.

3. Low voltage: Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.

4. Excessive leakage: Disassemble valve and clean all parts. Replace worn or damaged parts with a complete spare part kit for best results.

12.1.3 Coil Replacement

Turn off electrical power supply and disconnect lead wires. Proceed in the following manner:

1. Remove retaining cap or clip, spacer, name plate and housing.

2. Slip spring washer, insulating washer, coil and insulating washer off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.

3. Coil is now accessible for replacement. Reassemble by reversing sequence of disassembly. Refer to exploded view (Fig. 33) for identification and location of parts.

Note: *Solenoid must be completely reassembled, as the housing and internal parts complete the magnetic circuit.*

Caution: *When metal retaining clip disengages, it will spring upwards.*

12.1.4 Valve Disassembly

1. Drain driver's heating unit as previously explained in this section under paragraph *"Draining Heating System"*.

2. Disconnect connector from coil connector.

3. Disassemble valve in an orderly fashion paying careful attention to exploded view (Fig. 33) provided for identification of parts.

4. Remove retaining cap and slip the entire solenoid enclosure off the solenoid base subassembly.

Caution: *When metal retaining clip disengages, it will spring upwards.*

5. Unscrew solenoid base sub-assembly and remove core, plugnut gasket, plugnut assembly and solenoid base gasket.

6. Remove the four bonnet screws and valve bonnet, disc holder subassembly, disc holder spring, diaphragm/spring subassembly and body gasket.

7. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete spare part kit for best results.

Caution: *Do not damage valve seat in any manner, as its sealing feature will be affected, thus resulting in continuous leakage.*

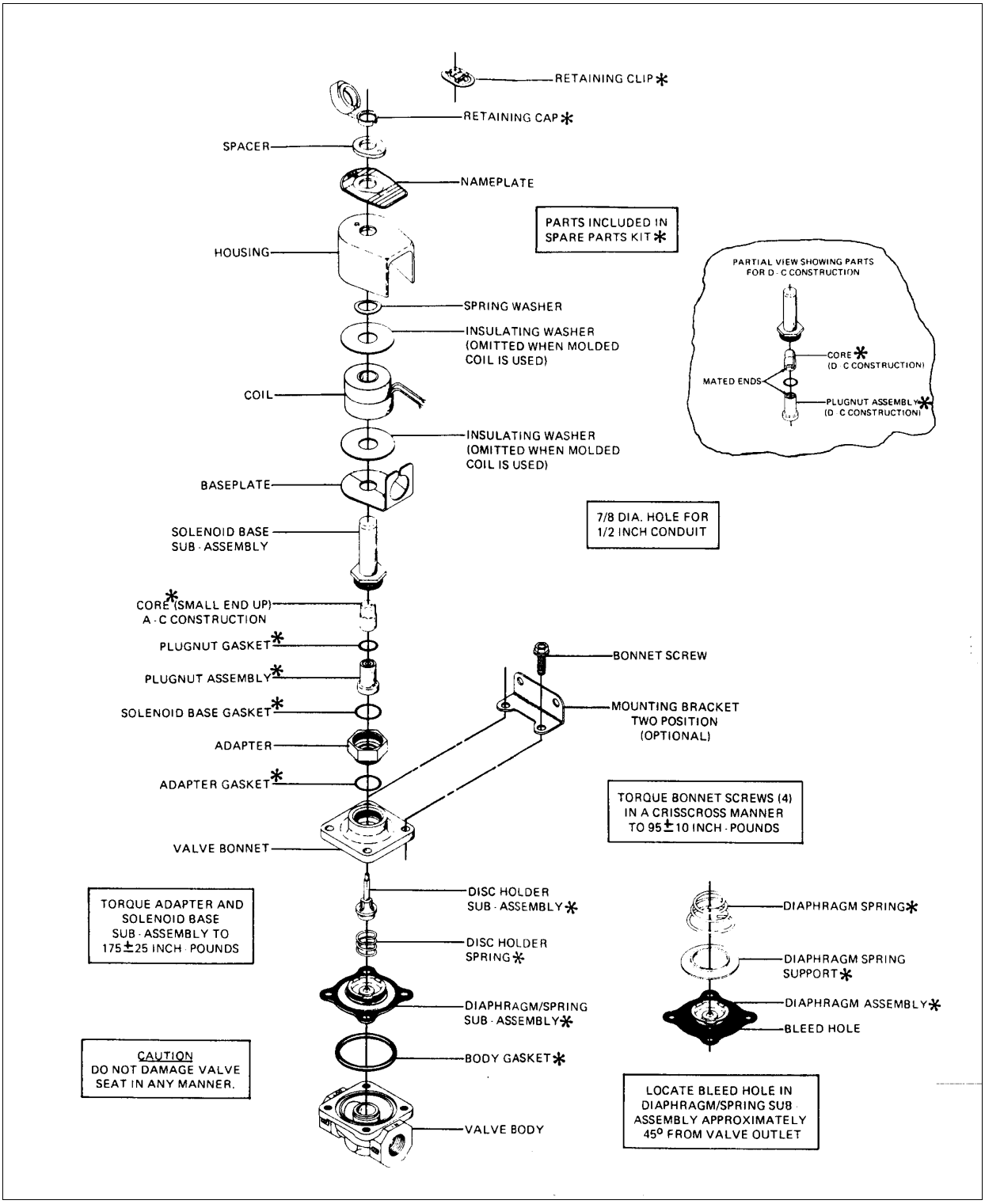


FIGURE 33: DRIVER'S WATER SOLENOID VALVE 22052

12.1.5 Valve Reassembly

1. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts (Fig. 33).

2. Replace body gasket and diaphragm/spring subassembly. Locate bleed hole in diaphragm/spring subassembly approximately 45° from valve outlet.

3. Replace disc holder spring and holder subassembly.

4. Replace valve bonnet screws. Torque bonnet screws in a criss-cross manner to 95 ± 10 inch-pounds.

5. Install solenoid base gasket, plugnut assembly and plugnut gasket. Position core (small end up for A-C construction) on plugnut assembly. For D-C construction, be sure plugnut assembly and core are installed with mated ends together.

6. Replace solenoid base subassembly and torque to 175 ± 25 inch-pounds.

7. Replace solenoid enclosure and retaining cap or clip. Reconnect the coil connector.

8. Refill heating system as previously stated under paragraph *"Filling Heating System"*, then bleed air from the driver's heating unit as stated previously under paragraph *"Bleeding heating system*

9. After maintenance, operate the valve a few times to be sure of proper opening and closing.

Note: *Should diaphragm/spring subassembly become disassembled, be sure to replace the diaphragm/spring support with lip facing upward towards the valve bonnet.*

12.2 Main Hot Water Solenoid Valve Actuator

12.2.1 Description

The flow of hot water to the vehicle main heater core is controlled by an electric water valve. The valve is located in the HVAC compartment (Fig. 29 and 34). This valve is self-adjusting and linear motorized.

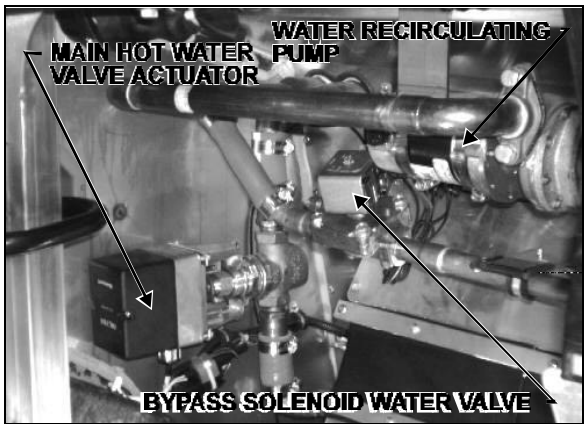


FIGURE 34: HVAC COMPARTMENT 22053

If leakage occurs after several years of operation, check stem and seat for wear. If either is worn, completely rebuild the valve, replacing all parts subject to wear. This normally includes replacing packing, stem, disc, internal springs, seats or seat rings, O-rings, and gaskets as applicable to the valve being rebuilt.

Any valve with a stem in good condition may be repacked without further repair. It is not necessary to remove the bonnet to repack the valve. Great care should be taken not to damage the valve stem or cause leakage after the packing is installed.

After repairing, use pipe sealing compound or tape on bonnet threads and threaded piping connections. Restore hot water pressure to test for leaks before reinstalling actuator. Remember that pressure forces the valve open during testing when actuator is off. Reinstall the actuator and check operation to be certain valve closes completely against normal operating pressures.

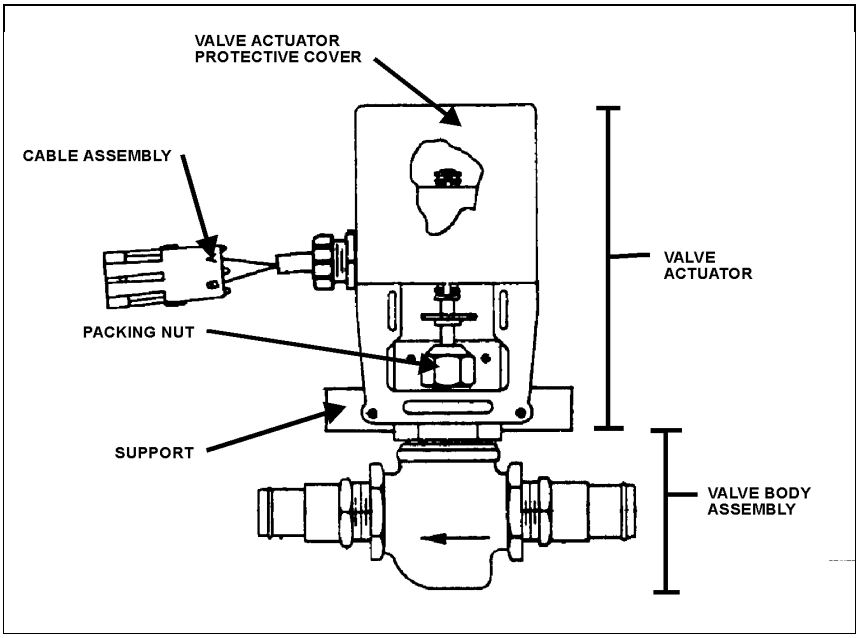


FIGURE 35: MAIN HOT WATER SOLENOID VALVE 22054

12.2.2 Valve Actuator Removal (Figure 35)

1. Stop engine and allow coolant to cool.

2. Close shutoff valve on the line located in the rear electric compartment to relieve water pressure from system. Refer to 12.6 Preheater System of this section to gain access to the heater line shutoff valve.

3. Disconnect cables and the fresh air sensor. Remove the main hot water solenoid valve actuator from the line by removing connectors at pipe outlets and removing screws on the support.

4. Remove the two screws retaining the valve actuator protective cover.

5. Remove the four screws retaining the collar.

6. Remove the stem botton.

7. Remove the actuator valve.

12.2.3 Valve Repacking

1. Hold stem by inserting a 1/16 inch diameter rod or nail in hole near the top of the stem. Unscrew the stem button. Do not tamper with the top locking set screw in stem button.

2. Remove packing nut, old packing, packing follower, and spring. Install new spring and packing follower. Use a small amount of lubricant Amoco H-100 and thread new packing very carefully over the stem with concave side down for 250 psi (1724 kPa) rubber packing.

3. Reinstall packing nut by pushing down to compressed spring until threads engage, and tighten until snug. Be certain the valve stem moves up and down. Reinstall stem button, stem extension (if applicable), and actuator.

12.2.4 Valve Rebuilding

Follow disassembly procedures as applicable. Replace all parts subject to wear and damage. Reassemble in reverse order using new parts.

Note: *Run down all bonnet cap screws until fingertight, and proceed to torque down evenly using a reduced torque. Space successive tightening at 180 degrees, etc, until the bonnet raised face contacts the body on all sides. Then apply torque as specified.*

12.2.5 Disassembly Procedures

1. Relieve water pressure from system and remove actuator.

2. Hold stem by inserting a 1/16 inch diameter rod or nail in the hole near the top. Partially unscrew set screw inside the motor actuator. Do not tamper with locking set screw in the top of the stem buttom. Unscrew motor.

3. Remove packing nut and all parts down to the bonnet.

4. Remove stem and plug. Direct acting threaded body valves (Fig. 36). Unscrew the bonnet. Lift out the stem and disc holder assembly and the plug.

5. Disassemble stem and plug. Threaded body valves. Unscrew plug (Fig. 36) from stem to remove disc and spring. The disc may have to be pried from the disc holder with a screwdriver. The valves have a staked stem and disc holder assembly (Fig. 36). The stem and plug cannot be disassembled on some valves with metal-to-metal seats.

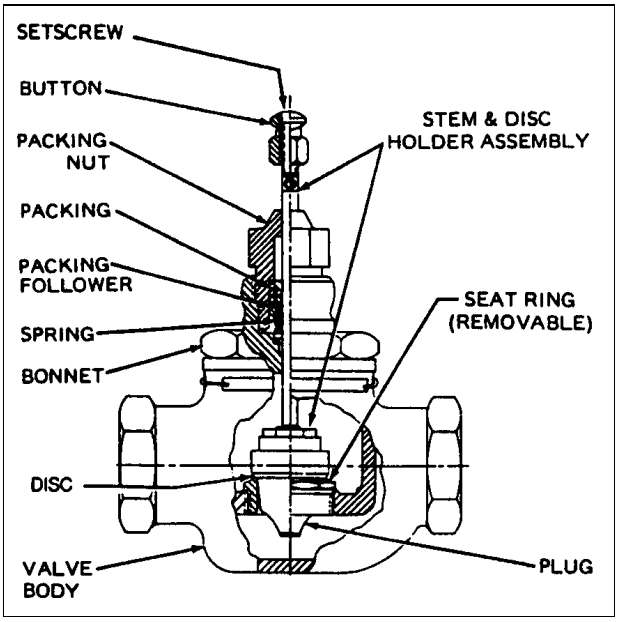


FIGURE 36: VALVE BODY ASSEMBLY 22055

12.2.6 Maintenance

Using solvent, remove all dirt and grease accumulation around the packing nut and stem.

Warning: *Permanent damage to respiratory system or skin tissue can result from careless handling of solvents. Special care should be exercised to avoid prolonged inhalation and/or contact with the skin.*

12.3 Water Recirculating Pump

12.3.1 Description

This vehicle is provided with a water recirculating pump which is located in the HVAC compartment. The water recirculating pump consists in a centrifugal pump and an electric motor which are mounted on a common shaft in a compact assembly.

The motor is equipped with prelubricated sealed ball bearings which require no maintenance. A self-adjusting mechanical shaft seal is incorporated in this assembly to prevent coolant leakage between the pump cavity and armature shaft. This seal derives its lubrication from the liquid pumped, and **it will be destroyed if permitted to operate dry.**

This pump requires no periodic maintenance other than replacement of motor brushes. Replacement of motor brushes can be performed without removing the pump assembly. Visual inspection of the pump should be made while the pump is in operation to determine if the shaft seal is intact. If there is evidence of coolant leakage, the unit must be disassembled for corrective measures. Disassembly of the pump will be necessary only in the case of a seal leak, bearing failure, or motor failure.

12.3.2 Removal

1. Stop engine and allow engine coolant to cool.

2. Close shutoff valve on the line located in the rear electric compartment. Refer to 12.6 Preheater System of this section to gain access to the heater line shutoff valve.

3. Disconnect the electrical wiring from the motor.

Warning: *Before proceeding with the following steps, check that coolant has cooled down.*

4. Remove the drain plug at the bottom of the pump and place a container to recover the residual coolant in the line.

5. Disconnect water lines from the pump at the flange connections.

6. Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

12.3.3 Disassembly (Refer to Fig. 37, Water Recirculating Pump and Motor)

1. Remove two brush caps (16, Fig. 37) and two brush assemblies (15, Fig. 37). When removing brushes, note the position of the brush in the tube. Brush life is significantly decreased if brushes are not replaced properly.

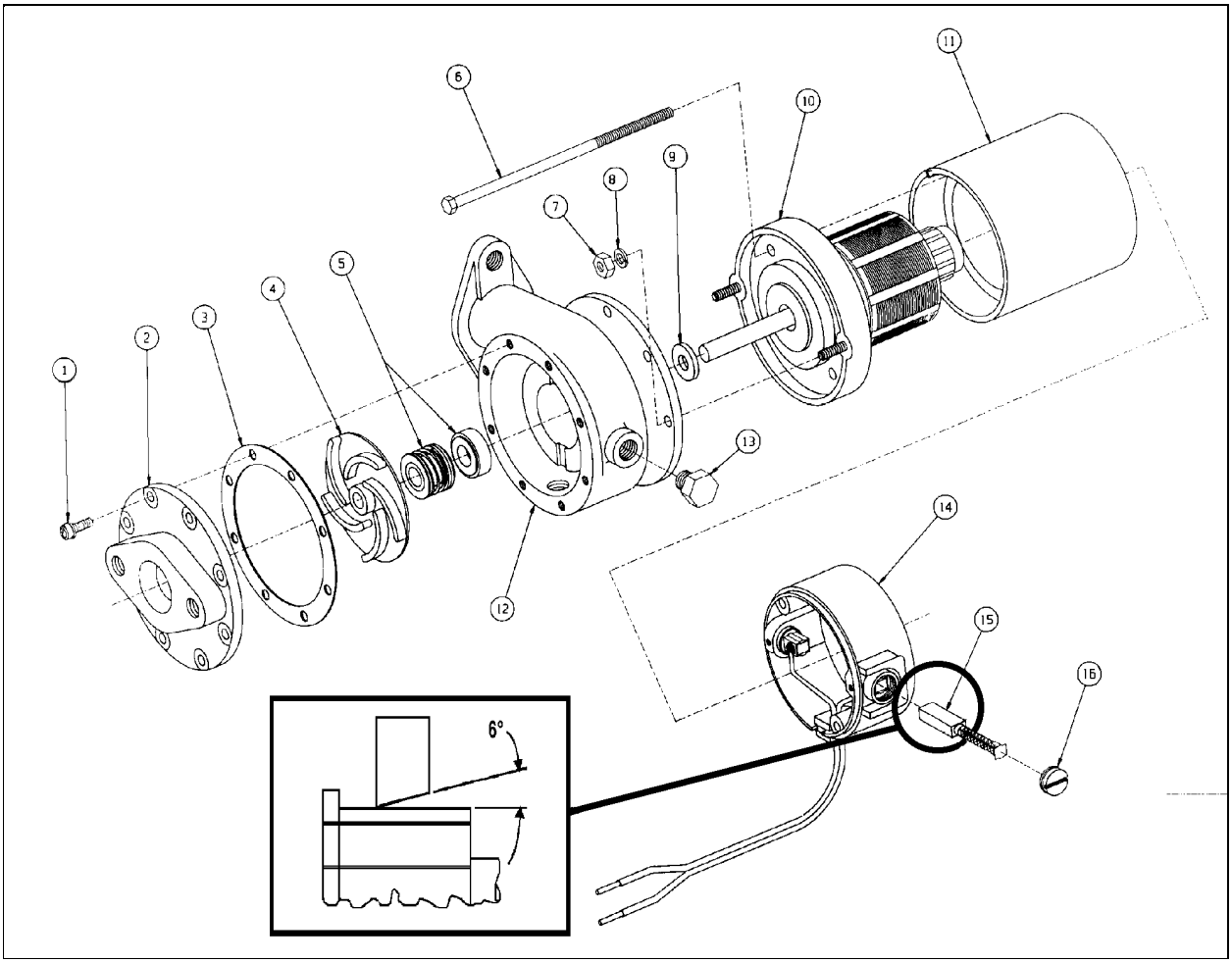


FIGURE 37: WATER RECIRCULATING PUMP

22056

2. Remove the pump cover (2, Fig. 37) by removing eight head screws. Remove cover carefully to prevent damage to gasket (3, Fig. 37).

3. Remove gasket (3, Fig. 37).

4. Remove two hex nuts and lock washers which hold pump assembly to the motor.

5. Remove the pump from the motor as follows:

a. Install puller tool assembly (MP Co. Part No. 24702 or equivalent) to pump body (12) using four screws removed from the pump cover (2).

b. Tighten the puller screw to press the motor shaft out of the impeller hub. The pump is now free from the motor.

6. Remove the puller tool.

7. Remove impeller (4) and components of the pump seal assembly (5).

Caution: Do not scratch or mar the sealing surface of this seat, as its sealing feature will be affected, thus resulting in continuous leakage.

Inspection

Components removed from the recirculating pump and motor assembly should be compared with new parts to determine the degree of wear.

12.3.4 Brushes

1. When removing brushes, note the position of the brush in the tube. Brush life is shortened if the brushes are not replaced properly.

2. Examine brushes for the following:

   a. Wear

      Replace the brushes if less than 25% of the usable brush is left (less than 0.300 inch [8 mm]).

   b. Chipped edges

      Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of their length.

   c. Annealed brush spring

      This can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten the brush caps properly, thus not providing a good low resistance contact between the terminal and the brush tube. Replace brushes showing evidence of annealed springs.

   d. Frayed or broken pigtail

      An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring. If the pigtail is badly frayed or broken, replace the brush.

3. Observe the following factors when replacing brushes:

   a. The face of a new brush is carefully cut to cause proper seating during the *"wear-in"* period.

   b. Improper installation can harm both the brush and the commutator.

   c. Replacement brushes should be of the proper grade.

   d. New brushes have a six (6) degree angle. The brush should always be inserted so that the angle is open away from the pump end of the assembly (inset, Fig. 37).

   e. Brush performance will be affected if the spring and terminal are not properly placed in the brush tube. The spring should be free over its entire length and the terminal should make good contact with the metal brush tube insert.

12.3.5 Bearings (Fig. 37)

1. Rotate the motor shaft. If the ball bearings show evidence of wear, they should be replaced.

2. The use of a bearing puller is recommended when removing the bearings to help prevent damaging the armature winding or the commutator.

3. Replacement bearings should be pressed into the same exact location as the original bearings.

4. It is recommended that a suitable sealant (such as Loctite or equivalent) be used between the shaft and the bearing, if the fit is not tight enough to prevent the shaft from spinning inside the inner race.

6. After replacing the bearings, check the position of the commutator in the motor by looking down into the brush tube. Neither the riser nor the edge of the commutator should be visible.

12.3.6 Commutator

1. The commutator is a precise assembly. Although it is solidly built and made of a fairly tough material, it can be easily ruined by careless handling.

2. The commutator should be refinished only on equipment which provides good concentricity and the proper finish.
3. The commutator should be refinished if a micrometer reading shows a difference between *"in track"* and *"off track"* diameter of 0.187 inch (4,7 mm) or more.
4. The commutator should be carefully undercut with a 0.025 inch (0,6 mm) or less slot width.
5. A 25 to 50 micromesh finish is desirable on a new or refinished commutator.
6. The commutator should not be touched with the fingers since sweat and body oils will rapidly discolor and oxidize its surface.

12.3.7 Miscellaneous (Fig. 37)

1. Check the shaft slinger (9) to make sure it is tight on the motor shaft. If the slinger slips on the shaft, it should be replaced.
2. Inspect seal assemblies (5) to determine wear. If the seal has leaked, or is badly worn, it is recommended that a complete new seal assembly be installed.
3. The impeller (4) is a press fit on the armature shaft. This press fit must be maintained to prevent the impeller from slipping. Install a new impeller if necessary.

12.3.8 Assembly (Fig. 37)

1. Install slinger (9) on the motor shaft.
2. Assemble body (12) to the motor.
3. Install seal assy (5).
4. Install impeller (4) in the following manner:

a. Place the impeller on a flat surface with the vanes against the flat surface.

b. Invert the motor and pump body assembly, then pilot the pump shaft into the impeller bore. **DO NOT HAMMER** on the motor shaft extension at rear of motor.

c. Press on motor and pump body until the machined face of the pump body is flush with the face of the flat surface on which the impeller is resting. The face of the impeller vanes must now be flush with the machined face of the pump body.

5. Install gasket (3). This gasket serves both to seal the cover and to establish the proper clearance between the face of the impeller and the pump cover.
6. Attach cover (2) to the pump body using eight head screws (1).
7. Install motor brushes assembly (15) and brush caps (16).

12.3.9 Installation

1. Apply gasket cement to the pump body line adapter and to the line flanges, put the two gaskets in place, and connect water lines from the pump at the flange connections. Position the pump and motor assembly on the mounting bracket. Position the mounting clamps over the motor and secure with mounting bolts.
2. Apply pipe sealant on threads of drain plug, and screw it in place.
3. Connect electrical wiring to the pump motor.
4. Open shuttoff valve located in the rear electric compartment (near the preheater). Refer to 12.6 Preheater System of this section to gain access to the heater line shutoff valve.
5. Fill the cooling system as previously instructed in this section under *"Filling Heating System"*, then bleed the system as previously instructed in this section under *"Bleeding Heating System"*.

12.4 Water Filter

12.4.1 Description

This vehicle is provided with a cleanable water filter, which is located in the HVAC compartment (refer to Fig. 15 and 29(behind the right air duct)).

12.4.2 Maintenance

Filter maintenance consists in changing the element at break-in 3000 miles (4 800 km), and subsequently every 50,000 miles (80 000 km) or once a year, whichever comes first.

Note: *Each time soldering is performed on any water pipe of the heating system, operate heating system a few minutes so that any foreign matter will be routed to the filters. Clean filters.*

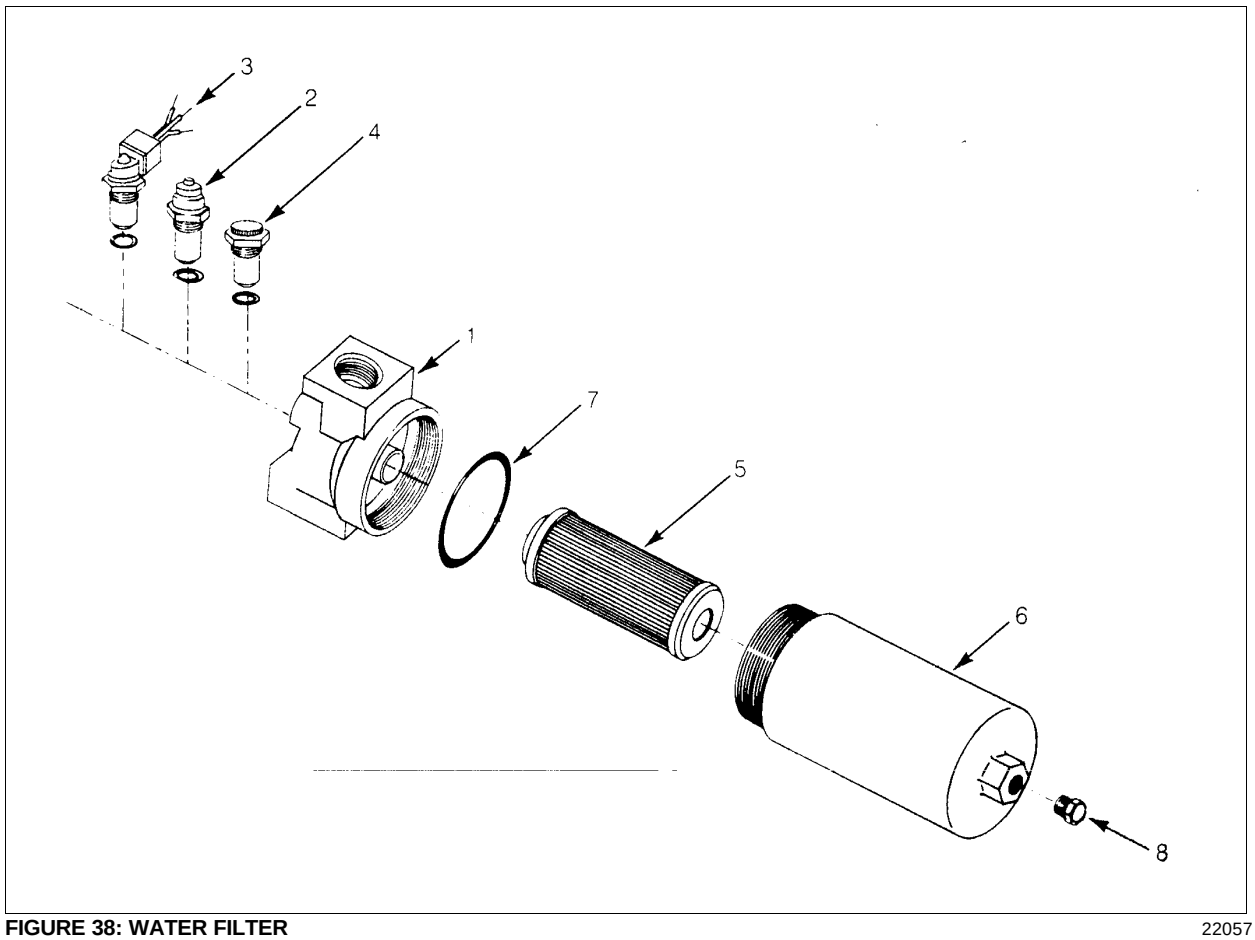


FIGURE 38: WATER FILTER 22057

12.4.3 Filter Servicing (Fig. 38)

1. Stop engine and allow engine coolant to cool.

2. Close shuttoff valve on the line located in the rear electric compartment. Refer to 12.6 Preheater System of this section to gain access to the heater line shutoff valve.

Warning: *Before proceeding with the following steps, check that coolant has cooled down.*

3. Rotate bowl (6) counterclockwise and remove.

4. Remove element (5) from housing. Discard all disposable elements. These elements are not cleanable.

5. Place new, clean element in housing, centering it on location in the head.

6. Inspect bowl seal and replace if necessary.

7. Replace bowl. Rotate clockwise and hand tighten.

8. Correct coolant level in surge tank as instructed previously in this section under *"Filling Heating System"*.

12.5 Bypass Solenoid Water Valve (Optional)

This valve is optional and is installed on the vehicle equipped with a preheater. The valve is located in the HVAC compartment (Fig. 29). This valve is similar to the driver' liquid solenoid valve. Refer to Fig. 33 for part names.

12.5.1 To Remove or Change the Coil

- Stop engine and allow engine coolant to cool.

- Close shuttoff valve on the line located in the rear electric compartment. Refer to 12.6 Preheater System of this section to gain access to the heater line shutoff valve.

To remove the solenoid coil:

First take out the retaining screw at the top of the coil housing. The entire coil assembly can be lifted off the enclosing tube.

To reassemble:

Make sure that the parts are placed on the enclosing tube in the following order:

1. Be sure to change electrical data plate according to coil specifications change.

2. Place coil and yoke assembly on the enclosing tube. Lay data identification plate in place.

3. Insert the coil retaining screw, rotate housing to proper position and tighten screw securely.

12.5.2 To Take the Valve Apart

To disassemble:

This valves may be taken apart by removing the socket head screws which hold the body and bonnet together. After removing the screws, carefully lift off the bonnet assembly (upper part of the valve). Don't drop the plunger. The diaphragm can now be lifted out. Be careful not to damage the machined faces while the valve is apart.

Note: *The above procedure must be followed before brazing solder type bodies into the line.*

To reassemble:

Place the diaphragm in the body with the pilot port extension up. Hold the plunger with the synthetic seat against the pilot port. Make sure the bonnet O-rings are in place, the bonnet assembly over the plunger, and that the locating sleeve in the bonnet enters the mating hole in the body. Insert body screws and tighten uniformly.

12.6 Preheating System (optional)

The preheater is located in the rear electric compartment. **To gain access to the pre-heater and the heater line shutoff valve.** Remove the preheater access panel screws. Remove the panel (Fig. 39).

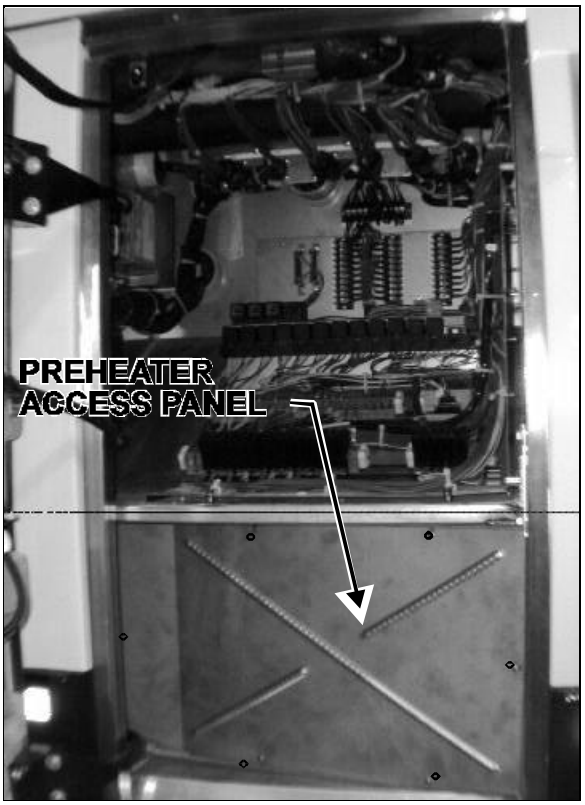


FIGURE 39: REAR ELECTRIC COMPARTMENT 22058

12.6.1 ESPAR (EBERSPÄCHER)

Description of Operations

This Auxiliary Preheating System is used for preheating and retaining the heat of water-cooled engines. It can be used before starting the engine to ease it's starting and to provide immediate inside heat upon operation of the heating system. It can also be used with engine running to maintain coolant heat and maintain the set temperature inside vehicle.

The heater operates independently from the vehicle engine. It is connected to the cooling and heating circuits, the fuel system and the electrical system of the vehicle.

The pilot lamp turns on when the heater is switched on. Combustion air flows in to flush out the combustion chamber and the water circulation pump is put into operation. The fuel metering pump conveys fuel in precise doses to the combustion chamber where fuel and combustion air form a combustible mixture which is ignited by the glow plug.

Once the flame sensor has signalled to the control unit that combustion has taken place correctly, the glow spark plug and ignition coil are switched off.

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger and transmit their heat to the water passing through the heat exchanger.

The heat is thermostatically controlled and operates intermittently, i.e. the switched-on times of the burner vary depending on the heat requirement. The water temperature depends on the setting of the built-in water thermostat.

The water circulation pump remains in operation as long as the heater is operating, even in the regulation intervals and during the delayed cutout of the switched-off heater. The pump can also be operated independently from the heater by means of an appropriate circuit.
The heater can be switched on at any time, even during the delayed cutout period. Ignition takes place once this delay time is over.

When the heater is switched off, the fuel supply is interrupted. The flame goes out, and at the same time a delayed cutout of some 2.5 minutes begins.
The combustion air still flowing flushes the remaining combustion gases out of the chamber and cools off the hot parts on the exhaust side of the heat exchanger, while the water circulation pump, still running, transmits the heat present in the heat exchanger, thus preventing local overheats. Once the delayed cutout time is over, both the combustion air blower and the water circulation pump switch off automatically. A cutout will take place in case of any failure of the preheater.

12.6.2 Webasto

Description of Operations

Switch on the heater. The operation indicator lamp comes on and the heater motor and circulating pump begin to run.

After about 10-25 seconds the solenoid valve opens and fuel is sprayed into the combustion chamber. At the same time, the electronic ignition unit produces high voltage (8000 V) and the mixture of fuel and air in the combustion chamber is ignited by the spark on the ignition electrodes.

The flame is indicated by the flame detector, then the electronic ignition unit stops producing high voltage and combustion continues by itself (spark on electrodes is required only to ignite the flame). At this moment, the heater is working and producing heat.

If the heater is switched off by the on/off switch, the solenoid valve interrupts fuel supply, combustion stops and indicator lamp turns off. Combustion air fan still blows air, cleaning the combustion chamber of any fumes and cooling down the combustion chamber. Coolant circulation pumps coolant, making a purge cycle for approximately 2-3 minutes, thus protecting the heater against overheating.

If the heater is not switched off by the on/off switch, the control thermostat will switch off the heater when coolant temperature reaches 165° ± 6°F (75° ± 3°C) and turns it on at 154° ± 9°F (68° ± 5°C). During this time, the heater (combustion) is off and the indication lamp and coolant pump are on. Combustion air fan blows air for 2-3 minutes and then turns off.

12.6.3 PREHEATING SYSTEM TIMERS (AUXILIARY) (Optional)

The timer, located on L.H. lateral is used to program the starting and stopping time of the preheating system. One of two optional Timers may be installed in your vehicle, Espar (41 000 BTU) (Fig. 40) or Webasto (80 000 BTU) (Fig. 41). The system indicator light, located on the dashboard, illuminates when the system is functional. The following offers system descriptions for both timers.

Caution: *The preheating system should not operate for more than one hour before starting engine as this could discharge batteries.*

Warning: *Preheating system must not operate when vehicle is parked inside or during fuel fill stops.*

Note: *Preheating system uses the same fuel as the engine.*

In case of failure:

1. Shut off and turn on again.
2. Check main circuit breaker and overheating switch (Espar) or overheat fuse (Webasto).
3. Have system repaired in a specialized shop.

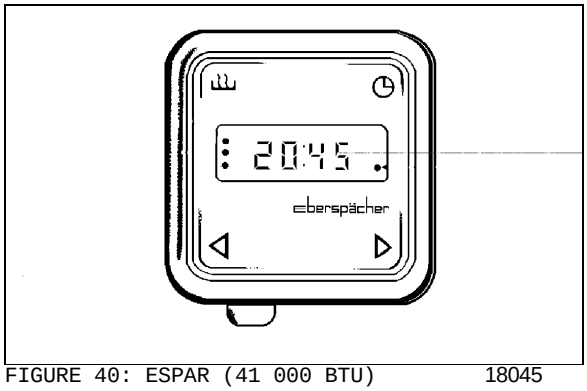


FIGURE 40: ESPAR (41 000 BTU) 18045

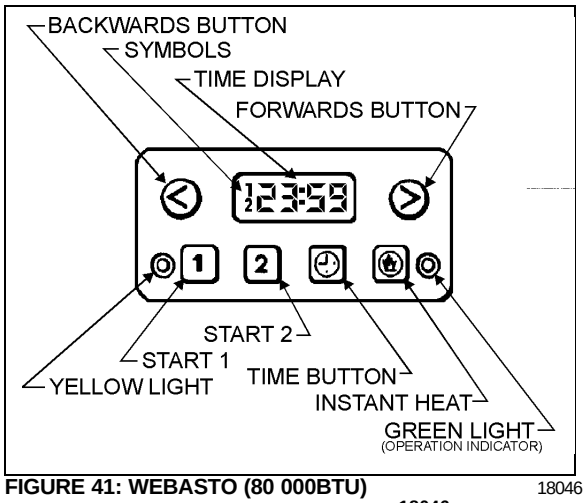


FIGURE 41: WEBASTO (80 000BTU) 18046

18046

12.6.4 Troubleshooting and Maintenance

Refer to the Webasto and Espar manuals annexed to the end of this section.

Note: *Switch on the preheating system briefly about once a month, even during the warm season.*

Caution: *During welding procedure on the vehicle, disconnect the preheater module connector in order to protect this system from voltage surges.*

13. SPECIFICATIONS

HVAC Logic panel

Make ..... Honeywell
Model W973B
Voltage rating..... 24 volts
Switching (on-off stages) .....Pilot duty spdt relays
Input signal (from electronic transmitter).....1 to 16 V DC
Supplier number..... W973B1016
Prevost number.....561805

Electronic transmitter

Make ..... Honeywell
Model ..... T7067B (modified for Prevost)
Voltage rating.....20 volts (from HVAC logic panel)
Current draw .....20 milliamperes
Output signalsTwo 1-16 volt signals ..... (one each for cooling and heating) to HVAC logic panel
Output signal rate of change (upon deviation from set point) .....2.5 V DC/1 °F (0,5 °C)
Supplier number..... T7067B1006
Prevost number.....561804

Fresh air inlet sensor

Make ..... Honeywell
Model C7046A
Sensing element .....Carbon type, thermistor-resistor element
Nominal resistance ..... 3000 ohms at 77 °F (25 °C)
Nominal sensitivity .....70 ohms/°F (124 ohms/°C) at mid-range
Supplier number.....C7046A1004
Prevost number.....950082

Return air sensor

Make .....Prevost
Prevost number (air sensor) 061961
Prevost number (temperature sensor) 372479

Discharge air sensor

Make ..... Honeywell
Type.....Non-adjustable thermistor sensor
Nominal resistance ..... 1420 ohms at 75 °F (24 °C)
Nominal sensitivity ..... 15 ohms/°F (25 ohms/°C) resistance increases as temperature falls
Supplier number..... T7022A1010
Prevost number.....561806

Main evaporator motor

Make	Prevost
Type	T-19
Voltage	27.5 V DC
Current draw	69 amps
Horsepower	2
Revolution	1750 rpm
Insulation	Class F
Motor life	20 000 hours
Brush life	10 000 hours
Motor supplier number	D509V54APRC1
Motor Prevost number	561939
Brush supplier number	1197
Brush Prevost number	561202

Condenser fan motors

Make	LeRoy-Somer
Type	TAP-12
Voltage	27.5 V DC
Current draw	23 amps
Horsepower	0.57
Revolution	1950 rpm
Insulation	Class F
Motor	20 000 hours
Brush life	10 000 hours
Qty	2
Supplier number	71B524/02
Prevost number	561558
Brush supplier number	9DB21003
Brush Prevost number	561914

Main evaporator air filter

Make	Permatron Corp.
Type	Washable 1" X 23 3/8" X 43 1/2" Polypropylene filter
Supplier number	MODEL IN-1
Prevost number	871051

Driver's unit evaporator motors

Make	MCC
Voltage	24 V DC
Quantity	2
Supplier number	250135
Prevost number	562167

Driver's unit evaporator air filter

Make	Permatron
Type	Washable 8"X18 3/4"X1/4" Polypropylene filter
Supplier number	MODEL "R"
Prevost number	871049

Refrigerant

Type R-134a
Quantity ..... 24 lbs (11 kg)

Compressor

Make ..... Carrier Transicold
Capacity ..... 41 CFM
Model 05G-134A
No. of cylinders 6
Bore ..... 2" (50,8 mm)
Operating speed ..... 400 to 2200 rpm (1750 rpm, nominal)
Minimum speed (for lubrification) ..... 400 rpm
Nominal horsepower 15
Oil pressure at 1750 rpm ..... 15 to 30 psi (103-207 kPa)
Oil capacity ..... 1.13 U.S. gal (4,3 liters)
Weight ..... 142 lbs (64,5 kg)
Approved oils
- Castrol ..... SW 68 (POE)
Supplier number 68PD541-104-7
Prevost number 950239

Compressor unloader valve

Make ..... Carrier Transicold
Type ..... Electric (AMC)
Voltage ..... 24 V DC
Watts 15
Supplier number (without coil) 17-40407-20
Prevost number (without coil) 950095
Coil supplier number 22-50030 (1)
Coil Prevost number 950096

Magnetic clutch

Make ..... Carrier Transicold
Type ..... Housing mounted 9" dia., 2-B grooves
Voltage ..... 24 V DC
Coil resistance at 68 °F (20 °C) ..... 5.15 - 5.69 ohms
Supplier number 50-01122-90
Prevost number 950204

Compressor V belts

Make ..... Dayco
Model ..... BX 97
Prevost number 506664
Qty 2

Condenser coil
Make ..... Carrier Transicold
Aluminum
Supplier number..... 68BC-509---104
Prevost number.....452482
Copper
Supplier number..... 68BC-509---104-1
Prevost number.....452483

Receiver tank (with sight glasses)
Make ..... Standard refrigeration
Maximum pressure..... 450 psig
Material .....ASTM A-515
Supplier number.....8409-19M
Prevost number.....871045

Filter dryer assembly
Make .....Alco
Supplier number..... EKH 307S
Prevost number.....950231

Moisture indicator
Make ..... Henry
Supplier number..... MI-30-7/8S
Prevost number.....950232

Driver's refrigerant liquid solenoid valve
Make ..... Parker
Type.....Normally closed with manual bypass
Nominal..... Capacity with R-129 Tons
Voltage.....24 V DC
Amperage draw..... 0.67 amps
Watts.....16
Supplier number (without coil) RB9MP3-MM
Prevost number (without coil) 95-0054
Coil supplier number..... R23MM-CB 24 V DC
Coil Prevost number 950055
Repair kit Prevost number 950056

Humidistat
Make ..... Honeywell
Model H402A
Scale range.....15 to 60 % relative humidity with OFF and ON position
Setting recommended.....30%
Sensing element ..... A thin (1 mil) moisture sensitive nylon ribbon
Supplier number.....H402A1023
Prevost number.....561803

Driver's hot water solenoid valve

Make	Asco
Type	Normally open (without manual bypass)
Voltage	24 V DC
Current draw	0.47 amp.
Watts	11.2
Pressure range	0 to 100 psi
Max. temperature	220°F
Supplier number (with coil)	106-269-1
Prevost number (with coil)	870812
Coil Prevost number	870960
Repair kit Prevost number	870872

Main hot water valve actuator

Make	Honeywell
Model	ML 784
Voltage	24 V DC
Type	Linear
Prevost number	64-1238
Supplier number	ML784A2071
Repair kit Prevost number (packing, follower, spring stem assembly and disc)	641261
Repair kit supplier number	14 00 2695-005

Single-seated valve

Model	V5011F
Prevost number	641239

Water recirculating pump

Make	M.P. pumps
Voltage	24 V DC
Supplier number	28689
Prevost number	871052

Water filter

Make	Parker
Supplier number (with element)	15CN1238WP
Prevost number (with element)	871028
Element supplier number	925566
Element Prevost number	871029

Driver's expansion valve

Supplier number	26-0190
Prevost number	950221

Main expansion valve

Make	Alco
Supplier number	058613
Prevost number	950237

Bypass solenoid water valve

Make	Parker Hanninfin
Bypass supplier number	RB21ME7-MM
Bypass Prevost number	870886
Coil supplier number	R-23MM24VDC-CB
Coil Prevost number	870886
Repair kit supplier number	76754
Repair kit Prevost number	870980

Preheating system

Make	Espar
Model	D 12 W
Capacity	41,000 Btu/h (12 kW)
Heating medium	Coolant
Rated voltage	24 V DC
Operating voltage	20-28 V DC
Electric power consumption (without coolant recirc. pump)	55 watts
Fuel consumption	0,4 U.S. gallons/hr (1,65 liters/hr)
Supplier number	25 1860 05
Prevost number	871077

Preheating system

Make	Webasto
Model	DBW 2020
Capacity	80 000 Btu/h (23,3 kW)
Heating medium	Coolant
Rated voltage	24 V DC
Operating voltage	20-28 V DC
Electric power consumption (without coolant recirc. pump)	120 watts
Fuel consumption	0,8 US gallons/hr (3 liters/hr)
Supplier number	666.640
Prevost number	871036

Carrier TRANSICOLD

Service Information

Nunber BAR-SER85-1

Date 6-14-85

Subject HOUSING-MOUNTED ELECTRIC CLUTCH

The procedure on the attached pages should be followed carefully when servicing the Carrier Transicold housing-mounted clutch. The following tools are recommended when removing and replacing this clutch:

TOOL LIST

DESCRIPTION	CTC PART NO. (WHERE APPLICABLE)
Spanner Wrench	07-00240
Rotor Installation Tool	07-00241
Socket Bearing Retaining Nut - Large	07-00242-01

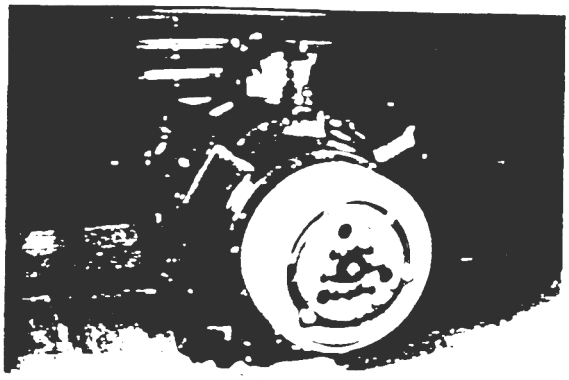
3/8" Socket Set
Torque Wrench
3 Leg Puller w/3 1/4-20 UNC Cap Screws
1- Bolt 7/8-14 UNC x 2" Long
Feeler Gauge .020 .030 .060
Grease Gun, Manual, 0.1 Oz Per Stroke
Depth Gauge 0-1/2"
Ohmmeter

Andrew Widay
Manager
CTC Service Engineering

UNITED TECHNOLOGIES CARRIER TRANSICOLD

05G COMPRESSOR HOUSING MOUNTED CLUTCH

The new housing-mounted electric clutch, HMC, eliminates drive belt loading on the 05G crankshaft, and applies this load directly to the crankcase of the compressor. The following procedure should be followed carefully whenever it becomes. necessary to remove and replace the HMC.



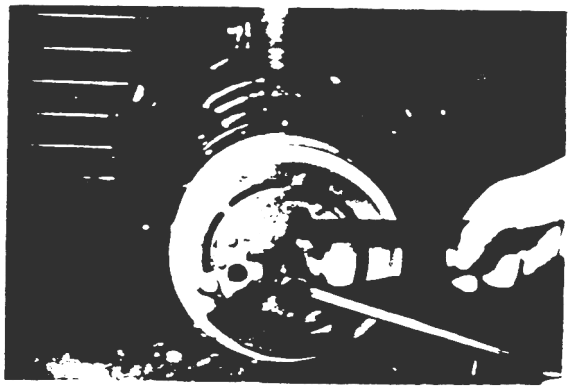
Housing-Mounted Clutch Removal

CAUTION: Remove drive belt before attempting to remove clutch.

1. Remove armature as a complete assembly by removing retaining capscrew (3/8-24 x 1-1/4" Lg), lockwasher, and special 3/8 washer from compressor crankshaft. Use special CTC tool P/N 07-00240 to prevent crankshaft rotation, as shown.

