GROUP 9

ACCESSORIES

HEATER SYSTEM - GT

CONTENTS

DESCRIPTION AND OPERATION

FLOW-THROUGH VENTILATION SYSTEM

A separate ventilation system for direct intake of outside air is controlled by two plastic fresh air inlet nozzles in the side kick panels and two lever operated inlet nozzles located on either end of the instrument panel assembly.

The air allowed to enter the passenger compartment will exit through outlets on both sides of the back glass. See Figure 9A-1.

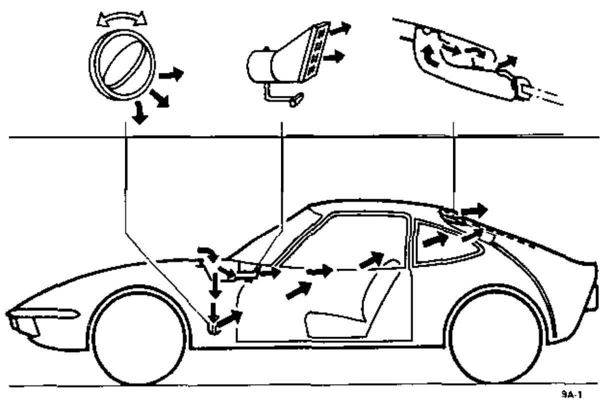


Figure 9A-1 GT Air Flow

HEATER SYSTEM DESCRIPTION

The GT heater system consists of two components assemblies: (1) heater assembly, and (2) control assembly. The heater assembly consists of the heater housing and air valves; heater core and blower motor and fan assembly.

The flow of air enters the car through the cowl; passes through the blower fan, through or around the heater core, past the air inlet door and is then directed to either the floor outlets or defroster outlets or both depending on the position of the defroster door.

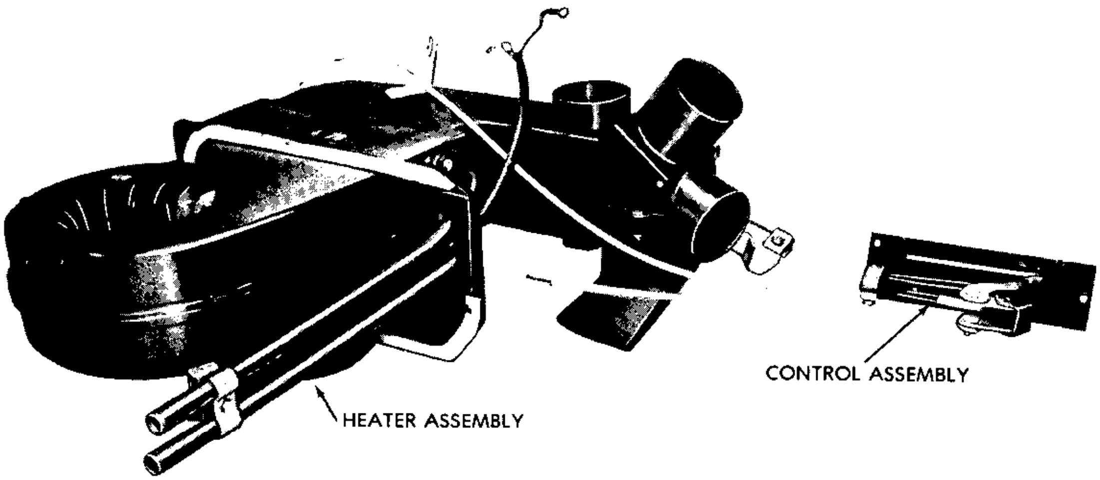


Figure 9A-2 Heater Assembly-Rear View

The heater-defroster air door directs the air to the floor outlets, defroster outlets, or apportions the air flow to both outlets depending on the position of the door. A manual water valve regulates the flow of coolant through the heater core, thereby varying the temperature of the air flow past the core. The blower motor is located in the forward portion of the heater housing. See Figure 9A-2.

Opening and closing of the heater defroster air door and manual water valve is accomplished by bowden cables connected to the heater control. The heater controls function as follows:

Air Inlet-Defroster Control (Upper Lever) This control (See Figure 9A-4) opens and closes the air inlet and heater-defroster air door which channels the air flow to either the heater outlets or to defroster outlets, or to both outlets simultaneously, depending on the position of the control.

Temperature Control (Lower Lever) - This lever regulates the flow of coolant through the heater core and the amount of air that can by-pass heater core thereby increasing or decreasing the air temperature proportionate to its travel (toward red square-warm; toward blue square-cold). Unheated air may be circulated through the car by leaving the temperature control in the OFF position (blue square).

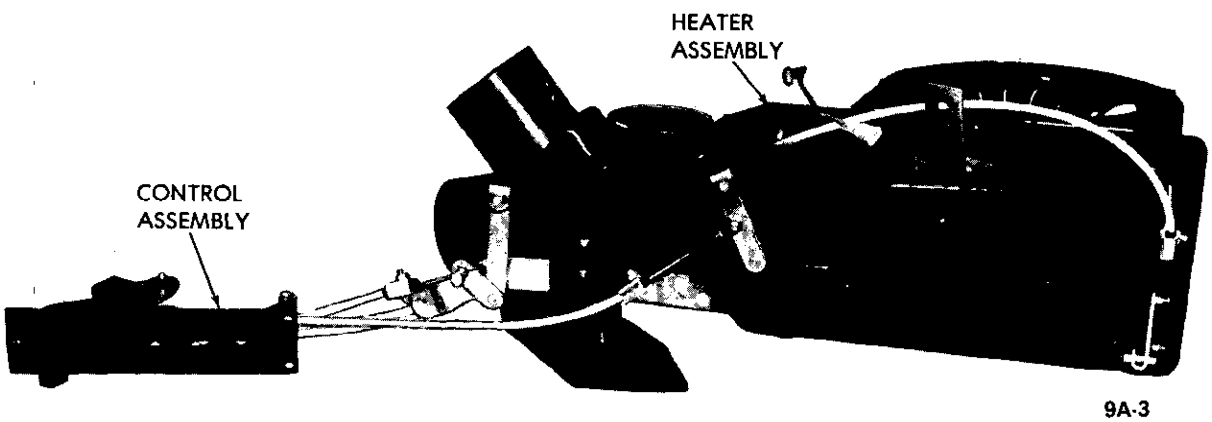


Figure 9A-3 Heater Assembly-Front View

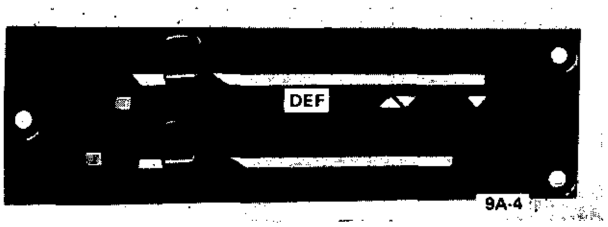


Figure 9A-4 Heater Control

Blower Switch - This switch actuates blower motor to low or high blower speed.

HEATER SYSTEM OPERATION

To operate heater proceed as follows:

1. Position air inlet, heater-defroster control as desired.

White arrow head pointing down--air out of heater outlets. White arrow head pointing up--air out of defroster outlets.

Between lower and upper position--air to both heater and defroster outlets.

2. Position temperature control as desired to increase or decrease temperature of air flow.

3. Position blower switch as desired to operate blower at low or high speed.

DIAGNOSIS

HEATER SYSTEM TROUBLE DIAGNOSIS

TROUBLE

Temperature of heated air at outlets too low.

CAUSE AND CORRECTION

Check radiator cap for proper sealing action-- replace if necessary.

Check for adequate coolant supply. If level is down, correct cause of coolant loss and refill radiator.

Inspect hose for kinks--relieve kink or replace hoses.

Check thermostat operation by measuring temperature of coolant at radiator. Temperature should be within 5 degrees F. of thermostat rated value (189 degrees F.).

Check that air doors and water temperature control valve are operating properly.

Check for plugged heater core--backflush heater core as necessary.

TROUBLE

Inadequate defrosting action.

CAUSE AND CORRECTION

Examine heater-defroster door for proper operations--adjust bowden cable as required so that door is fully closed in FULL DEFROST position.

Check that air hoses connecting to defroster outlets are secure.

Check for air leaks around edges of heater air distributor housing--seal leaks as necessary with body sealer. Check for body air leaks and seal as necessary with body sealer.

TROUBLE

Blower inoperative.

CAUSE AND CORRECTION

Check blower fuse--replace if necessary, fuse position 3 - amperage 8.

Check wiring for open circuit--correct as required.

Inspect for defective component (i.e., blower switch or blower motor)--replace or repair as necessary.

MAINTENANCE AND ADJUSTMENTS

CONTROL CABLE ADJUSTMENT

Adjustment of control cables is accomplished by positioning of the jacket or sheath of the control cable as held by the clamps on the control assembly and heater case.

To adjust control cables, loosen clamps and move cable sheath in or out as required to obtain full travel of lever or of door or both.

MAJOR REPAIR

REMOVAL AND INSTALLATION INSTRUMENT PANEL FRESH AIR OUTLET

Removal

1. Remove instrument panel cover assembly. Refer to Group 1.

2. Snap grille out of outlet.

3. Remove knob from lever and remove outlet.

Installation

1. Install outlet and knob onto lever.

2. Snap grille into outlet.

3. Install instrument panel cover assembly. Refer to Group 1.

REMOVAL AND INSTALLATION KICK PANEL FRESH AIR OUTLET

Removal

Using a screwdriver, carefully pry out outlet.

Installation

Install outlet.

REMOVAL AND INSTALLATION BLOWER SWITCH

Removal

1. Remove instrument panel assembly. Refer to Group 1.

2. Unscrew switch assembly from panel.

Installation

1. Screw switch assembly to instrument panel.

2. Install instrument panel assembly. Refer to Group 1.

REMOVAL AND INSTALLATION HEATER

Removal

1. Remove lower radiator hose, drain, and collect coolant.

2. Detach coolant feed (A) and return (B) hoses, in engine compartment from heater core. See Figure 9A-5.

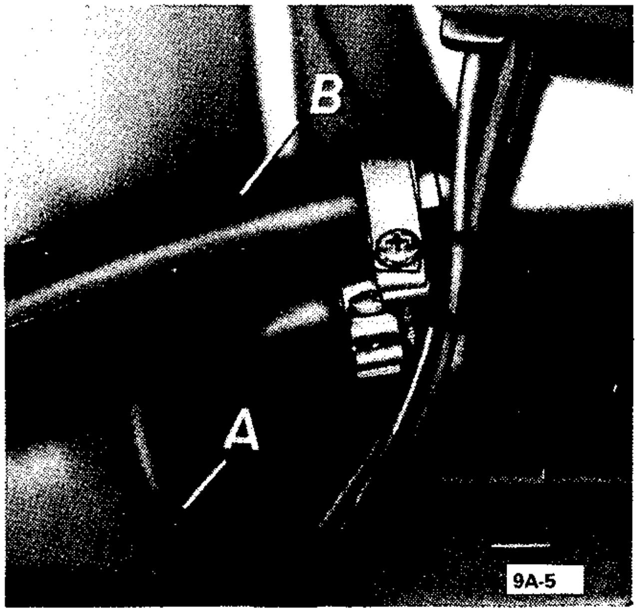


Figure 9A-5 Heater Hose Connections

3. In engine compartment remove hood lock control cable retaining clip and cable from lock bar. See Figure 9A-6.

Figure 9A-6 Hood Release Control Cable

4. Remove console shift cover between seats using the following instructions:

a. Remove ash tray and remove two screws under it.

b. Remove retaining screw in headlamp lever handle and remove handle.

c. Console cover is held in place by four push button type studs, unsnap studs by prying cover up and work cover upwards over shift lever and rubber shift lever boot.

5. Remove left cover and right plug in instrument panel cover and through openings remove instrument panel attaching screws (points A and B). See Figures 9A-7 and 9A-8. At this point it will be necessary to lower the steering column, refer to Group 3 for this procedure.

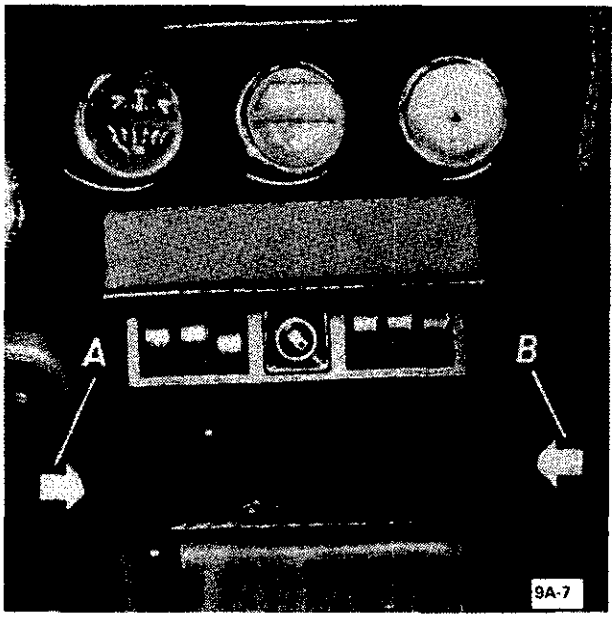


Figure 9A-7 Instrument Panel Cover Screw Cover and Plug Locations

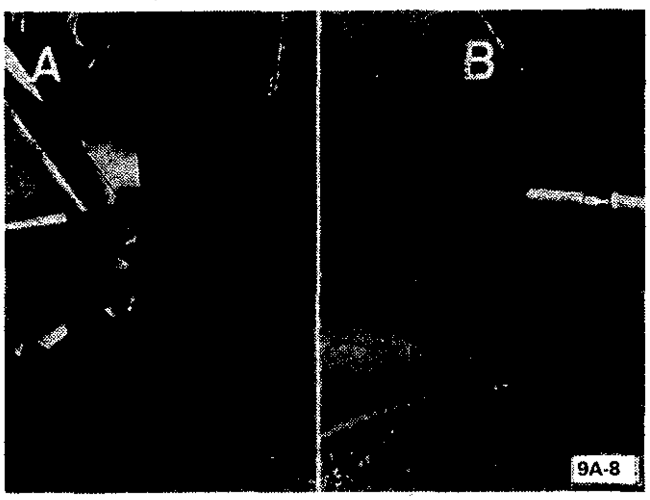


Figure 9A-8 Location of Hidden Screws

6. Remove two multiple wire plug connectors from steering column harness.

7. Detach speedo cable

8. Remove directional signal flasher unit. See Figure 9A-9.

Figure 9A-9 Directional Flasher Unit

9. Remove 6 instrument cluster retaining screws. See Figure 9A-10.

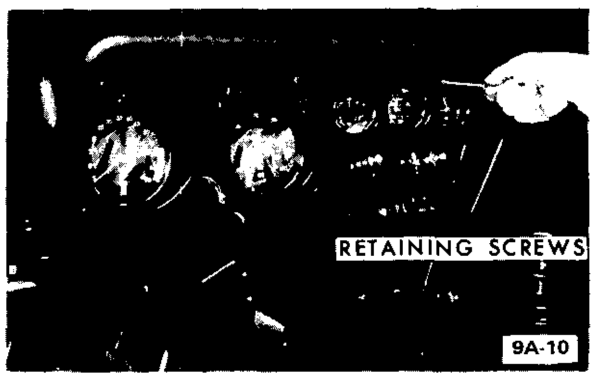


Figure SA-10 Removing Instrument Cluster detaining Screws

10. Grasp instrument cluster and pull straight back, being careful of wires, etc. See Figure 9A-11.

11. Unscrew heater controls (A) and support bracket (B). See Figure 9A-12.

12. Disconnect heater and defroster duct hoses from instrument panel. See Figure 9A-13.

Figure 9A-11 Removing Instrument Cluster

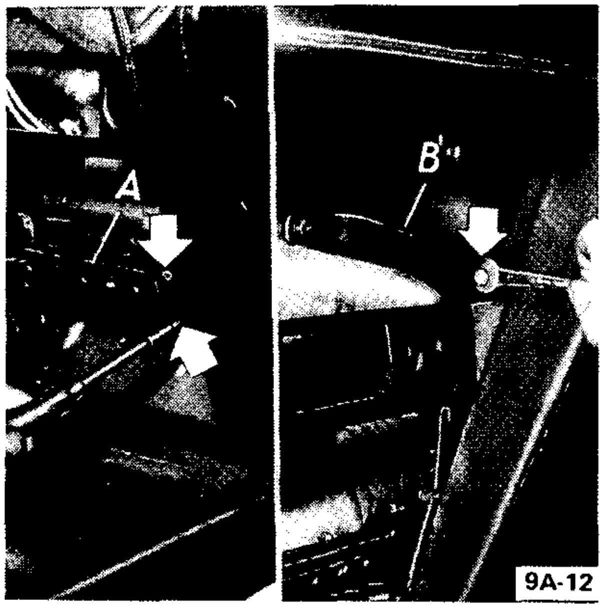


Figure 9A-12 Heater Control Screws and Support Bracket

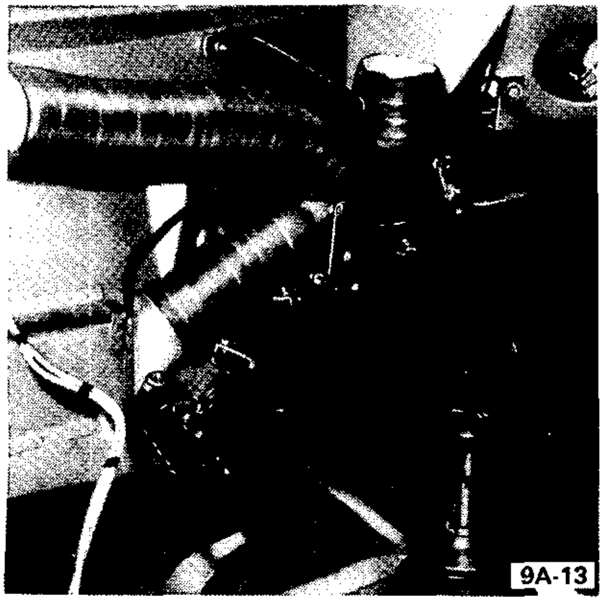


Figure 9A-13 Heater and Defroster Duct Hoses

13. Remove all screws from instrument panel padding and remove it from instrument panel. Arrow in Figure 9A-14 show location at left side of dash panel and windshield. Screws are located in same areas on right side.

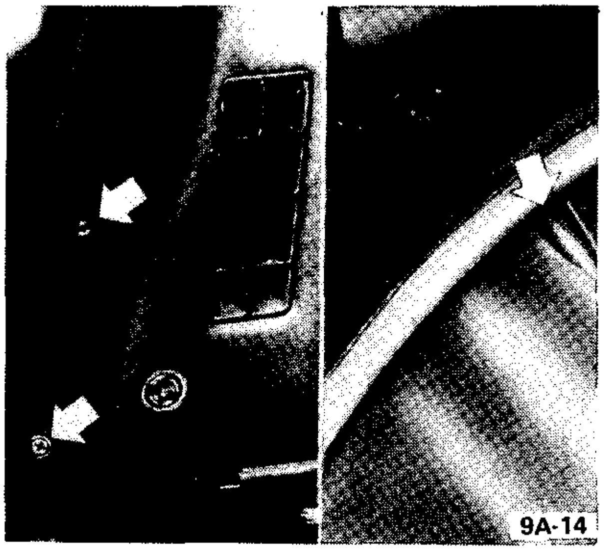


Figure 9A-14 Instrument Panel Padding Screws

14. Remove one bolt at top of heater blower case and two nuts from bottom of the case, and remove heater blower and case assembly. See Figure 9A-15.

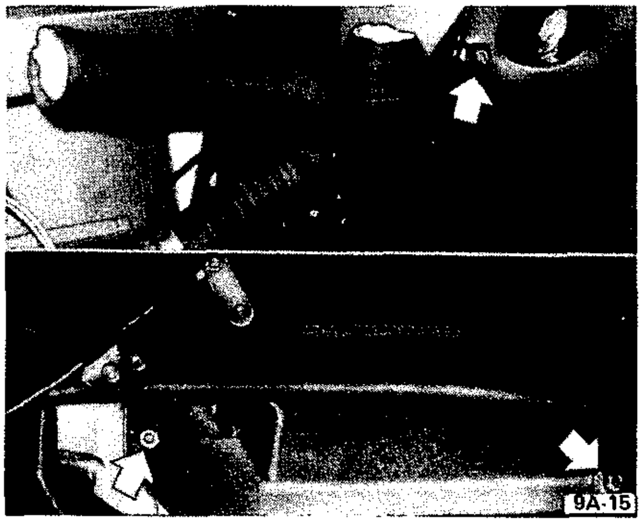


Figure 9A-15 Location of Heater blower Case Bolt and Screws

15. On removed heater assembly check relative position of mixed air door so that on installation of unit hand control levers can be positioned according to unit settings, either opened or closed position.

Installation

1. Install heater blower and case assembly, securing with one (1) bolt at the top and two (2) nuts from the bottom. See Figure 9A-15.

2. Install instrument panel padding and connect heater and defroster duct hoses, making sure hoses are properly positioned and connected. See Figure 9A-16.

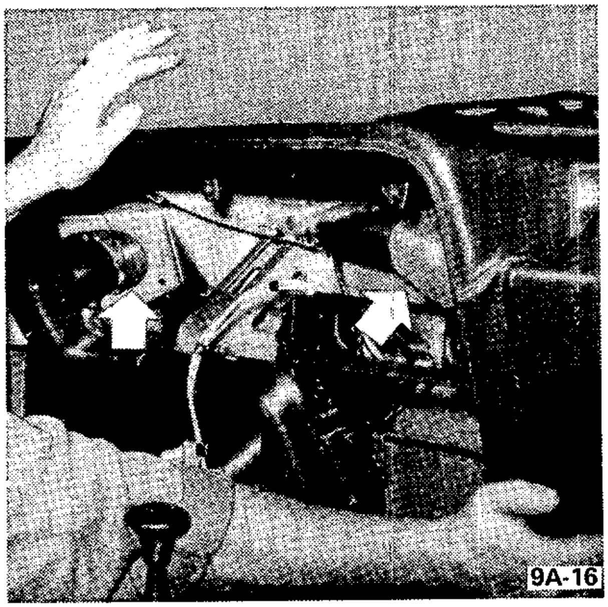


Figure 9A-16 Heater and Defroster Duct Hoses

3. Install support bracket (B) and heater control (A). See Figure 9A-12.

4. Carefully push cluster back into instrument panel housing, making sure electrical wires, etc., are not pinched.

5. Install six (6) cluster retaining screws. See Figure 9A-10.

6. Install directional signal flasher. See Figure 9A- 9.

7. Attach speedometer cable.

8. Attach two (2) multiple wire plug connectors in steering column harness.

9. Install steering column. Refer to Group 90.

10. Install instrument panel cover and attach through openings (points A and B). See Figures 9A-7 and 9A-8.

11. Install right and left opening covers.

12. Install the console shift cover between the seats using the following instructions:

a. Install console cover over shift lever and rubber shift lever boot.

b. Install cover by pushing down until cover snaps into the four (4) push button type studs.

c. Install two (2) screws under ash tray opening and install ash tray.

13. In engine compartment, install hood lock control cable to lock bar using retaining clip. See Figure 9A-6.

14. Attach return hoses (B) and coolant feed hoses (A) to heater core. See Figure 9A-5.

15. Attach lower radiator hose and add collected coolant.

16. Check for proper operation and leaks in system.

REMOVAL AND INSTALLATION DEFROSTER OUTLET

Removal

1. Remove instrument panel cover assembly. Refer to Group 1.

2. Remove screws securing outlet to cover assembly.

Installation

1. Install defroster outlet, securing with screws.

2. Install instrument panel cover assembly. Refer to Group 1.

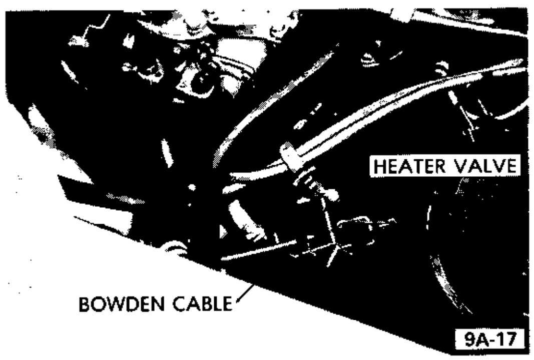


Figure 9A-17 Heater Valve

REMOVAL AND INSTALLATION HEATER VALVE

Removal

1. Remove lower radiator hose and drain and collect coolant.

2. Disconnect control cable.

3. Loosen heater hose clamps and remove valve from hoses. See Figure 9A-17.

Installation

1. Install valve into heater hoses and install hose clamps.

2. Connect control cable.

3. Install lower radiator hose and add collected coolant.

SPECIFICATIONS

Engine	
Recommended Coolant	Ethylene-Glycol Base
Thermostat Opens At (Degrees) F.	189
Cooling System Capacity (With Heater)	6 Qt.
Blower Motor Type	12 VDC
Blower Fan Type	Squirrel Cage

HEATER SYSTEM

OPEL 1900 - MANTA

CONTENTS

DESCRIPTION AND OPERATION

HEATER SYSTEM

The temperature of the air entering the vehicle is regulated by the heater valve and the blower. The distribution of this air is controlled by the heater air distributor housing under the instrument panel.

Moving the upper control lever from the left towards the right opens the heater valve. This lever regulates the flow of coolant through the heater core and thereby increases or decreases the air temperature proportionate to its travel. See Figure 9A-30.

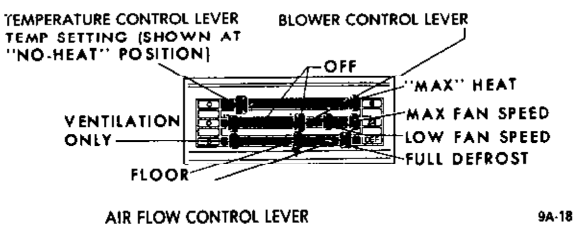


Figure 9A-30 Heater Control Assembly

The connectors for water inlet and outlet are located on the left side of the heater core, viewed in driving direction. The coolant flow is shown in the drawing. See Figure 9A-3 1.

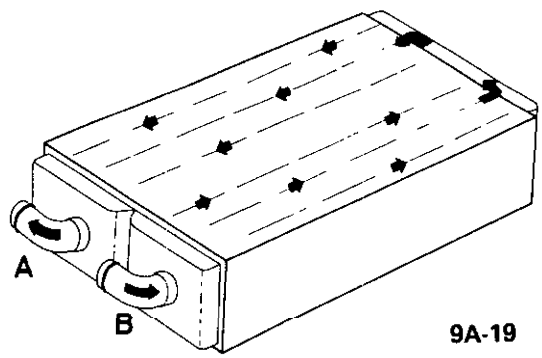


Figure 9A-31 Coolant Flow in Heater Core

Due to the separation of the inflowing and outflowing water in the heater **core,** an even heating of the air is attained, as the water does not cool down in the second part of the core.

A Water Outlet

B Water Inlet

The center lever actuates the two-stage blower motor.

Lever positions:

Left to Center - Motor Switched Off

Right of Center - **Lo** Blower

Right - Hi Blower

The lower lever opens and closes the air door which channels the air flow to either the lower heater outlets or to the defroster outlets.

In the left lever position, the air inlet is closed. Up to the center position, the air is directed to the lower heater outlets.

When moving the lever from center position towards the right, the air flow to the lower heater outlets is reduced and increased to the defroster outlets.

With the lever in its right position, the air is directed to the defroster outlets only. For windshield defrosting, all levers have to be moved to the right.

FUNCTION OF THE HEATER AND VENTILATION SYSTEM

The engine hood is provided with slots in front of the windshield. The air is directed through the slots into the heater housing located in the engine compartment, flows into the air distributor housing, and from there to the lower heater outlets and/or defroster outlets, depending on the position of the control.

The two-stage blower motor is arranged in the heater housing above the heater core and actuated by the center control. The blower motor draws in the air entering through the slots, blows the air through the heater core into the air distributor housing, and from there to the lower heater outlets and/or defroster outlets, depending on the position of the lower control. See Figure 9A-32.

The heater valve regulates the flow of coolant through the heater core, thereby varying the temperature of the air flow past the core.

The ventilation of vehicle interior is completed by a draft-free air circulation pattern. Vent slots are arranged below the back window which are connected through channels to the rear quarter side panel. From here, the inside air escapes into the open. The

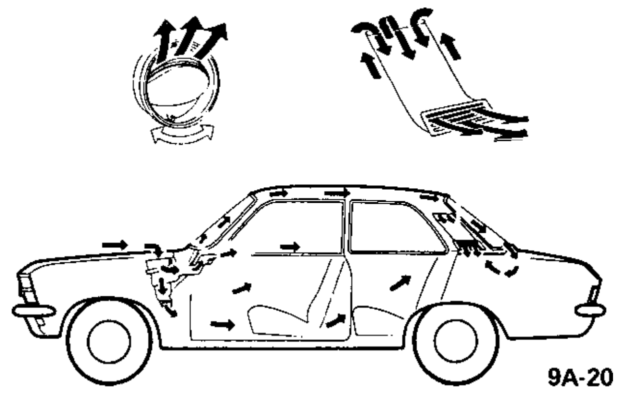


Figure 9A-32 Air Flow

head wind (caused by the car traveling down the road) promotes this process so that there is always fresh air in vehicle interior.

On the Model 54 Station Wagon, there will be no air outlets in the rear. For adequate flow-through type ventilation, it will be necessary to open a rear window.

Aside from the fresh air admission through the heater system, two fresh air inlet nozzles are arranged in the center of the instrument panel. These nozzles can be turned to direct the air flow in the desired direction. In addition, rotary flaps allow the regulation of the entering air or to shut off the air completely.

These nozzles admit unheated fresh air only and operate independent of the heater and defroster system.

DIAGNOSIS

HEATER SYSTEM TROUBLE DIAGNOSIS

TROUBLE

Temperature of heated air at outlets too low.

CAUSE AND CORRECTION

Check radiator cap for proper sealing action. Replace, if necessary.

Check for adequate coolant supply. If level is down, correct cause of coolant loss and refill radiator.

Inspect hose for kinks. Relieve kink or replace hoses.

Check thermostat operation by measuring temperature of coolant at radiator. Temperature should be within 5 degrees F. of thermostat rated value (189 degrees F.).

Check that air doors and water temperature control valve are operating properly.

Check for plugged heater core-backflush heater core as necessary.

TROUBLE

Inadequate defrosting action.

CAUSE AND CORRECTION

Examine heater-defroster door for proper operation. Adjust bowden cable so that door is fully closed in FULL DEFROST position.

Check that air hoses connecting to defroster outlets are secure.

Check for air leaks around edges of heater air distributor housing. Seal leaks, as necessary, with body sealer. Check for body air leaks and seal, as necessary, with body sealer.

TROUBLE

Blower inoperative.

CAUSE AND CORRECTION

Check blower fuse. Replace, if necessary, fuse position 4 - amperage 15.

Check wiring for open circuit. Correct, as required.

Inspect for defective component, (i.e., blower switch or blower motor) - replace or repair as necessary.

MAINTENANCE AND ADJUSTMENTS

CONTROL CABLE ADJUSTMENT

Adjustment of control **cables** is accomplished by positioning of the **jacket** or sheath of the control cable, as held by the clamps on the control assembly and heater case or by loosening screws and sliding bowden wire to obtain desired door or water valve position.

MAJOR REPAIR

REMOVING AND INSTALLING HEATER HOUSING

Removal

1. Unscrew hood lock together with ground wire (ground wire only on vehicles with radio interference suppression). See Figure 9A-33.

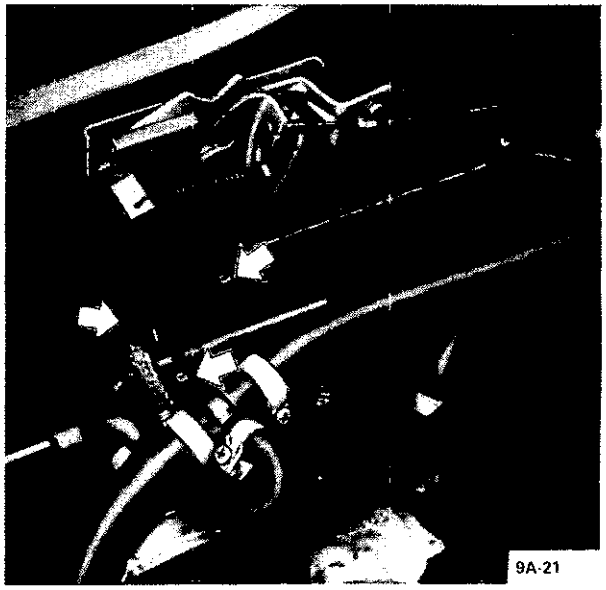


Figure 9A-33 Hood Lock Attachments

2. Unscrew heater housing cover.

3. Pull hose of windshield washer system off jet and take jet out of housing cover.

4. Unscrew bowden control wire from heater valve.

5. Unscrew heater housing from dash panel and pull it off carefully. See Figure 9A-34.

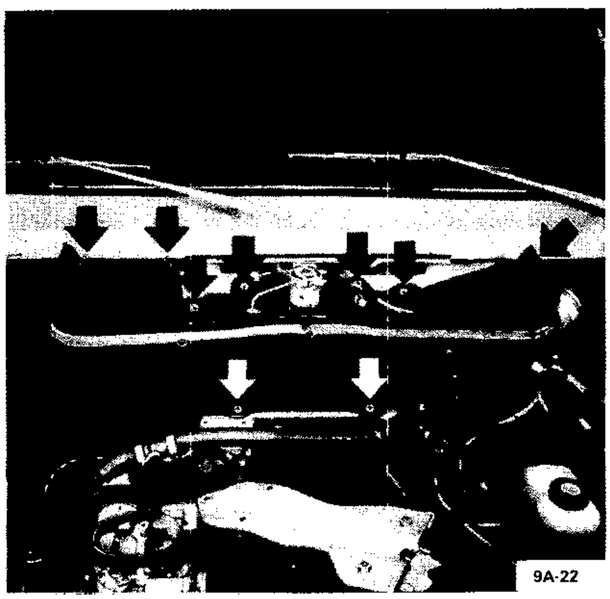
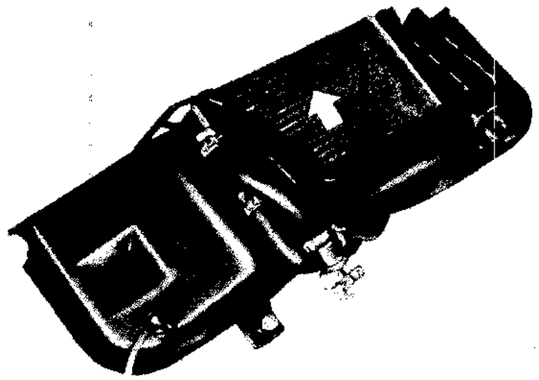


Figure 9A-34 Heater Housing Attachments

6. Remove **water** hoses from heater core and pull heater core out of heater housing. See Figure 9A-35.



9A-23

Figure SA-35 Heater Core

Installation

1. Apply sealing compound between heater housing and dash panel.

2. Install heater core into heater housing and attach water hoses. See Figure 9A-35.

3. Install heater housing to dash panel. See Figure 9A-44.

4. Install bowden control wire to heater valve.

5. Install windshield washer jet into housing cover and attach hose.

6. Install heater housing cover, and seal with a sealing compound.

7. Install hood lock, together with ground wire (ground wire only on vehicles with radio interference suppression).

REMOVING AND INSTALLING DEFROSTER OUTLETS

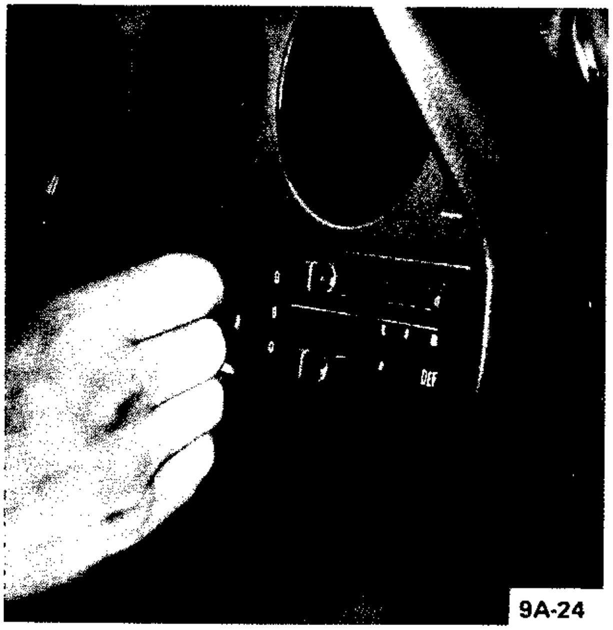
Removal

1. Pull out heater switch lever. See Figure 9A- 36.

2. Remove instrument cover.

3. Unscrew bowden control wires from heater valve and air distributor housing and pull out heater controls.

4. Remove glove compartment.

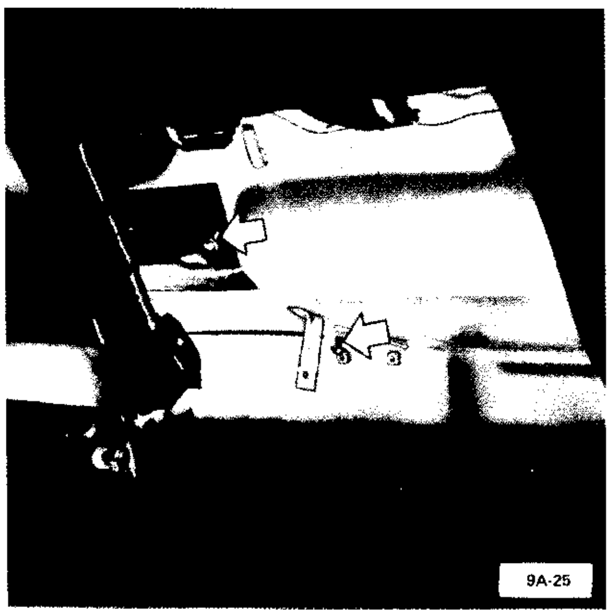


9A-24

Figure 9A-36 Removing Heater Switch Lever

5. Remove radio.

6. On right side, viewed in driving direction, remove air distributor housing attaching screws. See Figure 9A-37



9A-25

Figure SA-37 Air Distributor Housing Attaching Screws

7. On left side, viewed in driving direction, remove upper attaching screw through opening for heater control housing and lower attaching screw below instrument panel. See Figure 9A-38.

8. Pull air distributor housing off dash panel

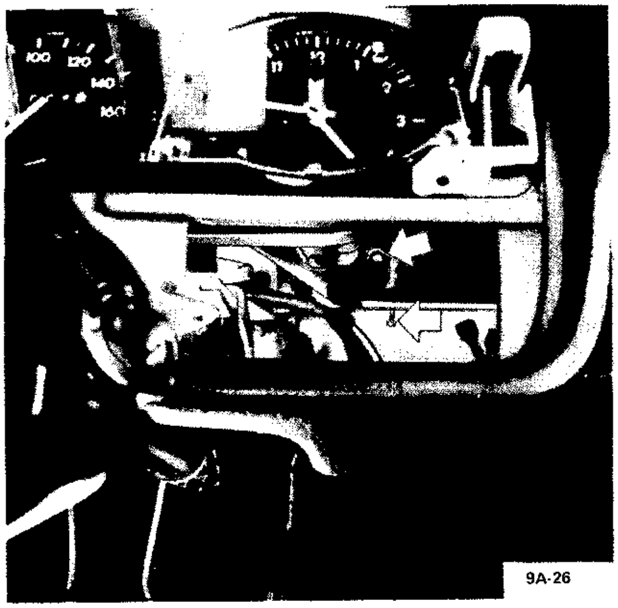


Figure 9A-38 Upper Attaching Screw

9. Pull defroster outlets downwards and remove outlets through glove compartment opening. See Figure 9A-39.

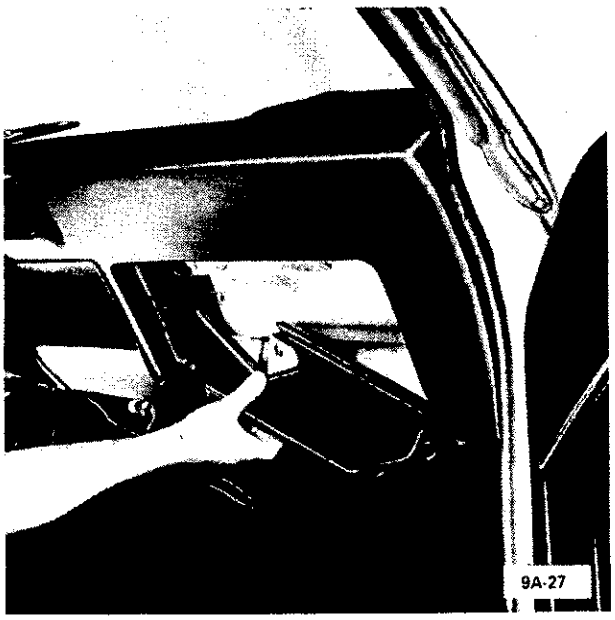


Figure 9A-39 Removing Defroster Jets

Installation

1. Apply sealing compound between air distributor housing and dash panel.

2. Install defroster outlets, securing with two (2) clips at the instrument panel. See Figure 9A-39.

3. Install air distributor housing to dash panel,

4. On left side, viewed in driving direction, install upper attaching screw through opening for heater control housing and lower attaching screw below instrument panel. See Figure 9A-38.

5. On right side, viewed in driving direction, install air distributor housing attaching screws. See Figure 9A-37.

6. Install radio.

7. Install glove compartment.

8. Install bowden control wires to heater valve and air distributor housing.

9. Install instrument cover.

10. Install heater switch lever.

REMOVAL AND INSTALLATION OF HEATER CONTROL HOUSING

Removal

1. Remove instrument panel cover - refer to operation, Removing and Installing Instrument Housing.

2. Remove two sheet metal screws for control housing attachment. See Figure 9A-40.

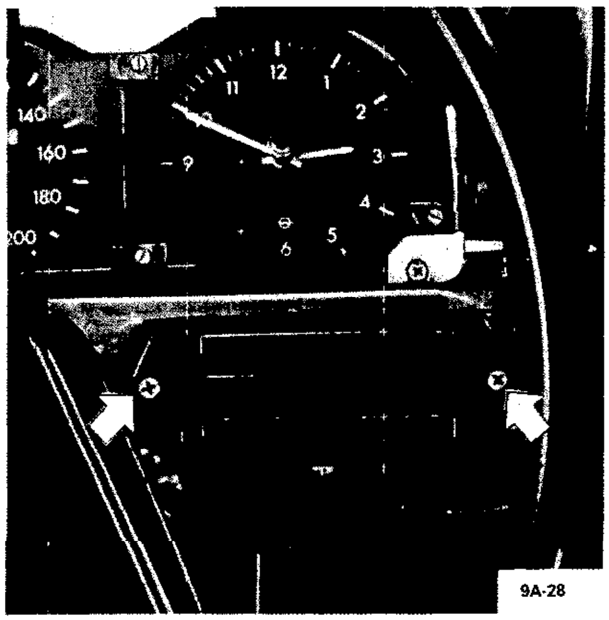


Figure 9A-40 Control Housing Attaching Screws

3. In engine compartment, detach bowden control wire from heater valve. See Figure 9A-41.

4. Detach bowden control wire from air distribution flap. See Figure 9A-42.

5. Pull wires off blower switch. See Figure 9A- 43.

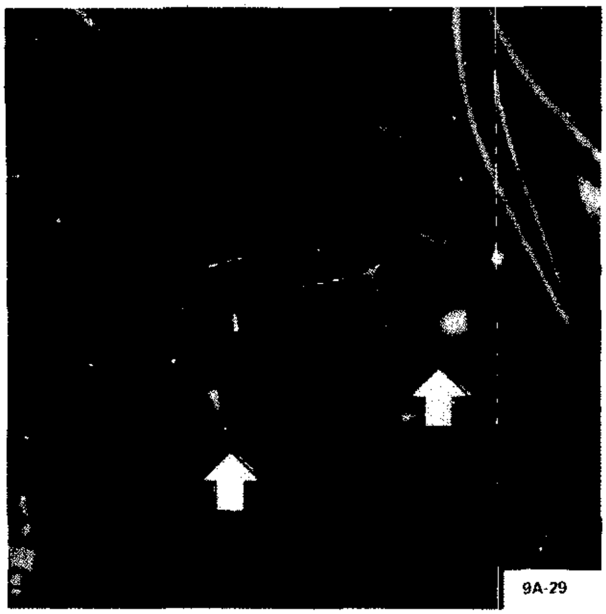


Figure 9A-4 1 Bowden Wire Attachment

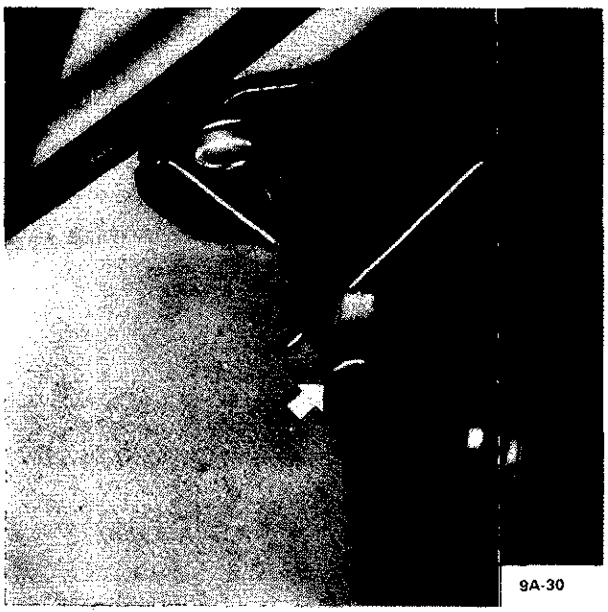


Figure SA-42 Control Wire to Distribution Door Attachment

A • Yellow Wire

B • Grey Wire

C - Brown Wire

6. Remove heater control housing.

Installation

1. Install heater control housing,

2. Install wires onto blower switch. See Figure 9A-53.

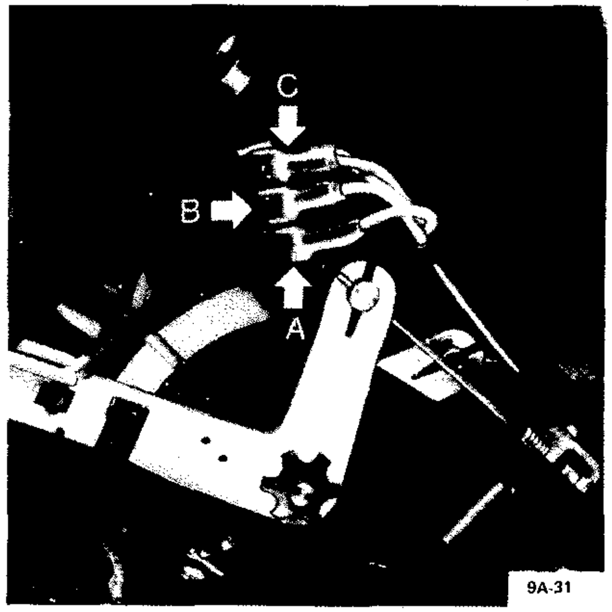


Figure 9A-43 Blower Switch Wires

A - Yellow Wire

B - Grey Wire

C - Brown Wire

3. Attach bowden control wire to air distribution flap. See Figure 9A-42.

4. In engine compartment, attach bowden control wire to heater valve. See Figure 9A-41.

5. Install two (2) sheet metal screws for control housing attachment. See Figure 9A-40.

6. Install instrument panel cover.

7. Adjust bowden control wires.

REMOVAL AND INSTALLATION OF HEATER MOTOR

Removal

1. In engine compartment, remove five (5) shroud cover attaching screws. See Figure 9A-44.

2. Carefully remove cover

3. Pull water hose off windshield wiper jet.

4. Disconnect wires to heater motor. For this purpose, disconnect multiple plug connection on left side of shroud. See Figure 9A-45.

5. Remove three (3) heater motor attaching screws. See Figure 9A-46.

6. Take off motor.

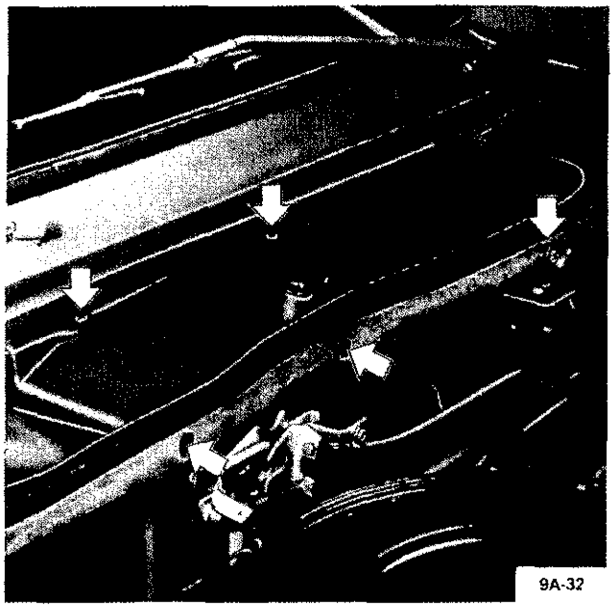


Figure 9A-44 Shroud Cover Attachments

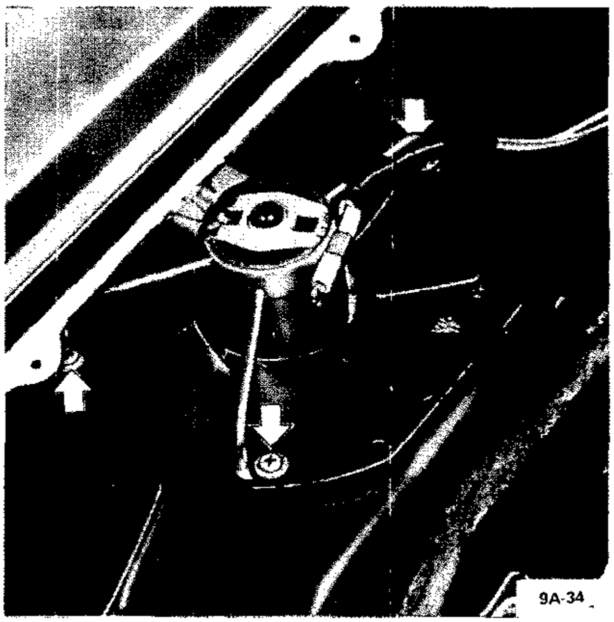


Figure 9A-46 Heater Motor Attaching Screws

Figure 9A-45 Heater Motor Wires

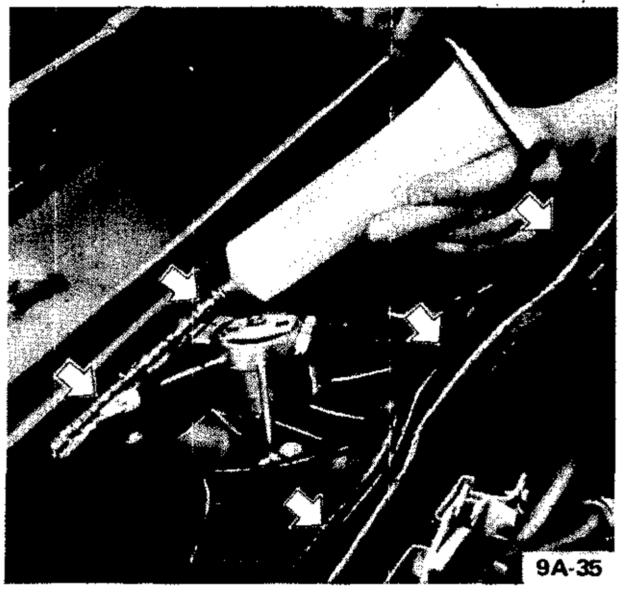


Figure 9A-47 Sealing Shroud

Installation

1. Install heater motor, attaching with three (3) screws. See Figure 9A-46.

2. Connect multiple plug on left side of shroud. See Figure 9A-45.

3. Seal shroud cover front and rear contacting areas with sealing cement. See Figure 9A-47.

4. Install shroud cover, attaching with five (5) screws.

SPECIFICATIONS

Engine

Recommended Coolant	Ethylene-Glycol Base
Thermostat Opens At (Degrees) F.	189
Cooling System Capacity (With Heater)	6 Qt.
Blower Motor Type	12 VDC
Blower Fan Type	Blade
Number of Fan Blades	7

REFRIGERANT COMPONENTS ALL MODELS

CONTENTS

DESCRIPTION AND OPERATION

FUNDAMENTAL PRINCIPLES OF REFRIGERATION

We all know **what** air conditioning does for us, **but** very few understand how or why it works. An air conditioner is functionally very similar to a refrigerator, so let's take a look at refrigeration. A refrigerator is a simple mechanism which, surprisingly enough, works quite a bit like a tea-kettle boiling on a stove. That may sound far-fetched, but there is more similarity between the two than most of us would suspect. In fact, a modern refrigerator can make ice-cubes and keep food cool and fresh only because a liquid called the refrigerant boils inside the freezer. Of course everyone knows a boiling tea-kettle is "hot" and a refrigerator is "cold". However, this is where most of us are apt to get confused. We usually think of "cold" as a definite, positive condition. Actually though, there is no such thing as "cold". The only way we can define it is in a rather negative sort of way by saying "cold" is simply the lack of heat just as darkness is the lack of light. We can't make things cold directly. All we can do is remove some of the heat they contain and they will become cold as a result. And that is the main job of any ice-box or refrigerator. Both are simply devices for removing heat.

All substances contain some heat. Theoretically, the lowest temperature that any substance could obtain is 459 degrees Fahrenheit below Zero. This may be called "Cold", and anything warmer than this contains heat. Since man has never succeeded in getting all the heat out of an object, we must think about the transfer of heat from one object to another when talking about controlling temperatures.

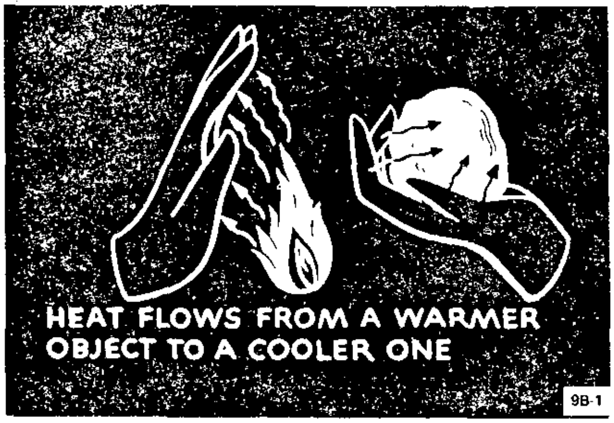


Figure 9B-1 Transfer of Heat

Transfer of Heat

The only thing that will attract heat is a colder object. Like water, which always flows down-hill, heat always flows down a temperature scale - from a warm level down to a colder one. When we hold our hands out toward the fireplace, heat flows from the hot fire out to our cold hands (Fig. 9B-1). When we make a snowball, heat always flows from our warm hands to the colder snow. In an ice-box, the ice always is colder than the stored food, so heat naturally is drawn out of the warm food by the colder ice.

Measurement of Heat

Everyone thinks he knows how heat is measured. Thermometers are used in most: homes. Whenever we speak of temperature from now on, we will mean Fahrenheit. They can tell how hot a substance is, but they can't tell us everything about heat.

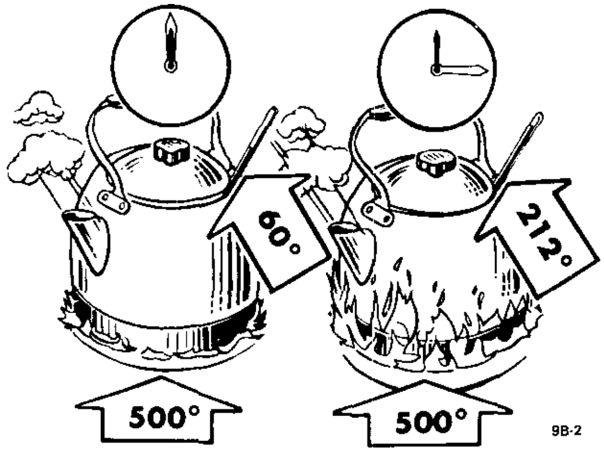


Figure 9B-2 Applied Temperature Alone is Not the Sole Measurement of Heat

When we put a tea-kettle on a stove, we expect it to get hotter and hotter until it finally boils. All during the process, we can tell exactly how hot the water is by means of a thermometer (Fig. 9B-2). However, our thermometer will show us that the flame is just as hot when we first put the tea-kettle on the stove as it is when the water finally boils. Why doesn't the water boil immediately then? Also, why does it take longer to boil a quart of water than a cupful? Obviously temperature isn't the only measurement of heat.

Even though heat is intangible, it can be measured by quantity as well as intensity. It is recognized that thermometers indicate only the intensity of heat. The unit for measuring quantity of heat is specified as that amount necessary to make 1 pound of water 1 degree warmer (Fig. 9B-3). We call this quantity of heat a British Thermal Unit. Often it is abbreviated to Btu.

Perhaps we can get a better idea of these two charac-

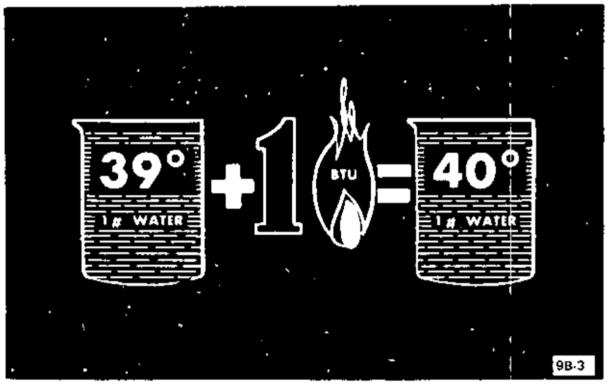


Figure 9B-3 Effect of One B.T.U. on One Pound of water

teristics of heat if we think of heat as a sort of coloring dye. If we add one drop of red dye to a glass of water, it will turn slightly pink. Another drop will make the water more reddish in color (Fig. 9B-4). The more drops of dye we add, the redder the water will get. Each drop of dye corresponds to 1 Btu and the succeedingly deeper shades of red are like increases in temperature.

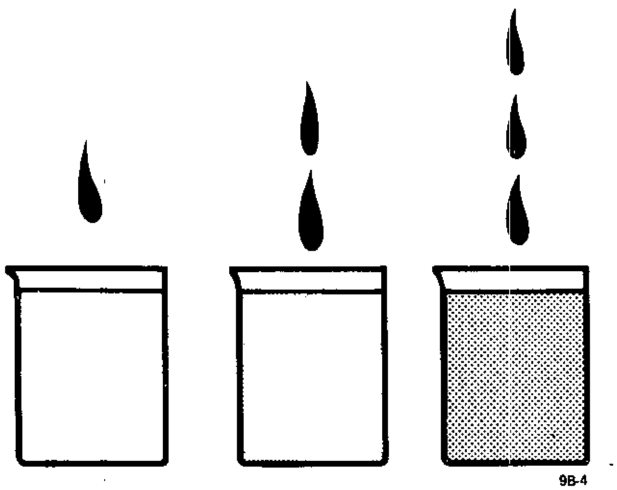


Figure 9B-4 Addition of B.T.U. Heats Water

It may seem a little puzzling to talk about beat in a story on air conditioning but, when you stop to think about it, we are handling heat exclusively. Although we ordinarily think of an air conditioner as a device for making air cold, it doesn't do that directly. What it does is take heat away from the incoming air and transfer that heat outside the vehicle.

We know now that cold is nothing more than the absence of heat, and that heat always flow from a warm object to a colder one. We also have a clearer idea of how heat is measured.

From everything we've learned about heat so far, it seems to behave in a perfectly normal manner. Yet sometimes heat will disappear without leaving a single clue.

Ice vs. Water for Cooling

Every once in a while in the old days, the ice-man would forget to refill the ice-box. Occasionally, as the last sliver of ice melted away, somebody would come up with a bright idea. He would remember that the water in the drain-pan always felt ice-cold when he had emptied it other times. So, he would get the thermometer out and check its temperature. Sure enough, it usually was about as cold as the ice. Why not put the drain-pan back in the ice compartment to keep things cold until the iceman returned the next day

It was a good idea. but it never worked. For some strange reason the ice-box never stayed cold. The drain water soon got quite warm and in a couple of hours, the butter in the ice-box would begin to melt, the milk would start to sour, and the vegetables would wilt.

Why did this happen? The drain water was only a few degrees warmer than the ice yet it didn't draw nearly as much heat out of the stored foods. However, the difference between the behavior of cold drain water and ice is the real secret as to how any refrigerator works and we can easily learn the answer by using an ordinary thermometer.

When we put a drain pan full of cold water into the ice compartment, we expect the heat to flow from the warm foods to the colder water. Remember, that heat always flows from a warm object to a colder object and when we add heat to water, it gets warmer. Each Btu of heat added to a pound of water makes it one degree warmer.

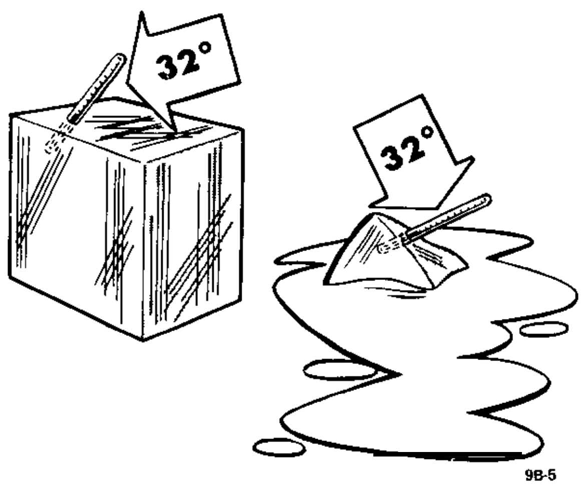


Figure 9B-5 Melting Ice Remains at 32 Degrees

If we were to put a thermometer in the cold drain water, we would see the temperature gradually creep upwards. That is to be expected because heat is flowing into the cold water making it warmer. Before long the water would be as warm as the stored foods. Then the water could no longer attract heat because heat will not flow from one warm object to another equally warm object. Since we no longer can draw heat out of the foods we no longer are cooling them.

Now, let's see what happens when we put ice instead of cold water into the ice-box. This time, we'll set the thermometer on top of the ice (Fig. 9B-5). When we first look at the thermometer, it reads 32 degrees. A couple of hours later, we open the ice compartment door. The ice block is smaller because some of the ice has already melted away - but the thermometer still reads 32 degrees. Again, still later, even more of the ice has melted, yet the termometer continues to read 32 degrees. So long as any ice remains, no matter how much of it has melted away, the temperature of the ice stays right at 32 degrees.

All this time the ice has been soaking up heat, yet it never gets any warmer no matter how much heat it **draws** from the stored food. On the other hand, the cold drain water got progressively warmer as it soaked up heat. Why is it the addition of heat will make water warmer yet won't raise the temperature of ice above the 32 degrees mark? If we till one drinking glass with ice and another with cold water, and put both glasses in the same room where they could absorb equal amounts of heat from the room air, we will find it takes much, much longer for the ice to melt and reach room temperature than it did for the water in the other glass to reach the same temperature. Obviously, most of the heat was being used to melt the ice. But it was the heat that apparently disappeared or went into hiding because if couldn't be located with a thermometer. To best describe this disappearing heat, scientists turned to Latin for the right word. They chose the word "latent" which means hidden.

Latent Heat

So latent heat is nothing more nor less than hidden heat which can't be found with a thermometer.

What happens to the latent heat? Where does it disappear to? At first it was thought it was in the **water** that melted from the ice. But that wasn't exactly the right answer because, upon checking water temperature as it melts from ice, it will be found that it is only a shade warmer than the ice itself. It is not nearly warm enough to account for all the heat the ice had absorbed. The only possible answer is that the latent heat had been **used** up to change the ice from a solid into a liquid.

Many substances can be either a solid, or a liquid, or a gas. It just depends on the temperature whether water for example was a liquid, or a solid (ice), or gas (steam) (Fig. 9B-6).

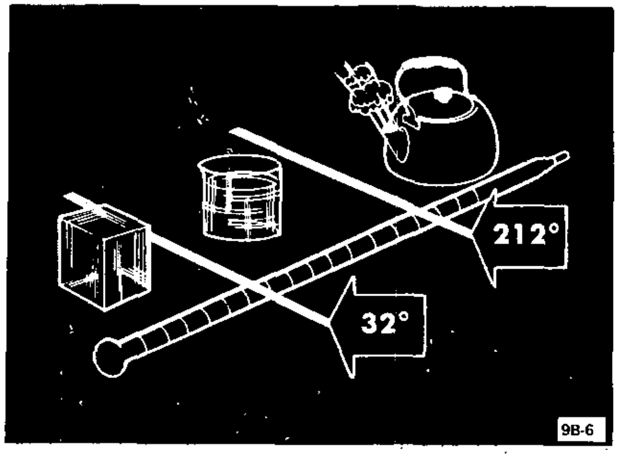


Figure 9B-6 Temperature Determines State of Water

If we put some water in a tea-kettle, set it over a tire and watch the thermometer as the water gets hotter and hotter, the mercury will keep rising until the water starts to boil. Then the mercury seems to stick at the 212 degrees mark. If we put more wood on the fire, despite all the increased heat, the mercury will not budge **above** the 212 degree mark (Fig. 9B-7).

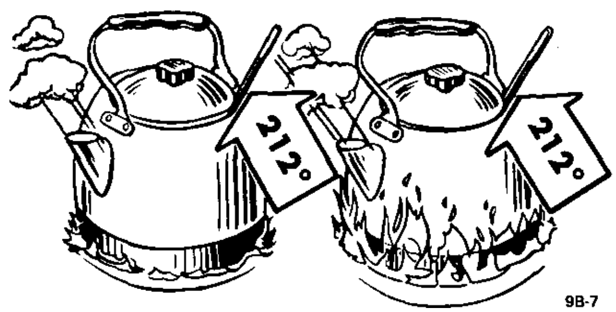


Figure 9B-7 Boiling Water Never Exceeds 2 12 Degrees

Even though many housewives won't believe it, no matter how large or hot you make the flame, you can't make water hotter than 2 12 degrees. As a liquid changes into a gas, it absorbs abnormally great amounts of heat without getting any hotter. Here is another instance where heat disappears.

Now we have two different kinds of latent heat, which are quite alike. To keep their identities separate, the first one is called latent heat of fusion. Since fusion means the same as melting, it is a good descriptive name. The other kind is called latent heat of vaporization because' that means the same as evaporation.

It may seem as though we have drifted into a story about heat instead of refrigeration. But in doing so, we have learned how a simple ice-box works. It's because the magic of latent heat of fusion gives ice the ability to soak up quantities of heat without getting any warmer.

Therefore, since it stays cold, it can continue to draw heat away from stored foods and make them cooler. The latent heat of vaporization can be an even better "magnet" because it will soak up even more heat.

Whenever we think of anything boiling, we instinctively think of it being very hot. However, that's not true in every case. Just because water boils at 212 degrees doesn't mean that all other substances will boil at the same temperature. Some would have to be put into a blast furnace to make them bubble and give off vapor. On the other hand, others will boil violently while sitting on a block of ice.

And so each substance has its own particular boiling point temperature. But regardless of whether it is high or low, they all absorb unusually large quantities of heat without getting any warmer when they change from a liquid into a vapor.

Consequently, any liquid that will boil at a temperature below the freezing point of water, will make ice cubes and keep vegetables cool in a mechanical refrigerator.

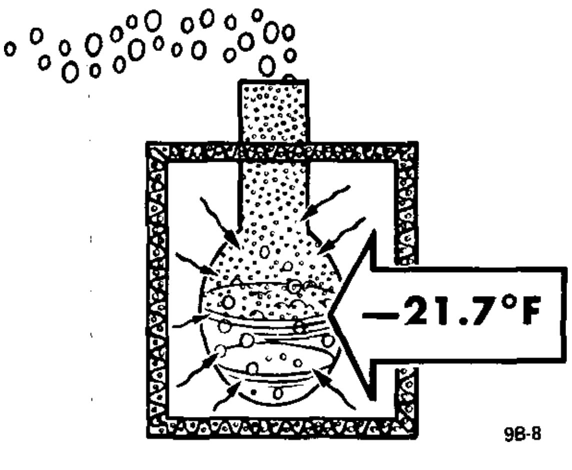


Figure 9B-10 Simple R-12 Refrigerator

Refrigerant - 12

Refrigerant-12 is used in the air conditioning system and boils at 21.7 degrees below zero. Maybe that doesn't mean very much until we picture a flask of R-12 **sitting** at the North Pole boiling away just like a tea-kettle on a stove. No one would dare pick up the flask with his bare hands because, even though boiling, it would be so cold and it would be drawing heat away from nearby objects so fast that human flesh would freeze in **a very** short **time.** If we were to put a flask of R-12 inside a refrigerator cabinet, it would boil and draw heat away from everything surrounding it (Fig. 9B-10). So long as any refrigerant remained in the flask, it would keep on soaking up heat until the temperature got down to 21.7 degrees below zero.

Now we can begin to see the similarity between a boiling tea-kettle and a refrigerator. Ordinarily we think of the flame pushing heat into the tea-kettle. Yet, it is just as logical to turn our thinking around and picture the tea-kettle pulling heat out of the flame. Both the tea-kettle and the flask of refrigerant do the same thing they draw in heat to boil although they do so at different temperature levels.

There also is another similarity between the ice-box and the mechanical refrigerator. In the ice-box, water from melting ice literally carried heat out of the cabinet. In our simple refrigerator, rising vapors do the same job.

Re-Using Our R-l 2

Water is so cheap that we could afford to throw it away. But R-12, or any other refrigerant, is too expensive just to let float away into the atmosphere. If there was some way to remove the heat from the vapor and change it back into a liquid, it could be returned to the flask and used over again (Fig. 9B-11).

There is a way, and that is where we find the biggest difference between the old ice-box and the modern refrigerator. We used to put in new ice to replace that lost by melting. Now we use the same refrigerant over and over again.

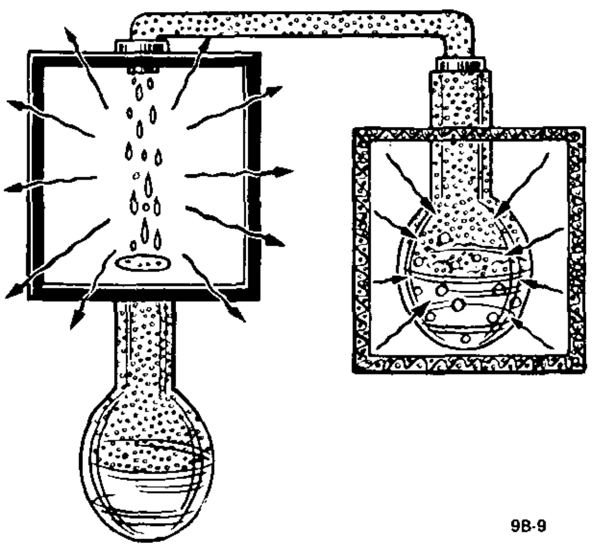


Figure 9B-1 1 Re-Using Refrigerant

We can change a vapor back into a liquid by chilling it, or do the same thing with pressure. When we condense a vapor we will find that the heat removed just exactly equals the amount of heat that was necessary to make the substance vaporize in the first place.

At last the lost is found! The latent heat of vaporization the heat that apparently disappeared when a liquid boiled into a vapor again reappears on the scene when that same vapor reverts back into a liquid. It is just like putting air into a balloon to expand it and then letting the same amount of air out again to return the balloon to its original condition.

We know that any substance will condense at the same temperature at which it boiled. This temperature point is a clear-cut division like a fence. On one side, a substance is a liquid. Immediately on the other side it is a vapor. Whichever way a substance would go, from hot to cold or cold to hot, it will change its character the moment it crosses over the fence.

But pressure moves the fence! Water will boil at 212 degrees under normal conditions. Naturally, we expect steam to condense at the same temperature. But whenever we put pressure on steam, it doesn't! It will condense at some temperature higher than 212 degrees. The greater the pressure, the higher the boiling point and the temperature at which a vapor will condense. This is the reason why pressure cookers cook food faster, since the pressure on the water permits it to boil out at a higher temperature. We know that R-12 boils at 21.7 degrees below zero. A thermometer will show us that the rising vapors, even though they have soaked up lots of heat, are only slightly warmer. But the vapors must be made warmer than the room air if we expect heat to flow out of them. Also, the condensing point temperature must be above that of room air or else the vapors won't condense.

This is where pressure comes to the rescue. With pressure, we can compress the vapor, thereby concentrating the heat it contains. When we concentrate heat in a vapor that way, we increase the intensity of the heat or, in other words, we increase the temperature, because temperature is merely a measurement of heat intensity. And the most amazing part of it all is that we've made the vapor hotter without actually adding any additional quantity of heat (Fig. 9B-12).

Use of Pressure in Refrigeration

Because we must live by press&s and gauges in air conditioning work, the following points are mentioned so that we will all be talking about the same thing when we speak of pressures.

All pressure, regardless of how it is produced, is measured in pounds per square inch (psi).

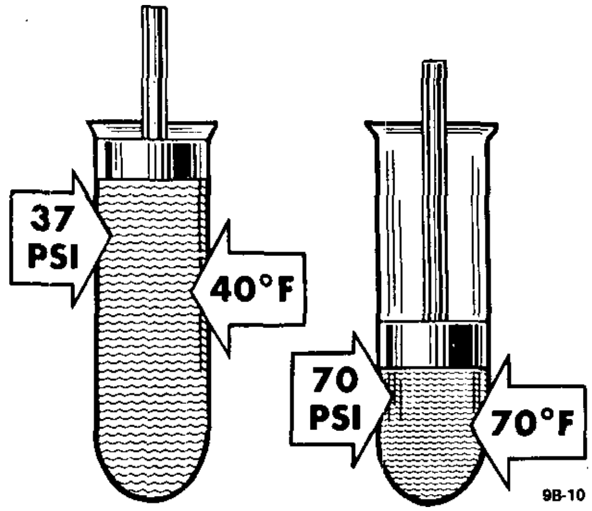


Figure 9B-12 Compressing a Vapor Concentrates its Heat

Atmospheric Pressure is pressure exerted in every direction by the weight of the atmosphere. At higher altitudes air is rarified and has less weight. At sea level atmospheric pressure is 14.7 psi.

Any pressure less than atmospheric is known as a partial vacuum or commonly called a vacuum. A perfect vacuum or region of no pressure has never been mechanically produced. Gauge pressure is used in refrigeration work. Gauges are calibrated in pounds (psi) of pressure and inches of Mercury for vacuum. At sea level "O" lbs. gauge pressure is equivalent to 14.7 lbs. atmospheric pressure. Pressure greater than atmospheric is measured in pounds (psi) and pressure below atmospheric is measured in inches of vacuum. The "0" on the gauge will always correspond to the surrounding atmospheric pressure, regardless of the elevation where the gauge is being used.

Basic Refrigerator Operation

We've now covered all the ground-rules that apply to refrigeration. Most likely they still are a little hazy, but it is easy enough to remember these main points. All liquids soak up lots of heat without getting any warmer when they boil into a vapor, and, we can use pressure to make the vapor condense back into a liquid so it can be used over again. With just that amount of knowledge, here is how we can build a refrigerator.

We can place a flask of refrigerant in an ice-box. We know it will boil at a very cold temperature and will draw heat away from everything inside the cabinet (Fig. 9B-13).

We can pipe the rising vapors outside the cabinet and thus provide a way for carrying the heat out. Once

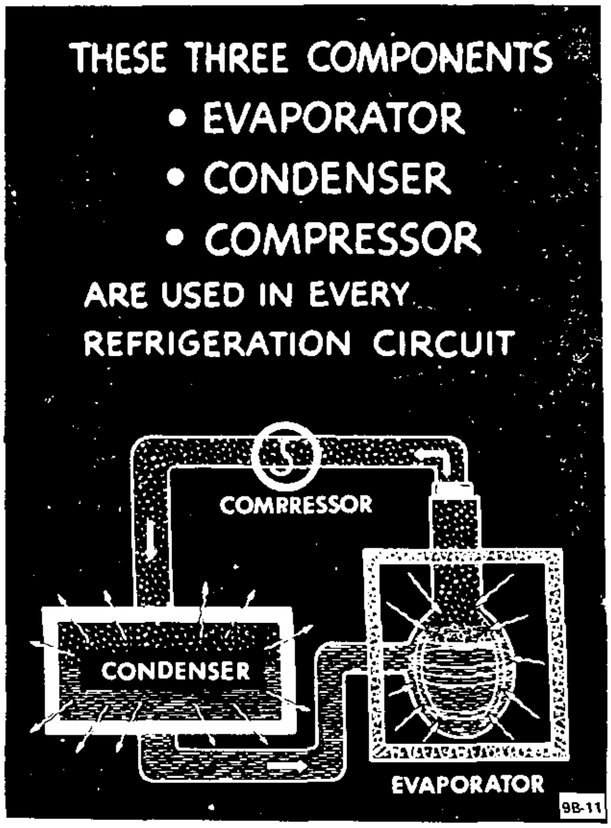


Figure 9B-13 Basic Refrigerant Circuit

we get the heat-laden vapor outside, we can compress it with a pump. With enough pressure, we can squeeze the heat out of "cold" vapor even in a warm room. An ordinary radiator will help us get rid of heat.

By removing the heat, and making the refrigerant into a liquid, it becomes the same as it was before, So, we can run another pipe back into the cabinet and return the refrigerant to the flask to be used over again.

That is the way most mechanical refrigerators work today. Now, let's look at an air conditioning unit to see how closely it resembles the refrigerator we have just described.

Basic Air Conditioner

When we look at an air conditioning unit, we will always find a set of coils or a tinned radiator core through which the air to be cooled passes. This is known as the "evaporator" (Fig. 9B-14). It does the same job as the flask of refrigerant we spoke about earlier. The refrigerant boils in the evaporator. In boiling, of course, the refrigerant absorbs heat and changes into a vapor. By piping this vapor outside the car we can bodily carry out the heat that caused its creation.

Once we get vapor out of the evaporator, all we have

Figure 9B-14 Evaporator Assembly

to do is remove the heat it contains. Since heat is the only thing that expanded the refrigerant from a liquid to a vapor in the first place, removal of that same heat will let the vapor condense into a liquid again. Then we can return the liquid refrigerant to the evaporator to be used over again.

Actually, the vapor coming out of the evaporator is very cold. We know the liquid refrigerant boils at temperatures considerably below freezing and that the vapors arising from it are only a shade warmer even though they do contain quantities of heat. Consequently, we can't expect to remove heat from sub- freezing vapors by "cooling" them in air temperatures that usually range between 60 and 100 degrees heat refuses to flow from a cold object toward a warmer object.

But with a pump, we can squeeze the heat-laden vapor into a smaller space. And, when we compress the vapor, we also concentrate the heat it contains. In this way, we can make the vapor hotter without adding any heat. Then we can cool it in comparatively warm air.

That is the only responsibility of a compressor in an air conditioning system (Fig. 9B-15). It is not intended to be a pump just for circulating the refrigerant. Rather, its job is to exert pressure for two reasons. Pressure makes the vapor hot enough to cool off in warm air. At the same time, the compressor raises the refrigerant's pressure above the condensing point at the temperature of the surrounding air so it will condense.

As the refrigerant leaves the compressor, it is still a vapor although it is now quite hot and ready to give up the heat that is absorbed in the evaporator. One of the **easiest** ways to help refrigerant vapor discharge its heat is to send it through a radiator- like contrivance known as a condenser (Fig. 9B-16).

The condenser really is a very simple device having no moving parts. It does exactly the same job as the radiator in a typical steam-heating system. There, the steam is nothing more than water vapor. In passing through the radiator, the steam gives up its heat and condenses back into water.

The same action takes place in an air conditioning

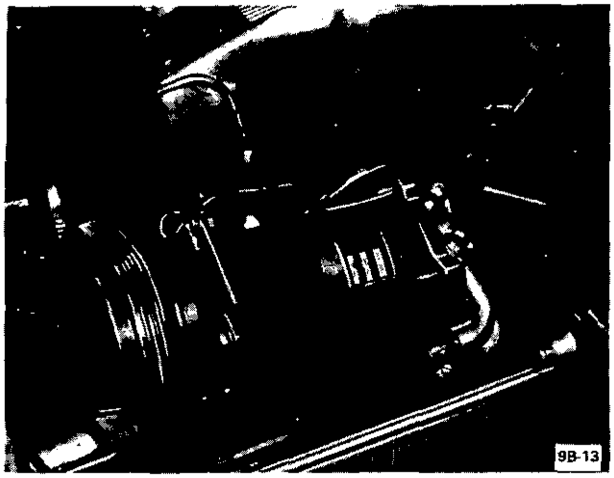


Figure 9B-15 Compressor Assembly - GT Shown

Figure 9B-16 Condenser Assembly

condenser. The refrigerant vapor gives up its heat, which is quickly and easily radiated into the surrounding air through the large finned surfaces of the condenser. In giving up its heat, the refrigerant vapor condenses back into liquid which collects in a pool at the bottom of the condenser.

As we have said before, when the refrigerant condenses into a liquid, it again is ready for boiling in the evaporator. So, we can run a pipe from the condenser back to the evaporator.

Main Units of the System

These three units then; the evaporator, the compressor, and the condenser are the main working parts of any typical air conditioning system. We have the evaporator where the refrigerant boils and changes into a vapor, absorbing heat as it does so. We have the pump or compressor to put pressure on the refrigerant so it can get rid of its heat. And we have a condenser outside the car body to help discharge the heat into the surrounding air.

Pressure and Flow

There is one more unit that co-operates with these three. It doesn't do any real work, but it does act as sort of a traffic officer in controlling the flow of the refrigerant through the system. To get a better idea of what this does. let's first do a little experimenting with an ordinary' tire pump.

When we use a tire pump to inflate an automobile tire, we are creating pressure only because we are "pushing" against the air already entrapped inside the tire. If you question this, just try pumping up a tire that has a large puncture in it. You could pump all day, and still not be able to build up any pressure. As fast as you would pump the air in, it would leak out through the puncture. About all you would be doing would be circulating nice fresh air through the tire. Unless you have something to push against - to block the flow of air - you can't create more than a mere semblance of pressure.

The same situation holds true in an air conditioning system. The compressor can pump refrigerant vapor through the system, but unless it has something to push against, it cannot build up pressure. All the compressor would be doing would be to circulate the vapor without increasing its pressure.

Yet we can't just block the flow through the system entirely. All we want to do is put pressure on the refrigerant vapor so it will condense at normal temperatures. What's more, this must be done some time after the vapor leaves the evaporator and before it returns again as a liquid. We can't have high pressure in the evaporator because that would slow down the boiling of the refrigerant and thus penalize the refrigerating effect.

Controlling Pressure and Flow

Pressure and flow can be controlled with a float valve, or with a pressure-regulating valve. They do the same job, but in a different way.

Since the float valve type will give us a better idea of pressure and flow control, let's look at it first (Fig. 9B-17).

It consists simply of a float that rides on the surface of the liquid refrigerant. As the refrigerant liquid boils and passes off as a vapor, naturally the liquid level drops lower and lower. Correspondingly, the float, because it rides on the surface of the refrigerant, also drops lower and lower as the liquid goes down.

By means of a simple system of mechanical linkage, the downward movement of the float opens a valve to let refrigerant in. The incoming liquid raises the fluid level and, of course, the float rides up with it. When the surface level of the refrigerant liquid reaches a desired height, the float: will have risen far

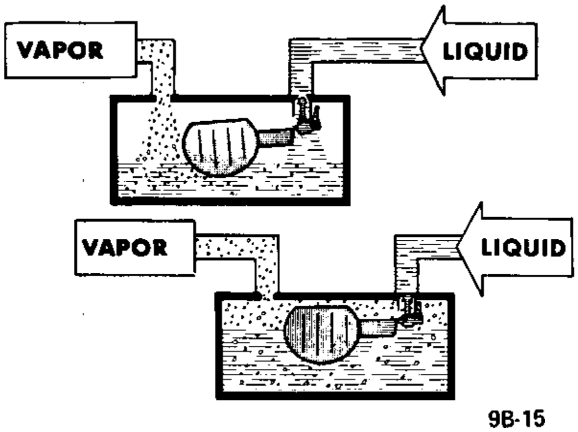


Figure 9B-17 Float Type Flow Valve

enough to close the valve and stop the flow of refrigerant liquid.

For the sake of simplicity, we have described the float and valve action as being in a sort of definite wide open or tight shut condition. Actually, though, the liquid level falls rather slowly as the refrigerant boils away. Likewise, the float goes down gradually and gradually opens the valve just a crack. New refrigerant liquid barely seeps in through the "cracked" valve. At such a slow rate of flow, it raises the liquid level in the evaporator very slowly.

With that in mind, it is easy to see how it would be possible for a stabilized condition to exist. By that, we mean a condition wherein the valve would be

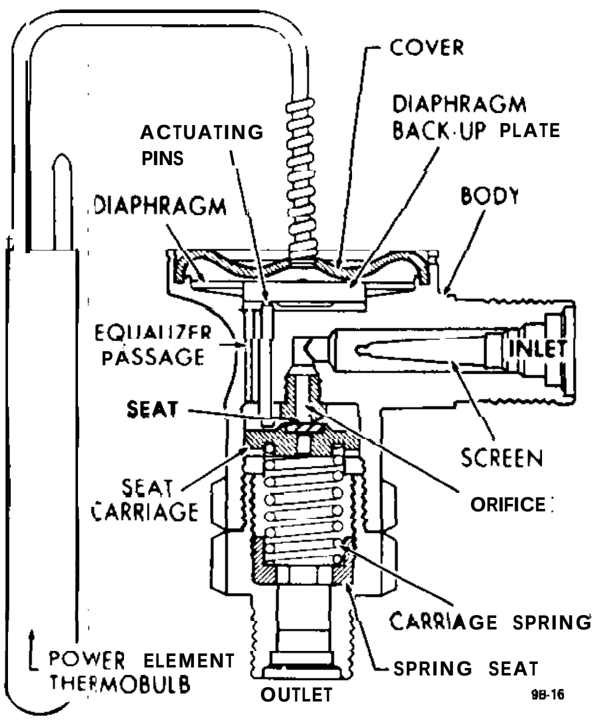


Figure 9B-18 Thermostatic Expansion Valve

opened barely enough to allow just exactly the right amount of refrigerant liquid to enter the freezer to take the place of that leaving as a vapor.

Thermostatic Expansion Valve

Automotive air conditioning systems use a thermostatic expansion valve in place of the float system.

Figure 9B-18 shows a cross-section of the valve which consists primarily of the gas-filled power element, body, actuating pins, seat and orifice. At the high pressure liquid inlet is a tine mesh screen which prevents dirt, tilings or other foreign matter from entering the valve orifice.

When the valve is connected in the system, the high pressure liquid refrigerant enters the valve through the screen from the receiver-dehydrator (which acts as a storage tank for the condensed refrigerant as it leaves the condenser) and passes on to the seat and orifice. Upon passing through the orifice the high pressure liquid becomes low pressure liquid. The low pressure liquid leaves the valve and flows into the evaporator core where it absorbs heat from the evaporator core and changes to a low pressure vapor, and leaves the evaporator core as such. The power element bulb is clamped to the low pressure vapor line just beyond the outlet of the evaporator (Fig. 9B-20).

The operation of the valve is quite simple. It is a matter of controlling opposing forces produced by a spring and the refrigerant pressures. For example: The pressure in the power element is trying to push the seat away from the orifice, while the spring is trying to force the seat toward the orifice. These opposing pressures are established in the design of the valve so that during idle periods, i.e. when the system is not operating, the spring force and the refrigerant pressure in the cooling coil are always

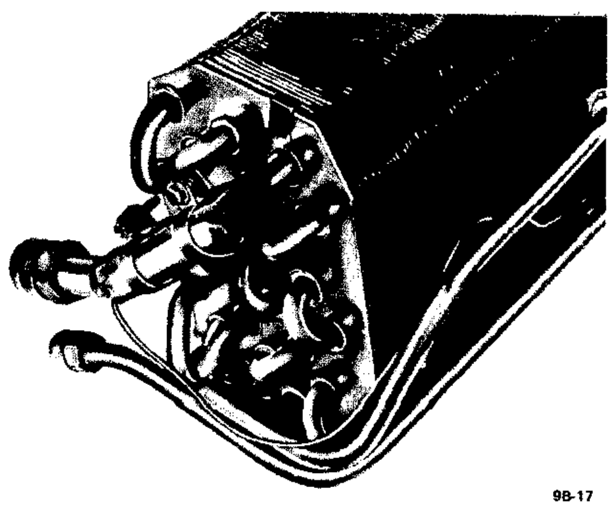


Figure 9B-20 Expansion Valve Bulb Location greater than the opposing pressure in the power element. Therefore, the valve remains closed. When the compressor is started, it will reduce the pressure and temperature of the refrigerant in the cooling coil to a point where the vapor pressure in the power element becomes the stronger. The seat then moves off the orifice and liquid starts to flow through the valve orifice into the cooling coil.

The purpose of the power element is to help determine the quantity of liquid that is being metered into the cooling coil. As the temperature of the low pressure line changes at the bulb, the pressure of the vapor in the power element changes, resulting in a change of the position of the seat. For example, if the cooling coil gets more liquid than is required, the temperature of the low pressure line is reduced and the resultant lowering of the bulb temperature reduces the pressure of the vapor in the power element, allowing the seat to move closer to the orifice. This immediately reduces the amount of liquid leaving the valve. Under normal operation, the power element provides accurate control of the quantity of refrigerant to the cooling coil.

To employ our tire pump analogy once more for clarity, it is the same situation that would exist if you were inflating a tire with a very slow leak. Providing you pumped the air into the tire as fast as it leaked out, you would be able to maintain pressure even though the air would merely be circulating through the tire and leaking out through the puncture.

To Sum Up

So far, we've discussed only what each unit in an air conditioning system does. We've learned that the evaporator is the unit in which liquid refrigerant soaks up heat from the air, the compressor is a pump for squeezing this heat out of the vapor, the condenser is a radiator for getting rid of the heat, and the thermostatic expansion valve is a device for regulating the pressure on the refrigerant. Now, let's find out how the temperature of the cooled air is controlled.

METHOD OF TEMPERATURE CONTROL

To achieve temperature control, the compressor is run intermittently, automatically turning on and off as necessary to maintain proper temperature.

Thermostatic Switch

The compressor can be started and stopped automatically through the use of an electro-magnetic clutch and a thermostat affected by variations of temperature.

The job is usually done by a gas bulb thermostat (Fig. 9B-21).

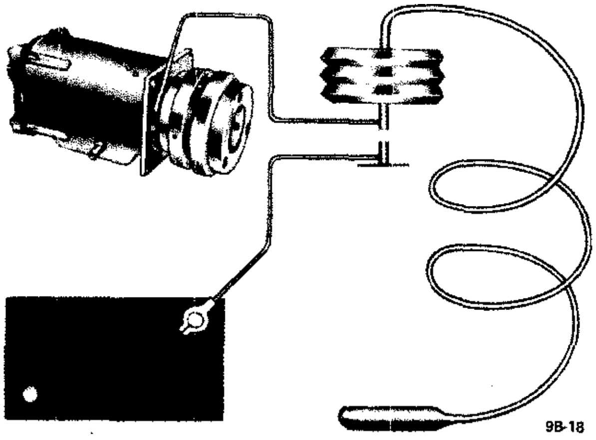


Figure 9B-21 Thermostatic Switch Schematic

With the gas bulb type of thermostat, a highly expansive gas is sealed into a metallic bulb which is located in the air stream as it leaves the evaporator. A small tube leads from the bulb to a bellows operated switch. As air temperature rises, the gas inside the bulb expands, travels through the tube to the bellows and closes the electrical switch that engages the compressor clutch.

Of course, as soon as the compressor starts running, the temperature begins to go down. As the air being cooled gets colder, the gas in the thermostat bulb begins to reduce the pressure on the switch bellows.

This flips "off' the switch and disengages the compressor clutch.

REFRIGERANTS

No matter how scientifically refrigerating machinery is built or how efficiently it runs, it alone cannot remove heat. The only thing that carries heat out of a refrigerator cabinet or an automobile is the substance we call the refrigerant.

There are many refrigerants known to man. In fact, any liquid that can boil at temperatures somewhere near the freezing point of water can be used.

But a boiling point below the temperature at which ice forms is not the only thing that makes a good refrigerant. A refrigerant should also be non- poisonous and non-explosive to be safe. Besides that, we want a refrigerant that is non-corrosive and one that will mix with oil.

Since Nature did not provide an ideal refrigerant, chemists went to work to see if they could do any better. They did! But it wasn't as simple as that.

At first, they tried to improve existing natural refrigerants. But after exploring innumerable trails along that line, they still hadn't gotten anywhere. So, they started from scratch and juggled molecules around to make an entirely new refrigerant. Eventually they succeeded by remodeling the molecules in carbon tetrachloride. This is the same fluid that is used in fire extinguishers and dry-cleaners' solvents.

From this fluid, the chemists removed two chlorine atoms and replaced them with two fluorine atoms. This newly-formed fluid carried the technical chemical name of dichlorodifluoromethane. Today, we know it as Refrigerant-12 or R-12.

Fluorine is an extremely temperamental substance. Under most conditions it is toxic and highly corrosive, and after is is manufactured, it has to be stored in special containers because it will eat through glass and will dissolve most metals in short order.

Despite its rambunctious character though, fluorine is completely tamed when it is combined with the other substances that go to make up the refrigerant. Each is non-toxic, non-inflammable, non-explosive, and non- poisonous; however, breathing large quantities of R-12 should be avoided.

Pressure. Temperature Relationship of R-12

A definite pressure and temperature relationship exists in the case of liquid refrigerants and their saturated vapors. Increasing the temperature of a substance causes it to expand. When the substance is confined in a closed container, the increase in temperature will be accompanied by an increase in pressure, even though no mechanical device was used. For every temperature, there will be a corresponding pressure within the container of refrigerant. A table of the temperature-pressure relationship of R-12 is presented below. Pressures are indicated in gauge pressure, either positive pressure (above atmospheric) in pounds or negative pressure (below atmospheric) in inches of vacuum.

°F	#Pressure	°F	#Pressure
-40	11.0*	50	46.1
-35	8.3*	50	52.0
-30	5.5*	60	57.7
-25	2.3*	65	63.7
-20	0.6	70	70.1
-15	2.4	75	76.9
-5	4.5	85	84.1
-0	6.8 9.2	90	99.6 91.7
5		95	
10	11.8 14.7	100	116.9 108.1
15	17.7	105	126.2
20	21.1	110	136.0
25	24.6	115	146.5
30	28.5	120	157.1
32	30.1	125	167.5
35	32.6	130	179.0
40	37.0	140	2045
45	41.7	150	232.0

*Inches of Vacuum.

Thus if a gauge is attached to a container of R- 12 and the room temperature is 70 degrees, the gauge will register 70 psi pressure; in a 100 degrees room the pressure will be 117 psi.

AIR CONDITIONING

Because air conditioning has always been very closely allied with mechanical refrigeration, most of us are apt to think of it only as a process for cooling room air.

But true air conditioning goes beyond the mere cooling of the air. It controls the humidity, cleanliness, and circulation of the air as well.

Whenever it gets warm and muggy in the summertime, someone is almost sure to say, "It's not the heat it's the humidity." But that is only partly right. Actually it is a combination of the two that makes us feel so warm temperature alone is not the only thing that makes us uncomfortable.

Humidity is nothing more nor less that the moisture content of the air. To a certain extent, it is tied in with the temperature of the air. Warm air will hold more moisture than will cold air. When air contains all the moisture it can hold, we say it is saturated, and the relative humidity is 100 percent. If the air contains only half as much water as it could possibly hold at any given temperature, we say that the relative humidity is 50 percent. If it contains only a fifth of its maximum capacity, we say that the relative humidity is 20 percent and so on. This amount of water vapor, or relative humidity, affects the way we perspire on hot days.

Nature has equipped our bodies with a network of sweat glands that carry perspiration to the skin surfaces. Normally, this perspiration evaporates and, in doing so, absorbs heat just like a refrigerant absorbs heat when it is vaporized in a freezer. Most of the heat thus absorbed is drawn from our bodies, giving us a sensation of coolness. A drop of alcohol on the back of your hand will demonstrate this principle very convincingly. Because it is highly volatile, alcohol will evaporate very rapidly and absorb quite a bit of heat in doing so, thereby making the spot on your hand feel unusually cool.

The ease and rapidity with which evaporation takes place, whether it be alcohol or perspiration, governs our sensation of coolness and to a certain extent, independently of the temperature. Of even more importance, the ease and rapidity of the evaporation are directly affected by the relative humidity or comparative dampness of the air. When the air is dry, perspiration will evaporate quite readily. But when the air contains a lot of moisture, perspiration will evaporate more slowly; consequently less heat is carried away from our body.

Thus, from the standpoint of comfort, complete air conditioning should control the relative humidity of the air as well as its temperature.

By reducing the humidity, we sometimes can be just as "cool" in a higher room temperature than otherwise would be comfortable. Laboratory tests have shown that the average person will feel just as cool in a temperature of 79 degrees when the relative humidity is down around 30 percent as he will in a cooler temperature of 72 degrees with a high relative humidity of 90 percent.

There are practical limits though within which we must stay when it comes to juggling humidity. For human comfort, we can't go much below a relative humidity of 30 percent because anything lower than that would cause an unpleasant and unhealthy dryness in the throat and nasal passages.

Summertime temperatures of 85 degrees sometimes bring with them relative humidities around 75 to 80 percent. Some coastal cities have relative humidities averaging as high as 87 percent. To gain maximum human comfort, an air conditioning system should cool the air down and reduce the humidity to comfortable limits.

The cooling job usually is done just as it is in a refrigerator. A compressor sends refrigerant through a chilling unit where it absorbs heat. The heat is drawn out of the air which circulates through the chilling unit. Along with the cooling job it does, the evaporator unit also removes much of the moisture from the air. Everyone is familiar with the sight of thick frost on the freezer of a refrigerator. That frost is simply frozen moisture that has come out of the air.

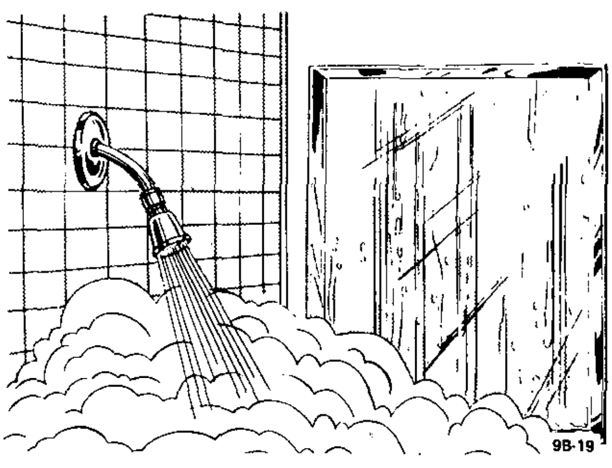


Figure 9B-22 Condensation

The evaporator unit in an air-conditioning system does the same thing with this one exception. Because its temperature is above the freezing point, the moisture does not collect in the form of ice or frost. Instead, the moisture remains fluid and drips off the chilling unit. This action is similar to what occurs on the cool bathroom mirror when a hot shower is turned on (Fig. 9B-22). A further advantage of air conditioning is that dust and pollen particles are trapped by the wet surfaces of the evaporator core and then drained off with the condensed moisture. This provides very clean, pure air for breathing, and is of great benefit to those who suffer from asthma or allergies such as hay fever.

Basic Refrigeration Cycle

Let's review the basic refrigeration cycle. Keep this basic cycle in mind because knowledge of the cycle, knowledge of the particular system you are working on and proper use of the gauges will permit quick, accurate diagnosis of problems as they arise.

Any refrigeration system takes advantage of the principles just described. The air conditioning system illustrated in Fig. 9B-23 contains five basic parts; a compressor, a condenser, a receiver, an expansion valve and an evaporator. Assuming R-12 as our refrigerant, let us follow through the refrigeration cycle.

Refrigerant gas under low pressure is drawn into the compressor where it is compressed to a high pressure. During compression, the refrigerant gas is heated. When sufficient pressure is built up, the hot gas passes into the condenser where it cools by giving off heat to the air passing over the condenser surfaces.

As the refrigerant gas cools, it condenses into a liquid at high pressure and accumulates in the receiver. The high pressure liquid refrigerant passes to the expansion valve at the entrance to the evaporator. At the valve orifice the pressure is lowered and the refrigerant enters the evaporator core as a low pressure liquid. When the refrigerant is exposed to the lower evaporator pressure, it begins to boil and is changed to a vapor state. As the refrigerant passes through the evaporator, it continues to boil by absorbing heat from the air passing over the evaporator surfaces until it is completely vaporized. From the evaporator the cool low pressure refrigerant gas is drawn back to the compressor and the cycle repeated.

Thus the air passing over the evaporator surfaces is cooled simply by giving up heat to the refrigerant during the boiling process.