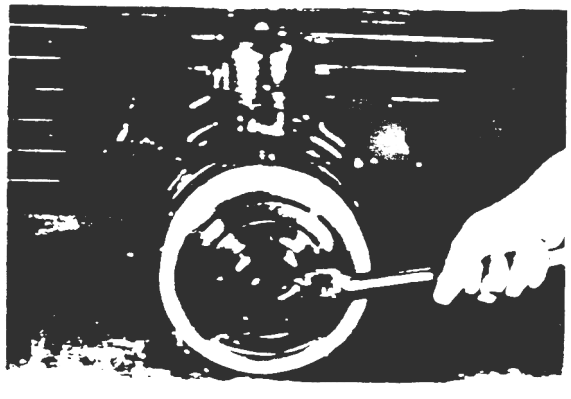
2. Install a 7/8-14 x 2" capscrew into the center hole of the armature assembly. Use this capscrew as a jacking bolt to remove the armature assembly. Use tool 07-00240 as in Step 1 to prevent crankshaft rotation.

   NOTE: Do not use a puller or pry against the armature hub or bumper plate, as this could cause damage to these parts.



3. Remove the clutch armature assembly from the compressor crankshaft as a complete assembly, as shown.

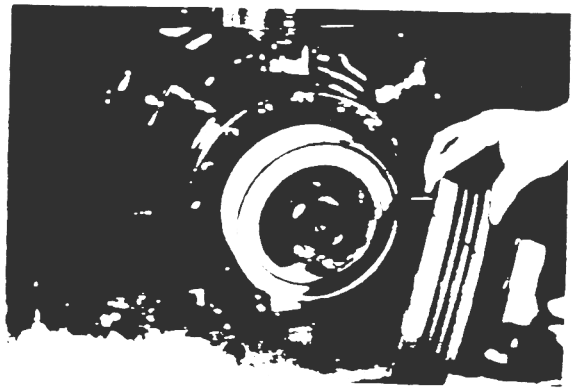
4. Remove the rotor retaining nut with special CTC tool P/N 07-00242-01.



5. Install a flange-type gear puller into the three 5/16-18 tapped holes in the clutch rotor assembly, as shown.

CAUTION: Use a washer or other protective device to prevent damage to crankshaft and threaded hole in the crankshaft by the puller. Never use a puller in the belt grooves, as damage to the rotor may result. Use a pry bar as shown to prevent rotation of the clutch rotor.

6. Once the rotor has been pulled From the clutch bearing mounting hub, carefully lift the rotor assembly away from the compressor, as shown.



7. To remove the clutch coil, disconnect the coil's electrical cable from the wiring harness. Then remove only the three 3/8- 16 capscrews holding the coil to the flange of the clutch bearing mounting hub, and carefully remove the coil, pulling straight out from the flange. Do not pry coil off, as it may bend the mounting plate.

Housing-Mounted Clutch Installation

1 Prior to instlling the H31C, inspect For dents, nicks, or burrs on the clut a bering mounting hub and clutch assembly. Correct if any are found , and clean clutch mounting hub and ID of clutch bearing with a chlorinated base or naphtha type solvent.

2. Inspect coil for damaged power leads , bent or cracked mounting plate, or burned or cracked potting material.

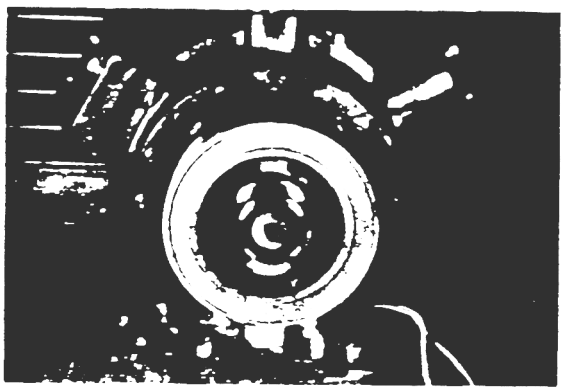
3. Check coil for electrical continuity, resistance, and shorts to ground.

   Resistance at 68°F: Lead to Lead 24 VDC coil 5.15-5.69 ohms
   12 VDC coil 1.92-2.12 ohms

   Lead to Ground 12/24 VDC coil INF or open

   Replace coil if above conditions are not met.

4. Slide the coil onto the clutch bearing mounting hub so that the lead wires exit between the 3 and 5 o'clock position, as shown.



5. Secure the coil to the bearing mounting hub flange with the three 3/8-16 capscrews removed in Step 7 of Clutch Removal. Torque capscrews to 25-30 ft-lb (3.46-4.15 MKG).

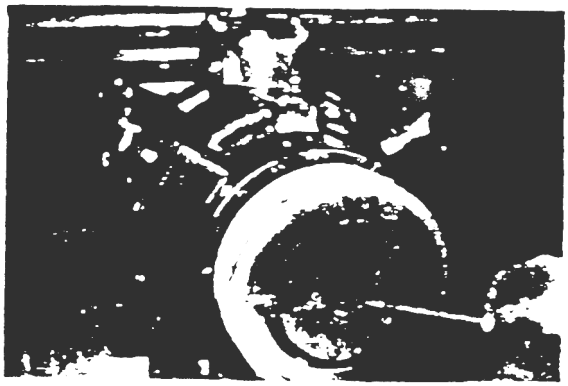
   CAUTION : Do not draw coil onto the clutch bearing mounting hub flange with the capscrews, as this may distort the coil.

6. To ease the installation of the rotor onto the clutch bearing mounting hub, preheat the inner race of the rotor bearing by placing an electric heater inside the bearing bore (a 75-100 watt outdoor post lamp style bult applied for 15-30 minutes may be used).

   CAUTION : Do not heat bearing with an open flame or heat bearing above 175°F.

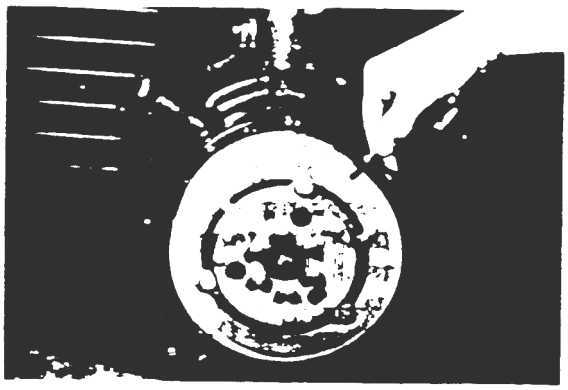
10. Place armature and hub assembly onto the compressor crankshaft and insure the hub seats on the crankshaft properly,

11. Insert the special key CTC P/N 68G2-9072 (1.75 **x** .250 x .199) in the keyway until outer end of key is flush with the hub's counter bore, as shown .



12. Secure armature assembly to crankshaft with the 3/8 special flat washer, lock washer, and 3/8-24 x 1-1/4" lg capscrew removed in Step 1 of Clutch Removal. Torque capscrew to 16-20 ft-lb using CTC tool P/N 07-00240 to prevent crankshaft rotation.

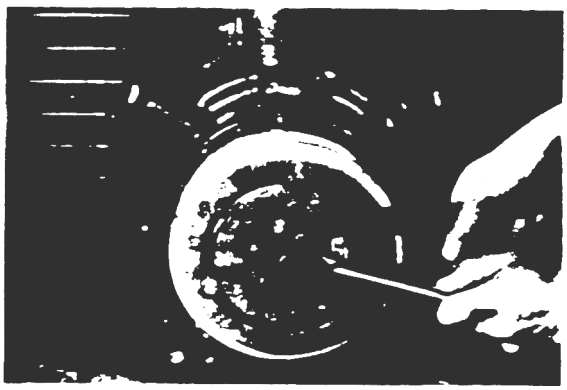
Steps 13-19 are for new clutch installation only. After the initial adjustment, shim stack should not be changed.



13. Measure the air gap between the armature and rotor surfaces, as shown.

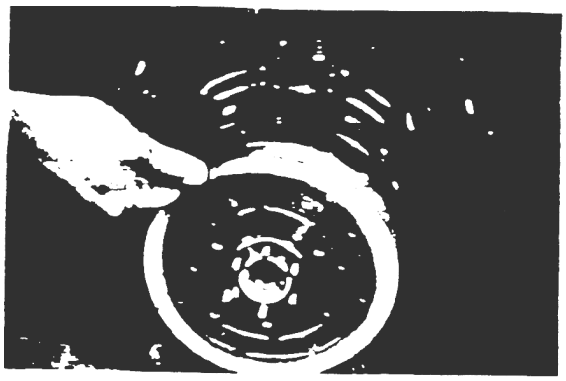
14. Record this measurement and determine the amount of shims that must be removed to obtain a . 030/ .060 air gap. The shims consist of 1-.010 and 6-.020 shims.

15. Remove the six armature plate to armature hub retaining nuts and washers. Use CTC tool P/N 07-00240 to prevent armature rotation, as shown.



16. Remove the required number of shims to obtain an air gap of .030/ .060.

17. Insert a .020 feeler gauge between the outside edge of the clutch bearing mounting hub and the inside edge of the armature mounting hub, as shown. The clearance should be .020 or greater,



18. Reinstall armature plate, washers, and retaining nuts and torque to 7 ft-lb using CTC tool P/N 06-00240 to prevent crankshaft rotation.

19. Recheck air gap to confirm that YOU have obtained the . 030/. 060 clearance.

FIELD SERVICE PROCEDURES

1. Greasing of Clutch Bearing

The clutch bearings are pre-greased by the bearing manufacturer with the proper operating charge. Do not add grease to the bearing for at least 5000 hours of bus operation.

CAUTION: Overgreasing of the bearing will cause the bearing to operate at higher temperatures that may result in:

1. Blowing grease through the bearing seals onto the clutch friction faces, causing clutch slippage. A slipping clutch tends to run extremely hot, resulting in forcing more grease from the bearing, thereby increasing slippage and burning the magnetic coil.

2. Reduction in torque transmission capacity.

This is a situation where “more” is not better.

Recommended frequency for adding grease:

Up to 5000 hours bus operation	None
After initial 5000 hours	Add O. 1 oz SR1-2 grease during preseason A/C system checkout (i. e., once per year during a Spring month)

Grease required q ust be “Chevron SR1-2" or CTC Engineering approved equal.

Procedure for Adding Grease to the Clutch Bearing

The grease fitting is located in the clutch bearing retaining nut. Access to the grease fitting is accomplished by remoVing the armatur assembly as in Step u, 2, and 3 of HMC Removal.

NOTE: The removal of the armature in order to add grease to the bearing is deliberate to insure that all grease spillage can be cleaned from the clutch, reducing the potential for clutch slippage and the resulting loss of clutch torque transmission capacity.

Any unauthorized modification of the clutch armature to facititate greasing of the bearing will void the clutch and compressor warranties.

It is recommended that a hand operated grease gun with approximately 0.1 oz delivery per stroke be used to add grease to the bearing. Grease gun must contain "Chevron SR 1- 2" grease.

Wipe the grease fitting clean of all dirt and foreign materials.

Attach grease gun to grease fitting. Insert 0.1 oz grease into bearing (1 to 2 strokes of the gun).

CAUTION: Do not give extra strokes "for good measure" as premature clutch performance degradation may result.

After adding grease to the bearing, wipe all grease spillage from clutch faces, retaining nut, and hubs. If you can see it, wipe it up.

Reinstall armature assemblv and torque retaining nut to 16-20 ft-lb torque, as in Steps 10, 11, and 12 of HMC Assembly.

2 . Inspection for Wear

CAUTION: Insure bus or compressor drive engine is not operating. Take extra precautions to prevent inadvertent engine starting while clutch is being serviced.

A) With clutch coil de-energized, measure distance from face of armature to face of rotor, as shown. Feeler gauges inserted between the rotor and armature friction faces is not recommended due to the uneven wear on the friction surfaces.

Energize the clutch coil and repeat the measurement. If the difference between the first and second measurements exceeds .110 inches, the clutch rotor and armature are to be replaced.

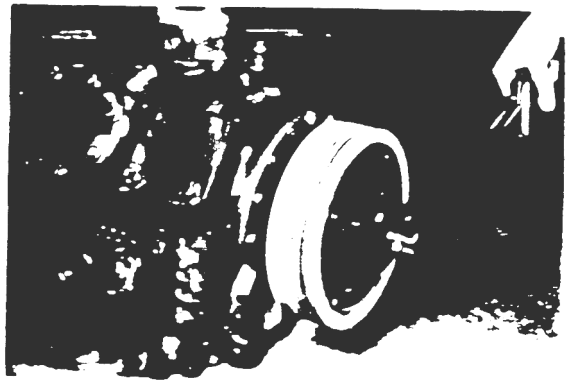
NOTE: Do not attempt to readjust the armature travel by removing shims. A catastrophic clutch failure may result. After initial (new) air gap adjustment the shim stack should never be changed.

7. After preheating bearing, slide rotor assembly onto clutch bearing mounting hub. To facilitate seating of the bearing on the hub, place CTC tool P/N 07-00241 against the inner race of the bearing and tap gently with a hammer. as shown.

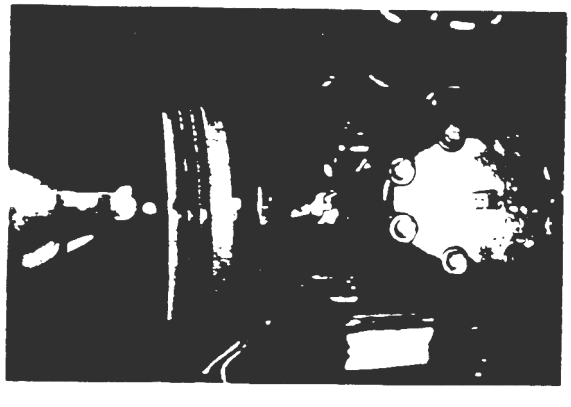
8. Install bearing retaining nut on clutch mounting hub and use torque wrench to tighten.

   If the smaller nut without the grease fitting is used, torque nut to 50 ft-lb with CTC tool P/N 06-00242-02 The taper on the nut faces the bearing.

   If the larger nut with the grease fitting is used, torque the nut with CTC tool P/N 07-00242-01. Due to the self-locking feature of the nut, the installation torque may vary. When installing the nut, observe the torque required to turn the nut onto the hub. After the nut seats the bearing against the hub, apply a torque 50 ft-lb greater than the installation torque.



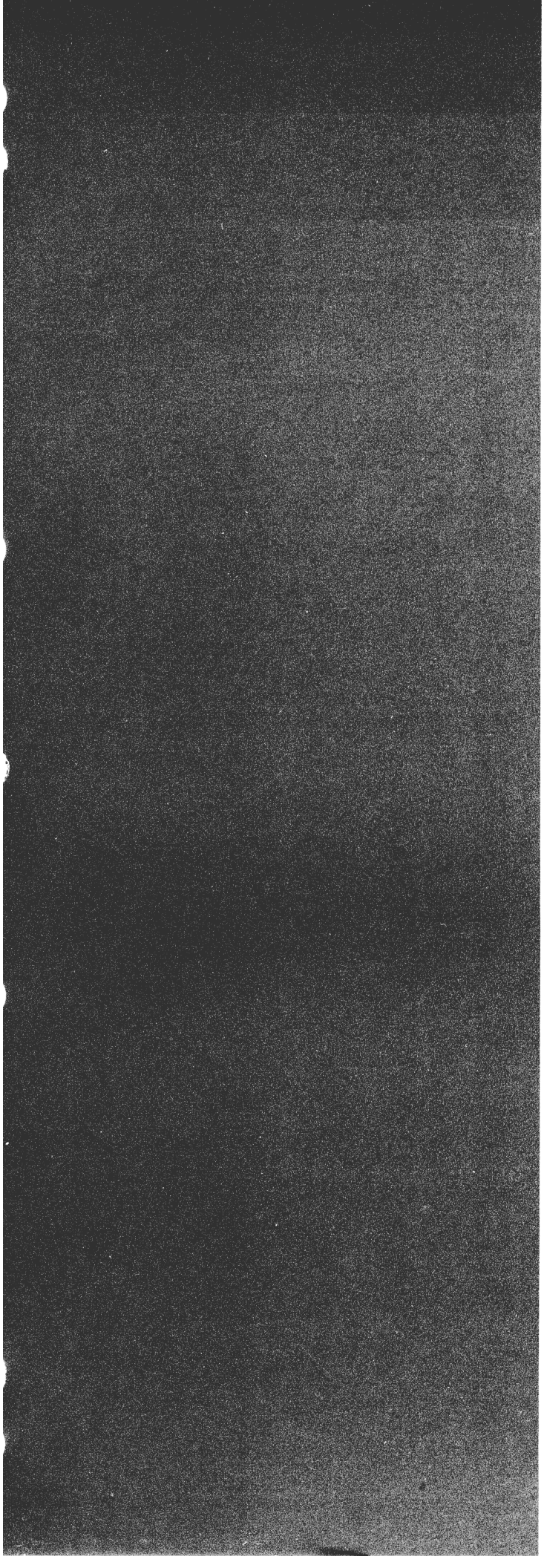
9. Check coil to rotor clearance by inserting .020 thick by .156 wide (msx.) feeler gauge through an outer slot in rotor, as shown. Insert the feeler gauge so it extends beyond the rear face of the rotor and rotate the rotor one full turn. There should be no rubbing or binding.



B) Sever mix rotor and armature assembles between used assemblies or new and used assemblies.

CAUTION: If either the armature or rotor assemblies are defective, both assemblies must be replaced.

C) If raised ribs on friction face are worn flat or nearly flat, replace armature and rotor assemblies.



Service and Repair Manual

Webasto

COOLANT HEATERS

DBW 2010
DBW 2020
DBW 300
DBW 350

Webasto

CIRCULATION PUMPS

U 4810
U 4814
U 4816

PRICE $5.50

INDEX

1. TECHNICAL DATA

The following data is subject to the normal tolerance for heaters if no tolerance is Decified. This is approximately ± 10% in an ambient of 20° C at normal voltage.

1.1 Technical data of the heaters

HEATER	DBW 2010	DBW 2020	DBW 300	DBW 350
DESIGN	Coolant heater with high-pressure nozzle			
HEAT OUTPUT k w Btu/h	(45.000)	(80.000)	(104.000)	(120.O00
FUEL	Diesel #1, #2 or Arctic			
FUEL CONSUMPTI0N l/h (g/h – US) (g/h – Imp.)	1.5 (0.4) (0.3)	3.0 (0.8) (0.7)	4.0 (1.2) (0.9)	4.4 (1.3) (1.0)
RATED VOLTAGE - V	12 or 24	12 or 24	12 or 24	12 OR 24
OPERATING VOLTAGE - V	10-14 or 20-28	10-14 or 20-28	10-14 or 20-28	10 -14 20-28
POWER CONSUMPTION OF HEATER WITHOUT COOLANT CIRCULATION PUMP - WATT	6 0	120	130	170
PERMISSIBLE AMBIENT TEMPE-RATURE DURING OPERATION: HEATER, CONTROL UNIT, COOLANT CIRCULATION PUMP -°C (“F)	–40 . . . . + 60 (-40. + 140)			

HEATER	DBW 2010	DBW 2020	DBW 300	DBW 350
STORAGE TEMPERATURE CONTROL UNIT HEATER, COOLANT CIRCULATING PUMP - °C (“F)	+ 85 max. (185 max.) – 40... + 85 (-40... + 185)			
MIN. CAPACITY OF COOLING SYSTEM l (Imp. gal.)	10 (2.2)	15 (3.3)		
PERMISSIBLE OPERATING PRESSURE OF THE COOLANT	bar (psi)	0.4-2.0 (6-29)	0.4-2.0 (6-29)	0.4-2.0 (6-29)	0.4-2.0 (6-29)
$C0_2$ IN EXHAUST GASES % BY VOL	10.5...11.0	10.5...11.0	10.5...11.0	10.5...11.0
CO IN EXHAUST GASES % BY VOL.	0.2 max.	0.2 max.	0.2 max.	0.2 max.
SMOKE NUMBER (BOSCH)	3.0 max.	3.0 max.	3.0 max.	3.0 max.
DIMENSIONS OF THE HEATER INCL. CONTROL UNIT mm TOL. ±3mm (inch)	L w H	584 (23) 205 (8.1) 228 (9)	680 (26.7 240 (9.5) 279 (11)	580 (26.7) 240 (9,5) 279 (11)	725 (28.5) 240 (95) 279 (11)
WEIGHT OF HEATER INCL. CONTROL UNIT kg (lb)	15 (33)	22 (48.5)	22 (48.5)	23 (50.7)

1.2 Technical data of the circulating pumps

CIRCULATING PUMP		U 4810	U 4814	U 4816
FLOW RATE l/h (imp. gal/min)		1600 (6.0) against 0.15 bar	5200 (19.0) against 0.2 bar	6000 (22.O) against 0.4 bar
NOMINAL VOLTAGE V		12 or 24	12 or 24	24
OPERATING VOLTAGE V		10-14 or 20-28	10-14 or 20-28	20-28
POWER CONSUMPTION	W	25	104	215
DIMENSIONS mm (inch)	L w H	173 (6,8) 94 (3.7) 77 (3,0)	221 (8.7) 108 (4.2) 105 (4.1)	295 (11.6) 113 (44) 114 (4.5)
WEIGHT kg (lb)		0.8 (1.8)	2.1 (4.6)	4.75 (10.5)
RECOMMENDED FOR HEATER*		DBW 2010	DBW 2020 DBW 300 DBW 350	DBW 2020 DBW 300 DBW 350

‘Choice of circulating pump depends on resistance of coolant circuit.

1.3 Permissible extension of the connections

HEATER	DBW 2010	DBW 2020	DBW 300	DBW 350
FUEL LINE: Øinternal mm (inch) length max. m (ft) suction head m (ft)	6* (0.25) 10 (33) 2 (6.6)	6* (0.25) 10 (33) 2 (6.6)	6* (O 25) 10 (33) 2 (6.6)	6* (0.25) 10 (33) 2 (6.6)
COMBUSTION AIR INTAKE PIPE: Ø internal mm (inch) length max. m (ft) bends max.	80 (3.2) 5 (16.5) 270°	80 (3.2) 5 (16.5) 270°	80 (3.2) 5 (16.5) 270°	80 (3.2) 5 (16.5) 270°
EXHAUST PIPE: Ø internal mm (inch) length max. m (ft) bends max.	38(1.5) 5 (16.5) 270°	70 or 80 2.75 or 3.2 5 (16.5) 270°	70 or 80 2.75 or 3.2) 5 (16.5) 270°	70 (2.75) 5 (16.5) 270°
HOSE CONNECTIONS INLET/OUTLET OD mm (inch)	18 (0.75)	38(1.5)	38(1.5)	38(1.5)
TEMPERATURE DIFFERENCE At INLET - °C) -OUTLET °F)	10 (18)	10 (18)	10 (18)	10 (18)

‘ Other dimensions upon request

2. GENERAL DESCRIPTION

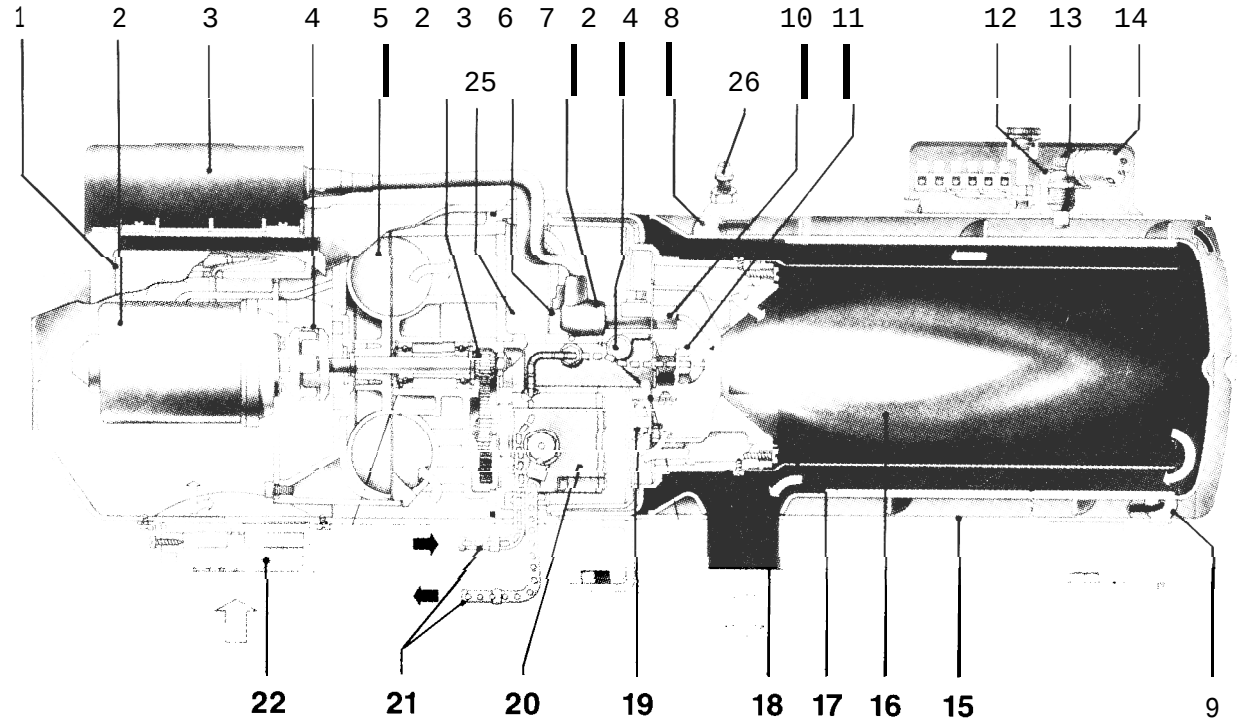
The coolant heater consists of a heat exchanger (15) and a turnable burner head. The burner can be swivelled, alternately, to two sides and, therefore, adapted to the installation conditions. When swivelled out, the fuel pump (20), the solenoid valve (6), the ignition electrodes (10), the flame detector (19), the fuel nozzle (11) and pre-heat thermostat *(green and bhe wires) (25)* are easily accessible for the maintenance. The nozzle holder incorporates the fuel nozzle, the ignition electrodes, the solenoid valve and the pre-heater.

Under the removable protection cap of the burner, which can be mounted in three different positions and supports the combustion air intake with adjusting shutter, the motor (2) is installed which drives, through a toothed gearing (23) the fuel pump (20). The combustion air fan provides the quantity of air necessary to burn the fuel atomized by the fuel nozzle.

The combustion air swirler (17) installed in the combustion chamber (16) mixes the fuel with the air. The mixture is ignited by a high-voltage ignition spark, The combustion is taking place in the combustion chamber inserted into the heat exchanger (15).

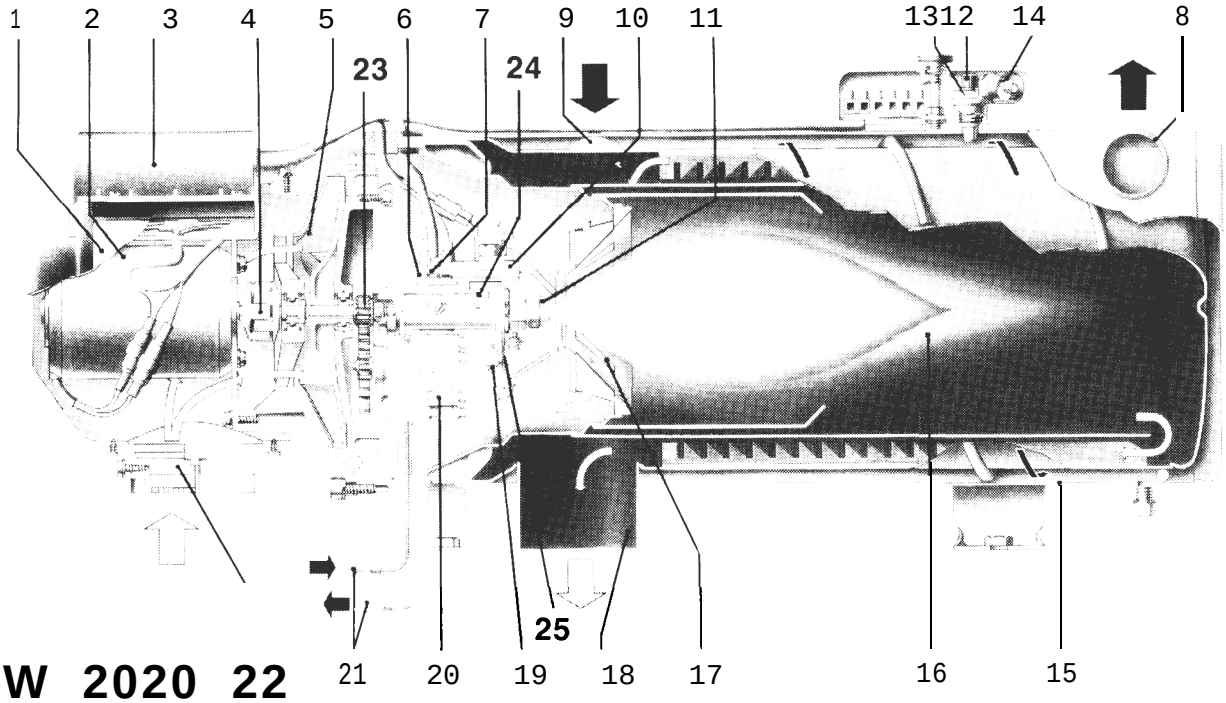
The electronic control unit (l), mounted on the burner, controls the coolant heater and the ignition unit (3). A coolant circulating pump is necessary to operate the heater.

1. Electronic control unit
2. Motor
3. Electronic ignition unit
4. Clutch
5. Combustion air fan
6. Solenoid valve
7. Electrode holder
8. Coolant outlet
9. Coolant inlet
10. Ignition electrodes
11. Fuel nozzle
12. Overheat fuse (white wires)
13. Control thermostat (green and red wires)*
14. Temperature limiter (green wires)
15. Heat exchanger
16. Combustion chamber
17. Combustion air swirler
18. Exhaust pipe
19. Flame detector
20. Fuel pump
21. Fuel pipes
22. Combustion air intake with adjusting shutter
23. Toothed gearing
24. Pre-heater
25. Pre-heat thermostat (blue and green wires)
26. Bleeding valve

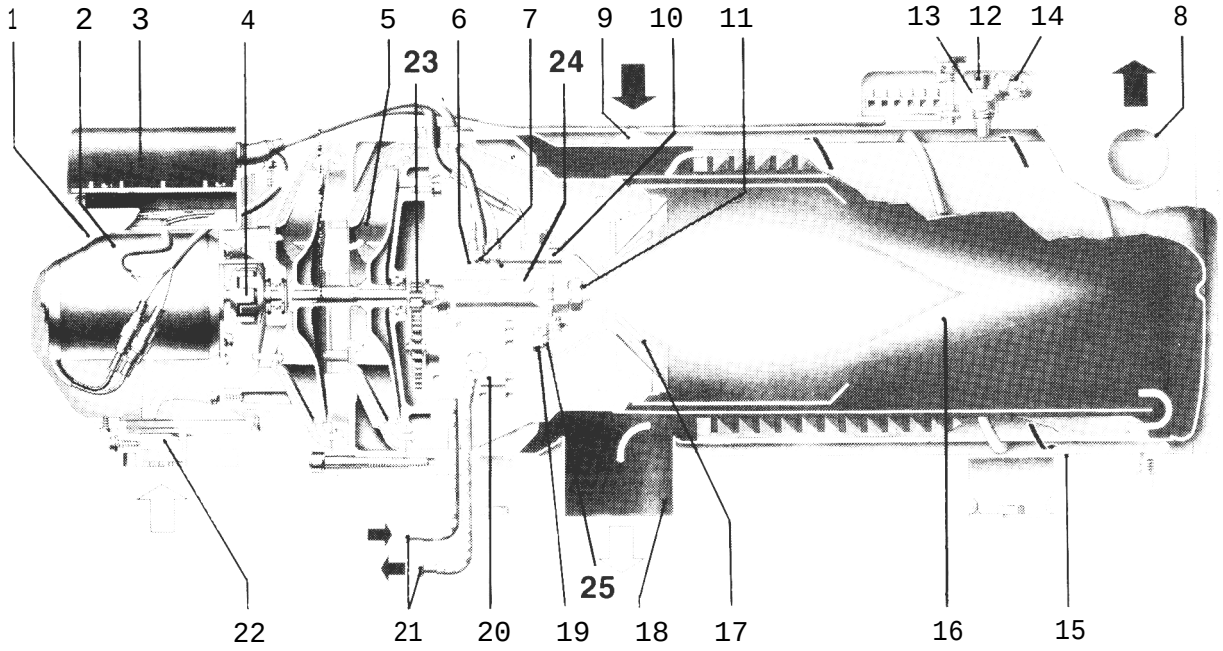


DBW 2010

‘ Second version of the control thermostat with white and orange wires.



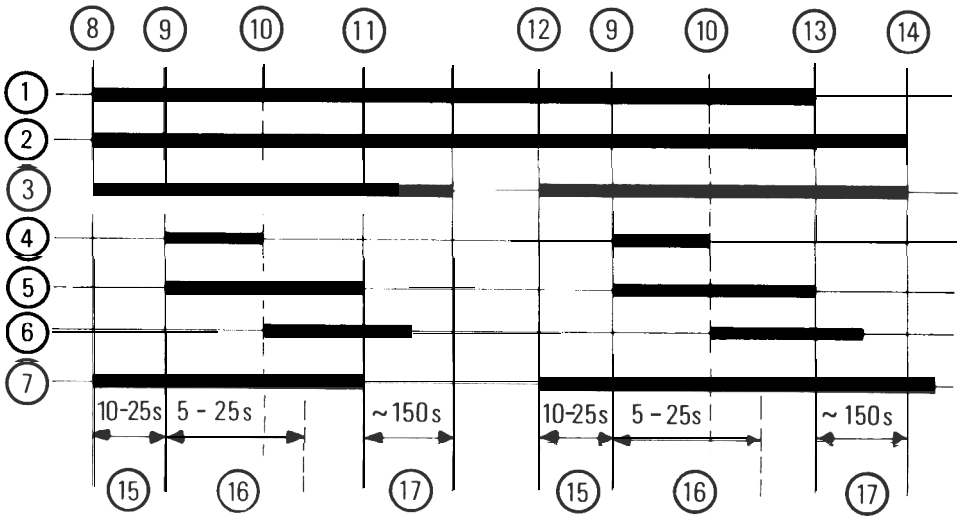
DBW 2020 22
DBW 300



DBW 350

2.1 DESCRIPTION OF OPERATION

1. Light green: operation indicator, control thermostat
2. Water circulation pump, negative heater
3. Heater motor
4. Electronic ignition unit
5. Solenoid valve
6. Flame detect
7. Control thermostat
8. Switch on
9. Start
10. Combustion
11. Control pause starts
12. Control pause ends
13. Switch off
14. Heater stops
15. Initial cycle
16. Safety delay time
17. Purge cycle



Use the switch to start the Webasto heater, The operation indicator lamp (1) comes on, the heater motor (3) and coolant circulating pump (2) begin to run. After about 10-25 seconds solenoid valve (5)opens and fuel is sprayed into the combustion chamber. At the same time electronic ignition unit produces high voltage (8000V) and the mixture of fuel and air in the combustion chamber is ignited by the spark on the ignition electrodes. The flame is indicated by the flame detector, then the electronic ignition unit stops producing high voltage and combustion continues by itself (spark on electrodes is required only to ignite the flame). At this moment the heater is working and produces heat.

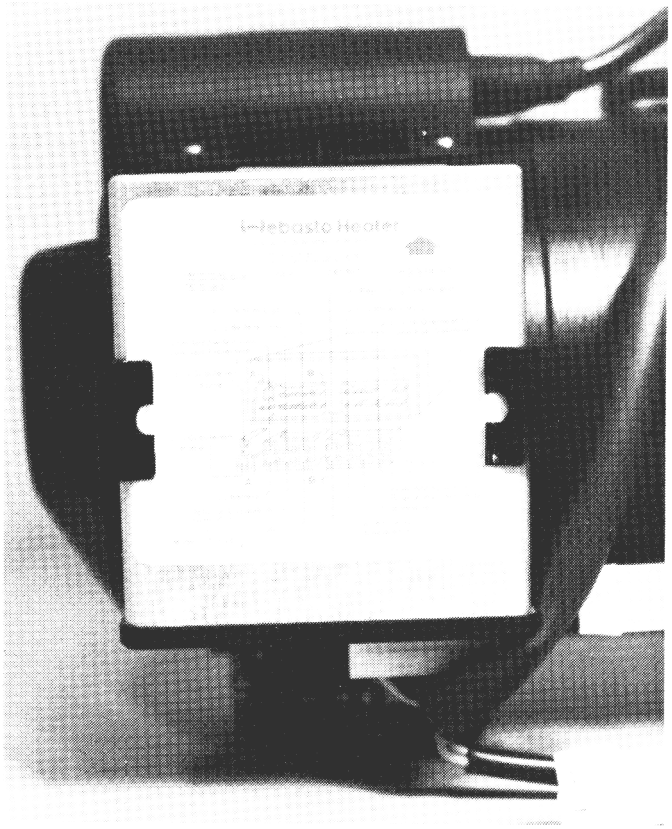
interrupts fuel supply, combustion stops and indicator lamp turns off, Combustion air fan still blows air, cleaning the combustion chamber of any fumes and cooling down the combustion chamber. Coolant circulation pump pumps coolant, making a purge cycle for approximately 2-3 minutes, thus protecting heater against overheating.

If the heater is not switched off by the on/off switch, the control thermostat will switch off the heater when coolant temperature reaches 75° ± 3° C (165° ± 6° F) and turn it on at 68° ± 5° C (154° ± 9° F). During this time the heater (combustion) is off, the indication lamp and coolant pump are on. Combustion air fan blows air for 2-3 min. and then turns off.

3. PARTS OF THE HEATER

3.1 Electronic control unit (1)

Description: The electronic control unit serves to switch the heater on and off, to control the different components of the motor, the solenoid valve, the ignition spark coil, and to check the combustion.



The signals of the flame detector, the control thermostat and the overheat fuse are utilized, accordingly, for this purpose. In case the functions are defective, the control unit switches the heater automatically off.

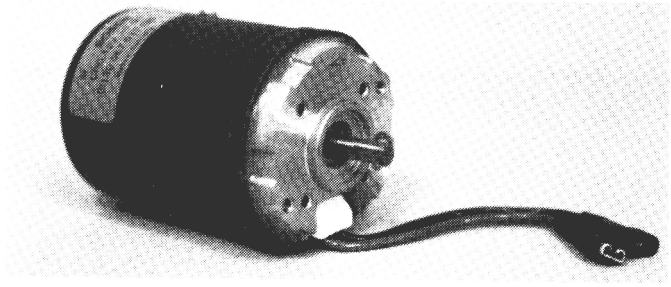
Checks: A check-up of the control unit is possible only if the incoming as well as the outgoing signals are simulated. The testing apparatus (see item 7.2) comprises all the necessary parts for a complete function test of the control unit.

A defective control unit must not be repaired but has to be completely exchanged,

Remarks: if the electronic control unit is exposed to heat impact (max. 60° C (140° F), e.g. in the mounting case), it should be moved to a cooler position (possibly by extending the wiring harness).

3.2 Motor (2)

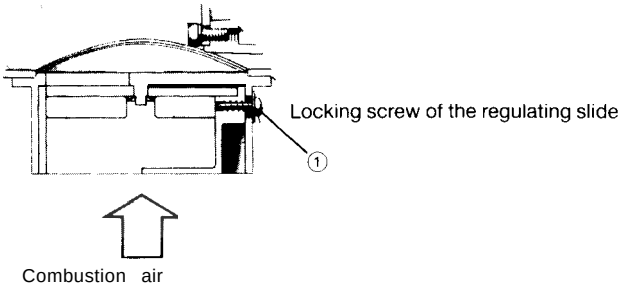
Description: The motor, through a coupling, drives the combustion air fan, and through a toothed gearing, the fuel pump.



Rated motor r.p.m.:	DBW 2010	4500 RPM
	DBW 2020	5000 RPM
	DBW 300	5800 RPM
	DBW 350	5600 RPM

Checks: Check the mounting condition (rough running). The single parts of the motor cannot be exchanged. The cables and the drain hole must show downwards.

3.3 Combustion air intake — regulation (22)

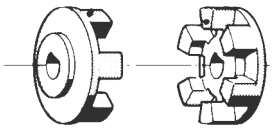


Description: The regulation of the combustion air at the intake socket serves to relate exactly the combustion air quantity to the fuel quantity atomized by the high-pressure atomizer nozzle.

Checks: In case the intake socket is loose, it has to be exchanged completely.

3.4 Clutch (4)

Description: The clutch represents the mechanical connection between motor and combustion air fan.



Checks: Before re-using the clutch, it has to be checked for cracks and the condition of the flat portion in the hole. Too much play on the shaft produces loud continuous noise.

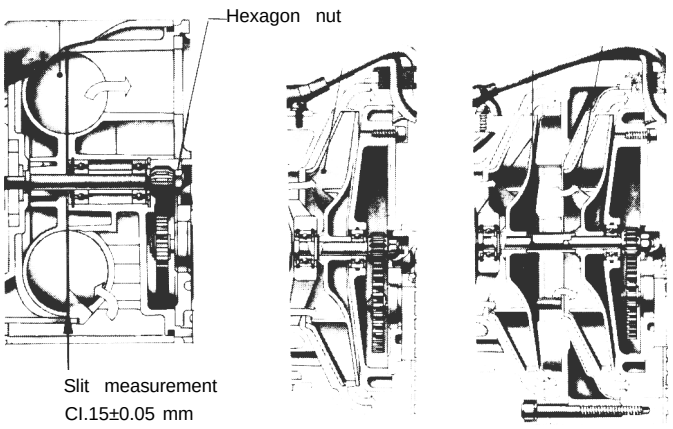
3.5 Combustion air fan (5)

Description: The combustion air fan forwards the air necessary for the combustion. There exist different fan types:

DBW 2010	— lateral canal fan
DBW 2020/300	— radial fan
DBW 350	— two-stage radial fan.

Checks: The impeller has to be checked for dirt deposits, grinding traces and cracks.

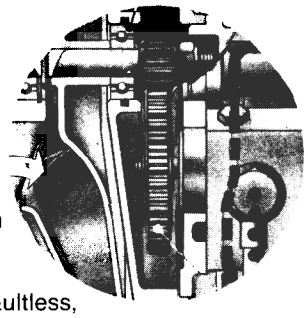
Only DBW 2010: The looseness of the impeller has to be checked. The narrow point of the split between impeller and fan case (measurable with a spy) has to be set to0.15 ±0.05 mm with a hexagon nut on the shaft.



DBW 2010 DBW 2020/300 DBW 350

Only DBW 2020/300: The hub of the impeller has to be checked for cracks, and the cover disc (backwell) as to its stability.

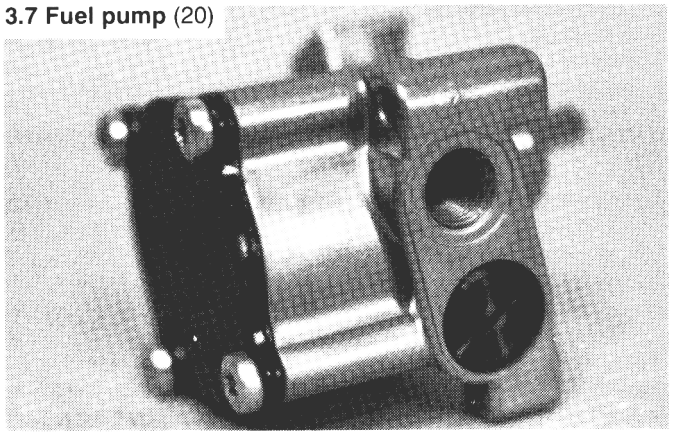
3.6 Toothed gearing



Description: The gears drive the fuel pump with a gear ratio of 1:3.5.

Checks: If signs of wear are showing within the sector of the toothed gearing as well as at the flat portion of the entrainer in the hole of the biggest gear, the gears have to be exchanged. If the gears are still faultless, it is recommended to re-lubricate with grease Isoflex LDS 18 of Kübler — max. 0.5 cm³, evenly distributed within the gears sector.

3.7 Fuel pump (20)



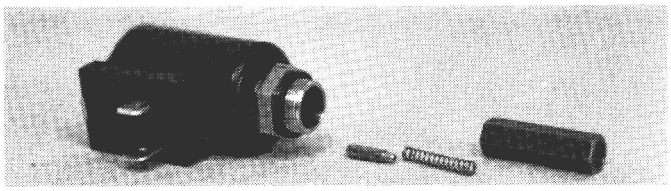
Description: The fuel pump (single-staged toothed pump) delivers the fuel from the tank to the heater and brings it to a pressure of 8–0,5 bar (116–7 psi) for DBW 2010, 10±0,5 bar (145±7 psi) for DBW 2020, 300, 350.

Checks: When mounted, the following measures can be taken:

1. check the cover sealing and the fuel connections for tightness;
2. check the pressure regulation valve if dirty; an obstructed air relief drill hole may be cleaned with compressed air; in case the dirt is pressed into the O-ring of the regulation piston, the pressure regulating valve has to be exchanged;
3. check the strainer on the suction side fuel intake for dirt and clean if necessary;
4. set the pump pressure (see also item 6.18).

In order to control the shaft packing and the entrainer disc, the fuel pump has to be dismounted.

3.8 Solenoid valve (6)



Description: The solenoid valve interrupts the fuel supply when the heater is switched off. When there is no current, the solenoid valve is closed.

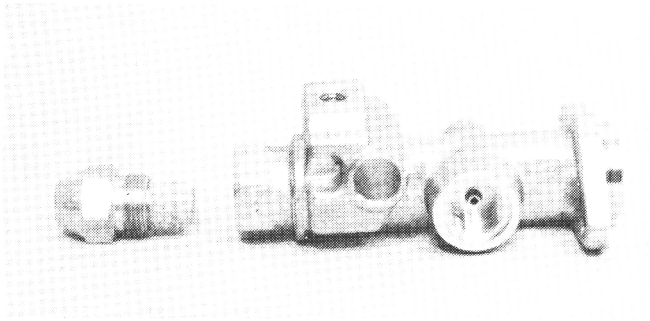
Checks: The electrical function and the tightness of the solenoid valve have to be controlled. The opening voltage is for

heater 12V	8 V
heater 24V	17 V.

A leaky zero adjustment (solenoid valve) and a dripping atomizer nozzle are indicated by after-smoking during the purge cycle (there may also happen a short after-smoking if the space between the solenoid valve and the nozzle is emptid; this is normal).

The gasket disc on the armature has to be controlled as to damage; exchange the armature if necessary.

3.9 Fuel nozzle (nozzle holder) (11)



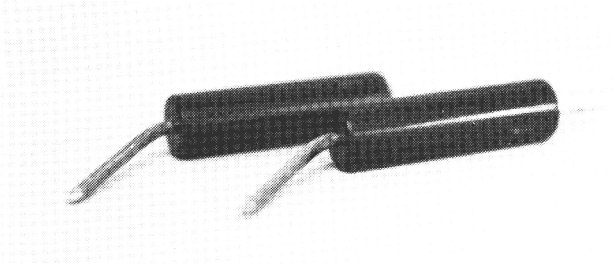
Description: The fuel nozzle is screwed into the nozzle holder; it atomizes the fuel.

Checks: Do not clean the nozzle bore hole and the slits with solid objects as wire or drawing pins; do not blow with compressed air, The sealing surfaces on the high-pressure nozzle and the nozzle holder have to be undamaged, clean and without grooves.

The high-pressure nozzle can be checked as to its regular atomizing on the ignition electrodes with the burner opened and the plug withdrawn.

A high-pressure nozzle obliquely spurting or very dirty has to be replaced.

3.10 Ignition electrodes (10)

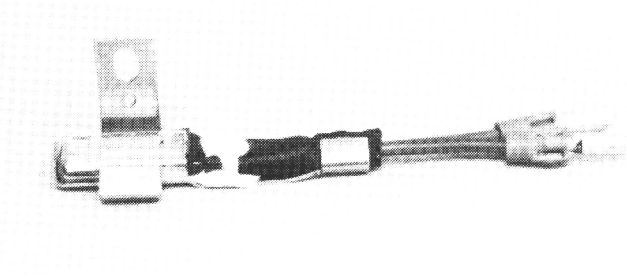


Description: The ignition spark is formed between the points of the ignition electrodes, thus introducing the combustion process.

Checks: Only the condition of the insulation body has to be controlled. It must not show any cracks or damages.

The distance between the ignition electrodes can be checked and regulated with a gauge (see item 6.9).

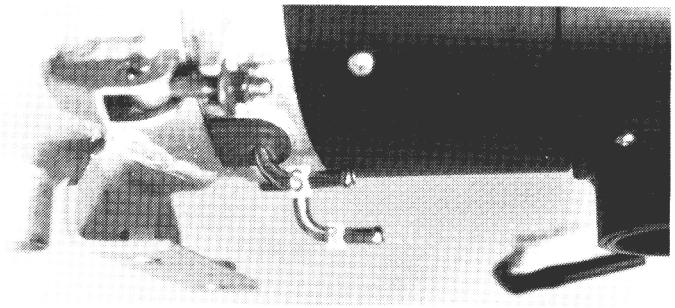
3.11 Flame detector (19)



Description: The flame detector is a photosensitive resistance feeding the electronic control unit with the signal “flame”.

For checking – see instructions on page 21, item 6.8.
Attention — the disc has to be plane.

3.12 Fuel line on the heater (21)

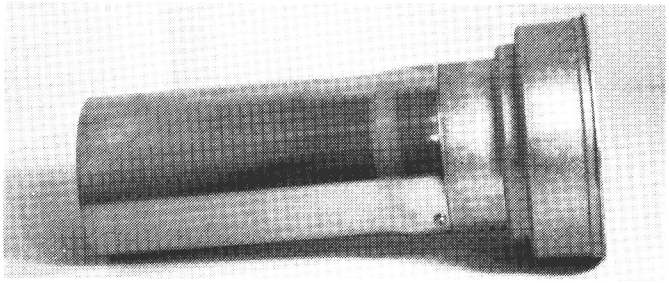


Description: The fuel pipes from the fuel tank are connected to the fuel suction pipe and the fuel return pipe on the heater.

Checks: The fuel hose has to be perfectly tight and without kinks, It must not pucker when the hose clip is tightened.

The fuel pipes on the heater as well as the fuel hose have to be replaced when defective.

3.13 Combustion chamber (16), **Combustion air swirler** (17)



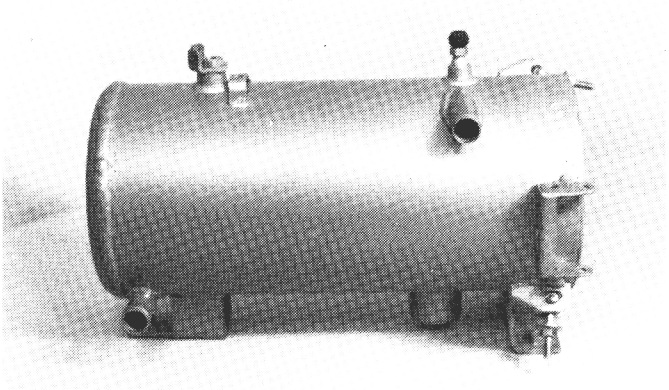
Description: Within the burner tube of the combustion chamber the fuel-air mixture, prepared by the high-pressure nozzle, is burned.

Checks: Soot deposits have to be removed.

Only DBW 2010: In case the twist body has been damaged by a too intensive heat effect, the combustion chamber and the flame detector have to be replaced.

Note — It is important that the combustion chamber is cleaned and inspected periodically.

3.14 Heat exchanger (15)

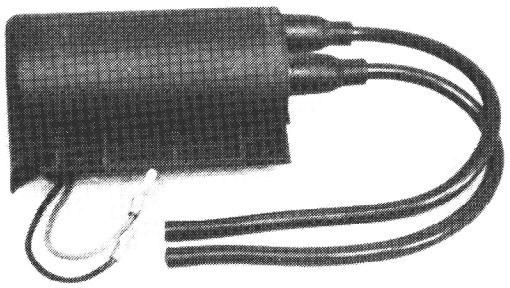


Description: The heat, produced by the combustion, is transmitted to the medium (coolant mixture) flowing through the heat exchanger.

Checks: Combustion residue has to be removed with a jet of water and a brush.

Exterior damages, as big marks caused by pressure, may affect the coolant flow.

3.15 Electronic ignition unit (3)

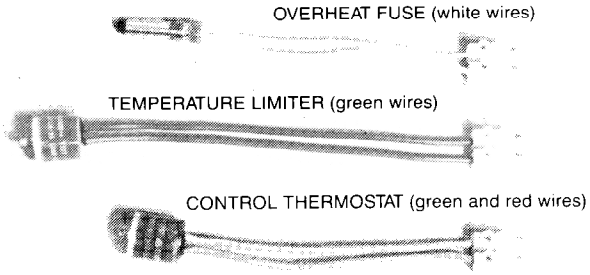


Description: Within the electronic ignition unit, a high voltage of approx. 8000 volt is generated and brought to the two ignition electrodes. The electronic ignition unit is only in operation during the starting phase.

Checks: When connecting a direct current of 12 V resp. of 24 V (positive to black, and negative to brown cable), the sparks must spring over on the ignition spark track.

Attention: Never switch on the electric ignition unit without the ignition electrodes.

3.16 Overheat fuse (12), **Temperature limiter** (green wires) (14)



Description: The overheat fuse protects the heater against too high and inadmissible temperatures. The overheat fuse contains a fusible link reacting when the admissible temperature is exceeded (138° C [280° F]), and switches the heater off with a purge cycle.

The temperature limiter is a thermostat which, after having been released (95° C [203° F]), can be reset by restarting the heater only if coolant temperature is below 95° C (203° F).

The deliverable overheat fuses, fusible links and temperature limiter are listed in the respective spare parts lists.

Checks: The electrical volume has to be checked. At room temperature, the contact is closed.

3.17 Control thermostat (green and red wires*) (13)

Description: After the operation temperature has been reached the control thermostat assumes the intermittent operation. By alternative switching on and off, the temperature of the heat medium is maintained at a constant level.

Switching temperature:

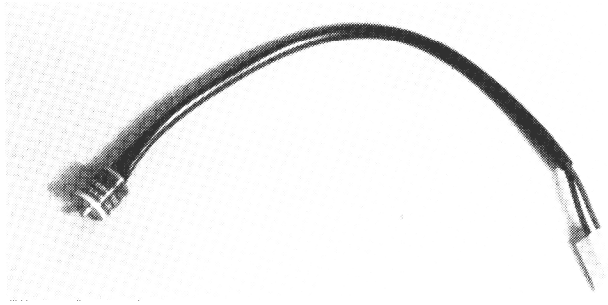
I Version	— closes at	68 ±5° C (154 ±9°F)
	— opens at	75 ±3° C (167 ±6°F)
II Version*	— closes at	60 ±5° C (140 ±9°F)
	— opens at	70 ±3° C (158 ±6°F)

Checks: The electrical volume has to be checked. At room temperature, the contact is closed, and when the temperature rises above the upper switching point, it opens.

Remarks: Only 2020, 300 and 350. Optional control thermostat (see item 12 on pages 9 and 10) could be mounted in the heating system, instead of the control thermostat located on the heater.

*Second version of the control thermostat with white and orange wires.

3.18 Pre-heat thermostat (blue and green wires) (25)

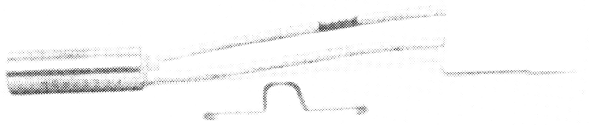


Description: The pre-heat thermostat is installed in the burner on the back wall (2010) or on the disc (2020, 300, 350). It switches the heating element (24) which warms up the fuel in the nozzle holder.

Switching temperature: — closes at 0° C (32 “F)
— opens at 8° C (48° F)

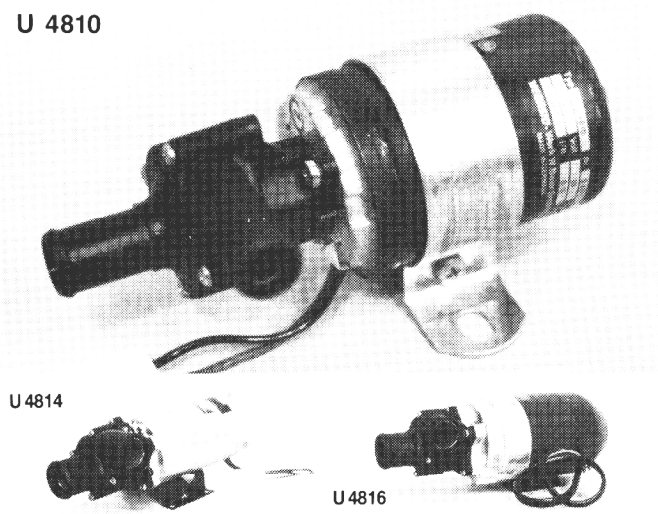
Checks: The electrical volume has to be checked. At room temperature the thermostat opens. It closes when the temperature drops under 0° C and opens at 8° C.

3.19 Pre-heater (24)



Pre-heater is a heating element located in the nozzle holder. Operated by pre-heat thermostat (green and blue wires) heats fuel when the temperature drops under 0° C (32° F).

3.20 **Coolant circulating pumps U 4810 / U 4814 / U 4816**



Description/installation: The circulating pump is mounted into and connected to the cooling respectively, the heating cycle. Technical data of the circulating pumps see item 1.2 and the installation instructions of the respective heaters.

NOTE — when connecting the circulating pump electrically, do not mix the cable colours (see wiring diagrams — item M 1 on pages 8-10) otherwise the rotation is incorrect.

Checks: The pump housing has to be checked for its tightness. In case coolant flows out (see item 6.19 on page 26).

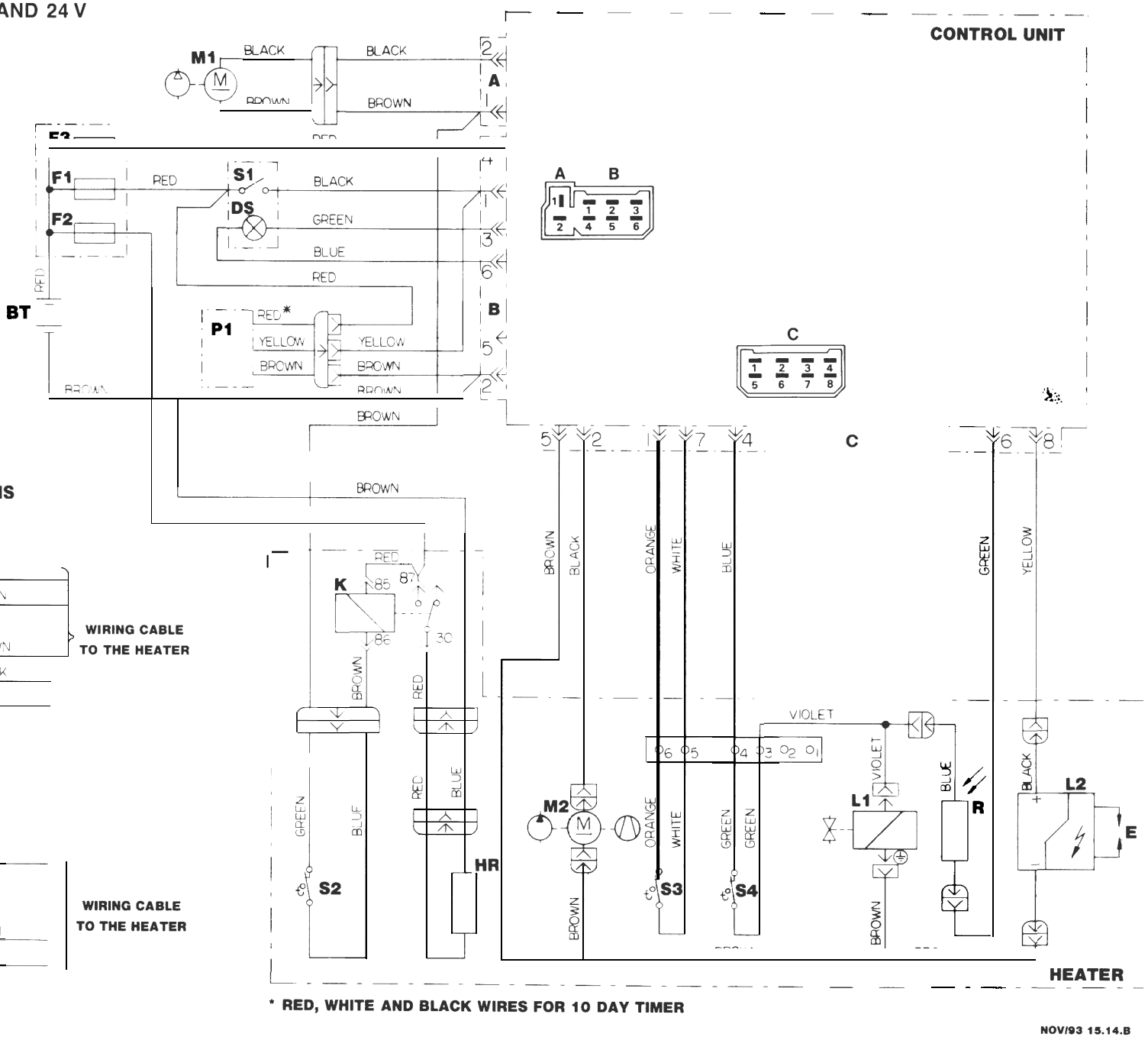
Hose connections and hose clips have to be tight, A defective circulating pump may cause the heater to overheat.

Only U 4816: Check the length of the carbon brushes.

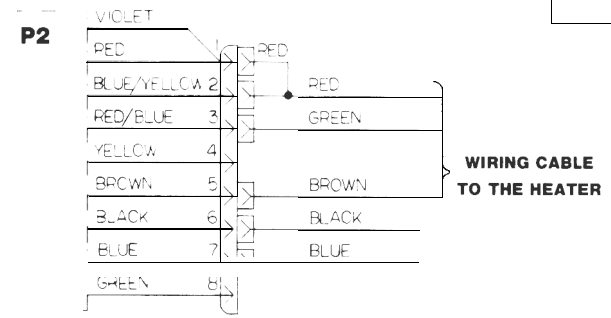
4. ELECTRICAL SCHEMATICS

4.1 DBW 2010 12 V AND 24 V

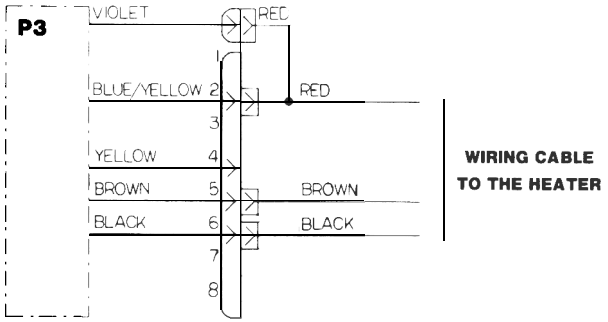
DS	INDICATOR LIGHT
E	IGNITION ELECTRODES
F1	FUSE 7.5A
F2	FUSE 25A
HR	HEATING ELEMENT (fuel pre-heating)
K	RELAY (fuel pre-heating)
L1	SOLENOID VALVE
L2	IGNITION COIL
M1	COOLANT CIRCULATING PUMP
M2	HEATER MOTOR
P1	TIMER (72 HOUR OR 10 DAY)
P2	TIMER (24 HOUR)
P3	TIMER (7 DAY)
R	FLAME DETECTOR
S1	ON / OFF SWITCH
S2	PRE-HEAT (FUEL) THERMOSTAT (blue and green wires)
S3	CONTROL THERMOSTAT (white and orange wires)
S4	TEMPERATURE LIMITER (green and green wires)



24 HOUR TIMER CONNECTIONS

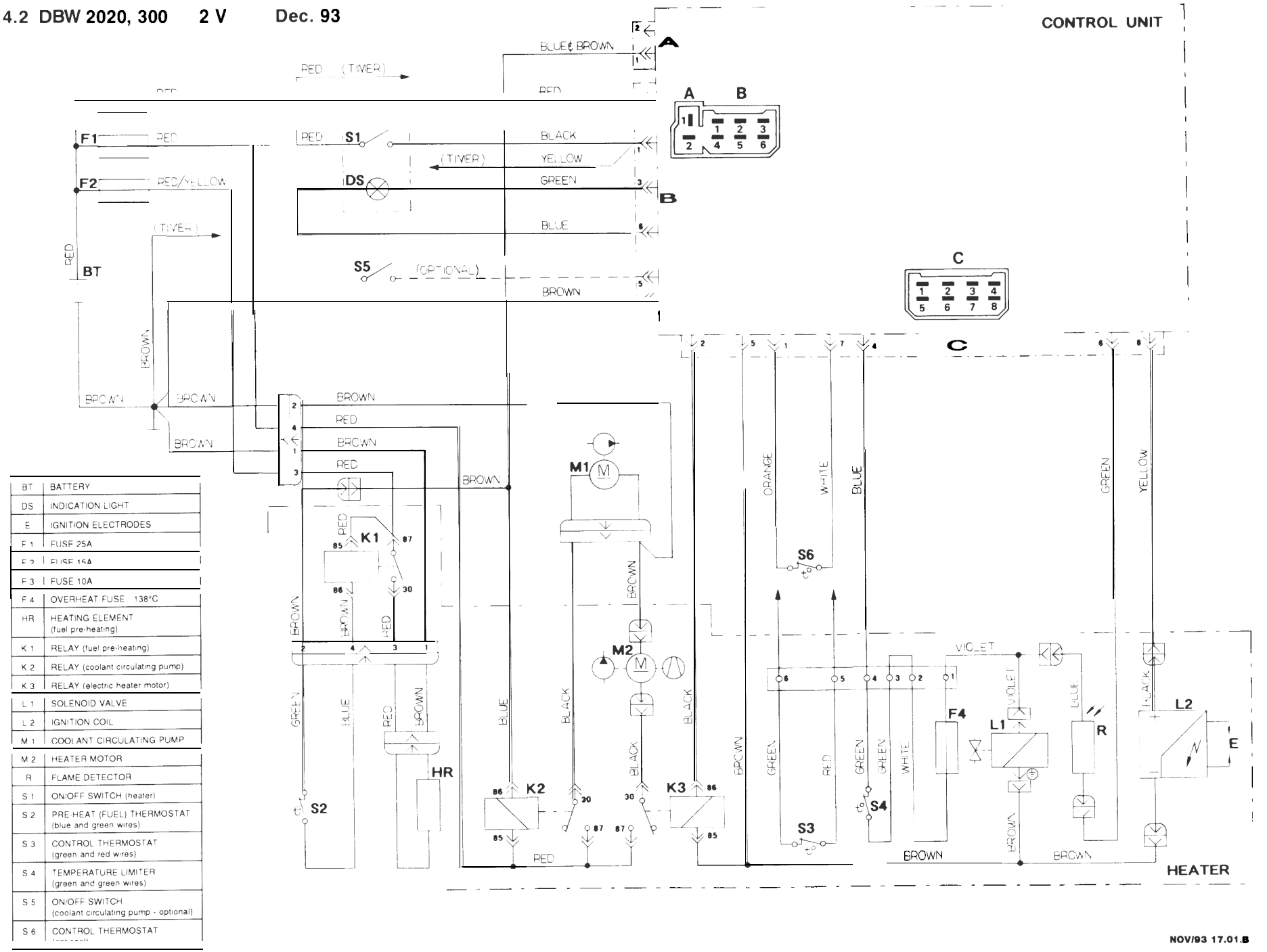


7 DAY TIMER CONNECTIONS



* RED, WHITE AND BLACK WIRES FOR 10 DAY TIMER

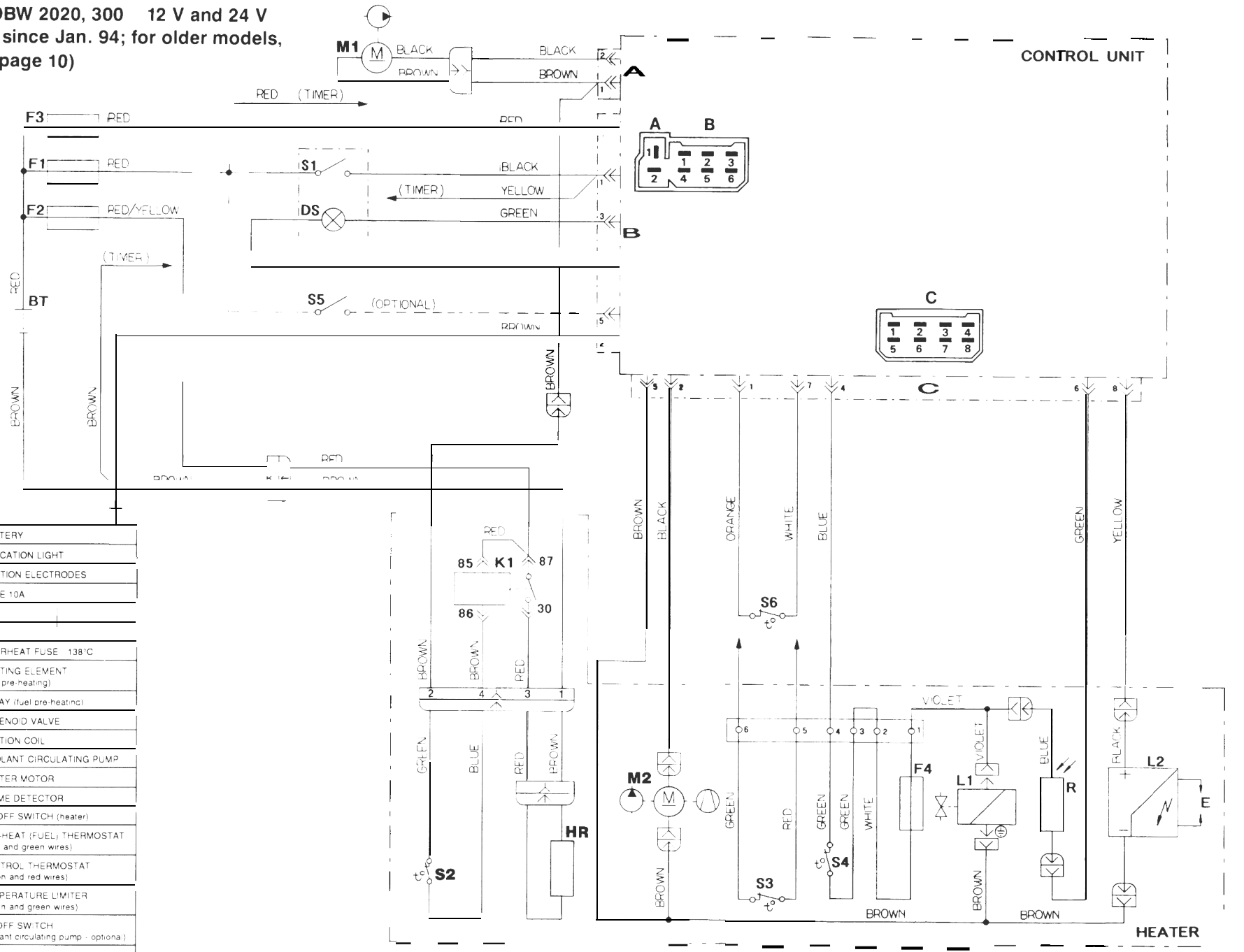
NOV/93 15.14.B



BT	BATTERY
DS	INDICATION LIGHT
E	IGNITION ELECTRODES
F 1	FUSE 25A
F 2	FUSE 15A
F 3	FUSE 10A
F 4	OVERHEAT FUSE 138°C
HR	HEATING ELEMENT (fuel pre-heating)
K 1	RELAY (fuel pre-heating)
K 2	RELAY (coolant circulating pump)
K 3	RELAY (electric heater motor)
L 1	SOLENOID VALVE
L 2	IGNITION COIL
M 1	COOLANT CIRCULATING PUMP
M 2	HEATER MOTOR
R	FLAME DETECTOR
S 1	ON/OFF SWITCH (heater)
S 2	PRE HEAT (FUEL) THERMOSTAT (blue and green wires)
S 3	CONTROL THERMOSTAT (green and red wires)
S 4	TEMPERATURE LIMITER (green and green wires)
S 5	ON/OFF SWITCH (coolant circulating pump - optional)
S 6	CONTROL THERMOSTAT

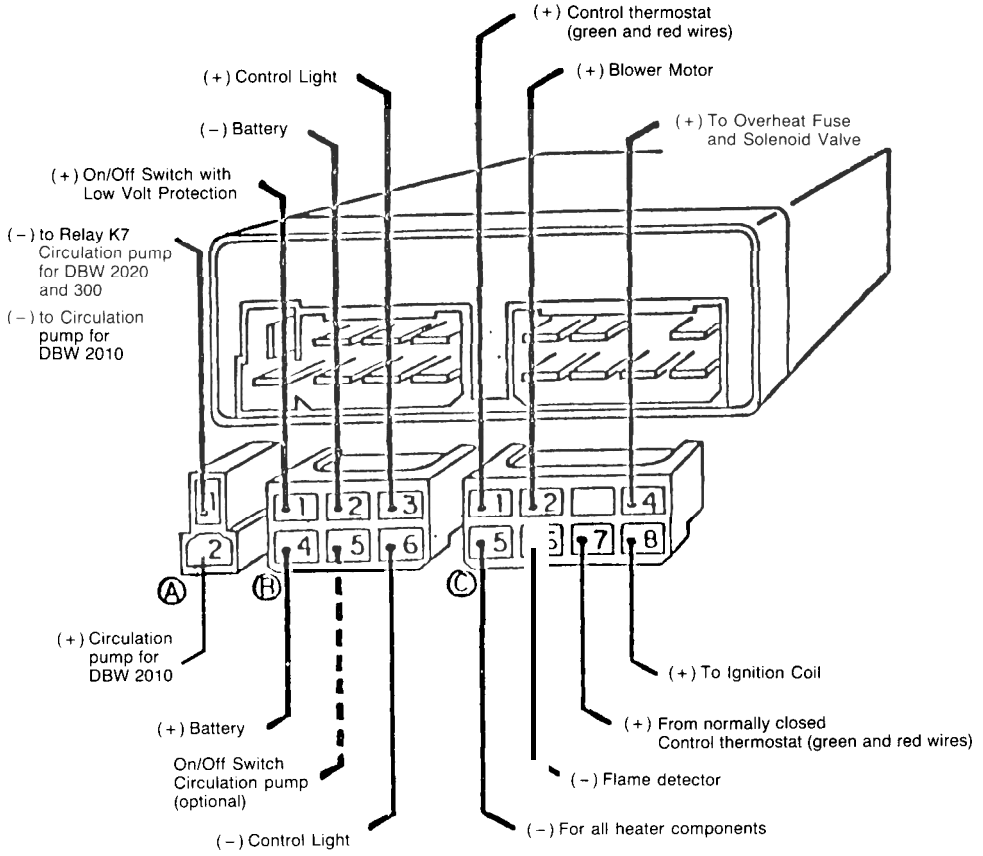
NOV/93 17.01.B

4.3 DBW 2020, 300 12 V and 24 V (12 V since Jan. 94; for older models, see page 10)

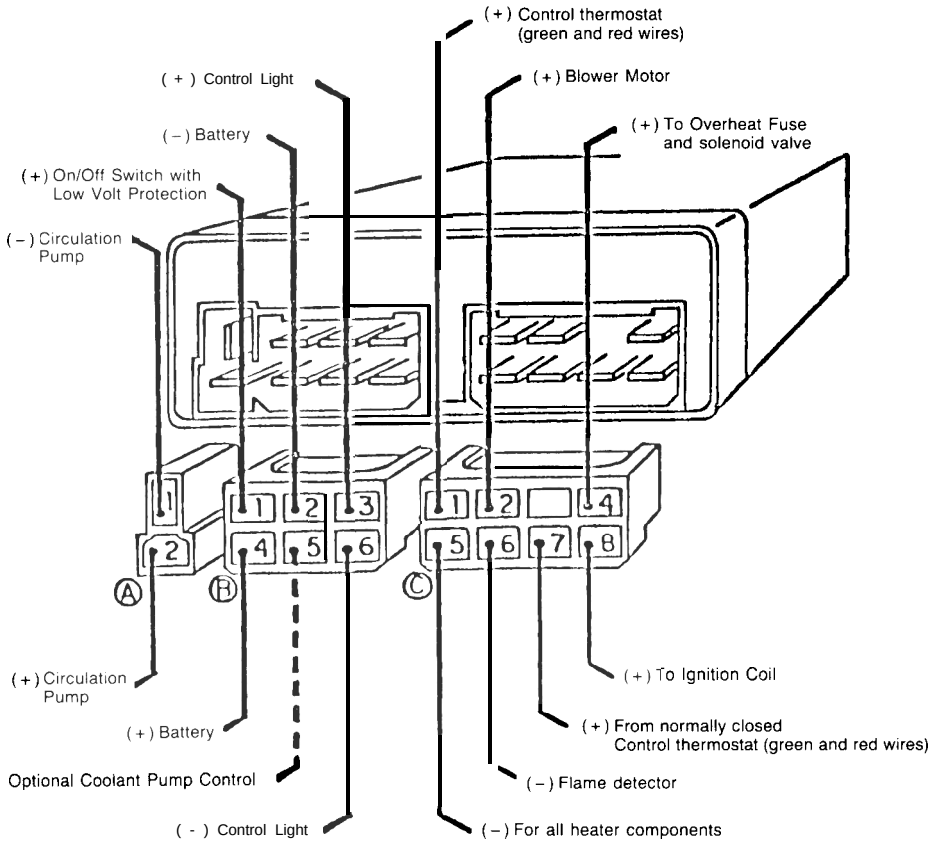


BT	BATTERY
DS	INDICATION LIGHT
E	IGNITION ELECTRODES
F 1	FUSE 10A
F 4	OVERHEAT FUSE 138°C
HR	HEATING ELEMENT (fuel pre-heating)
K 1	RELAY (fuel pre-heating)
L 1	SOLENOID VALVE
L 2	IGNITION COIL
M 1	COOLANT CIRCULATING PUMP
M 2	HEATER MOTOR
R	FLAME DETECTOR
S 1	ON/OFF SWITCH (heater)
S 2	PRE-HEAT (FUEL) THERMOSTAT (blue and green wires)
S 3	CONTROL THERMOSTAT (green and red wires)
S 4	TEMPERATURE LIMITER (green and green wires)
S 5	ON/OFF SWITCH (coolant circulating pump - optional)
S 6	CONTROL THERMOSTAT (optional)

4.4 IDENTIFICATION OF TERMINALS OF CONTROL UNIT — 12 Volt only



4.5 IDENTIFICATION OF TERMINALS OF CONTROL UNIT — 24 Volt only



5. TROUBLE SHOOTING

5.1 QUICK CHECK

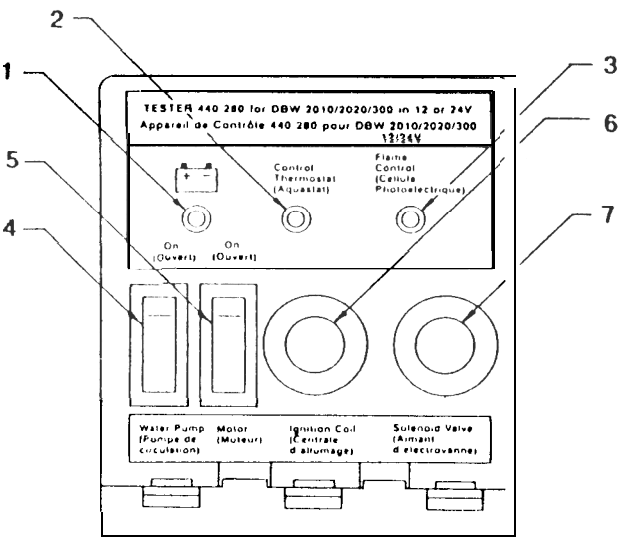
PROBLEM		CHECK, REPAIR OR REPLACE IF NECESSARY																						
		Check Voltage Supply	Electrical Fuse	Electrical Harness and Connection	Switch	Overheat Fuse or Temperature Limiter (green wires)	Control Thermostat (green and red wires)	Flame detector	Control Unit	Ignition Electrodes	Ignition Coil — Coil Wire	Electric Motor	Fuel Supply	Fuel Pump	Fuel Solenoid Valve	High Pressure Nozzle	Coolant Circulating Pump	Combustion Air Intake	Exhaust System	Heating System
Switch On	No Function	●	●	●	●		●																	
Control Light	OFF after 30 Seconds					●		●	●	●	●	●	●	●	●									
Blower Motor in Unit	Does Not Run	●	●	●			●		●			●												
Blower Motor in Unit	No Prime Cycle	●							●															
Blower Motor in Unit	No After Run								●															
Coolant Circulation Pump	Does Not Run	●	●	●					●			●												
Ignition Spark	Absent		●	●				●	●		●													
Combustion	Does Not Take Place					●			●	●	●		●	●	●	●								
Combustion	Stops after 30 Seconds	●		●				●	●															
Combustion	Cannot Be Stopped				●				●						●									
During Combustion	Light Colour Smoke												●	●		●								
During Combustion	Dark Colour Smoke	●			●							●	●						●	●				
Heating Unit	Overheating			●		●		●								●				●				

5.2 TESTER INSTRUCTIONS (TESTER PART #440-280)
For Heaters DBW 2010 / 2020 / 300 — 12 or 24 Volt

The tester unit has been designed to quickly check the proper operation of the various heater components. By using the tester in place of the heater control unit, you are able to manually control the heater to test components and actually operate the unit in heating mode.

The actual testing is completed in two steps, first you do an individual components test and then a manual start and run test, both designed to pinpoint actual problems in the heater system.

The tester should be used in conjunction with the Service and Repair Manual #699,745 for DBW 2010/ 2020/ 300 heaters which details complete troubleshooting and repair procedures.



1 LED Input power to heater
2 LED - Control thermostat
3 LED Flame detector
4 On/Off switch circulating pump
5 On/Off switch motor
6 push button - ignition spark generator
7 push button - fuel solenoid valve

TEST PROCEDURES

1. Set-Up:

A Remove connector blocks from heater control unit, Inspect for loose wires, corrosion and proper wire connections.

B Plug control unit connector blocks into tester
Note — Make sure WATER PUMP and MOTOR switches 4 and 5 are in the "OFF" position

C Put heater swltch/tlmer to "ON" and turn vehicle heater valve to "FULL" mode (if equipped)

D Proceed to component test procedures.

2. Component Test Procedures:

• WARNING •

DO NOT ATTEMPT TO TEST OR RUN HEATER WITH BURNER HEAD OPEN. ENSURE BURNER HEAD IS PROPERLY CLOSED AND SECURED IN PLACE.

Test Step	Result	If not:
A Tester connected	- BATTERY LED 1 unit lights up	- test input voltage at control terminals B4 (+) and B2 (-) - check battery connections - check battery voltage
	- CONTROL THERMOSTAT LED 2 lights up	- test switch/timer - test control thermostat on heater

Note — Since the heater operates in the 60°C to 70°C (On to Off/Off to On) range, if the vehicle engine IS hot (e.g. coolant above 70°C), the heater WiII not start until the coolant temperature drops below 60°C. THIS IS NORMAL.

B Push FUEL SOLENOID VALVE button 7 several times	- clicking of solenoid should be heard	- test temperature fuse iIf equipped) - test solenoid valve
C Push ignition spark coil button 6	- sparking should be heard	- check electrode gap - test igniltion spark coil
D Turn MOTOR switch 5 on	- motor should run	- test motor
E Turn WATER PUMP switch 4 on	- pump should run	- test pump

3. Manual Test Run of Heater:

• WARNING •

DO NOT ATTEMPT TO TEST OR RUN HEATER WITH BURNER HEAD OPEN. ENSURE BURNER HEAD IS PROPERLY CLOSED AND SECURED IN PLACE.

A Turn WATER PUMP switch 4 "ON".

B Turn MOTOR switch 5 "ON"

C. Push and hold FUEL SOLENOID VALVE button 7 "ON" (starts fuel flow to combustion chamber)

D Push and hold IGNITION SPARK COIL button 6 "ON" (starts electrodes sparking) until combustion has taken place.

Note — Hold IGNITION SPARK COIL button "ON" until FLAME DETECTOR LED 3 lights or combustion is heard, then release; in any case, do not hold button on for more than 15 seconds.

Results:

1 LED 3 lights and combustion achieved
- operation normal

2 Combustion achieved but no LED 3 light
- check flame detector

3 Combustion not achieved and no LED 3 light
- check fuel nozzle
- check fuel pressure
- check for blocked fuel lines (dirt or ice)
- check ignition electrodes for damage and set gap

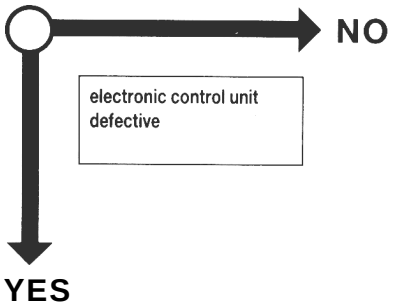
E Heater should now be in heating mode and will continue to run until you release the fuel solenoid valve button 7 which stops fuel flow and extinguishes flame immediately. Allow heater to continue running (for cool down) approximately 30 seconds and then turn WATER PUMP switch 4 and MOTOR switch 5 "OFF".

Note – If flame does not stop when the FUEL SOLENOID VALVE button 7 is released, turn MOTOR switch 5 "OFF" to stop heater.
- check solenoid valve

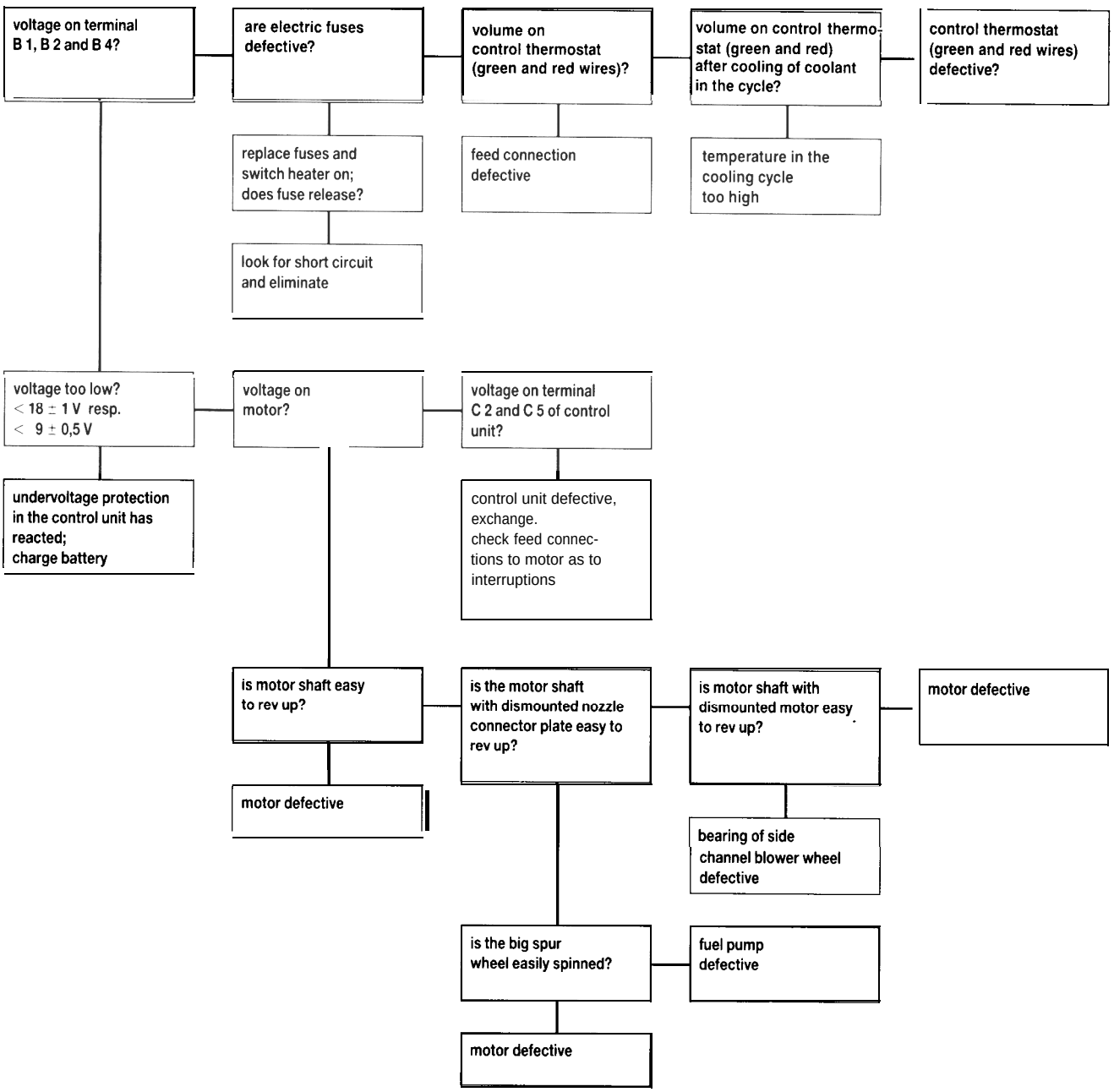
F. If manual test run has been successfully completed, turn heater switch/timer "OFF", remove the tester and reconnect the control unit. Once done, turn switch/timer "ON"; if heater does not start, control unit is defective; replace control unit and retest heater.

5.3 INSTRUCTION FOR FAULT FINDING

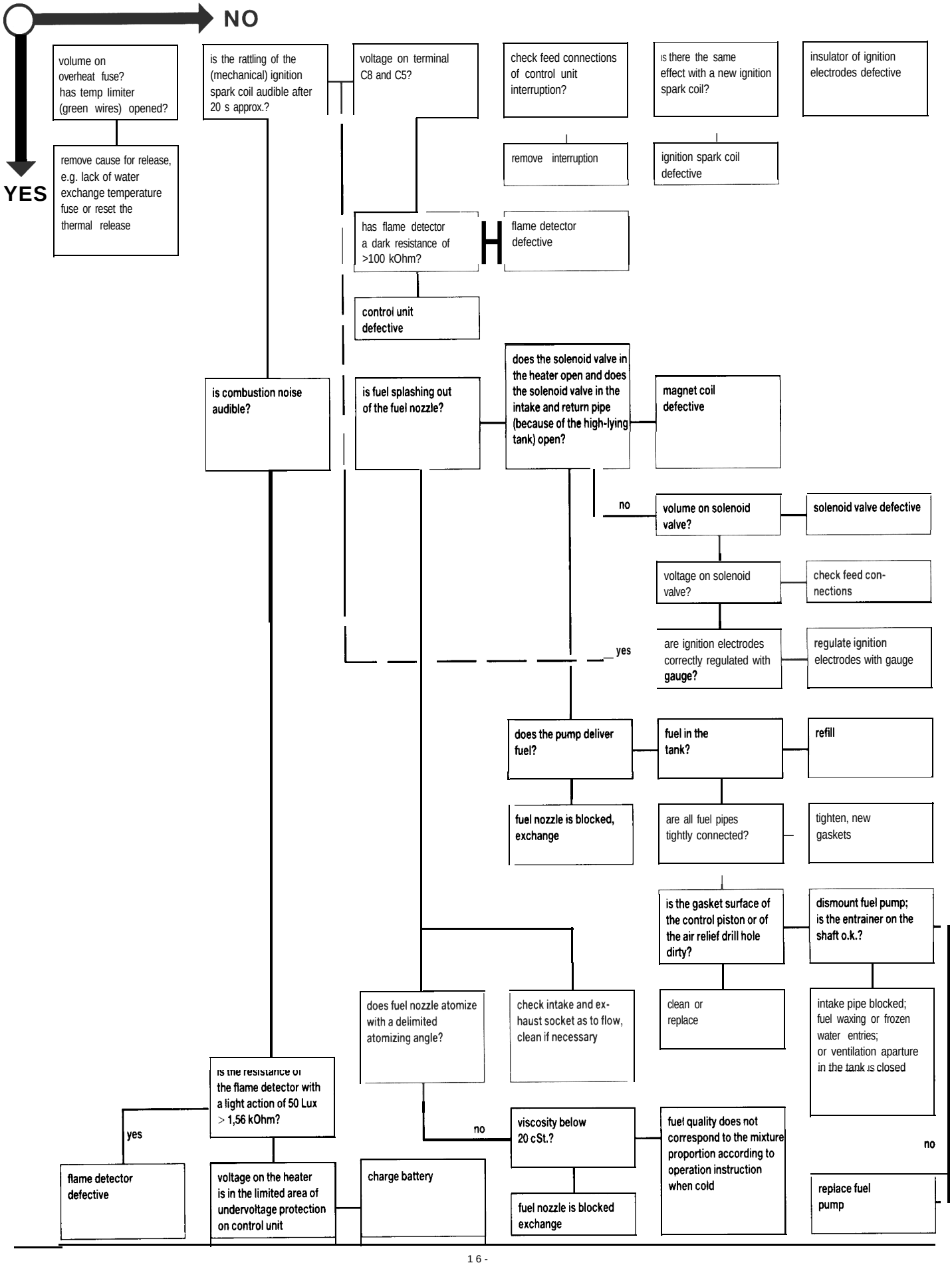
5.3.1 COMBUSTION STARTS IMMEDIATELY WHEN HEATER IS SWITCHED ON



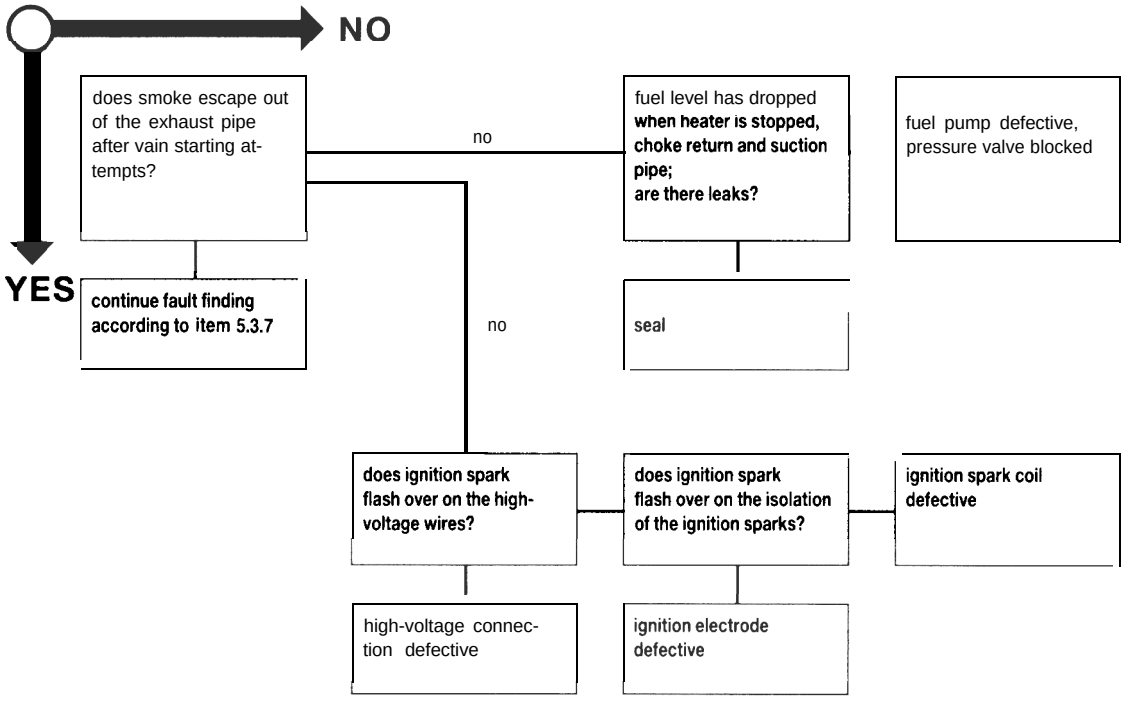
5.3.2 HEATER DOES NOT START WHEN SWITCHED ON



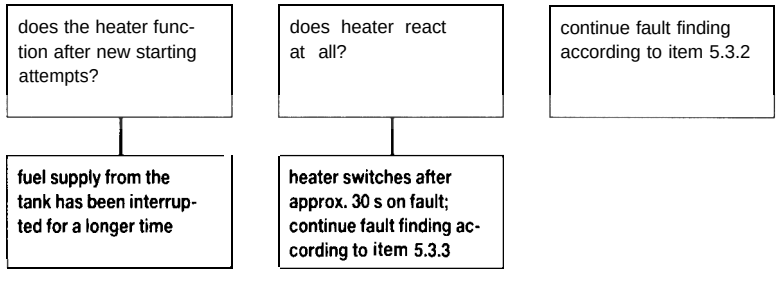
5.3.3 AFTER SWITCHING ON, THE HEATER SWITCHES REPEATEDLY AFTER APPROX. 30 SECONDS ON FAULT



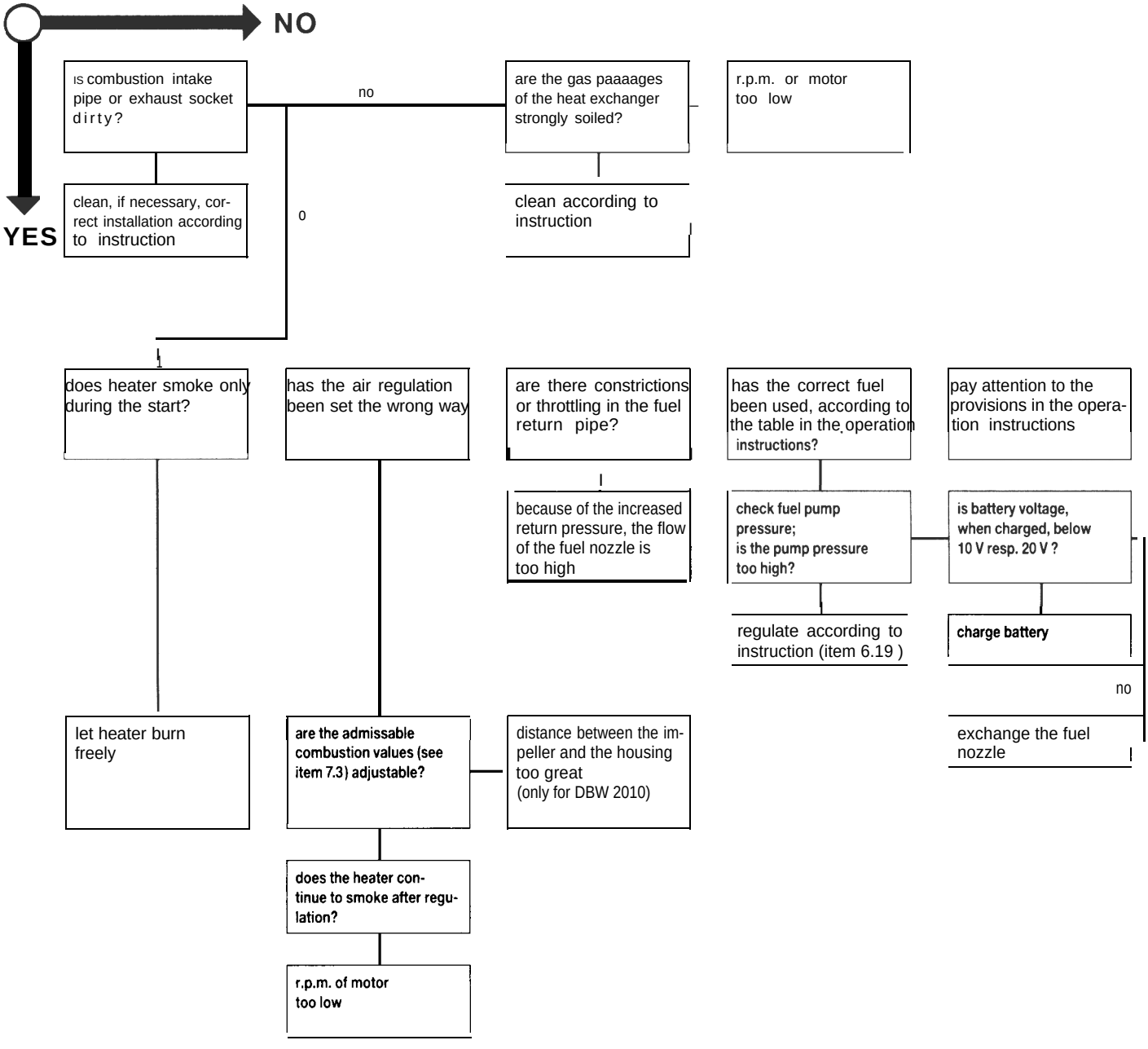
5.3.4 HEATER STARTS ONLY AFTER SEVERAL STARTING ATTEMPTS



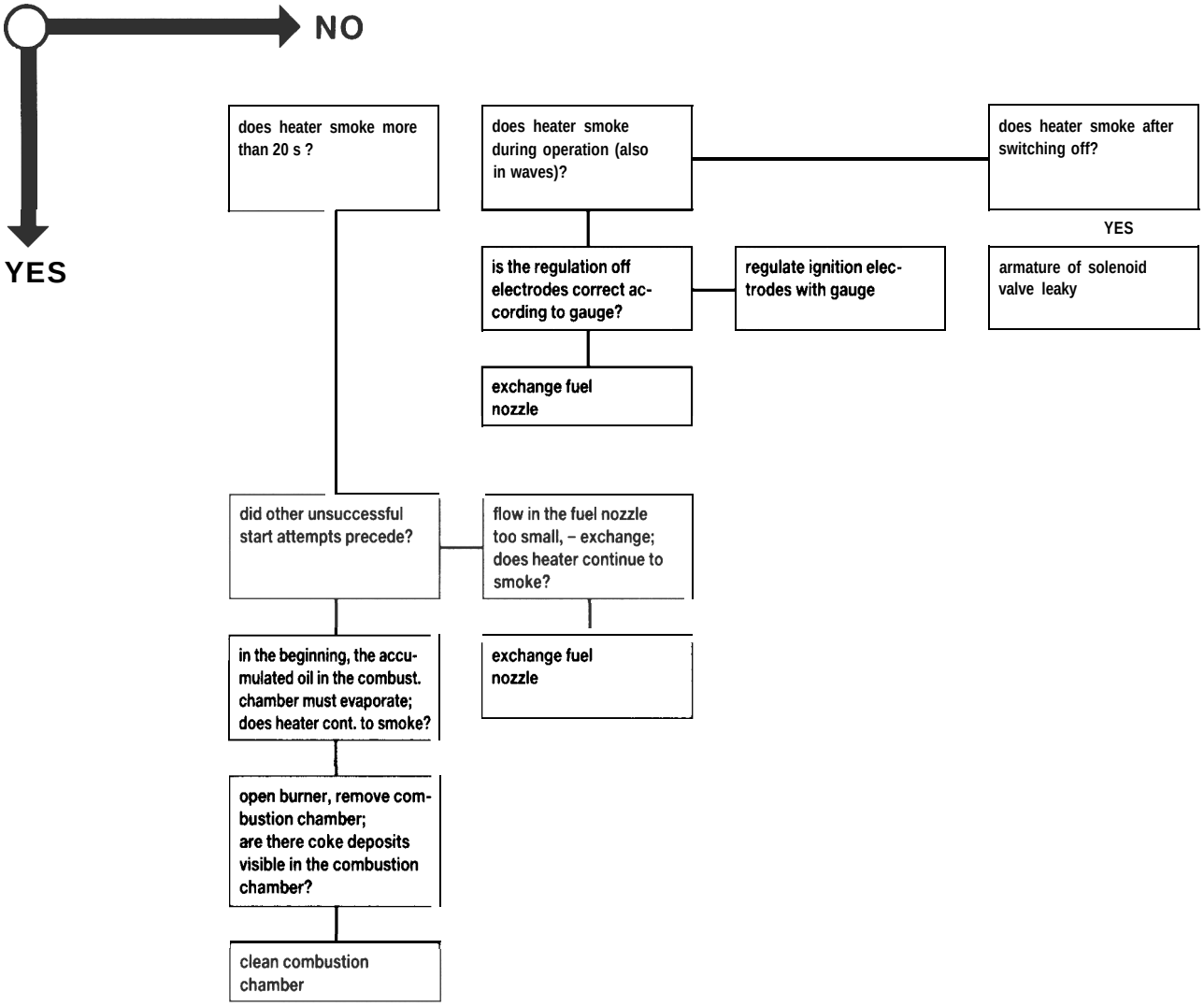
5.3.5 HEATER SWITCHES OFF BY ITSELF DURING OPERATION



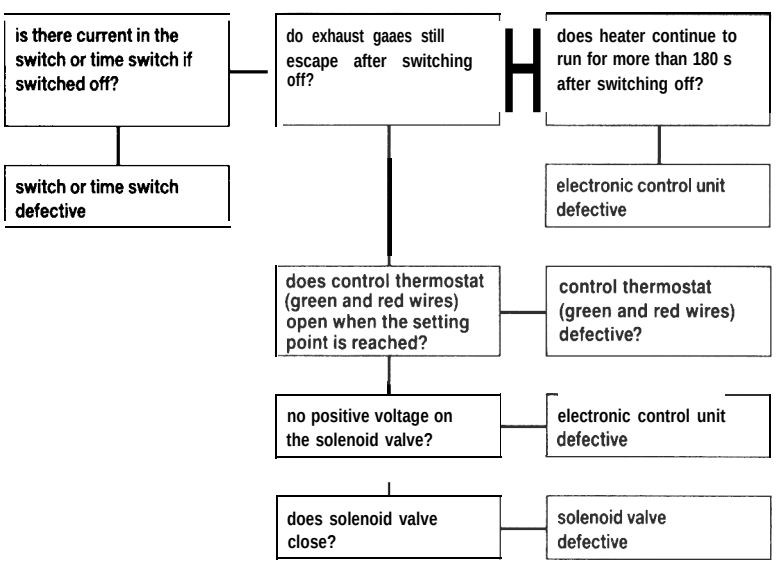
5.3.6 HEATER SMOKES



5.3.7 HEATER SMOKES



5.3.8 HEATER CANNOT BE SWITCHED OFF



6. REPAIRING INSTRUCTION

6.1 Imporant operating tips

— Maintenance of the heater is necessary for proper operation. Read and understand the manual handbook before you attempt to repair.