CHEMICAL INSTABILITY AND REFRIGERATING SYSTEM FAILURES

A sealed refrigerating system is a complex physical-chemical combination which is designed for stability

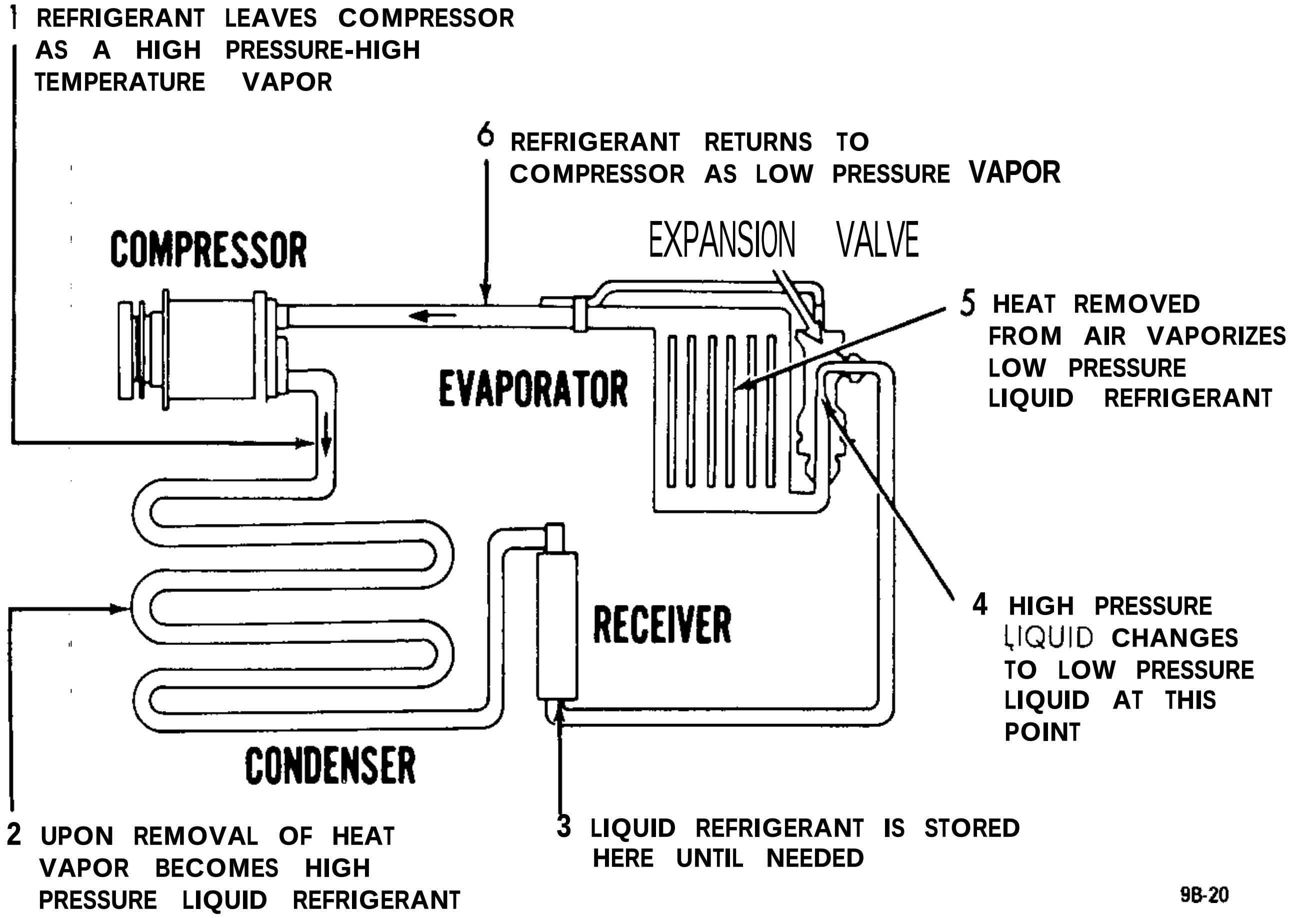


Figure 9B-23 Basic Refrigeration Cycle

within certain operating limits. If these limits are exceeded, many physical and chemical reactions occur. Since the results of these reactions within the system cannot be easily removed, they build up into a constantly accelerating vicious circle to eventually fail the system.

CHEMICAL INGREDIENTS OF AN AUTOMOTIVE AIR CONDITIONING SYSTEM

All systems involve metals, refrigerant, and oil which are basic and essential. The desiccant, or dehydrating agent, and another chemical ingredient, synthetic rubber, makes it even more complex.

All of these ingredients have chemical properties which are entirely different from each of the others. In spite of these differences, by proper selection of the ingredients and controlled processes in manufacture, plus careful servicing procedures they can be combined so that they "live together" to provide many years of satisfactory and trouble-free operation.

If, however, only one undesirable element is added or is allowed to enter the system, it can start a chain of chemical reactions which upsets stability and interferes with the operation of the unit.

Metals

In most cases, metals contribute to the decomposition of R-12 and oil in varying amounts. All are attacked by acids.

Each of the metals in common use in a system has been selected for a specific reason; heat conductivity, durability, strength, and chemical composition.

Under favorable conditions, the amounts of decomposition of Refrigerant-12 and oil produced by these metals is negligible and allowable. However, if undesirable substances are added and the temperature is increased, the rate of decomposition and the production of harmful acids increases proportionally.

Refrigerant

The chemical properties of refrigerants are very important factors in the stability of a system since the refrigerant penetrates to every nook and cranny of the unit.

Among the many desirable properties of R-12, is its stability under operating conditions. However, while more stable than the other refrigerants under the same conditions, it, too, can be caused to form harmful acids which will eventually fail the system.

Oil

Oil is the most complex of all of the organic chemicals. Its stability in a refrigerating system is dependent upon the source of crude oil and its method of refining. A good refrigerating oil must be free of sludge and gum-forming substances and free of harmful impurities, such as sulphur. It must also be stabilized to resist oxidation and must have a high degree of resistance to carbonization.

The chemical properties of the lubricating oil form another very important consideration in the chemical stability within the system. Like the refrigerant, it travels to every nook and cranny of the unit.

The factory obtains the finest oils which have been refined from the most desirable crudes. It is reprocessed at the factory before it is charged into a system or poured into a container for resale. Its voscosity and flash point are checked and it is forced through many sheets of filtering paper.

Even the containers in which it is poured for resale are processed. As you recive it for field service it is the cleanest, dryest, and purest oil that is humanly possible to make. Leaving the container uncapped even for a few minutes allows the oil to absorb moisture from the air. Many system failures have been caused by chemical reactions which were started by servicemen adding contaminated oil.

Desiccants (Dehydrating Agent)

Over the years the industry has spent hundreds of thousands of dollars in finding and developing chemical substances which are suitable for use in refrigerating systems. An ideal desiccant must have the following characteristics:

I. High capacity.

2. High efficiency.

3. Low tendency to powder.

4. Absorb moisture without reacting chemically with it.

5. Allow refrigerant to flow through it with minimum restriction.

6. Retain moisture at high temperature.

This has been a difficult combination to find. While some desiccants excel in several of the desirable characteristics, they are unsatisfactory in others.

Activated Silica Alumina, used in current receiver-dehydrators, is a most satisfactory desiccant. However, its ability to retain moisture is affected by its temperature. As the temperature increases, its ability decreases. This means that moisture which is retained at a lower temperature may be put back into the system at a higher temperature.

MAINTAINING CHEMICAL STABILITY IN THE REFRIGERATION SYSTEM

The metal internal parts of the refrigeration system and the refrigerant and oil contained in the system are designed to remain in a state of chemical stability as long as pure R-12 plus refrigeration oil is used in the system. However, when abnormal amounts of foreign materials, such as dirt, air or moisture are allowed to enter the system, the chemical stability may be upset (Fig. 9B-24).

Figure 9B-24 System Contaminants

When accelerated by heat, these contaminants may form acids and sludge and eventually cause the breakdown of components within the system. In addition, contaminants may affect the temperature pressure relationship of R-12, resulting in improper operating temperature and pressures and decreased efficiency of the system.

The following general practices **should** be observed to maintain chemical stability in the system:

Whenever it becomes necessary to disconnect a refrigerant or gauge line, it should be immediately capped. Capping the tubing will also prevent dirt and foreign matter from entering.

Tools should be kept clean and dry. This also includes the gauge set and replacement parts.

When adding oil, the container should be exceptionally clean and dry due to the fact that the refrigeration oil in the container is as moisture-free as it is possible to make it. Therefore, it will quickly absorb any moisture with which it comes in contact. For this same reason the oil container should not be opened until ready for use and it should be capped immediately after use.

When it is necessary to open a system, have everything you will need ready and handy so that as little time as possible will be required to perform the operation. Don't leave the system open any longer than is necessary.

Finally, after the operation has been completed and the system sealed again, air and moisture should be evacuated from the system before recharging.

THE PRIMARY CAUSES OF SYSTEM FAILURES

Leaks

A shortage of refrigerant causes oil to be trapped in the evaporator. Oil may be lost with the refrigerant at point of leakage. Both of these can cause compressor seizure.

Oil circulates in the system with the refrigerant; in solution with the liquid and in globules with the vapor. It leaves the compressor by the action of the pistons and mixes with the refrigerant liquid in the condenser. The oil then enters the evaporator with the liquid and, with the evaporator properly flooded, is returned to the compressor through the low pressure line. Some of the oil returns as globules in the vapor, but more important, it is swept as a liquid along the walls of the tubing by the velocity of the vapor. If the evaporator is starved, the oil cannot return in sufficient quantities to keep the compressor properly lubricated.

High Temperature and Pressure

An increase in temperature causes an increase in pressure. This accelerates chemical instability due to existing contaminants in the system, and initiates chemical instability in clean systems. Other results are brittle hoses, "O" ring gaskets, and valve diaphragms with possible decomposition, broken compressor discharge reeds, and seized compressor bearings.

A fundamental law of nature accounts for the fact that when a substance, such as a refrigerant, is increased in temperature, its pressure is also increased.

Any chemical reactions caused by contaminants already in the system are greatly accelerated as the temperature increases. A 15 degree rise in temperature doubles the chemical action. Even in a good clean system, heat alone can start a chain of harmful chemical reactions.

While temperature alone can cause the synthetic rubber parts to become brittle and possibly to decompose, the increased pressure can cause them to rupture or blow.

As the temperature and pressure increases the stress and strain on the compressor discharge reeds also increases. This can result in broken reeds. Due to the effect of the contaminants caused by high temperature and pressure, compressor bearings can be caused to seize.

High temperature and pressure are also caused by air in the system.

Air in the System

Air results from a discharged system or careless servicing procedures. This reduces system capacity and efficiency and causes oxidation of oil into gum and varnish.

When a leak causes the system to become discharged, the resulting vacuum within the system will cause air to be drawn in. Air in the system is a non-condensable gas and will build up in the condenser as it would in an air compressor tank. The resultant heat produced will contribute to the conditions discussed previously.

Many systems are contaminated and also reduced in capacity and efficiency by servicemen who either do not know or are careless regarding proper servicing procedures.

Too frequently, systems which have been open to the atmosphere during service operations have not been properly purged or evacuated. Air is also introduced into the system by unpurged gauge and charging lines. Remember that any air in the system is too much air.

Poor Connections

Hose clamp type fittings must be properly made. Hoses should be installed over the sealing flanges and with the end of the hose at the stop flange. The hose should never extend beyond the stop flange. Locate the clamp properly and torque as recommended. Be especially careful that the sealing flanges are not nicked or scored or a future leak will result.

When compression fittings are used, over tightening can cause physical damage to the "0" ring gasket and will result in leaks. The use of torque and backing wrenches is highly recommended. When making a connection with compression fittings, the gaskets should always be first placed over the tube before inserting it in the connection. Another precaution - inspect the fitting for burrs which can cut the "O" ring.

Restrictions

Restrictions may be due to powdered desiccant or dirt and foreign matter. This may result in starved evaporator and loss of cooling, or a seized compressor.

When the amount of moisture in a system sufficiently exceeds the capacity of the desiccant, it can break down the desiccant and cause it to powder. The powder passes through the dehydrator screen with the refrigerant liquid and is carried to the expansion valve screen. While some of it may pass through the valve screen into the evaporator, it may quickly build up to cause a restriction.

Due to the fact that sufficient oil can not be returned to the compressor, it may seize.

Dirt

Dirt, which is any foreign material, may come from cleaner residues, cutting, machining, or preserving oils, metal dust or chips, lint or dust, loose rust, soldering or brazing fluxes, paint or loose oxide scale. These can also cause seized bearings by abrasion or wedging, discharge and expansion valve failure, decomposition of refrigerant and oil, or corrosion of metal parts.

Corrosion

Corrosion and its by-products can restrict valve and drier screens, rough bearing surfaces or rapid fatiguing of discharge reeds. This can result in high temperature and pressure, decomposition or leaks. In any event, this means a wrecked compressor.

From this, we can see the vicious circle that can be produced in a refrigerating system to cause its failure. Corrosion can be the indirect cause of leaks, and leaks can be the direct cause of corrosion. We can also see the important role we as servicemen play in maintaining chemical stability.

The major cause of corrosion is moisture.

Moisture

Moisture is the greatest enemy of refrigerating systems. Combined with metal, it produces oxide, Iron Hydroxide and Aluminum Hydroxide. Combined with R-12 it produces Carbonic acid, Hydrochloric acid, and Hydrofluoric acid. Moisture can also cause freeze-up of expansion valve and powdered desiccant.

Although high temperature and dirt are responsible for many difficulties in refrigerating systems, in most instances it is the presence of moisture in the system that accelerates these conditions. It can be said, therefore, that moisture is the greatest enemy of all. The acids that it produces, in combination with both the metals and the refrigerant, cause damaging corrosion. While the corrosion may not form as rapidly with R-12 as with some other refrigerants, the eventual formation is as damaging.

If the operating pressure and temperature in the evaporator is reduced to the freezing point, moisture in the refrigerant can collect at the orifice of the expansion valve and freeze. This temporarily restricts the flow of liquid causing erratic cooling.

As previously mentioned, moisture in excess of the desiccant's capacity can cause it to powder.

YOU SHOULD KNOW AND REMEMBER..

That the inside of the refrigeration system is completely sealed from the outside world. And if that seal remains broken at any point - the system will soon be destroyed. That complete and positive sealing of the entire system is vitally important and that this sealed condition is absolutely necessary to retain the chemicals and keep them in a pure and proper condition.

That all parts of the refrigeration system are under pressure at all times, whether operating or idle, and that any leakage. points are continuously losing refrigerant and oil.

That the leakage of refrigerant can be so silent that the complete charge may be lost without warning.

That refrigerant gas is heavier than air and will rapidly drop to the floor as it flows from a point of leakage.

That the pressure in the system may momentarily become as high as 400 lbs. per square inch, and that under such pressure the molecules of refrigerant are forced out through the smallest opening or pore.

That the compressor is continually giving up some lubricating oil to the circulating refrigerant and depends upon oil in the returning refrigerant for continuous replenishment. Any stoppage or major loss of refrigerant will therefore be fatal to the compressor.

That the extreme internal dryness of a properly processed system is a truly desert condition, with the drying material in the receiver holding tightly on to the tiny droplets of residual moisture.

That the attraction of the drying material for moisture is so powerful that if the receiver is left open, moisture will be drawn in from the outside air.

That just one drop of water added to the refrigerant will start chemical changes that can result in corrosion and eventual breakdown of the chemicals in the system. Hydrochloric acid is the result of an R-12 mixture with water.

That the smallest amount of air in the refrigeration system may start reactions that can cause malfunctions.

That the drying agent in the receiver-dehydrator is Activated Silica Alumina (silica-gel).

That the inert gas in the expansion valve capillary line is carbon dioxide.

DESCRIPTION OF AIR CONDITIONING COMPONENTS

Compressor

The compressor is located in the engine compartment. The purpose of the unit is to draw the low pressure gas from the evaporator and compress this gas into a high temperature, high pressure gas. This action will result in the refrigerant having a higher temperature than the surrounding air.

The compressor is of basic double action piston design. Three horizontal double acting pistons make up a six cylinder compressor (See Figure 9B-162). The pistons operate in 1-1/2 inch bore and have a 1-1/8 inch stroke. A swash plate keyed to the shaft drives the pistons. The shaft is belt driven through a magnetic clutch and pulley arrangement. An oil pump mounted at the rear of the compressor picks up oil from the bottom of the compressor and lubricates the bearings and other internal parts of the compressor.

Reed type valves at each end of the compressor open or close to control the flow of incoming and outgoing refrigerant. Two gas tight passages interconnect chambers of the front and rear heads so that there is one common suction port, and one common discharge port. The internal parts of the compressor function, as follows:

1. Suction Valve Reed Discs and Discharge Valve Plates - The two suction valve reed discs and two discharge valve plates (see Figure 9B-25) operate in a similar but opposite manner. The discs are composed of three reeds and function to open when the pistons are on the intake portion of their stroke (downstroke), and close on the compression stroke. The reeds allow low pressure gas to enter the cylinders. The discharge valve plates also have three reeds, however, they function to open when the pistons are on the compression portion of their stroke (upstroke), and close on the intake stroke. High pressure gas exits from discharge ports in the discharge valve plate. Three retainers riveted directly above the reeds on the valve plate serve to limit the opening of the reeds on the compression stroke.

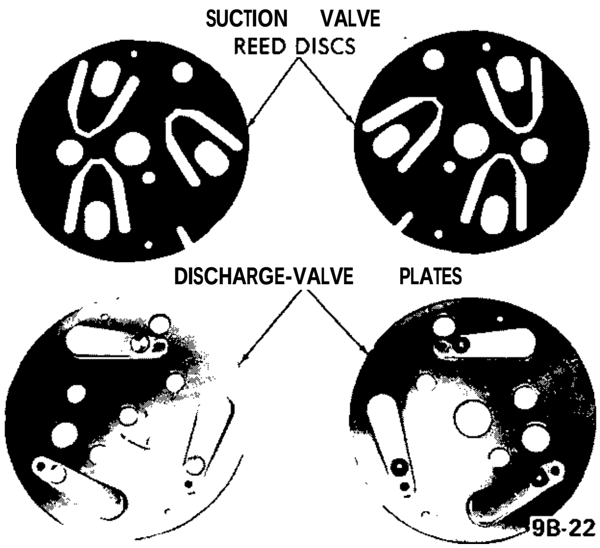


Figure 9B-25 - Compressor Suction Valve Reed Discs and Discharge Valve Plates

2. Front and Rear Heads - The front and rear heads (Figure 9B-26) serve to channel the refrigerant into and out of the cylinders. The front head is divided into two separate passages and the rear head is divided into three separate passages. The outer passage on both the front and rear heads channels high pressure gas from the discharge valve reeds. The middle passage of the rear head also contains the port opening to the superheat switch cavity. This opening in the rear head permits the superheat switch to be affected by suction gas pressure and suction gas temperature for the operating protection of the compressor. The inner passage on the rear head houses the oil pump inner and outer rotors. A Teflon sealing material is bonded to the sealing surfaces separating the passages in the rear head. "O" rings are used to affect a seal between the mating surfaces of the heads and the shell. The front head suction and discharge passages are connected to the suction and discharge passages of the rear head by a discharge tube and suction passage in the body of the cylinder assembly. A screen located in the suction port of the rear head prevents foreign material from entering the circuit.

3. Oil Pump - An internal tooth outer rotor and external tooth inner rotor comprise the oil pump. The pump works on the principle of a rotary type pump. Oil is drawn up from oil reservoir in underside of shell through the oil inlet tube (see Figure 9B-27)

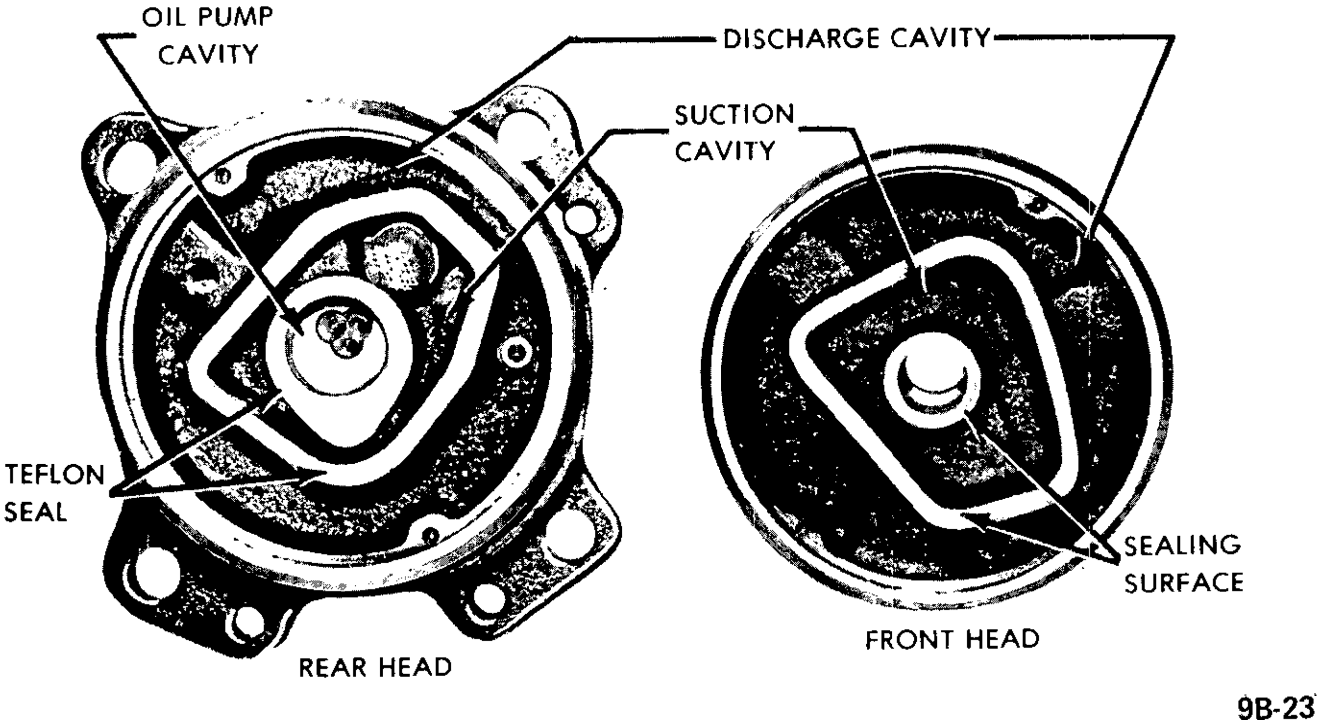


Figure 9B-26 Compressor Front and Rear Heads

and circulated through the system via a 3/16 inch diameter oil passage through the shaft center and also four 5/64 inch diameter holes drilled perpendicular to the shaft. The inner rotor is driven by the shaft.

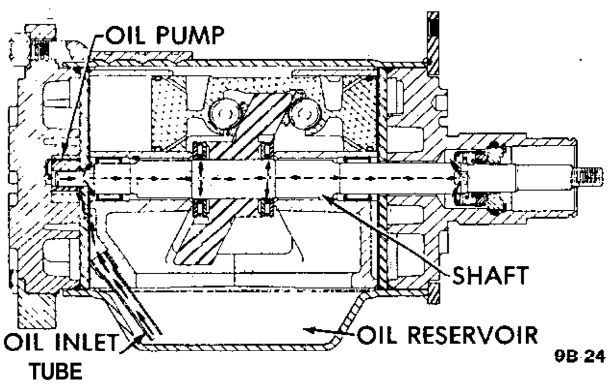


Figure 9B-27 Compressor Oil Flow

4. Shaft and Swash Plate Assembly - The shaft and swash plate assembly (see Figure 9B-162) consists of an elliptical plate positioned obliquely to the shaft. As the plate and shaft rotate, the surface of the plate moves to and fro lengthwise relative to the centerline of the shaft. This reciprocating motion is transmitted to the pistons which contact the surface of the swash plate. A woodruff key locks the swash plate onto the shaft. The swash plate and shaft are serviced as an assembly. The shaft is driven by a pulley when the magnetic clutch is energized. A needle thrust bearing and a mainshaft bearing support the shaft horizontally and vertically.

5. Needle Thrust Bearing and Races - Two needle thrust bearings, each "sandwiched" between two races are located on either side of the swash plate hub. The front needle thrust bearing and races provide 0.010" to 0.015" clearance between the top of the pistons and the rear side of the front suction valve reed disc (see Figure 9B-28). The rear needle thrust bearings and races provide 0.0005" to 0.0015" clearance between the hub of the swash plate and the rear hub of the rear cylinder. Races of various thicknesses are provided for service replacement to achieve required clearances when rebuilding units.

6. Cylinder Assembly and service Pistons (Factory installed pistons are ringless) -The cylinder assembly (front cylinder and rear cylinder) is serviced only as a matched set. Alignment of the two halves is maintained by two dowel (locater) pins.

The double ended pistons are made of cast aluminum. There are two grooves on each end of the service piston. The outer grooves will receive a piston ring. The inner grooves act as oil scraper grooves to collect any excess oil. Two oil return holes are drilled

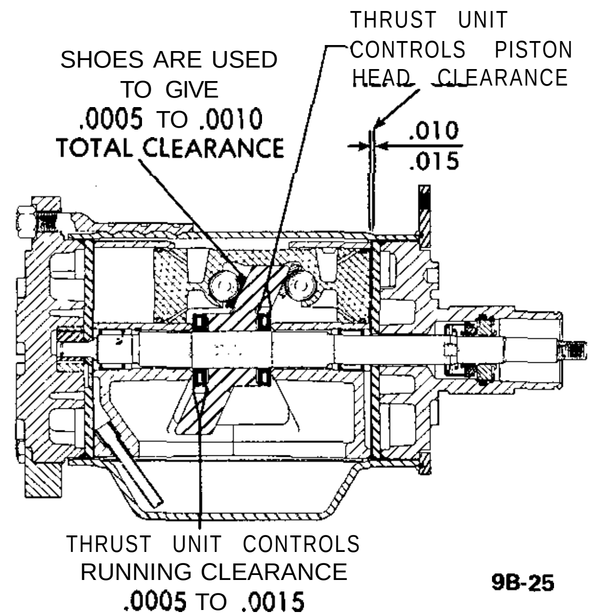


Figure 9B-28 Compressor Needle Thrust Bearings and Races

into the scraper grooves and allow oil to drain back into the reservoir.

7. Shoe Discs • The shoe discs are made of bronze and act as a bearing between the ball and the swash plate. An oil circulation hole is provided through the center of each shoe for lubrication purposes. These shoes are of various thicknesses and are provided in 0.0005 inch increments. Ten sizes are available for service replacement. A basic "zero" shoe size is available' for preliminary gauging procedures when rebuilding a cylinder assembly.

8. Suction Passage Cover-The suction passage cover fits over a suction passage (see Figure 9B-30) in the body of the cylinder assembly. Low pressure vapor

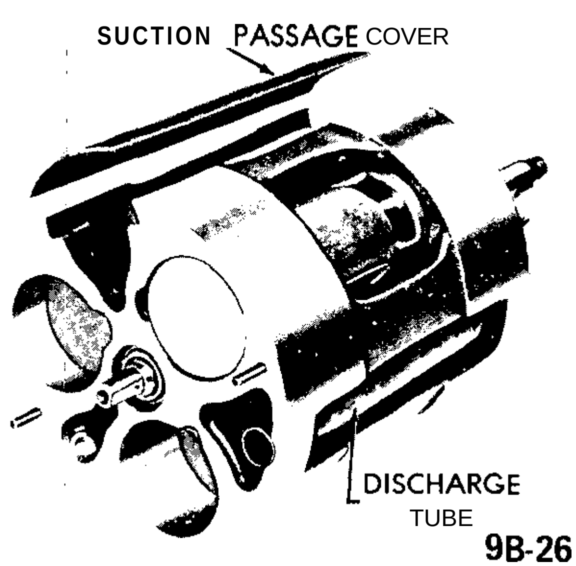


Figure 9B-30 Suction Passage and Discharge Tube

flows from the suction port through the suction passage in the cylinder assembly, and into the suction cavity of the front head.

9. Discharge Tube - The discharge tube is used to connect the discharge cavity in the front head with the discharge cavity in the rear head. High pressure vapor discharge is channeled via the tube to the discharge cavity and port. A slightly modified discharge tube is provided to be used as a service replacement (see Figure 9B-31). The service replacement tube has a reduced end and a built up shoulder to accomodate an "0" ring and bushing. These added parts achieve the necessary sealing of the high pressure vapor within the compressor.

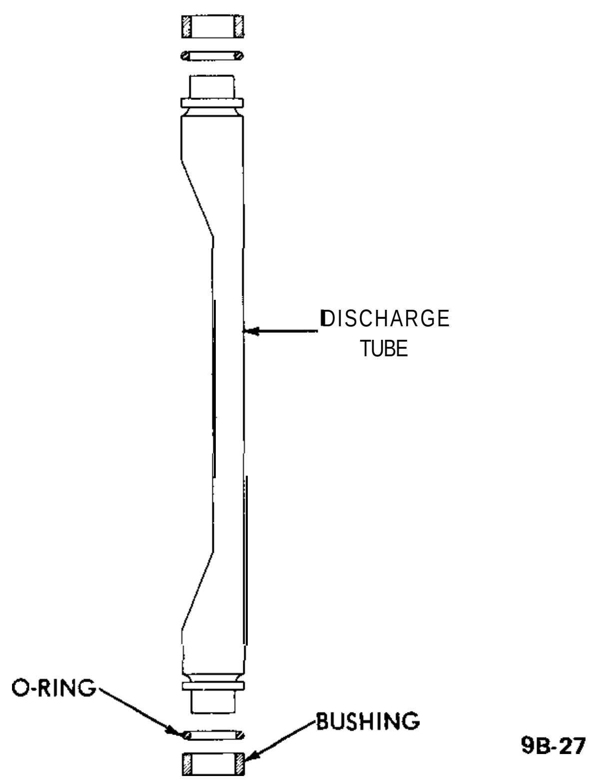


Figure 9B-31 Service Replacement Discharge Tube

10. Pressure Relief Valve - The purpose of the pressure relief valve is to prevent the discharge pressure from exceeding 440 psi. Opening of the pressure relief valve will be accompanied by a loud popping noise and the ejection of some refrigerant from the valve. If the pressure relief valve is actuated due to excessive pressures in the compressor, the cause of the malfunction should be corrected immediately. The pressure relief valve is located on the rear head of the compressor.

11. Shell and Oil Drain Screw • The shell of the compressor contains a reservoir which furnishes a continuous supply of oil to the moving parts of the compressor. A baffle plate covers the reservoir and

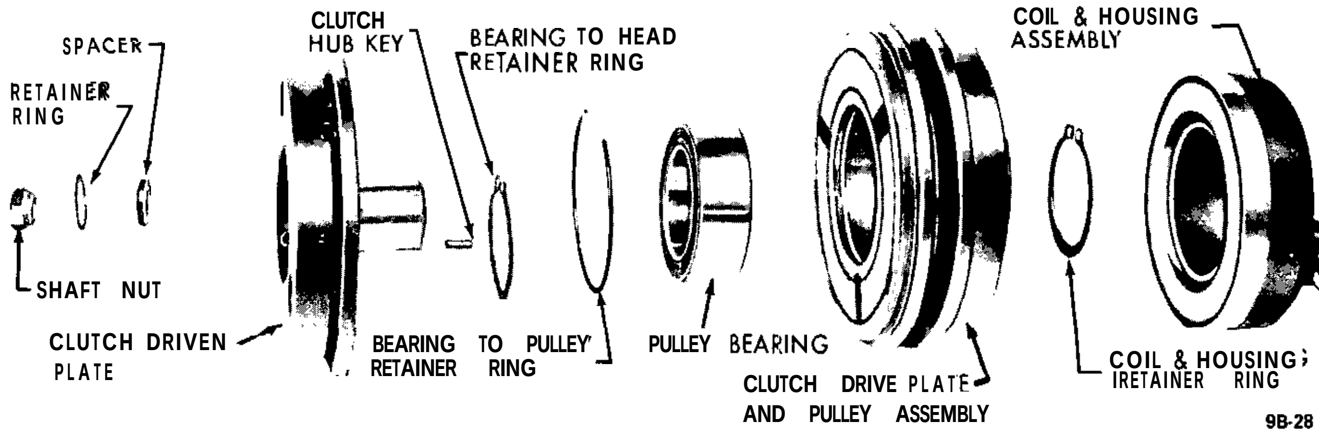


Figure 9B-32 Magnetic Clutch and Pulley Assembly

is tack-welded to the inside of the shell. In addition, an oil drain screw and gasket are located on the side of the reservoir and are provided for draining or adding of oil to system. To add oil, compressor must be removed from car. The necessity to add oil should only be required when the system has ruptured violently and oil has been lost along with refrigerant. Under controlled conditions or slow leak conditions it is possible to loose only a small amount of oil with the refrigerant gas. The serial number, part or model number, and rating of the compressor is stamped on name plates located on top of shell.

12. Magnetic Clutch and Pulley Assembly - The magnetic clutch and pulley assembly (see Figure 9B-32) together transmit power from the engine crankshaft to the compressor. The magnetic clutch is actuated when the air conditioning temperature switch and the fan switch located on the evaporator cover assembly are closed. When the switches are closed, the coil sets up a magnetic field and attracts the armature plate (movable element of the clutch driven plate). The armature plate portion of the clutch driven plate moves forward and contacts the friction surface of the pulley assembly, thereby mechanically linking the compressor to the engine. The compressor will operate continuously whenever the air conditioner clutch compressor switch and the fan switch are closed. When one or both of the switches are open the armature plate will be released due to spring tension and move away from the pulley assembly. This allows the pulley to rotate without driving the shaft. It should be noted that if the air conditioner system was in use when the engine was turned off, the armature plate may remain in contact with the pulley due to residual magnetism. When the engine is started the armature plate will separate from the pulley assembly. The coil is rated at 3.85 ohms (85 degrees F.) and will draw 3.2 amperes at 12 volts D.C.

Condenser

The condenser which is made of aluminum is located

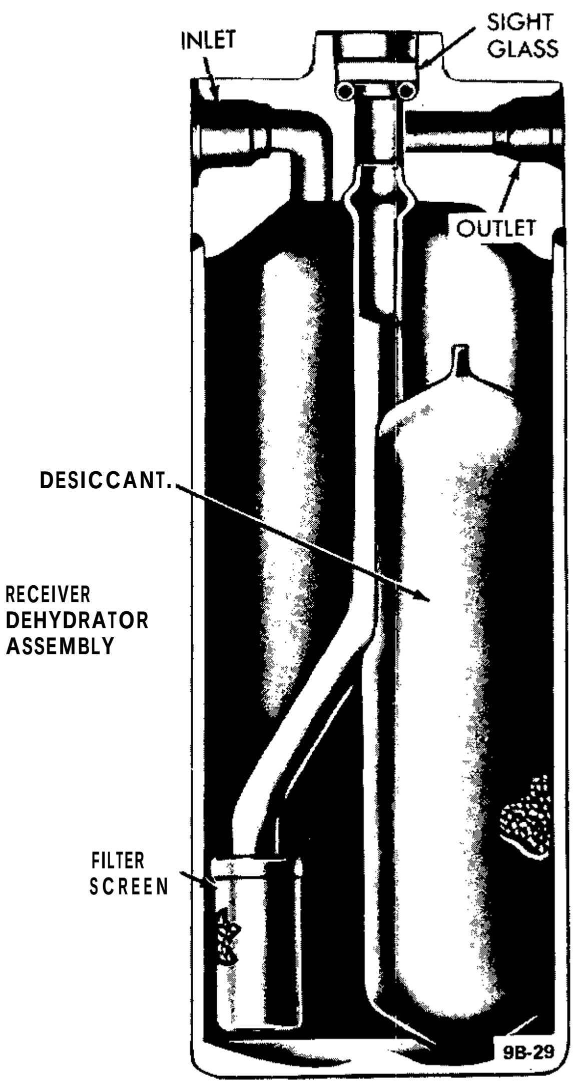


Figure 9B-33 Receiver Dehydrator Assembly in front of the radiator so that it receives a high volume of air flow. Air passing over the condenser **absorbs** the heat from the high pressure gas and causes the refrigerant to condense into a high pressure liquid.

Receiver. Dehydrator

The receiver-dehydrator is located in the engine compartment. The purpose of the receiver dehydrator is two fold: the unit insures a solid column of liquid refrigerant to the expansion valve at all times, and also absorbs any moisture in the system that might be present. A bag of desiccant (moisture absorbing material) is provided to absorb moisture. A sight glass (see Figure 9B-33) permits visual checking of the refrigerant flow for bubbles or foam. The continuous appearance of bubbles or foam above an ambient temperature of 70 degrees F. usually indicates an inadequate refrigerant charge. Bubbles or foam appearing at ambient temperatures below 70 degrees F. do not necessarily indicate an inadequate charge and may appear even when the system is operating properly. A filter screen in the unit prevents foreign material from entering the remainder of the system.

Expansion Valve

The expansion valve is mounted on the evaporator core inside the passenger compartment. The function of the expansion valve is to automatically regulate

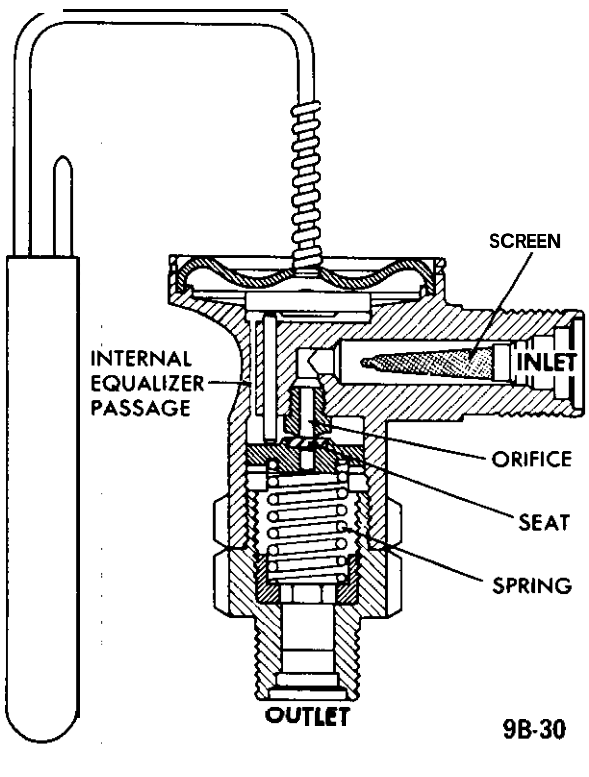


Figure 9B-34 Expansion Valve

the flow of refrigerant into the evaporator. The expansion valve is the dividing point in the system between the high and low pressure liquid refrigerant. A temperature sensing bulb is connected by a capillary tube to the expansion valve (see Figure 9B-34). The temperature sensing bulb (clamped to the outlet pipe on the evaporator) measures the temperature of the evaporator outlet pipe and transmits the temperature variations to the expansion valve (see Figure 9B-34). The capillary tube and bulb are tilled with carbon dioxide and sealed to one side of the expansion valve diaphragm.

An increase in temperature will cause the carbon dioxide in the bulb and capillary tube to expand, overcoming the spring pressure and pushing the diaphragm against the operating pins (see Figure 9B-34). This in turn will force the valve off its seat. When the refrigerant low pressure gas flowing through the outlet pipe of the evaporator becomes more than 6 degrees higher or warmer than the temperature at which it originally began to vaporize or boil, the expansion valve will autmotatically allow more refrigerant to enter evaporator. If the temperature of the low pressure gas decreases to less than 6 degrees above the temperature at which it originally began to vaporize or boil, the expansion valve will automatically reduce the flow of refrigerant. Thus, an increase or decrease in the flow of refrigerant through the evaporator will result in an increase or decrease in the cooling by the evaporator. The temperature, humidity and volume of the air passing over the evaporator affects the rate of absorption of heat by the evaporator. As the ambient temperature bulb calls for more or less refrigerant will increase or decrease. When the air is very warm, the heat transfer from the air to the refrigerant is great and a greater quantity of refrigerant is required to maintain the temperature at the evaporator pipe at the predetermined value. Conversely, cool days will result in less heat transfer and thereby require lesser quantities of refrigerant to maintain the predetermined temperature of the cvaporator outlet pipe.

Evaporator

The function of the evaporator is to cool and dehumidify the air flow in the passenger compartment. The evaporator assembly consists of an aluminum core enclosed in a reinforced plastic housing. Two (2) water drain ports are located in the bottom of the housing. Two refrigerant lines are connected to the side of the evaporator core: one at the bottom and one at the top. The expansion valve is attached to the lower (inlet) pipe, the outlet pipe is attached to the upper pipe. The temperature sensing bulb of the expansion valve is clamped to the outlet pipe of the evaporator core. The high pressure liquid refrigerant, after it is metered through the expansion valve, passes into the evaporator core where it is allowed to expand under reduced pressure. As a result of the reduced pressure the refrigerant begins to expand and return to the original gaseous state. To accomplish this transformation it begins to boil.

The boiling action of the refrigerant demands heat. To satisfy the demand for heat, the air passing over the core gives up heat to the evaporator and is subsequently cooled.

DIAGNOSIS

GENERAL INFORMATION

The following is a brief description of the type of sympton each refrigerant component will evidence if a malfunction occurs:

Compressor

Compressor malfunction will appear in one of four ways: noise, seizure, leakage, or low discharge pressure.

Resonant compressor noises are not cause for alarm; however, irregular noise or rattles may indicate broken parts or excessive clearances due to wear. To check seizure, de-energize the magnetic clutch and check to see if drive plate can be rotated. If rotation is impossible, compressor is seized. Low discharge pressure may be due to a faulty internal seal of the compressor, or a restriction in the compressor.

Low discharge pressure may also be due to an insufficient refrigerant charge or a restriction elsewhere in the system. These possibilities should be checked prior to servicing the compressor. If the compressor is inoperative; but, is not seized, check to see if current is being supplied to the magnetic clutch coil terminals.

Condenser

A condenser may malfunction in two ways: it may leak, or it may be restricted. A condenser restriction will result in excessive compressor discharge pressure. If a partial restriction is present, sometimes ice or frost will form immediately after the restriction as the refrigerant expands after passing through the restriction. If air flow through the condenser or radiator is blocked, high discharge pressures will result. During normal condenser operation, the outlet pipe will be slightly cooler than the inlet pipe.

Receiver-Dehydrator

A receiver-dehydrator may fail due to a restriction inside body of unit. A restriction at the inlet to the receiver-dehydrator will cause high head pressures. Outlet tube restrictions will be indicated by low head pressures. Outlet tube restrictions will be indicated by low head pressures and little or no cooling. An excessively cold receiver-dehydrator outlet may be indicative of a restriction.

Expansion Valve

Expansion valve failures usually will be indicated by low suction and discharge pressures, and insufficient evaporator cooling. The failure is generally due to malfunction of the power element and subsequent closing of the valve. A less common cause of the above symptom is a clogged inlet screen.

Evaporator

When the evaporator malfunctions, the trouble will show up as inadequate supply of cool air. A partially plugged core due to dirt or a faulty blower will generally be the cause.

Refrigerant Line Restrictions

Restrictions in the refrigerant lines will be indicated as follows:

1. Suction Line - A restricted suction line will cause low suction pressure at the compressor, low discharge pressure and little or no cooling.

2. Discharge Line -A restriction in the discharge line generally will cause the pressure relief valve to open.

3. Liquid Line - A liquid line restriction will be evidenced by low discharge and suction pressure, and insufficient cooling.

Use of Receiver-Dehydrator Sight Glass for Diagnosis

At temperatures higher than 70 degrees F, the sight glass may indicate whether the refrigerant charge is sufficient. A shortage of liquid refrigerant is indicated after about five minutes of compressor operation by the appearance of slow-moving bubbles (vapor) or a broken column of refrigerant under the glass. Continuous bubbles may appear in a properly charged system on a cool day. This is a normal situation. If the sight, glass is generally clear and performance is satisfactory, occasional bubbles do not indicate refrigerant shortage.

If the sight glass consistently shows foaming or a broken liquid column, it should be observed after partially blocking the air to the condenser. If under this condition the sight glass clears and the performance is otherwise satisfactory, the charge shall be considered adequate.

In all instances where the indications of refrigerant shortage continues, additional refrigerant should be added in 1/4 lb. increments until the sight glass is clear. **An** additional charge of 1/4 lb. should be added as a reserve. In no case should the system be overcharged.

LEAK TESTING SYSTEM

The following two methods are recommended when attempting to locate refrigerant leaks in the system. Loss of regrigerant is always indicative of a leak since refrigerant is not consumed and does not wear out.

1. Open Flame Method - This method utilizes a gas operated torch type leak detector (J-6084). Use of this method is recommended when checking for leaks in confined areas. To perform test, light torch and adjust to obtain a pale blue flame, approximately 3/8 inch in height, in burner.

Explore for leaks by moving end of search tube around suspected area. Check bottom of connections since Refrigerant-12 is heavier than air and will be more apparent at underside of fittings. The flame color will turn yellow-green when a small leak is detected. Large leaks will turn the flame blue or purple.

WARNING: ***Do not breathe fumes resulting from burning of refrigerant gas. These fumes are extremely poisonous.***

2. Liquid Leak Detectors - This method utilizes a solution which will bubble (soap solution) to signify a gas leak. Use of this method of checking is recommended for locating small leaks.

FUNCTIONAL TESTING SYSTEM

Functional testing is a measurement of the air conditioner system performance to determine if discharge air temperature, pressure in suction line, and pressure in discharge line are within specific limitations.

To perform Functional test proceed as follows:

1. Remove protective caps from the compressor adapter fittings located on compressor.

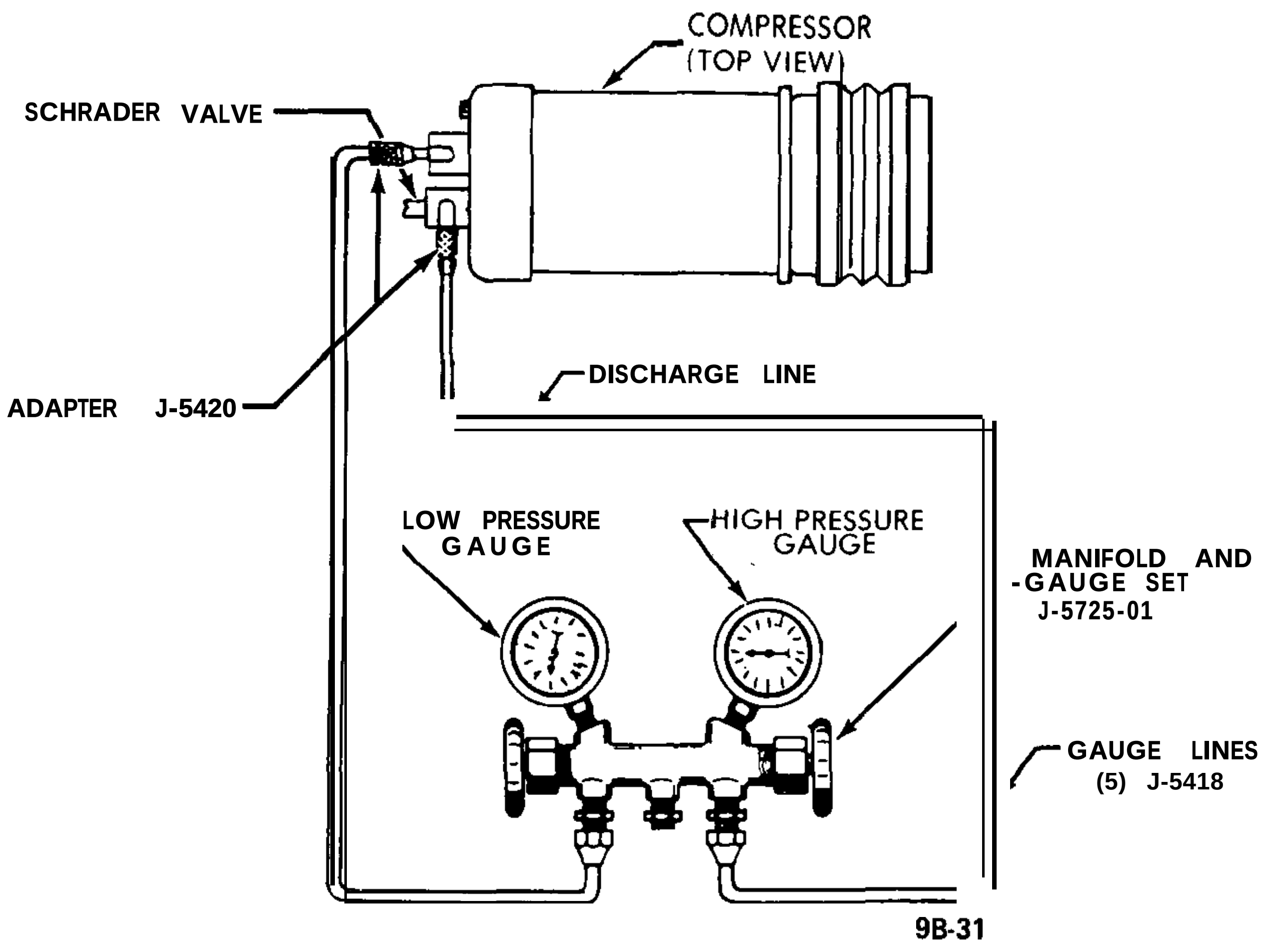


Figure 9B-40 Functional Test Set-Up

2. Interconnect manifold and gage set (J-5725-01), gage charging lines (J-5418) and gage adapters (J-5420) to air conditioning *system as* shown *in* Figure 9B-40.

3. Place transmission in "Park" for automatics and in neutral for manuals. Apply hand brake.

4. Turn blower switch to the "Hi" position.

5. Turn temperature switch to "Max" position.

6. Run engine at 2000 RPM for ten (10) minutes with car doors and windows closed and the hood up. Place a high volume industrial type fan in front of radiator if head pressure should **exceed 250** psi and also at high ambients to bring the pressures to within the limits specified in the Functional Charts in Division V.

In the case of the Opel 1900 and the Manta, a thermometer should be placed in a position to read the temperature of the air discharging from the right-hand A/C outlet. In case of the GT, a thermometer should be placed in a position to read the temperature of the air discharging from the left-rear A/C outlet.

HEATER-AIR CONDITIONER REFRIGERANT CIRCUIT TROUBLE DIAGNOSIS GUIDE

Insufficient Cooling (Check Air Flow)

Normal Air Flow (Inspect system for visual defects. Run functional tests.)

Discharge Air - Normal Temp Check for air leaks through dash, car body, windows, or from heater or ventilators.

Discharge Air - High Temp Check sight glass for foaming **and** compressor clutch for engagement.

No Compressor Clutch Engagement **Check connec**tions at clutch switch, harness connectors, and check clutch switch.

No ***Foaming*** Compare evaporator pressure to that on functional test table.

Foaming System is probably low on refrigerant. **Check** for leaks, repair, ***evacuate,*** and charge. If foaming still occurs, check for restriction in refrigerant lines between condenser and receiver dehydrator.

Evaporator Pressure Normal Compare head pressure to pressure on functional test table.

Evaporator Pressure Low Ice may be forming on evaporator. Low volume of air discharging at A/C outlet after system has been running above idle condition for approximately 15-30 minutes. Discharging air gradually elevating in temperature. Check expan***sion*** valve. If valve isn't permitting flow of liquid, this will be indicated by a warm pipe out of the evaporator. This may be caused **by:** 1) Clogged or Plugged inlet screen in the expansion valve; 2) Broken capillary line; or 3) Discharged temperature bulb. If the valve is okay, the pipe out of the evaporator will be cold.

Evaporator Pressure High Check the expansion valve to determine if themobulb is making good contact and is properly insulated. Operate engine at 2000 RPM with maximum air conditioning setting. If evaporator pressure remains high, feel suction line. If line feels frosty or extremely cold with relative high ambient conditions, then partially cover the condenser to obtain head pressures from 265 psi to 280 psi maximum. If evaporator pressure ***rises*** above 30 psi, change the expansion valve.

Also, check if compressor may be the cause due to some internal or external mechanical trouble which prevents reduction of pressure. Check for external troubles, slipping belt, bad clutch and/or pulley, or improper clutch engagement, before investigating the compressor internally.

Head Pressure High Check for the following: Condenser air flow low, air in system, excessive refrigerant in system, restriction in condenser.

Head Pressure Low Restriction in flow of refrigerant to evaporator, or expansion valve plugged or defective.

Low Air Flow (Check blower operation and evaporator. Check operation of controls.)

Ice Blocking Evaporator Run functional test. If evaporator pressure is low, ice may form on evaporator and reduce air flow.

Evaporator Pressure Low Ice may be forming on evaporator. Low volume of air discharging at A/C outlet after system has been running above idle **con**dition for approximately 15-30 minutes. Discharging air gradually elevating in temperature. Check expansion valve. If valve isn't permitting flow of liquid, this will be indicated by a warm pipe out of the evaporator. This may be caused by: 1) Clogged or plugged inlet screen in the expansion valve; 2) Broken capillary line, or 3) Discharged temperature bulb. If the valve is okay, the pipe out of the evaporator will be cold.