— If the vehicle requires electric welding, the heater must be electrically disconnected from the vehicle (both "+" and "-" connections).

— The heater should not be operated in enclosed areas as garages, shops, etc., without connections to an exhaust extraction system.

— The battery must not be disconnected while the heater is running, otherwise the heater will overheat.

— The heater should be shut off when refueling.

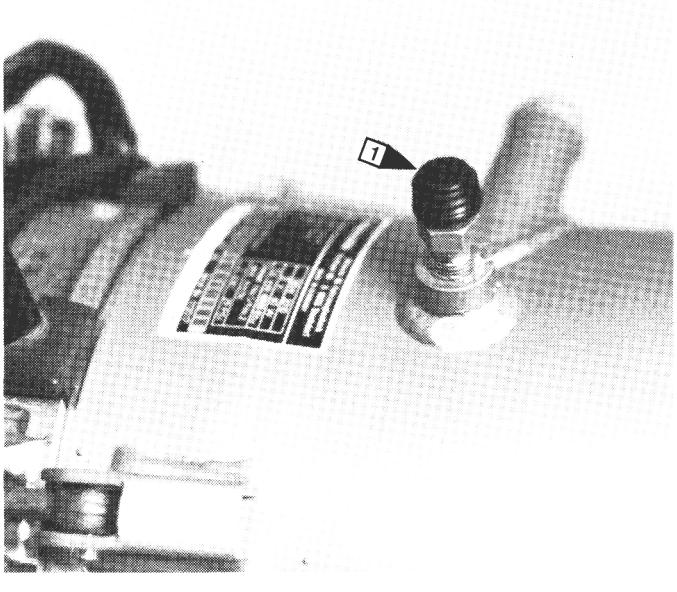
— It is recommended that the diesel heater is switched on and operated periodically during the off season (summertime).

— It is very important that the heater is inspected once a year, even if it works properly. A good time to do this is prior to the season for its use.

6.2 Bleeding the cooling system

Check your installation of DBW series Heater. Check for restriction on the system (pinched hoses, air in system, coolant pump operation, polarity of coolant pump electrical connectors, brown wire to A-1 — see pages 8 -11 on control unit), Check coolant inlet and outlet on coolant pump. Coolant inlet to be fed by static pressure of engine cooling system, coolant pump discharge to lower connection on heater. Check mounting position with Webasto installation drawing.

1. Fill cooling system.
2. Disconnect control thermostat (#5 in wiring diagram - pages 8 - 10),
3. Set heater valve to maximum heat, if so equipped.
4. Turn heater on. This will start coolant circulating pump only.
5. Remove urpper heater hose clam~ and push screw driver in between pipe and hose to let air escape. Repeat this at least four times with engine running or use bleeder valve if so equipped (1).

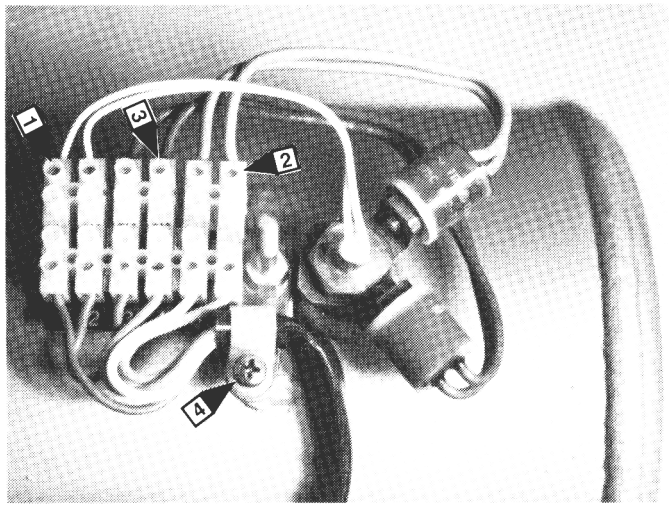


6. Reconnect coolant hose and plug in thermostat. Add coolant. Start heater and check for operation.
7. Temperature differential between coolant inlet and outlet should not exceed 10° C (18° F) after 5 minutes of operation.

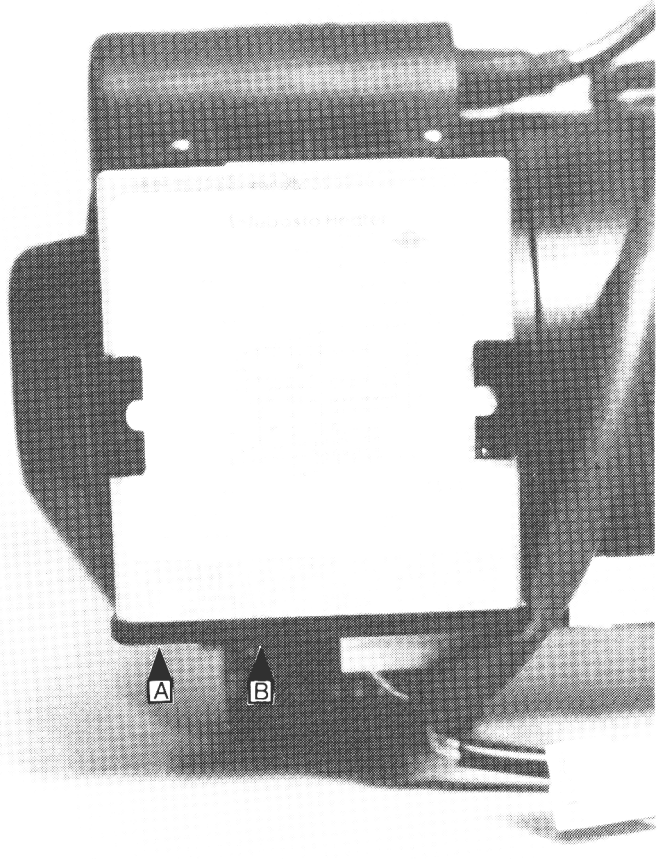
6.3 Removing the burner unit

Replacement of certain components in the combustion unit is made easier if the burner unit is first removed and placed on a bench.

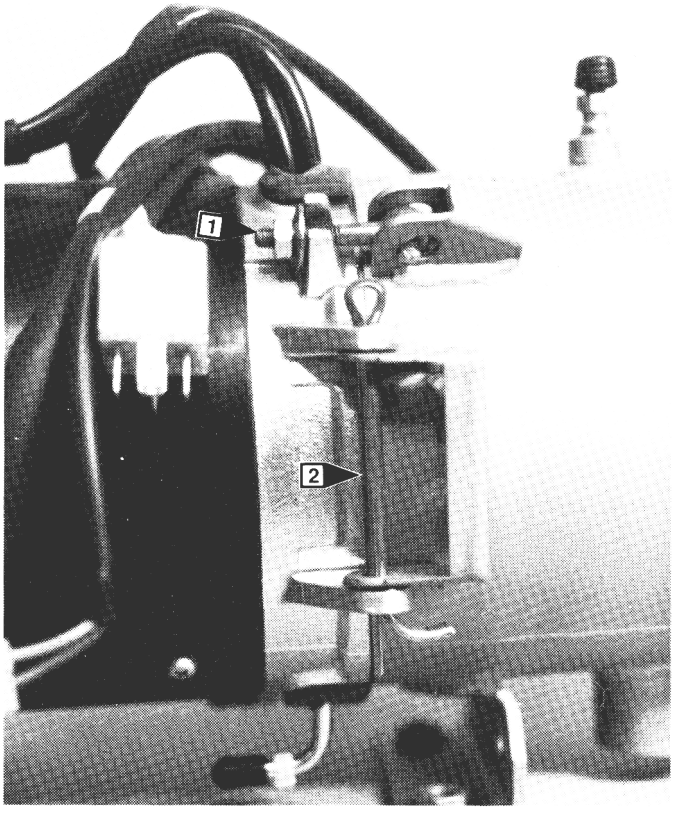
1. Remove the cover on the thermostats, and pull out the connection for the overheat fuse (1), control thermostat (2) and temperature limiter (3), unscrew the clamp (4) and lift up the connectors.



2. Remove block connectors A and B from the control unit and disconnect the fuel lines from the heater connection pipes. Plug the pipes.



3. Loosen two eye bolt nuts (1), swing out, remove the hinge pin (2) and lift off the burner unit.

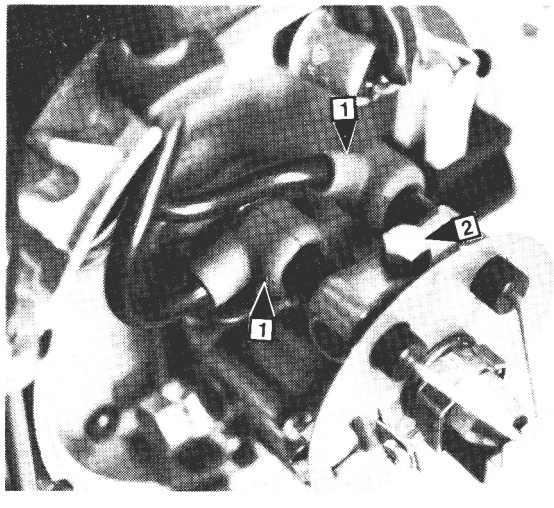


6.4 Installing the burner unit

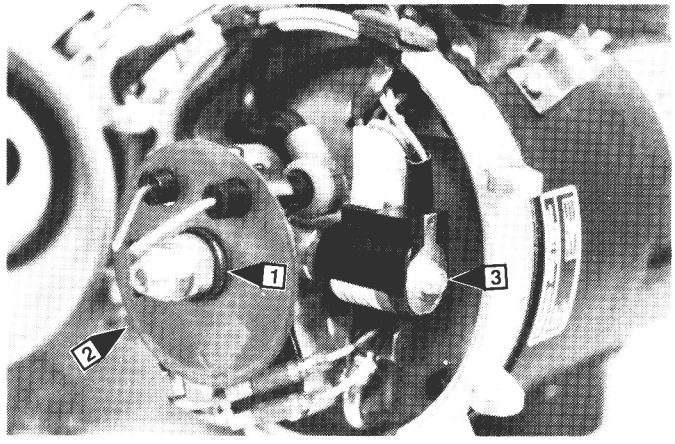
1. Place burner unit in position and fit the split pin in the hinge.
2. Reposition the eye bolts and tighten.
3. Connect the fuel lines and tighten the clamps. The suction line, which is provided with a filter, must be connected to the pipe marked “S”.
4. Re-fit terminal block, Connect the overheat fuse, control thermostat and temperature limiter (see wiring diagram pages 8 - 10). Tighten screws of clamp and cover,
5. Plug connectors A and B into the control unit and thoroughly seal all around the connectors with a sealing compound,
6. Switch on and check function.

6.5 Replacing the solenoid valve

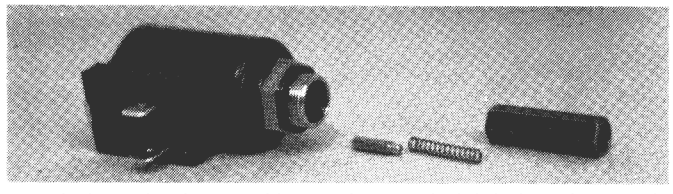
1. Remove the burner unit according to the instructions on page 18, item 6.3.
2. Disconnect the ignition cables from the electrodes (1) and loosen the retaining clamp bolt (2).



3. Remove the ring (1) holding disc (2).
   Lift and carefully turn the disc (2), so that it releases from the ignition electrodes and nozzle holder. Allow the disc to hang from the electric cables.
4 Disconnect the electric cables and unscrew the lock nut from the solenoid valve (3).



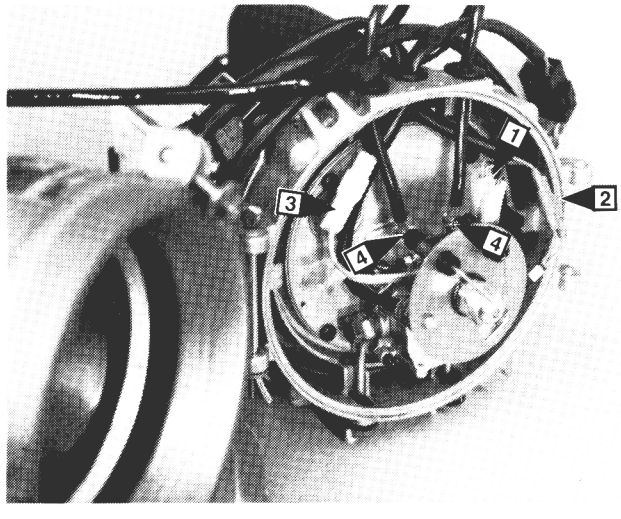
5. Pull out the magnetic head so the valve can be screwed off.
6. Replace the O-ring on the nozzle holder.
7. Unscrew the lock nut from the new valve.
8. Assemble the solenoid valve.



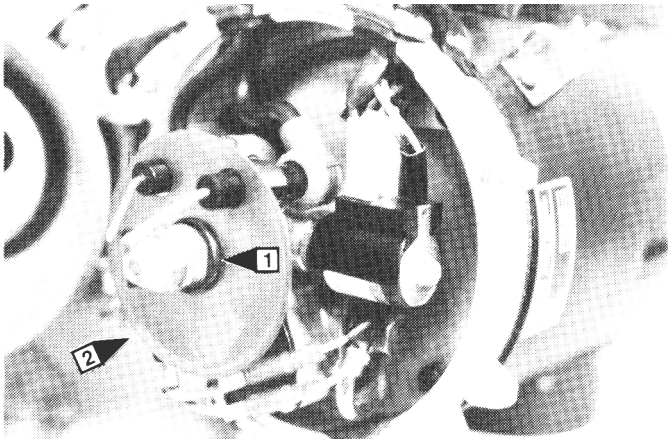
9 Fit the valve into position and screw it tightly into the nozzle holder.
10. Push the magnetic head into position and make sure that the boss registers in the end plate recess. Screw on the lock nut and washer.
11. Connect the electric cables and put the flame control support disc back in its original position.
12 Install ring on the nozzle holder, adjust and tighten the electrodes (see page 21, item 6.9)
13. Install the burner unit in the proper position according to the instructions on page 19, item 6,4).

6.6 Replacing the fuel pump

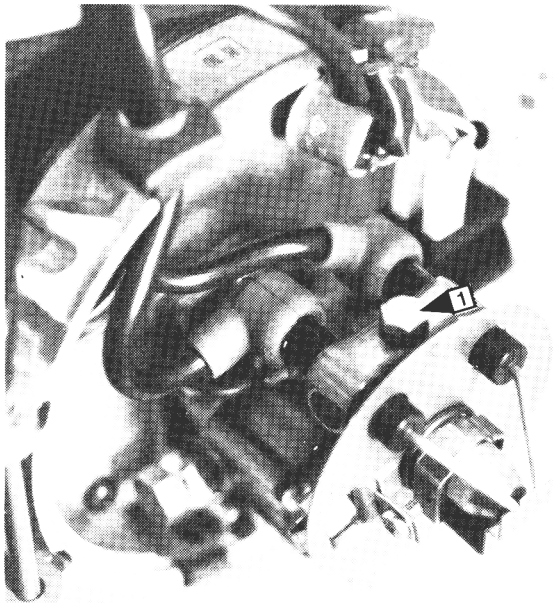
1. Remove the burner unit according to the instructions on page 18, item 6.3.
2. Disconnect electrical wires for solenoid valve (1), flame detector (2), pre-heater (3), ignition electrodes (4).



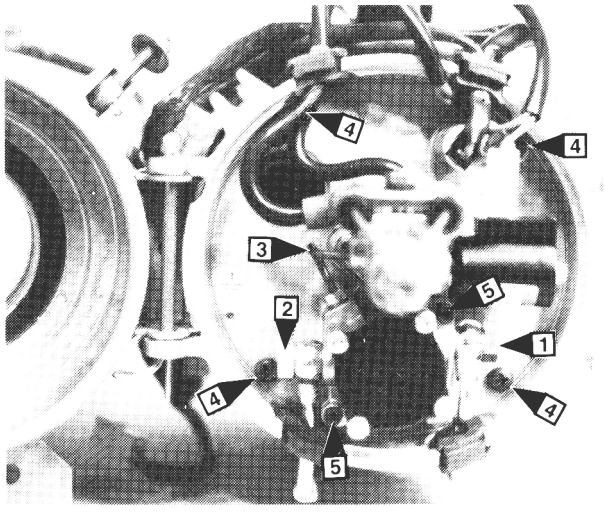
3 . Remove the ring (1), holding disc (2), lift and carefully turn the disc (2), so that it releases from the ignition electrodes and the nozzle holder.



4. Loosen the retaining clamp bolt (1) and dismount ignition electrodes.



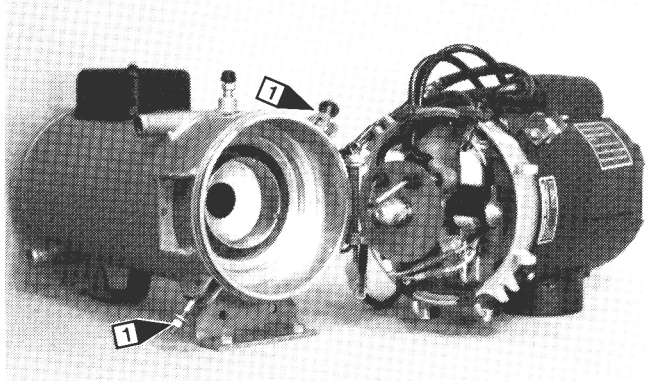
5. Disconnect the return (1) and suction (2) pipes from the fuel pump, Disconnect the delivery pipe (3) from the pump to the nozzle holder. Unscrew the four screws (4) on the back wall and take it out with the nozzle holder and the fuel pump. Remove both bolts (5) which secure the pump.



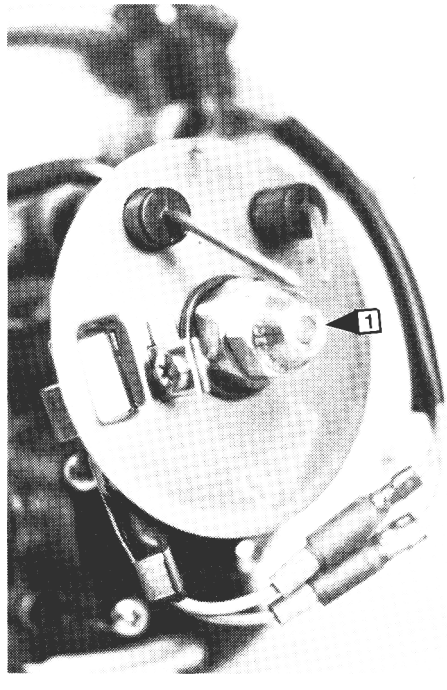
6. Remove the ring from the fuel pump shaft and dismount gear-wheel.
7. Install new fuel pump.
   NOTE: Do not touch the pump regulating screw, The pump has been pre-set to the correct pressure.
8. Screw pump to the back plate, install gear wheel on the fuel pump shaft and fit it in the heater.
9. Connect all fuel pipes and electrical cables.
10. Install disc with flame detector and ignition electrodes. Adjust ignition electrodes (see page 21, item 6.9)
11. Replace the fuel filter on the suction line.
12. Install the burner unit according to the instructions on page 19, item 6.4)

6.7 Replacing the nozzle

1. Loosen the eye bolt nuts (1) to release the eye bolts and swing out the burner unit without stretching the fuel lines and electric cables.



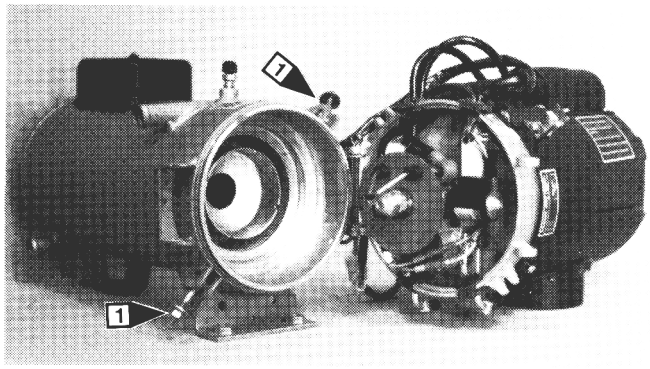
2. Unscrew the nozzle (1), use the nozzle wrench (see page 28, item 7.5) or two wrenches (16 mm and 19 mm). Make sure the ignition electrodes are not moved.



3. Install and tighten the new nozzle. Make sure that the ignition electrodes are not moved; if it is necessary adjust them — see page 21, item 6.9.
4. Swing the unit back into its initial position and tighten the nuts on the eye bolts. Fit new band clamps around the electric cables if the old ones were removed.

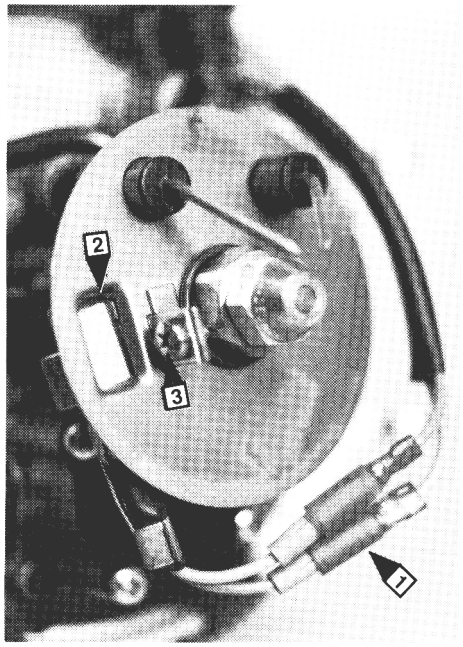
6.8 Checking or replacing the flame detector

1. Loosen the nuts on the eye bolts (1) and swing out the burner unit without stretching the fuel lines and electric cables.



2. Detach the electric cables (1) for the flame control and connect to an ohm-meter. Calibrate the ohm-meter and check the resistance by placing your thumb over and then removing it from the “window” (2). If the flame control is operating properly, the instrument should clearly register resistance.

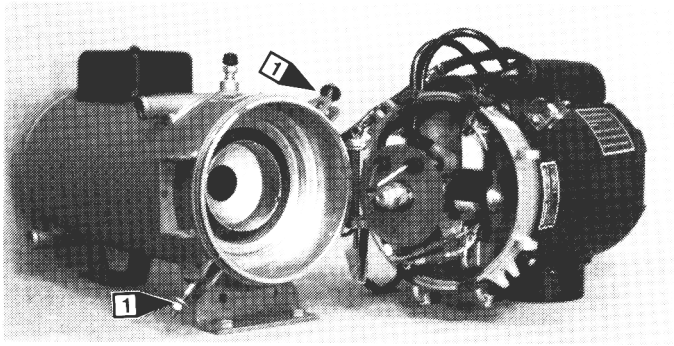
   High resistance when dark, less than 200 OHM with light on element.



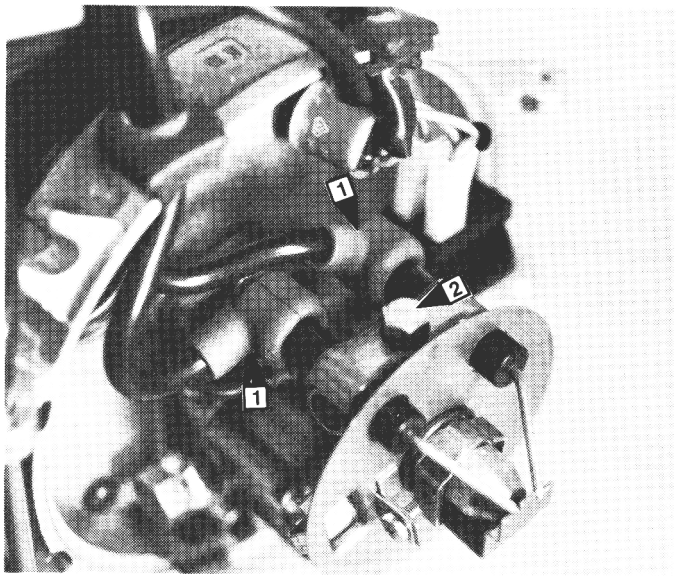
3. To remove the flame detector, unscrew it (3 - above picture) from the support disc.
4. Check the gap between the tips of the electrodes with gauge and adjust if necessary. (See page 21, item 6.9)
5. Swing the combustion unit back into its initial position and tighten up the nuts on the eye bolts.

6.9 Adjusting or replacing the ignition electrodes

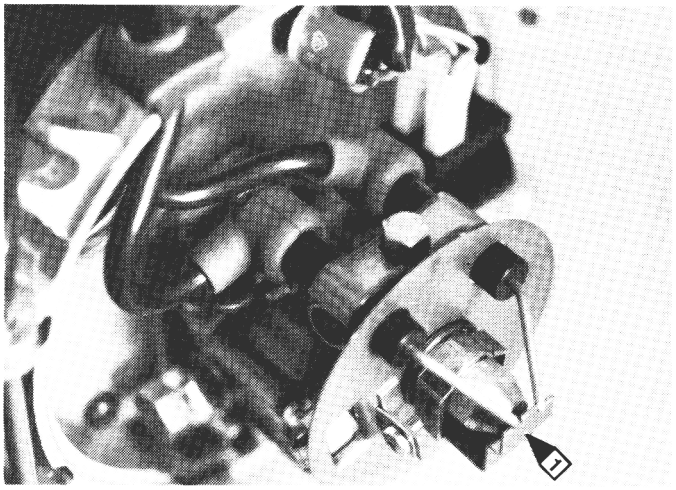
1. Loosen the eye bolt nuts(1) to release the eye bolts and swing out the burner unit without stretching the fuel lines and electric cables.



2. Disconnect the ignition cables (1) from the electrodes and loosen the retaining clamp bolt (2).



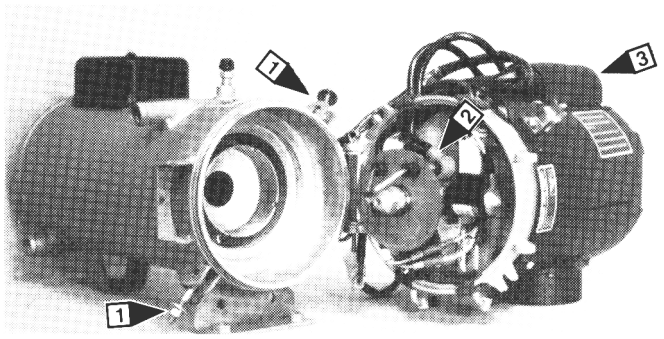
3. Fit the new electrodes into position and connect the electrodes to the ignition cables.
4. Place gauge (1) on nozzle pipe’s hex and insert the electrode tips in the gauge recesses.
5. Tighten the retaining clamp bolt and remove the gauge.



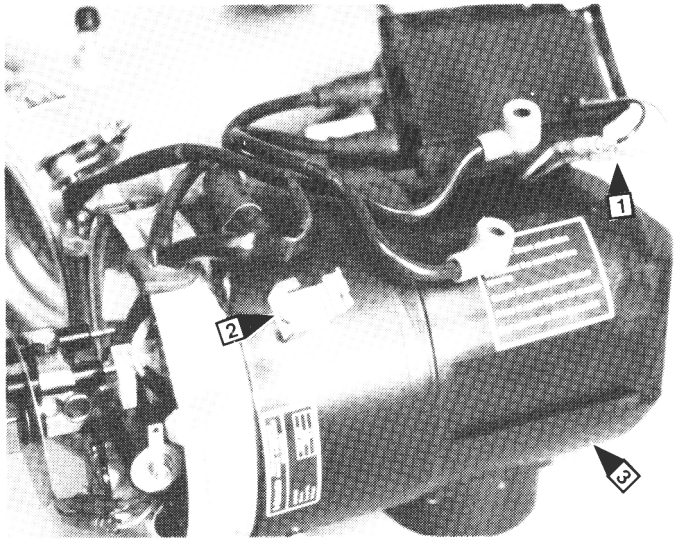
6. Make sure the cables fit neatly in their rubber grommets and the grommets into their niches.
7. Close the burner unit and tighten nuts on the eye bolts. Fit new band clamps to the electric cables if the earlier ones were removed.
8. Switch on and check function.

6.10 Replacing the electric motor

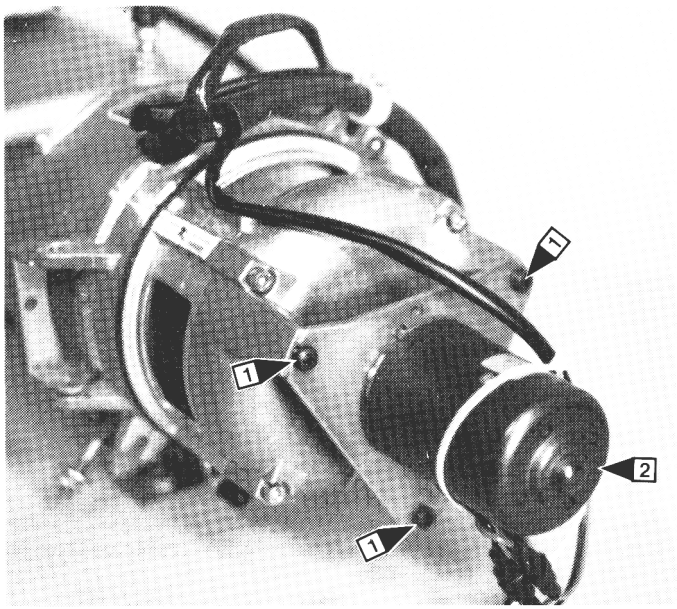
1. Remove the connectors from the control unit.
2. Loosen the eye bolt nuts(1) to release the eye bolts and swing out the combustion unit without stretching the fuel lines and electric cables.
3. Disconnect the ignition cables (2) from the electrodes and unscrew the ignition unit (3).



4. Lift up the ignition unit, disconnect wires (1) and unscrew the four screws (2) securing the protection cover (3).



5. Pull off the protection cover far enough in order to disconnect the electric cables from the electric motor. Then move the cover to the one side.
6. Unscrew the mounting flange (1) and electric motor (2).

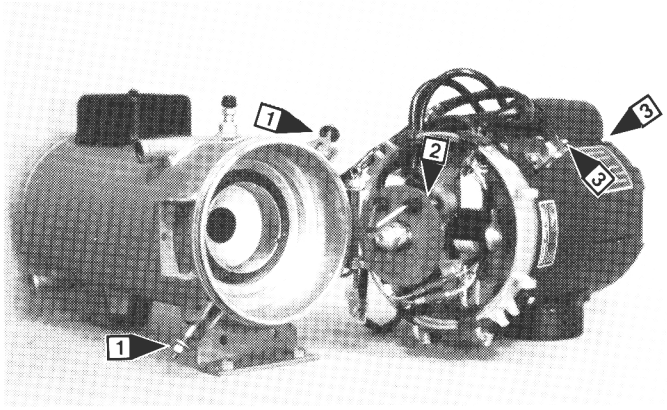


7. Screw the new electric motor to the flange and then to the housing.
8. Connect the electric cables to the motor.
9. Push on the protection cap. Wires to the ignition unit have to go through the hole in the protection cap.
10. Screw on the protection cap, Make sure that the cable harness is placed correctly in the groove in the housing.
11. Connect wires to the ignition unit and screw it on.
12. Tighten the protection cover. Use one of the upper screws to clamp tight the control unit cable harness.
13. Close the burner unit and tighten up the nutson the eye bolts. Fit new band clamps around the electric cables if the old ones were removed.
14. Insert the connectors into the control unit and seal thorouqhly all around the connection with a sealing compound.

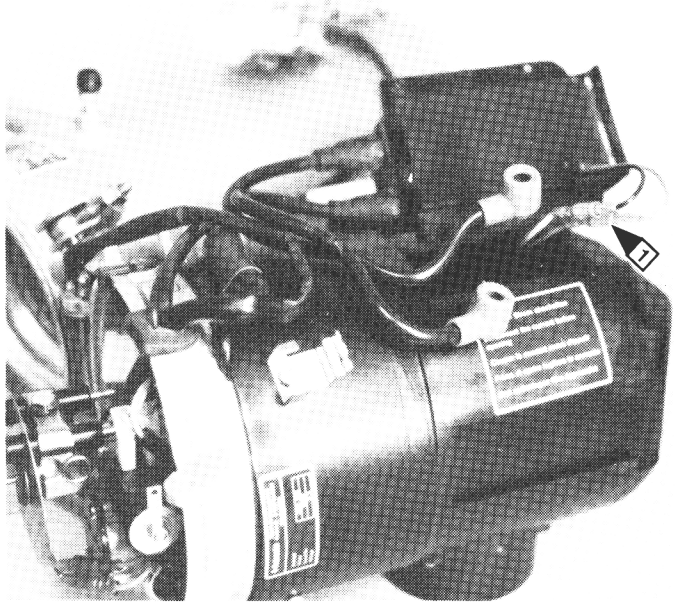
6.11 Replacing the ignition unit

NOTE! If the ignition is faulty, check also the flame detector (see page 21, item 6.8)

1. Loosen the eye bolt nuts(1) and release the eye bolts and swing out the burner unit without stretching the fuel lines and electric cables.
2. Disconnect the ignition cable from the electrodes (2) and unscrew the ignition unit's four retaining screws (3).

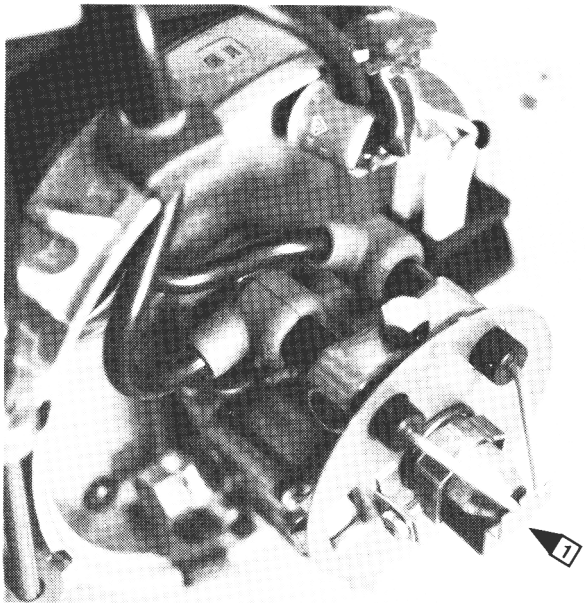


3. Lift up the ignition unit sufficiently in order to disconnect the connectors for the electric cables (l).



4. Press the connectors for the electric cables (1 upper picture) together.
   Brown — Brown
   Black — Yellow

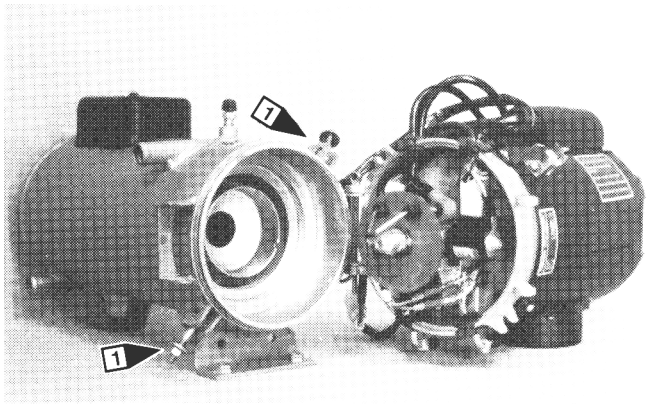
5. Place the ignition unit in position and make sure that the electric cables are not jammed.
6. Tighten the ignition unit and press the ignition cable securely into the niches to make a secure fit.
7. Check the gap between the tips of the electrodes gauge (1) and adjust if necessary.



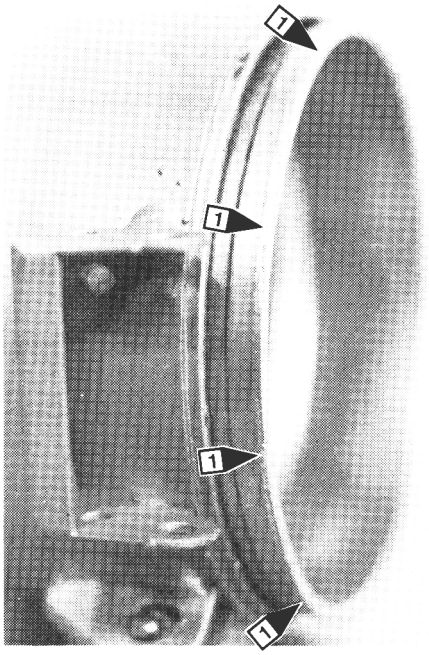
8. Close the burner unit and tighten up the nuts on the eye bolts. Fit new band clamps around the electrical cables if the old ones were removed.
9. Insert the connectors into the control unit and seal thoroughly all around the connection with a sealing compound.
10. Turn on the main switch and check function.

6.12 Replacing or cleaning the combustion chamber

1. Loosen the eye bolt nuts (1) to release the eye bolts and swing out the burner unit without stretching the fuel lines and electric cables.



2. Carefully pry loose the combustion chamber from the heat exchanger. Using a screw driver, pry loose all around a little at a time (1).



3. Clean the chamber with a brush and also the inside of the heat exchanger from carbon.

NOTE! If there is no even carbon deposit pattern on the sides of the combustion chamber the fuel nozzle may be faulty.
The nozzle hole is made with great precision and the slightest wear can negatively affect the fuel spray. This in turn will result in an asymmetrical combustion flame and poor performance.

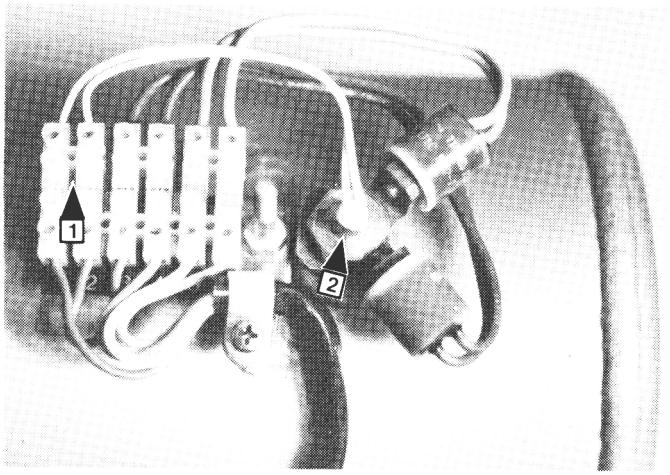
4. Push the combustion chamber into the heat exchanger. If it is not possible to push it in all the way, use a plastic mallet and lightly tap all around the edge.
5. Close the burner unit and tighten up the nuts on the eye bolts.
6. Turn on switch and check function.

6.13 Replacing the overheat fuse

First find out the reason why the unit has overheated before fitting a new fuse. A probable cause is air in the coolant system, an inoperative coolant pump or kinks in the hoses.

1. Lift up the protective cap on top of the heat exchanger.
2. Detach the connector from the terminal block (1) and replace the fuse (2) with the help of the P-grip pliers.
3. Re-fit the connector and the protection cap.
4. Switch on and check function.

NOTE! Overheat thermostat is to be connected to #1 and #2 on terminal block.

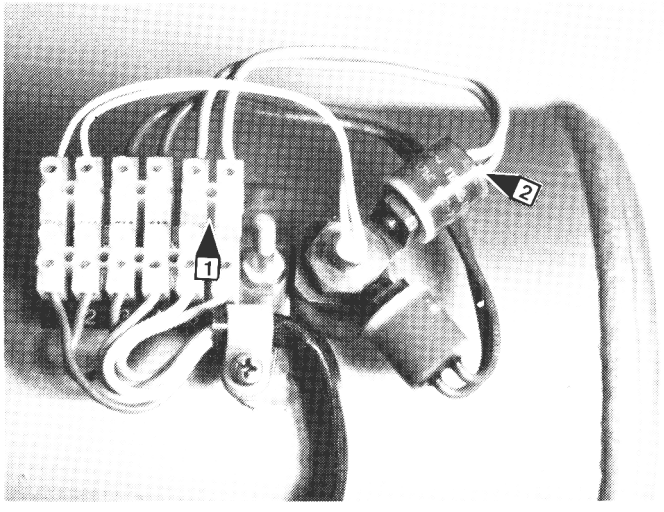


NOTE! The protection cap must be installed, otherwise the thermostats will not function properly.

6.14 Replacing the control thermostat (green and red or white and orange wires).

1. Lift up the protective cap on top of the heat exchanger.
2. Detach the connector (1) at the terminal block and unscrew the thermostat (2).
3. Screw tight the new thermostat to the retainer and re-fit the connector.
4. Fit the protection cap, turn on the main switch and check function.

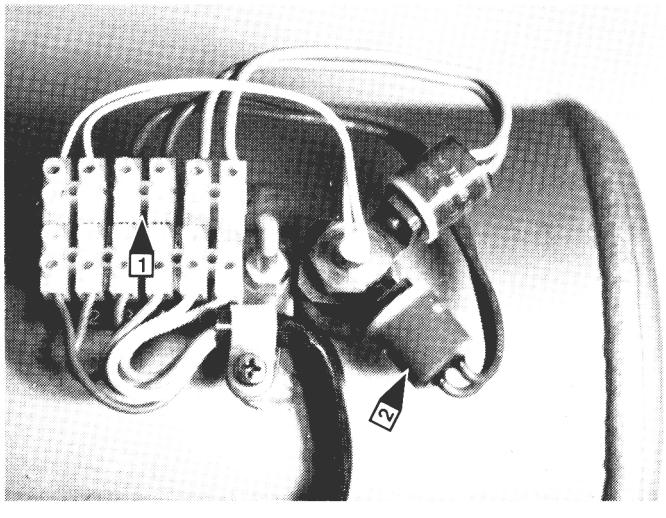
NOTE! Control thermostat is to be connected to #5 and #6 on terminal block.
The protection cap must be installed, otherwise the thermostats will not function properly.



6.15 Replacing the temperature limiter (green wires)

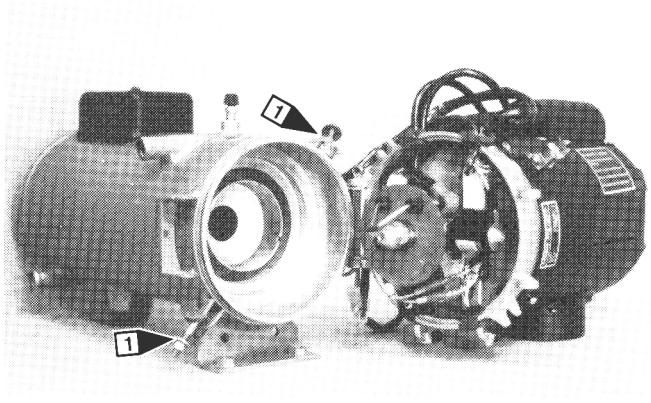
1. Lift up the protective cap on top of the heat exchanger.
2. Detach the connector (1) at the terminal block and unscrew the thermostat (2),.
3. temperature limiter into the copper angle and re-fit the connector.
4. Fit the protection cap, turn on the main switch and check function.