Blower Not Operating Check for the following: Fuse blown, blower switch defective, wire broken or loose connection, poor ground connection, or blower motor defective.

Blower Operating Normal Check for the following: Restriction or leakage in air ducts, A/C outlets not opening.

MAINTENANCE AND ADJUSTMENTS

GENERAL SERVICE INFORMATION AND SAFETY PRECAUTIONS

General Information

All subassemblies are shipped sealed and dehydrated. They are to remain sealed until just prior to making connections, and should be at room temperature before uncapping. This prevents condensation of moisture from air that enters the system.

All precautions should be taken to prevent damage to fittings or connections. Even minute damage to a connection could cause it to leak. Any fittings with grease or dirt on them should be wiped clean with a cloth dipped in alcohol.

Do not clean fitting or hoses with solvents because they are contaminants. If dirt, grease or moisture gets inside the pipes or hoses and cannot be removed, the pipe or hose is to be replaced. Use a small amount of clean refrigeration oil on all tube and hose connecting joints, and lubricate the "O" ring gasket with this oil before assembling the joint. The oil will help in effecting a leak-proofjoint and assist the "O" ring to slip into the proper location without being cut or damaged. Always use new "O" rings.

When tightening joints, use a second wrench to hold the stationary part of the connection to prevent twisting and to prevent hose kinking. Kinked hoses are apt to transmit noise and vibration. Tighten all connections in accordance with recommended torques (see Division VI, Specifications).

Do not connect receiver-dehydrator assembly until all other connections have been made. This is necessary to insure maximum moisture removal from system.

It is important that air conditioning hoses do not rest on or contact body sheet metal except where necessary. Because of the high frequency at which the compressor operates, the passenger compartment is susceptible to transfer of noise.

Safety Piecautions

The following safety precautions should always be followed when servicing refrigerant charged components:

1. Do not leave Refrigerant-12 cylinder uncapped.

2. Do not carry cylinder in passenger compartment of car.

3. Do not subject cylinder to high temperatures.

4. Do not weld or steam clean on or near cylinder.

5. Do not fill cylinder completely.

6. Do not discharge vapor into area where flame is exposed or directly into engine air intake.

7. Do not expose eyes to liquid - WEAR SAFETY GOGGLES whenever discharging, charging or leak testing system.

CHARGING AND DISCHARGING SYSTEM

Removal of any part in the refrigerant circuit will require discharging of the entire system.

Discharging the System

1. Remove caps from gauge fittings on the compressor adapter fitting on the compressor.

2. With both valves on manifold gauge set (J-5725-04) closed (clockwise), attach manifold to the compressor adapter fitting on the compressor, using J-5420 valve adapter at suction gauge fitting and J-9459 valve adapter at discharge gauge fitting. See Figure 9B-41.

3. Fully open high pressure valve on manifold gauge set to allow escape of refrigerant from system through the manifold gauge set and out the center fitting and hose. (Place end of hose in clean container to collect oil loss due to rapid discharge of system).

4. When hissing ceases, indicating all refrigerant has escaped, close high pressure valve on manifold gauge set by turning valve clockwise.

Evacuating the System

When the refrigeration system is depressurized and opened for service, some air will enter the lines, regardless of how quickly openings are capped. In order to remove this air and as much as possible of the moisture it contains, the complete system must be evacuated. Evacuating is merely the process of removing all air from the system, thereby creating a vacuum in the system.

Under no circumstances should alcohol be used in the system in an attempt to remove moisture, regardless of the successful use of alcohol in other refrigeration systems.

Preparations for Evacuating Complete System

1. Check the low pressure gauge for proper calibra-

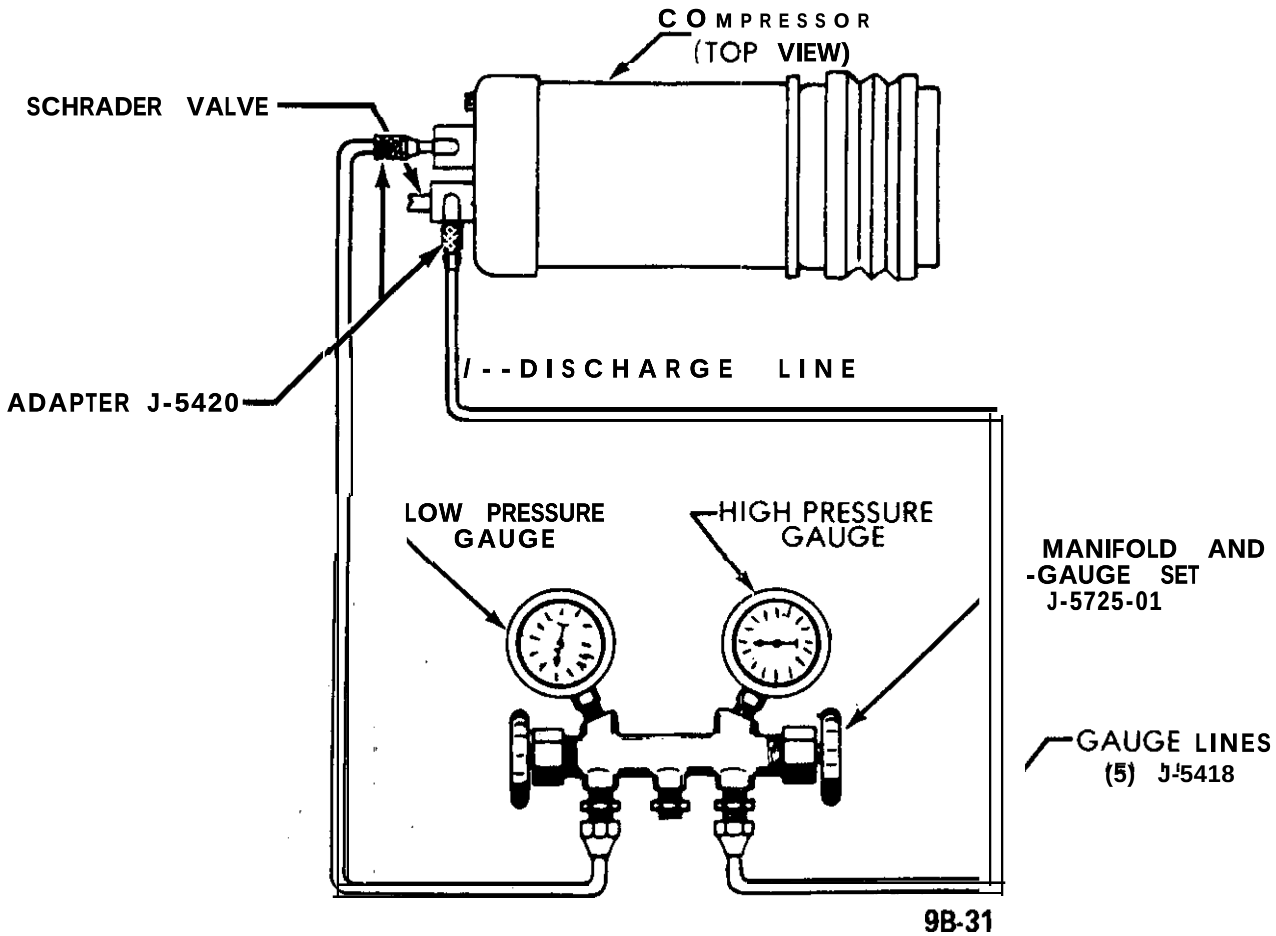


Figure 9B-41 Set-Up For Discharging System

tion. With the gauge disconnected from the refrigeration system, be sure that the pointer indicates to the center of zero. Lightly tap gauge a few times to be sure pointer is not sticking. If necessary, calibrate as follows:

A. Remove cover from gauge.

B. Holding gauge pointer adjusting screw firmly with one hand, carefully force pointer in the proper direction in proper amount to position pointer through the center of "O" position. Tap gauge a few times to be sure pointer is not sticking. Replace gauge cover.

2. If gauge is not already connected to compressor, connect as follows:

A. Close hand shut-off valves on gauge set by turning clockwise.

B. Remove caps from gauge fittings on the compressor adapter fitting.

C. Attach valve adapter (J-5420) to end of the hose from the low pressure gauge and connect this adapter fitted hose to suction gauge fitting.

D. Attach valve adapter (J-9459) to end of hose from the high pressure gauge and connect this adapter fitted hose to the discharge fitting.

3. Attach a flexible gauge hose to center fitting of the gauge set and attach the other end of this hose to vacuum pump (J-5428-03).

Evacuating Complete System

1. Turn hand shut-off valve on low pressure gauge of gauge set to full clockwise position.

2. Slowly turn valve on high pressure gauge counterclockwise from full clockwise position, letting any pressure build-up escape completely. Close high pressure valve.

3. Check oil level in vacuum pump and, if necessary, add refrigeration oil. Make sure dust cap on discharge side of pump has been removed.

4. Start the vacuum pump and slowly open low and high pressure sides of manifold gauge set to avoid forcing oil out of refrigeration system and pump, Pressure is now being reduced on both sides of the refrigeration system. If oil is blown from the vacuum pump, it should be refilled to the proper level.

5. Observe low pressure gauge and operate vacuum pump until gauge shows 28-29 inches vacuum. In all evacuating procedures, specifications of 28-29 inches of vacuum is used. This evacuation can only be attained at or near sea level.

For each 1000 feet above sea level where this operation is being-performed, the specification should be lowered by one inch of mercury vacuum. At 5000 feet elevation, only 23 inches to 24 inches of vacuum can normally be obtained.

If vacuum cannot be pulled to the minimum specification for the respective altitude, it indicates a leak in the system or gauge connections or a defective vacuum pump. In this case, it will be necessary to check for leaks as described under "Leak Testing Refrigerant System".

When specified vacuum level (28-29 inches at sea level) is obtained, continue to run vacuum pump for ten (10) 'additional minutes. During these ten (10) minutes:

A. Prepare for charging the system. If using a charging station, till charging cylinder. If using manifold gauge set, make all preparations for charging system as described under "Disposable Can Method" or "Refrigerant Drum Method".

B. Measure oil loss collected as a result of rapid discharge.

C. Uncap compressor oil injector (J-24095) and open valve. Flush J-24095 with refrigerant, close valve and insert pick-up tube into graduated container of clean refrigerant oil.

D. Connect J-24095 to suction fitting at the compressor adapter fitting. When valve on J-24095 is opened, the vacuum applied to the discharge side of the system will suck oil into system from container. Therefore, close observation of oil level in the container is necessary.

E. Note level of oil in container. Open valve on J-24095 until oil level in container is reduced by an amount equal to that lost during discharge of system, then shut valve. Take care not to add more oil than was lost.

F. Disconnect J-24095 and attach pick-up tube fitting to schraeder fitting to cap tool. See Figure 9B-42.

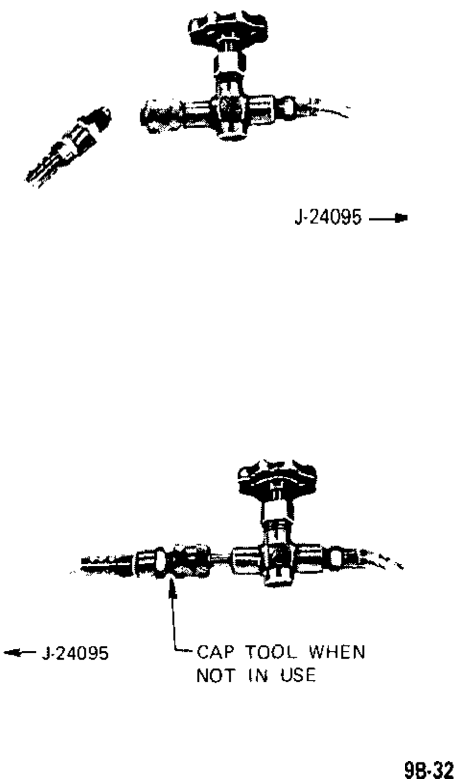


Figure 9B-42 Oil Injector J-24095

6. Turn hand shut-off valves at low and high pressure gauges of gauge set to full clockwise position with vacuum pump operating, then stop pump. Carefully check low pressure gauge approximately for two (2) minutes to see that vacuum remains constant. If vacuum reduces, it indicates a leak in the system or gauge connections.

Charging the System

The system should be charged only after being evacuated as outlined in "Evacuating the System".

Refrigerant Drum Method

1. Connect center flexible line of gauge set to refrigerant drum.

2. Place refrigerant drum in a pail of water which has been heated to a maximum of 125 degrees F.

WARNING: Do not allow temperature of water to exceed 125 degrees F. High temperature will cause excessive pressure and possible softening of fusible safety plugs in the refrigerant drum. It may not be necessary to use hot water if a large drum is used (over approximately 100 lbs.).

3. Place refrigerant drum (in pail of water) on scales (bathroom or commercial, perferably commercial).

Do not turn refrigerant **drum** upside down, as this would allow liquid refrigerant to enter compressor which may cause damage.

4. If line at center gauge fitting has not been purged of air, loosen line at center fitting on gauge set and crack valve on refrigerant drum to blow air from line. Retighten line at center fitting and record exact weight of refrigerant tank in water on the scales.

5. Open valve on refrigerant drum and **both valves** on gauge set to allow refrigerant to flow into system. Continue charging until the scales show that 2 lbs. Opel 1900 - Manta and 2 1/4 lbs. GT, of refrigerant have been transferred from refrigerant drum to system.

If full charge cannot be obtained, close both valves on gauge set, start engine, and set temperature control knob to full cold position with blower in Max Hi. Open low pressure valve on gauge set slowly and leave open until full charge is added.

WARNING: Observe high pressure gauge while charging with compressor running. Shut off engine if pressure exceeds 250 psi. A large fan placed in front of the car will help reduce excessively high head pressure.

6. Close both valves on gauge set (high pressure valve will already be closed if charging was completed by running compressor) and close valve on refrigerant drum.

If the engine was used to complete the charge into the system, close valve on refrigerant drum to permit compressor to draw any refrigerant left in the line from the drum to the center fitting of the gauge set, then close the low pressure valve on the gauge set.

7. Operate engine at 2000 RPM with temperature control knob at full cold, blower speed in Max Hi. After ten minutes of operation, observe appearance of refrigerant in receiver-dehydrator. If bubbles are observed, open low pressure gauge valve and valve on refrigerant drum to allow more refrigerant to enter system. Close valve when receiver-dehydrator clears up.

If an air inlet temperature is below 70 degrees F. when this check is made, bubbles may appear, even though the proper amount of refrigerant is in the system. Air inlet temperature must be 70 degrees F. or above to make an accurate check.

8. When refrigerant has been installed, continue to operate system and test for proper operation as outlined under "Operational Test".

9. When satisfied that air conditioning system is operating properly, stop engine, remove gauge set and replace protective caps on compressor fittings.

WARNING: *A considerable amount of refrigerant will collect in the high pressure line, since some of this refrigerant will have condensed into liquid refrigerant. Wrap the high pressure gauge fitting at the compressor with a shop cloth before disconnecting the valve from the gauge fitting, to prevent injury to personnel.*

10. Using leak detector, check complete system for leaks.

Disposable Can Method

After having depressurized, repaired (if necessary) and evacuated the refrigerant system, the system **may** be charged as follows using refrigerant in disposable cans:

1. Obtain three (3) 1 lb. cans or one 12 lb. can of refrigerant.

2. If using 1 lb. cans, **mount two (2) cans** in J-6272-02 (Multi-opener) or attach J-6271 (single-can opener valve) on one can. If using the 12 lb. disposable can, attach J-23390 (disposable can control valve) on can.

WARNING: ***Make sure outlet valve on opener is closed (clockwise) before installing opener.***

A. If the J-6272-02 multi-opener is used, raise locking lever, position three (3) cans of refrigerant and force locking lever down to secure cans and at same time puncture top of can to make it ready for charging.

B. If the J-6271 valve is used, back off the valve from the can top retainer, slip the valve onto the can and turn the valve into retainer until tight. DO NOT open outlet valve during this operation, as turning the valve into the retainer punctures top of can to make it ready for charging.

3. Connect center flexible line of gauge set to fitting on a can opener valve. If the line at center gauge fitting has not been purged of air, loosen line at center fitting on gauge set and "crack" valve at can opener (for a second or two) to force air from the line. Retighten line at center fitting.

4. Open valve at refrigerant source and at low and high pressure valves on manifold gauge set. Leave valve open at refrigerant source until all refrigerant (when using 1 lb. can) has 'entered the refrigeration system or system is fully charged. Close valve on can.

A. If the system is charged using 1 lb. cans and the J- 627 1 valve, disconnect valve from can. Leave valve closed to flexible line to the center fitting of the manifold gauge set. Install valve on a new and full disposable can of refrigerant.

B. If system is charged using J-6272-02, close the valve of opener after all cans are empty. Release the locking lever and discard the three (3) empty cans. If this tool will be used to complete the charge with additional cans to provide the required refrigerant charge, leave the empty cans in position, locate one full can and lock the lever into place. These empty cans balance the assembly and prevent the loss of refrigerant through the open "series" passage. Align the pierced hole in the empty can with the punch in the cover of the tool.

If the J-6271 valve for single cans is available, complete charging as explained in 4a above.

5. Close high side valve on manifold gauge set,

WARNING: ***Prior to starting up engine, the high side valve on the charging manifold must be closed due to excessive pressure build-up which can result in bursting of the container(s) causing serious injury. If you are inexperienced in the use of this procedure, seek professional assistance.***

6. Operate engine at 2000 RPM with temperature control knob at full cold position and blower speed on Max Hi. If air inlet temperature at the condenser is below 70 degrees F. when this check is made, bubbles may appear, even though the proper amount of refrigerant is in the system. Air inlet temperature must be 70 degrees F. or above to make an accurate check.

7. When refrigerant has been installed, continue to operate system and test for proper operation as outlined under "Operational Test".

8. When satisfied that the air conditioning system is operating properly, stop engine, remove gauge set and replace protective caps on suction and discharge fittings.

WARNING: *A considerable amount of refrigerant will collect in the high pressure line, since some of this refrigerant will have condensed into liquid refrigerant. Wrap the high pressure fitting at the compressor with a shop cloth before disconnecting the valve from the gauge fitting to prevent damage-or injury to personnel.*

9. Using a leak detector, check complete system for leaks.

Charging Station Method

INSTALLING J-8393-02

1. Be certain compressor hand shut-off valves to gauge fittings are closed (counterclockwise).

2. Be certain all valves on charging station are closed.

3. Connect high pressure gauge line to compressor high pressure gauge fitting.

4. Turn high pressure hand shut-off valve one turn clockwise, and high pressure control one turn counterclockwise (open). Crack open low pressure control and allow refrigerant gas to hiss from low pressure gauge line for three seconds, then connect low pressure gauge line to low pressure gauge fitting on compressor adapter fitting. (Place J-9459 adapter on hose, then attach adapter to gauge fitting.)

FILLING CHARGING CYLINDER

1. Open Control valve on refrigerant container.

2. Open valve on bottom of charging cylinder, allowing refrigerant to enter cylinder.

3. Bleed charging cylinder to valve (behind control panel) only as required to allow refrigerant to enter cylinder. When refrigerant reaches desired charge level, close valve at bottom of charging cylinder and be certain cylinder bleed valve is closed securely.

While filling the cylinder, it will be necessary to close the bleed valve periodically to allow boiling to subside so that refrigerant level in the charging cylinder can be accurately read.

CHARGING THE SYSTEM USING J-8393-02

1. With charging station connected, as previously described, remove low pressure gauge line at compressor adapter fitting.

2. Crack open high and low pressure control valves on station and allow refrigerant gas to purge from system. Purge slowly enough so, that oil does not escape from system along with refrigerant.

3. When refrigerant flow nearly stops, connect low pressure gauge line to compressor adapter fitting.

4. Turn on vacuum pump and open vacuum control valve.

5. With system purged as above, run pump until 26-28 inches of vacuum is obtained Continue to run pump for 15 minutes after the system reaches 26-28 inches vacuum.

In all evacuating procedures, the specification of 26-28 inches of mercury vacuum is used. These figures are only attainable at or near sea level. For each 1000 feet above sea level where this operation is being performed, the specifications should be lowered by 1 inch. For example, at 5000 feet elevation, only 21 to 23 inches vacuum can normally be obtained.

6. If 26-28 inches vacuum (corrected to sea level) cannot be obtained, close vacuum: control valve and

shut off vacuum pump. Open refrigerant control valve and allow some refrigerant to enter system. Locate and repair all leaks.

7. After evacuating for 15 minutes, add 1/2 lb. of refrigerant to system. Purge this 1/2 lb. and reevacuate for 15 minutes. This second evacuation is to be certain that as much contamination is removed from the system as possible.

8. Only after evacuating as above, system is ready for charging. Note reading on sight glass of charging cylinder. If it does not contain a sufficient amount for a full charge, till to proper level.

9. Close low pressure valve on charging station. Fully open station refrigerant control valve and allow all liquid refrigerant to enter system. When full charge of refrigerant has entered system, turn off refrigerant control valve and close both hand shut-off valves.

10. If full charge of refrigerant will not enter system, close high pressure control and refrigerant control valves. Start engine and run at low idle with compressor operating. Crack refrigerant control valve and low pressure control on station. Watch low side gauge and keep gauge below 50 psi by regulating refrigerant control valve. Closing valve will lower pressure. This is to prevent liquid refrigerant from reaching the compressor while the compressor is operating. When required charge has entered system, close refrigerant control valve and close low pressure control.

11. System is now charged and should be performance- tested before removing gauges.

Adding Refrigerant

The following procedure should be used in adding small amounts of refrigerant that may have been lost by leaks or while opening system for servicing the compressor. Before adding refrigerent to replace that lost by leaks, check for evidence of oil loss and add oil if necessary.

This procedure will only apply if the air inlet temperature is above 70 degrees F. at the condenser.

1. Remove caps from compressor gauge fittings. Attach gauge set to gauge fittings, making sure adapter (J- 5420) is between low pressure gauge hose and suction gauge fitting, and J-9459 is between high pressure gauge hose and discharge gauge fitting.

2. Start engine, turn air conditioning temperature control knob to full cold position, blower switch to Max Hi. Operate for ten (10) minutes at 2000 RPM to stabilize system.

3. Observe the refrigerant through the sight glass cover of receiver-dehydrator with the system operating, to see if there are any bubbles evident.

a. If no bubbles are evident, then bleed system slowly through the discharge valve until bubbles appear in the receiver-dehydrator. Add 1 lb. of refrigerant as explained under "Charging the System".

b. If bubbles are visible in the receiver-dehydrator with the temperature control knob in the full cold position and the blower at MAX speed, it indicates a partial or complete plug in a line, a shortage of refrigerant, or both. Correct condition. Add refrigerant until the sight glass clears, then add another 1 lb. of refrigerant.

4. Attach flexible hose from center fitting of gauge set loosely to refrigerant drum or on disposable can valves. Open high and low pressure valves on the gauge set slightly to purge pressure gauge lines of air. Tighten fitting of refrigerant drum or can when satisfied that all air has removed from gauge lines. Close (clockwise) both hand shut-off valves or gauge set.

5. Partially charge system.

REFRIGERANT DRUM METHOD:

A. Place pail containing hot water that does not have a temperature exceeding 125 degrees F. on scales, place refrigerant drum in pa" containing water, note weight and only open low pressure valve on gauge set.

B. Start engine, turn temperature control knob to full cold position and place blower switch in Max Hi. Operate engine for 10 minutes at 2000 RPM to stabilize system.

C. With compressor operating, slowly open valve on refrigerant drum and allow refrigerant to flow into system (through manifold gauge set) until liquid indicator clears up and immediately shut off valve at gauge set or on refrigerant drum. Check weight of refrigerant drum and pail of water. Then slowly open valve on gauge set (or refrigerant drum) and add one more lb. of refrigerant. Note total amount of refrigerant added.

DISPOSABLE CAN METHOD:

A. Make sure the outlet valve on the J-6271 valve is fully clockwise and attach the J-6271 to a 1 lb. can of refrigerant by backing off the valve from the top of the retainer, slipping the valve onto the can and turning the valve into the retainer until tight. DO NOT accidentally open outlet valve during this operation, as turning the valve into the retainer punctures the top of the can to make it ready for charging.

B. Connect center flexible line of gauge set to the fitting on the valve.

C. Start engine, turn temperature control knob to full cold position, set blower switch to Max Hi. Operate engine for 10 minutes at 2000 RPM to stabilize system.

D. With compressor operating, slowly open valve on refrigerant can and allow refrigerant to flow into system (through manifold gauge set) until liquid indicator clears up and immediately shut off valve at gauge set and on refrigerant can. Check weight of can and valve assembly and record.

E. Add an additional 1 lb. of refrigerant by adding refrigerant from the can just weighed until can is empty. Attach another can and add refrigerant until can and valve assembly weigh the same as recorded.

6. Close valves at refrigerant drum or can.

7. Test for leaks and make operational check of system.

ADDING OIL TO THE SYSTEM (MAJOR OVERHAUL)

The oil in the refrigeration system does not remain in the compressor during system operation, but circulates throughout the system. The compressor is initially charged with 10 oz. of 525 viscosity oil. After system has been in operation the oil content in the compressor will vary depending on the engine RPM and air conditioning load. At higher engine RPM's a lesser amount of oil will be retained in the compressor reservoir. It is important that the total system oil content does not vary from a total of 10-1/2 oz. Excessive oil content will reduce cooling capacity. Inadequate oil content may result in damage to compressor moving parts.

The refrigeration system will not require adding of oil unless there is an oil loss because of a ruptured line, badly leaking compressor seal, replacement of evaporator, compressor, receiver-dehydrator, or loss due to a collision. Oil is generally added to the system via the oil drain hole in the lower side of the compressor for this condition. To add oil to the system via the compressor, the compressor must be removed. If no major loss of oil has occurred and a component (condenser, receiver-dehydrator or evaporator) is removed for servicing, the oil may be added directly to the component. To add oil to a component removed for servicing and when no major loss has occurred, drain and measure oil in component, then replace with a like amount. To add oil to the system when a major loss of oil is evidenced, or when the compressor is being serviced, remove compressor, drain and measure oil, and replace oil amount specified in the Oil Replacement Table.

OIL REPLACEMENT TABLE

Condition	Amount of Oil Drained From Compressor	Amount of 525 Oil to Install In Compressor
1. Major loss of oil and a component (condenser, receiver-dehydrator, or evaporator) has to be replaced.	a. More than 4 oz.	a. Amount drained from compressor, plus amount for component being replaced. Evaporator - Add 2 oz. Condenser - Add 1 oz. Receiver-Dehydrator - Add 1 oz.
	b. Less than 4 oz.	b. Install 6 oz., plus amount for component being replaced as shown above.
2. Compressor being replaced with a service replacement compressor - no major oil loss.	a. More than 1 1/2 oz.	a. Same amount as drained from compressor being replaced.
	b. Less than 1 1/2 oz.	b. Install 6 oz

Condition	Amount of Oil Drained From Compressor	Amount of 525 Oil to Install In Compressor
3. Compressor being replaced with a service replacement compressor major oil loss evident.	a. More than 4 oz.	a. Same amount as drained from compressor being replaced.
	b. Less than 4 oz.	b. Install 6 oz.
4. Compressor being rebuilt or repaired - no major oil loss evident.	a. More than 1 1/2 oz.	a. Same amount as drained from compressor, plus 1 oz. additional.
	b. Less than 1 1/2 oz.	b. Install 7 oz.
5. Compressor being rebuilt or repaired major loss of oil evident.	a. More than 4 oz.	a. Same amount as drained from compressor, plus 1 oz. additional.

If foreign material is noted in oil drained from system or evidence of moisture is obvious in the components removed, it is recommended that the entire system be flushed and the receiver-dehydrator be replaced. A full oil charge of 10 oz. of 525 viscosity refrigeration oil should be replaced in the system. It should be noted that all service replacement compressors will be supplied with 10 oz. of oil. In most cases it will be necessary to drain oil from service replacement compressor and refill it with amount as specified in the Oil Replacement Table.

FLUSHING THE SYSTEM

Flushing of the system may involve all the components of the system or individual components in the system. The components may be flushed while mounted in the engine compartment or may be removed for flushing. When a component is not removed, disconnect all refrigerant lines or hoses attached to component. To perform flushing operation, connect a cylinder of refrigerant-12 to the component to be flushed, then invert the cylinder and open the cylinder valve so that the liquid refrigerant pours out and through the component. When liquid Refrigerant-12 reaches atmospheric pressure, it immediately drops to minus 21.7 degrees F. Insure that area immediately surrounding outlet of component is clear of anything that may be damaged by contact because of the sudden drop in temperature.

In all cases where a complete system flushing operation is performed, the receiver-dehydrator and the filter screen on the expansion valve should be replaced. If the evaporator assembly is flushed while installed in the car, the temperature bulb on the evaporator outlet pipe must be disconnected to keep the expansion valve from closing at the inlet source.

It is recommended that dry nitrogen be used as a flushing agent due to the low cost involved. In addition, dry nitrogen will not cause a temperature drop, as in the case of refrigerant-12, which results in thickening of refrigerant oil. Dry nitrogen has the additional advantage of removing moisture from the system.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF COMPRESSOR - OPEL 1900 - MANTA

Removal

1. Remove negative battery cable from battery.

2. Remove air cleaner and heat pipe. Cover the carburetor to keep out dirt etc.

3. Discharge system. Refer to DISCHARGING SYSTEM.

4. While system is discharging remove sheet metal cover. See Figure 9B-50.

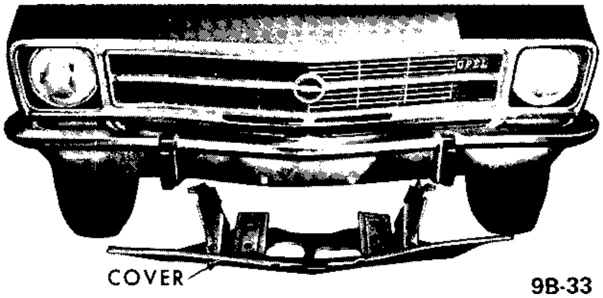


Figure 9B-50 Sheet Metal Cover Removed

5. Unplug compressor clutch electrical plug, and remove idler pulley bracket assembly and ground wire. See Figure 9B-5 1. Radiator hose is removed for photographic reasons only.

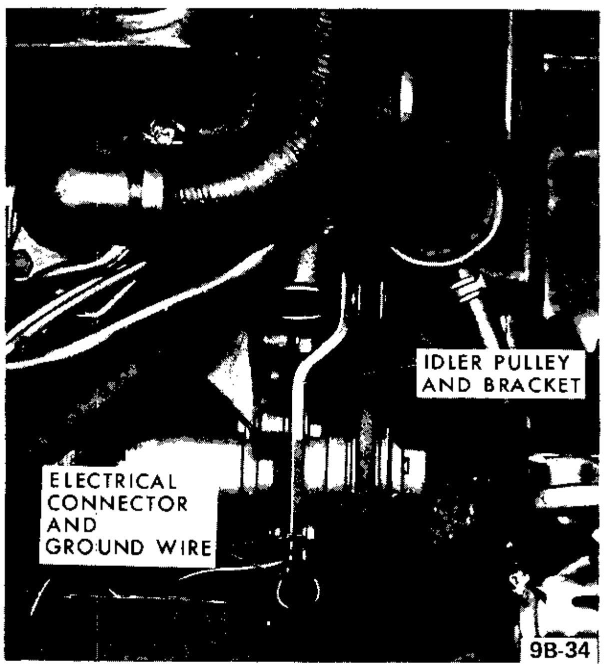


Figure 9B-5 1 Location of Idler Pulley, Bracket and Ground Wire Opel 1900 . Manta

6. After system is completely discharged, remove refrigerant hoses from compressor adapter fitting and cap hoses and adapter fitting to keep contaminants from entering.

7. Support compressor from underneath and remove three (3) compressor mounting support bolts and support bracket. Carefully lower compressor. See Figure 9B- 52. During removal, maintain the compressor position so that the sump is downward. Do not rotate compressor shaft.

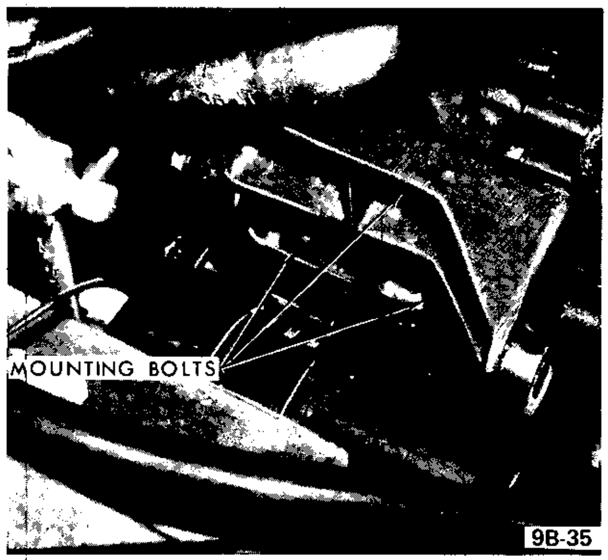


Figure 9B-52 Location of Compressor Mounting Support Bolts Opel 1900 Manta

Installation

1. Support compressor from underneath and install into position from under car. Insure that compressor has sufficient oil charge.

2. Install three (3) compressor mounting support bolts. See Figure 9B-52.

3. Install compressor support bracket. Torque bolts to 20 lb.ft. See Figure 9B-53.

4. Install idler pulley, fan belt, bracket assembly and ground wire. Plug in compressor clutch electrical plug. See Figure 9B-54.

5. Install refrigerant hoses and evacuate system. Refer to EVACUATING THE. SYSTEM.

6. While system is being evacuated install sheet metal cover. See Figure 9B-50.

7. Install air cleaner and heat pipe.

8. Install negative battery cable and charge system. See CHARGING THE SYSTEM.

REMOVAL AND INSTALLATION OF RECEIVER-DEHYDRATOR ASSEMBLY . OPEL 1900 MANTA

Removal

1. Discharge system. Refer to DISCHARGING THE SYSTEM.

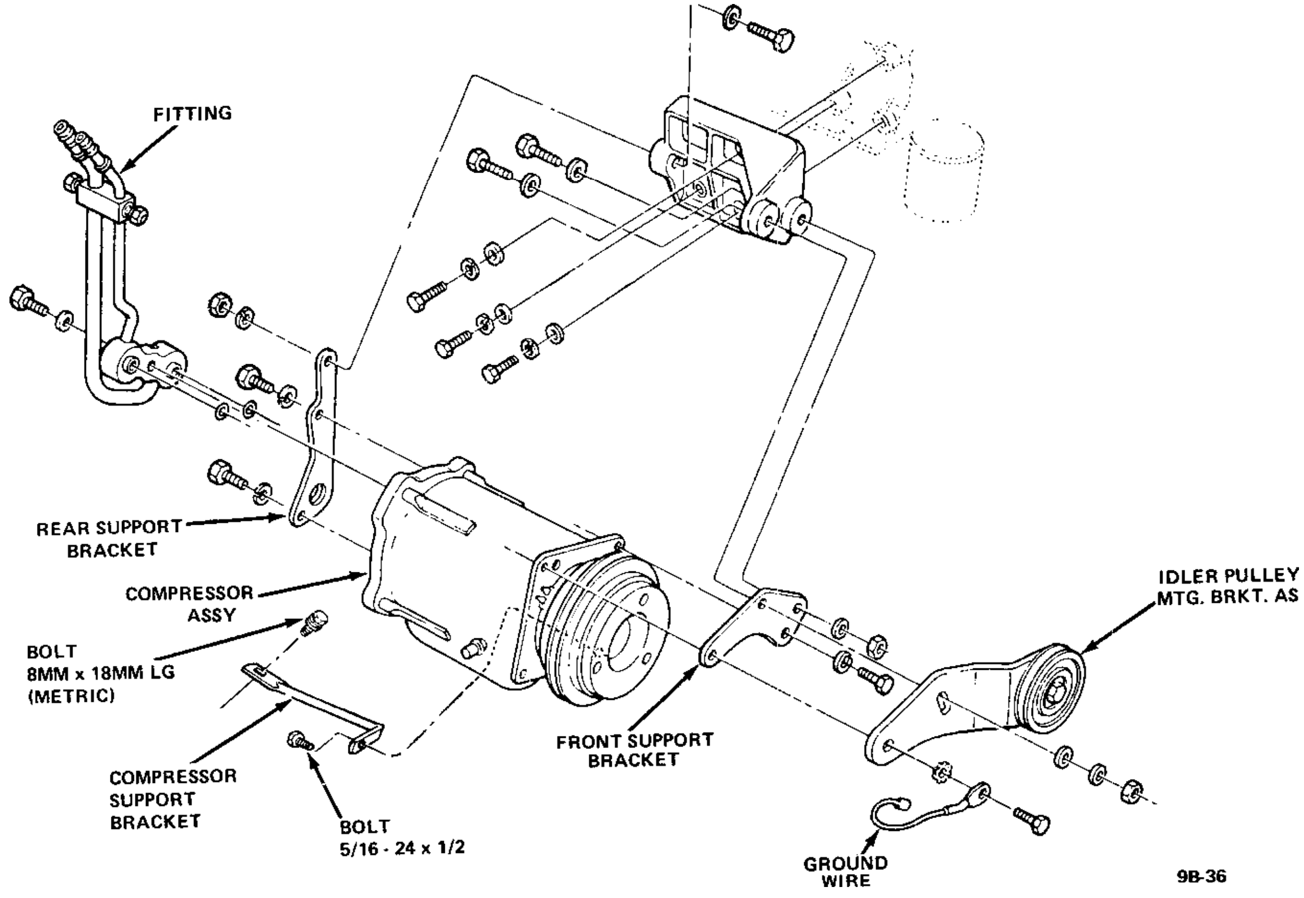


Figure 9B-53 Compressor Installation Opel 1900 Manta

2. Disconnect refrigerant lines to both ends of receiver-dehydrator and tape closed open ends of refrigerant lines, and also the open ends of the inlet and outlet pipes of the receiver-dehydrator.

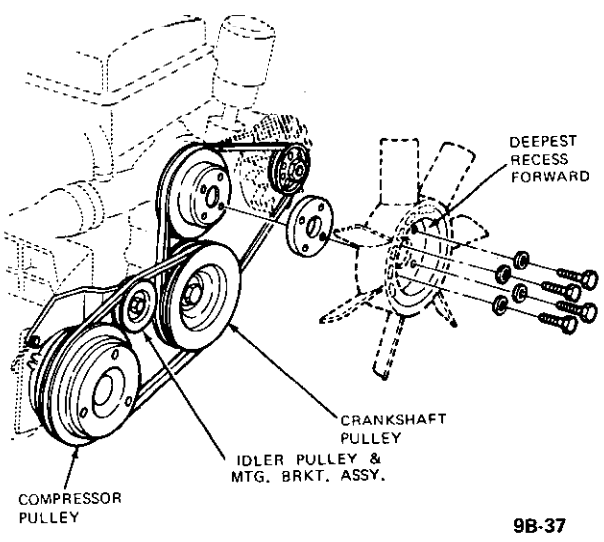


Figure 9B-54 Compressor Pulley. Idler Pulley and Mounting Bracket Assembly - Opel 1900 Manta

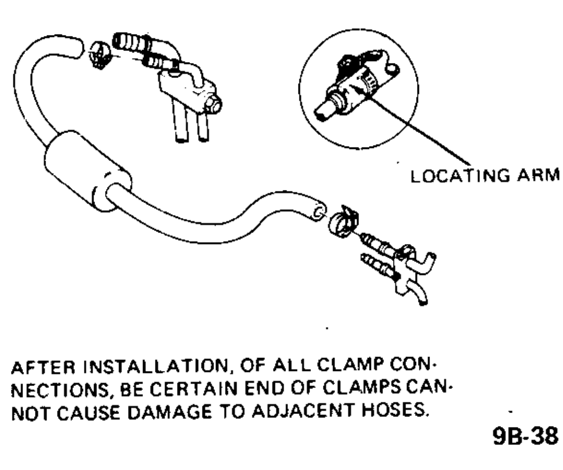


Figure 98.55 Hose **and Clamp** Installation - Opel **1900 Manta**

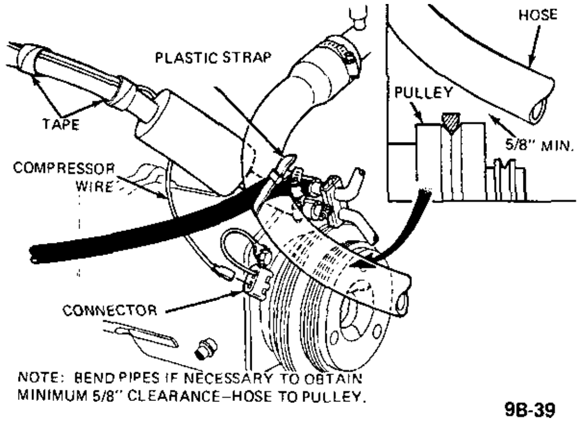


Figure 9B-56 Pipes, Hoses and Compressor Wire Location - Opel 1900 Manta

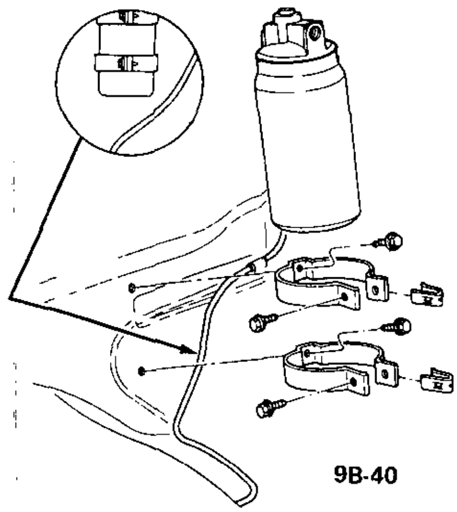


Figure 9B-57 Receiver Dehydrator Support Bracket. Opel 1900 - Manta

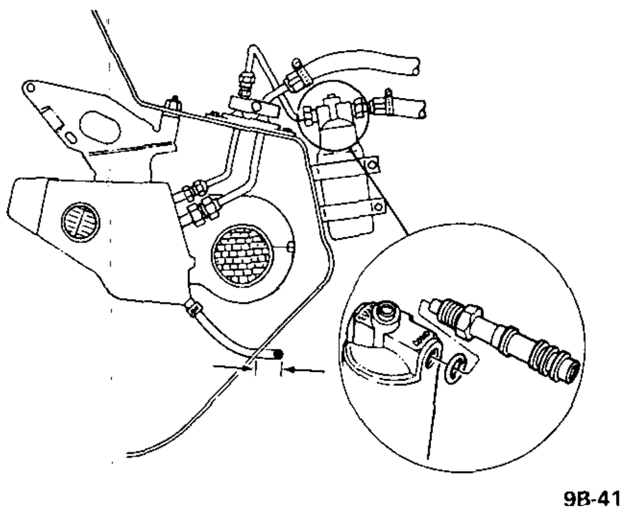


Figure 9B-58 Receiver Dehydrator O-Ring and Drain Hose Location - Opel 1900 - Manta

3. Remove two (2) screws securing receiver-dehydrator within support bracket and lift out receiver-dehydrator.

Installation

If the receiver-dehydrator has been exposed to the atmosphere for any amount of time, (more than five (5) minutes), the receiver-dehydrator should be replaced, since the life of the dessicant is probably expended.

1. Install receiver-dehydrator. Using new o-rings during installation. Lubricate o-rings prior to installation using No. 525 viscosity oil.

2. Evacuate and charge system. Refer to CHARGING AND DISCHARGING SYSTEM.

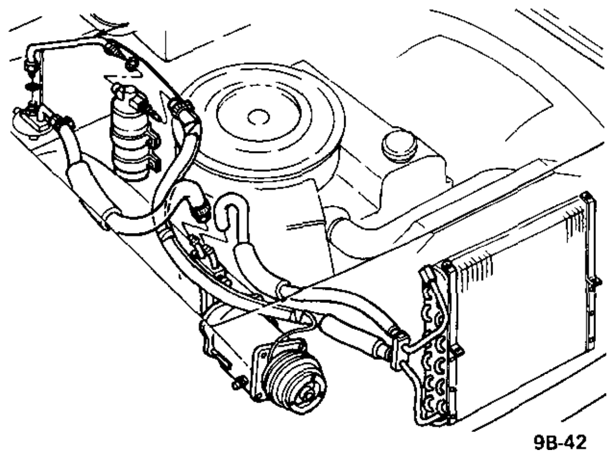


Figure 9B-60 Receiver Dehydrator Hoses and O-Rings Opel 1900 Manta

Figure 9B-61 Removing Left Side Distributor Duct

REMOVAL AND INSTALLATION OF EVAPORATOR AND EXPANSION VALVE. OPEL 1900 · MANTA

Removal

1. Remove negative battery cable from battery.

2. Remove left side of distributor duct, and in line fuse. See Figure 9B-61.

3. Remove glove box. See Figure 9B-62.

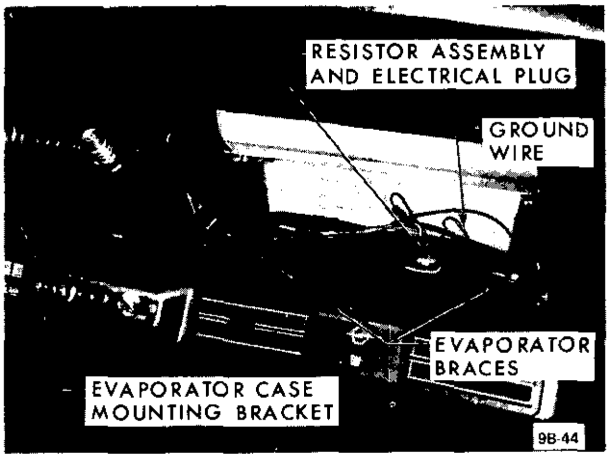


Figure 9B-62 Glove Box Removed

4. Discharge refrigerant from system. (Refer to DISCHARGING SYSTEM) and disconnect refrigerant hose from evaporator outlet and pipe from evaporator inlet and tape the open ends of the refrigerant lines and evaporator pipes. See Figure 9B-63.

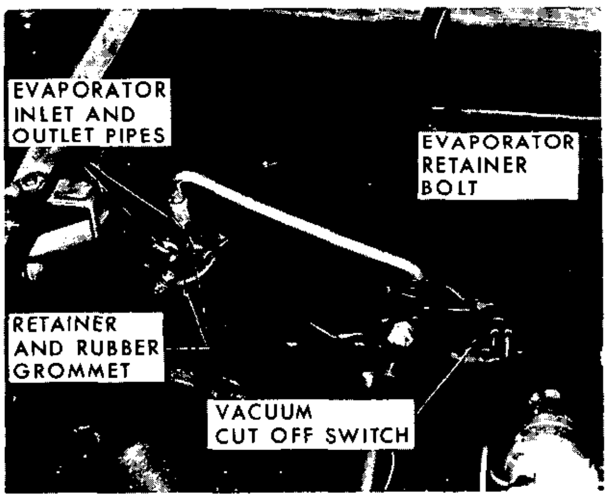


Figure 9B-63 Location of Refrigerant Hoses, Pipes, Vacuum Cut Off Switch and Evaporator Attaching Bolt (Left Side) · Opel 1900 · Manta

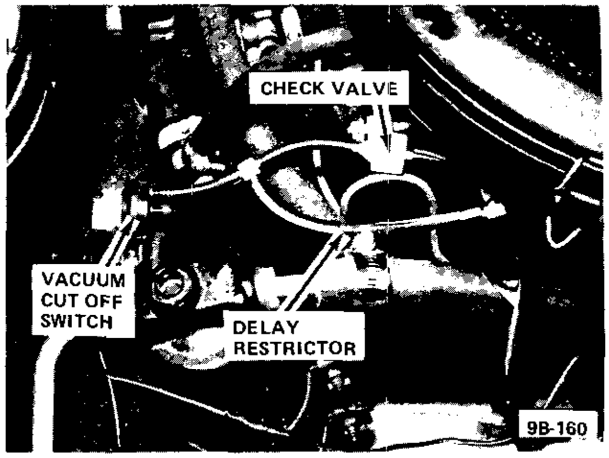


Figure 9B-64 Delay Restrictor and Check Valve **Hose Assembly Location**

5. Disconnect the delay restrictor and check valve hose assembly from the vacuum cut-off switch and disconnect the electrical wiring. See Figures 9B-63 and 64.

6. Remove evaporator inlet and outlet pipes retainer and rubber grommet. See Figure 9B-65.

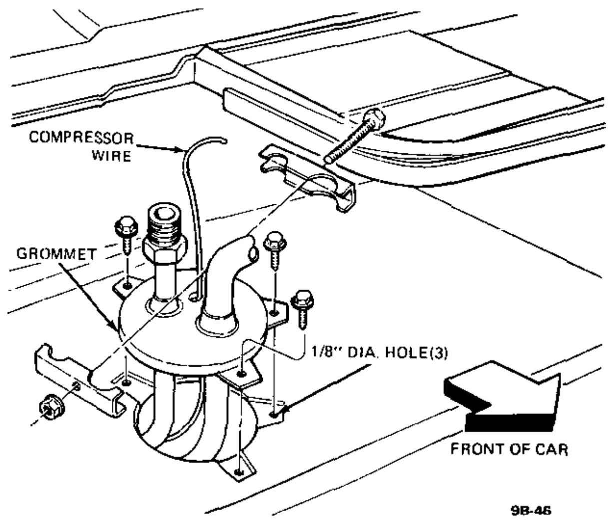


Figure 9B-65 Inlet and Outlet Pipes retainer and Rubber Grommet-Opel 1900 · Manta

Figure 9B-66 Location of Upper Evaporator Attaching Bolt. (Right Side) - Opel 1900 - Manta

7. Remove two (2) upper evaporator attaching nuts. See Figures 9B-66 and 9B-67.

8. Remove two (2) attaching case mounting bracket to instrument panel screws. See Figure 9B-67.

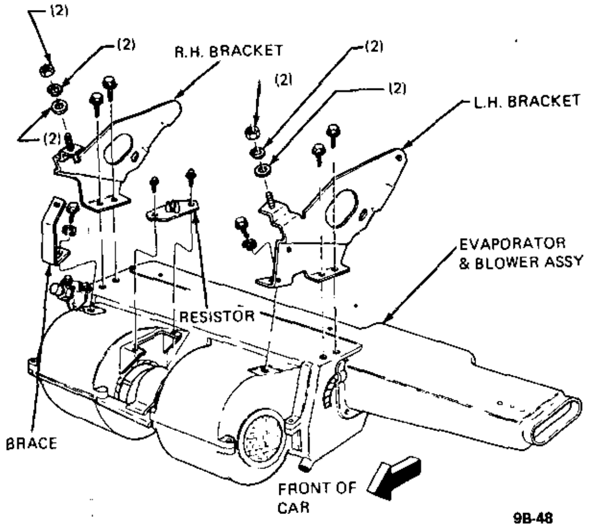


Figure 9B-67 Evaporator and Blower Assembly Brackets and Attachments - Opel 1900 - Manta

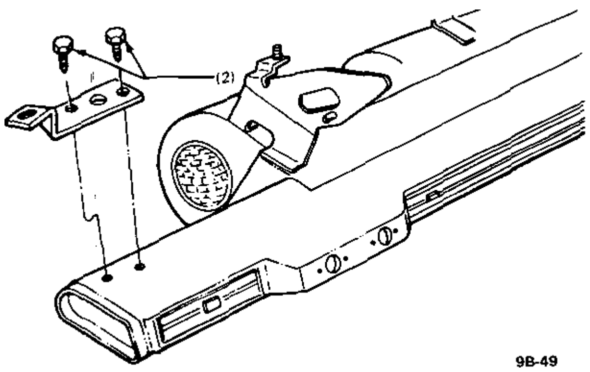


Figure 9B-68 Evaporator and Blower Assembly Center Support Bracket-Opel 1900 Manta

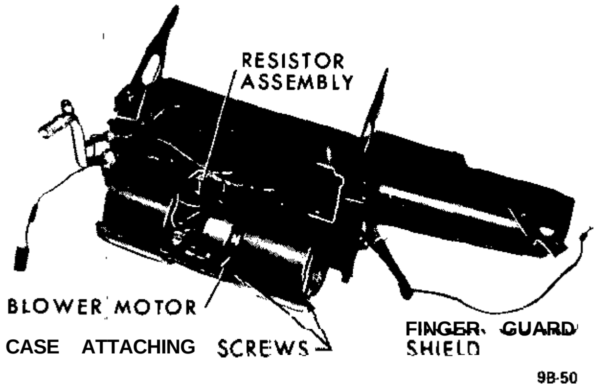


Figure 9B-69 Assembly Removed - Opel 1900 Manta

9. From underneath evaporator case, disconnect two (2) drain hoses.

10. Carefully remove assembly from car. See Figure 9B- 69.

11. Disconnect resistor electrical connector and remove resistor assembly. See Figure 9B-69.

12. Remove blower case and blower motor attaching screws and remove assembly. See Figure 9B-69.

13. Remove all remaining attaching screws and remove evaporator assembly. See Figure 9B-70.

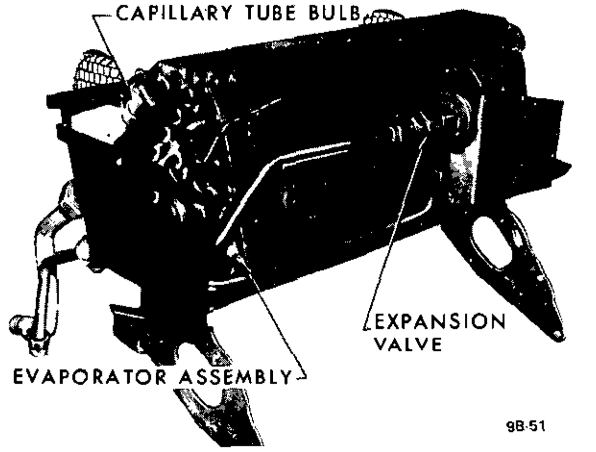


Figure 9B-70 Evaporator and Expansion Valve Assembly - Opel 1900 Manta

14. Disconnect expansion valve capillary tube bulb attached to the outlet pipe of the evaporator. See Figure 9B-70.

15. Disconnect inlet and outlet ends of expansion valve from refrigerant lines, and tape closed open ends of refrigerant lines and inlet and outlet ports of expansion valve.

Installation

If expansion valve or refrigerent lines have been exposed to the atmosphere for any amount of time and moisture may have entered the valve or the system, flush the system and install new receiver-dehydrator or valve as necessary.

Due to the possible adjustment difficulties involved if the expansion valve is disassembled, disassembly of the valve is not recommended. The valve may be cleaned by submerging it in a bath of trichlorethylene, alcohol, or similar solvent. Dry by blowing filtered compressed air through the outlet port of the valve. The filter screen at the inlet port may be replaced. Remove screen by threading a 10-32 NF screw into old filter screen. With a washer and a nut on the screw arranged to work as a puller screw, hold the body of the screw and turn the nut. Insert the new filter screen into the inlet port and lightly tap screen only enough to seat.

1. Install expansion valve using new o-rings during installation. Lubricate o-rings prior to installation using No. 525 viscosity oil.

2. Install evaporator assembly and case attaching screws. See Figure 9B-70.

3. Install blower motor assembly into case and secure with attaching screws. See Figure 9B-69.

4. Install finger guard shields and fan housing case. See Figure 9B-69.

5. Install resistor assembly and electrical connector. Install blower motor connector. See Figure 9B-69.

6. Install assembly into car carefully guiding evaporator pipes up through cowl opening. See Figure 9B-71.

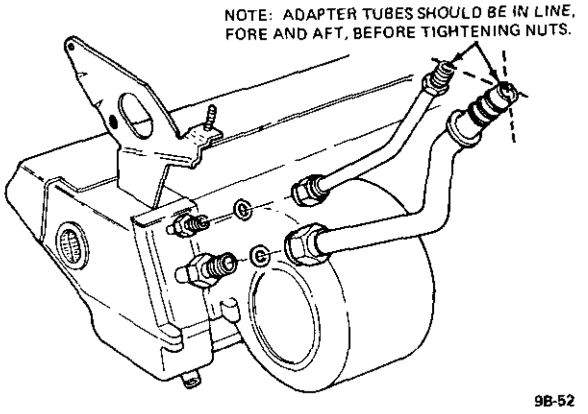


Figure 9B-7 1 Inlet and Outlet Pipes and O-Rings - Opel 1900 Manta

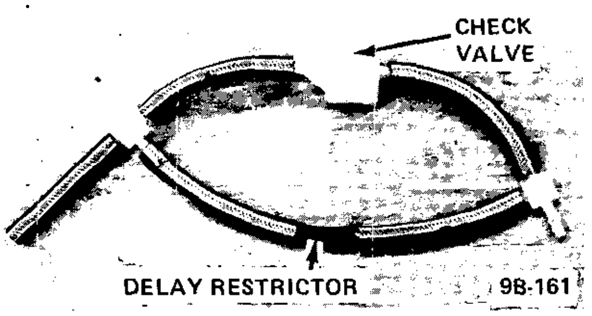
7. Install two (2) upper attaching evaporator attaching nuts. See Figures 9B-66 and 9B-67.

8. Install two (2) attaching case mounting bracket to instrument panel screws. See Figure 9B-67.

9. Connect two (2) drain hoses underneath evaporator.

10. Install evaporator inlet and outlet pipes retainer and rubber grommet. See Figure 9B-65.

11. Connect vacuum cut-off switch and electrical wiring, making sure the delay restrictor and check valve hoses are installed correctly. See Figures 9B-63 and 64.



9B-72 Delay Restrictor and Check Valve Hose Assembly

12. Install refrigerant hoses and pipes using new o-rings on line fittings and evacuate system. Refer to EVACUATING SYSTEM.

13. While system is being evacuated, install in-line fuse and left side of distributor duct. See Figure 9B-61.

14. Install glove box.

15. Install negative battery cable and charge system. Refer to CHARGING SYSTEM.

REMOVAL AND INSTALLATION OF CONDENSER ASSEMBLY -OPEL 1900. MANTA

Removal

1. Remove negative battery cable from battery.

2. Remove air cleaner.

3. Discharge system. Refer to DISCHARGING SYSTEM.

4. While system is discharging, remove lower radiator hose from radiator and drain coolant into a suitable container.

5. Remove fan shroud.

6. On vehicles with automatic transmission, unscrew oil lines from connectors on lower radiator tank and plug lines. It is essential that no dirt enters the oil lines. When unscrewing oil lines, hold connectors on lower radiator tank with pliers to avoid leakages. Ensure that no dirt enters oil cooler.

7. Remove upper radiator hose from radiator.

8. Remove lower attaching nut and slide radiator upward and out of engine compartment.

9. Remove inlet and outlet hoses from condenser

pipes and tape closed the open ends of refrigerant lines, and also the open ends of the inlet and outlet pipes of the condenser.

10. Remove two (2) top retaining screws.

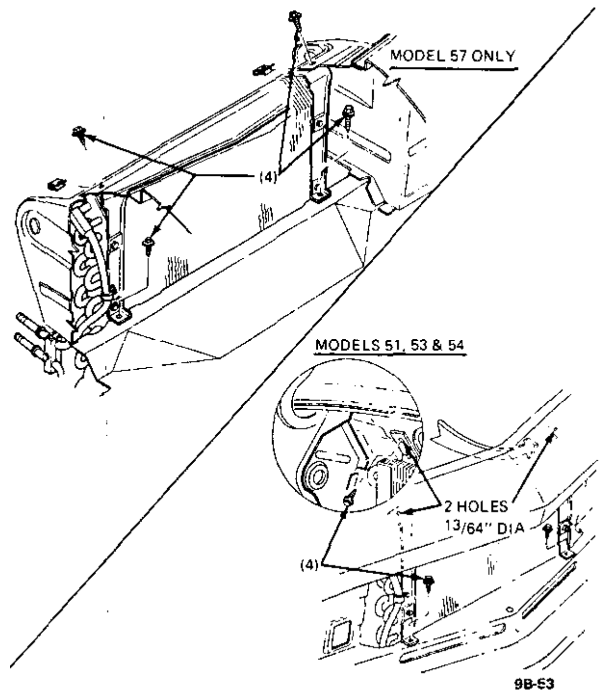


Figure 9B-73 Condenser Retaining Screws - Opel 1900 - Manta

11. Remove radiator grille and two (2) condenser to body mounting screws. See Figure 9B-74.

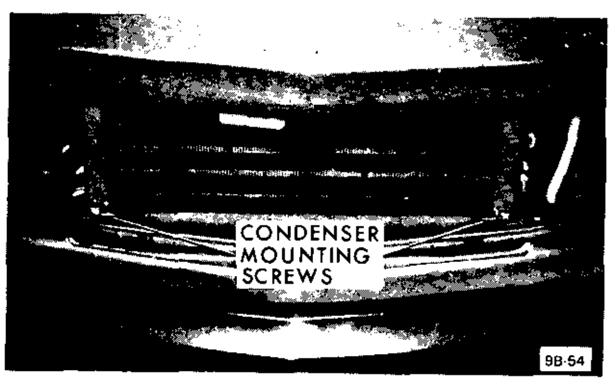


Figure 9B-74 Condenser Assembly and Attachments. Opel 1900 - Manta

12. Remove condenser.

Installation

If refrigerant circuit or condenser has been **exposed** to the atmosphere and moisture may be present in the **circuit, the system and/or component must be**

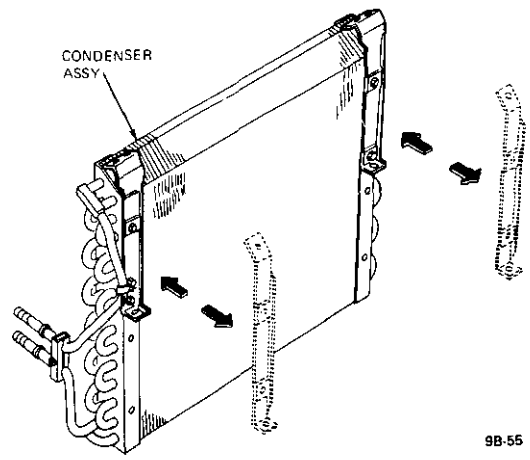


Figure 9B-75 Condenser Assembly Mounting **Brackets Opel 1900 Manta**

flushed prior to installation. Refer to FLUSHING THE SYSTEM.

1. Install condenser into car and install 2 condenser to body mounting screws. See Figure 9B-74. Install radiator grill.

2. Install 2 top retaining screws.

3. Remove tape from the condenser pipes and re- frigerant hoses and install hoses using new o-rings on lines lubricated with No. 525 viscosity oil.

4. Evacuate system. Refer to EVACUATING SYSTEM.

5. While system is being evacuated, install radiator **into engine compartment and secure lower attaching nut.**

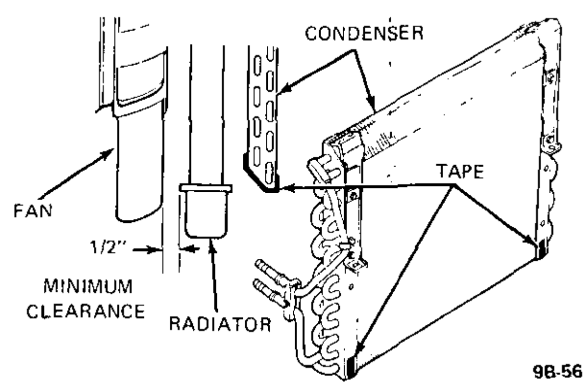


Figure 9B-76 Clearance Between Lower Radiator Tank and Fan Blades - Opel 1900 Manta

6. On vehicles with automatic transmissions, fasten

oil cooler lines to lower radiator tank. It is essential that no dirt enters the oil lines. When tightening oil lines hold connectors on lower radiator tank with pliers to avoid leakages. Ensure that no dirt enters oil cooler. Torque to 11-15 Ibs. ft.

7. Install fan shroud.

8. Install upper radiator hose.

9. Install lower radiator hose and add collected coolant.

All Opel 1900's and Manta's are provided with a radiator initial fill of an anti-freeze solution containing corrosion inhibitor. The anti-freeze has either a glycol or glycerin base and protects the engine against freezing, down to minus 22 degrees F. (minus 30 degrees C.). Before the start of the cold season, coolant must be checked with a hydrometer and if necessary, brought to the necessary specific gravity by adding anti-freeze. Anti-freeze added, must have a glycol or glycerin base. As the specific gravities of all anti-freeze solutions having a glycol or glycerin base are practically the same, the hydrometer can be used for all these types. Because of the tolerances of the hydrometer, or slight differences in specific gravity, variations of plus or minus 5 degrees can be expected. Coolant must be checked at a temperature of plus 68 degrees F. (plus 20 degrees C.).

IO. Install negative battery cable and air cleaner.

11. Charge system. Refer to CHARGING SYSTEM.

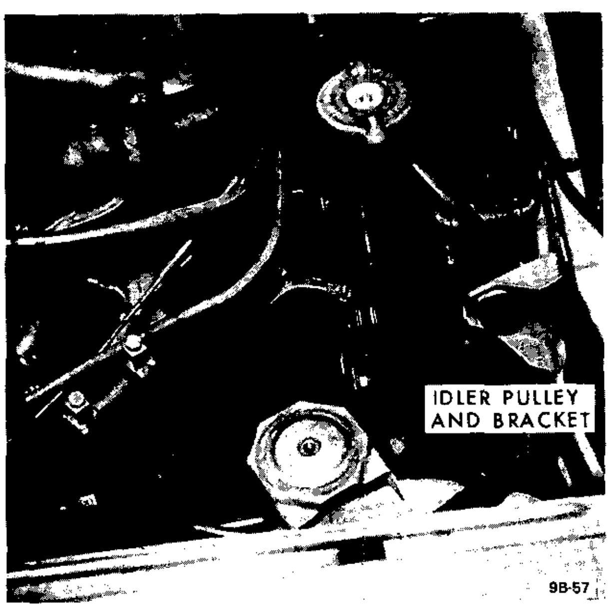


Figure 9B-80 Location of Idler Pulley and Bracket Assembly - GT

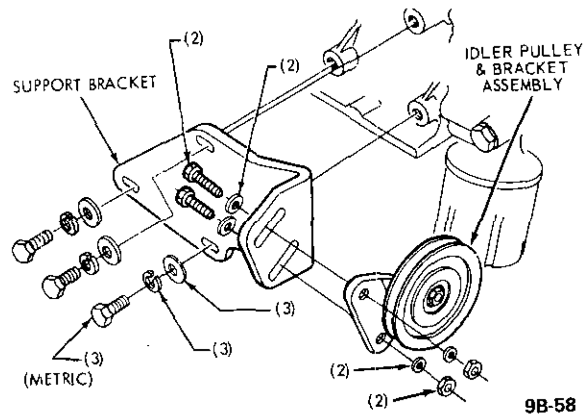


Figure 9B-81 Idler Pulley and Bracket Assembly and Support Bracket GT

REMOVAL AND INSTALLATION OF COMPRESSOR. GT

Removal

1. Remove negative battery cable from battery.

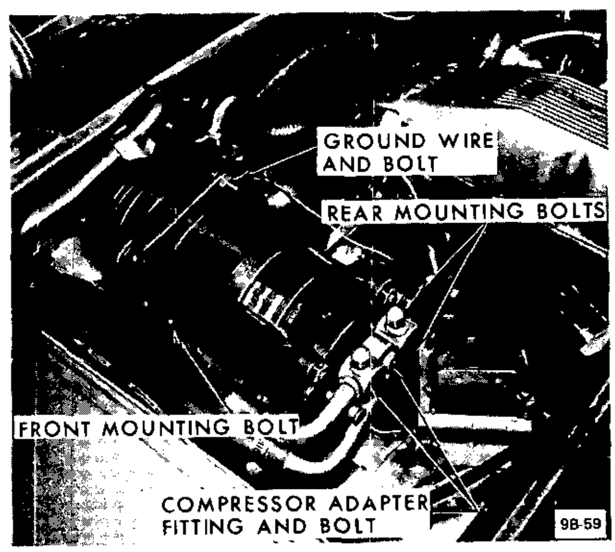


Figure 9B-82 Compressor Adapter Fitting, Ground **Wire. and Front and Rear Mounting Bolts - GT**

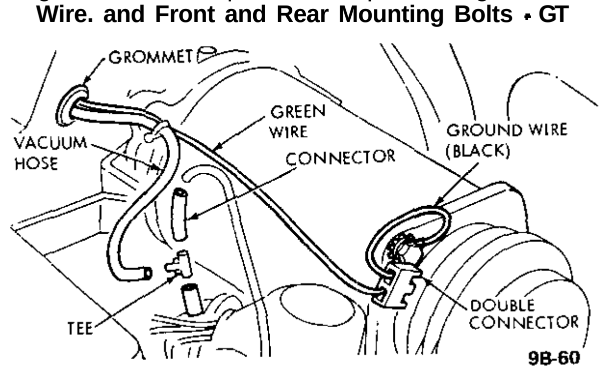


Figure 9B-83 Electrical Connector and Ground Wire GT

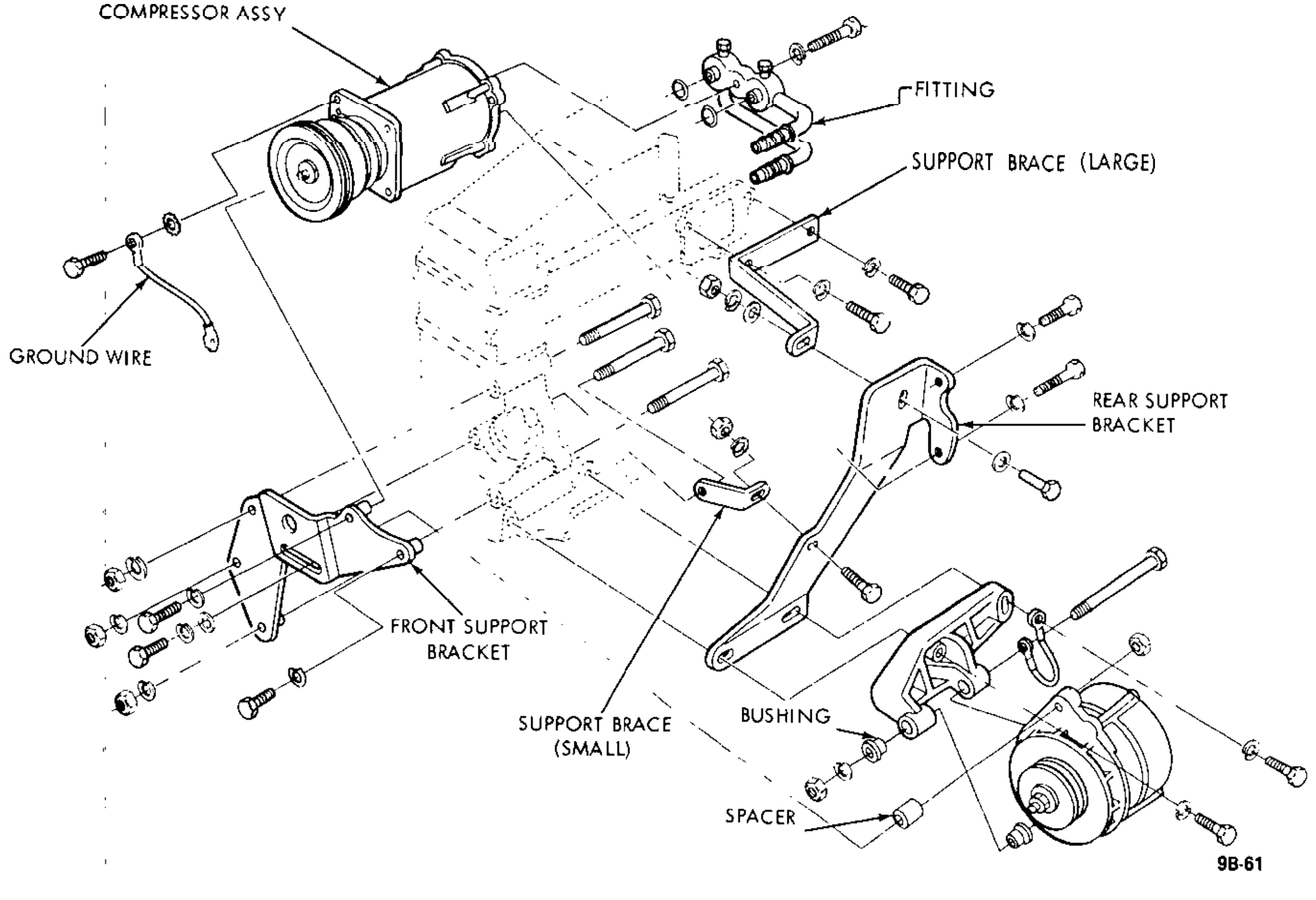


Figure 9B-84 Compressor Installation GT

2. Discharge system. Refer to DISCHARGING SYSTEM.

3. While system is discharging remove air cleaner and loosen idler pulley and bracket assembly. See Figure 9B-80.

4. Remove bolt holding compressor adapter fitting into rear head. Disengage from compressor and tape closed openings in both lines and ports in rear head. It is important to seal compressor ports to avoid a loss of refrigeration oil and also to prevent foreign material and moisture from entering compressor. See Figure 9B-82.

5. Remove bolt and ground wire, unplug electrical connector, and remove 2 rear compressor mounting bolts. See Figure 9B-82.

6. Remove 2 front compressor mounting bolts, clutch drive belt, and lift out compressor. During removal, maintain the compressor position so that the sump is downward. Do not rotate compressor shaft. See Figure 9B-84.

Installation

1. Install compressor into mounting brackets and secure with 4 mounting bolts. See Figure 9B-84.

2. Untape lines and ports, and install compressor adapter fitting and bolt using new o-rings. See Figure 9B-82.

3. Evacuate system. Refer to, EVACUATING SYSTEM.

4. While system is being evacuated, install drive belt and tighten idler pulley. See Figure 9B-80.

5. Install bolt and ground wire and plug in electrical connector. See Figure 9B-83.

6. Install air cleaner and negative battery cable.

7. Charge system. Refer to, CHARGING SYSTEM.

REMOVAL AND INSTALLATION OF RECEIVER-DEHYDRATOR ASSEMBLY. GT

Removal

1. Discharge system. Refer to DISCHARGING SYSTEM.

2. Disconnect refrigerant lines to both ends of receiver-dehydrator and tape closed open ends of re-

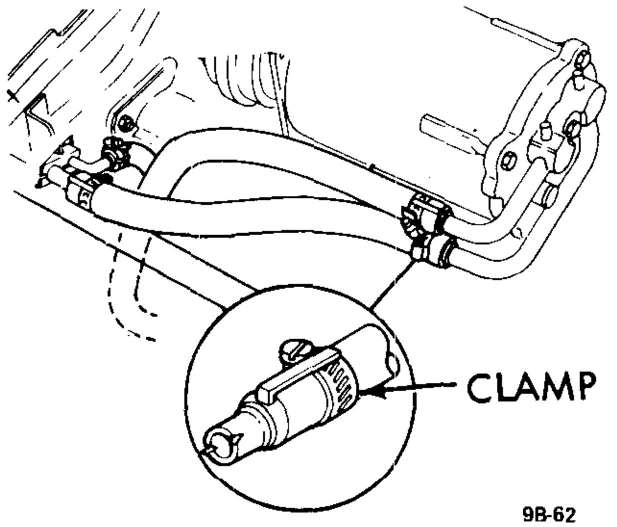


Figure 9B-85 Refrigeration Hose Clamps Installation GT

frigerant lines, and also the open ends of the inlet and outlet pipes of the receiver-dehydrator. See Figure 9B-86.

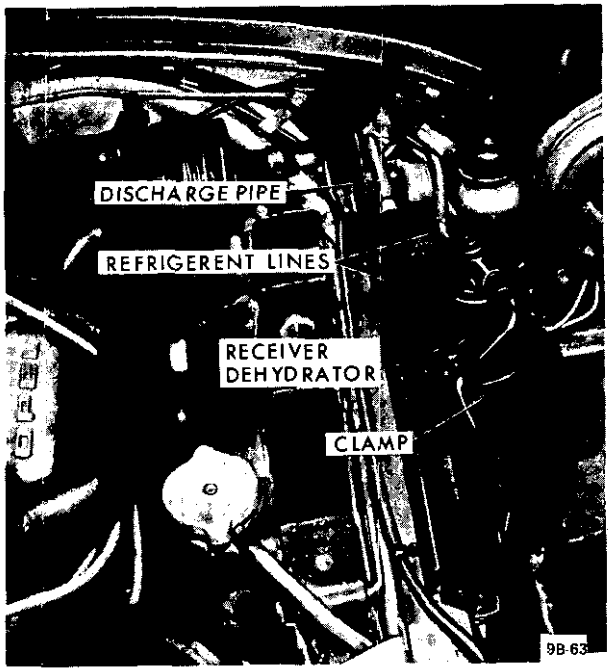


Figure 9B-86 Receiver-Dehydrator GT

3. Remove 2 screws securing receiver-dehydrator and clamps to support bracket and lift out receiver dehydrator. See Figure 9B-86.

Installation

1. Install receiver-dehydrator using new o-rings during installation. Lubricate o-rings prior to installation using No. 525 viscosity oil.

2. If the receiver-dehydrator has been exposed to the atmosphere for any amount of time, (more than 5 minutes), the receiver-dehydrator should be replaced, since the life of the dessicant is probably expended.

3. Evacuate and charge system. Refer to CHARGING AND DISCHARGING SYSTEM.

REMOVAL AND INSTALLATION OF EVAPORATOR AND EXPANSION VALVE. GT

Removal

1. Disconnect negative battery cable.

2. Discharge system. Refer to, DISCHARGING SYSTEM.

3. While system is discharging, remove attaching screws and lift out luggage tray. See Figure 9B-87.

Figure 9B-87 Luggage Tray

4. Remove all evaporator cover screws and remove cover. See Figure 9B-88.

5. Remove electrical plug connector from the resistor assembly and unplug blower motor connection and remove ground wire. See Figure 9B-90.

6. From underneath evaporator housing, disconnect two (2) drain hoses. See Figure 9B-91.

7. From under car remove 4 nuts securing evaporator mounting bracket to floor. See Figures 9B- 92 and 9B-93.

Figure 9B-88 Evaporator Cover Assembly and Attaching Screws GT

Figure 9B-90 Electrical Connections, Ground Wire GT

8. Remove inlet and outlet pipes from evaporator and tape closed the refrigerant lines and also the open ends of the inlet and outlet pipes of the evaporator. See Figure 9B-94.

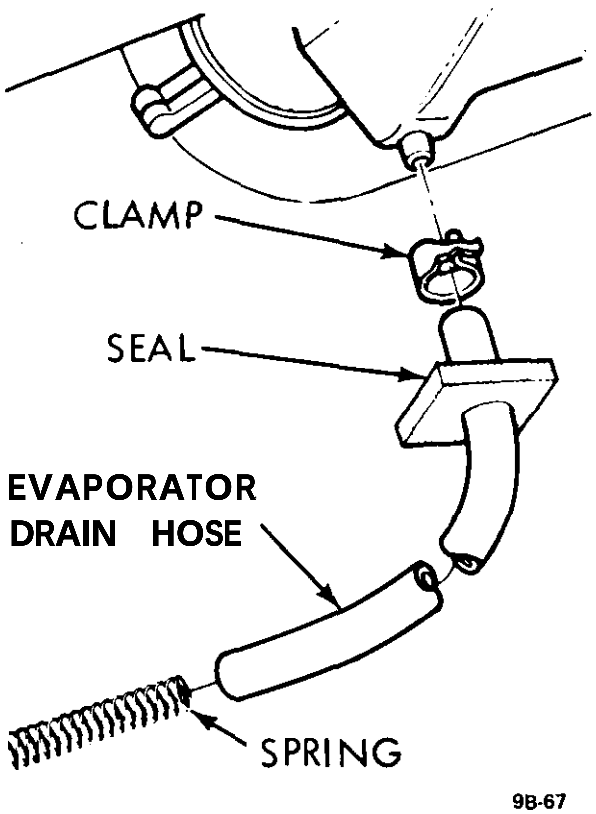


Figure 9B-91 Drain Hose GT

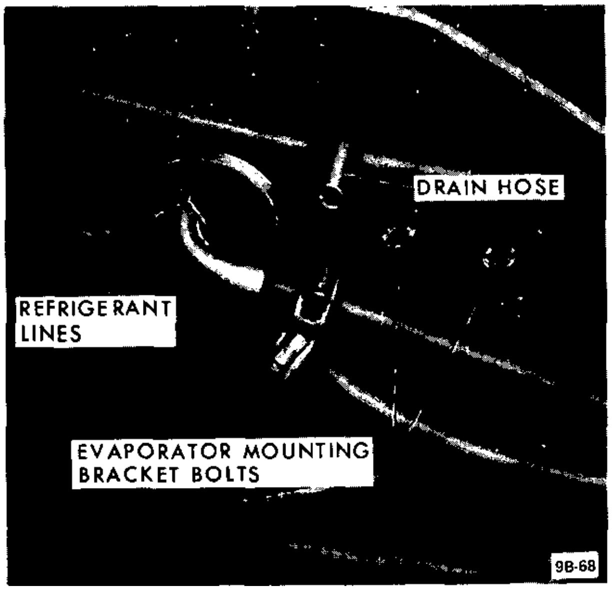


Figure 9B-92 Evaporator Mounting Bracket Bolts Driver Side GT

9. Lift off the mounting bracket and remove the evaporator assembly from the car.

10. Remove the resistor assembly. See Figure 9B-90.

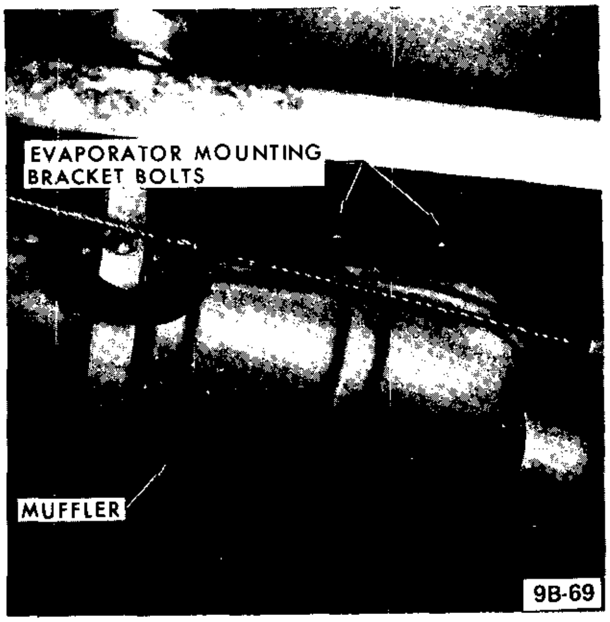


Figure 9B-93 Evaporator Mounting Bracket Bolts Passenger Side - GT

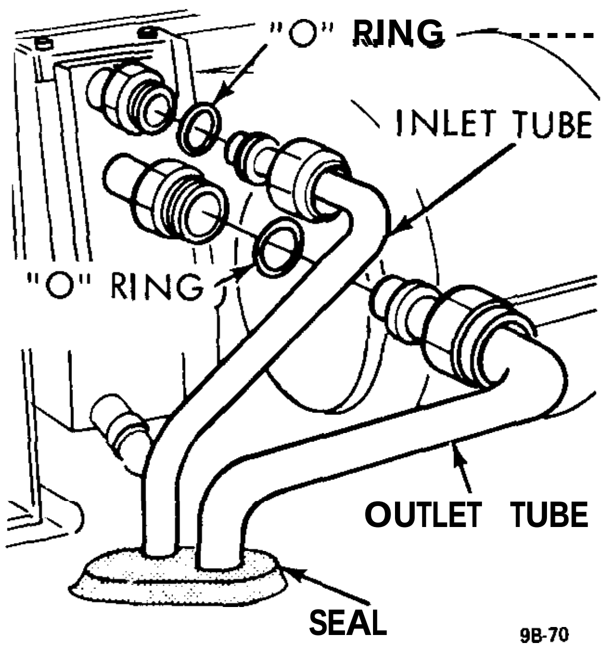


Figure 9B-94 Inlet and Outlet Pipes and O-Rings GT

11. Remove blower case and blower motor attaching screws and remove assembly.

12. Remove all remaining attaching screws and remove evaporator assembly. See Figure 9B-95.

13. Disconnect expansion valve capillary tube bulb attached to the outlet pipe of the evaporator. See Figure 9B-95.

14. Disconnect inlet **and** outlet ends of expansion

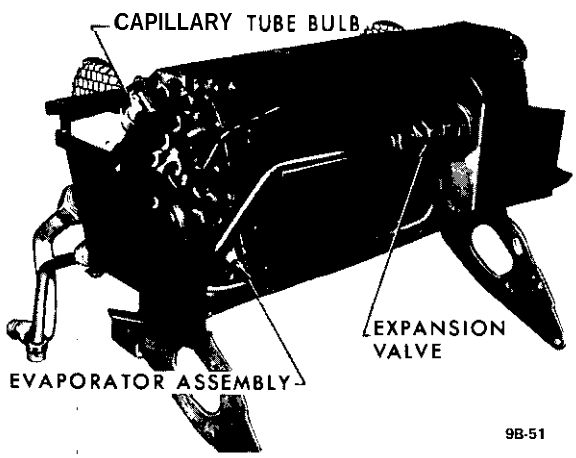


Figure 9B-95 Evaporator and Expansion Valve Assembly GT

valve from refrigerant lines, and tape closed open ends of lines and inlet and outlet ports of expansion valve.

Installation

If expansion valve or refrigerant lines have been exposed to the atmosphere for any amount of time and moisture may have entered the valve or the system, flush the system and install new receiver-dehydrator or valve as necessary.

Due to the possible adjustment difficulties involved if the expansion valve is disassembled, disassembly of the valve is not recommended. The valve may be cleaned by submerging it in a bath of trichlorethylene, alcohol, or similar solvent. Dry by blowing filtered compressed air through the outlet port of the valve. The filter screen at the inlet port may be replaced. Remove screen by threading a 10-32 NF screw intp old filter screen. With a washer and a nut on the screw arranged to work as a puller screw, hold the body of the screw and turn the nut. Insert the new filter screen into the inlet port and lightly tap screen only enough to seat.

1. Install expansion valve using new o-rings during installation. Lubricate o-rings prior to installation using No. 525 viscosity oil.

2. Install evaporator assembly and case attaching screws.

3. Install blower motor assembly into case and secure with attaching screws.

4. Install finger guard shields and fan housing case.

5. Install resistor assembly.

6. Install evaporator assembly into car and install mounting bracket. See Figure 9B-96.

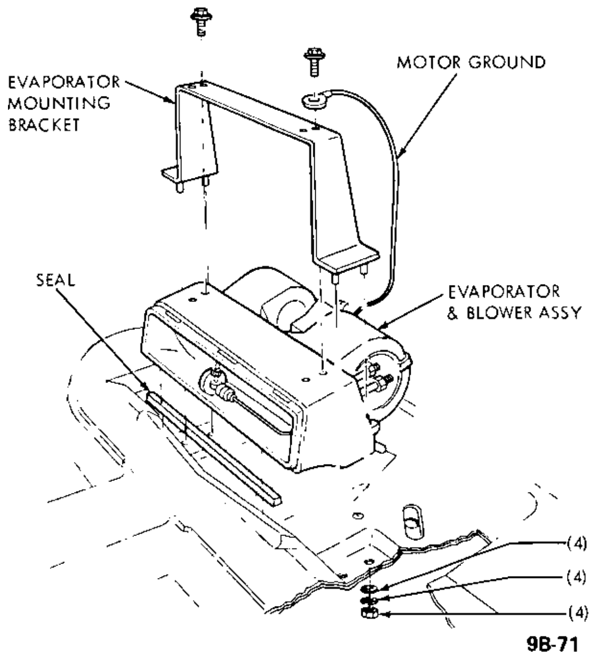


Figure 9B-96 Evaporator and Blower Assembly - GT

7. Untape the refrigerant lines and the inlet and outlet pipes from the evaporator and install using new o-rings on line fittings.

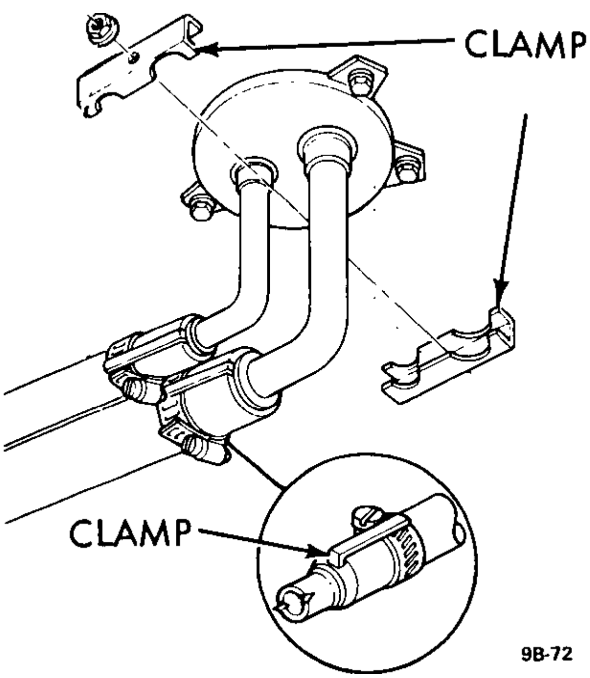


Figure 9B-97 Refrigerant Hoses and Hose Clamps Under Car - GT

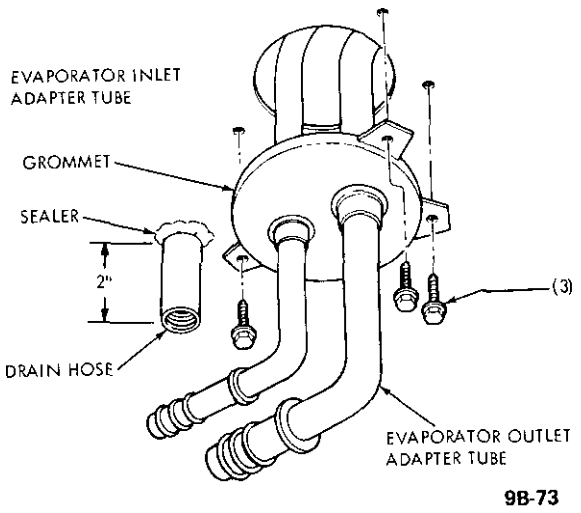


Figure 9B-98 Refrigerant Hoses Retainer Grommet - Under Car - GT

8. From under car install four (4) nuts securing evaporator mounting bracket to floor. See Figures 9B- 92 and 9B-93.

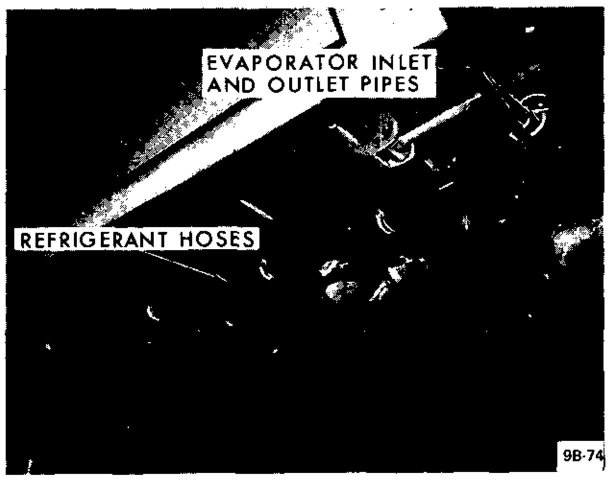


Figure 9B-100 Refrigerant Hoses - Under Car GT

9. Evacuate system. Refer to EVACUATING SYSTEM.

10. While system is being **evacuated, connect** drain hoses underneath evaporator housing.

11. Plug in the resistor assembly electrical connector plug and connect the blower motor connection and install ground wire and 2 mounting brackets to case screws using the rearward holes. See Figure 9B-90.

12. Install the evaporator cover and all cover screws. See Figure 9B-88.

13. Install luggage tray and attaching screws. See Figure 9B-87.

14. Connect the negative battery cable.

15. Charge system. Refer to CHARGING SYSTEM.

REMOVAL AND INSTALLATION OF CONDENSER RECEIVER- DEHYDRATOR ASSEMBLY - GT

Removal

1. Disconnect negative battery cable.

2. Discharge system. Refer to DISCHARGING SYSTEM.

3. While the system is discharging, remove the charcoal cannister, washer jar, battery and battery tray. Battery needs only to be set up out of the way and not removed from the car.

4. Disconnect inlet and outlet pipes of condenser receiver-dehydrator and tape closed the open ends of refrigerant lines, and also the open ends of the inlet and outlet pipes of the condenser. See Figure 9B-101.

5. Disconnect discharge line from condenser and tape closed open ends of discharge pipe and condenser inlet.

6. Remove 4 condenser attaching screws and lift out condenser. See Figure 9B-101.

7. Remove 2 screws retaining receiver-dehydrator to condenser and remove.

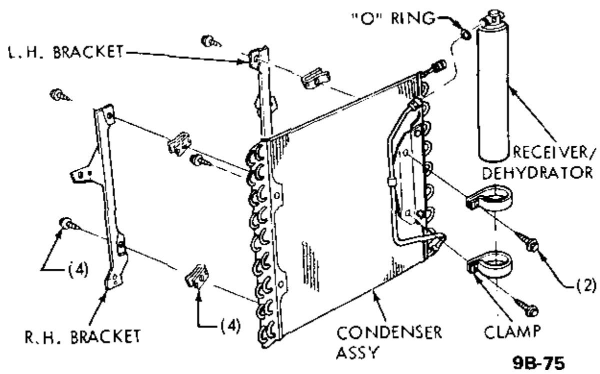


Figure 9B-101 Receiver - Dehydrator. Condenser Attaching Screws and Brackets - GT

Installation

If refrigerant circuit or condenser has been exposed to the atmosphere and moisture may be present in the circuit, the system and/or component must be flushed prior to installation. Refer to FLUSHING THE SYSTEM.

1. Install receiver-dehydrator to condenser and fasten with 2 clamps and 2 screws.

2. Install condenser into car and secure with 4 attaching screws. See Figure 9B-101.

3. Untape discharge line and pipe and install using new o-rings lubricated with No. 525 viscosity oil.

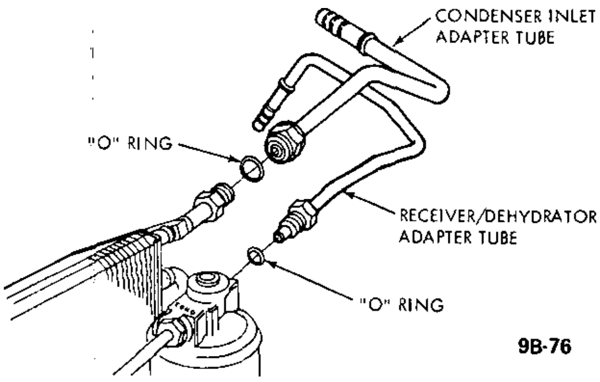


Figure 9B-102 Condenser • Receiver • Dehydrator O-Rings. GT

4. Untape and install inlet and outlet pipes into the receiver-dehydrator using new o-rings lubricated with No. 525 viscosity oil.

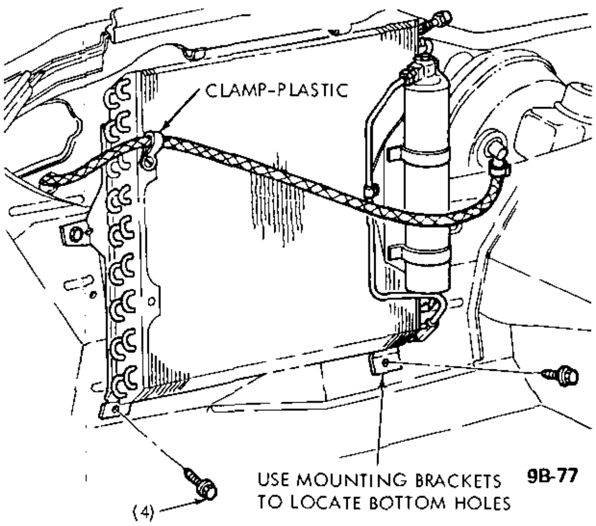


Figure 9B-103 Condenser Assembly • GT

5. Evacuate system. Refer to EVACUATING SYSTEM.

6. While system is being evacuated, install the charcoal cannistor, washer jar, battery tray and battery and connect negative battery cable.

7. Charge system. Refer to CHARGING SYSTEM.

DISASSEMBLY AND REASSEMBLY OF CLUTCH DRIVE PLATE AND SHAFT SEAL

It is not necessary to remove the compressor or disconnect refrigerant lines to remove or install clutch parts on the GT, however, the compressor must be removed from the Opel 1900 • Manta.

Disassembly

1. Firmly clamp holding fixture (J-9396) in a vise and attach compressor assembly to fixture (see Figure 9B-104).

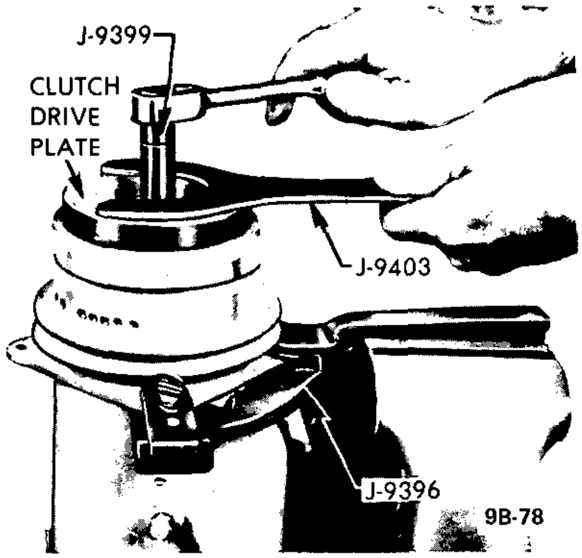


Figure 9B-104 Removing or Installing Shaft Nut

2. Hold hub of clutch drive plate with wrench (J-9403). Using special thin wall 9/16 inch socket (J-9399) and 3/8 inch drive, remove shaft nut.

3. Install threaded hub puller (J-9401) onto hub of clutch drive plate (see Figure 9B-105). Hold body of hub puller with wrench, tighten center screw of hub puller, and lift off clutch drive plate and woodruff key.

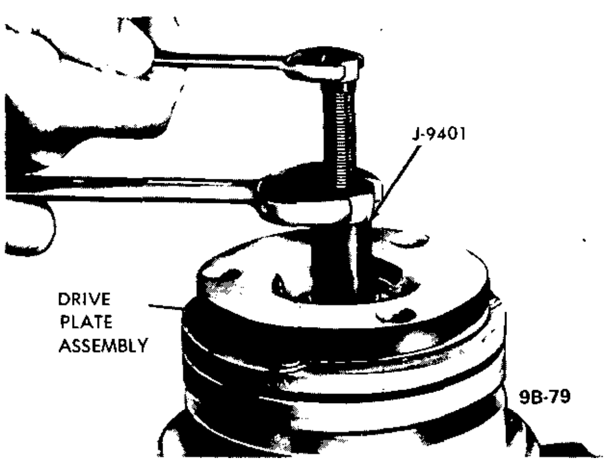


Figure SE-105 Removing Clutch Drive Plate

4. Using No. 21 Truarc pliers (J-5403) take out retainer ring from hub of clutch drive plate (see Figure 9B-106). Lift our spacer.

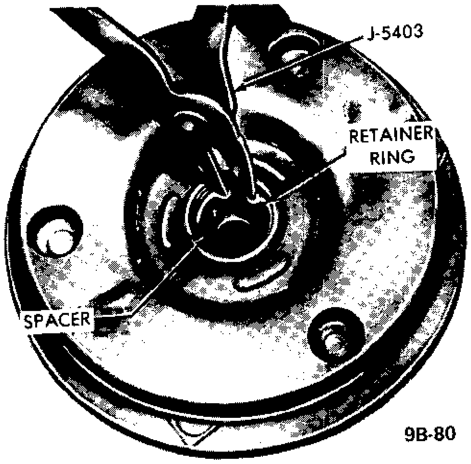


Figure 9B-106 Removing or Installing Retainer Ring in Clutch Drive Plate

5. If compressor has an absorbent sleeve in the neck, pry out the sleeve retainer and remove the sleeve. Remove the seal seat retainer ring, using No. 21 Truarc pliers, Tool J-5403, (see Figure 9B-107).

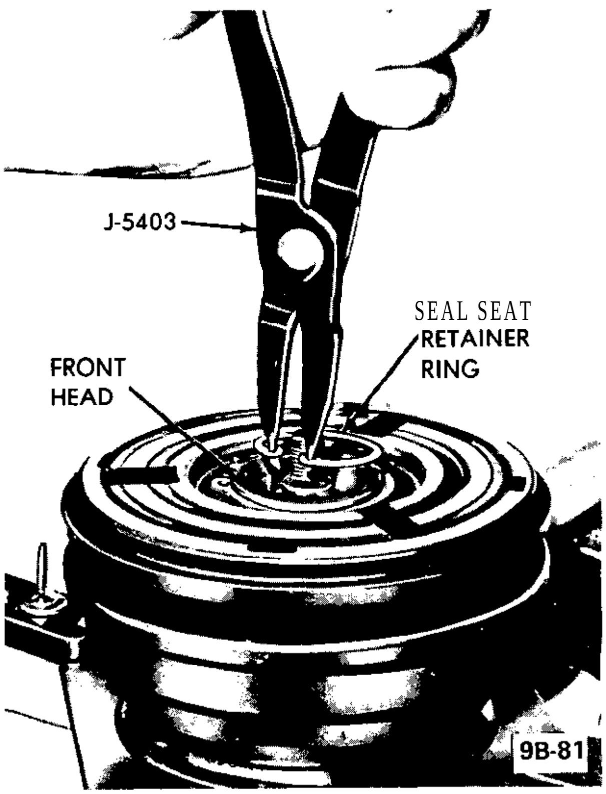


Figure 9B-107 Removing or Installing Shaft Seal Seat Retaining Ring

6. Thoroughly clean the area inside the compressor neck surrounding the shaft, the exposed portion of the seal seat and the shaft itself of any dirt or foreign material. This is absolutely necessary to prevent any such material from getting into the compressor.

7. Remove the seal seat (see Figure 9B-108) using Tool J-23128. Insert Tool J-23128 into seal seat and tighten, using a twisting motion remove the seal seat.