NOTE! Temperature limlier **is** to be connected to #3 and #4 on the terminal block.
The protection cap must be installed, otherwise the thermostats will not function properly.

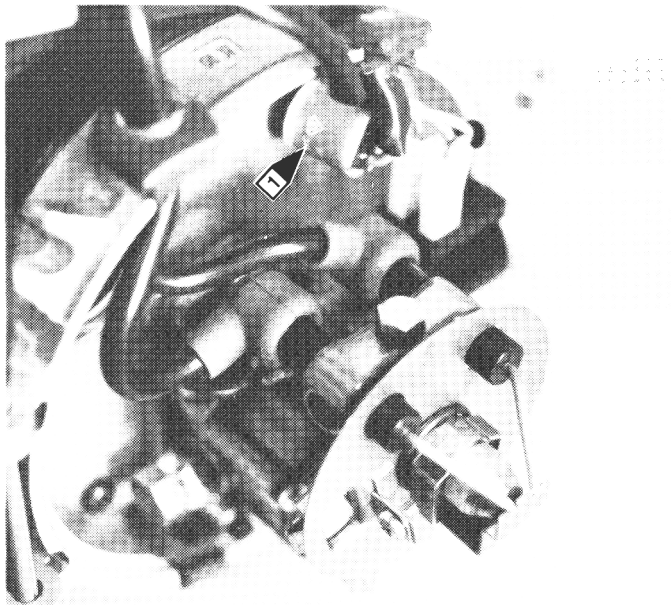


6.16 Replacing the pre-heat thermostat (green and blue wires)

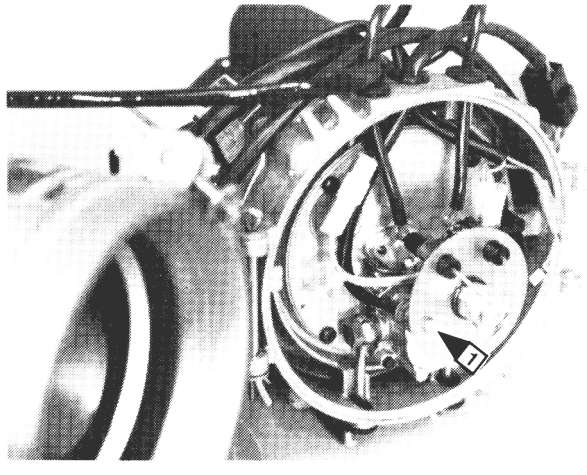
1. Loosen the nuts (1) on the eye bolts and swing out the burner unit without stretching the fuel lines and electric cables.



2. Unscrew the pre-heat thermostat (1) and disconnect wires.



LOCATION OF THE PRE-HEAT THERMOSTAT
FOR DBW 2010 MODEL (1)



LOCATIONS OF THE PRE-HEAT THERMOSTAT
FOR DBW 2020, DWB 300 AND DBW 350 MODELS (1)

3. Install new thermostat and connect electric wires.
4. Swing the burner back into its inital position and tighten the nuts on the eye bolts.

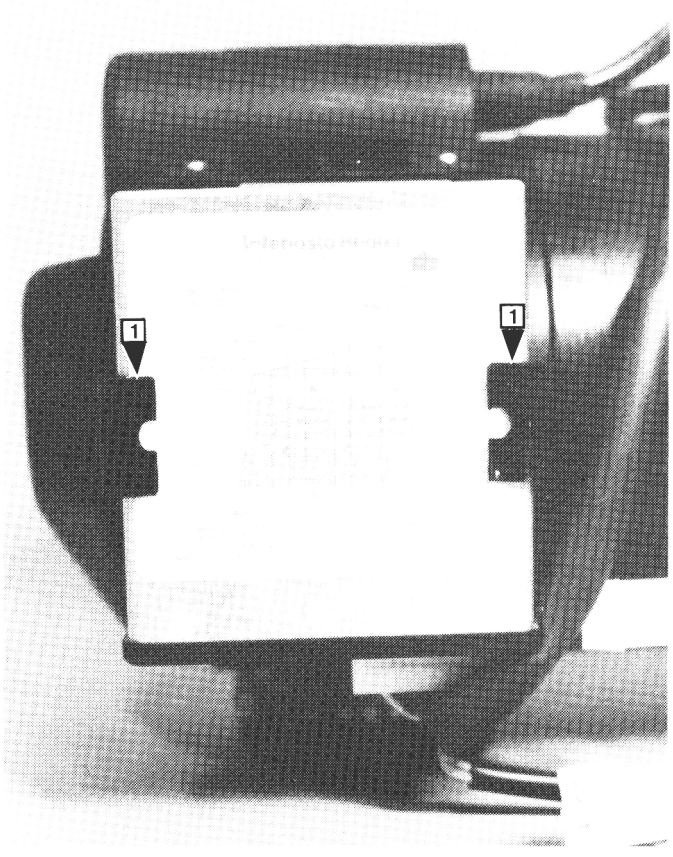
6.17 Replacing the control unit

Built into the control unit is an under-voltage protection which cuts out when voltage drops to the following:

18.5 ±1 volt for 24 volt System
9.5 ±1 volt for 12 volt System

The low-voltage protection resets automatically when the heater is started with the switch or the timer.

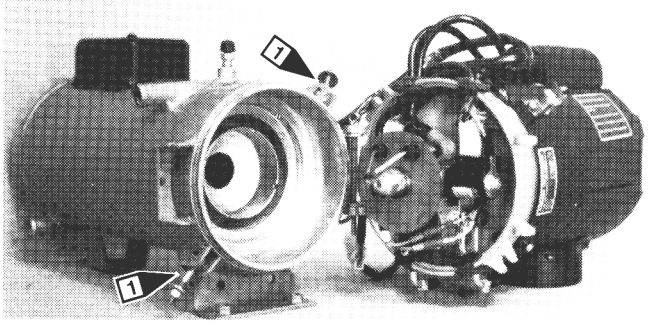
1. Detach the connectors from the control unit and pry the unit loose from the retaining clamp (l).



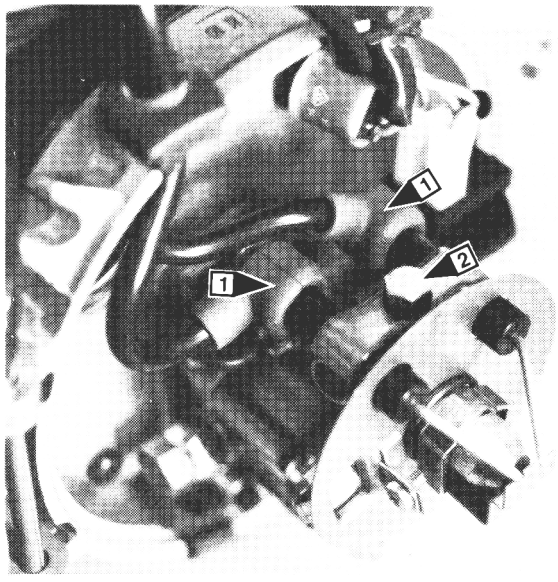
2. Press securely the new control unit into the attachment and re-fit the electrical connections.
3. Seal thoroughly all around the electrical connections with a sealing compound.
4. Switch on and check function.

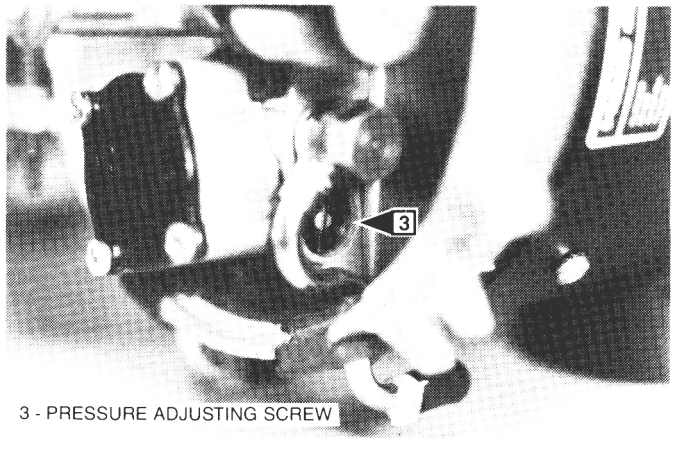
6.18 Checking and adjusting the fuel pressure

1. Loosen the eye bolt nuts (1) to release the eye bolts and hinge out the combustion unit without stretching the fuel lines and electric cables.



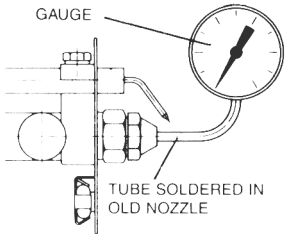
2. Disconnect the ignition cables (1) from the electrodes and unscrew (2) the electrodes.

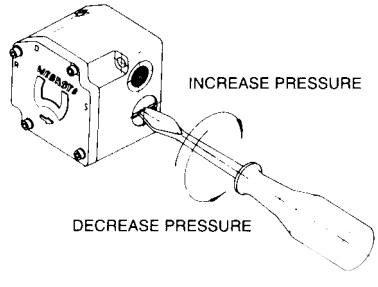




3 - PRESSURE ADJUSTING SCREW

3. Remove the nozzle and fit nipple and pressure gauge.





FUEL PRESSURE:	DBW 2010	8 –0,5 bar (16 – 7 psi)
	DBW 2020	10 ~0,5 bar (145 ±7 psij
	DBW 300	10 ~0,5 bar (145 ±7 psi)
	DBW 350	10 ~0,5 bar (145 ±7 psi)

4. Stop the heater and remove the nipple and pressure gauge.
5. Tighten the nozzle.
6. Fit the ignition electrodes, flame control and ignition cables into position and adjust the electrode gap with gauge (see page 21, item 6.9).
7. Close the burner unit and tighten the nuts on the eye bolts. Fit new band clamps around the electric cables if the old ones were removed.
8. Check function.

6.19 Repairing of the coolant circulating pump

Removing

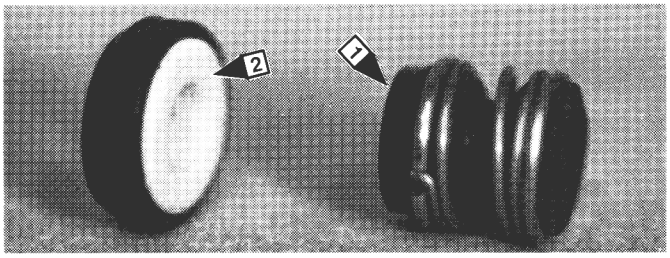
1, Drain the coolant. The coolant hose may have to be pinched with hose pinchers.
2. Detach the connector from the pump electric cables (1).
3. Disconnect the coolant hoses from the pump and unscrew from the bracket.

Disassembling

1. Clean the outside of the pump and secure it in a vice with soft jaws.
2, Unscrew the cover (2) from the body of the pump and remove the O-ring (3).
3. Unscrew the impeller nut (4) and carefully pry loose the impeller (5) with two screwdrivers,
4. Remove the spring seal (7), ceramic (6) and rubber (9) seals. In U481O0move the rubber washer (10).
5. Inspect all parts and replace if necessary. Seals are always replaced.

Assembling

1. Mount all parts in order as shown on page 26 and 27. Silicone seal (6) and spring seal (7) must be fitted in the way shown below. Hard side of the spring seal (1) touches to the ceramic seal (2).



Installing

1. Mount pump.
2. Screw the coolant hoses tight to the pump and remove pinchers if used.
3. Re-fit the connector for the electriccables and seal all around the connection with a sealing compound.

   Match the colours in order to check that the cables are connected correctly; otherwise the pump will rotate in the wrong direction.
   A-1 to brown wire on pump (see wiring diagrams pages 8- 11).
4. Fill the system with the coolant and bleed the heater according to the instructions on page 18, item 6.2.
5. Switch on and check function and for leakage.

IMPORTANT: COOLANT PUMP LEAKAGE

The **U48** series pump uses an internal spring seal which is lubricated by the coolant and, due to the sealing design, there will normally be a certain amount of leakage; however, if the pump is used with coolant that has a high concentration of solids (depends on ratio of mixture), is operated dry (without coolant) or has not been operated at all for several weeks, the seals can be damaged causing excessive leakage. In these cases the pump does not require complete replacement but should have a new seal kit installed.

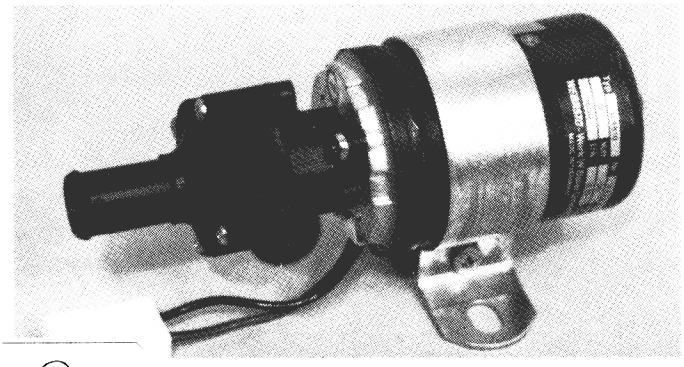
In addition, if leakage is caused by a cracked or damaged body housing, there is also a housing kit available rather than replacing the complete pump.

The compfete pump should only be replaced if the motor is seized or is not operating properfy.

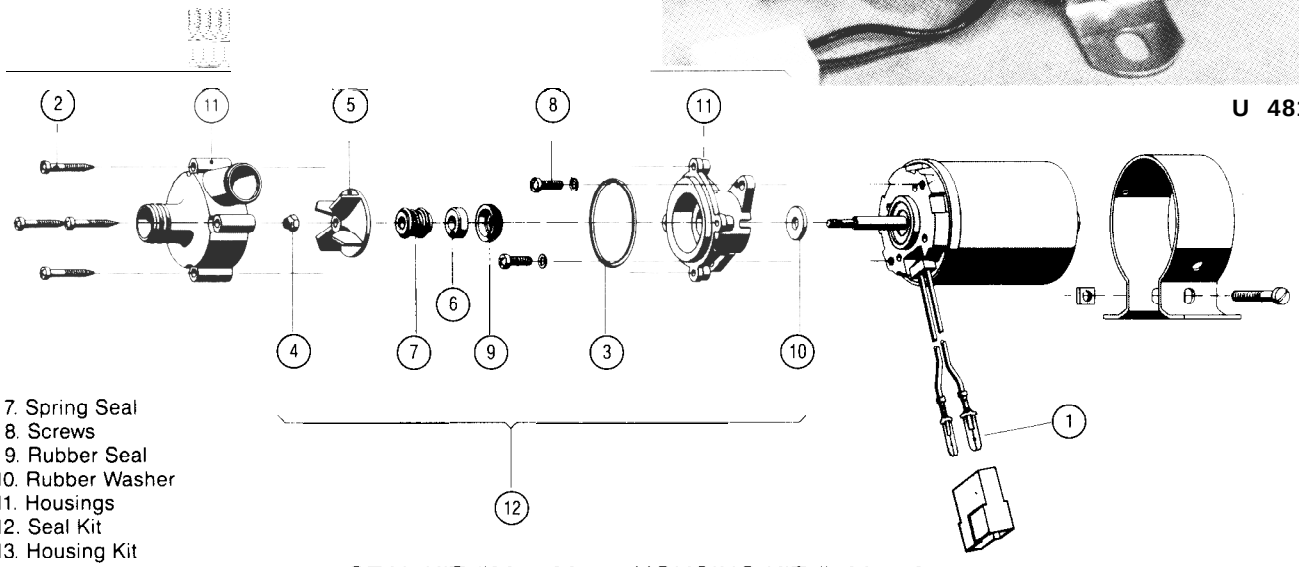
Important points:
- Ž leaking problem, use seal and/or housing kits as required.
- Ž complete pump only when motor is seized or malfunctioning.
- Ž avoid coolant leakage, use a proper coolant ratio mix, never run the pump dry and use the heater at least once a week all year round.

Circulating pump U4810

1. Plug Connector
2. Screws
3. O-Ring
4. Impeller Nut
5. Impeller
6. Ceramic Seal



U 4810

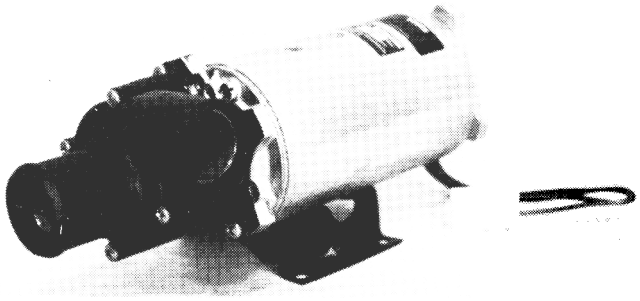


7. Spring Seal
8. Screws
9. Rubber Seal
10. Rubber Washer
11. Housings
12. Seal Kit
13. Housing Kit

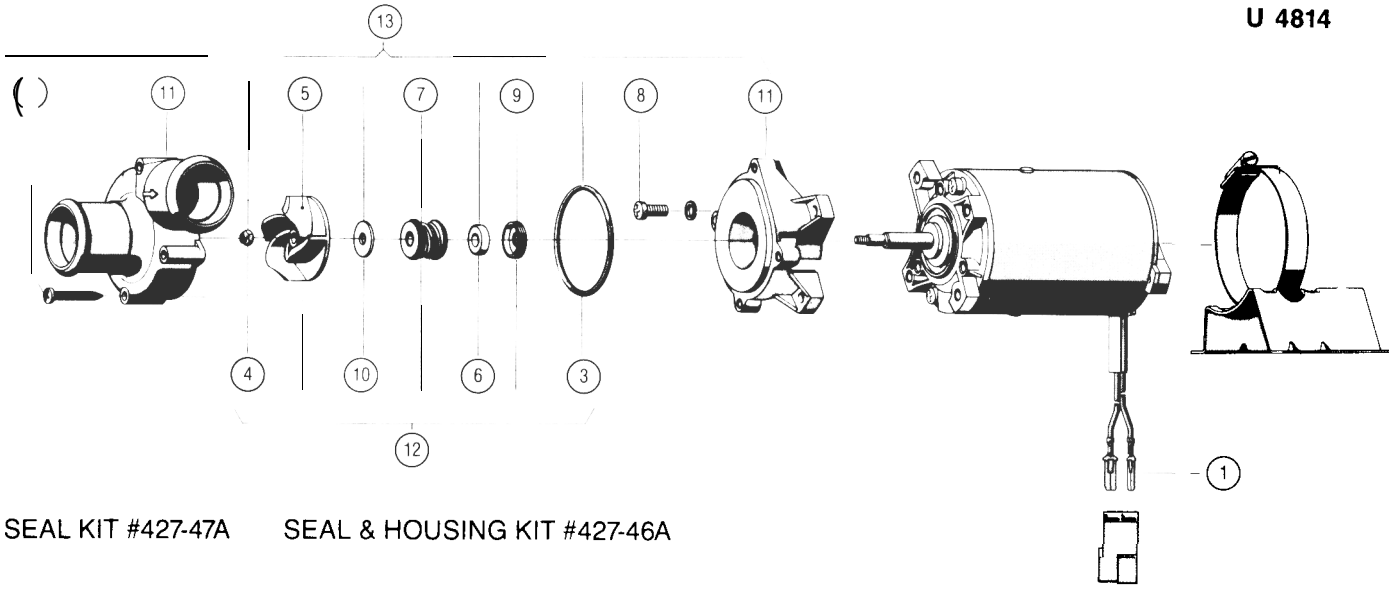
SEAL KIT #307-49A HOUSING KIT #400-556

Circulating pump U4814

1. Plug Connector
2. Screws
3. O-Ring
4. Impeller Nut
5. Impeller
6 Ceramic Seal
7. Spring Seal
8. Screws
9. Rubber Seal
10. Washer
11. Housings
12. Seal Kit
13. Seal & Housing Kit



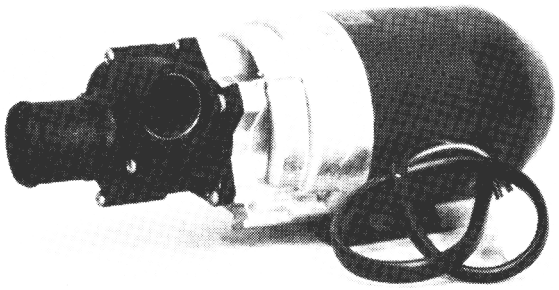
U 4814



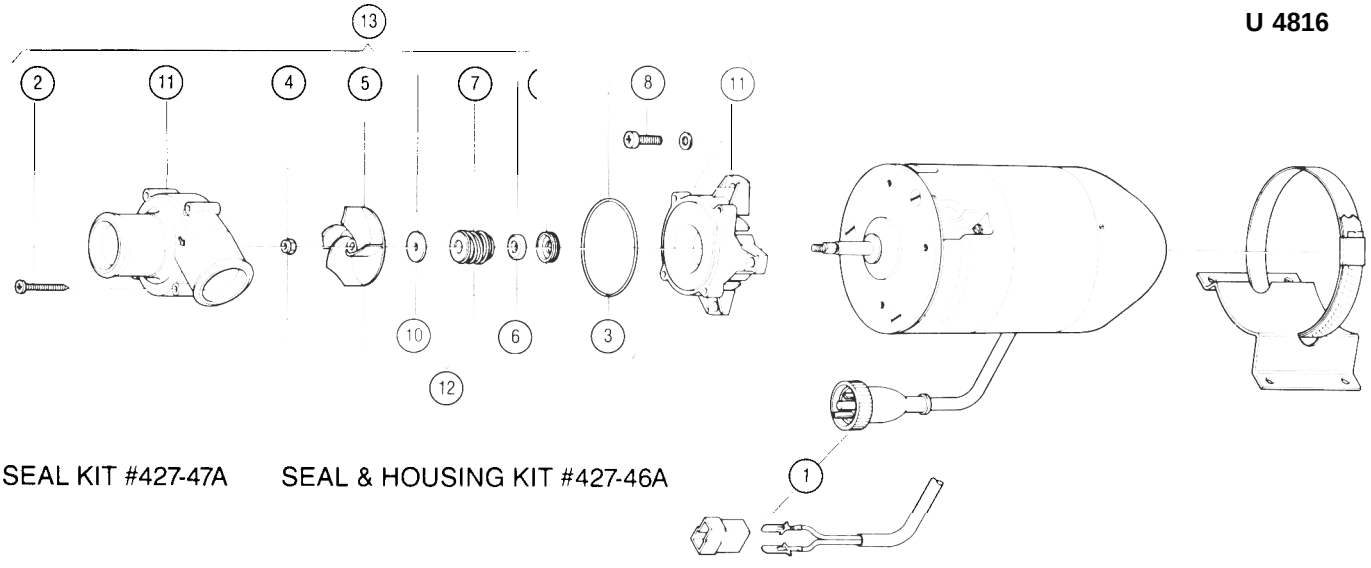
SEAL KIT #427-47A SEAL & HOUSING KIT #427-46A

Circulating pump U4816

1. Plug Connector
2 Screws
3. O-Ring
4. Impeller Nut
5. Impeller
6. Ceramic Seal
7 Spring Seal
8. Screws
9. Rubber Seal
10. Washer
11. Housings
12. Seal Kit
13. Seal & Housing Kit



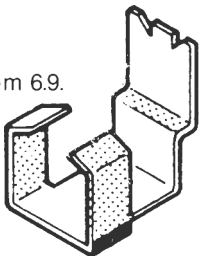
U 4816



SEAL KIT #427-47A SEAL & HOUSING KIT #427-46A

7. INSTRUMENTS AND TOOLS

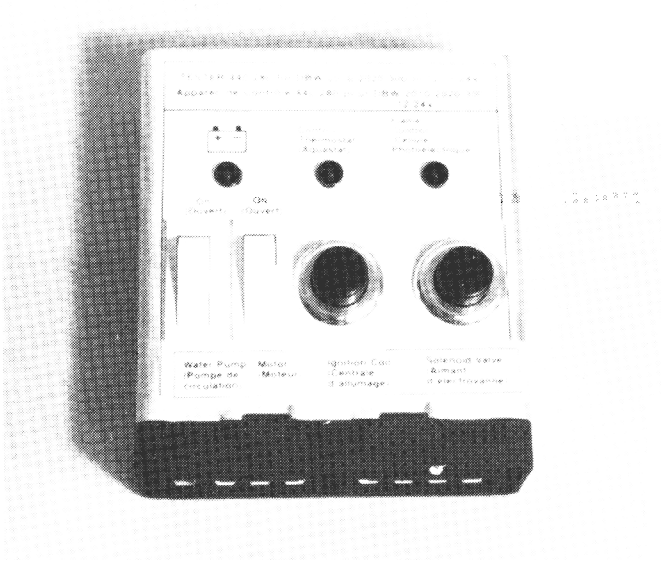
7.1 Gauge



Gauge for regulation of the ignition electrodes on nozzle connections.
Regulation of the ignition electrodes, see item 6.9.
Gauge is mounted on the heater.
Part number: 310.646

7.2 Testing gear

The testing apparatus is suitable fortesting the electronic control unit and the heater.

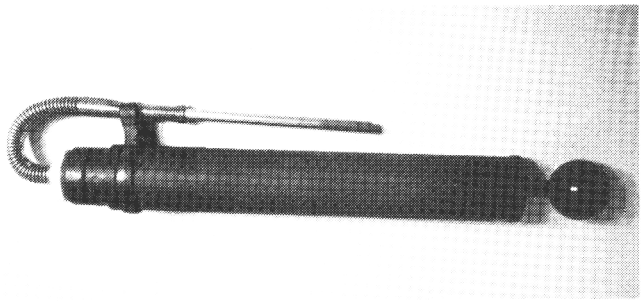


The tester is connected to the heater after taking out the control unit.
Part number: 440.280

7.3 Equipment for checking CO_2

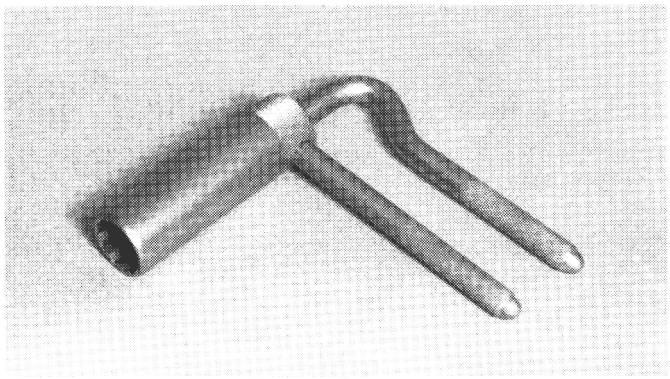
In case of repairs to the burner, irregularities of the combustion or in function tests, the CO_2 in the exhaust should be measured and, if necessary, reset.
Use measuring equipment to check CO_2 in the exhaust gases.

7.4 Equipment for checking 'Smoke Number'



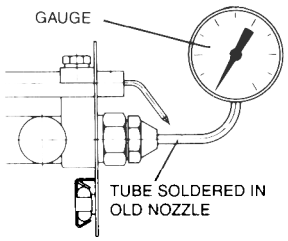
For checking Smoke Number use BRIGON smoke tester.

7.5 Nozzle wrench



Nozzle wrench to screw the high pressure nozzle out and in
Part number: 243.035

7.6 Fuel pressure gauge



Instead of the fuel nozzle, a used nozzle is screwed in, into which a pipe with connected manometer (indication range 0 ÷12 bar (0 ÷180 psi) is soldered (see item 6.19).
PART NUMBER 600.190

— NOTES –

TERMS OF WARRANTY

COVERING

Webasto DBW-MODEL COOLANT HEATERS AND U48-MODEL COOLANT PUMPS

1. A request may be lodged in accordance with the warranty terms individuaIJy enumerated hereafter onfy if the installation was carried out in conformity with our valid installation instructions and furthermore,in conformity with installation drawings prepared by the purchaser and reviewed by us. The absence of compliance with these provisions precludes all warranty requests.

2. The warranty period 12/24 months (as noted below) is effective from the installation date or in the case of OEM installation the registration date of the vehicle. In any event the warranty period may not exceed 24 or 36 months (as noted below) from the original date of delivery by Webasto.

équipement	warranty period	Not to exceed from delivery date
DBW Coolant Heaters (DBW 2010, 2020 & 300 only)	24 months	36 months
Coolant Pumps		
U 4810	24 months	36 months
U 4814 / U 4816	12 months	24 months

3. Within the said period, we warrant the equipment against perceptible and hidden defects and against the absence of covenanted properties or characteristics, and we so warrant it exclusively in such reamer that we, at our own discretion, either repair or replace in our plant those parts of the equipment delivered which demonstrably, despite proper utilization and compliance with the pertinent and valid installation and operating instructions, became unserviceable or suffered sigtilcantly impaired serviceability as a result of circumstances predating the passing and assumption of risk, be it due to defective materials or workmanship. **The parts replaced become our property and must be returned to our plant prepaid. AU other requests are specifically excluded from the warranty and the purchaser acknowledges that the warranty shall only pertain to the work set out above. Without limiting the generality of the exclusion, it is hereby understood and agreed that reimbursement of expenses incurred in connection with repair work, travel expenses, dismantling and reassembly of the equipment delivered and other requests for damages of all kind under whatever legal title, for personal injury or for damage to objects not forming part of our delivery, are specifically excluded in law.** Changes in construction or execution generally effected by us before delivering an order or a piece of equipment shall not entitle the purchaser to formulate a request.

4. Where a warranty request has been approved, the lowest return shipping charges will be borne by us within Canada.

5. Where the warranty terms have been fulfilled (par. 1-4), all requests for reduction of purchase price or rehibition are hereby precluded.

6. Our warranty becomes null and void where the goods delivered have been modified by others or by the installation of parts of foreign origin without our consent. **The warranty also becomes null and void where our valid installation and operating instructions have not been observed.** A warranty request which may be justified as such becomes null and void if our ability to repair the object of the request has been impaired by treating it improperly or othemvise modifying it, e.g. by removing parts thereof.

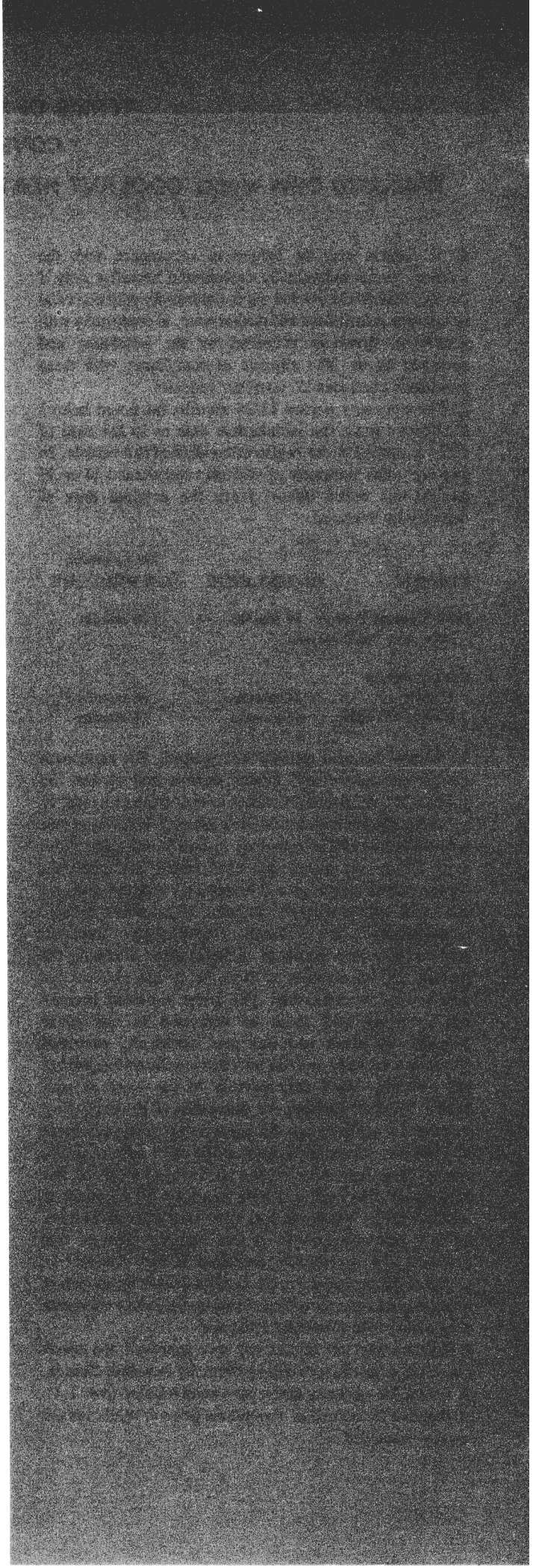
7. The following are not covered by warranty: fuel nozzles, fuel falters, temperature fuses, fuses, carbon brushes, wiring harnesses, corrosion, natural wear and tear, and damage caused by improper treatment. We shall, in particular, not be liable for changes in the condition or the operating characteristics of the goods delivered by us where such changes are caused by improper storage or by climatic or other influences. The warranty shall not cover defects attributed to faulty design or choice of unsuitable materials where the customer has demanded such construction or material despite prior warning.

8. All provisions and clauses which are not in accordance with our terms of warranty or with our general conditions of sale and delivery, be they made by whoever, whenever, and in whatever form, are null and void, and we are not obligated to specillcally disclaim them. The acceptance and fulfilment of an order containing other conditions and clauses shall not change, broaden or restrict our liability nor our other obligations in any way.

9. We decline every responsibility arising out of difficulties encountered upon re-selling or utilizing our products or merchandise sold by us abroad, as a result of regulations protecting industrial property

10. Warranty requests can only be taken into consideration if made in writing immediately upon discovering the defect, and such requests must include the product serial number and date of installation. In requesting warranty, the rectification of the defect without charge must be specifically demanded. The repair or replacement shall not extend nor renew the warranty term.

11. It is a pre-condition for every warranty request lodged in accordance with the above provisions that the warranty card has been completed by the installer and returned to us with the parts objected to. In addition, the duplicate of the warranty card (control card) must have been returned to us immediately after installing the equipment. We are, at our own discretion and without prejudice to our terms or warranty and without admitting any liability, prepared to bear the cost of installation and dismantling within the framework of our Official Warranty Time List. It shall be a condition for accepting the cost of installation and dismantling labour that the work is earned out by us or by a service facility duly authorized by us,



Webasto

CANADA:

Webasto Thermosystems (Canada) Ltd.
4450 Mainway,
Burlington, Ontario L7L 5Y5
Telephone: (905) 335-4143
Fax: (905) 335-6958

U. S. A.:

Webasto Thermosystems Inc.
1598 East Lincoln,
Madison Heights, Michigan
48071
Telephone: (810) 545-8770
Fax: (810) 545-8773

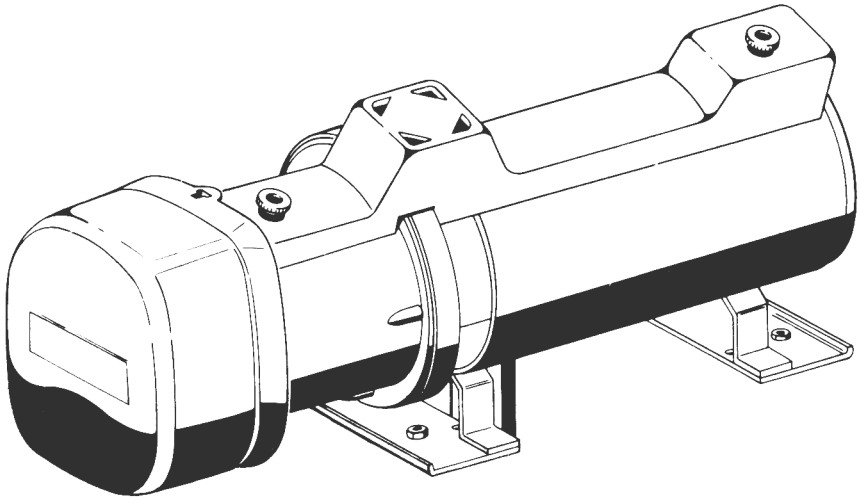
PART NO. 699.745 NOV 94 *Subject to modification.*

Espar

D12W

UNIVERSAL AND BOXED VERSIONS

INSTALLATION
TROUBLESHOOTING
& SPARE PARTS



NOVEMBER 1993

ESPAR D12W COOLANT HEATER

The ESPAR D12W is a diesel-fired 14,000 BTU/hr coolant heater, quality engineered to provide a dependable means of preheating, maintaining heat or providing supplemental heat to water cooled engines and heating systems. For ease of installation, the D12W is available in a universal version or in a weather resistant steel box for applications where adequate protection is not available.

The heater is connected in the coolant system of the vehicle engine and pumps coolant from the engine, heats it and returns it to the engine. By routing the hot coolant through vehicle heat exchangers it is also possible to heat the interior of the vehicle. Since the heater runs on diesel fuel and 12 or 24 volt power, it is able to perform this completely independent of the vehicle engine. A temperature regulating switch in the unit regulates the coolant temperature between a low of **155°F (68°C)** and a high of **176°F (80°C)** by automatically cycling the heater off and on as required.

Note: There are two (2) temperature regulating switches available for the D12W. One is the standard switch that comes with the heater (155°F [68°C] / 176° F [80°C]) and should be used for preheating applications only. If using the heater for preheat **and** supplemental heat (eg. school buses), the hot switch should be used. This switch lets the water heat up to approx 194° F (90°C) before shutting the heater off. Check the parts list for the correct part number for the switch you require.

The D12W can be operated from the vehicle cab by an on/off switch or preselect timer or a combination of both.

Temperature regulating and overheat shut down switches are among the safety features which make the D12W a safe and dependable heating system.

GENERAL SPECIFICATIONS

Heat Output (± 10%) 41,000 BTU/hr

Current Draw (± 10%)	**TYPE**	**START**	**RUNNING**
Standard Pump	12V	17.1 Amps	7.1 Amps
	24V	13.5 Amps	3.5 Amps
High Capacity Pump	12V	23.1 Amps	13.1 Amps
	24V	16.6 Amps	6.6 Amps

Fuel Consumption (±10%)
0.44 US Gal/hr
0.36 Imp Gal/hr
1.65 Litre/hr

Coolant Pump Flow (± 5%) at 200 m Bar head pressure	**Standard**	**High Capacity**
	475 US Gal/hr	690 US Gal/hr
	396 Imp Gal/hr	552 Imp Gal/hr
	1800 Litre/hr	2600 Litre/hr

Operating Voltage Range
* 10.5 to 14.0 vdc at 12 vdc
* 21.0 to 28.0 vdc at 24 vdc

*The heater control unit is equipped with a low voltage cutout at 10.5V or 21.0V. The unit will automatically shut down at the low voltage level to protect the heater.

NOTE: The coolant pump will not shut down at low voltage levels.

Coolant Temperature Range (± 5%)

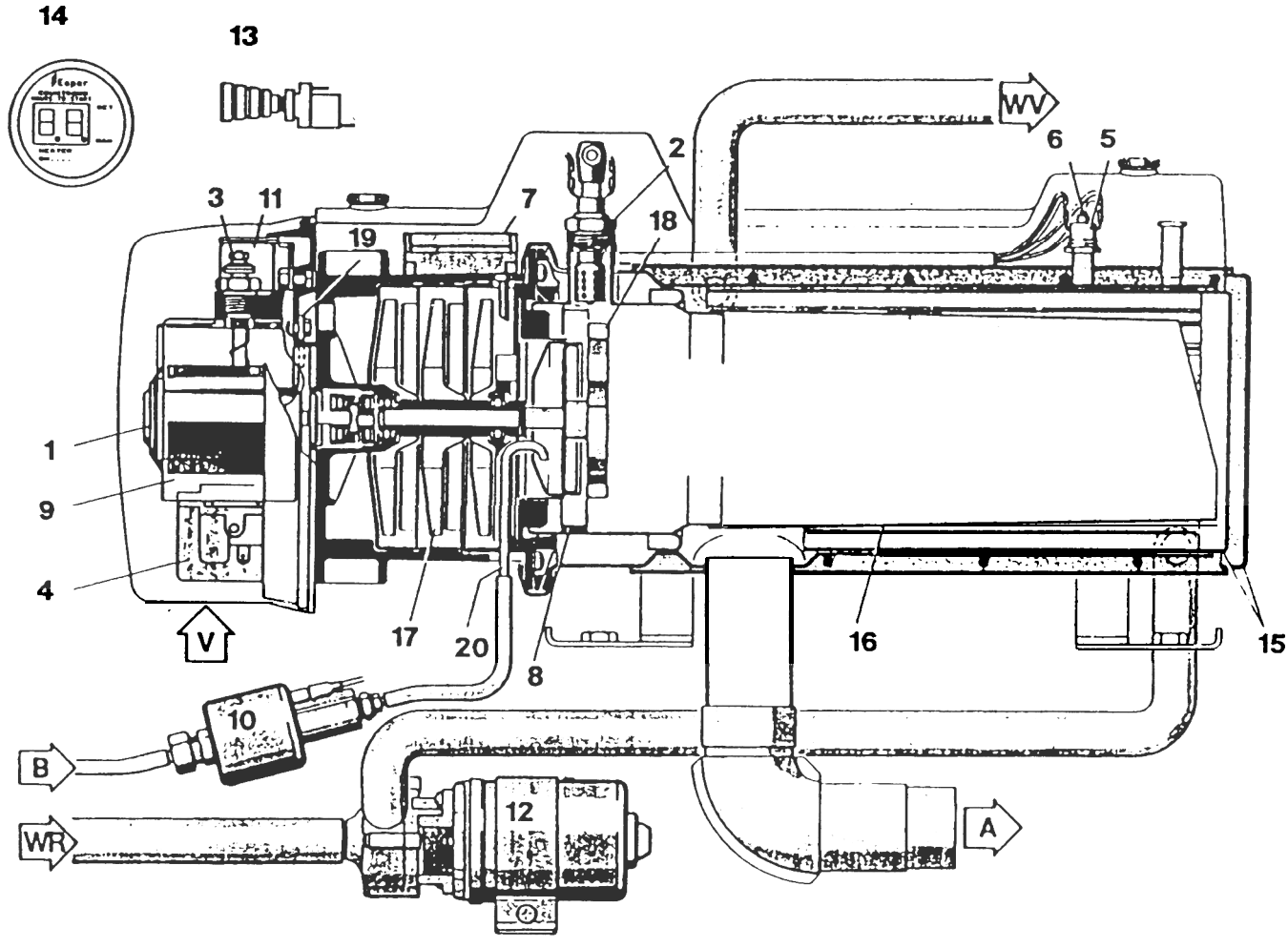
Standard Switch
At 155°F heater switches on (68°C)
At 176°F heater switches off (80°C)

Hotter Switch
At 178°F heater switches on (81°C)
At 194°F heater switches off (90°C)

Overheat Temperature Shutdown (± 5%) 235°F (115°C)

Controls: On/Off switch or optional 99 hour countdown timer.

D12W HEATER OVERVIEW



1. Combustion Motor
2. Glow Plug
3. Series Resistor for Glow Plug
4. Ignition Spark Generator
5. Temperature Regulating Switch
6. Overheat Cutout Switch
7. Flame Sensor
8. Wick Ring
9. Control Unit
10. Fuel Metering Pump
11. Coolant Pump Relay
12. Coolant Pump
13. Push/Pull Switch
14. 99 Hour Timer
15. Heat Exchanger
16. Flame Pipe
17. Combustion Air Blower
18. Atomizer
19. Air Valve
20. Fuel Pipe

A = Exhaust Outlet
B = Fuel in
v = Combustion Air
WR = Coolant in

INSTALLATION PROCEDURES

WARNING

1. Correct installation of this heater is necessary for proper operation. Read and understand the installation manual enclosed before you attempt to install.
2. Do not install heater in passenger compartment.
3. Do not install in enclosed areas where combustible fumes can be present. Do not install heaters in engine compartments of gasoline powered boats.
4. The heater exhaust is hot. Keep a minimum of 2“ clearance from any heat sensitive material.
5. Install heater exhaust so that papers, rags, etc., cannot come in contact with it.
6. Route heater exhaust so that exhaust fumes cannot enter the passenger compartment.
7. Heater must be turned off when vehicle or boat is being refueled.
8. Double check all fuel and exhaust connections for leaks after installation.
9. For any questions or the name of your nearest authorized Espar representative. call:

U.S. 800-387-4800 Canada 800-668-5676

WARNING

Safety Hazard on Coolant Heaters Used With Improper Antifreeze Mixtures

The use of ESPAR coolant heaters requires that the coolant in the system to be heated contain a proper mixture of water and antifreeze to prevent coolant from freezing or slushing.

If the coolant becomes slushy or frozen, the heater’s coolant pump cannot move the coolant causing a blockage of the circulating system. Once this occurs, pressure will build-up rapidly in the heater and the coolant hose will either burst or blow off at the connection point to the heater.

This situation could cause engine damage and/or personal injury. Great care should be taken to ensure a proper mixture of water and anitfreeze is used in the coolant system.

Please refer to engine manufacturer’s or coolant manufacturer’s recommendations for your specific requirements.

1. Heater Location

Depending on the type of vehicle, the best location for mounting the heater will vary greatly. If the heater can be mounted in aprotected area (eg: storage compartment, step box, engine compartment, etc.), the universal type can be used. However, if this is not possible the boxed version must beused.

Basically the heater may be mounted anywhere on the vehicle with the following conditions:

A. Locate the heater below the normal coolant level of the engine.

B. Locate heater where road sprayer debris cannot damage it.

C. **DO N0T** mount heater inside the vehicle passenger area.

When selecting the Location, consider the following:

A. EngineCoolant Hose Connections

B. Heat Exchanger Connections (if applicable)

C. Fuel Line Connections

D. Electrical Connections

In all cases, “the closer, the better.”

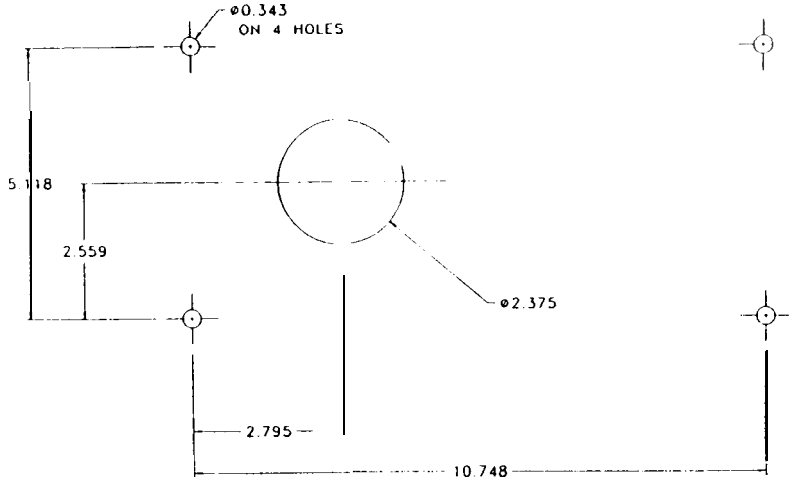
2. Heater Mounting

2 A. Universal Type

The heater is mounted using four (4) rubber shock mounts between heater and mounting surface. Hole pattern for mounting universal type is shown in Figure 2A.

NOTE: For severe vibration applications, heavier mounts may be required.

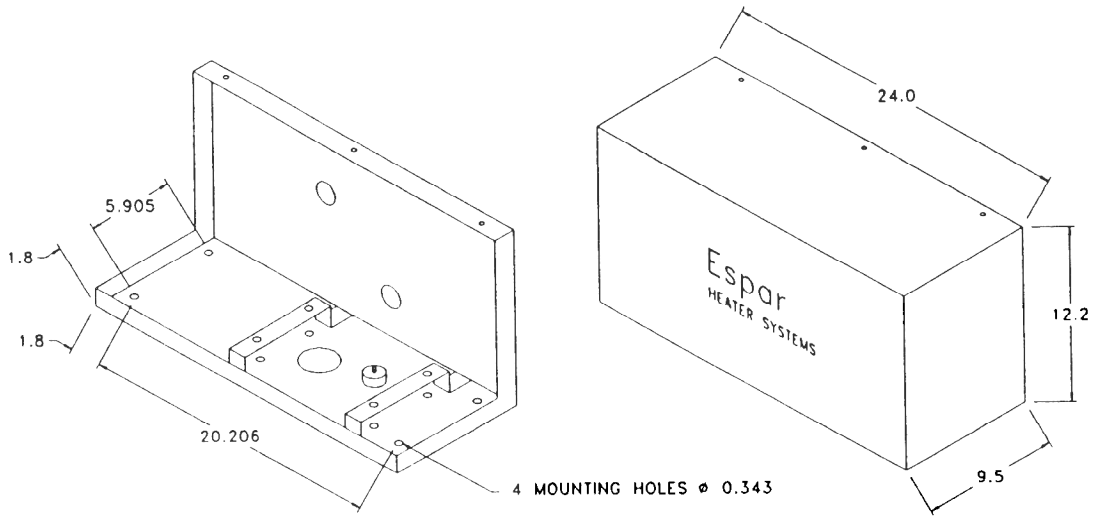
Figure 2A: Universal Type Heater Mounting



2 B. Boxed Type

The heater is mounted in a steel box with four (4) rubber shock mounts. These mounts are used between the heater and the box. The overall box dimensions are shown in Figure 2 B below

Figure 2B Boxed Type Heater Mounting



3. Coolant Hose Connections

To provide fast and efficient heating of a coolant system, heated coolant should enter the front and circulate to the rear of the engine where it should be drawn off (as shown in Figure 3). It is necessary to install the heater to provide coolant flow in the same direction as the flow within the engine so that when the heater is operated **with the engine running** there is no opposing flow. If this flow is not possible then the heater must not be used while the engine is running.

If heat exchangers are being used, they should be connected in the coolant line from the heater to the engine.