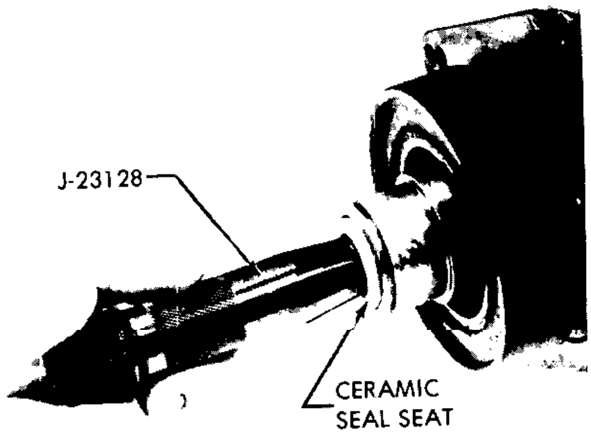


Figure SE-108 Removing or Installing Ceramic Shaft Seal seat

8. Remove the seal assembly, using Tool J-9392. Press tool downward on seal while twisting it clockwise to engage the tabs of the seal assembly. Gently but firmly, pull tool straight out (see Figure 9B-109).

9. Remove the seal seat "O" ring, using Tool J-9553 (see Figure 9B-110).

10. Recheck the inside of the compressor neck and the shaft. Be sure these areas are perfectly clean before installing new parts.

Reassembly

1. Coat the new seal seat "O" ring with clean refrigeration oil and install it in its groove in the compressor neck. Tool J-21508 may be used to accomplish this. (See Figure 9B-111)

2. Coat the "O" ring and seal face of the new seal assembly with clean refrigeration oil. Carefully mount the seal assembly to Tool J-9392 by engaging the tabs of the seal with the tangs of the tool.

3. Place seal protector, Tool J-22974, over end of shaft and carefully slide the new seal assembly onto the shaft. Gently twist the tool clockwise while pushing the seal assembly down the shaft until the seal

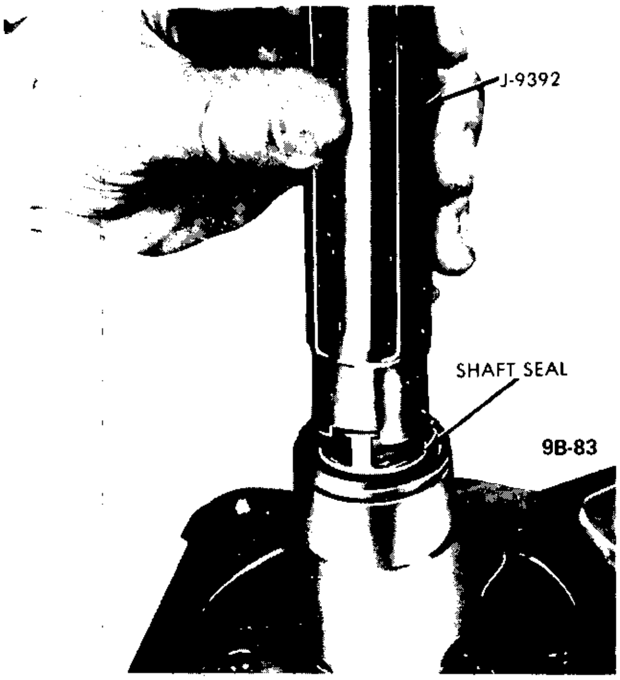


Figure 9B-109 Removing or Installing Shaft Seal

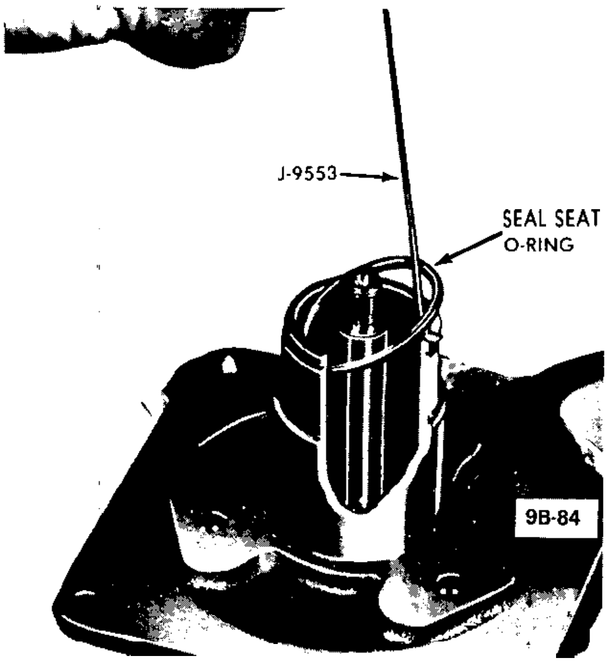


Figure 9B-110 Removing Seal Seat O-Ring

assembly engages the flats on the shaft and is seated in place. Disengage the tool by pressing downward and twisting tool counterclockwise.

4. Coat the seal face of the new seal seat with clean refrigeration oil. Mount the seal seat on Tool J-9393 and install it in the compressor **neck,** taking care not to dislodge the seal seat "O" ring and being sure the seal seat makes a good seal with the "0" ring.

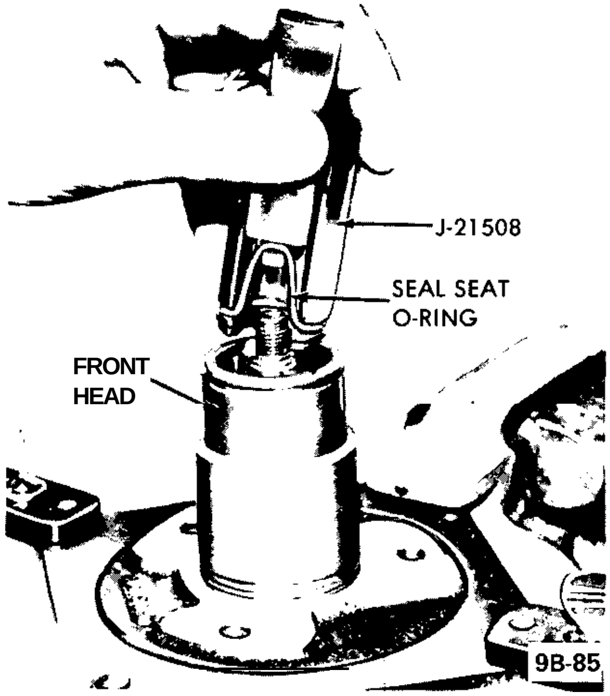


Figure 9B-111 Installing Seal Seat O-Ring

5. Install the new seal seat retainer ring with its flat side against the seal seat, using No. 21 Truarc pliers (J-5403). Use the sleeve from Tool J-9393 to press in on the seal seat retainer ring so that it snaps into its groove. Remove seal protector J-22974 from the end of the shaft.

6. Install Compressor Leak Test Fixture (J-9625) on rear head of compressor and connect gage charging lines as shown in Figure 9B-112. Pressurize suction side of compressor with Refrigerant-12 vapor to drum pressure. Temporarily install the shaft nut and, with compressor horizontal and oil sump down, **rotate** the compressor shaft in normal direction of rotation several times by hand. Leak, test the seal with a propane torch type leak detector in good condition. Correct any leak found. Remove and discard the shaft nut.

7. Remove any excess oil, resulting from installing the new seal parts, from the shaft and inside the compressor **neck.**

8. Install the new absorbent sleeve by rolling the material into a cylinder, overlapping the ends, and slipping it into the compressor neck with the overlap at the top of the compressor. Using a small screwdriver or similar instrument, carefully spread the sleeve so that in its final position, the ends butt together at the top vertical centerline. Install the new sleeve retainer so that its flange face will be against the front end of the sleeve. Using the sleeve from Tool J-9393, press and tap with a mallet, setting the retainer and sleeve into place, until the outer edge of

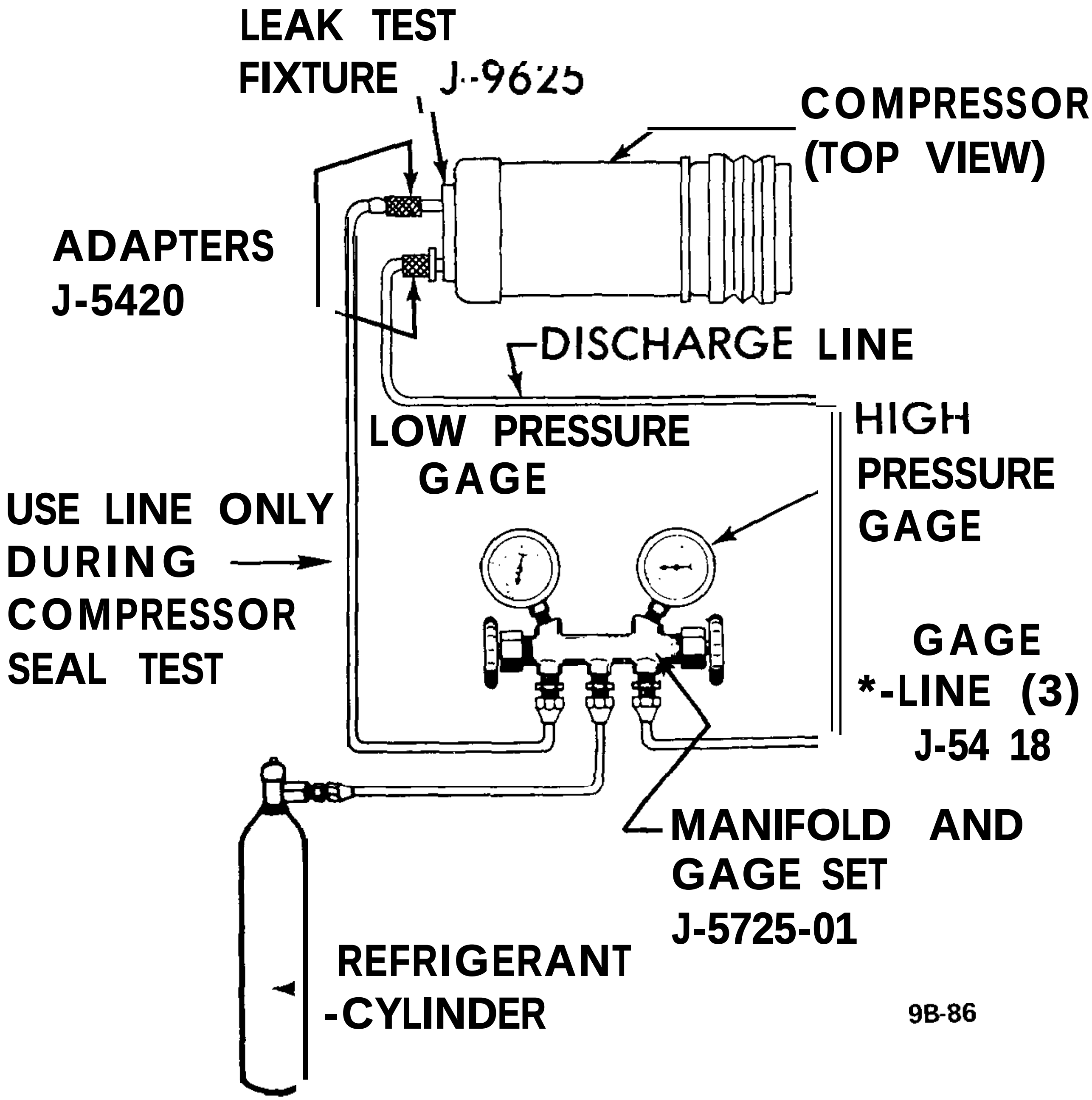


Figure 9B-112 Leak Testing Shaft Seal and Seal Seat O-Ring

the sleeve retainer is recessed approximately 1/32" from the face of the compressor neck.

9. Insert woodruff key into hub of clutch drive plate so that it projects out approximately 3/16 inch (see Figure 9B-113) and position clutch drive plate onto shaft.

10. Using drive plate installer (J-9480), screw installer on end of shaft as shown in Figure 9B-114. Hold nut and turn bolt until clutch drive plate is pressed within 3/32 inch of the pulley assembly.

11. Reassembly spacer into hub of clutch drive plate.

12. Reassemble retainer ring into hub of clutch drive plate (see Figure 9B-106) using No. 21 truarc pliers (J-5403).

13. Thread on new shaft nut using special thin wall 9/16 inch socket (J-9399) and 3/8 inch drive. Hold clutch drive plate secure using Wrench (J-9403) and torque nut to 15 lb. ft. The air gap between the friction surfaces of the pulley assembly and clutch

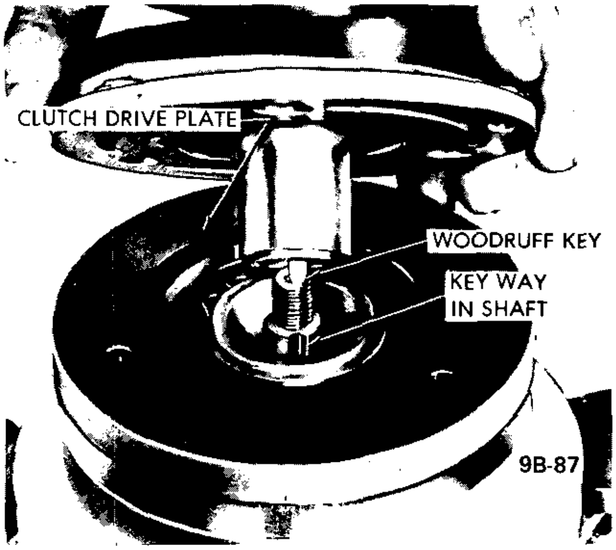


Figure 9B-113 Positioning Clutch Drive Plate on Shaft

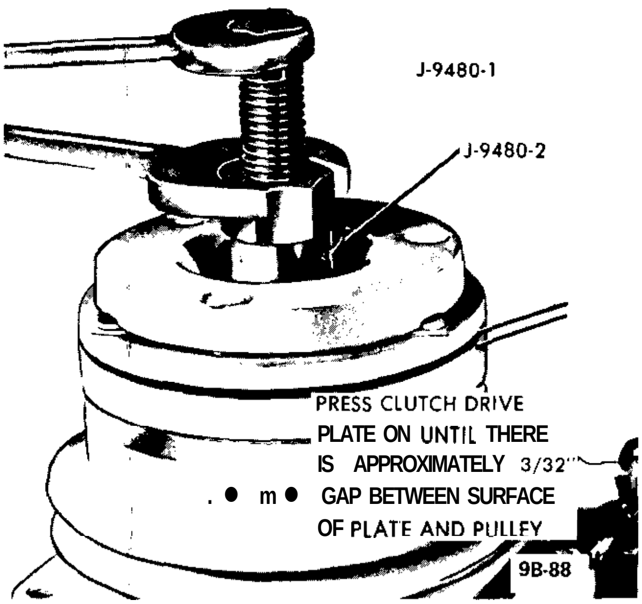


Figure 9B-114 Installing Clutch Drive Plate

drive plate should be approximately 1/32 to 1/16 inch (see Figure 9B-115).

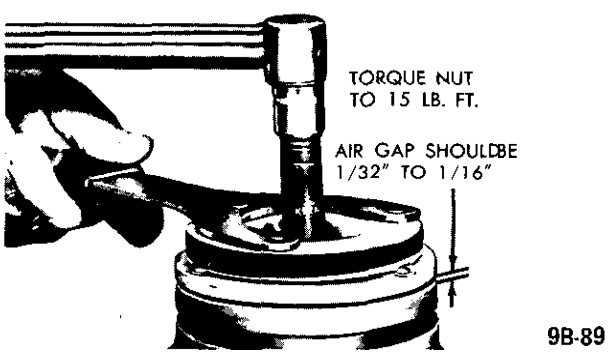


Figure 9B-116 Torquing Shaft Nut

DISASSEMBLY OF PULLEY ASSEMBLY, AND COIL AND HOUSING ASSEMBLY

It is not necessary to remove the compressor or disconnect refrigerant lines to remove or install clutch parts on the GT, however, the compressor must be removed from the Opel 1900 - Manta.

Disassembly

1. Disassemble clutch drive plate.

2. Using No. 26 Truarc pliers (J-6435) remove bearing to head retainer ring (see Figure 9B-116).

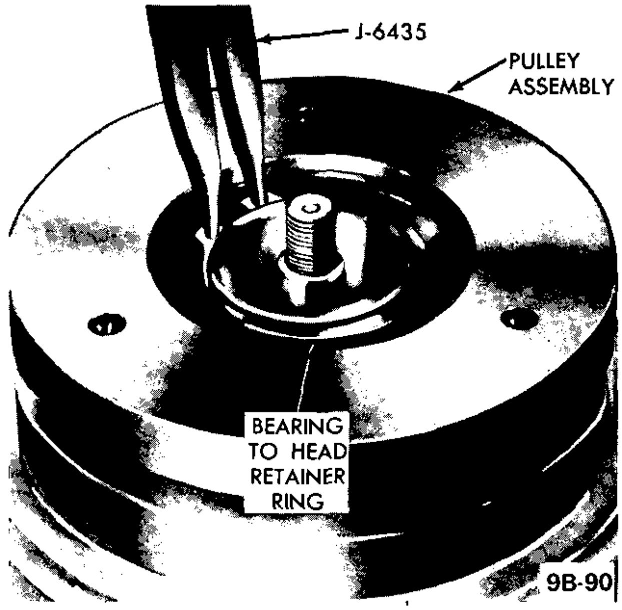


Figure 9B-116 Removing or Installing Bearing to Head Retainer Ring

3. Place puller pilot (J-9395) on hub of front head and take off pulley assembly (see Figure 9B-117), using pulley puller (J-8433).

Puller pilot (J-9395) must be used. If force is exerted on shaft, damage will result to the internal parts of the compressor.

4. Remove bearing to pulley retaining ring with a small screwdriver (see Figure 9B-118).

5. Drive out bearing (see Figure 9B-119) by use of puller Pilot (J-9398) and Handle (J-8092).

Do not take out pulley bearing unless it is going to be replaced as removal may damage bearing.

6. Mark position of coil and housing assembly in relationship to shell of compressor, remove coil and housing retainer ring (see Figure 9B-120) using No.

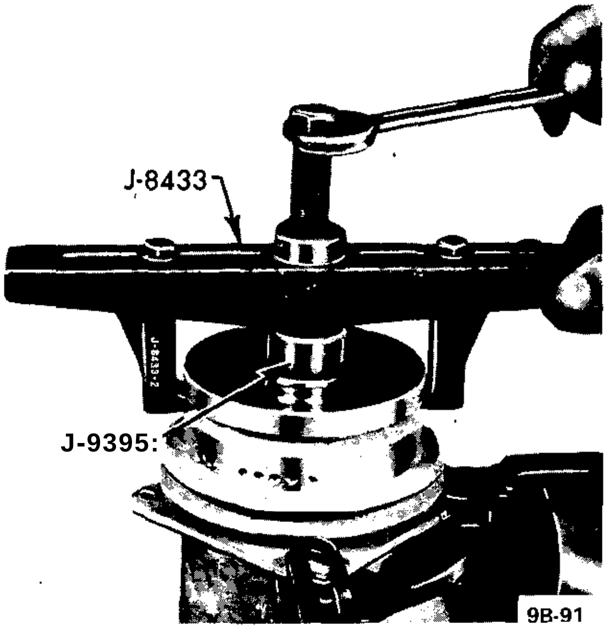


Figure 9B-117 Removing Pulley Assembly

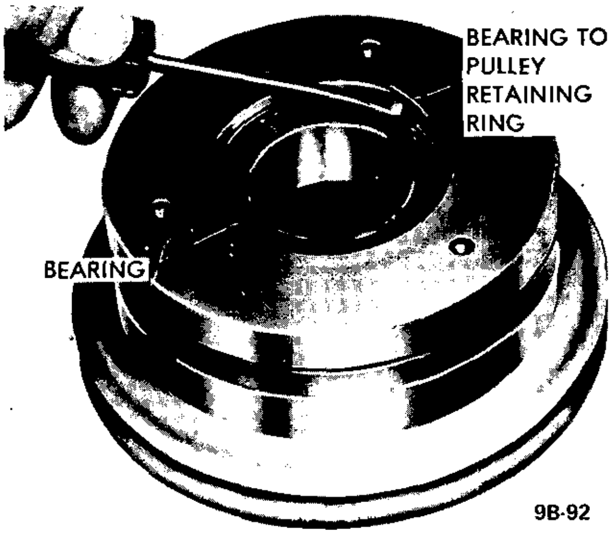


Figure 9B-118 Removing Pulley Bearing Retainer

26 truarc pliers (J-6435), and lift out coil and housing assembly.

Reassembly

1. Reassemble coil and housing assembly reverse of disassembly.

2. Drive new bearing into pulley assembly (see Figure 9B-121) with installer (J-9481) and handle (J-8092).

3. Lock bearing in position with bearing to pulley retainer ring (see Figure 9B-118).

4. Drive pulley assembly onto hub of front head (see

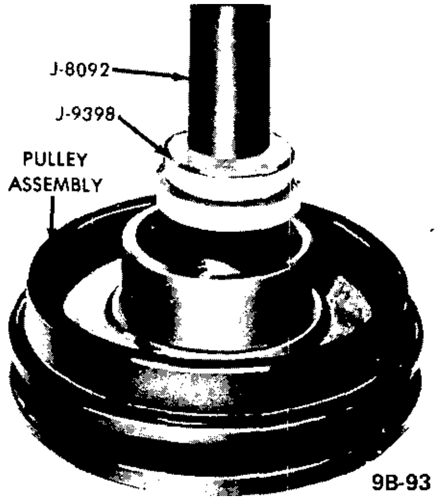


Figure 9B-119 Removing Bearing From Pulley Assembly

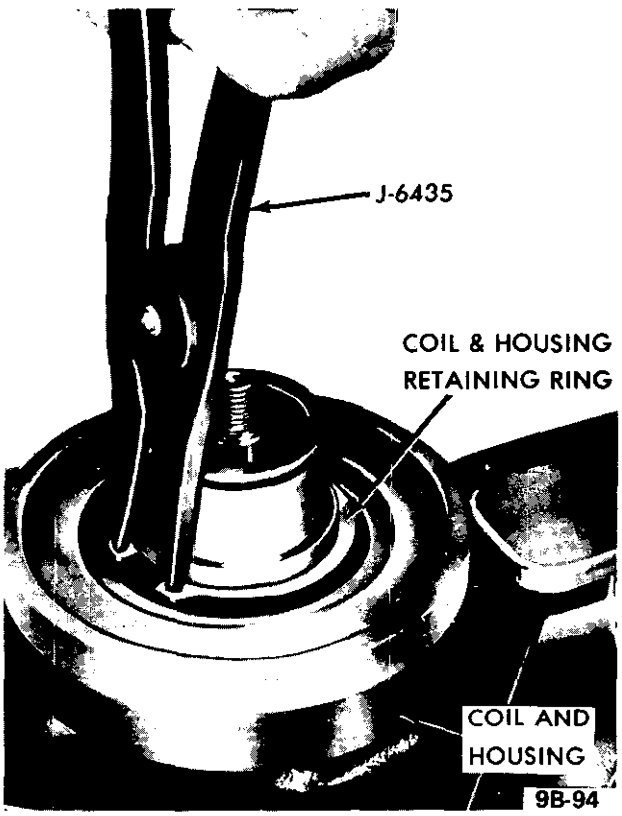


Figure 9B-120 Removing or Installing Coil and Housing Retainer Ring

Figure 9B-122) using installer (J-9481) and handle (J- 8092).

If the pulley assembly is going to be **reused, clean the** friction surface with trichlorethylene, alcohol, or a similar solvent.

5. Lock pulley assembly in position with bearing to head retainer ring (flat side of retainer ring downward) using No. 26 Truarc pliers (J-6435). (See Figure 9B-116).

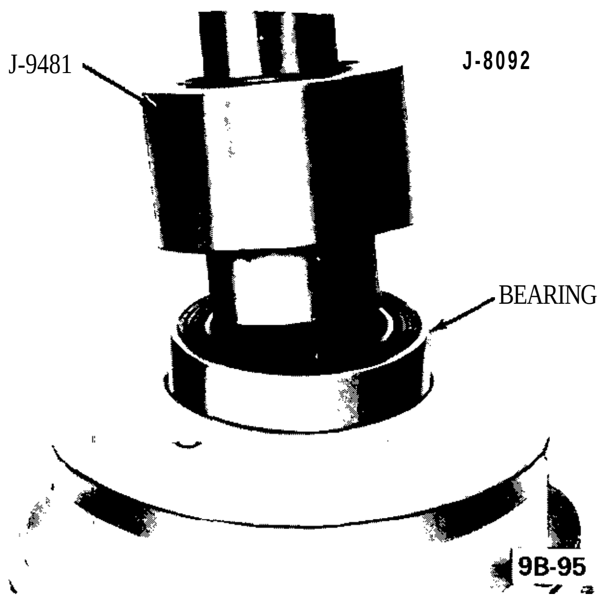


Figure 9B-121 Installing Bearing into Pulley Assembly

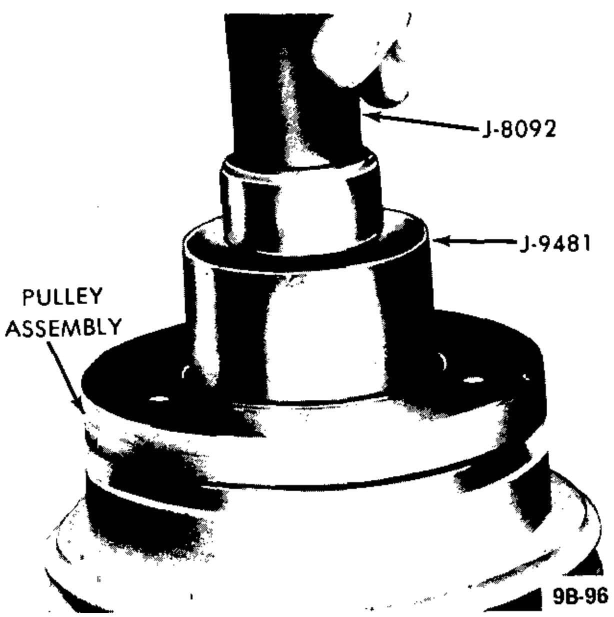


Figure SB-122 Installing Pulley Assembly

6. Reassemble clutch drive plate.

DISASSEMBLY AND REASSEMBLY OF INTERNAL PARTS OF COMPRESSOR AND LEAK TESTING COMPRESSOR

A clean work area and a place for each part removed is required to properly disassemble and reassemble compressor. The internal parts of the compressor must be kept free of dirt or foreign material.

When working with compressor, under no circumstances should compressor be rested on pulley end.

Disassembly of Rear Head, Oil Pump, Rear Discharge Valve Plate, and Rear Suction Valve Reed Disc

If compressor is not going to be disassembled any further than removal of rear head, oil pump, rear discharge valve plate, or rear suction valve reed disc, omit Steps "1, 2 and 4".

1. Disassemble clutch drive plate and shaft seal.

2. Disassemble pulley assembly, and coil and housing assembly.

3. Clean surface of compressor shell and dry with compressed air.

4. Remove compressor from holding fixture (J-9396), unscrew drain screw. Drain, measure and record amount of oil in compressor.

5. Reinstall compressor in holding fixture (J-9396) positioned as shown in Figure 9B-123.

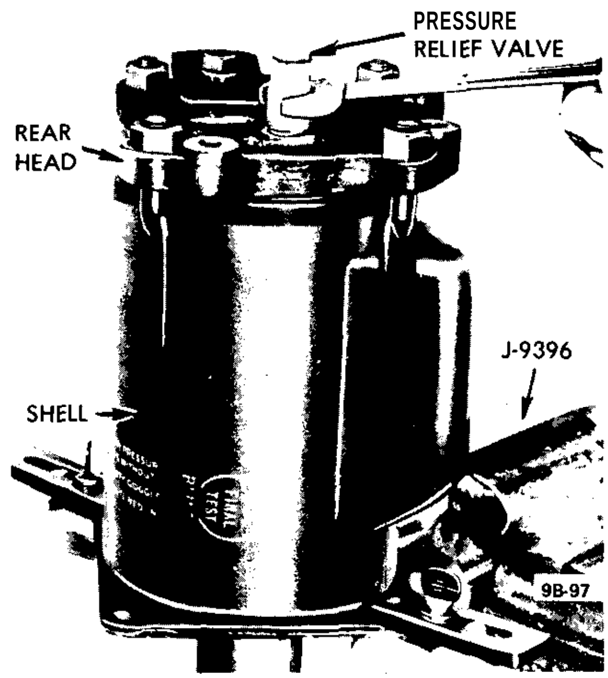


Figure 9B-123 Compressor Installed in Holding Fixture

6. Unscrew and discard four lock nuts from rear of compressor, and lift off rear head by tapping it with a mallet. If Teflon sealing surface is damaged (see Figure 9B-124), replace rear head. Clean or replace suction screen as necessary.

7. Pencil mark top side of both oil pump rotors and lift out rotors. Replace both oil pump inner and outer rotors if one or both are damaged or worn.

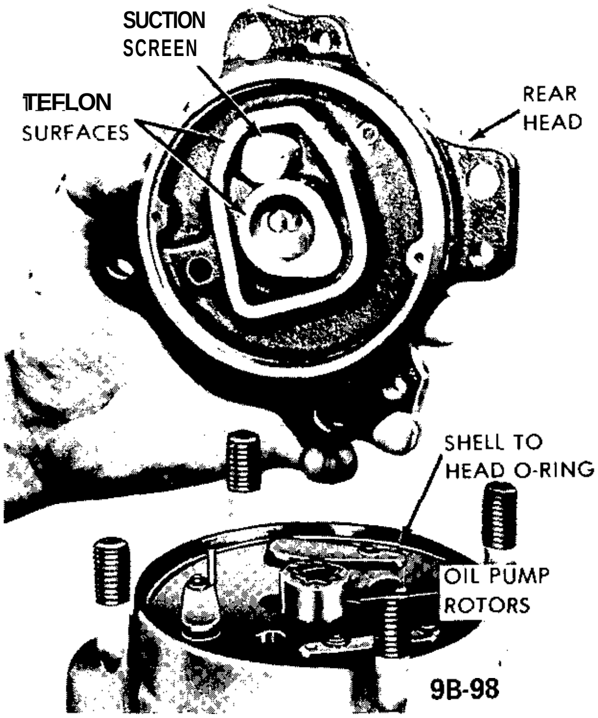


Figure 96-l 24 Rear Head Removal

8. Take out and discard shell to head "O" ring.

9. Carefully pry out rear discharge valve plate and rear suction valve reed disc with screwdrivers (see Figures 9B-125 and 9B-126). Check both pieces and replace as necessary.

During disassembly, the disc generally adheres to the plate and both pieces lift out together.

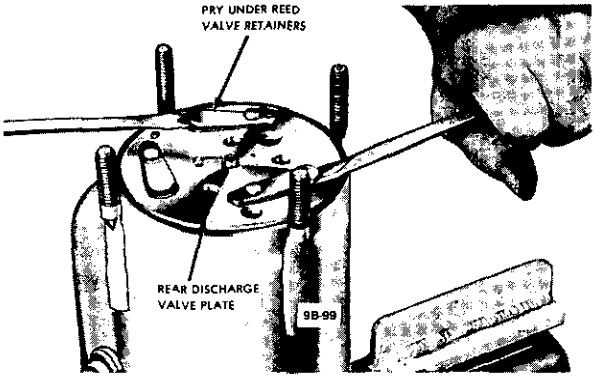


Figure 96-l 25 Removing Rear Discharge Valve Plate

Removing Cylinder Assembly, and Disassembly of Front Suction Valve Reed Disc, Front Discharge Valve Plate, and Front Head

1. Pull out oil inlet tube (see Figure 9B-127) and oil inlet tube "O" ring using Remover (J-6586).

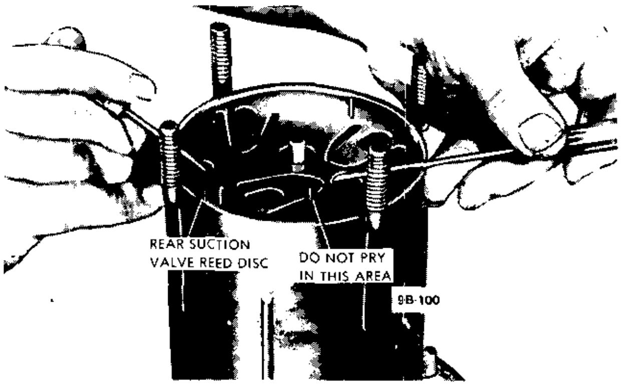


Figure 96-l 26 Removing Rear Suction Valve Reed Disc

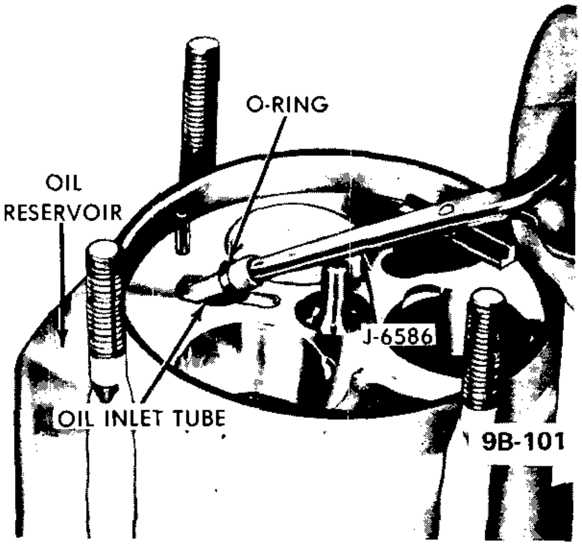


Figure 9B-127 Removing Oil Inlet Tube

2. Push shaft upward from front head and lift out cylinder assembly (see Figure 9B-128), front suction valve reed disc, and front discharge valve plate.

When lifting out the cylinder assembly, the front suction valve reed disc and the front discharge valve plate generally adhere to the cylinder assembly and lift out with it. Check and replace if necessary.

Depending on wear or damage to cylinder assembly, it may be advisable to replace complete cylinder assembly. If service replacement cylinder is used omit following steps and continue on with subparagraph entitled "FINAL REASSEMBLY OF CYLINDER ASSEMBLY".

3. Disassemble front head from shell by tapping front head with a mallet to unseat head, and lifting straight out through rear of shell the front head and shell to head "O" ring (see Figure 9B-130). Discard "O" ring.

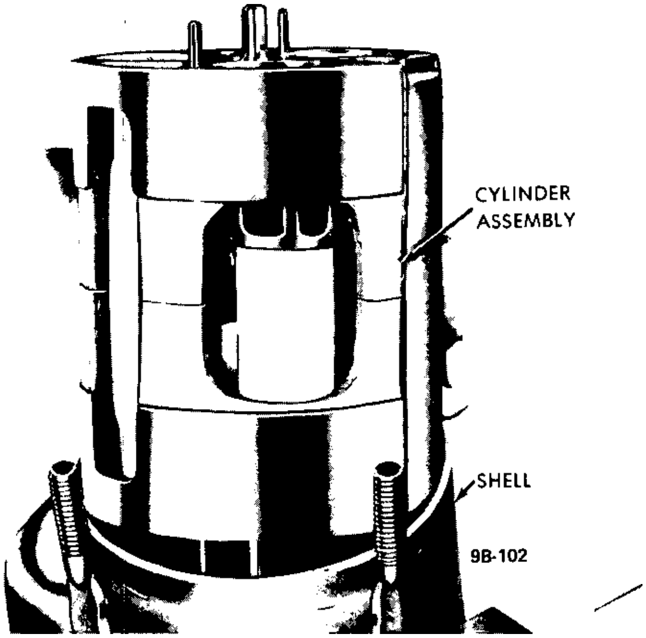


Figure 9B-128 Removing Internal Cylinder Assembly

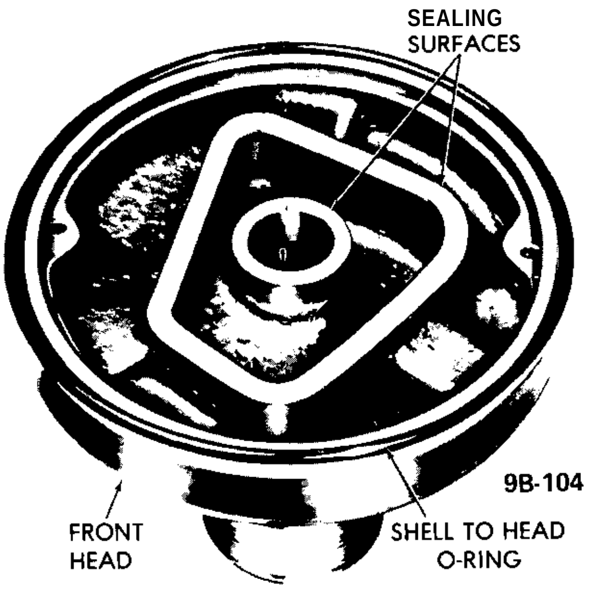


Figure 9B-131 Front Head Sealing Surfaces

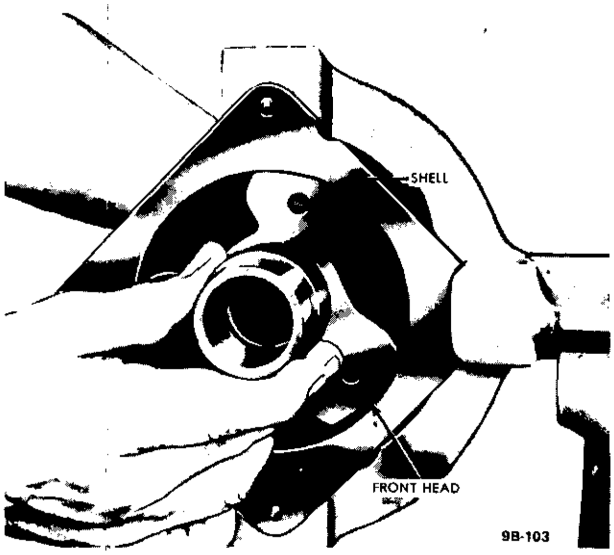


Figure 9B-130 Removing Front Head

If sealing surfaces of front head (see Figure 9B- 13 1) are damaged, replace front head. There is no Teflon on front head sealing surface.

Disassembly of Cylinder Assembly

1. Pry off suction pass cover using screwdriver (see Figure 9B-132).

2. Place cylinder assembly (front end downward) on top of compressing fixture (J-9397), number pistons and cylinders "1, 2 and 3" to facilitate reassembly (see Figure 9B-133), and separate cylinder halves using a hard rubber mallet or hammer and wood block.

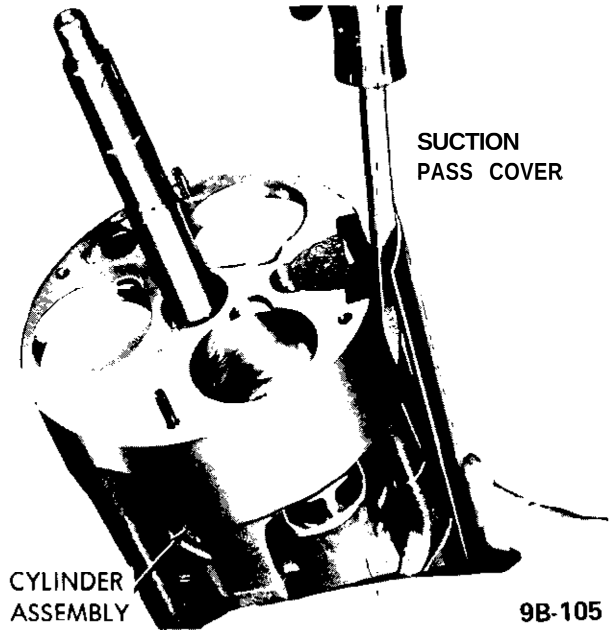


Figure 9B-132 Removing Suction Pass Cover

3. Disassemble rear cylinder half and discharge tube from cylinder assembly and discard discharge tube.

Depending on whether or not discharge tube comes out with rear cylinder half or remains in front cylinder half it may be necessary to rotate shaft and swash plate assembly (using a 9/16 inch opened wrench on shaft seal portion of shaft) to achieve necessary clearance.

4. Carefully disassemble from cylinder assembly (see Figure 9B-134) and lay in respective place on

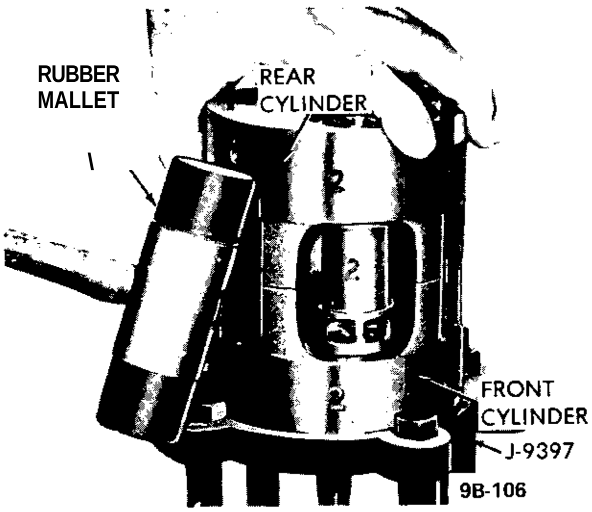


Figure 9B-133 Separating Cylinder Halves

parts tray (J-9402) the following: number "1, 2 and 3" pistons, piston drive balls, and (if service pistons) piston rings. To disassemble rotate swash plate until piston is at highest point, raise swash plate approximately 1/2 inch and lift out piston and related parts one at a time. Discard shoe discs and rear needle thrust bearing and races.

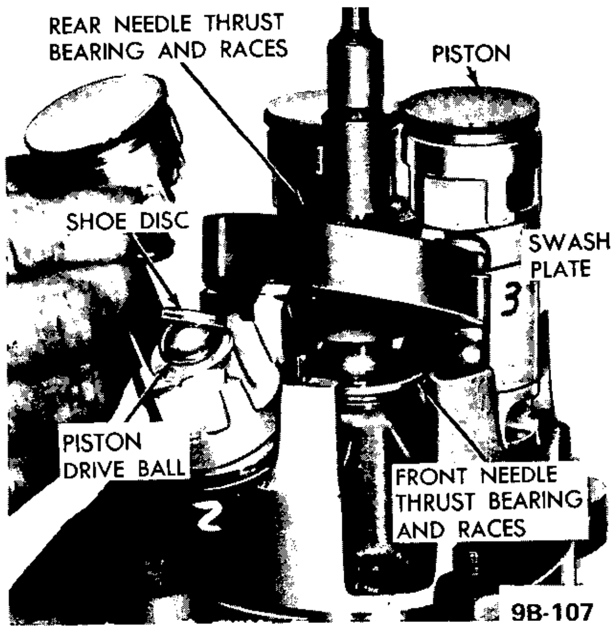


Figure 9B-134 Disassembly of Cylinder Assembly - Service Pistons Shown

Examine piston drive balls and replace if necessary. The front end of the piston may be identified by a recessed notch (see Figure 9B-135).

5. Lift out shaft and swash plate assembly and front needle thrust bearing races. Discard front needle thrust bearing and races.

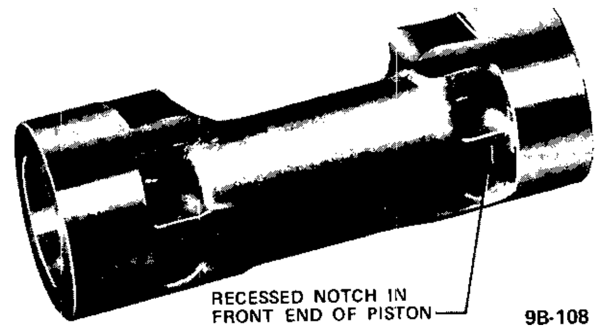


Figure 9B-135 Piston Identification Ringless

Examine shaft and swash plate assembly and replace as necessary.

6. Wash all salvaged parts of cylinder assembly in bath of trichlorethylene, alcohol, or similar solvent and dry parts with filtered, dry compressed air.

Examine front and rear cylinder halves, front and rear main shaft bearings, and replace as necessary. If bearings are to be replaced, drive out of cylinder halves with suitable socket or punch. Install new bearing (lettering on bearing edge facing outward) using bearing installer (J-9432). See Figure 9B-136.

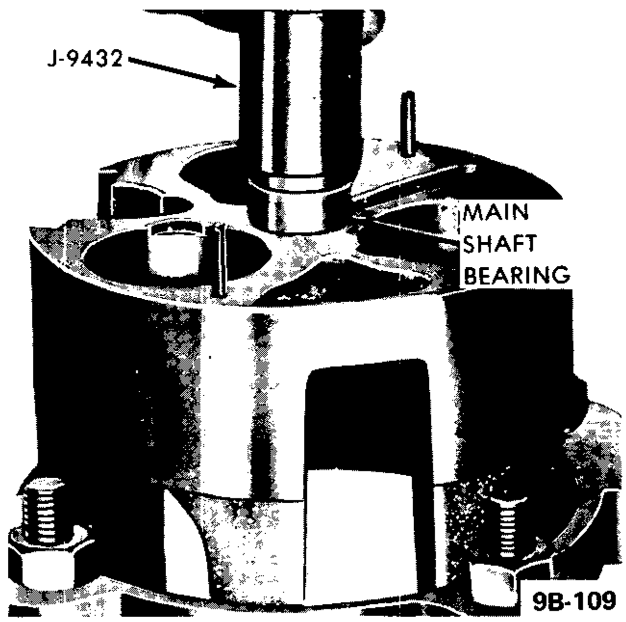


Figure 9B-136 Installing Main Shaft Bearing

Partial Reassembly of Cylinder Assembly, and Gaging of Piston Play and Shaft End Play

1. Obtain from parts stock four "zero" thrust races, two needle thrust bearings, and three "zero" shoe discs.

2. Place front cylinder on top ofcompressing fixture (J-9397) as shown in Figure 9B-137).

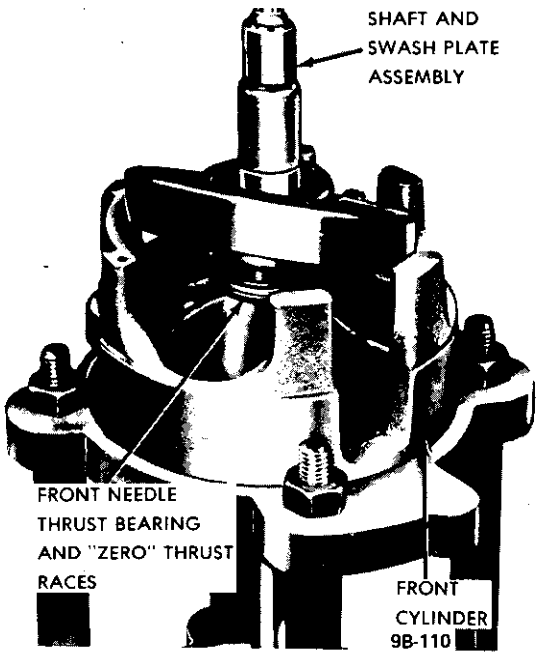


Figure 9B-137 Shaft and Front Needle Thrust BE in Cylinder Half

3. Generously coat with clean petroleum jelly two "zero" thrust races, and a new needle thrust bearing. Assemble races and bearing to front end of shaft and swash plate assembly and insert assembly into front cylinder '(see Figure 9B-137).

4. Assemble two additional "zero" thrust races and a new needle thrust bearing to rear end of shaft and swash plate assembly.

5. Lightly coat ball pockets of the three pistons with clean petroleum jelly and place a piston drive ball in each pocket.

6. Lightly coat the three "zero" shoe discs with clean petroleum jelly and place a disc on only the piston drive ball at the front of each piston.

Do not place shoe discs on rear piston drive balls. Do not reassemble piston rings on pistons (if service pistons) at this time. Use lubricant in sufficient quantity so that piston drive balls and shoe discs stick to piston.

7. Rotate shaft and swash plate assembly until high point of wash plate is over No. "1" cylinder bore. Position No. "1" piston onto swash plate (see Figure 9B-137) and lower the piston and swash plate so the front end (notched end - see Figure 9B-138) of the piston enters the cylinder bore.

In order to fit the piston onto the swash plate, the shaft and swash plate assembly must be raised approximately 1/2 inch, and also the front needle thrust bearing and races must be held up against the hub of the swash plate.

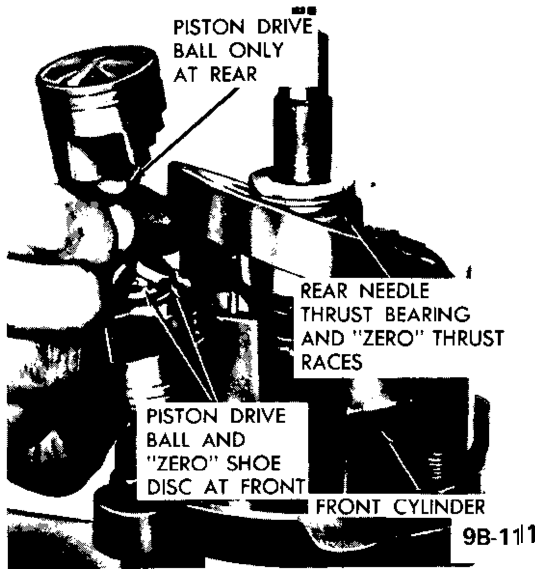


Figure 9B-138 Installing Piston Into Cylinder Half Service Piston Shown

8. Repeat preceding step for reassembly of pistons No. "2" and No. "3".

9. Reassemble rear cylinder onto front cylinder using wood block and mallet (see Figure 9B-140).

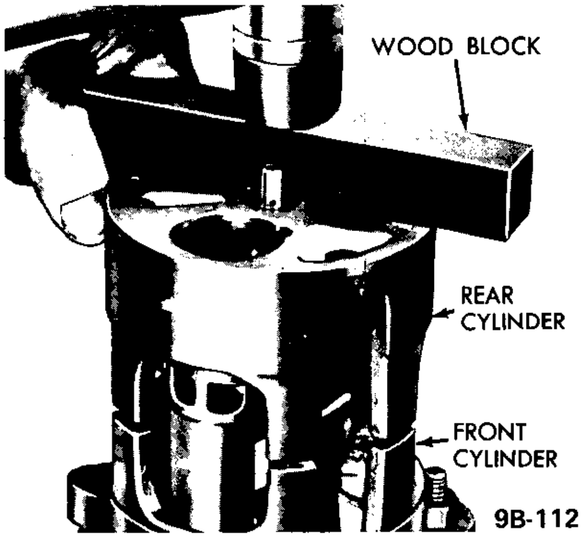


Figure 9B-140 Assembling Rear Cylinder Half

10. Remove cylinder assembly from on top of compressing fixture (J-9397), position assembly inside fixture so that discharge tube opening in cylinder halves is located between fixture legs, and front of cylinder assembly is downward. Install and torque fixture nuts to 15 lb. ft.

11. Gage piston play as follows:

(a) Using a feeler gage, select a leaf or combination of leaves which result in satisfactory "feel" when inserted between rear piston drive ball and swash plate (see Figures 9B-141 and 9B-142).