There are two methods of connecting to the coolant system:

A. Install hose fitting in existing holes in the engine block (these will have blanking plugs in them).

or

B. Install “T” piece connectors in existing coolant hoses.

Whichever method is used, remember to draw coolant from the engine to the heater from the furthest rear point (bottom, left or right) of block and return coolant from heater (or heat exchangers if applicable) to the engine at a forward block connection (suction side of engine water pump is ideal).

TYPICAL COOLANT HEATER FLOW DIAGRAM

Figure 3 A: Installation in the coolant circulating system with heat exchangers

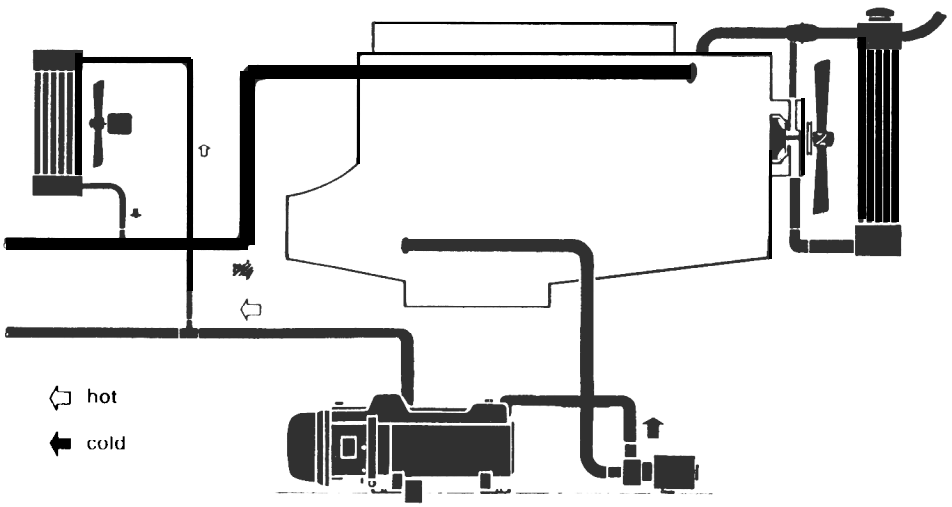
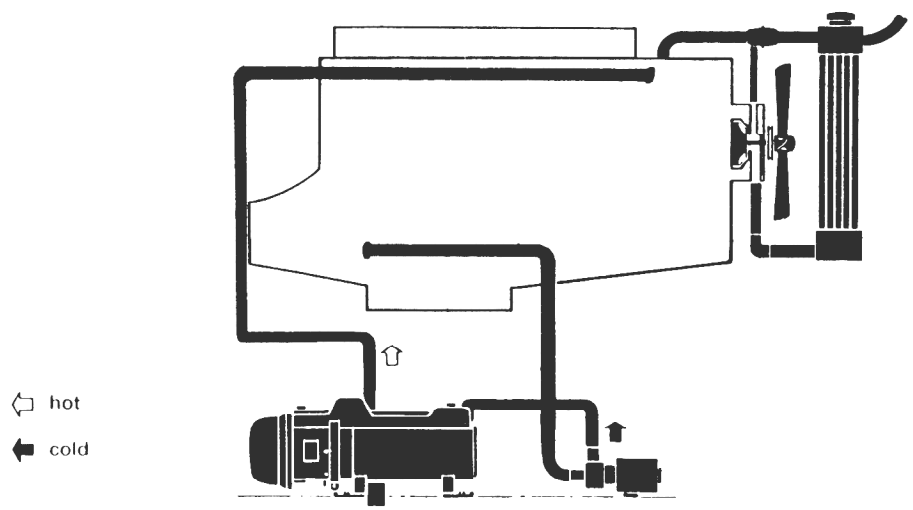


Figure 3 B: Installation in the coolant circulating system without heat exchangers

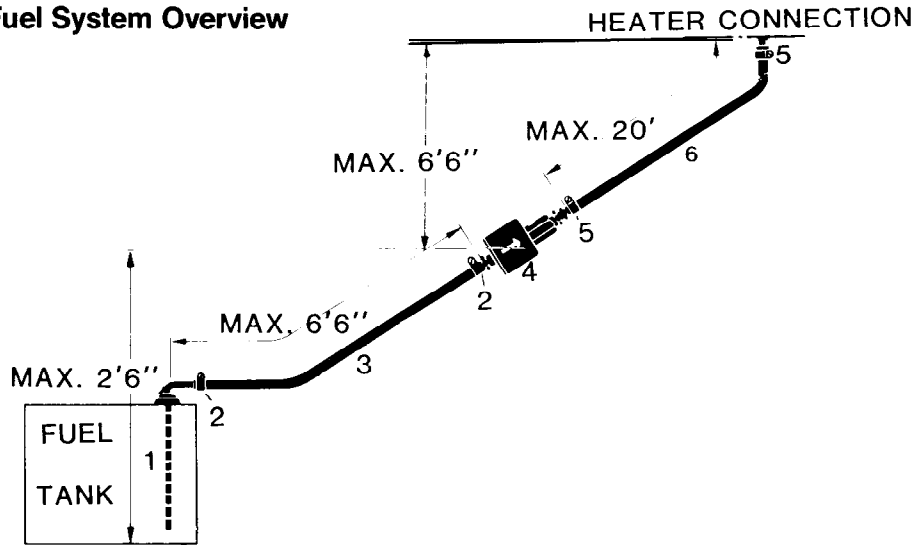


4. Fuel System

The fuel metering pump is the heart of the system and must be installed properly to insure successful heater operation,

All parts necessary are included in the installation kit or can be purchassed separately.

Figure 4: Fuel System Overview



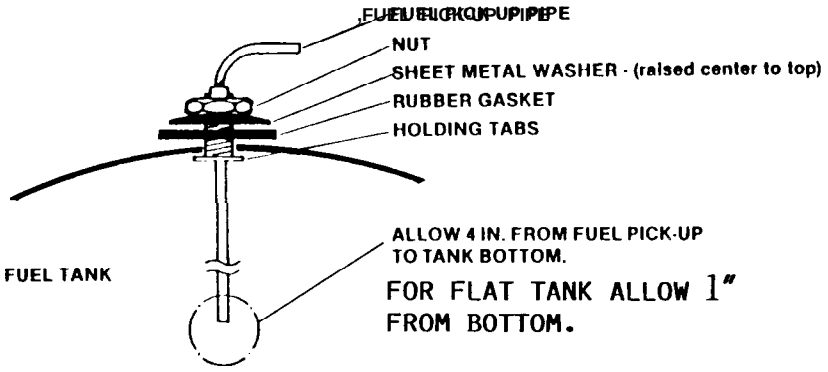
1. Fuel Pick Up Pipe (4mm)
2. 10mm Clamp
3. 5.0mm ID Fuel Line
4. Fuel Metering Pump
5. 7mm Clamp
6. 3.5mm ID Fuel Line

Installation Instructions

1. Fuel Pick Up Pipe
   - Decide on location point for pipe in tank (in a protected area)
   - Drill a one inch (1") hole in tank or blanking plate
   - Install pick-up pipe as shown in Figure 4 A.

CAUTION: Entry point must be above highest possible fuel level in tank.
NOTE: Alternative fuel pick up methods are also available.

Figure 4 A: Fuel Pick Up Pipe Installation



2. Fuel Metering Pump

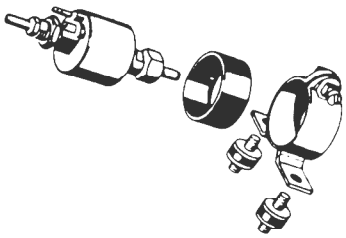
- Decide on location for fuel pump

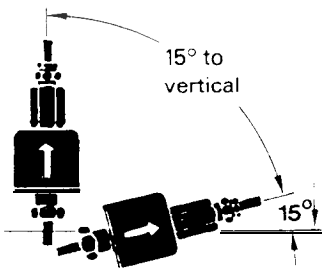
- Must be in a protected area near fuel tank

The fuel line maximum lengths are shown in Figure 4.
DO NOT EXCEED THESE LIMITS

- Using bracket, rubber seal and mounts, install fuel pump as shown in Figure 4 B.

Figure 4 B: Fuel Pump Installation





NOTE: The mounting angle of the fuel pump is critical, it is necessary to adhere to this angle to allow any air or vapor in the fuel lines to pass through the pump rather than cause a blockage and to provide accurate metering of the fuel.

NOTE: Always use fuel line of proper side ID - other sizes of fuel line will cause air or vapor locks and reduce suction causing improper heater operation.

3. Fuel Lines

- Route fuel lines and cut to length

- Connect the fuel lines using the clamps provided

- Connect as shown in Figure 4

5. Electrical Connections

A. Universal Type

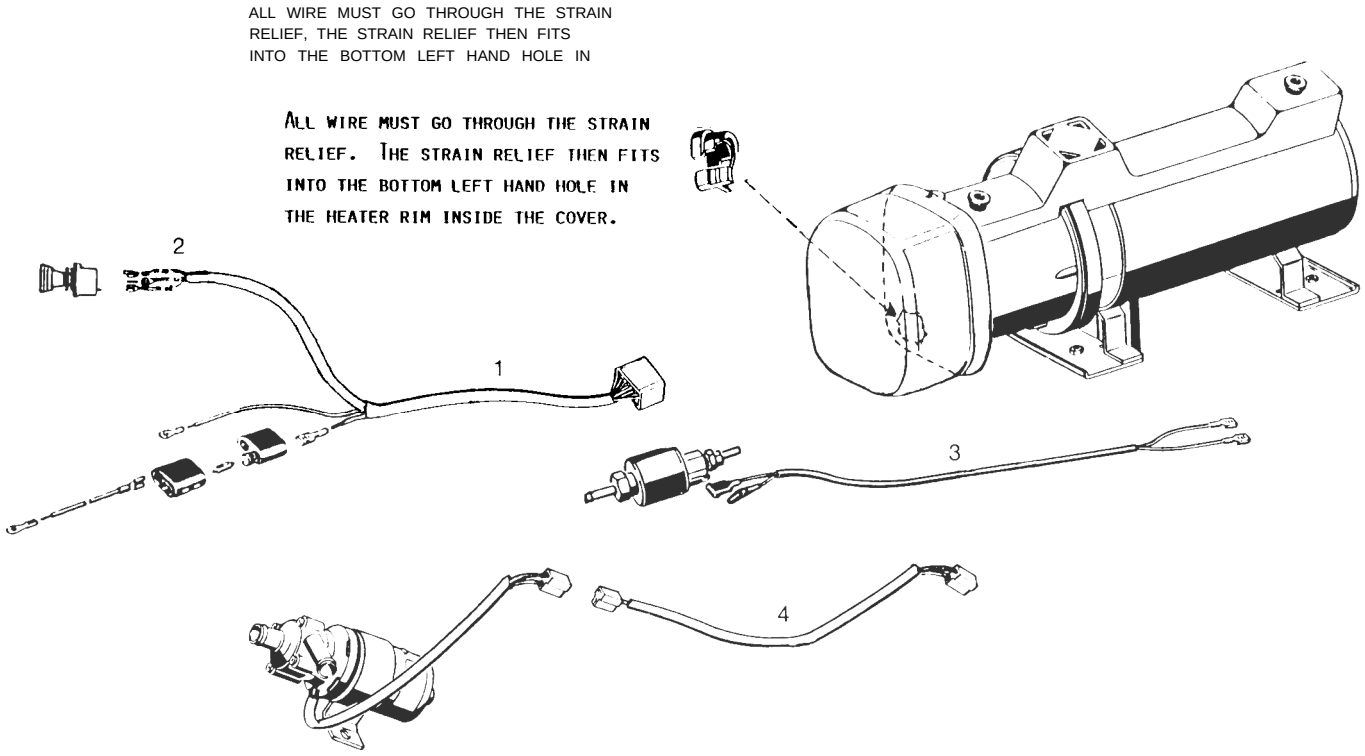
1. Power Harness — 2 core harness (red and brown) with short ground lead
   Red wire direct to vehicle battery (positive)
   Brown wire to frame (ground)

2. Switch Harness: — 3 core harness (red, brown and yellow)
   Run to location of switch

3. Fuel Pump Harness: — 2 core harness (green and green)
   Run to location of fuel pump

4. Water Pump Harness: — 2 core harness (red and brown)
   Connect to plug at the water pump

5. Pig Tail Harness: (not shown) — Connects the above harnesses to the heater wiring under the cover



NOTE: All harnesses should be cut to length and properly routed (using tie wraps) to avoid breakage and friction damage.

NOTE: All exposed electrical connections should be coated with protective grease (petroleum gel, vaseline, etc.).

B. Boxed Version

1. Power Harness -2 core harness (red and brown) with short ground lead
   - Red wire direct to vehicle battery (positive)
   - Brown wire direct to vehicle battery (negative)

2. Switch Harness: -3 core harness (red, brown and yellow)
   - Run to location of switch

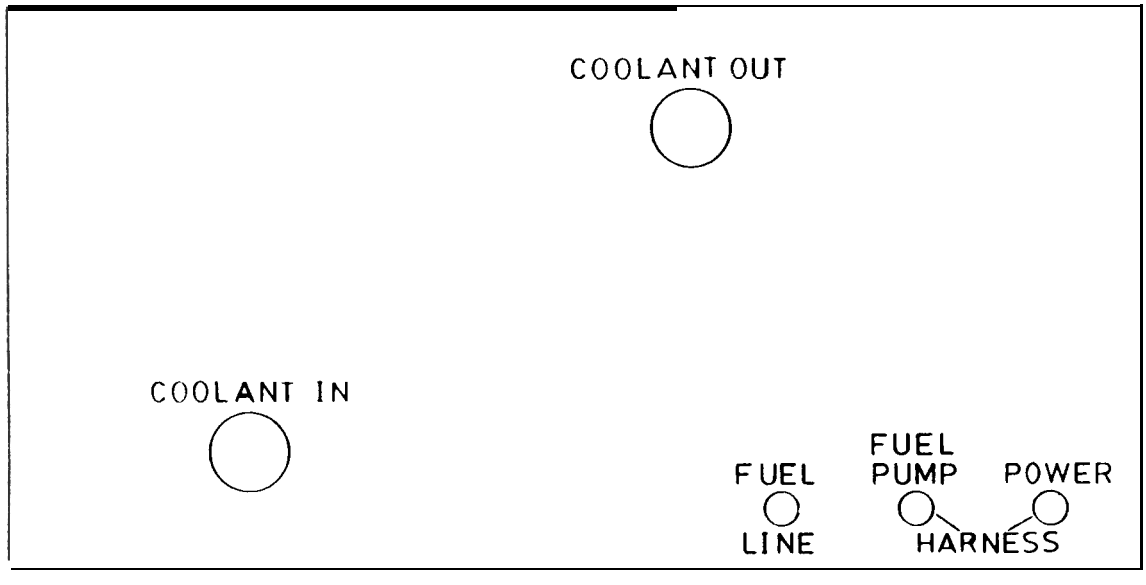
3. Fuel Pump Harness -2 core harness (green and green)
   - Run to location of fuel pump

4. Water Pump Harness - Pre-connected inside box

5. Pig Tail Harness: - Connects the above harnesses to the heater wiring under the cover

All harnesses should enter heater box through sealing grommets as shown in Figure 5 B. (if applicable).

Figure 5 B. Electrical connections - Boxed version



NOTE: All harnesses should be cut to length and properly attached (using tie wraps) to avoid breakage and friction damage.

NOTE: All exposed electrical connections should be coated with protective grease (petroleum gel, vaseline, etc.).

6. Exhaust Connection

A 42mm (15/8") diameter flexible stainless steel exhaust pipe (4 meters long - 13 feet maximum) is used with this heater. Feed the exhaust pipe through the silicone (white) gasket on the bottom of the box and attach to the exhaust outlet at the heat exchanger in the box (as shown in Figure 6. if applicable). Once secured to the heater exhaust outlet, the exhaust pipe must run to an open area to the rear or side of the vehicle so that fumes cannot build up and enter the cab or the heater box.

NOTE: THE EXHAUST IS HOT — KEEP A MINIMUM OF 2" CLEARANCE FROM ANY HEAT SENSITIVE MATERIAL.

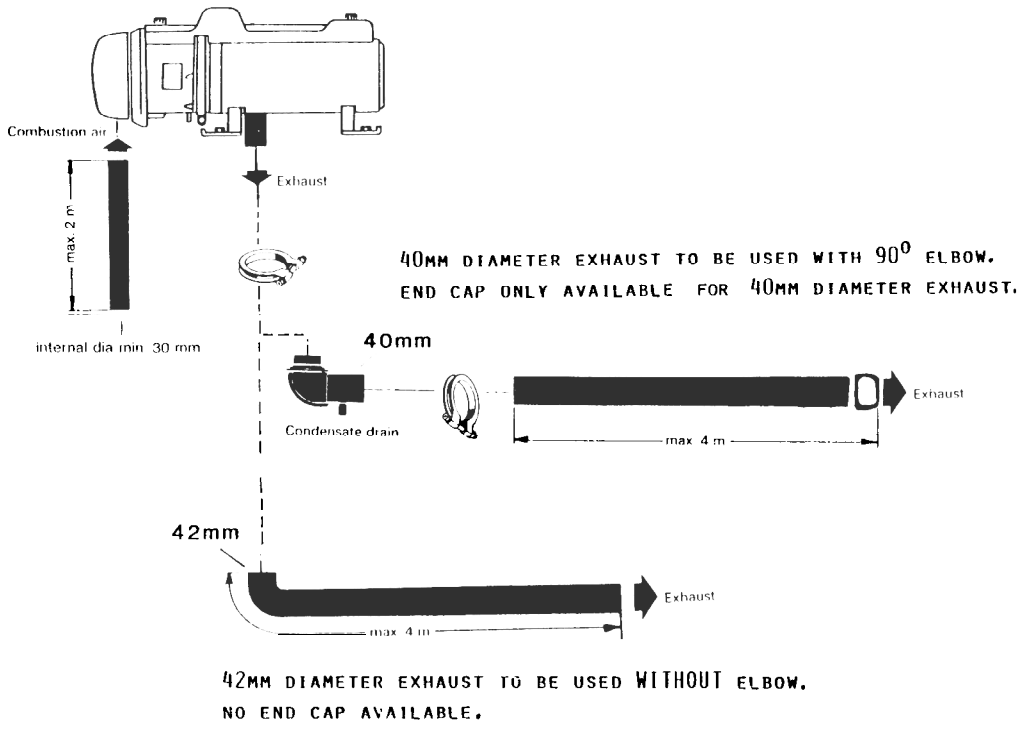
Route exhaust so that exhaust fumes cannot enter the passenger compartment or the heater box.

Run exhaust so that it cannot be plugged by dirt, snow or water and allows water produced by combustion to run out.

Install exhaust pipe with a slight slope or drill a hole (5mm) in lowest point to allow water to run out.

Any restriction in exhaust will cause operational problems.

Figure 6.



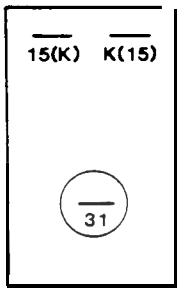
7. Operating Switches

A push/pull switch is provided with the heater, already connected to a fifteen foot (15') switch harness. Connect switch harness to connector block inside heater box and run harness to suitable location. Install switch and reconnect harness. Alternatively a 99 hour count down timer can be used. This timer can be used to start the heater either manually or automatically at a preset time (1-99 hrs).

Control Wiring

On/Off Switch (supplied with heater)

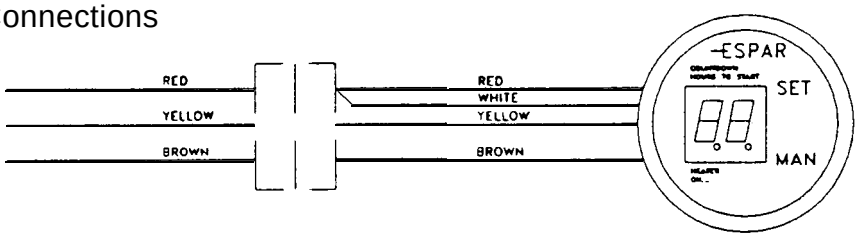
Wire connections
Brown - 31
Red - K(15)
Yellow - 15(K)



NOTE: Wired as above the switch light glows when pulled on and is out when pushed in.

99 Hour Digital Timer:

Wire Connections



8. Pre-Start Procedures

NOTE: Prior to starting the heater, run the engine and top up coolant, to engine manufacturers recommendations.

Bleed the coolant system after heater installation as follows:

1. Fill the cooling system with coolant.
2. Run the engine and Espar coolant pump only for 5 minutes to bleed air from the coolant system.

NOTE: To operate Espar coolant pump only put power to Pin #5 (yellow with red stripe wire) of the 6 pin connector under the heater hood.

3. Shut off the engine.
4. Refill coolant and install radiator cap.

WARNING: When removing radiator cap use extreme caution because coolant may be hot and under pressure.

9. Heater Operation

A. Switch On - Start Up

Once switched on the following sequence of events takes place:

1. Switch light comes on.
2. Control box does system check.
3. Coolant circulation pump comes on.
4. Combustion blower comes on.
5. Glow plug and spark generator are activated.
6. Fuel metering pump starts.
7. Fuel and air mixture are ignited by glow plug.
8. Once ignition takes place the flame sensor will automatically switch the glow plug and spark generator off.

Ignition Time: 3 minutes maximum

NOTE: If the heater fails to ignite it switches off automatically not more than 3 minutes after being switched on. On initial start up several restarts may be required to prime the fuel system.

B. Running

Once ignition is successful the following operations take place

1. Heater switches into run mode.

2. Once the coolant reaches approximately 176°F (80°C), the heater will automatically cycle off.

NOTE: As long as the heater is switched on, the coolant pump will continue to circulate coolant regardless of whether the heater is ignited or has cycled off.

3. In cycled off mode the heater will automatically restart once the coolant temperature reaches 155° F (68° C) (with hot switch the temperatures are higher).

4. The heater will continue to run as described above until it is switched off either manually or by the timer.

NOTE: 1. While in running mode if the heater should shut down due to flame out it will automatically shut off the fuel supply (after no more than 4 minutes).
2. During operation the heater continually senses the input voltage from the batteries - if the input voltage drops to approximately 10.5v or 21v the heater will automatically shut down.

C. Switching Off

When the heater is switched off the fuel pump stops and flame is extinguished. The combustion air motor and coolant circulating pump continue to run for a three minute cool down cycle (approximate). Then the heater completely shuts off.

10. Safety Equipment

The flame is monitored by the flame sensor, while overheat termperature is monitored by the overheat cutout switch. both influence the control unit, which switches off the heater in the event of malfunction.

1. If the heater fails to ignite, it will switch off automatically within 3 minutes after being switched on.

2. If the flame goes out spontaneously during operation, the fuel supply stops after no more than 4 minutes.

3. If there is a malfunction caused by the blower motor - the motor current fuse built into the control unit blows and shuts off the heater.
4. If the heater should overheat (due to lackof coolant) the overheat cutout switch stops the fuel metering pump. The heater will shut off after the 3 minute cool down cycle.
5. When the coolant temperature reaches the desired peak value, the coolant thermostat keeps this temperature approximately constant by alternately switching the heater on and off.

NOTE: - The coolant must contain a minimum of 10% antifreeze at all times as a protection against corrosion. Fresh water will corrode internal heater parts.
- During **electrical welding work** on the vehicle, **disconnect** the **power** to the **heater,** in order to protect the control unit.

WARNING: The heater must be switched off while fuel tank on vehicle is being filled. The heater MUST NOT be operated in garages or enclosed areas due to combustion fumes.

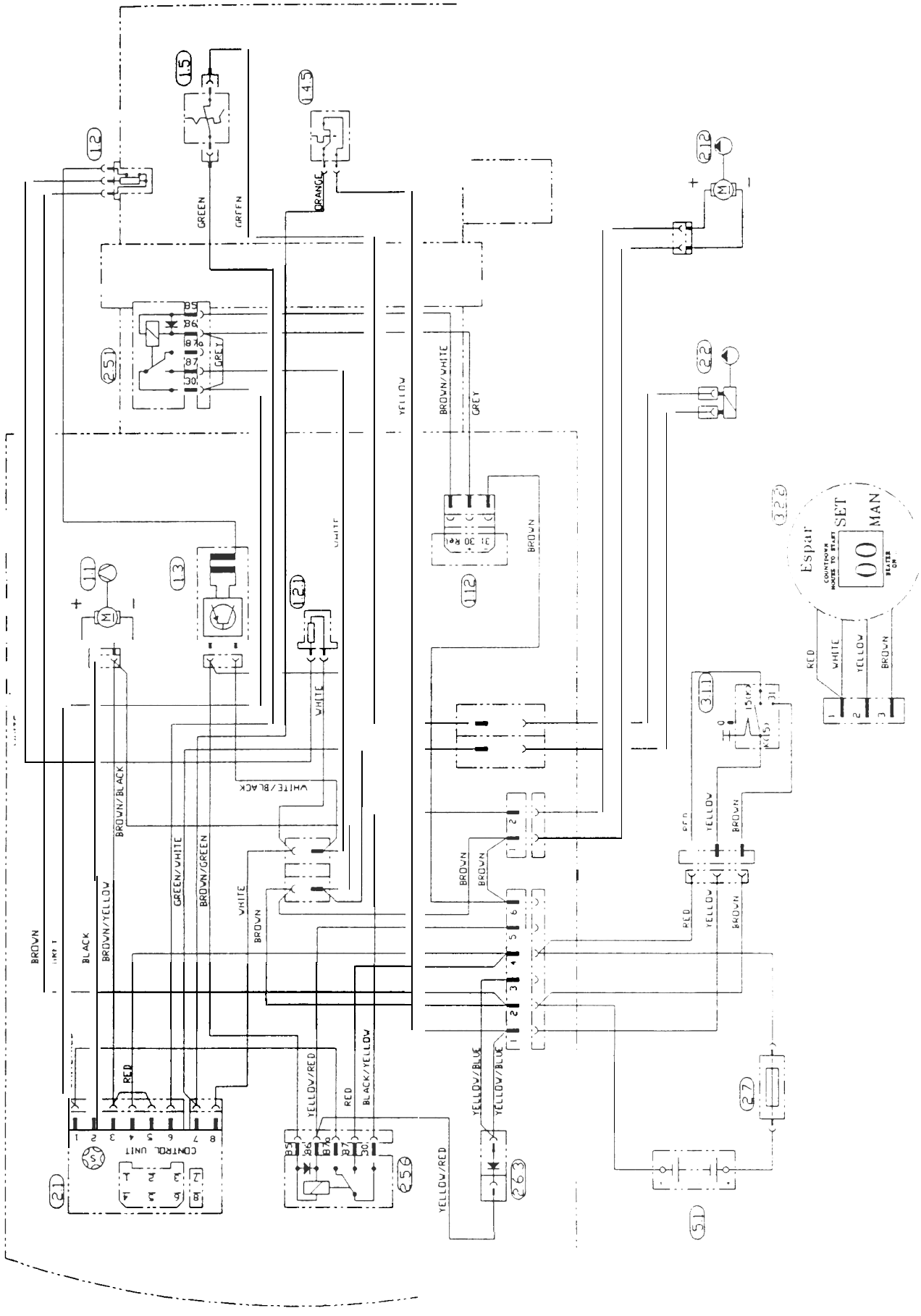
11. Periodic Maintenance

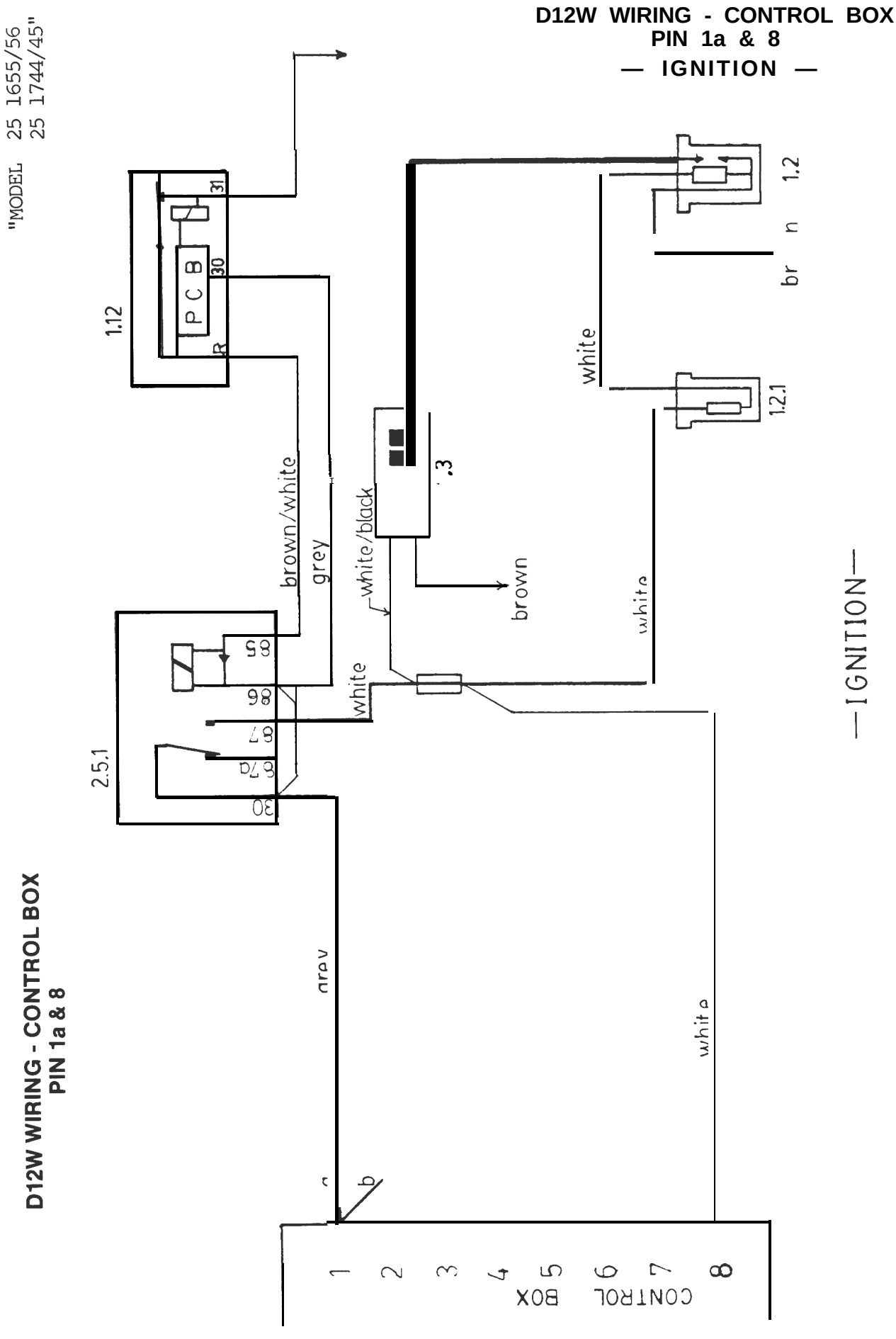
1. Remove and inspect the glow plug for carbon build up. Clean and/or replace.
2. Clean the glow plug chamber using brass brush (Espar part number CAO 05 003) to remove any carbon build up. Use of nondetergent 100% volatile carburetor cleaner and air gun will also help in cleaning.
3. Remove and inspect the flame sensor, clean with a soft cloth if necessary.
4. Check coolant hoses, clamps, and make sure all valves are open before you start your heater or it will overheat. Maintain the engine manufacturers recommended coolant level and ensure that the heater is properly bled after service on or involving the coolant system.
5. Inspect combustion air intake and exhaust for blockage.
6. Run your heater and check for proper operation during regular P.M. throughout the year.
7. Maintain your batteries and all electrical connections in good condition. With insufficient electrical power the heater will not start. Low and high voltage cutouts will shut the heater down automatically.
8. Use fuel suitable for the climate (see engine manufacturers recommendations). Blending used engine oil with diesel fuel is not recommended.

Wiring Diagram Legend
D12W Universal 12v/24v
25 1744/45

1.1	Blower motor
1.2	Glow / Spark Plug
1.2.1	Series Resistor
1.3	Ignition spark generator
1.4.5	Temperature regulating switch
1.5	Safety thermal cutout switch
1.12	Flame monitor
2.1	Control unit
2.2	Fuel metering pump
2.5.1	Glow plug relay
2.5.6	Coolant pump relay
2.6.3	Coolant pump diode
2.7	Main fuse, 30A
2.12	Coolant circulating pump
3.1.1	Push/pull switch
3.2.2	Timer, 99hr countdown
5.1	Battery

WIRING DIAGRAM
D12W - 12V & 24V
25 1744 / 25 1745

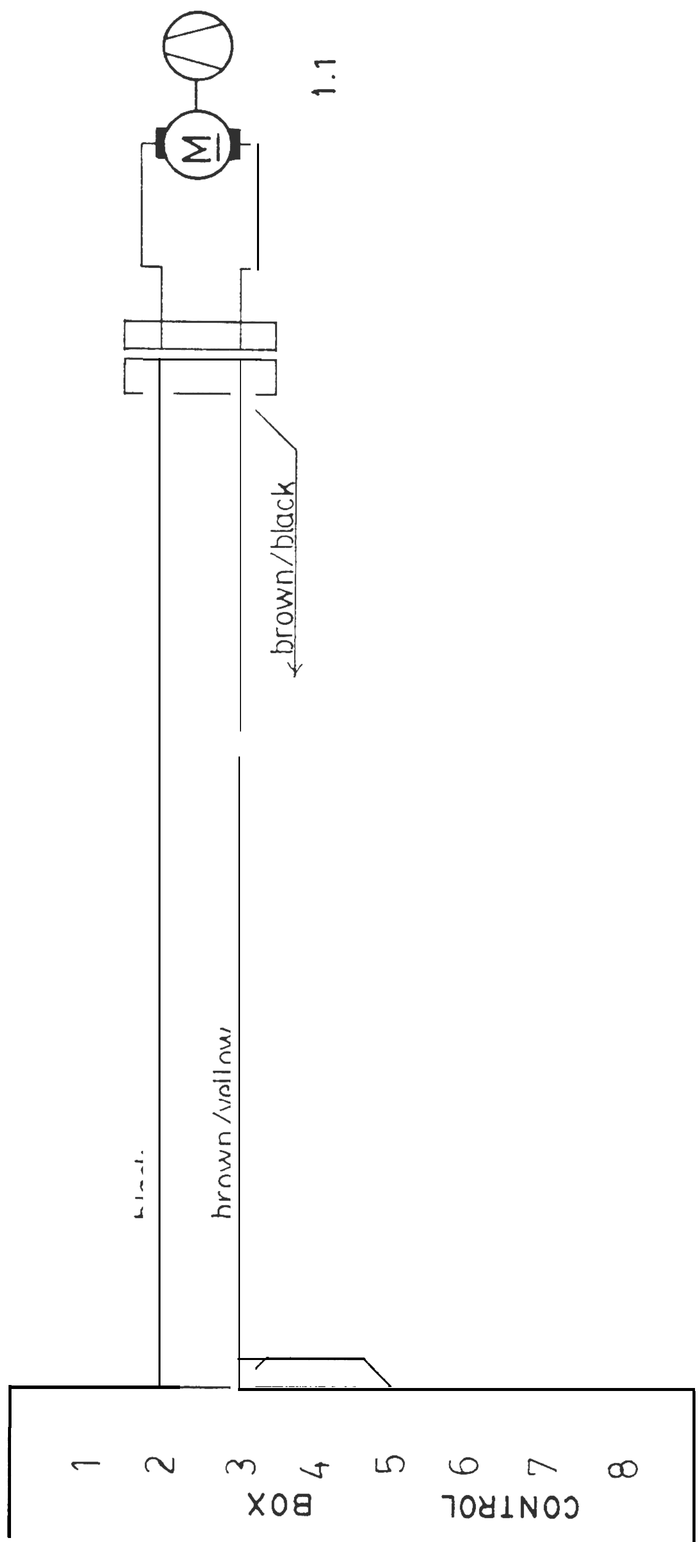



"MODEL 25 1655/56
25 1744/45"
D12W WIRING - CONTROL BOX
PIN 1a & 8
— IGNITION —
1.12
P C B
31
30
R
brown/white
grey
white/black
.3
brown
white
1.2
br n
1.2.1
white
2.5.1
85
86
87
87a
30
—IGNITION—
D12W WIRING - CONTROL BOX
PIN 1a & 8
grey
white
b
CONTROL BOX
1 2 3 4 5 6 7 8

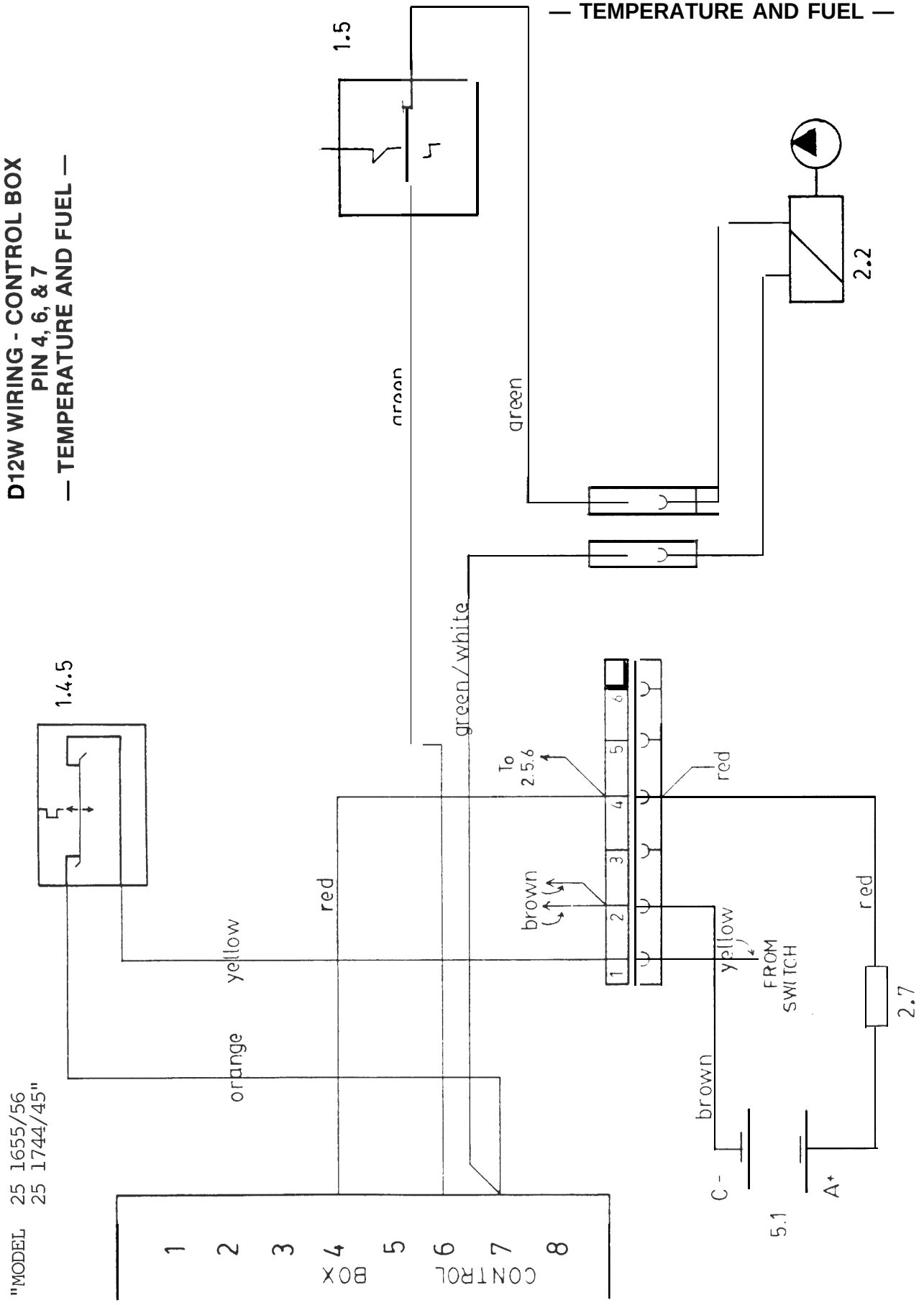
D12W WIRING - CONTROL BOX
PIN 2,3, & 5
— BLOWER MOTOR —

"MODEL 25 1655/56
25 1744/45"

D12W WIRING - CONTROL BOX
PIN 2, 3, & 5
— BLOWER MOTOR —

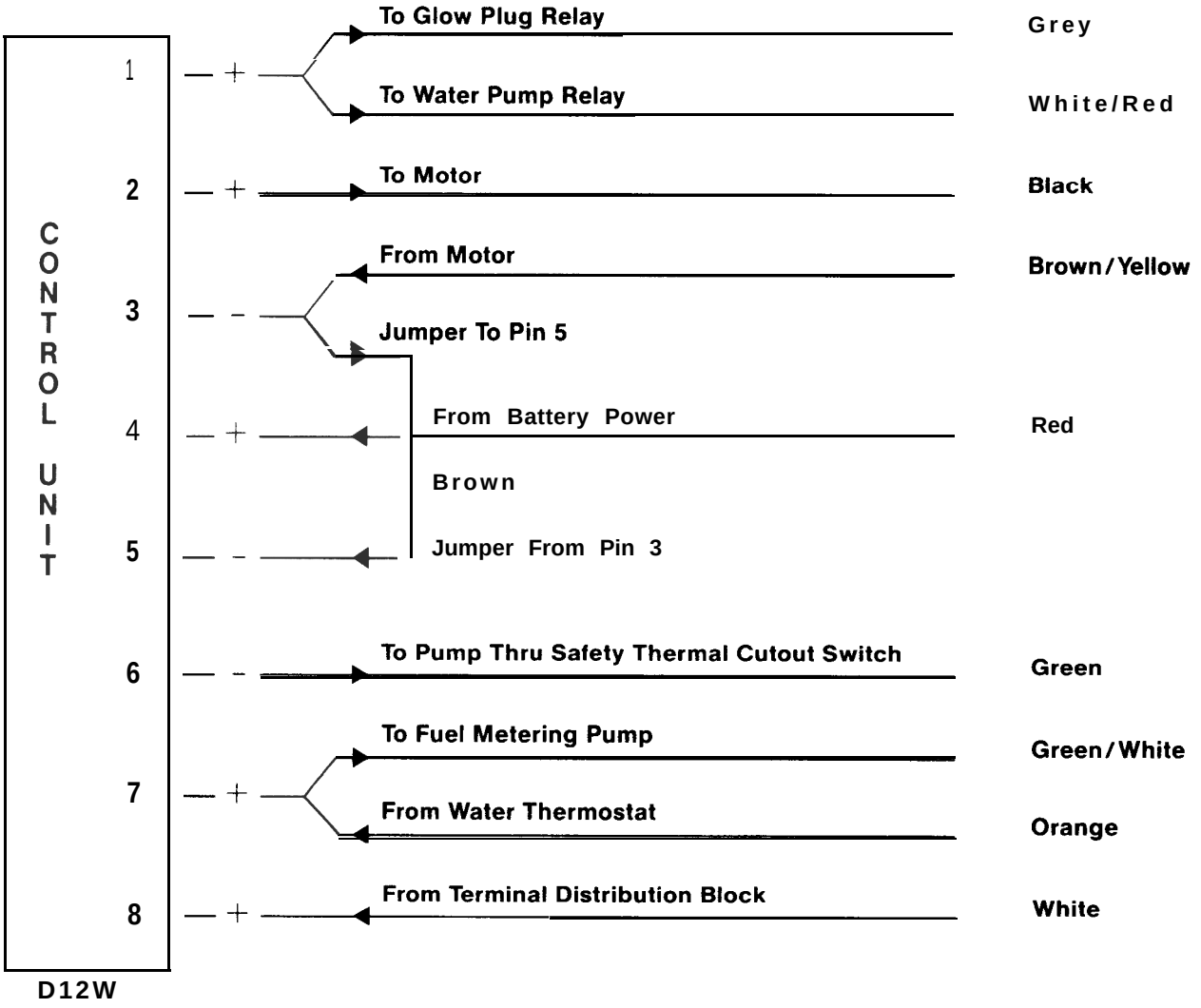


D12W WIRING - CONTROL BOX
PIN 4,6, & 7
— TEMPERATURE AND FUEL —



D12W - 12v - CONTROL UNIT

#25 -1570-50



Power Input: + Pin #4 Red
- Pin #3 Brown/Yellow

TROUBLESHOOTING

Should failure occur, there are several items which should be checked first before any major troubleshooting is done.

Basic Troubleshooting

Check the following:

1. Fuse in power harness.
2. Motor fuse in control box.
3. Glow plug.
4. Electric lines and connections.
5. Are combustion air and exhaust pipes clear?
6. Is there fuel in the tank?
7. Does the coolant pump run when heater is switched on?

   If not — check for voltage at coolant pump motor.
   If you have voltage: - replace coolant pump.
   If no voltage: - replace control unit.

If the heater still does not function proceed with the following checks.

Troubleshooting

Fault → / Cause ↓	No blower noise approx. 5 secs. after switch-on	Blower runs, approx. 5 secs. after switch-on, for about 5 secs., then cuts automatically	Blower runs about 5 secs. after switch-on, pump ticks, automatic cutout after 3 minutes	Blower runs about 5 secs. after switch-on, pump does not tick, then automatic cutout after 3 minutes	Heater cuts out permanently during heating operation	Heating capacity insufficient or heater goes off by itself	Heater smokes and soots	Blower continues to run after switch-off longer than the usual delayed cutoff time (3 - 4 minutes)
Main 16A fuse defective	0							
Glow ignition plug (GZE 201) coked/defective			0					
Motor current fuse in control unit defective	0							
Safety thermal cutout switch has responded					0			
Ignition spark generator defective			0					
Glow plug series resistor defective			0					
Undervoltage		0						
Overvoltage		0			0			
Control unit not supplying pulses for the fuel metering pump				0				
Reed relay in control unit has no contact		0						
On/off switch, timer, control switch defective	0							
Plug relay sticking in D12W (25 1744/45) with temperature switch			0					
Electronic delayed shutoff unit defective in D12W (25 1744/45) with flame sensor								0

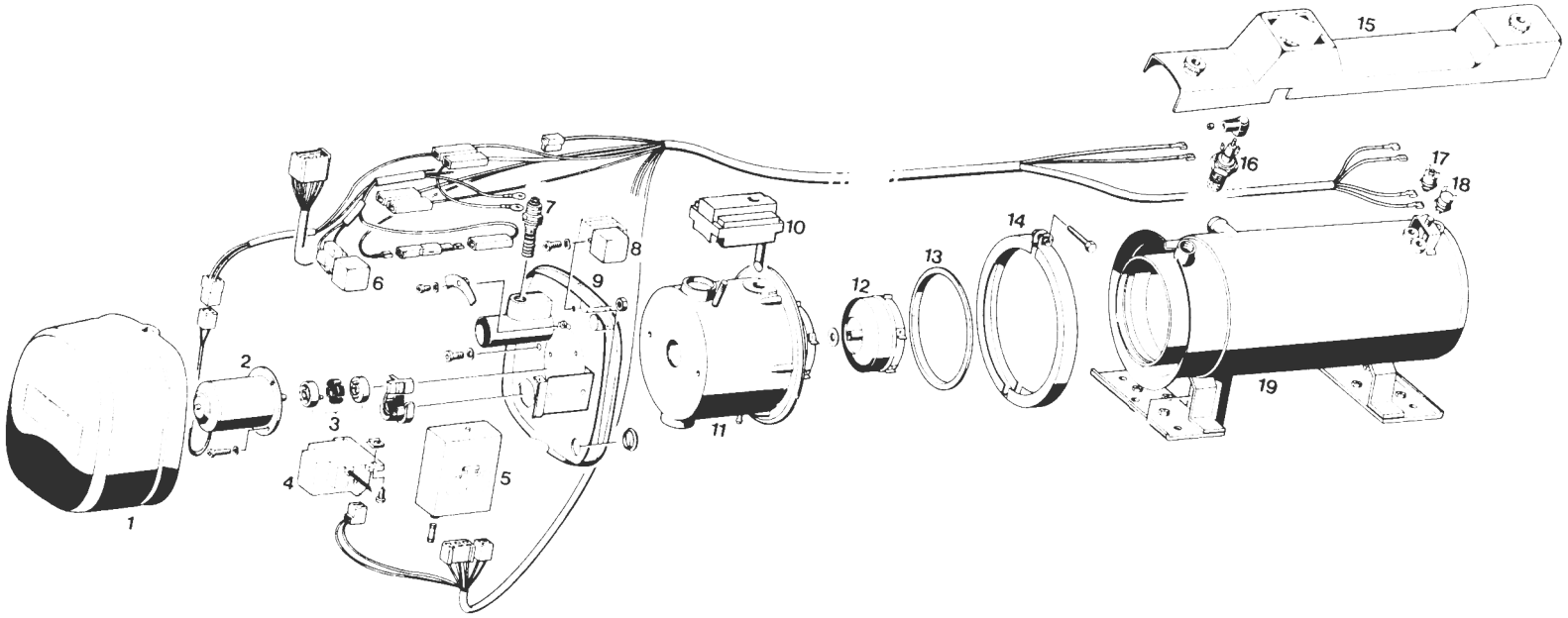
Check	Remedy
Visual/continuity check	Remove short-circuit in the wiring or coke from the heating coil of the glow ignition plug, replace the glow ignition plug if necessary
Visual/continuity check	If necessary, change glow ignition plug
Visual/continuity check	Remove damage in combustion air system motor or blower, change the motor current fuse
Switch off the heater Check water flow (min. 1000 l/h)	Remove air from water circuit, operate the safety thermal cutout switch
Hold high-tension cable approx. 5 mm away from earth	If necessary, change the ignition spark generator
Visual/continuity check	If necessary, change the glow plug series resistor
Measure voltage at 6-pin plug, terminals 4 and 2, min. voltage 10.5 or 21 V	Charge battery Check wiring for voltage drops
Measure voltage at 6-pin plug, terminals 4 and 2, max. voltage 14.5 or 29 V	Check dynamo regulator, change if necessary
Connect pilot light to the contacts of the fuel metering pump or terminal 6 on the control unit, if no pulses are available	Change the control unit
See Fault	Change the control unit
Visual/continuity check	If necessary, change the operating element
Check relay functioning	If necessary, change the plug relay
See Fault	Change the optical flame sensor

Troubleshooting

Fault → / Cause ↓	No blower noise approx. 5 after switch-on	Blower runs, approx. 5 secs. after switch-on, for about 5 secs., then cuts automatically	Blower runs about 5 secs. after switch-on, pump ticks, automatic cutout after 3 minutes	Blower runs about 5 secs. after switch-on, pump does not tick, then automatic cutout after 3 minutes	Heater cuts out permanently during heating operation	Heating capacity insufficient or heater goes off by itself	Heater smokes and soots	Blower continues to run after switch-off longer than the usual delayed cutoff time (3 - 4 minutes)
Fuel metering pump not pumping				0				
Fuel metering pump pumping too much							0	
Fuel metering pump pumping too little			0			0		
Fuel line leak Filter clogged Air in the fuel line			0			0		
Combustion and/or exhaust line clogged							0	
Combustion air blower speed too low							0	
Electric motor defective	0							
Blower damage (Combustion air blower damage)	0							
Temperature switch does not respond in D12W 25 1744/45			0					
Optical flame sensor defective in D12W 25 1744/45			0					

Check	Remedy
Connect test lamp to the fuel metering pump when pulses are present	Replace fuel metering pump
Measure fuel quantity; if the quantity is outside the permissible tolerance	Replace fuel metering pump
Measure fuel quantity; if the quantity is outside the permissible tolerance	Replace fuel metering pump
Visual check	Seal and bleed fuel line, change filter
Visual check	Remove blockage
Measure speed at motor shaft 5900 RPM ± 10% (at rated voltage)	Change electric motor
If the shaft of the electric motor does not turn	Replace burner
If the shaft of the electric motor turns	Change electric motor
Defect is present when there is still minus at terminal 85 (glow plug relay) after max. 120 sees. after switch-on	Change temperature switch
Clean quartz rod on flame sensor with a soft cloth: if no function:	Change the optical flame sensor

– NOTES –



1 Hood
2 Electric motor
3 Coupling
4 Ignition spark generator
5 Control unit
6 Glow plug relay
7 Series resistor
8 Water pump relay
9 Support plate
10 Flame sensor in D· 2W 25 1744/45
11 Burner
12 Atomizer
13 Sealing ring
14 Profile clip
15 Cable duct
16 Glow plug
17 Safety thermal cutout switch
18 Control switch
19 Heat exchanger

Repair Steps

1. Removing and installing the glow plug
2. Removing and installing the safety thermal cutout switch
3. Removing and installing the control switch
4. Removing and installing the temperature switch
5. Removing and installing the ignition spark generator
6. Removing and installing the series resistor
7. Removing and installing the series resistor
8. Removing and installing the electric motor
9. Removing and installing the water pump diode
10. Removing and installing the glow plug and water pump relays
11. Removing and installing the burner head
12. Removing and installing the flame sensor

---

1. Removing and installing the glow plug

Undo the knurled nuts and remove the cable duct.
Detach plug connector and cable plug from the glow plug.
Unscrew the glow plug using deep 5/8% socket.
Screw the glow plug back in, or replace it
if necessary, following visual and continuity test.

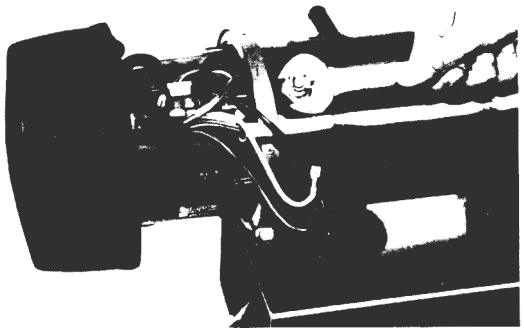


Fig. 1

2. Removing and installing the safety thermal cutout switch

Undo the knurled nuts and remove the cable duct.
Detach the cable plug.
Unscrew the safety thermal cutout switch.
Replace the safety thermal cutout switch.

Fig. 2

3. Removing and installing the control switch

Undo the knurled nuits and remove the cable duct.
Detach the cable plug.
Unscrew the control switch.
Replace the control switch.

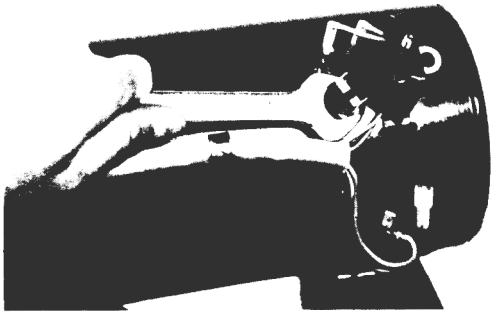


Fig. 3

4. Removing and installing the temperature switch (heater design 25 1744/45)

Remove the protective rubber cap.
Detach the cable plug.
Unscrew the temperature switch.
Replace the temperature switch.

Fig. 4

5. **Removing and installing the ignition spark generator**

Remove the hood.
Undo the knurled nuts and remove the cable duct.
Detach plug connector and cable plug from the glow plug.
Unscrew the plug connector from the high-tension cable.
Pull the high-tension cable out through the rubber grommet.
Remove the plug housing from the ignition spark generator.
Undo the screws from the ignition spark generator.
Replace the ignition spark generator.
Pass the high-tension cable back through the rubber grommet and screw on the plug connector.
Reattach the plug housing to the ignition spark generator.
Reattach the plug connector and the cable plug to the glow plug.

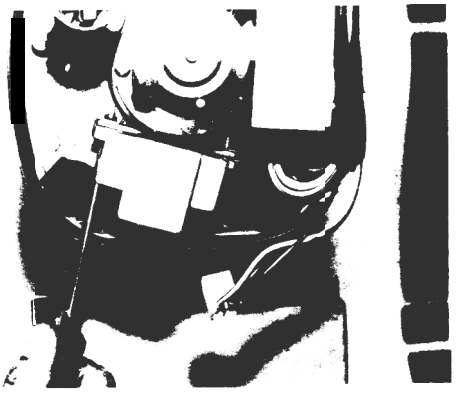


Fig. 5

6. Removing and installing the control unit

Remove the hood.
Detach both plugs from the control unit.
Remove the control unit off the holding bracket,
Replace the control unit.

N o t e

When installing a new control unit a motor current fuse must be placed in it.

Fig. 6

Cat. No. for motor current fuse
12 V 2515700501 00
24 V 251531 050200

7. Removing and installing the series resistor

Remove the hood.
Undo the connecting cable from the series resistor
Unscrew the series resistor.
After visual and continuity test, screw the series resistor, or if necessary a new one, back in.

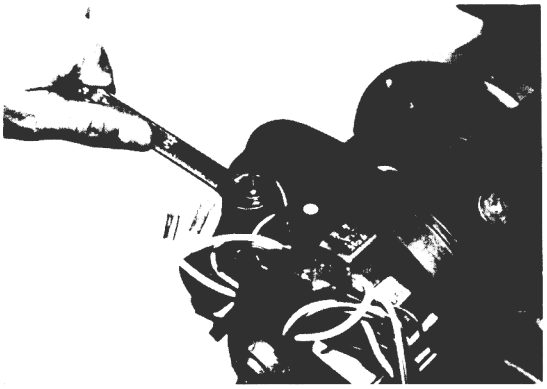


Fig. 7

8. Removing and installing the electric motor

Check the motor current fuse in the control unit and replace it if necessary.
Remove the hood.
Detach the plug housing from the electric motor at the cable harness.
Remove the control unit (see repair step 6).
Undo the 3 cross-head screws on the flange of the electric motor.
Remove the electric motor.
Install the new electric motor.

Note
When the motor is replaced, the driver pins of the two coupling halves must be seated in the recesses of the driver disc.

Fig. 8

9. Removing and installing the water pump diode

Remove the hood.
Detach the cable plug from the diode housing.
install a new diode (diode connections cannot be mixed up).

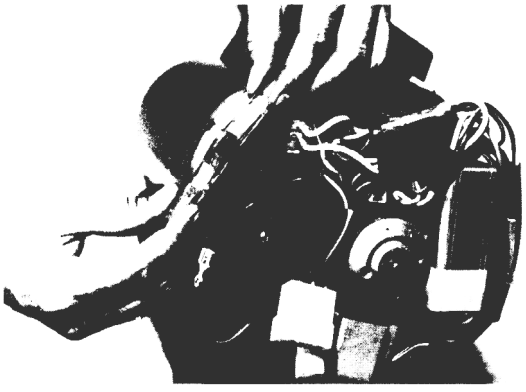


Fig. 9

10. Removing and installing the glow ignition plug and water pump relays

Detach the relay from the connection base.
Replace the relay.

Fig. 10

11. Removing and installing the burner head

Undo the knurled nuts and remove the cable duct.
Remove the hood.
Detach the cable plugs from the safety thermal cutout, control and temperature switches.
Detach plug connector and cable plug from the glow plug.
Undo the fuel connection and detach it.
Detach the plug connections for current supply (6-pin plug), for the water pump (2-pin plug) and the fuel metering pump (2-pin flat connector housing).
Pull cable with plug out of the penetration hole.
Open the Vee-profile clamp and remove the burner head.

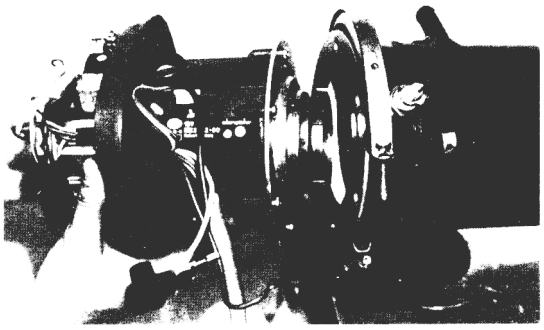


Fig. 11

Note:
The seal should as a rule be changed when the burner head is changed.

12. Removing and installing the flame sensor (heater design 25 1744/45)

Undo the knurled nuts and remove the cable duct.
Detach the plug from the flame sensor.
Undo the cross-head screw in the middle of the flame sensor housing.
Pull the flame sensor out of the hole.
Replace the flame sensor. Make sure that silicone sealing washer is re-used with new sensor.

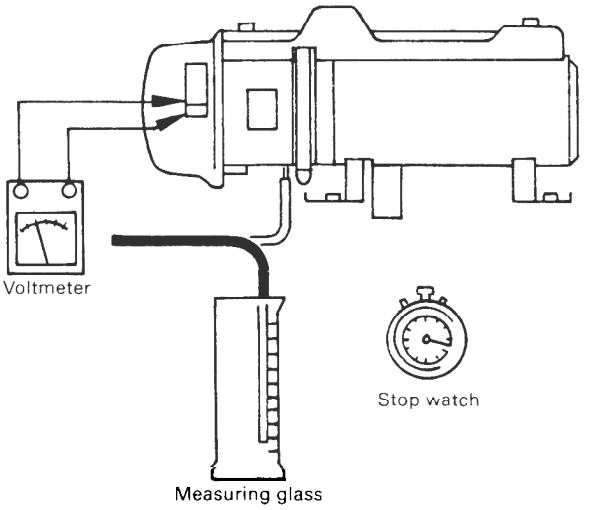
Fig. 12

Tightening torque of cross-head screw is 1 ft-lb maximum.

Measuring the fuel quantity

IMPORTANT:

Only measure the fuel quantity when the battery is sufficiently charged. At least 11/22 V and at most 13/26 V must be applied at the control unit during measurement.

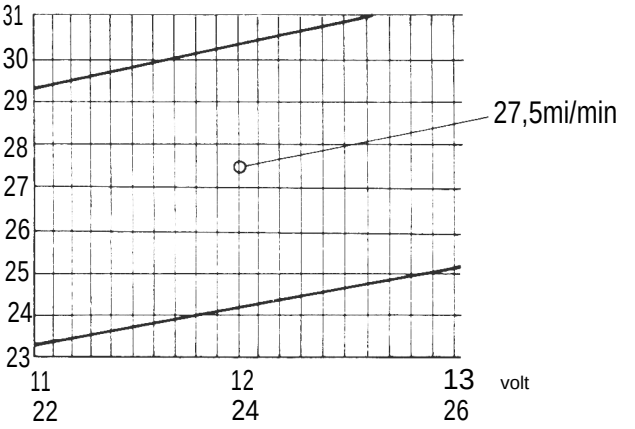


1. Preparation

Detach the fuel line from the heater and place it into a measuring glass (50 ml). Connect voltmeter to terminal 3 (–) and 4 (+) of the 6-pin plug. Have a stop watch ready.
Switch on the heater until fuel is being pumped evenly. The fuel line is now filled and bled.
Switch off the heater, and empty the measuring glass.

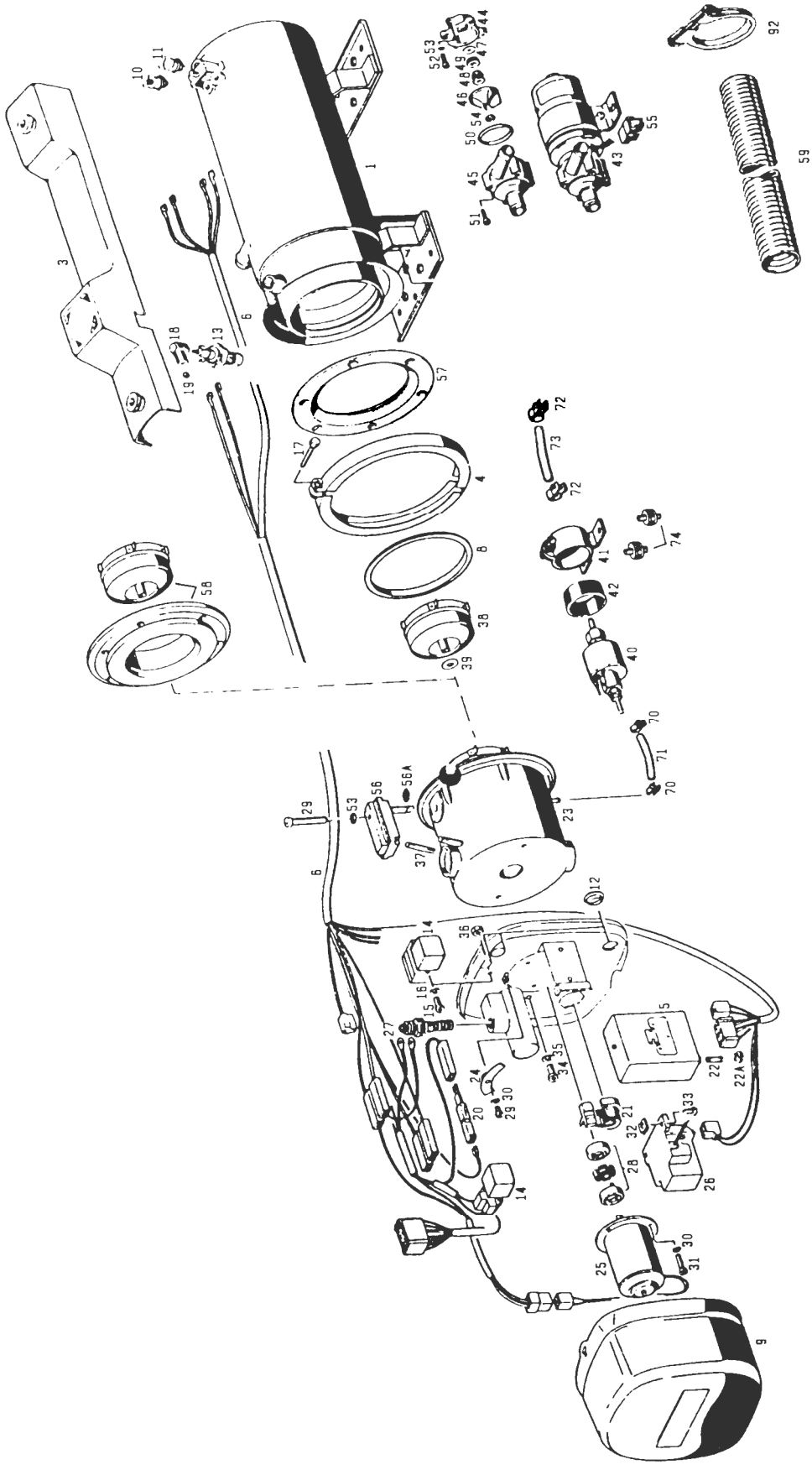
2. Measurement

Switch on the heater.
As soon as fuel is being pumped, switch on the stop watch, read off the voltage on the meter, switch the heater back off after one minute, and read off the fuel quantity.

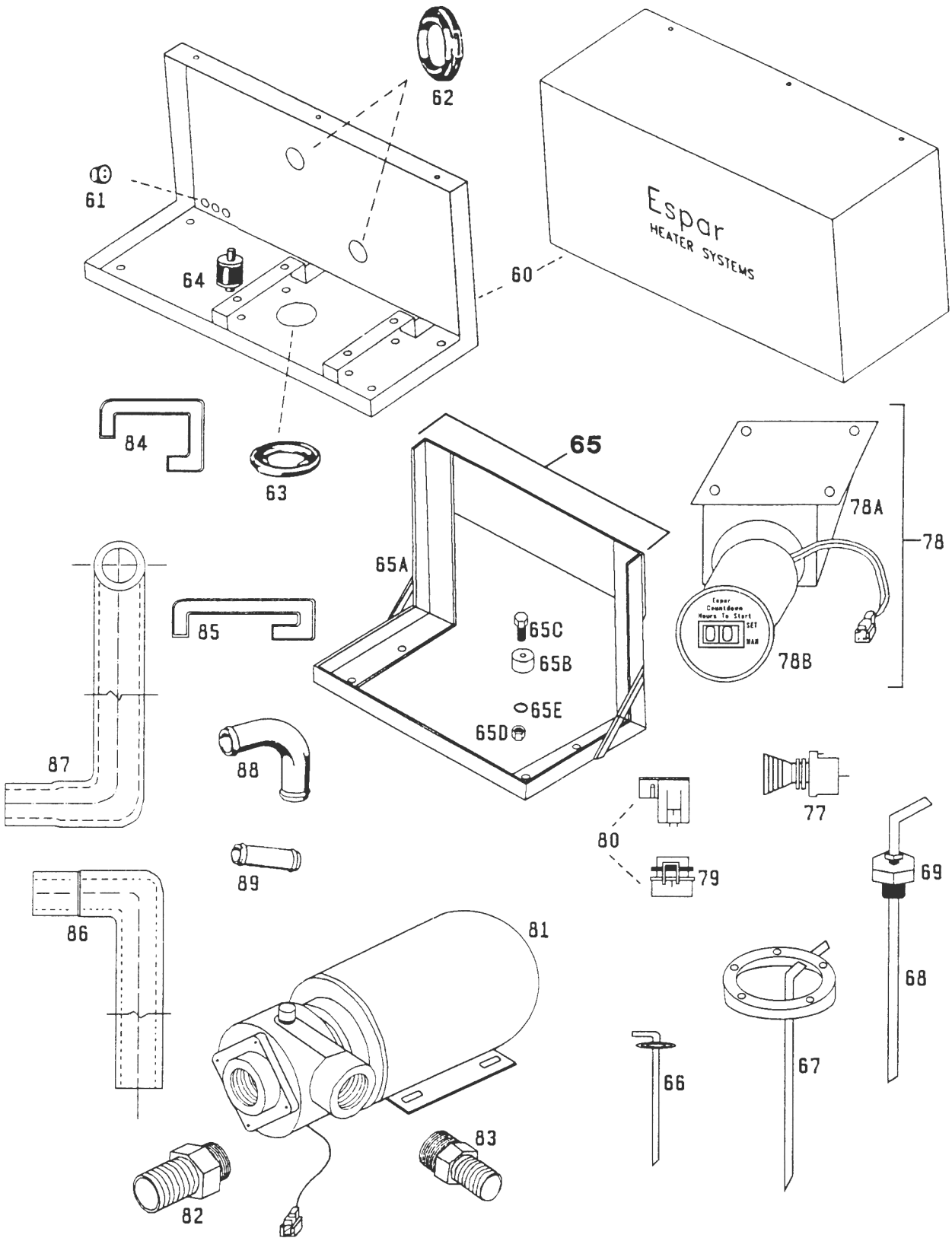


3. Evaluation

Using the diagram, read upwards from the measured voltage and horizontally from the fuel quantity measured during one minute.
The intersection of the two lines must be within the two limit curves. If not, replace the metering pump.


1
3
4
6
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
22A
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
56A
57
58
59
70
71
72
73
74
92

PARTS MANUAL



PARTS LIST

*All parts for 12 or 24 volt heaters are the same except as noted.

Ref. No.	Description		Part Number
1	Heat Exchanger	Model 25 1744/45	25 1678 06 00 00
3	Glow Plug Cover		25 1571 01 04 00
4	Clamp		25 1571 01 02 00
5	Control Box	12V	25 1570 52 00 00
		24V	25 1571 52 00 00
6	Main Heater Harness		25 1656 01 02 00
8	Seal Ring		25 1571 01 00 09
9	Hood		25 1571 01 00 05
10	Safety Thermal Cutout Switch		25 1578 01 00 03
11	Temperature Regulating Switch Standard		25 1571 41 01 01
	High Temperature Switch		25 1436 01 00 03
12	Grommet		20 1280 09 01 03
13	Glow Plug		25 1431 01 00 03
14	Relay	12V	203 00 065
		24V	203 00 066
15	Fillister Head Screw M5x12		H
16	Spring Washer B5		H
17	Screw M6x40		100 10 053
18	Ignition Line Plug Connector (Cover)		206 00 150
19	Reduction Piece		206 31 019
20	Diode		208 00 012
21	Grommet		320 31 061
22	Fuse TT8	12V	204 00 080
	Fuse TT4	24V	460 26 016
22 A	Fuse Holder Cap		204 00 102
23	Burner		25 1655 16 00 00
24	Combustion Air Regulator		25 1571 15 04 00
25	Electric Motor	12V	25 1570 15 05 00
		24V	25 1571 15 05 00
26	Ignition Spark Generator		20 1643 01 01 00
27	Glow Plug Series Resistor	12V	25 1570 15 00 02
		24V	25 1571 15 00 02
28	Coupling Complete		25 1426 99 55 00
29	Filiister Head Screw M4x8		H
30	Spring Lockwasher B4		H
31	Fillister Head Screw M4x20		CA3 00 107
32	Sheetmetal Nut		119 10 031
33	Sheetmetal ScrewB4.8x19		H
34	Fillister Head Screw M6x12		CA3 00 103
35	Serrated Lockwasher B6		CA3 00 308
36	Hex Nut M5		CA3 00 206
37	Screw M5x40		106 10 020
38	Atomizer		25 1656 1 6 06 00

Ref. No.	Description		Part Number
39	Spacer Washer - Burner		25 1426 15 03 01
40	Fuel Metering Pump	12V	25 1570 45 00 00
		24V	25 1571 45 00 00
41	Fuel Metering Pump Holder		25 1156 20 00 11
42	Rubber Ring -FMP		20 1449 00 10 01
43	Coolant Circulating Pump	12V	25 1655 25
		24V	25 1656 25
44	Pump Flange		25 1571 25 01 01
45	Coolant Pump Case		25 1571 25 01 02
46	Impeller Wheel		25 1571 25 01 03
47	Disc		25 1571 25 01 05
48	Axial Face Seal		329 00 090
49	Ring Complete		329 00 082
50	O Ring		320 31 095
51	Self Tapping Screw BZ3.9X25		H
52	Fillister Head Screw M4xI2		H
53	Spring Washer B4		H
54	Locknut M4		114 10 055
55	Female 2 Hole Socket		206 31 004
56	Flame Sensor	12V	25 1655 99 01 01
		24V	25 1656 99 01 01
56 A	Seal Ring		25 1656 01 00 02
57	Flange		Special Order Only
58	Baffle Plate with Atomizer		25 1571 99 18 00
59	Flexible Stainless Steel Exhaust 42mm		WG4 42 000

BOX PARTS AND ACCESSORIES

60	Heater Box - Base	Special Order Only
	Cover	Special Order Only
61	Grommet for Harnesses and Fuel Line	20 1280 09 01 03
62	Grommet for Coolant Hose	CA0 11 009
63	Silicone Exhaust Gasket	20 1282 20 00 02
64	Rubber Shock Mounts 5/16“	CA0 00 040
65	Side Mount Mounting Bracket Kit	CA0 10 056
65 A	Bracket Only	CA0 10 027
65 B	Mounting Spacers	CA0 30 122
65 C	Bolt M8x50	CA3 00 128
65 D	Hex Nut M8	CA3 00 209
65 E	Lock Washer 8mm	CA3 00 302

FUEL SYSTEM

66	Standard Fuel Pick Up Pipe	CA0 12 058
67	Custom Ring Type Fuel Pick Up Pipe	CA0 12 012
Not Shown	Gasket for #67	CA0 12 040
68	Custom Straight Pick Up Pipe	
	16“ Length	CA0 00 030
	24” Length	CA0 12 053

Ref. No.	Description		Part Number
69	Compression Fitting		
	1/4" NPT		CA0 12 044
	3/8" NPT		CA0 00 031
	1/2" NPT		CA0 12 005
70	9mm Fuel Line Clamp (Pressure Side)		10 2061 00 90 98
71	3.5mm Rubber Fuel Hose (Pressure Side)		360 75 300
72	10mm Fuel Line Clamp (Suction Side)		10 2063 01 00 98
73	5mm Rubber Fuel Hose (Suction Side)		360 75 130
74	6mm Rubber Shock Mounts for Fuel Pump		20 8460 01 00 15
	ELECTRICAL SYSTEM		
Not Shown	Installation Harness Kit		CA1 60 512
	Includes: 15' Power Harness		
	25' Switch Harness		
	20' FMP Harness		
	10' Water Pump Harness		
Not Shown	Pigtail Harness		CA1 60 519
77	Push/Pull Switch with Light	12V	CA1 00 003
		24V	CA1 00 004
Not Shown	Replacement Bulb	12V	207 00 005
		24V	207 00 006
78	99 Hour Countdown Timer with Bracket		CA1 00 050
78 A	Bracket Only		CA0 00 032
78 B	Timer Only		CA1 00 051
79	Main Fuse 30A		CA1 07 004
80	Main Fuse Holder		CA1 07 001
	PLUMBING SYSTEM		
81	High Capacity Water Pump	12V	CA1 00 019
		24V	CA1 00 083
82	1" Pump Fitting		CA0 11 015
83	5/8" Pump Fitting		CA0 11 002
84	Preformed Hose - Standard Pump to Heater		CA0 11 010
85	Preformed Hose - High Capacity "Pump to Heater		CA0 11 008
86	Preformed Hose -90° to High Capacity Pump		CA0 11 012
87	Preformed Hose -90° to Heater Outlet		CA0 11 013
88	1" Steel Elbow 90°		CA0 11 021
89	1" Steel in Line Connector		CA0 11 022
Not Shown	7/8" Hose Clamp		CA1 10 038
Not Shown	1" Hose Clamp		CA1 10 039

– NOTES -

– NOTES –

Carrier

TRANSICOLD

OPERATION AND SERVICE MANUAL

MODEL 05G and 05G BUS COMPRESSOR

UNITED TECHNOLOGIES CARRIER TRANSICOLD

Carrier Transicold Division, Carrier Corporation, P.O. Box 4805, Syracuse, N.Y. 13221 U. S. A.
Carrier Transicold E.T.O. Boite Postale Nr. 16 Franqueville – Saint–Pierre 76520 Boos, FRANCE

Replaces: 62-03432-01 and T-199-02

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1
DESCRIPTION

1.1 INTRODUCTION

This operation and service manual covers the Carrier Transicold Model 05G compressors. These compressors are designed for refrigeration (trailer) or air conditioning (bus & rail) applications. (See Figure l-l) The following table list the special tools for the 05G compressors.

PART NO.	SPECIAL TOOLS
07-00219	Wrench, Compressor Sight Glass
07-00223	Pliers, Compressor Unloader Ring
07-00240-01	Wrench, Spanner (for Housing Mounted Clutch)
07-00241	Rotor Installation Tool (for Housing Mounted Clutch)
07-00242-01	Bearing Retaining Nut Socket (3.5") (Housing Mounted Clutch)
07-00242-02	Bearing Retaining Nut Socket (3") (for Housing Mounted Clutch)
07-00260-00	Acid Test Kit
07-00265-01	Totaltest Kit (Packaae of 1)
07-00266-00	Replacement Tubes for Totaltest Kit
58-00869-00	Filter, Felt (Suction Sock for System Clean Up)

1.2 GENERAL DESCRIPTION

The Model 05G compressors are of the open-drive reciprocating type. A crankshaft, connecting rods, pistons, and reed type valves accomplish vapor compression. Compressor wear is minimized by splash lubrication and by force feed lubrication. There are three types of oil pumps (Vane, Gear and Low Profile Gear) driven directly from the end of the compressor crankshaft. (See Figure 1-3)

CAUTION

The gear oil pump must be set to rotate in the same direction as the crankshaft. (Refer to section 3.4)

The tapered end of the crankshaft, which extends outside the crankcase, is adaptable to a variety of direct drive or belt–driven clutch mechanisms. A mechanical seal prevents refrigerant leakage where the rotating shaft passes through the crankcase.

The compressor is equipped with flanges for connecting suction and discharge service valves. Connections are also provided for pressure gauges and safety cutout switches. Sight glasses installed on both sides of the crankcase, provides a means for checking oil level in the compressor crankcase. A drain plug facilitates draining of oil from the crankcase and an oil fill plug enables addition of oil when necessary. A bottom plate provides access through the bottom of the crankcase for maintenance.

WARNING

Do not operate compressor unless suction and discharge service valves are open.

Capacity of the Model 05G compressor is determined by piston displacement and clearance, suction and discharge valve size, compressor speed, suction and discharge pressure, type of refrigerant, and unloader valves.

1.3 COMPRESSOR REFERENCE DATA

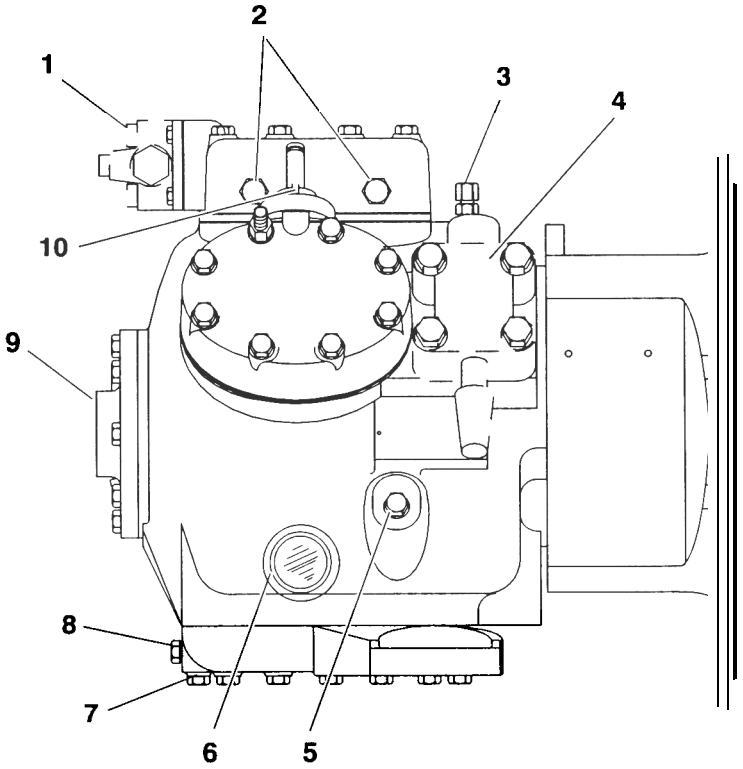
Model	05 G-37CFM	05G–41CFM
Displacement	37CFM	41CFM
No. Cylinders	6	
Bore	50.8 mm (2.00 in)	
Stroke	49.2 mm (1.937 in)	54.36 mm (2.14 in)
Weight	62 kg (137 Ibs)	
SPEED (RPM) FOR OIL PUMP		
Vane	900 to 2200	
Gear	500 to 2200	
Low Profile Gear	500 to 2200	

NOTE

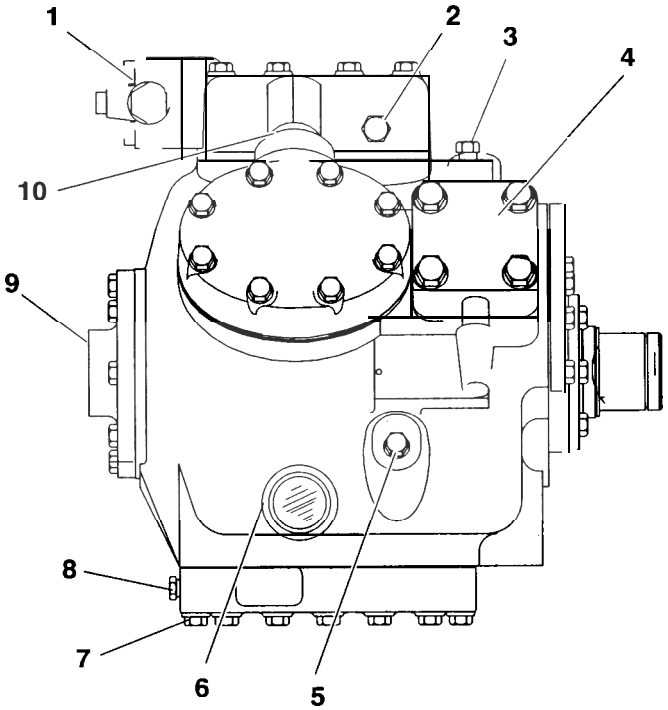
The oils below are suitable for use with evaporator temperatures above –40°F (-40°C).

Approved Oil for REFRIGERATION USE (TRAILER)	
Refrigerant	**Oil**
R-12, R-22, R-500 or R-502	Zerol 150 Synthetic P/N 07-00274

Approved Oil for AIR CONDITIONING USE (BUS AND RAIL)	
Refrigerant	**Oil**
R-12 or R-22	Calumet Refining: R030
	Texaco: WF68
	Witco: 4GS Suniso
R-134a	Castrol Icematic: SW-68



REFRIGERATION COMPRESSOR (TRAILER)



AIR CONDITIONING COMPRESSOR (BUS & RAIL)

1. Discharge Service Valve
2. High Pressure Connection
3. Low Pressure Connection
4. Suction Service Valve
5. Oil Fill Plug
6. Oil Level Sight Glass
7. Bottom Plate
8. Oil Drain Plug
9. Oil Pump (See Figure 1-3)
10. Unloader

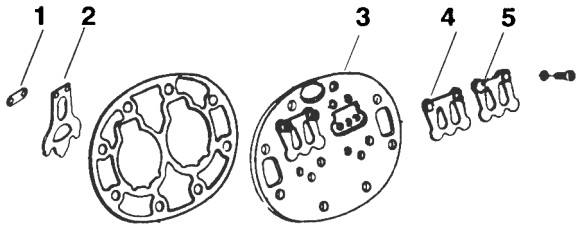
Figure 1-1. Model 05G Compressor

1.4 DETAILED DESCRIPTION

1.4.1 SUCTION AND DISCHARGE VALVES

The compressor uses reed type suction and discharge valves made of highest quality steel for long life. The valves operate against hardened integral seats in the valve plate.

The downstroke of the piston admits refrigerant gas through the suction valve, and then compresses this gas on the upstroke, thereby raising it's temperature and pressure. The compressed gas is prevented from recentering the cylinder on it's next downstroke by the compressor discharge valve. (See Figure 1-2)



1. Position Spring
2. Suction Valve
3. Valve Plate
4. Discharge Valve
5. Discharge Valve Stop

Figure 1-2. Suction & Discharge Valve

1.4.2 SUCTION & DISCHARGE SERVICE VALVES

The suction and discharge service valves used on the compressor are equipped with mating flanges for connection to flanges on the compressor. These valves are provided with a double seat and a gauge connection, which allows servicing of the compressor and refrigerant lines (See Figure l-l).

Turning the valve stem counterclockwise (all the way out) will *backseat* the valve to open the suction or discharge line to the compressor and close off the gauge connection. In normal operation, the valve is backseated to allow full flow through the valve. The valve should always be backseated when connecting the service manifold gauge lines to the gauge ports.

Turning the valve stem clockwise (all the way forward) will *frontseat* the valve to close off the suction or discharge line to isolate the compressor and open the gauge connection.

To measure suction or discharge pressure, midseat the valve by opening the valve clockwise about 2 turns. With the valve stem midway between frontseated and backseated positions, the suction or discharge line is open to both the compressor and the gauge connection.

1.4.3 LUBRICATION SYSTEM

There are three types of oil pumps (Vane, Gear and Low Profile Gear) driven directly from the end of the compressor crankshaft (See Figure 1-3). Force-feed lubrication of the compressor is accomplished by a oil pump driven directly from the compressor crankshaft. Refrigeration oil is drawn from the compressor crankcase through the oil filter screen and pick up tube to the oil pump located in the bearing head assembly. The crankshaft is drilled to enable the pump to supply oil to the main bearings, connecting rod bearings, and the shaft seal.

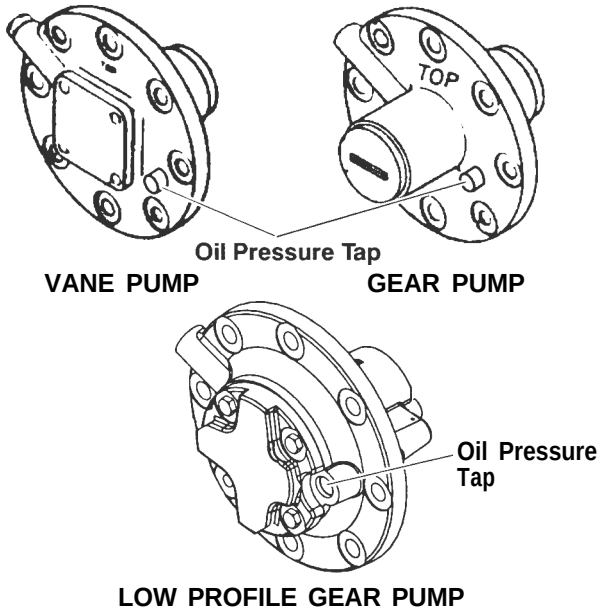


Figure 1-3. Oil Pumps

CAUTION

The Gear oil pump must be set to rotate in the same direction as the crankshaft. (Refer to section 3.4)

The oil flows to the pump end main bearings, connecting rod bearings and seal end main bearings, where the oil path is divided into two directions. The largest quantity flows to the oil relief valve, which regulates oil pressure at 15 to 18 psi (2.09 to 2.30 kg/cm2) above suction pressure. When the oil pressure reaches 15 to 18 psi above suction pressure, the relief valve spring is moved forward allowing oil to return to the crankcase. The remaining oil flows through an orifice and into the shaft seal cavity to provide shaft seal lubrication and cooling. This oil is then returned to the crankcase through an overflow passage.

An additional oil pressure relief valve, built into the Gear and Low Profile Gear Oil Pump, is open at speeds above 400 rpm to relieve a portion of the oil pressure to the crankcase in order to maintain oil pressure below an acceptable maximum. At low speeds, the valve is closed to ensure adequate oil pressure at 400 rpm. At speeds above 1900 rpm, the oil pressure will be 25 to 30 psi (2.8 to 3.1 kg/cm²) above suction pressure.

The crankcase pressure equalization system consists of two oil return check valves and a l/8-inch pressure equalization port between the suction manifold and crankcase. Under normal conditions, check valves are open and allow for oil return to the crankcase. Under flooded start conditions, pressure rises in the crankcase and closes the check valves, preventing excess oil loss. The equalization port allows for release of excessive pressure, that has built up in the crankcase, to the suction manifold; this ensures that the oil loss is kept to a minimum.

1.5 COMPRESSOR UNLOADER

The 6 cylinder 05G compressor can be applied with 2 bank of unloading.

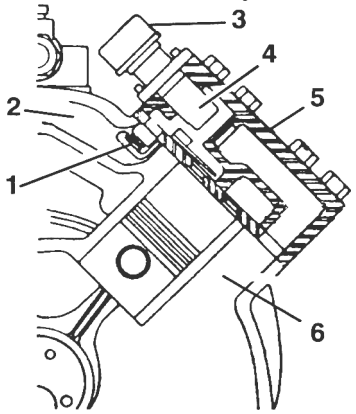
There are two types of compressor unloader systems; the first one is the hot gas bypass and the second is the suction cutoff. They are easily distinguished from each other by observing the bottom side of the compressor cylinder head, it is either blank (Hot gas bypass) or has a cover plate (Suction cutoff).

The two types of compressor unloader systems can be controlled with either a pressure actuated valve or an electrically actuated (solenoid) valve.

1.5.1 HOT GAS BYPASS UNLOADER

The compressor is equipped with an unloader for capacity control. This consists of a self-contained, cylinder head bypass arrangement (See Figure 1-4) which is electronically controlled by the temperature controller.

The capacity controlled cylinder is easily identified by the solenoid which extends from the side of the cylinder head. When the solenoid energizes, the cylinder unloads allowing discharge gas to circulate as shown in Figure 1-5. The unloaded cylinder operates with little or no pressure differential, consuming very little power. A de-energized solenoid reloads the cylinder as shown in Figure 1-6.



1. Discharge Check Valve
2. Discharge Manifold
3. Solenoid Valve
4. Piston Bypass Control Valve
5. Cylinder Head
6. Suction Manifold

Figure 1-4. Compressor Unloader – Hot Gas Bypass

a. Major Working Parts

1. Solenoid and valve system
2. Spring loaded piston type bypass control valve
3. Spring loaded discharge check valve

b. Unloaded Operation

Pressure from the discharge manifold (Figure 1-5, item 15) passes through the strainer (9) and bleed orifice (8) to the back of the piston bypass valve (7). Unless bled away, this pressure would tend to close the piston (6) against the piston spring (5) pressure.

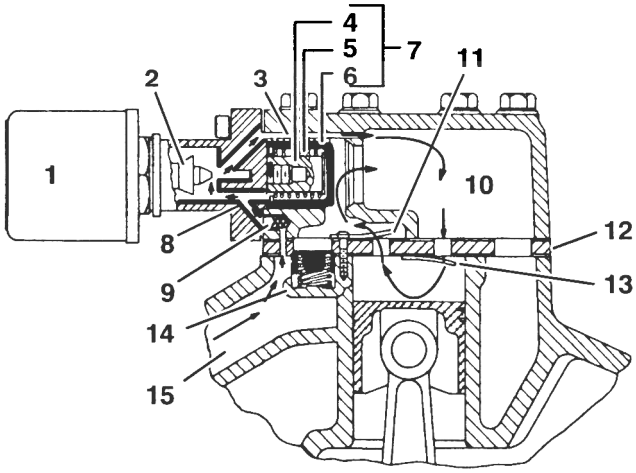
With the solenoid valve (1) *energi.zed* the solenoid valve stem (2) will *open* the gas bypass port (3).

Refrigerant pressure will be bled to the suction manifold (10) through the opened gas bypass port . A reduction in pressure on the piston bypass valve will take place because the rate of bleed through the gas bypass port is greater than the rate of bleed through the *bleed orifice* (8).

When the pressure behind the piston has been reduced sufficiently, the valve spring will force the piston bypass valve *back*, *opening* the gas bypass from the discharge manifold to the suction manifold.

Discharge pressure in the discharge manifold will close the discharge piston check valve assembly (14) isolating the compressor discharge manifold from the individual cylinder bank manifold.

The *unloaded* cylinder bank will continue to operate *fully unloaded* until the solenoid valve control device is *de-energized* and the gas bypass port is closed.



1. Solenoid Valve
2. Valve Stem
3. Gas Bypass Port
4. Spring Guide
5. Spring
6. Piston
7. Piston Bypass Valve
8. Bleed Orifice
9. Strainer
10. Suction Cavity
11. Cylinder Discharge Valve
12. Valve Plate
13. Cylinder Suction Valve
14. Discharge Piston Check Valve Assembly
15. Discharge Manifold

Figure 1-5. Compressor CyIinder Head Unloaded – Hot Gas Bypass

c. Loaded Operation

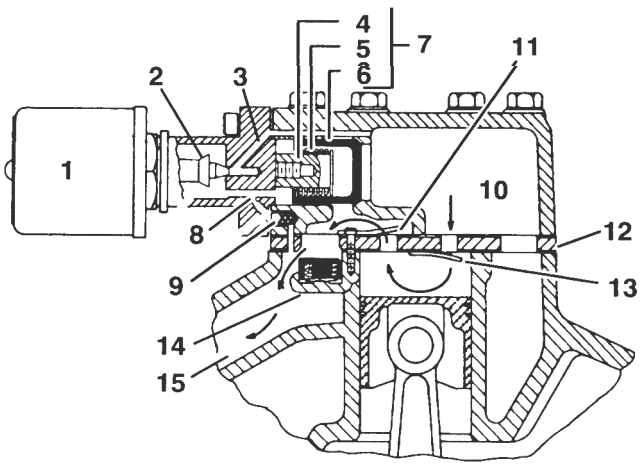
Discharge pressure bleeds from the discharge manifold (Figure 1-6, item 15) through the strainer (9) and (8) bleed orifice to the solenoid valve stem (2) chamber and the back of the piston bypass valve (7).

With the solenoid valve (1) *de-energized* the solenoid valve stem will close the gas bypass port (3).

Refrigerant pressure will overcome the bypass valve spring (5) tension and force the piston (6) *forward closing* the gas bypass from the discharge manifold to the suction manifold (10).

Cylinder discharge pressure will force open the discharge piston check valve assembly (14). Refrigerant gas will pass into the compressor discharge manifold.

The loaded cylinder bank will continue to operate fully loaded until the solenoid valve control device is energized and the gas bypass port is opened.



1. Solenoid Valve
2. Valve Stem
3. Gas Bypass Port
4. Spring Guide
5. Spring
6. Piston
7. Piston Bypass Valve
8. Bleed Orifice
9. Strainer
10. Suction Cavity
11. Cvlinder Discharge valve
12. Valve Plate
13. Cylinder Suction Valve
14. Discharge Piston Check Valve Assembly
15. Discharge Manifold

Figure 1-6. Compressor Cylinder Head Loaded – Hot Gas Bypass

1.5.2 SUCTION CUTOFF UNLOADER

The compressor is equipped with unloaders for capacity control. This consists of a self-contained, suction cut-off arrangement which is electronically controlled by the temperature controller.

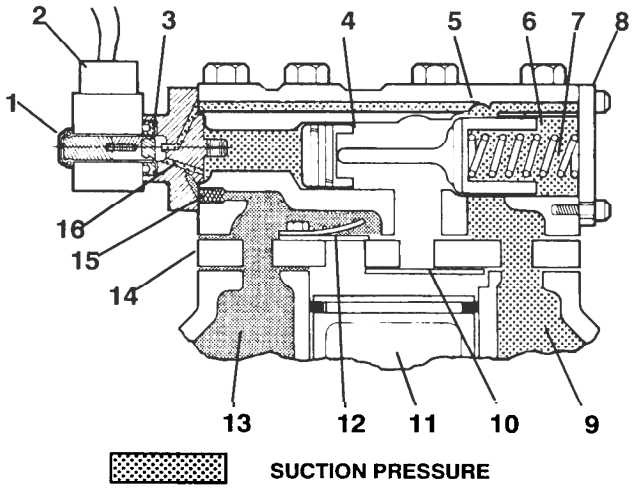
The capacity controlled cylinders are easily identified by the solenoid which extends from the side of the cylinder head. When the solenoid energizes, cylinders unload, preventing suction gas from being drawn into the cylinder (See Figure 1-7). The unloaded cylinders operate with little or no pressure differential, consuming very little power. A de-energized solenoid reloads the cylinders as shown in Figure 1-8.

a. Major Working Parts

1. Solenoid and valve system
2. Unloader piston assembly
3. Spring and cover plate

b. Unloaded Operation

When the unloader valve solenoid energizes, the capacity control valve port opens (item 3, Figure 1-7). This allows the discharge gas behind the unloader piston assembly (item 4) to vent back to the suction side. The unloader valve spring (item 7) at this point, can move the unloader valve body to the left, blocking the unloader suction port. The cylinder bank is now isolated from the compressor suction manifold to unload these two cylinders. No refrigerant is allowed into the cylinders and no compression takes place.

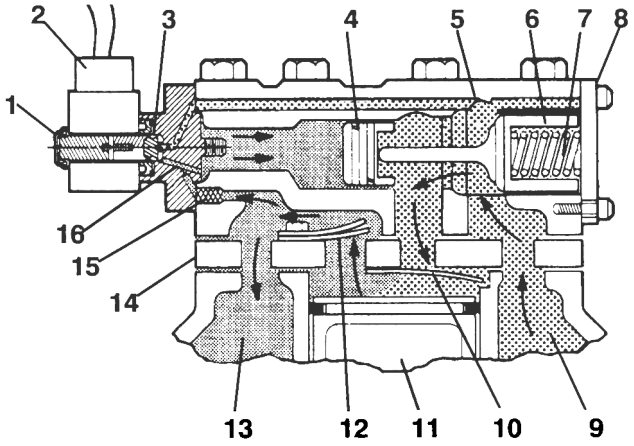


1. Solenoid Valve
2. Coil
3. Capacity Control Valve (Open)
4. Unloader Piston
5. Cylinder Head
6. Valve Body
7. Valve Spring
8. Cover Plate
9. Suction Manifold
10. Suction Valve
11. Piston
12. Discharge Valve
13. Discharge Manifold
14. Valve Plate
15. Strainer
16. Bleed Orifice

Figure 1-7. Compressor Cylinder Head (Unloaded) – Suction Cutoff

c. Loaded Operation

When the unloader valve solenoid de-energizes, the capacity control valve port closes (item 3, Figure 1-8). This allows discharge pressure to build-up behind the unloader piston assembly. The high pressure will compress the unloader valve spring, opening the unloader suction port. Suction gas can now be drawn into the cylinders, running the bank fully loaded.