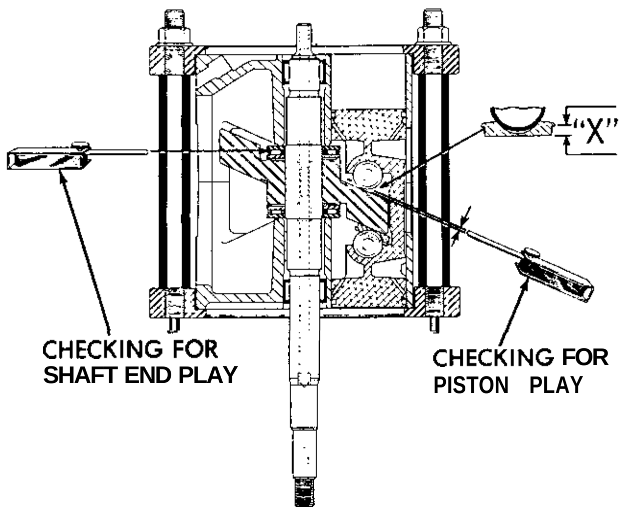


Figure 9B-141 Checking Piston and Shaft End Play

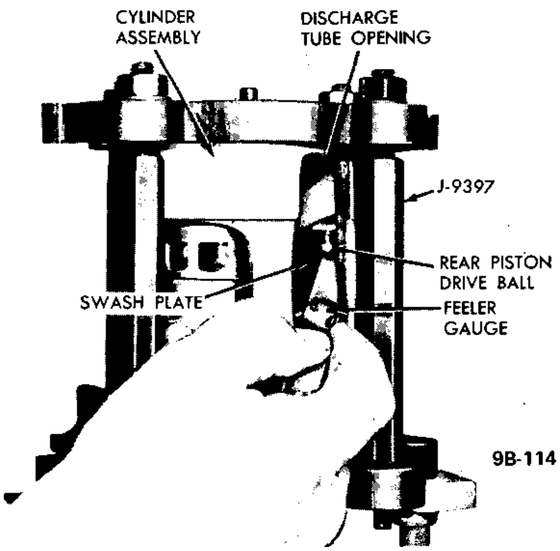


Figure 9B-142 Checking Clearance Between Rear Piston Drive Ball and Swash Plate

(b) Remove selected leaf or leaves from feeler gage and attach end of spring scale that is calibrated in ounces. (A generator brush spring scale (J-5 184) or the spring scale for checking distributor point setting may be used for this step).

(c) Reinsert feeler gage leaf or leaves between rear piston drive ball and swash plate and draw leaf or leaves out again, simultaneously measuring "drag" on leaf or leaves (see Figure 9B-143). If correct leaf (leaves) has been selected, spring scale will read between 4 to 8 ounces pull (the higher reading is desired). To perform this step correctly, feeler gage leaf (leaves) must be withdrawn straight out with a steady even motion, and all surfaces involved must be coated with No. 525 viscosity oil. Record gage dimension.

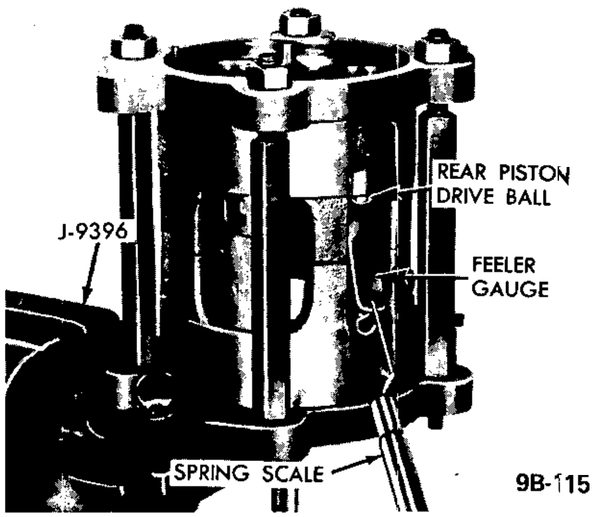


Figure 9B-143 Checking Drag on Selected Feeler Gage Leaf with Spring Scale

Use of the spring scale establishes a standard of measurement of the amount of feeler gage leaf "drag" required.

(d) Rotate the shaft and swash plate assembly 120 degrees and perform a second check (Steps "a, b and c") between same piston drive ball and swash plate. Record gage dimension.

(e) Rotate shaft and swash plate again approximately 120 degrees and repeat third check (Steps "a, b and c") between same piston drive ball and swash plate. Record gage dimension.

(f) From the three recorded checks (Steps "c, d and e") select minimum feeler gage reading and obtain from stock (ref. to the Shoe Disc Table for part number of shoe disc) one shoe disc corresponding to the minimum gage reading (ref. example below). Place shoe disc in respective position on parts tray (J-9402).

Shoe Disc Table

SERVICE PART NO.	ID. NO. STAMPED
	SHOE DISC
6557000	0 ("Zero" Shoe Disc)
6556175	17 1/2
6556180	
6556185	1 8 %
6556190	19
6556195	19 1/2
	20
6556200	20 1/2
6556210	21
6556215	21 1/2
6556220	22

EXAMPLE

Piston' No.	1st Check	2nd Check	3rd Check
1	.019	.020	.019
(Select No. 19 - Shoe Disc)			
2	.020	.020	.019
(Select No. 19 • Shoe Disc)			
3	.021	.020	.021
(Select No. 20 Shoe Disc)			

(g) Repeat Steps "c, d, e and f" for other two pistons and obtain two more selected shoe discs for other two pistons. In the rebuilt cylinder assembly, each piston will have one selected shoe disc and one "zero" shoe disc.

12. Gage shaft end play as follows:

(a) Using a feeler gage, select a leaf or combination of leaves which result in satisfactory "feel" when inserted between rear needle thrust bearing and outer rear thrust race (see Figure 9B-144).

(b) Remove selected leaf or leaves from feeler gage. Attach to end of spring scale calibrated in ounces. (A generator brush spring scale (J-5184) or the spring scale for checking distributor point setting may be used for this step).

(c) Reinsert feeler gage leaf (leaves) between rear needle thrust bearing and outer rear thrust race and draw leaf (leaves) out again, this time simultaneously noting the "drag" or pull on the leaf (leaves) as measured by the spring scale (see Figure 9B-145). If correct leaf (leaves) have been selected, spring scale will read between 4 to 8 ounces pull (the higher reading is desired). To perform this step correctly, the feeler gage leaf (leaves) must be withdrawn straight out with a steady, even motion. All contacting surfaces involved in gaging operation must be coated with No. 525 viscosity oil.

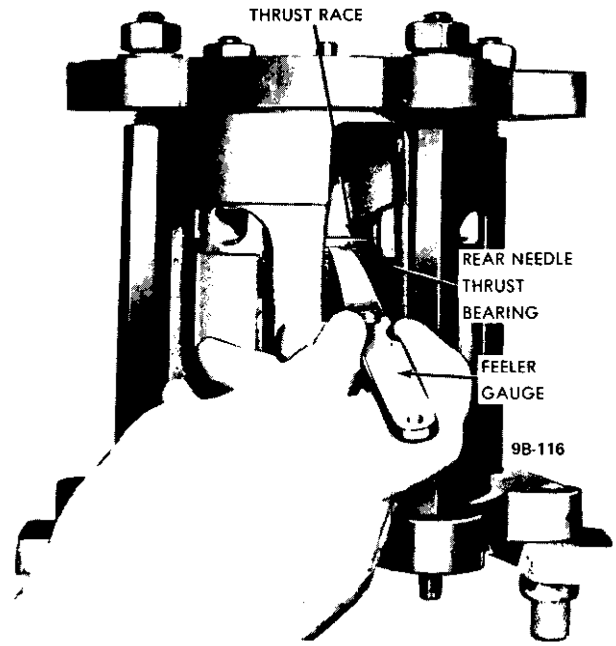


Figure 9B-144 Gaging Clearance Between Rear Needle Thrust Bearing and Outer Rear Thrust Race

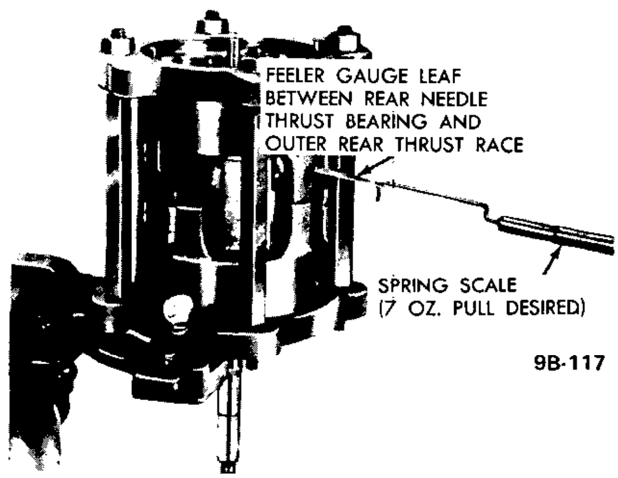


Figure 9B-145 Checking Drag on Selected Feeler Gage Leaf with Spring Scale

The measurement for selection of the thrust race needs to be performed at only one place on the shaft and swash plate assembly.

(d) Select from stock one thrust race (ref. Thrust Race Table for part number of thrust race) corresponding to the feeler gage reading determined in step "c", and place the selected thrust race in the parts tray slot designated for the outer rear thrust race. If, for example a feeler gage reading of 0.009 inch results, a thrust race with a number "9", stamped on it should be selected.

Thrust Race Table

SERVICE PART NO.	ID NO. ON RACE	THICK-NESS
6556000	0	.0920
6556050	5	.0965
6556055	5 1/2	.0970
6556060	6	.0975
6556065	6 1/2	.0980
6556070	7	.0985
6556075	7 1/2	.0990
6556080	8	.0995
6556085	8 9	.1000
6556090	1/2	.1005
6556095	9	.1010
6556100	10	.1015
6556105	10 1/2	.1020
6556110	11	.1025
6556115	11 1/2	.1030
6556120	12	.1035

The selected thrust race will replace only the "zero" outer rear thrust race. The remaining three "zero" thrust races will remain as part of the cylinder assembly.

13. Remove cylinder assembly from inside compressing fixture (J-9397), place on top of compressing fixture (see Figure 9B-133) and disassemble rear cylinder from front cylinder using rubber mallet or hammer and wood block.

14. Carefully disassemble one piston at a time from front cylinder and lay piston, front and rear piston drive balls and front "zero" shoe disc in respective slot of parts tray (J-9402). To disassemble, rotate swash plate until piston is at highest point, raise a swash plate approximately 1/2 inch and lift out piston and related parts, one at a time.

15. Remove outer rear "zero" thrust race from shaft and set it aside for future gaging procedures.

16. Remove previously selected outer rear thrust race from parts tray, lightly coat with clear petroleum jelly and assemble onto shaft.

Final Reassembly of Cylinder Assembly

1. Reassemble piston rings (if service pistons) onto pistons (ring scraper groove toward center of piston) and rotate ring so that break or gap in ring can be squeezed together when piston is being inserted into cylinder bore.

2. Reassemble piston drive balls, "zero" and selected shoe discs onto No. "1" piston, and apply clear petroleum jelly to piston pockets and shoe discs so that balls and discs stick to piston. BE SURE to reassemble balls and shoe discs into their specific positions on front and rear of piston.

3. Rotate shaft and swash plate assembly until high point of swash plate is over No. "1" cylinder bore. Position No. "1" piston onto swash plate (see Figure 9B-146) and lower the piston and swash plate so that the front end (notched end) of the piston enters the cylinder bore.

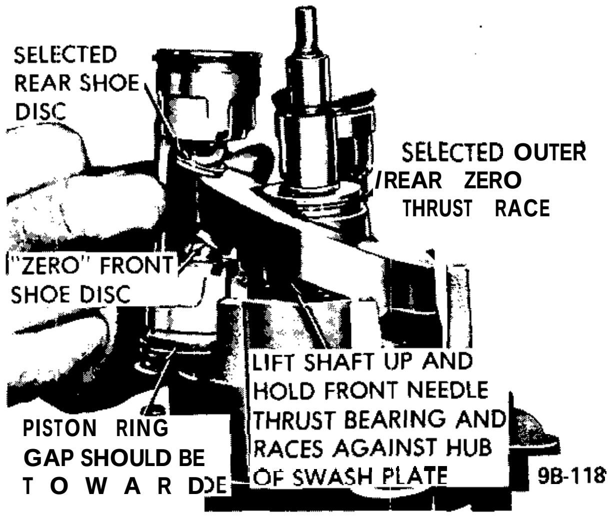


Figure 9B-146 Installing Piston Assembly in Front Cylinder Half - Service Pistons Shown

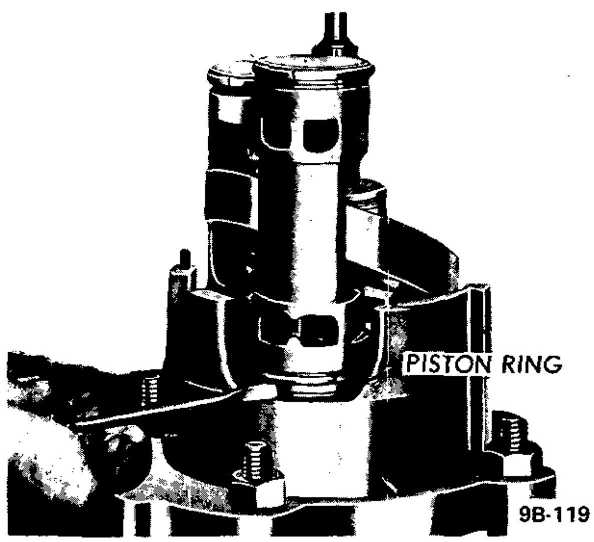


Figure 9B-147 Compressing Front Piston Rings - Service Pistons

In order to tit the piston onto the swash plate and into the cylinder bore, the swash plate must be raised approximately 1/2 inch, the front needle thrust bearing and races must be held up against the hub of the swash plate, and the service piston rings must be squeezed together (see Figure 9B-147). Lubricate cylinder bore, piston assembly and wash plate with No. 525 viscosity oil to facilitate reassembly.

4. Repeat procedure in Steps 1 and 2 for installation of No. 2 and No. 3 pistons.

5. Obtain new service replacement discharge tube and assemble into front cylinder (see Figure 9B-148).

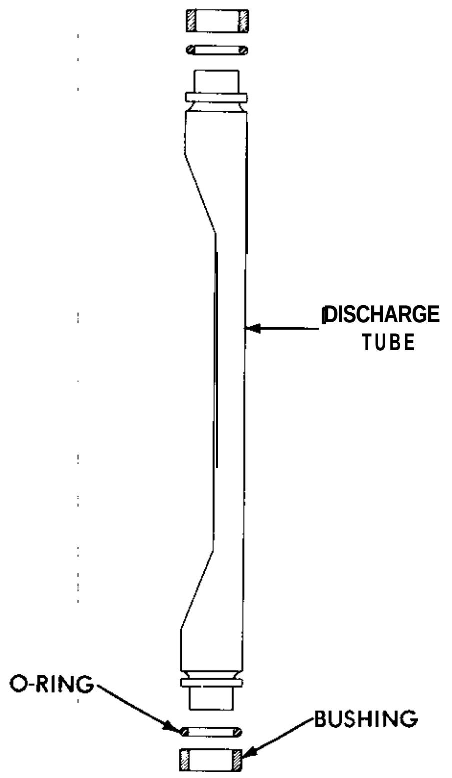


Figure 9B-148 Service Replacement Discharge Tube

6. Liberally lubricate cylinder bores of rear cylinder with No. 525 viscosity oil and reassemble rear cylinder onto front cylinder being sure to compress service piston rings. Align discharge tube and dowel pins, and tap cylinder halves together. Check for free rotation of shaft.

If pistons are positioned in a "stair-step" arrangement (see Figure 9B-150), installation of rear cylinder will be facilitated. In addition once the service piston and ring are started into the cylinder, slight rotation of the shaft to and fro will work the ring into the bore.

7. Liberally lubricate with No. 525 viscosity oil,

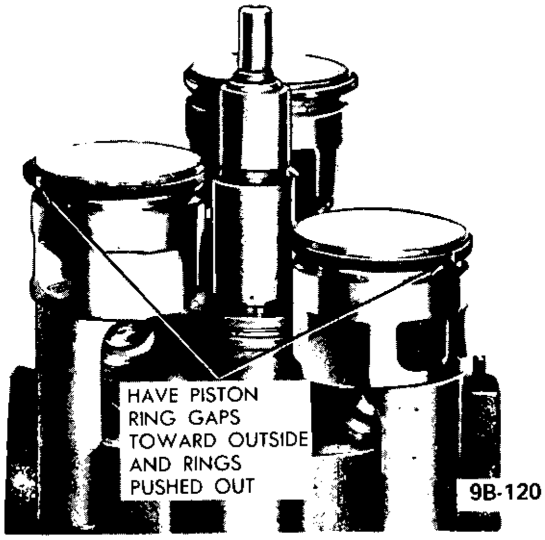


Figure SE-150 Pistons Positioned in Stair-Step Arrangement · Service Pistons Shown

suction pass cover and lips ofsuction passage in body of cylinder assembly, and reassemble suction pass cover over suction passage (see Figure 9B-151).

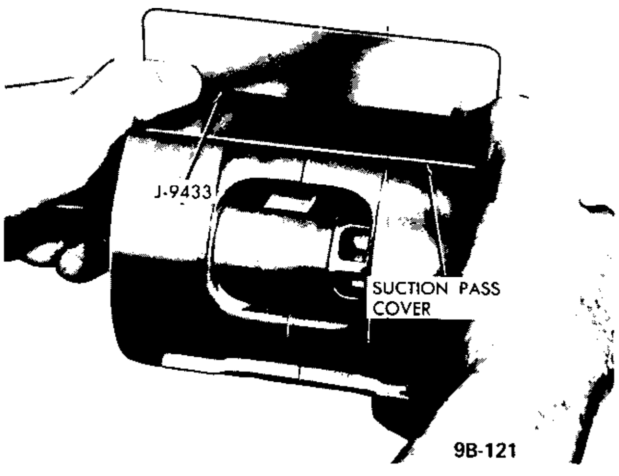


Figure 9B-151 Installing Suction Pass Cover

8. Assemble both service replacement discharge tube "O" rings and bushings (see Figure 9B-152) onto cylinder assembly.

Reassembly of Front Suction Valve Reed Disc, Front Discharge Valve Plate, Front Head. and Installing of Cylinder Assembly

1. Assemble suction reed valve disc to front of cylin-

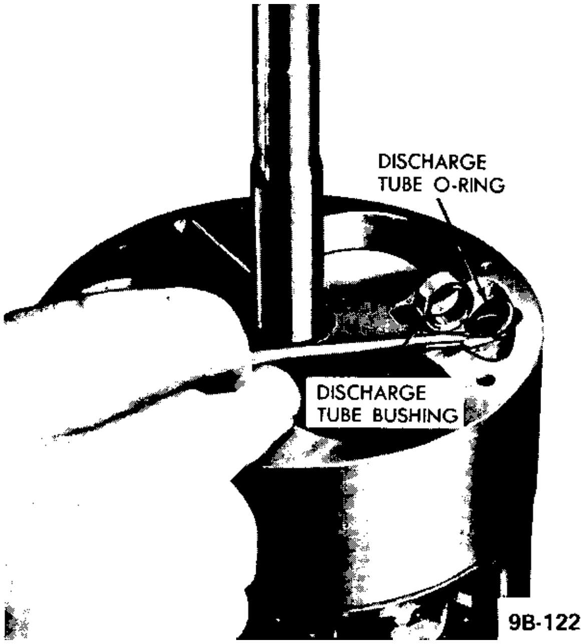


Figure 9B-152 Installing Discharge Tube O-Ring and Bushing

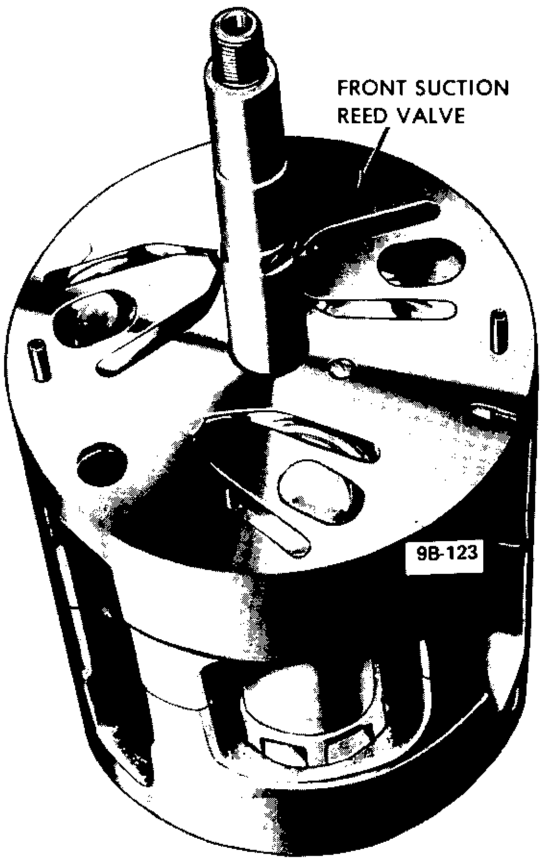


Figure 9B-153 Front Suction Valve Reed Disc installed

der assembly and align with dowel pins, suction port and discharge port (see Figure 9B-153).

2. Assemble front discharge valve plate to front of cylinder assembly and align with dowel pins.

3. Coat sealing surfaces on front head (see Figure 9B- 154) with No. 525 viscosity cdl.

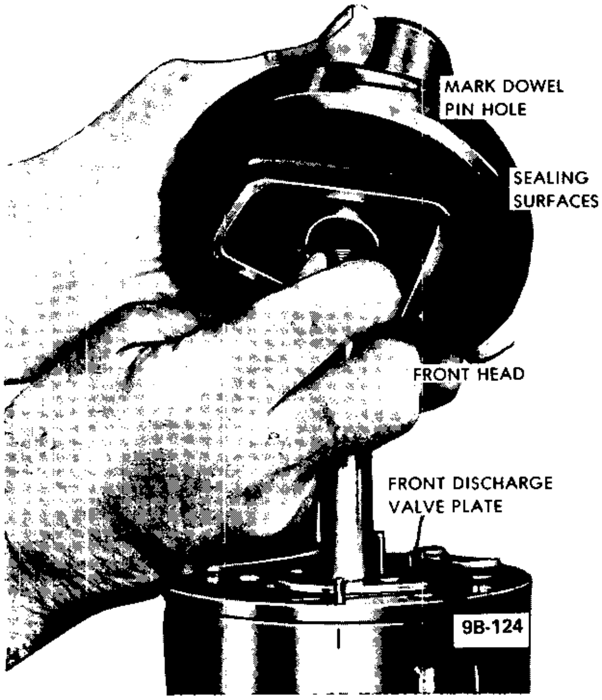


Figure 9B-154 Placing Front Head on Cylinder Assembly

4. Murk with pencil on side of front head the location of dowel pin holes (see Figure 9B-154), align front head with dowel pins, and tap head lightly with mallet to seat on cylinder assembly.

5. Place new shell to head "O" ring on shoulder of front head (see Figure 9B-155) and liberally coat "O" ring and front head sealing surface with No. 525 viscosity oil.

6. Install she11 in holding fixture (J-9396) and position so that rear studs of shell are up. Coat inside surface of shell with No. 525 viscosity oil.

7. Reassemble, as a unit, cylinder assembly and front head into the shell. See Figure 9B-156. Extreme care must be used to prevent she11 to head "O" ring seal from being damaged.

Reassembly of Rear Suction Valve Reed Disc, Rear Discharge Valve Plate, Oil Pump and Rear Head

1. Rotate the cylinder assembly and front head until

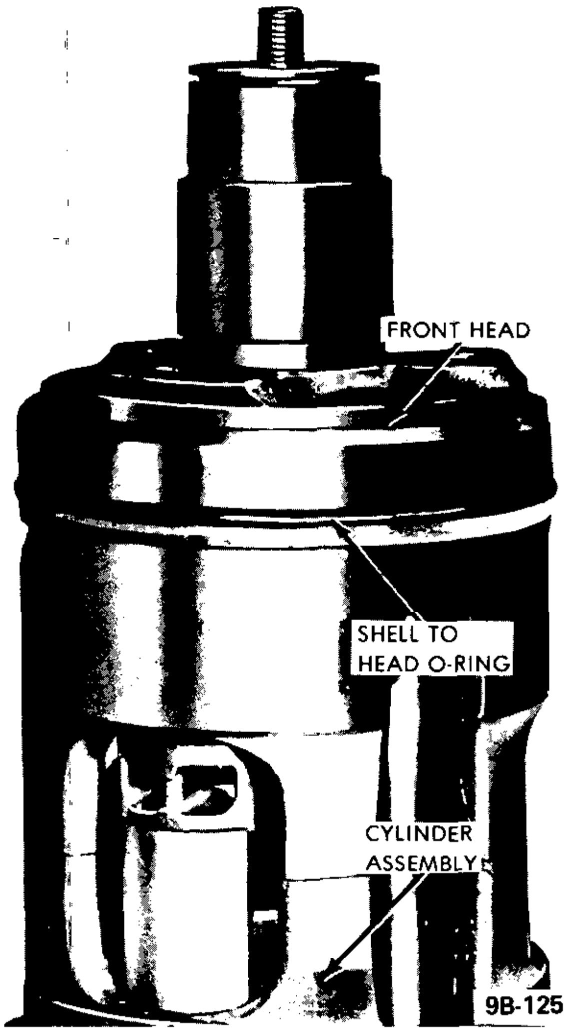


Figure 9B-155 Shell To Front Head O-Ring Installment

the hole for the oil inlet tube in the cylinder assembly is aligned with the reservoir hole in the shell, and reassemble the oil inlet tube and "O" ring.

2. Assemble suction reed valve disc to rear of cylinder assembly and align with dowel pins, suction port, and discharge port of cylinder assembly.

3. Assemble rear discharge valve plate to rear of cylinder assembly and align with dowel pins.

4. Reassemble inner and outer oil pump rotors so that the sides previously identified are in their original location, and then position oil pump outer rotor as shown in Figure 9B-157.

5. Generously coat with No. 525 viscosity oil new shell to head "0" ring and install in shell (see Figure 9B-157).

6. Coat Teflon sealing surface of rear head with No. 525 viscosity oil, mark with pencil on side of rear head the location of the dowel pin holes and reassemble onto compressor.

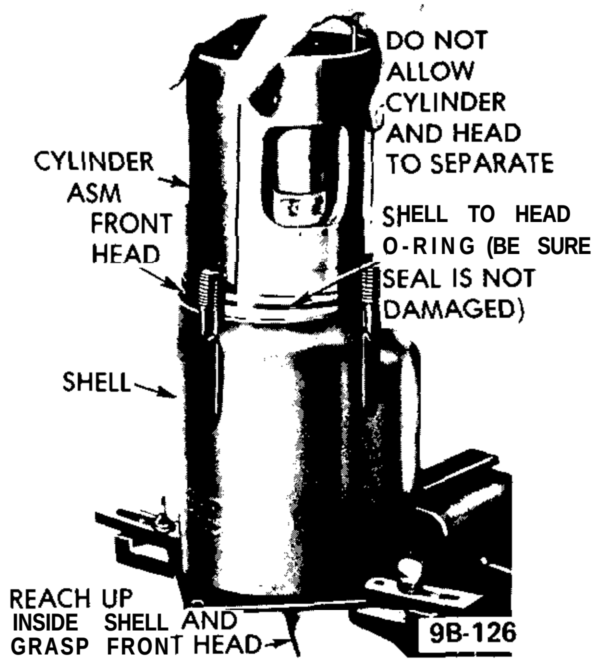


Figure SB-156 Installing Front Head and Cylinder Assembly in Shell

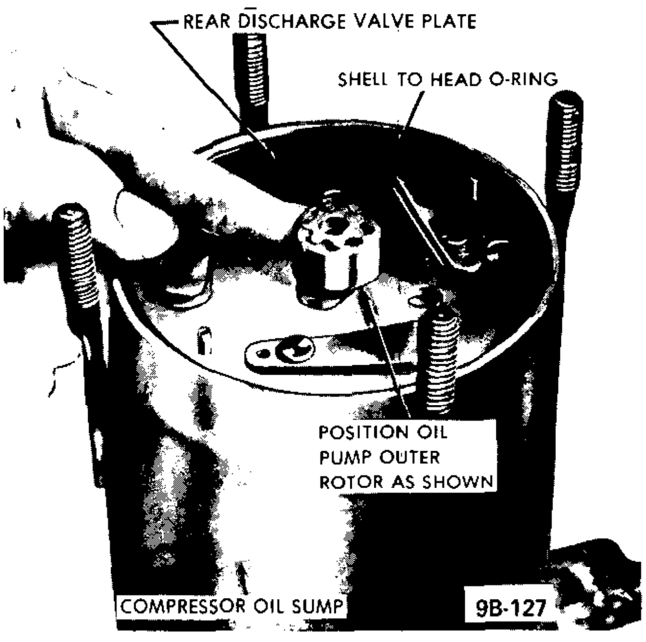


Figure 9B-157 Positioning Oil Pump Outer Rotor

It may be necessary to reposition oil pump outer rotor slightly in order to install rear head. In addition, if dowel pins do not engage' holes in rear head, grasp front head and rotate cylinder assembly slightly (see Figure 9B-158).

7. Assemble new nuts to threaded shell studs and torque to 10 lb. ft. If pressure relief valve has been removed, reassemble using a new pressure relief valve gasket.

8. Reassemble new lubricated suction and discharge

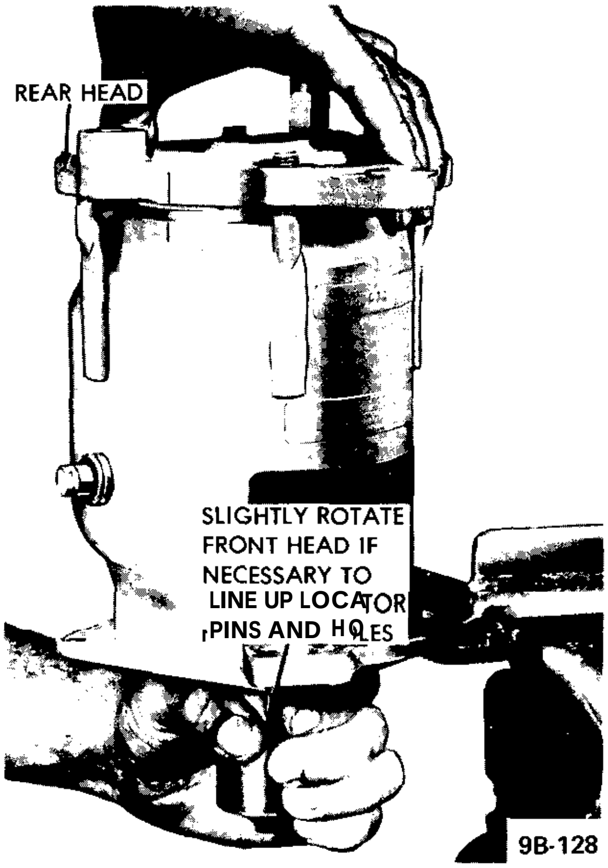


Figure 9B-158 Installing Rear Head

"O" rings into suction and discharge ports of rear head.

9. Reassemble shaft seal onto front of shaft and swash plate assembly. Do not reassemble clutch drive plate at this time.

Leak 'Testing Compressor

1. After the shaft seal pressure test has been performed, change the test circuit to the configuration shown in Figure 9B-160.

2. With hose attached only to high pressure side of Leak Test Fixture J-9625, open high pressure valve to charge high pressure side of compressor. As soon as high pressure gage stabilizes reading, close valve. If high pressure gage drops back immedaitely when valve is closed, an internal leak is indicated. Correct leak as necessary.

If an internal leak is indicated, the leak may exist about the head sealing surface or Teflon seal, discharge tube, shell to head "O" rings, or suction valve reed discs.

3. Remove drain screw from shell and add No. 525 viscosity oil as specified.

4. Reassemble pulley assembly, and coil and housing assembly onto hub of front head.

5. Complete reassembly by installing clutch drive plate onto hub of front head. See Figure 9B-164 disassembled view of compressor.

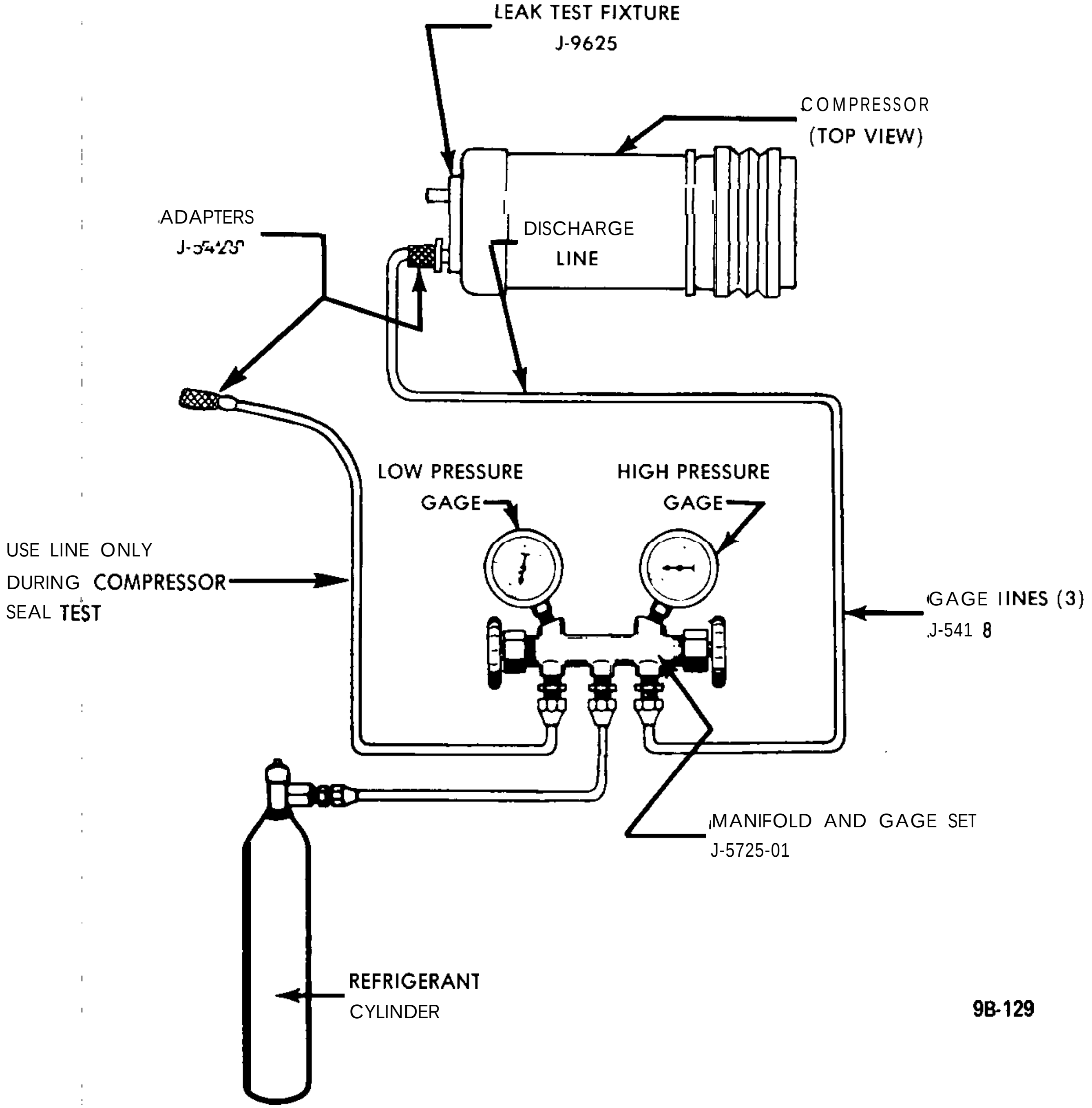


Figure 9B-160 Compressor Infernal Leak Test

SPECIFICATIONS

Tightening Specifications

Part	Location	Torque Lb. Ft.
Nut	Drive Plate Nut to Compressor Shaft	15
Nut	Rear Head to Shell	21
Cap	Schrader Service Valve	5

Compressor Specifications

Type	Six Cylinder Axial Opposed
Make	Frigidaire
Effective Displacement (Cu. In.)	9.2
Oil	525 Viscosity
Oil Content (New)	10 Fl. Oz.
Air Gap Between Clutch Drive Plate and Pulley	0.022 to 0.057 In.
Clutch Type	Magnetic
Belt Tension	1 10-125 Lbs. Irritial
	80 Lbs. Retension

Pipe and Hose Connection Torque Chart

Metal Tube Outside Dia.	Thread and Fitting Size	Steel Tubing Torque Lb. Ft.	Aluminum or Copper Tubing Torque Lb. Ft.	Nominal Torque Wrench Span
1/4	7/16	10-15	5-7	5/8
3/8	5/8	30-35	11-13	3/4
5/8	7/8	30-35	21-27	1 1/16
3/4	1 1/16	30-35	28-33	1 1/4

General Specifications

Thermostat Opening Temperature	189
Capacity of Cooling System With Air Conditioner (Quarts)	6 (Approx.)
Type of Refrigerant	Refrigerant 12
Refrigerant Capacity (Fully Charged)	
Opel 1900 • Manta	2 Lbs.
GT	2 1/4 Lbs.

Functional Test Procedures

1. Place transmission in park for automatics and in neutral for manuals. Apply hand brake.

2. Turn blower switch to HI position,

3. Turn temperature switch to MAX position

4. Run engine at 2000 RPM for ten (10) minutes with car doors and windows closed and the hood up. Place a commercial high volumn fan in front of condenser if head pressure should exceed 250 psig.

A commercial high volumn fan should be placed in front of the condenser at high ambients to bring the pressures to within the limits specified in the Functional Charts. When testing the Opel 1900 and Manta, a thermometer should be placed in a position to read the temperature of the air discharging from the right-hand A/C outlet. When testing the GT, a thermometer should be placed in a position to read the temperature of the air discharging, from the left-rear A /C outlet.

FUNCTIONAL TEST - OPEL 1900. MANTA

Temp. of Air Entering Cond.	70	80	90	100	110
Engine RPM	2000	2000	2000	2000	2000
Comp. Head Pressure*	155.165	195.205	200-210	250-260	270.280
Suction Press.'	19	22	22	27	29
Discharge Air Temperature*	38-43	40.45	42-47	45-50	47-52

*When compressor clutch disengages,

FUNCTIONAL TEST - GT

Temp. of Air Entering Cond.	70	80	90	100	110
Engine RPM	2000	2000	2000	2000	2000
Comp. Head Pressure"	125.135	145.155	180-190	210-220	150.260
Suction Press."	17	20	20	22	24
Discharge Air Temperature*	37-42	38-43	39-44	40-45	45-50

"When compressor clutch disengages

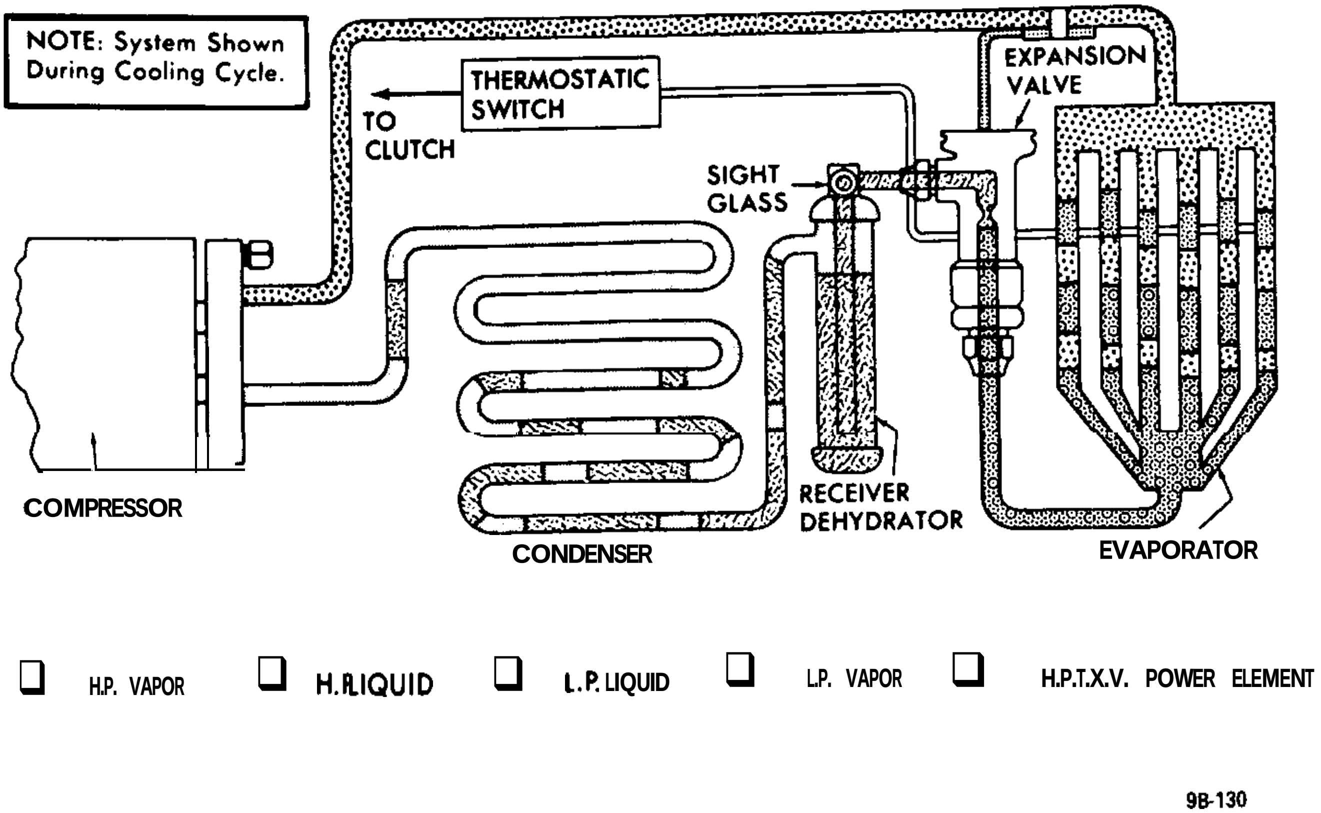
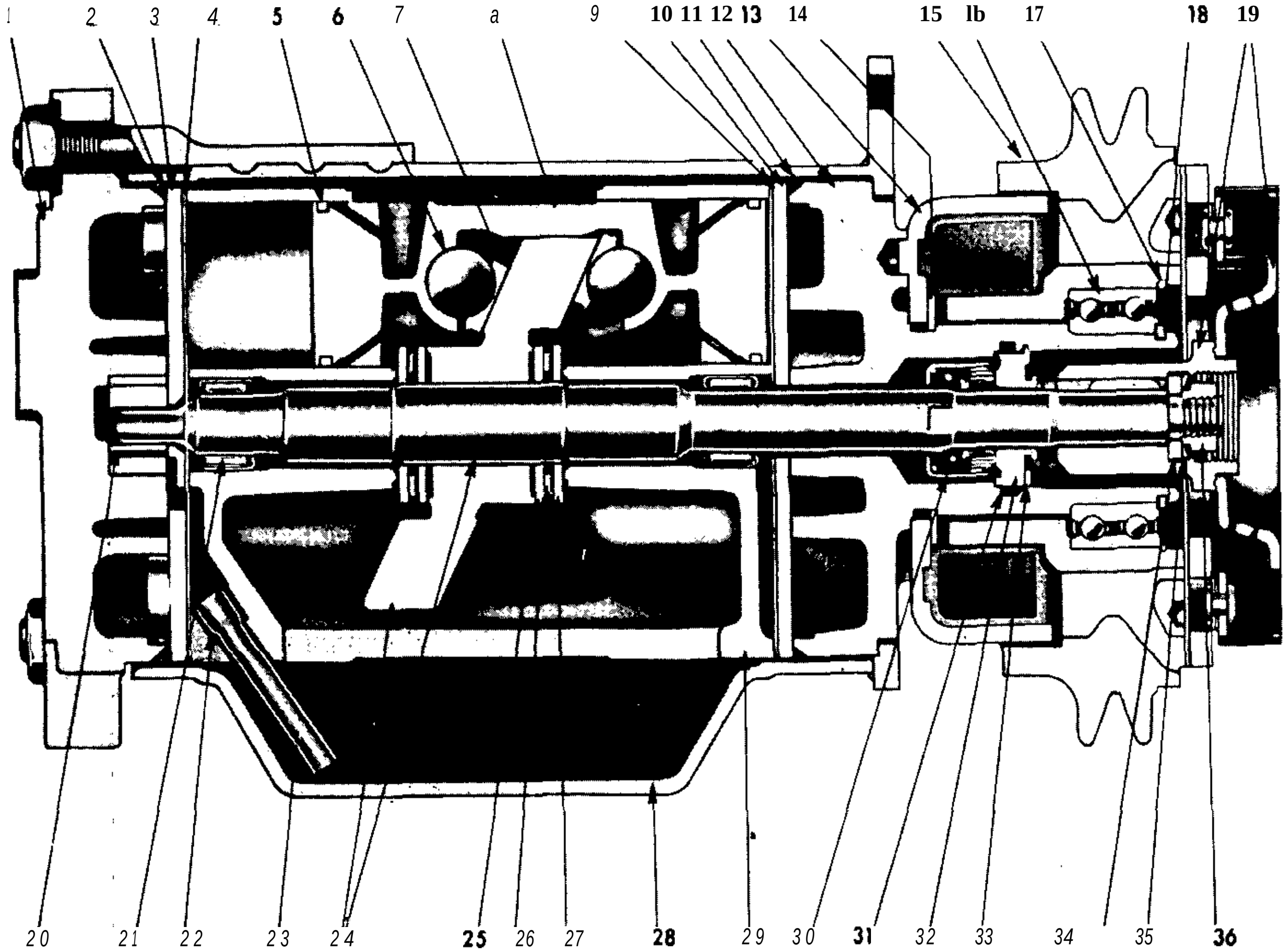


Figure 96-l 61 Cycle of Operation



1. Rear Head
2. Rear Head to Shell "O" Ring
3. Rear Discharge Valve Plate
4. Rear Suction Reed Plate
5. Piston Ring
6. Piston Drive Ball
7. Ball Seat (Shoe Disc)
8. Piston
9. Front Suction Reed Plate
10. Front Discharge Valve Plate
11. Front Head to Shell "O" Ring
12. Front Head
13. Coil and Housing Assembly
14. Coil Housing Retaining Ring
15. Pulley and Bearing Assembly
16. Pulley Bearing
17. Pulley Bearing Retainer Ring
18. Pulley and Bearing Retainer Ring
19. Clutch Hub and Drive Plate Assembly
20. Oil Pump Gears
21. Mainshaft Bearing (Rear)
22. Oil inlet Tube "O" Ring
23. Oil Inlet Tube
24. Wobble (Swash) Plate and Mainshaft Assembly
25. Thrust Race
26. Thrust Bearing
27. Thrust Race
28. Compressor Shell
29. Cylinder Assembly
30. Shaft Seal
31. Shaft Seal Seat "O" Ring
32. Shaft Seal Seat
33. Shaft Seal Seat Retainer Ring
34. Spacer
35. Clutch Hub Retainer Ring
36: Shaft Nut

9B-131

Figure 9B-162 Compressor Section View

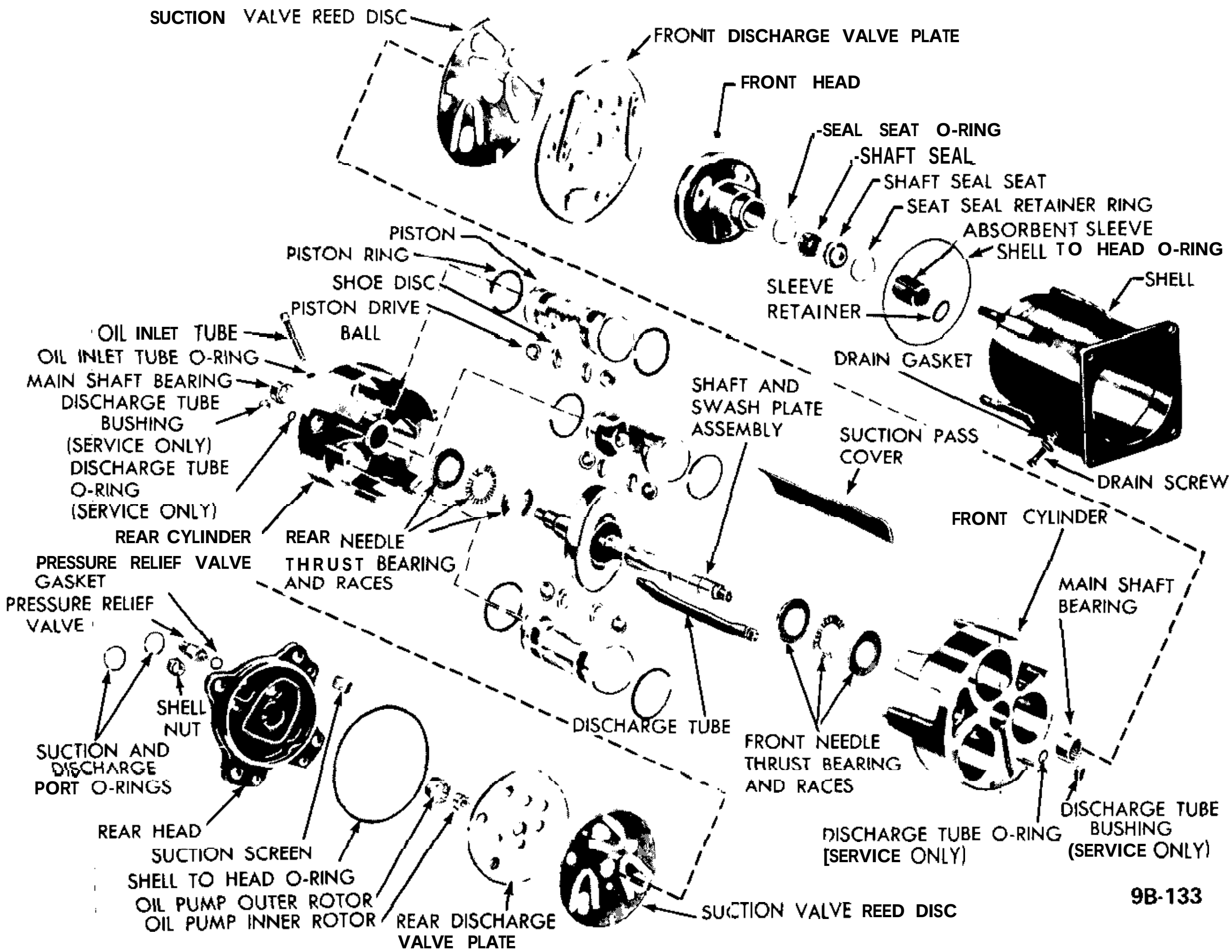
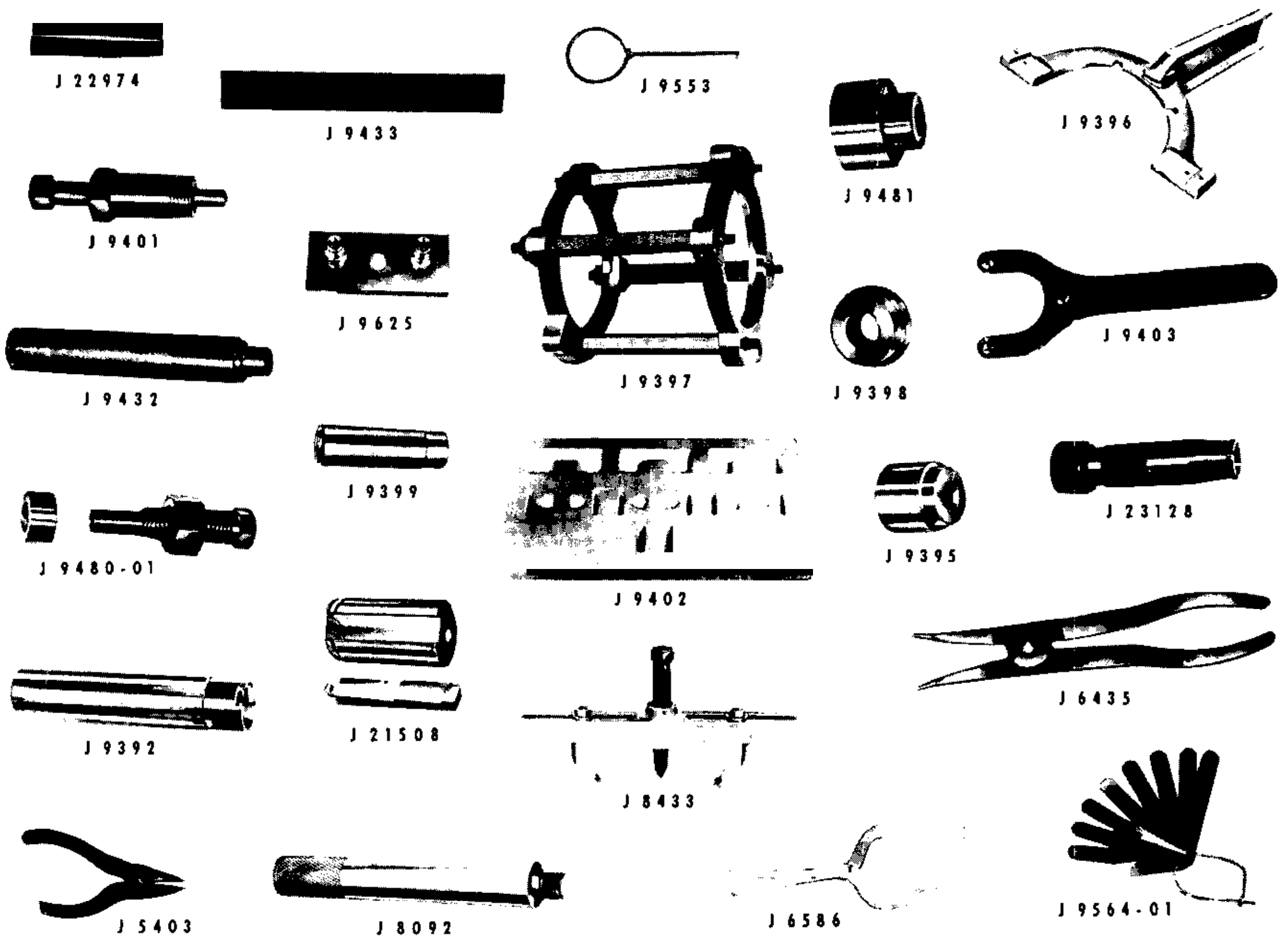