SUCTION PRESSURE

DISCHARGE PRESSURE

1. Solenoid Valve
2. Coil
3. Capacity Control Valve (Closed)
4. Unloader Piston
5. Unloader Head
6. Valve Body
7. Valve Spring
8. Cover Plate
9. Suction Manifold
10. Suction Valve
11. Piston
12. Discharge Valve
13. Discharge Manifold
14. Valve Plate
15. Strainer
16. Bleed Orifice

Figure 1-8. Compressor Cylinder Head (Loaded) – Suction Cutoff

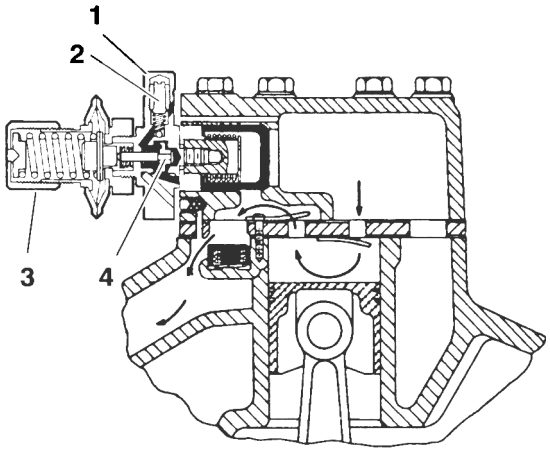
1.5.3 PRESSURE-OPERATED UNLOADERS

There are two types of compressor unloader systems; the first one is the hot gas bypass and the second is the suction cutoff. They are easily distinguished from each other by observing the bottom side of the compressor cylinder head, it is either blank (Hot gas bypass) or has a cover plate (Suction cutoff).

The two types of compressor unloader systems can be controlled with either a pressure actuated valve or an electrically actuated (solenoid) valve.

The pressure–operated unloaders are controlled by suction pressure and actuated by discharge pressure. The unloader valve controls two cylinders. On startup, controlled cylinders do not load up until differential between suction and discharge pressure is 10 psi (1.7 kg/cm²).

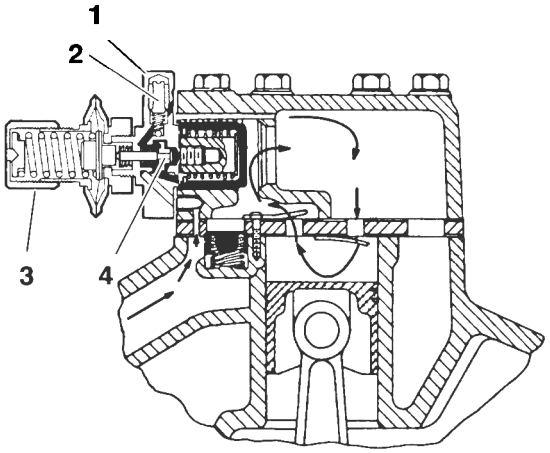
During *loaded operation*, when suction pressure is above the valve control point, the poppet valve will close. Discharge gas bleeds into the valve chamber; the pressure closes the bypass piston; and the cylinder bank loads up. Discharge gas pressure forces the check valve open, permitting gas to enter the discharge manifold. See Figure 1-9.



1. Sealing Cap
2. Pressure Differential Adjustment Screw
3. Control Set Point Adjustment Nut
4. Poppet Valve

Figure 1-9. Pressure-Operated Unloader Loaded Operation

During *unloaded operation*, when suction pressure drops below the valve control point, the poppet valve will open. Discharge gas bleeds from behind the bypass piston to the suction manifold. The bypass piston opens, discharge gas is recirculated back to the suction manifold and the cylinder bank is unloaded. Reduction in discharge pressure causes the check valve to close, isolating the cylinder bank from the discharge manifold. See Figure 1-10.



1. Sealing Cap
2. Pressure Differential Adjustment Screw
3. Control Set Point Adjustment Nut
4. Poppet Valve

Figure 1-10. Pressure-Operated Unloaded – Unloaded Operation

SECTION 2

COMPRESSOR REPLACEMENT

2.1 COMPRESSOR REMOVAL

Refer to the operation and service manual covering the equipment in which the compressor is installed for specific removal instructions. A general removal procedure is given below.

a. If compressor is completely inoperative, frontseat the suction and discharge service valves to trap the refrigerant in the unit. If the compressor will operate, pump down the unit; then, frontseat the suction and discharge service valves.

b. Ensure power source is removed from any controls installed on the compressor.

c. Remove refrigerant using a refrigerant recove~ system.

d. Disconnect refrigerant lines at service valve flange connections on the compressor; retain hardware.

e. Remove any components necessary to gain access to the compressor or to enable removal.

f. Disconnect the drive mechanism at the compressor.

g. Remove mounting hardware and remove compressor from unit.

h. If compressor is to be repaired, refer to section 3 for repair procedures. if a replacement compressor is to be installed, refer to section 2.2 for replacement procedures.

2.2 COMPRESSOR REPLACEMENT

Consult the unit service parts list for the correct replacement.

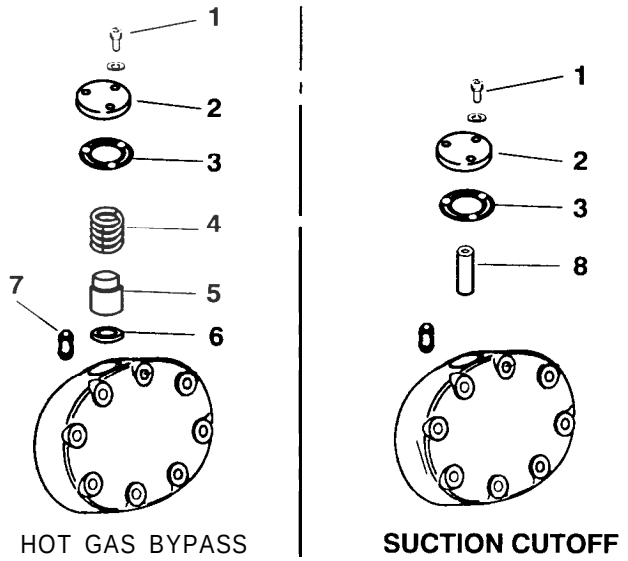
Service replacement compressors are furnished without suction and discharge service valves and unloader valves. The service valves are normally retained on the unit to isolate the refrigerant lines during compressor replacement. Blank-off pads are installed on the service replacement compressor valve flanges. These pads must be removed prior to installing the compressor. If the defective compressor is to be returned for overhaul or repair, install the pads on the compressor for sealing purposes during shipment.

Service replacement compressors are furnished with cylinder head bypass piston plugs installed on the unloader flanges in lieu of the unloader valves. The unloaders (if used) must be removed from the defective compressor and transferred to the replacement compressor prior to installation. Refer to section 2.2.1.

If the defective compressor is to be returned for overhaul or repair, install the plugs on the compressor for sealing purposes during shipment.

2.2.1 INSTALLING COMPRESSOR UNLOADERS

a. Remove the three socket head capscrews holding piston plug to cylinder head of the replacement compressor. See Figure 2-1.



1. Capscrews
2. Flange Cover
3. Gasket
4. Spring
5. Bypass Piston Plug
6. Seat Ring
7. Strainer
8. Sleeve Plug

Figure 2-1. Removal of Piston Plug

b. Remove flange cover, gasket, spring, bypass piston plug, and seat ring. A tapped hole is provided in piston plug for use with a jackscrew to enable removal of the plug. One of the socket head capscrews maybe used as a jackscrew.

c. Remove the three socket head capscrews holding unloader in the cylinder head of the defective compressor; remove the unloader and retain the capscrews.

NOTE

Capscrews removed from the bypass piston plug flange cover are not interchangeable with capacity control unloader valve capscrews. When installing the unloaders, be sure to use the unloader capscrews.

d. Using a new gasket and unloader ring pliers (P/N 07-00223), install the unloaders in the cylinder heads of the replacement compressor. Refer to Table 3-1, for required torque values.

e. If the defective compressor is to be returned for overhaul or repair, install the bypass piston plug, spring, seat ring and flange cover onto the cylinder heads.

2.2.2 INSTALLING COMPRESSOR

WARNING

Midseat service valves or by other means relieve pressure in replacement compressor before removing plugs.

CAUTION

The high capacity oil pump must be set to rotate in the same direction as the crankshaft. (Refer to Section 3.4)

a. Install the compressor by reversing the procedure of section 2.1. Install new locknuts on compressor mounting bolts and new gaskets on suction and discharge service valves.

b. Check oil level in sight glass (See Figure 2-2). If necessary, add or remove oil.

c. Leak test, evacuate, and dehydrate the compressor.

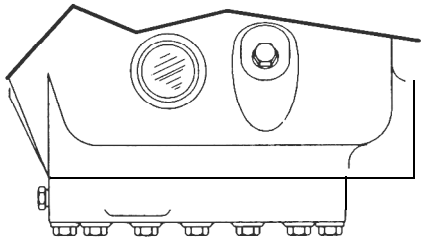
d. Fully backseat suction and discharge service valves.

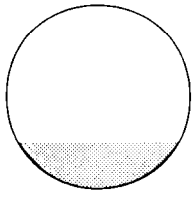
e. Run the compressor and check for leaks and noncondensibles in the refrigerant system.

f. Check refrigerant level.

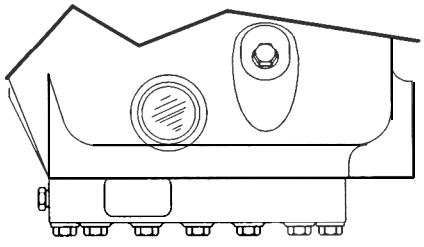
g. Recheck compressor oil level.

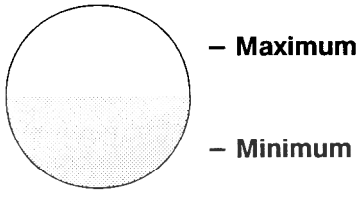
h. Check operation of compressor unloaders (if installed).





OLD SIGHT GLASS LOCATION and PROPER LEVEL





NEW SIGHT GLASS LOCATION and PROPER LEVEL

Figure 2-2. Oil Level in Sight Glass

SECTION 3

COMPRESSOR MAINTENANCE

3.1 INTRODUCTION

Prior to disassembly of the compressor, oil must first be drained from the crankcase. Place the compressor in a position where it will be convenient to drain the oil. Remove the oil fill plug to vent the crankcase. Loosen the drain plug and allow the oil to drain out slowly.

If dismantled parts are to be left overnight or longer, dip them in clean compressor oil (to prevent rusting) and store in protected area.

Refer to Table 3-1 for torque values for tightening bolts.

3.2 INSPECTION AND PREPARATION FOR REASSEMBLY

a. Clean all parts with an approved solvent. Use a stiff bristle brush to remove dirt from grooves and crevices.

b. Inspect all parts for wear and overall condition. Replace any defective or excessively worn parts.

c. Inspect suction and discharge valve seats (on valve plate).

d. If unloaders are installed, inspect operation of unloader.

e. After cleaning, ensure all moving parts are coated with compressor oil before reassembly.

f. Use only new gaskets during reassembly. Ensure all gaskets (includes cylinder head, valve plate, and unloader or bypass plug gaskets) are installed dry.

3.3 CYLINDER HEAD AND VALVE PLATE

a. Disassembly

WARNING

Do not unscrew capscrews all the way before breaking seal. Entrapped pressure could result in injury.

1. Loosen cylinder head capscrews. If the head is stuck, tap it lightly with a wooden or lead mallet to free it. Be careful not to drop the head or damage the gasket sealing surface. Remove cylinder head capscrews and gasket. (See Figure 3-1)

2. Remove the discharge valve capscrews, lock washers, stops, and valves.

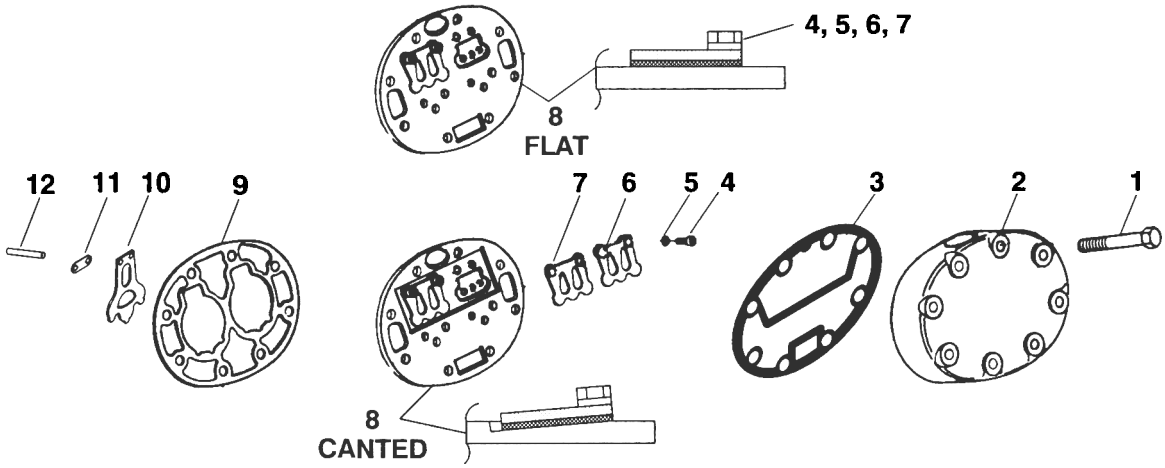
3. Free the valve plates from the cylinder deck by using the discharge valve capscrews, without washers, as jackscrews through the outermost tapped holes in the valve plate after the valve stops and valves have been removed. Remove the valve plate gasket.

4. Discard valves and gaskets. Use only new valves and gaskets when assembling cylinder head and valve plate assemblies.

b. Reassembly

Some 05G compressors for refrigeration use only may have “canted” valve plates. The “canted valve” design allows a reduction in the distance between the discharge valve and the top of the piston. When piston is at TDC the volume of the compression chamber is smaller, contributing to increased compressor efficiency.

1. Install only new valves and gaskets, and do not interchange valves.



1. Capscrew
2. Cylinder Head
3. Cylinder Head Gasket
4. Capscrew
5. Lockwasher
6. Discharge Valve Stop
7. Discharge Valve
8. Valve Plate
9. Valve Plate Gasket
10. Suction Valve
11. Position Spring
12. Dowel Pin

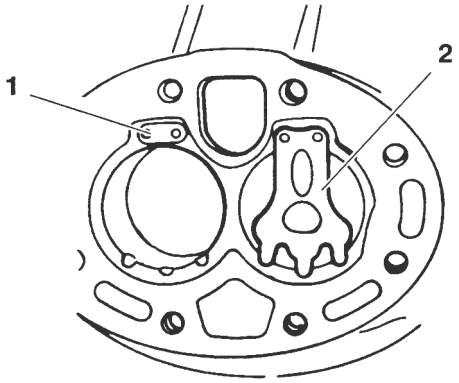
Figure 3-1. Cylinder Head & Valve Plate

2. Install suction valve positioning spring on dowel pins. Assemble positioning spring springs with spring ends bearing against cylinder deck. The spring will bow outward in the middle. (See Figure 3-2)

3. Place suction valve on dowel pins, over the positioning spring.

4. Place valve plate and new valve plate gasket on cylinder deck ensuring that the valve plate is properly positioned on the four dowel pins.

5. Using a small screwdriver, operate the suction valves to ensure that the valve tips are not being held by the valve plate gasket. (See Figure 3-3)



1. Positioning Spring
2. Suction Valve

Figure 3-2. Installing Suction Valves

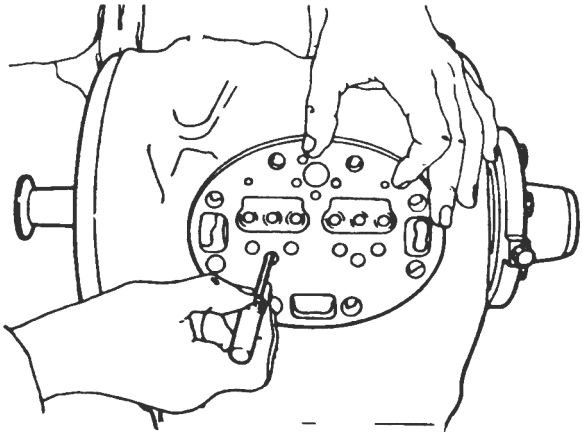


Figure 3-3. Checking Suction Valve

6. Install discharge valve and discharge valve stop with capscrews and lock washers.

7. Install capscrews, cylinder head and new cylinder head gasket with flat side to valve plate, ensuring that the gasket and cylinder head are properly positioned on the valve plate. Torque the capscrews, in a diagonal pattern, to a value shown in Table 3-1.

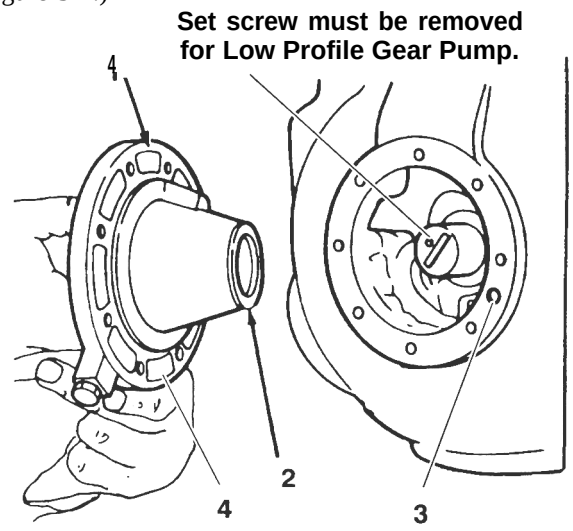
3.4 OIL PUMP AND BEARING HEAD

There are three types of oil pumps (Vane, Gear and Low Profile Gear) driven directly from the end of the compressor crankshaft.

3.4.1 LOW PROFILE GEAR PUMP

a. Removal

Remove eight capscrews and remove oil pump bearing head assembly, gasket and thrust washer. (See Figure-3-4.)

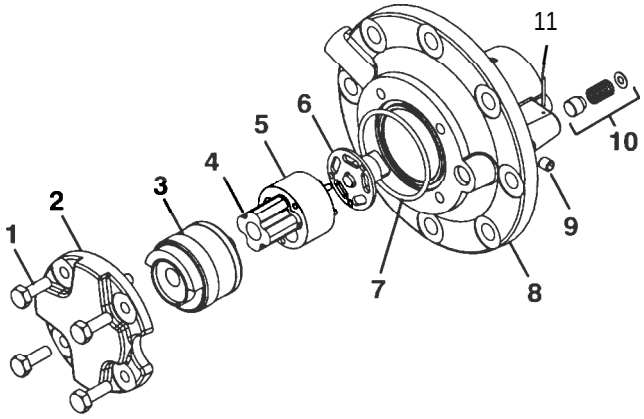


1. Oil Pump & Bearing Head
2. Thrust Washer
3. Oil Pickup Tube
4. Oil Inlet Port

Figure 3-4. Oil Pump and Bearing Head Assembly

b. Disassembly, & Inspection

If it was determined that the oil pump was not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are not available. However, in the event the pump requires inspection or cleaning, disassembly and reassembly by referring to Figure 3-5. Clean all parts; coat all moving parts with compressor oil before proceeding with reassembly.



1. Capscrews
2. Cover
3. Reversing Assembly
4. Pinion
5. Gear
6. Drive
7. O-Ring
8. Oil Pump & Bearing
9. Set Screw
10. Relief Valve
11. Pin

Figure 3-5. Low Profile Gear Oil Pump

c. Reassembly

1. Install the pump end thrust washer on the two dowel pins located on the bearing head. (See Figure 3-4.)

CAUTION

Ensure that thrust washer does not fall off dowel pins while installing oil pump.

2. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push oil pump on by hand ensuring that the thrust washer remains on the dowel pins, the tang on the end of the drive segment engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The pump should mount flush with the crankcase and should be oriented as shown in Figure 1-1.

3. Align the gasket and install the eight capscrews in the mounting flange. Refer to Table 3-1, for applicable torque values.

3.4.3 VANE PUMP

a. Removal

1. Remove four capscrews, gaskets and remove oil pump cover; this will free the oil feed guide retaining spring, cover gasket, and the oil feed guide. (See Figure 3-7.)

2. Remove the two drive segment capscrews and lock washer and remove the drive segment.

3. Remove eight capscrews and remove oil pump bearing head assembly and gasket. (See Figure 3-4.)

b. Disassembly, & Inspection

If it was determined that the oil pump was not operating properly, it is recommended that the entire oil pump and bearing head assembly be replaced to ensure trouble-free operation. However, if the cause of oil pump failure can be determined in the field and replacement parts for the pump are available, the pump can be repaired. The pump end bearing is integral with the bearing head and is not replaceable.

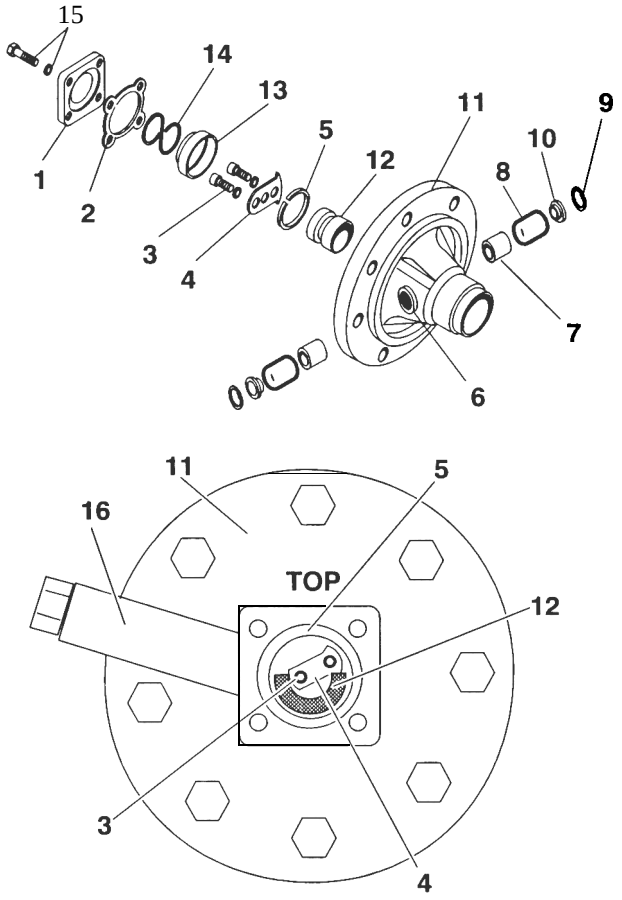
1. Remove the plunger snap ring with snap ring pliers. As each snap ring is removed, the spring guide, plunger spring, and plunger may be removed from the cylinder in the bearing head. Identify parts to ensure replacement in same cylinder.

2. Push the pump rotor out of the bearing head by forcing against the rotor. Apply force from the bearing side and remove rotor from the opposite side. The pump rotor retaining ring will come out with the rotor.

3. Clean all parts; coat all moving parts with compressor oil before proceeding with reassembly.

4. Insert the pump rotor into the bearing head from the side opposite the bearing, with the rotor retaining ring in place on the rotor. Install the rotor retaining ring with the chamfered edge in. Compress the retaining ring (close gap) in order to fit the rotor and ring into their proper positions.

5. Insert one of the plungers into a cylinder in the bearing head (flat end in); then insert the plunger spring and spring guide. Insert retaining ring with ring pliers. Force the spring guide down to compress the plunger spring and to allow the retaining ring to fit into its locking groove. Follow the same procedure to reassemble the other plunger spring, guide and snap ring in its plunger cylinder.



1. Oil Pump Cover
2. Cover Gasket
3. Capscrews and Lockwashers
4. Oil Pump Drive
5. Rotor Retaining Ring
6. Pump Vane Cylinder
7. Pump Vane
8. Vane Spring
9. Retaining Ring
10. Spring Guide
11. Bearing Head
12. Pump Rotor
13. Oil Feed Guide
14. Retainer Spring
15. Capscrews and Washers
16. Oil Inlet Passage

Figure 3-7. Vane Oil Pump

c. Reassembly

1. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push oil pump on by hand ensuring that the bearing head mounts flush to the crankcase body. The top of the bearing head is marked on the mounting flange.

2. Align the gasket and install the eight capscrews in the mounting flange. Refer to Table 3-1, for applicable torque values.

3. Install the drive segment with the two capscrews and lock washer.

4. Insert the oil feed guide with the large diameter in. Insert the guide retaining spring so that it fits over the smaller diameter of the feed guide. The pump cover can now be installed.

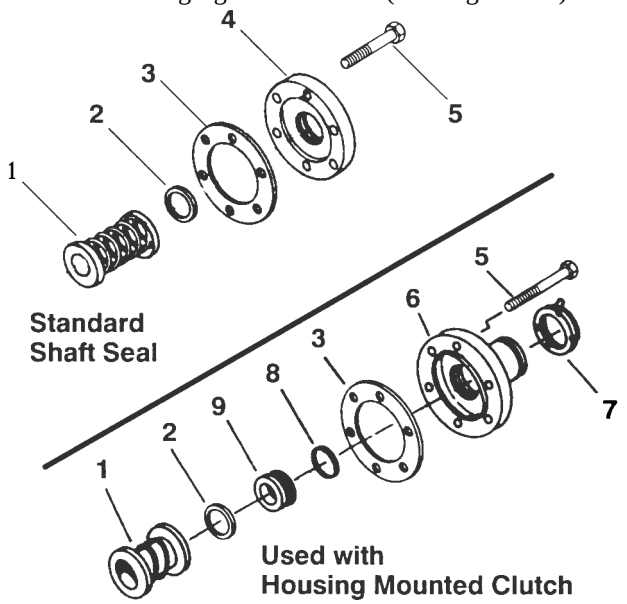
5. Place the pump cover, with a new gasket, over the guide retaining spring and compress the spring to enable installation of the cover capscrews.

3.5 SHAFT SEAL

a. Disassembly

1. Remove 6 capscrews, remove shaft seal cover or clutch mounting hub and carbon washer. (See Figure 3-8)

2. Tap seal end of crankshaft to loosen seal grip on shaft. Using two long screwdrivers, pry out the shaft seal but do not damage gasket surface. (See Figure 3-9)



1. Shaft Seal
2. Carbon Ring
3. Gasket
4. Seal Plate
5. Hex Head Screw
6. Clutch Mounting Hub
7. Snap Ring or Nut
8. O-Ring
9. Wear Ring

Figure 3-8. Shaft Seal

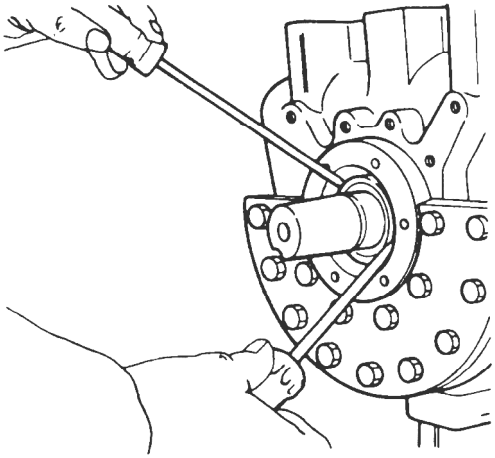


Figure 3-9. Shaft Seal Removal

b. Reassembly

1. Install new shaft seal assembly, cover gasket, and cover plate only. Never install a used seal assembly or gasket. A new carbon washer should never be installed in a used cover plate. When installing the seal assembly, use care not to damage carbon washer or seal seat.

2. Remove new carbon washer from new seal assembly. Lubricate shaft and neoprene seal bellows where it contacts the shaft. Slide seal assembly onto shaft until neoprene bellows start to grip the shaft.

3. Install the OLD carbon washer in the new seal seat. Install two capscrews in opposite sides of the old cover plate. Draw up capscrews evenly to properly position new seal assembly against shoulder on shaft. Remove capscrews and old carbon washer and cover plate.

4. Lubricate new carbon washer and carbon washer seal seat with refrigerant oil. Install new carbon washer in seal seat, taking care not to damage the carbon washer or the seat. Ensure that notches in carbon washer are aligned with two small knurls inside the seal seat. Install the new cover plate and gasket. Draw capscrews down evenly to prevent damage to carbon washer.

NOTE

Do not touch carbon washer sealing surface with your fingers.

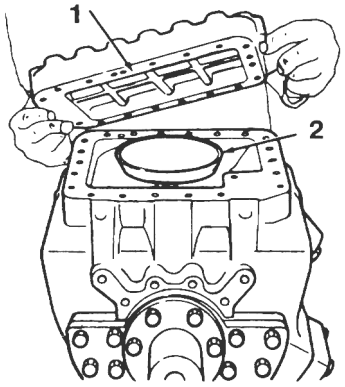
3.6 COMPRESSOR RUNNING GEAR REMOVAL

In order to disassemble Piston, Rod and Rings, first the cylinder head, oil pump and shaft seal must be disassembled (Refer to sections 3.3,3.4 and 3.5).

a. Bottom Plate, Strainer, and Connecting Rod Caps

1. Turn the compressor over, bottom side up, and remove the bottom plate. (See Figure 3-10) Scrape off gasket.

2. Remove the oil strainer,

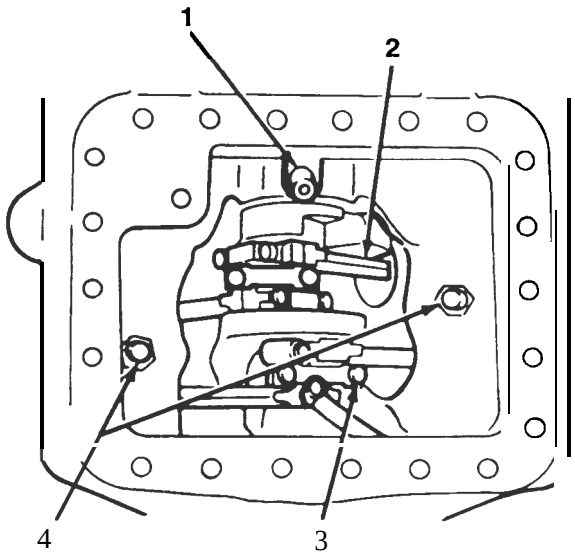


1. Bottom Plate
2. Oil Strainer

Figure 3-10. Bottom Plate Removal

3. Match mark each connecting rod cap and connecting rod for correct reassembly. Remove the capscrews, flat washers and connecting rod caps. It is recommended that the capscrews and flat washers be discarded and new capscrews (special) and flat washers be installed during compressor reassembly. (See Figure 3-11)

4. Push the piston rods down so that the piston ring extend below the cvlinders. Remove and discard piston rings. Use only new rings when reassembling the compressor. (See Figure 3-12.)



1. Oil Pressure Relief Valve
2. Connecting Rod and Cap
3. Capscrew
4. Check Valves

Figure 3-11. Bottom Plate and Oil Strainer Removed

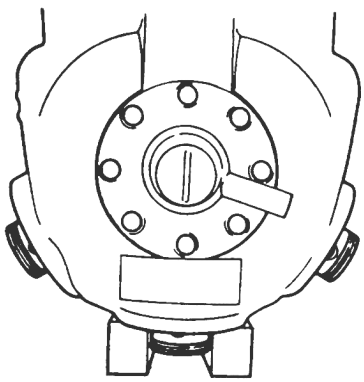


Figure 3-12. Piston Rings Removed

b. Crankshaft and Seal End Thrust Washer

CAUTION

Do not allow crankshaft to drop on connecting rods inside the crankcase when removing the crankshaft.

1. Push piston rod assemblies out of the way and remove crankshaft and seal end thrust washer.

2. Remove and check operation of oil return check valves (See Figure 3-11). The check valves are free floating devices and can easily be checked visually.

3. Remove and check oil pressure relief valve (See Figure 3-11). The oil pressure relief valve is a spring loaded device which can be checked by using a small piece of stiff wire to ensure that the spring can be depressed.

4. Remove piston rod assemblies.

c. Pistons, Rods, and Rings

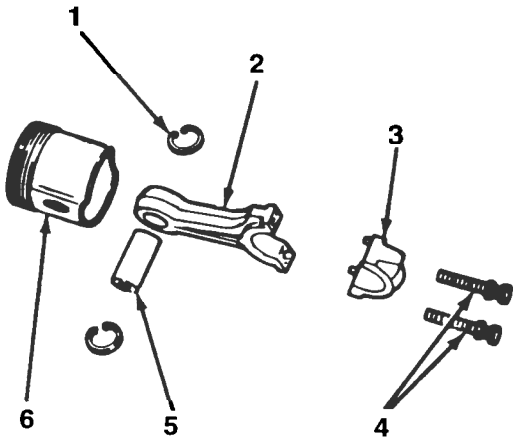
1. Piston and pin, and connecting rod and rod cap are matched sets and must not be interchanged. That is, if either the piston or piston pin is to be replaced, you must replace both of them. Likewise, if a connecting rod or rod cap must be replaced, both must be replaced.

2. Match mark and disassembly pistons, pins, connecting rods, and caps. (See Figure 3-13)

3. Check wear dimensions of disassembled parts to determine if they are worn beyond limits given in Table 3-2.

4. If parts are worn beyond limits, replace them in matched sets as specified above.

5. Coat piston pins with compressor oil and reassembly pistons, pins, and connecting rods in matched sets.



1. Lock Ring
2. Connecting Rod
3. Connecting Rod and Cap
4. Capscrew
5. Piston Pin
6. Piston

Figure 3-13. Connecting Rod, Piston, and Pin

d. Seal End Main Bearings

1. Inspect seal end main bearings. Check wear dimensions to determine if they are worn beyond limits given in Table 3-2.

2. If worn beyond limits remove seal end main bearings.

3.7 COMPRESSOR RUNNING GEAR REASSEMBLY

a. Seal End Main Bearings

1. When installing new seal end main bearings the oil groove is on top of the compressor with V grooves pointing to each other. When installed, there must be a 5/16 inch (7.93 mm) gap between the two bearings (See Figure 3-14).

2. Line boring seal end main bearings.

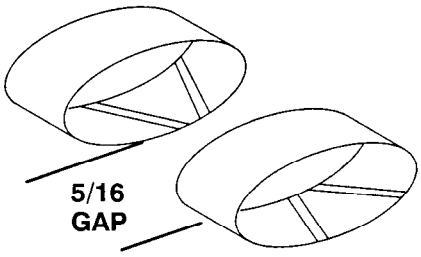


Figure 3-14. Seal End Main Bearings

b . Pistons, Rods, and Rings

Prior to installing new piston rings, it is necessary to break the hard glazed surface of the cylinder in order to reduce the wearing-in period of the new rings. Break the glaze by honing lightly in an up and down rotating motion. Clean thoroughly after breaking glaze.

Some 05G compressors for refrigeration use only may have contoured pistons (See Figure 3-15). When installing contoured pistons into compressor, check suction valve and contoured piston are in the same orientation.

Figure 3-15. Contoured Piston

1. The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore about one inch below the top of the bore. Align the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are shown in Table 3-2.

2. Install the piston and rod assemblies up through the bottom of the crankcase and into the cylinders. Allow pistons to extend beyond the top of the cylinder to enable installation of piston rings. Pistons must be installed so that the chamfer, on the connecting rod, faces toward the crankshaft journals. Center rods on each crankshaft throw may be installed in either direction. (See Figure 3-16)

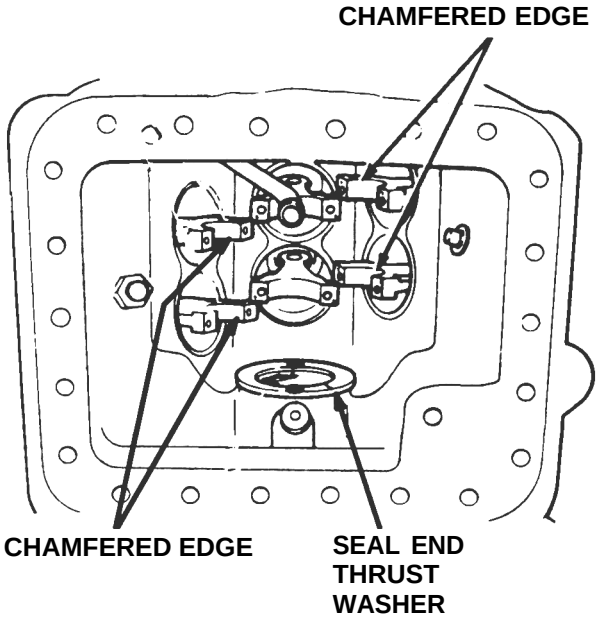


Figure 3-16. Installing Piston Rod Assemblies and Seal End Thrust Washer

3. Depending on date of manufacture, the compressor may be fitted with double or single ring pistons. Double ring and single ring pistons may be installed in the compressor, as long as matched pistons are used on each bank.

4. Old double ring pistons (with wider lower ring groove), the oil ring is installed in the groove nearest the bottom and the compression ring in the groove nearest the top. The oil ring is notched on the outside circumference. This notch must be installed towards the bottom. (See Figure 3-17)

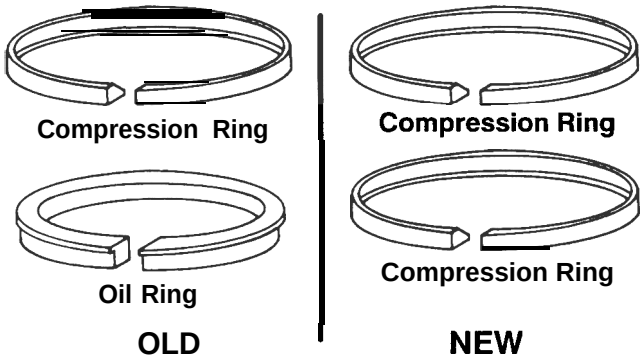


Figure 3-17. Piston Rings

5. The compression ring is chamfered on the inside circumference. This ring is installed with the chamfer towards the top. If using a double ring piston, stagger the ring end gaps so they are not aligned.

6. Measure side clearance between ring and ring groove in piston. Maximum dimensions are provided in Table 3-2.

c. Crankshaft and Seal End Thrust Washer

1. Two brass thrust washers are used. The pump end thrust washer is positioned on two dowel pins located on the bearing head and is installed with the oil pump and bearing head assembly. The seal end thrust washer is positioned just ahead of the seal end main bearing on two dowel pins installed in the crankcase. Both thrust washers should be inspected for wear and scoring before reassembly (Refer to Table 3-2).

2. Install the seal end thrust washer on the two dowel pins. (See Figure 3-16) Ensure piston rods are pushed out of the way and install the crankshaft.

CAUTION

Do not allow crankshaft to drop on connecting rods inside the crankcase when installing the crankshaft.

d. Bottom Plate, Strainer, and Connecting Rod Caps

1. Do not tap piston with hammer if rings are caught at entrance to the cylinder. Using a ring compressor, squeeze rings sufficiently to allow piston to be pushed down into the cylinder. Ensure that ring ends are staggered so that the gaps are not aligned, and lightly tap piston down into the cylinder. (See Figure 3-18) The ring compressor can be easily fabricated from a piece of sheet metal.

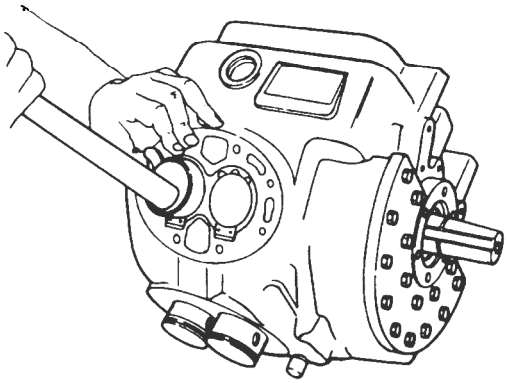


Figure 3-18. Installing Pistons

2. Install connecting rod caps on connecting rods using new capscrews (special) and flat washers. Reuse of the old capscrews is not recommended. Ensure that the caps are installed on the dowel pins. Torque capscrews to torque value shown in Table 3-1. Ensure freedom of movement of crankshaft after capscrews are torqued on each rod cap.

3. Check operation and reinstall check valves and relief valve. (See Figure 3-11). The check valves are free-floating devices and can easily be checked visually. The relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

4. Clean and reinstall the oil strainer.

5. Using a new gasket, install the bottom cover plate. See figure 1-1 for relative location of compressor mounting flanges. Torque cover capscrews, in a diagonal pattern, to the torque value shown in Table 3-1.

6. Reassembly the cylinder head, oil pump and shaft seal (Refer to sections 3.3,3.4 and 3.5).

3.8 SUCTION STRAINER

NOTE

Suction strainer has been preformed to fit into suction cavity.

Remove and clean the suction strainer. (See Figure 3-19) Check it for damage. If it is damaged, replace suction strainer. Install suction strainer and suction service valve using a new gasket.

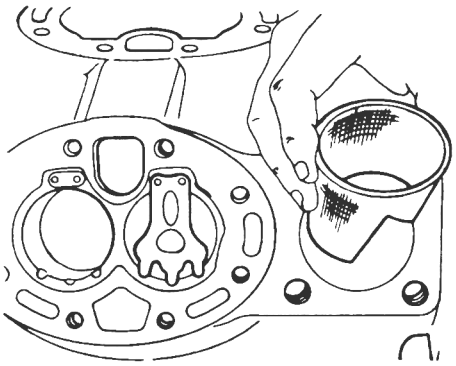


Figure 3-19. Installing Suction Strainer

3.9 ADDING OIL

Add the proper oil charge to the compressor through the oil fill plug. Refer to section 2.2.2 for the required oil charge. Refer to unit operation manual for other methods of adding oil to compressor.

3.10 INSTALLING COMPRESSOR

Refer to section 2.2.2 and the unit service manual to install the compressor. Allow compressor to run for 4 to 5 hours before checking new shaft seal assembly for leaks.

SIZE DIAMETER (INCHES)	THREADS PER INCH	TORQUE RANGE		USAGE
		FT-LB	M K G	
1/16	27 (pipe)	8 to 12	1.11 to 1.66	Pipe Plug – Crankshaft
1/8	27 (pipe)	15 to 20	2.07 to 2.77	Oil Return Check Valve – Crankcase
1/4	20 (pipe)	20 to 25	2.77 to 3.46	Pipe Plug – Gauge Connection
1/4	20	10 to 12	1.38 to 1.66	Connecting Rod Capscrew
1/4	28	6 to 10	0.83 to 1.38	Oil Pump Drive Segment (Vane Pump)
		12 to 16	1.66 to 2.21	Unloader Valve
5/16	18	16 to 20	2.21 to 2.77	Cover Plate – Plate End
				Bearing Head (Vane Pump)
		20 to 30	2.77 to 4.15	Discharge Service Valve
3/8	16	40 to 50	5.53 to 6.92	Pump End Bearing Head
				Bottom Plate - Crankcase
				Cylinder Head
				End Flange
				Shaft Seal Cover
1/2	13	55 to 80	7.61 to 11.06	Suction Service Valve
#l 0	32	4 to 6	0.55 to 0.83	Oil Pump Drive Segment (Vane Pump)
1-1/2	18 NEF	35 to 45	4.84 to 6.22	Oil Level Sight Glass

NEF — National Extra Fine

Table 3-2. Wear Limits

PART NAME	FACTORY MAXIMUM		FACTORY MINIMUM		MAXIMUM WEAR BEFORE REPAIR	
	INCHES	MM	INCHES	MM	INCHES	MM
SEAL END						
End Play (Seal Removed)	0.035	0.8890	.030	0.7620	–	–
Main Bearing Diameter	1.8760	47.6504	–	–	.002	0.051
Main Bearing Journal Diameter	–	–	1.8725	47.5615	.002	0.051
PUMP END						
Main Bearing Diameter	1.3760	34.9504	–	–	.002	0.051
Main Bearing Journal Diameter	–	–	1.3735	34.8869	.002	0.051
CONNECTING ROD						
Connecting Rod Diameter	1.3768	34.9707	–	–	.0020	0.051
Piston Pin Bearing	0.6883	17.4752	0.6878	17.4701	.001	0.0254
CRANKSHAFT						
Crankpin Diameter	–	–	1.3735	34.8869	.0025	0.0635
Throw – Height **(37 CFM)**	0.9698	24.6329	0.9678	24.5821	–	–
Throw – Height **(41 CFM)**	1.072	27.2288	1.070	27.1780	–	–
THRUST WASHER (Thickness)						
Pump End	0.145	3.6830	0.144	3.658	.0250	0.6350
Seal End	0.157	3.987	0.155	3.937	.0250	0.6350
CYLINDERS and PISTONS						
Bore	2.0010	50.8254	–	–	.002	0.051
Piston (Diameter)	–	–	See Figure 3-20		.002	0.051
Piston Pin (Diameter)	–	–	0.6873	17.4574	.001	0.025
Piston Ring Gap	0.013	0.3302	0.005	0.127	.025	0.635
Piston Ring Side Clearance	0.002	0.051	0.001	0.0254	.002	0.051

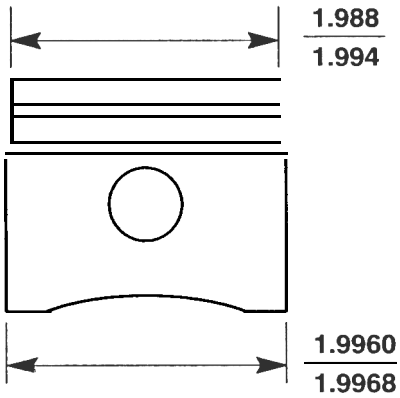


Figure 3-20. Piston Dimension (Wear Limits)

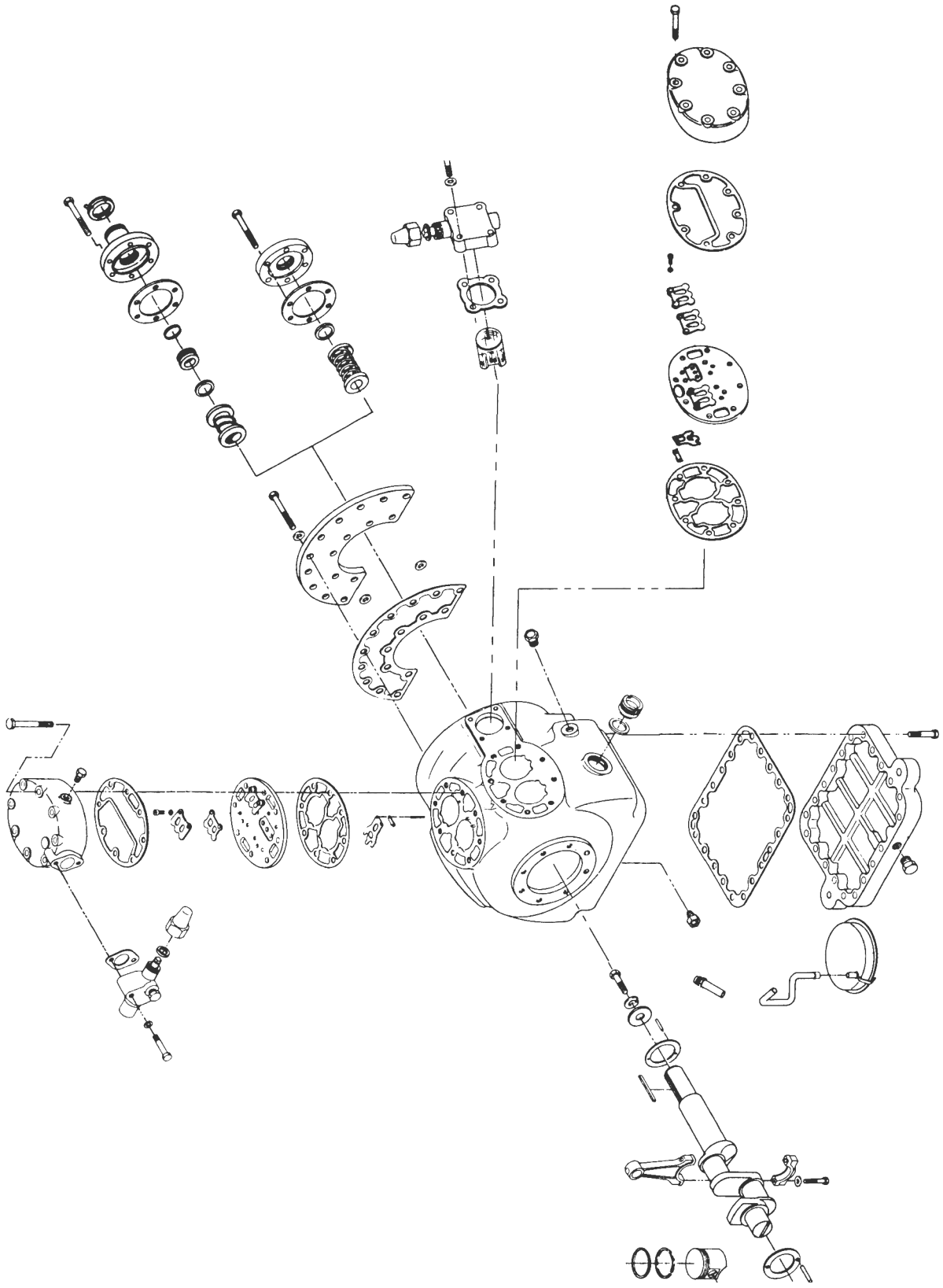


Figure 3-21. Compressor Exploded View