Figure 96-l 64 Compressor Exploded View



J 22974 SEAL PROTECTOR
J 9401 HUB AND DRIVE PLATE ASSEMBLY REMOVER
J 9432 NEEDLE BEARING INSTALLER
J 9480-01 HUB AND DRIVE PLATE ASSEMBLY INSTALLER
J 9392 SHAFT SEAL REMOVER AND INSTALLER
J 5403 SNAP RING PLIERS
J 9433 SUCTION CROSS-OVER COVER SEAL INSTALLER
J 9625 PRESSURE TEST SET

J 9399 COMPRESSOR SHAFT NUT SOCKET
J 21508 "O" RING INSTALLER
J 8092 THREADED DRIVER HANDLE
J 9553 "O" RING REMOVER
J 9397 COMPRESSING FIXTURE
J 9402 PISTON ASSEMBLY TRAY
J 8433 PULLEY PULLER
J 9481 PULLEY BEARING AND PULLEY INSTALLER

J 9398 PULLEY BEARING REMOVER
J 9395 PULLEY PILOT
J 9396 HOLDING FIXTURE
J 9403 CLUTCH HUB HOLDING TOOL
J 6586 OIL INLET TUBE REMOVER
J 23128 CERAMIC SEAL SEAT REMOVER AND INSTALLER
J 6435 SNAP RING PLIERS
J 9564-01 FEELER TENSION GAUGE SET

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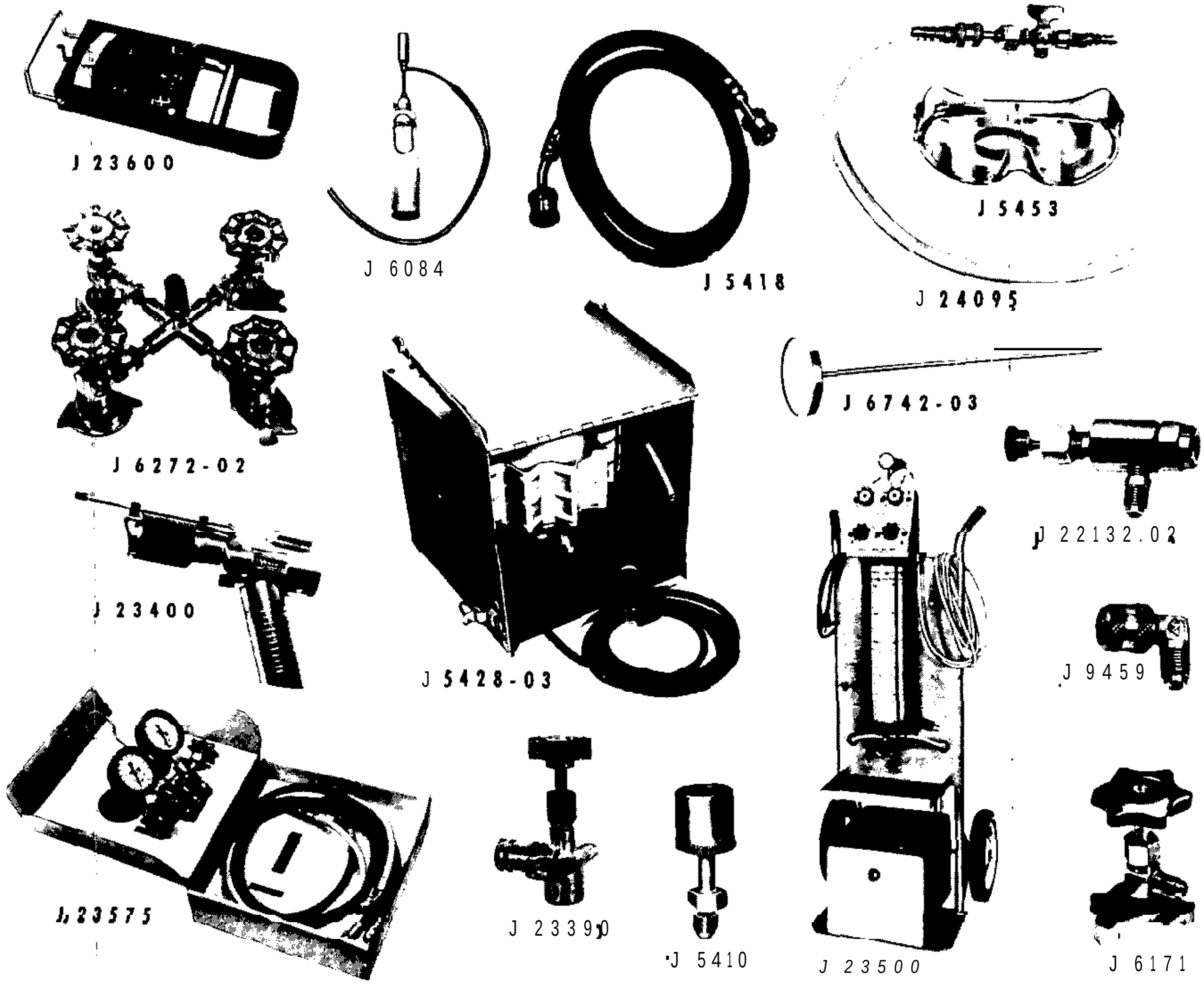
Figure 9B-165 Special Tools



J 23600 **BELT TENSION** GAUGE
J *6212.01* **#4 MULTI-OPENER** . 4 CAN **REFRIGERANT OPENER**
J 23400 **ELECTRONIC LEAK** DETECTOR
J **23575 COMPLETE** MANIFOLD **ASSEMBLY**
J **6084 LEAK DETECTOR**
J **5428-03** VACUUM PUMP
J **23390 12 LB. DISPOSABLE REFRIGERANT** CAN **CONTROL VALVE**
J **5420 GAUGE ADAPTER**
J **5453** GOGGLES
J 24095 COMPRESSOR **OIL** INJECTOR
J **6742-03 THERMOMETER** - DIAL **TYPE (25°-125°)**

J **5418-36B GAUGE** CHARGING **LINE 36" BLUE**
J **5418 -36R** " " " -36" **RED**
J **5418-48W** " " " **48" WHITE**
J5418-72B " " " 72" **BLUE**
J **5418-72R** " " " . **72" RED**
J **5418-72W** " " " . **72" WHITE**
J 23500 **PORTABLE** AIR **CONDITIONER SERVICE STATION**
J **22132-02 SCHRADER** VALVE **CORE REMOVER** 'AND **INSTALLER**
J 9459 90' **GAUGE ADAPTER**
J **6271 FITS-ALL** VALVE

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Figure 9B-166 Special Tools

AIR CONDITIONER SYSTEM
OPEL 1900 - MANTA

CONTENTS

DESCRIPTION AND OPERATION

GENERAL DESCRIPTION OF SYSTEM

The air conditioner is intended to give maximum cooling comfort within the vehicle. To do this, careful attention must be given to the following Sections. The system operates on recirculated air only and is entirely independent of the vehicle heater.

Recirculated inside air is drawn into the unit, passed through the evaporator core and into the car through the adjustable outlets in the evaporator case.

Operation of Controls

System controls are the AIR knob controlling the three speed blower motor switch and the TEMP knob which controls the setting of the thermostatic switch. When operating this system, the heater must be off for maximum cooling.

Air Knob

Turning the AIR knob clockwise operates the three-speed blower motor.

Temp Knob

This knob may be regulated to control the degree of cooling desired. Fully clockwise provides maximum cooling; however, turning the knob to the center detent position provides adequate cooling for highway operation.

When maximum cooling is required, outside air should not be admitted to the car.

When the unit is set for maximum cooling and the vehicle is being driven continuously at highway speeds or at elevations of 4,000 ft. or more, there is a possibility of the formation of ice on the evaporator core fins.

DIAGNOSIS

TROUBLE DIAGNOSIS GUIDE

Insufficient Cooling

CHECK AIR FLOW

FAN DOES NOT RUN Correct electrical fault.

FAN RUNS - Check air velocity.

NOT OK Clean evaporator inlets.

Clean evaporator core.

Clean evaporator outlets.

OK Check refrigeration (refer to Refrigeration Diagnosis Guide).

MAINTENANCE AND ADJUSTMENTS

ADJUSTMENT OF THERMOSTATIC SWITCH

The system makes use of a thermostatic switch with a self-supporting air sensing capillary. This capillary controls the switch by sensing the temperature of the air leaving the evaporator fins.

Checking for Proper Operation

1. Install the gauge set and set up the vehicle as described under FUNCTIONAL TESTING SYSTEM in Refrigerant Components Section.

2. Movement of the temperature control knob should result in a definite change in suction pressure and cycling of the compressor clutch.

3. If compressor continues to operate regardless of the knob adjustment, it indicates that the switch points are fused, which will lead to evaporator freeze- up. The switch should be replaced.

Adjusting Switch

If, after the foregoing checks, the switch seems to be operating correctly, adjust for proper setting if necessary, as follows:

1. Set up car as described in FUNCTIONAL TESTING SYSTEM in Refrigerant Components Section.

2. The suction side of the system, read on the low pressure gauge, should pull down to the pressure shown in the chart in SPECIFICATIONS in Refrigerant Components Section.

3. Remove the face plate retaining screws and remove face plate assembly noting the position of the air sensing capillary so that it can be reinstalled in the same location as when removed. See Figure 9B-170.

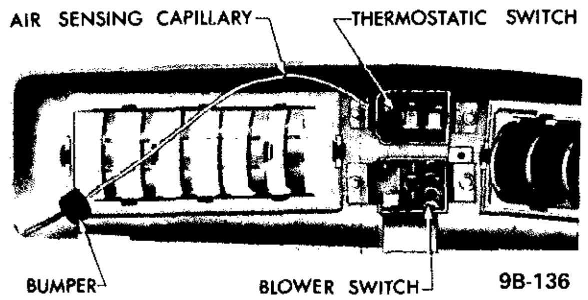

Figure 9B-170 Location of Air Sensing Capillary

4. Remove the thermostatic switch retaining screws and remove switch. Remove the non-metal end plate from the switch to gain access to the switch adjusting screw. Check the screw for stripped or otherwise damaged threads.

5. If the low side pressure was less than the prescribed pressure at the end of each cooling cycle, turn the adjusting screw a partial turn clockwise. See Figure 9B-171.

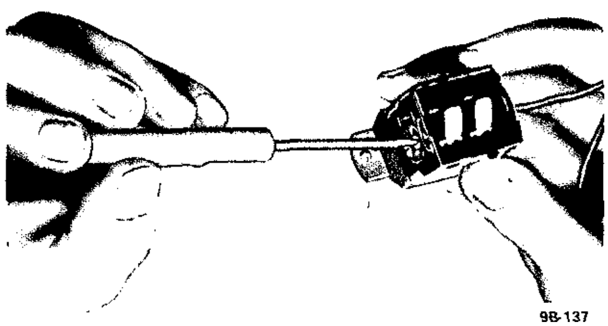

Figure 9B-171 Adjusting Thermostatic Switch

6. If the pressure was more than the prescribed value, turn the adjusting screw counter-clockwise.

7. Reinstall switch end plate and install switch in face plate. Install face plate on evaporator assembly assuring that the air sensing capillary has been replaced properly.

8. Check system performance. If further adjustment is needed, repeat steps 3 thru 7 until the correct pressure is reached.

Do not attempt to run a performance test with the face plate and switch removed from the evaporator assembly - inaccurate reading, will result. Always replace the switch and face plate assemblies before checking the system performance.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF BLOWER SWITCH

Removal

1. Remove the face plate retaining screws and remove the face plate assembly. See Figure 9B-172.

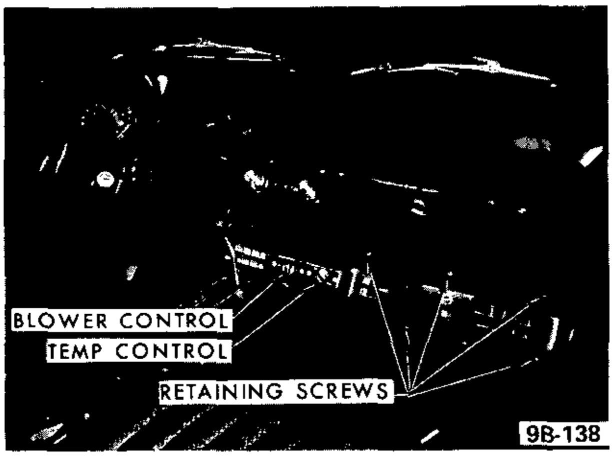

Figure SE-172 Face Plate Retaining Screws and Controls

2. Remove the blower switch retaining screws and remove switch.

Installation

1. Install the blower switch and retainer screws.

2. Install the face plate and secure with the retainer screws. See Figure 9B-172.

REMOVAL AND INSTALLATION OF TEMPERATURE CONTROL SWITCH

Removal

1. Remove the face plate retaining screws and remove the face plate assembly noting the position of the air sensing capillary so that it can be reinstalled in the same location as when removed. See Figure 9B- 173.

2. Remove the temperature control switch retaining screws and remove switch.

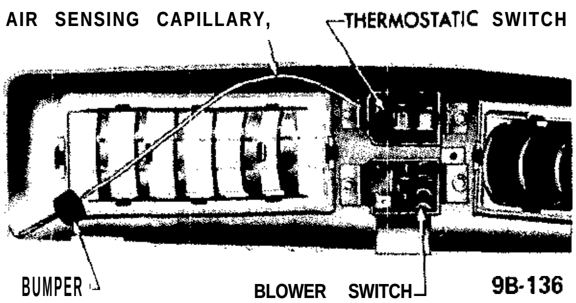

Figure SB-173 Location of Air Sensing Capillary

Installation

1. Install the temperature control switch and secure with the retaining screws.

2. Position the air sensing capillary in the exact location as was noted when removing.

3. Install the face plate and secure with the retaining screws. See Figure 9B-172.

REMOVAL AND INSTALLATION OF RESISTOR ASSEMBLY

Removal

1. Disconnect the negative battery cable.

2. Remove the glove box assembly.

3. Disconnect the electrical plug from the resistor assembly. See Figure 9B-176.

4. Remove two (2) screws and remove resistor assembly.

Installation

1. Install the resistor assembly and secure with two (2) screws.

2. Install the electrical plug onto the resistor assembly. See Figure 9B-176.

3. Install the glove box assembly.

4. Connect the negative battery cable.

REMOVAL AND INSTALLATION OF BLOWER MOTOR ASSEMBLY

REMOVAL

1. Remove the negative battery cable from the battery.

2. Remove the left side of distributor duct, and the in-line fuse. See Figure 9B-174.

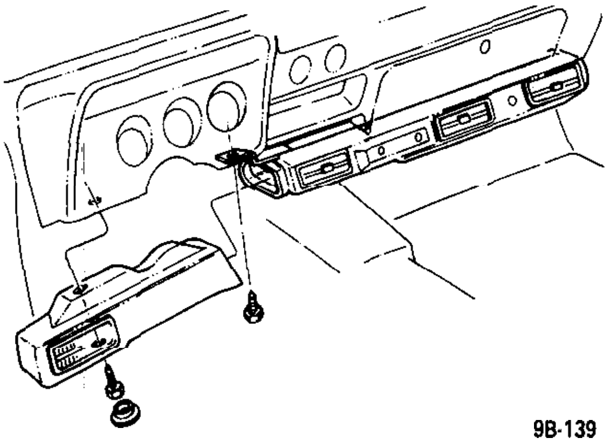

Figure SB-174 Location of Distributor Duct (Left Side) Retaining Screws

Figure 9B-175 Removing Left Side Distributor Duct

3. Remove the glove box assembly. See Figure 9B-176.

4. Discharge refrigerant from system, (refer to DISCHARGING SYSTEM) and disconnect refrigerant hose from evaporator outlet and pipe from evaporator inlet and tape the open ends of the refrigerant lines and evaporator pipes. See Figure 9B-178.

5. Disconnect the delay restrictor and check valve hose assembly from the vacuum cut-off switch and disconnect the electrical wiring. See Figure 9B-180.

6. Remove evaporator inlet and outlet pipes retainer and rubber grommet. See Figure 9B-178.

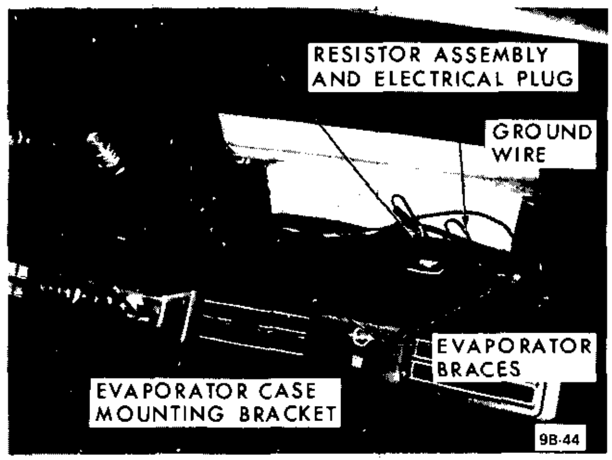

Figure 9B-176 *Glove* Box Removed

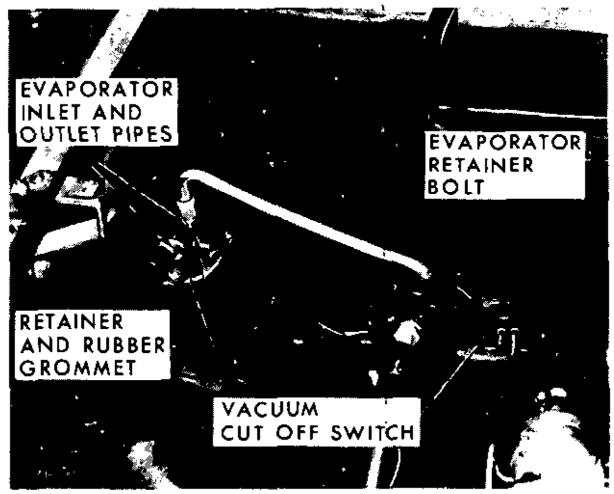

Figure SB-178 Location of Refrigerant Hoses, Pipes, Vacuum Cut Off Switch and Evaporator Attaching Bolt (Left Side)

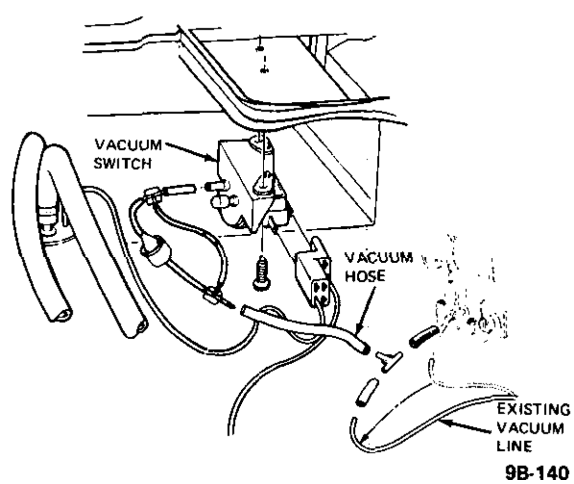

Figure 9B-180 Vacuum Hoses and Wiring

7. Remove 2 upper evaporator attaching nuts. See Figures 9B-178 and 9B-181.

Figure 9B-181 Location of Upper Evaporator Attaching Bolt (Right Side)

8. Remove 2 attaching case mounting bracket to instrument panel screws. See Figure 9B-182.

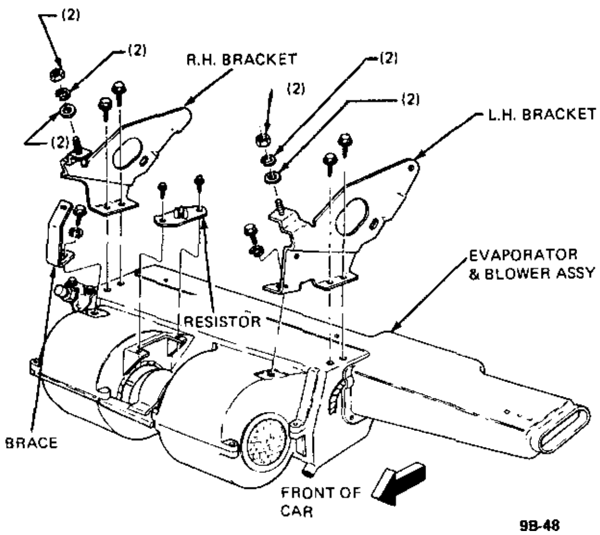

Figure SB-182 Evaporator and Blower Assembly Brackets and Attachments

9. From underneath evaporator case, disconnect two (2) drain hoses.

10. Carefully remove assembly from car. See Figure 9B-184.

11. Disconnect resistor electrical connector and remove resistor assembly. See Figure 9B-184.

12. Remove the blower case and blower motor attaching screws and remove assembly. See Figure 9B-184.

Installation

1. Install the blower motor assembly into case

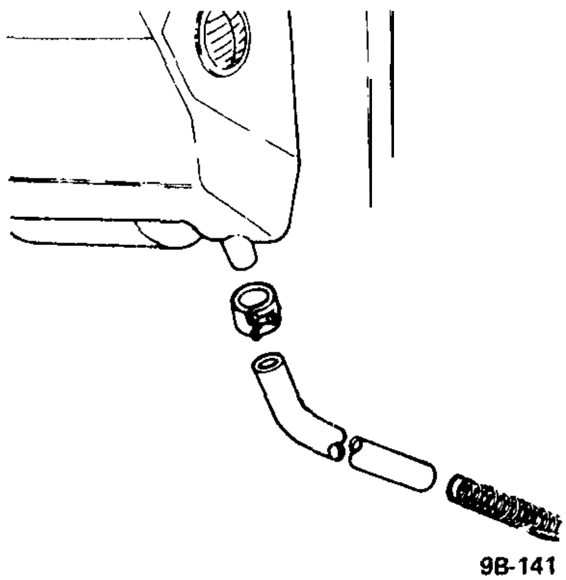

Figure 9B-183 Drain Hose

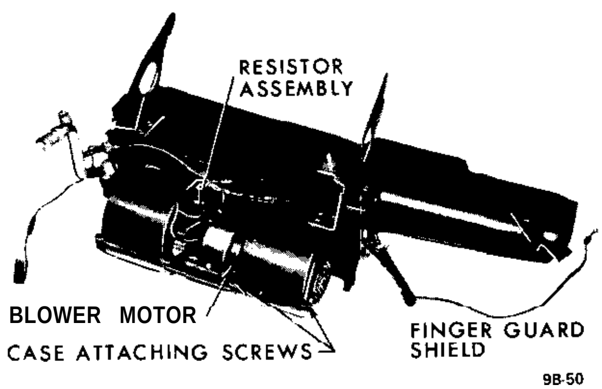

Figure 9B-184 Assembly Removed

bracket with the electrical connector side of the motor to the right side of the bracket. Attach the mounting strap.

2. Assemble the case halves and attach the cover plate.

3. Install the resistor assembly and electrical connector. Install blower motor connector. See Figure 9B-184.

4. Install assembly into car carefully guiding evaporator pipes up through cowl opening. See Figure 9B-185.

5. Install 2 upper evaporator attaching nuts. See Figures 9B-178 and 9B-181.

6. Install 2 attaching case mounting bracket to instrument panel screws. See Figure 9B-182.

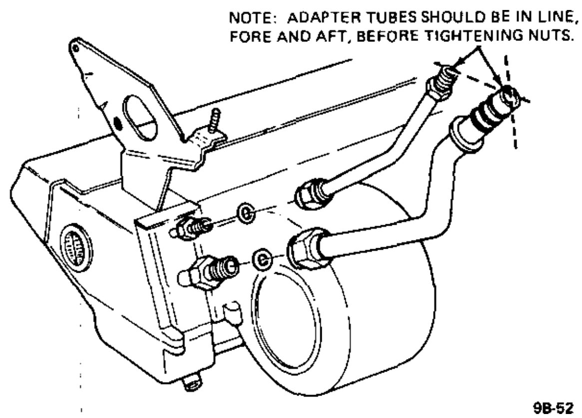

Figure 9B-185 Evaporator Inlet and Outlet Pipes and O-Rings

7. Connect the 2 drain hoses underneath evaporator.

8. Install evaporator inlet and outlet pipes retainer and rubber grommet. See Figure 9B-178.

9. Connect vacuum cut-off switch and electrical wiring,, making sure the delay restrictor and check valve hose are installed correctly. See Figure 9B-180.

10. Install refrigerant hoses and pipes using new o-rings on line fittings and evacuate system. Refer to EVACUATING SYSTEM.

11. While system is being evacuated install the in-line fuse and left side of distributor duct. See Figure 9B-174.

12. Install the glove box.

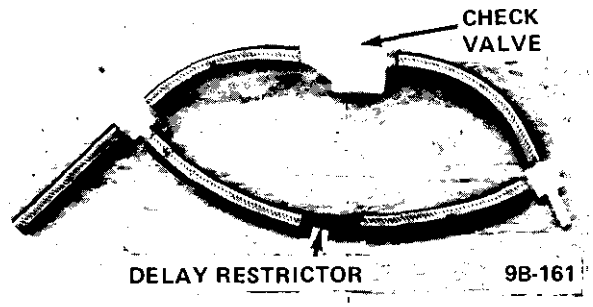

Figure 9B-186 Delay Restrictor and Check Valve Hose Assembly

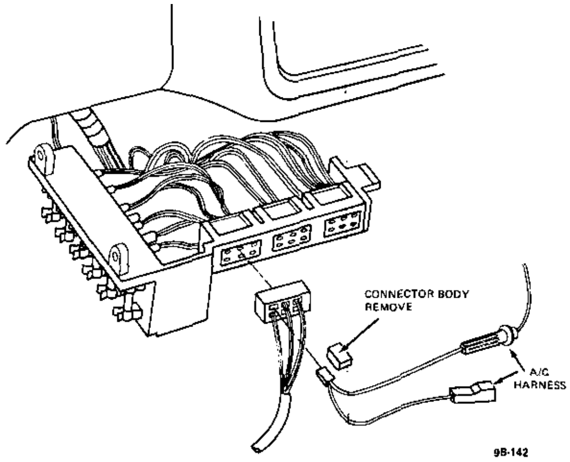

Figure 9B-187 Fuse Block Connections

13. Install negative battery cable and charge the system. Refer to CHARGING SYSTEM.

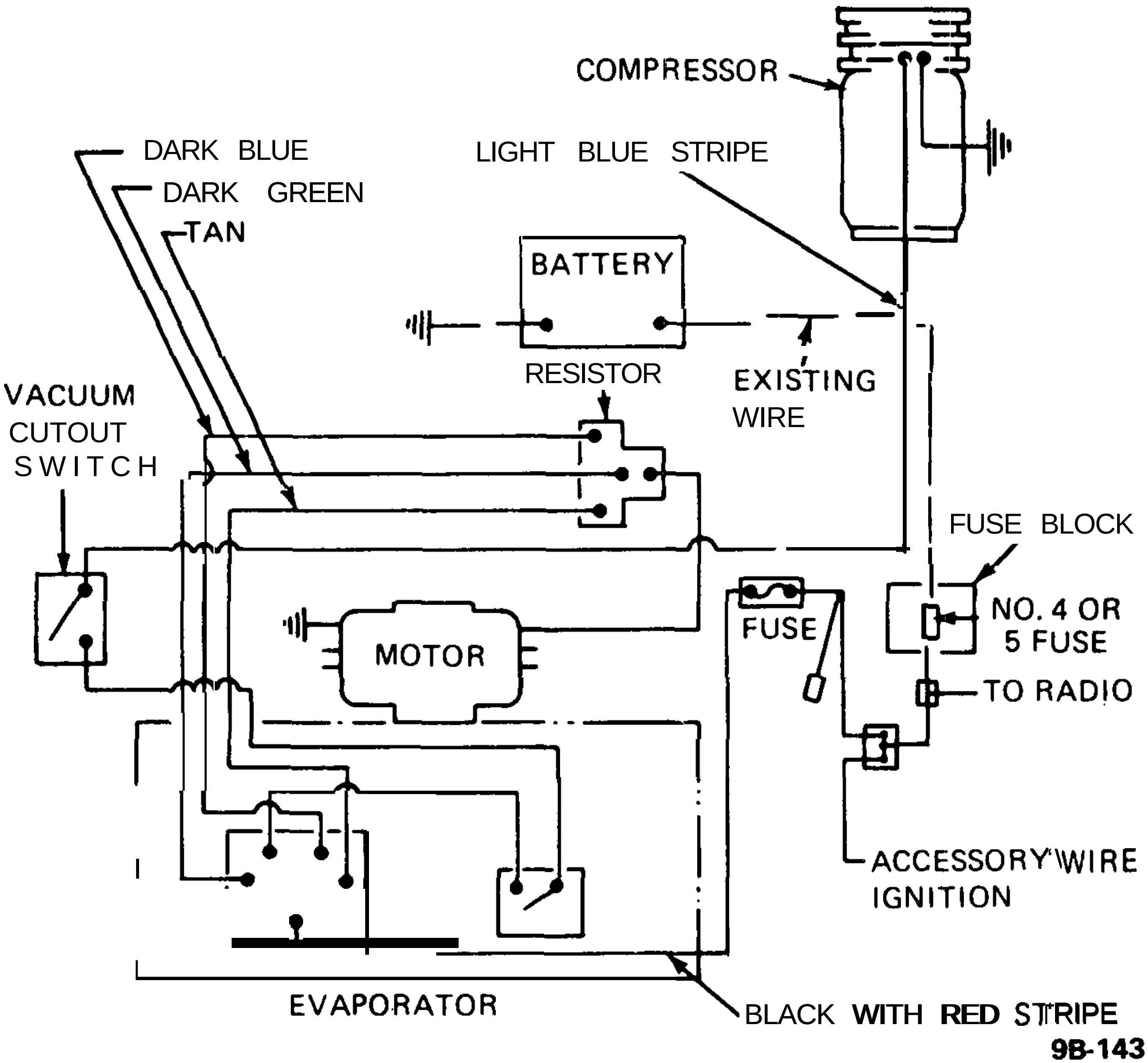

Figure 9B-188 Wiring Schematic

SPECIFICATIONS

Blower Motor Type	12 VDC
Blower Fan Type	Squirrel Cage

AIR CONDITIONER SYSTEM

GT

CONTENTS

DESCRIPTION AND OPERATION

GENERAL DESCRIPTION OF SYSTEM

The air conditioner is intended to give maximum cooling comfort within the vehicle. To do this, careful attention must be given to the following sections. The system operates on recirculated air only and is entirely @dependent of the vehicle heater.

Recirculated inside air is drawn into the unit, passed through the evaporator core and into the car through the adjustable outlets in the duct assembly.

CONTROLS

System controls are the AIR knob controlling the three speed blower motor switch and the TEMP knob which controls the setting of the thermostatic switch. When operating this system, the heater must be off for maximum cooling.

Air Knob

Turning the AIR knob clockwise operates the three-speed blower motor.

Temp Knob

This knob may be regulated to control the degree of cooling desired. Fully clock-wise provides maximum cooling; however, turning the knob to the center detent position provides adequate cooling for highway operation.

When maximum cooling is required, outside air should not be admitted to the car.

When the unit is set for maximum cooling and the vehicle is being driven continuously at highway speeds or at elevations of 4,000 ft. or more, there is a possibility of the formation of ice on the evaporator core tins.

DIAGNOSIS

TROUBLE DIAGNOSIS GUIDE

Insufficient Cooling

CHECK AIR FLOW

FAN DOES NOT RUN - Correct electrical fault.

FAN RUNS - **Check air velocity.**

NOT OK - Clean evaporator inlets.

Clean evaporator core.

Clean evaporator outlets.

OK - Check refrigeration (refer to Refrigeration Diagnosis Guide).

MAINTENANCE AND ADJUSTMENTS

ADJUSTMENT OF THERMOSTATIC SWITCH

The system makes use of a thermostatic switch with a self-supporting air sensing capillary. This capillary controls the switch by sensing the temperature of the air leaving the evaporator tins.

Checking for Proper Operation

1. Install the gauge set, and set up the vehicle as described under FUNCTIONAL TESTING SYSTEM in Refrigerant Components Section.

2. Movement of the temperature control knob should result in a definite change in suction pressure and cycling of the compressor clutch.

3. If compressor continues to operate regardless of the knob adjustment it indicates that the switch points are fused, which will lead to evaporator freeze-up. The switch should be replaced.

Adjusting Switch

If after the foregoing checks, the switch seems to be operating correctly, adjust for proper setting if necessary, as follows:

1. Set up car as described in FUNCTIONAL TESTING SYSTEM in Refrigerant Components Section.

2. The suction side of the system, read on the low pressure gauge, should pull down to the pressure shown in the chart in SPECIFICATIONS in Refrigerant Components Section.

3. Remove the duct assembly retaining screws and remove the duct assembly noting the position of the air sensing capillary so that it can be reinstalled in the same location as when removed. See Figure 9B-190.

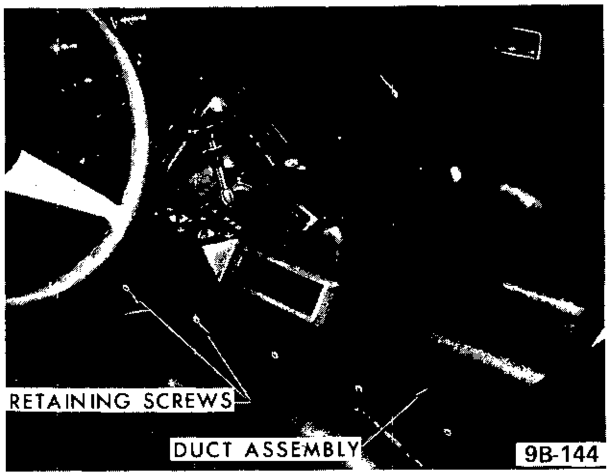

Figure 9B-190 Duct Assembly and Retaining Screws

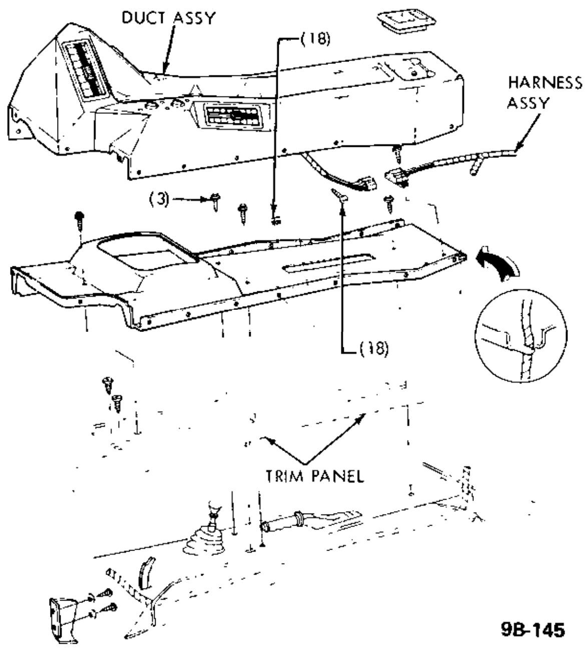

Figure 9B-19 1 Duct Assembly

4. Remove the thermostatic switch retaining screws and remove switch. Remove the non-metal end plate from the switch to gain access to the switch adjusting screw. Check the screw for stripped or otherwise damaged threads.

5. If the low side pressure was less than the prescribed pressure at the end of each cooling cycle, turn the **adjusting screw a partial turn clockwise. See** Figure 9B-192.

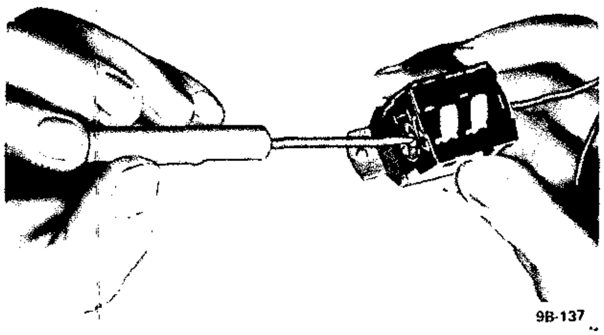

Figure 98.192 Adjusting Thermostatic Switch

6. If the pressure was more than the prescribed value, turn the **adjusting screw counter-clockwise.**

7. Reinstall switch end plate and install switch in face plate. **Install** face plate on evaporator assembly assuring that the air sensing capillary has been replaced properly.

8. Check system performance. Iffurther adjustment is needed, repeat steps 3 thru 7 until the correct pressure is reached.

Do not attempt to run a performance test with the duct assembly and switch removed from the evaporator assembly - inaccurate readings will result. Always replace the switch and duct assemblies before checking the system performance.

MAJOR REPAIR

REMOVAL AND INSTALLATION OF VACUUM SWITCH,

Removal

1. Remove right trim pad below instrument panel.

2. Remove two (2) screws and unplug the vacuum hose and electrical connector. See Figure 9B-193.

Installation

1. Install two (2) screws and plug in electrical connector **and connect** the delay **restrictor** and check valve hose assembly.

2. Install right trim pad.

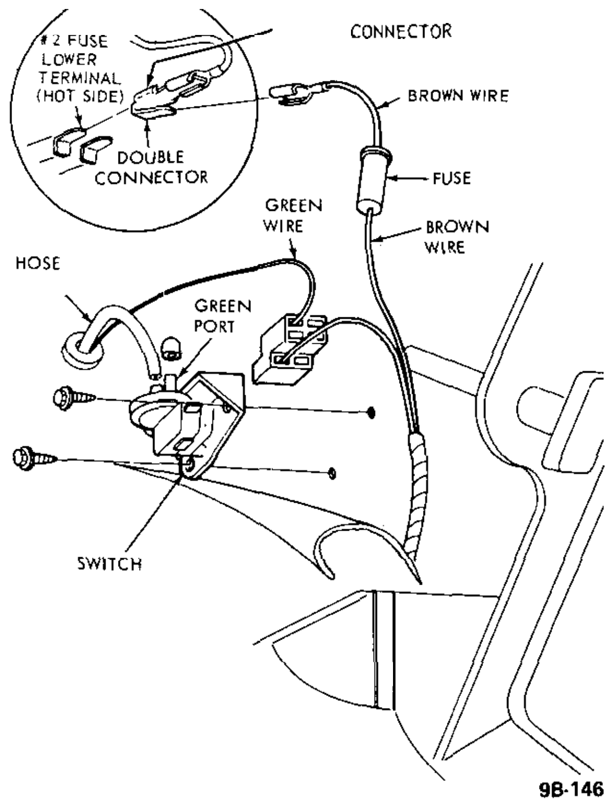

Figure 9B-1 93 Vacuum Switch

REMOVAL AND INSTALLATION OF BLOWER SWITCH

Removal

1. Remove the **negative** cable **from the battery**

2. Remove the retaining screws from the duct assembly. See Figure 9B-190.

3. Remove 2 blower switch retaining screws and **remove** blower **switch.**

Installation

1. Install the blower switch and secure with two (2) retaining screws.

2. Install the duct assembly retaining screws.

3. Install the negative battery cable.

REMOVAL AND INSTALLATION OF TEMPERATURE CONTROL SWITCH

Removal

I. Remove the negative battery cable.

2. Remove the retaining screws from the duct assembly. See Figure 9B-190.

3. Lift up duct assembly and note the position of the air sensing capillary so that it can be reinstalled in the same location as when removed.

4. Remove the temperature control switch retaining screws and remove switch.

Installation

1. Install the temperature control switch and secure with the retainer screws.

2. Position the air sensing capillary in the exact location as was noted when removing.

3. Install the duct assembly retaining screws.

4. Install the negative battery cable.

REMOVAL AND INSTALLATION OF RESISTOR ASSEMBLY

Removal

1. Remove the negative battery cable from the battery.

2. Remove the luggage tray attaching screws and lift out tray. See Figure 9B-194.

Figure 9B-194 Luggage Tray

3. Remove all evaporator cover attaching screws and remove cover. See Figure 9B-195.

Figure 9B-195 Evaporator Cover Assembly and Attaching Screws

4. Remove the electrical plug **connector** from the resistor assembly.

5. Remove 2 resistor attaching screws and remove resistor assembly. See Figure 9B-197.

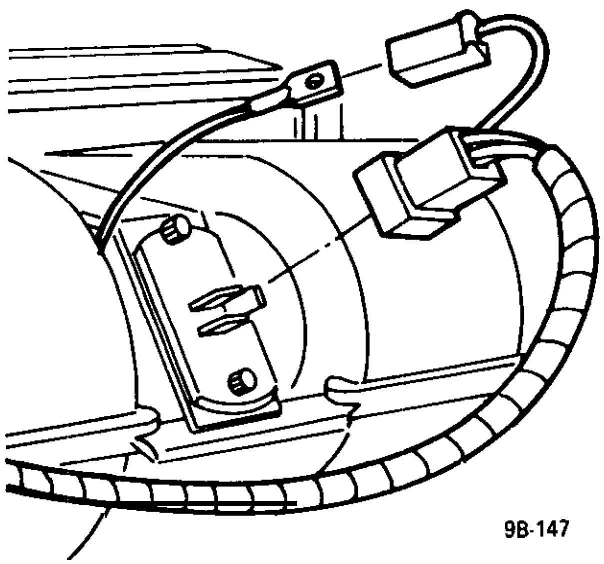

Figure 9B-196 Resistor and Blower Motor Connections

Figure 9B-197 Electrical Connections

Installation

1. Install the resistor assembly and two (2) attaching screws. See Figure 9B-198.

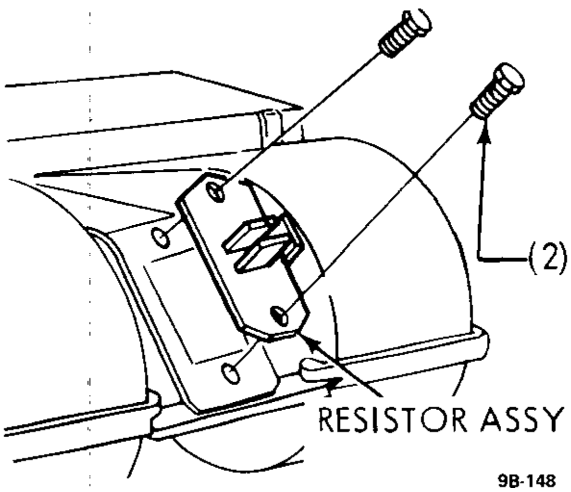

Figure 9B-198 Resistor Assembly Attaching Screws

2. Install the electrical plug connector.

3. Install the evaporator cover and attaching screws. See Figure 9B-195.

4. Install the luggage tray and attaching screws. See Figure 9B-194.

5. Install the negative battery cable

REMOVAL AND INSTALLATION OF BLOWER MOTOR ASSEMBLY

Removal

1. Disconnect the negative battery cable from the battery.

Figure 9B-200 Luggage Tray

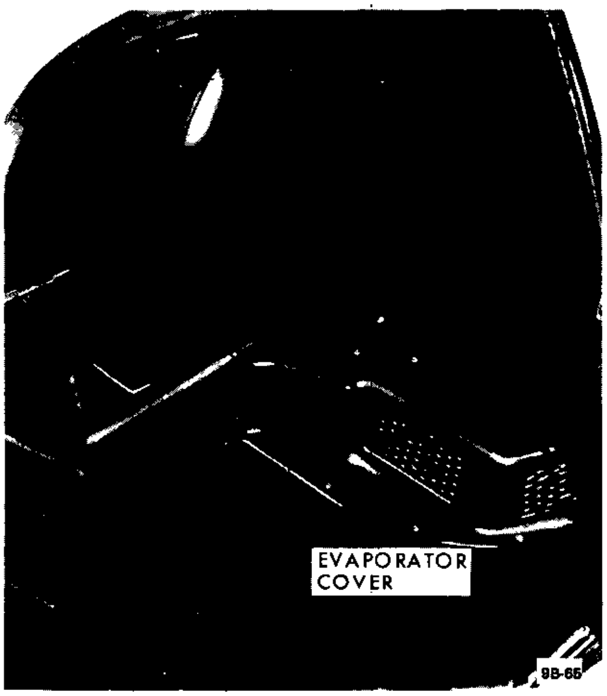

Figure 9B-201 Evaporator Cover Assembly and Attaching Screws

2. Discharge system. Refer to DISCHARGING SYSTEM in Refrigerant Components Section.

3. While system is discharging remove the luggage tray attaching screws and lift out tray. See Figure 9B-200.

4. Remove all evaporator cover screws and remove cover. See Figure 9B-201.

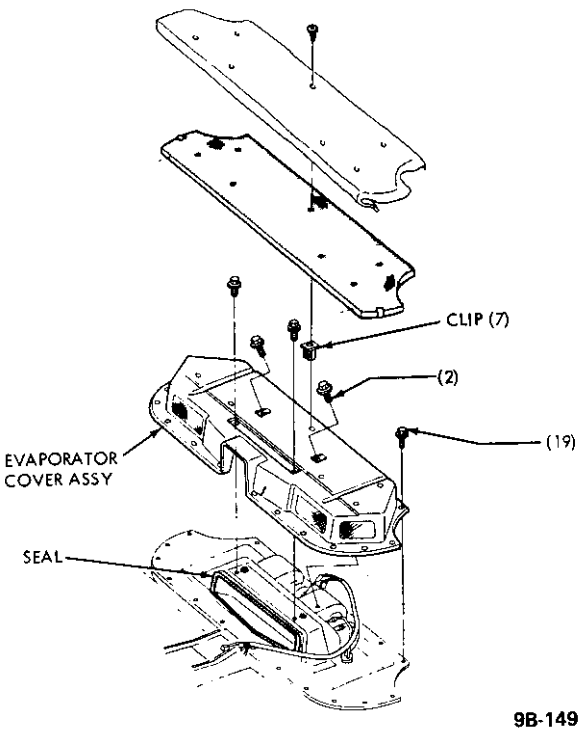

Figure 9B-202 Evaporator Cover and Luggage Tray

Figure 9B-203 Electrical Connections and Ground Wire

5. Remove the electrical plug connector from the resistor assembly, and unplug blower motor connection and remove ground wire. See Figure 9B-203.

6. From underneath evaporator housing, disconnect 2 drain hoses. See Figure 9B-204.

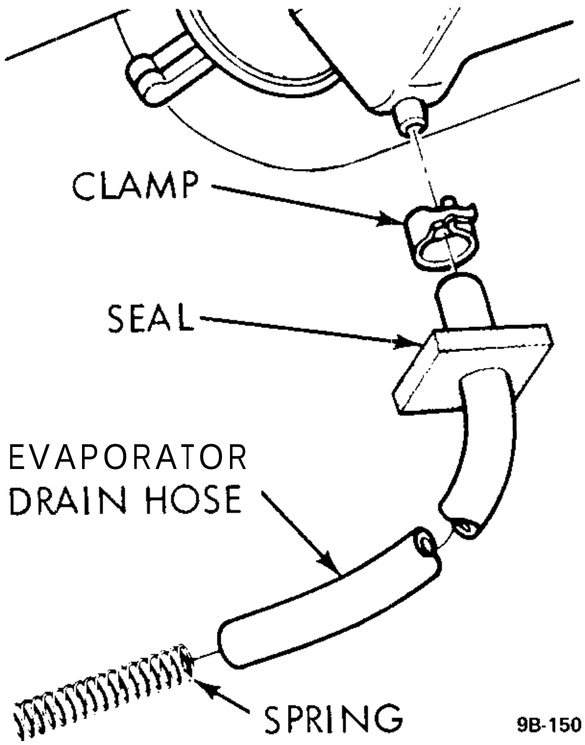

Figure 9B-204 Drain Hose

7. From under car remove 4 nuts securing evaporator mounting bracket to floor. See Figure 9B- 205 and 9B-206.

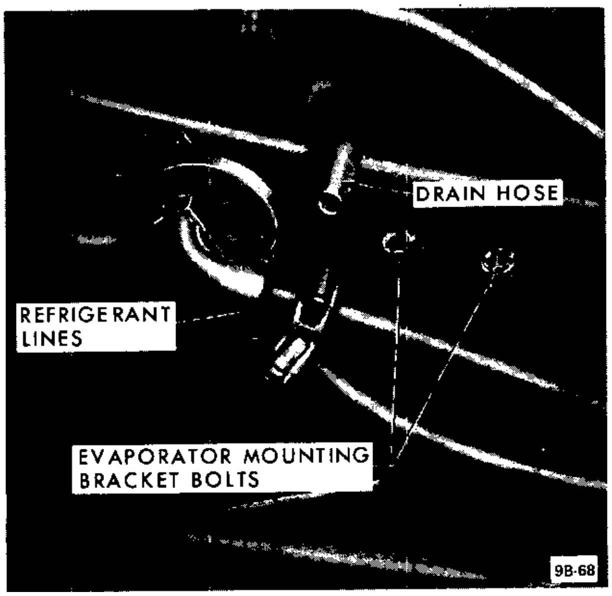

Figure 9B-205 Evaporator Mounting Bracket Bolts - Driver Side

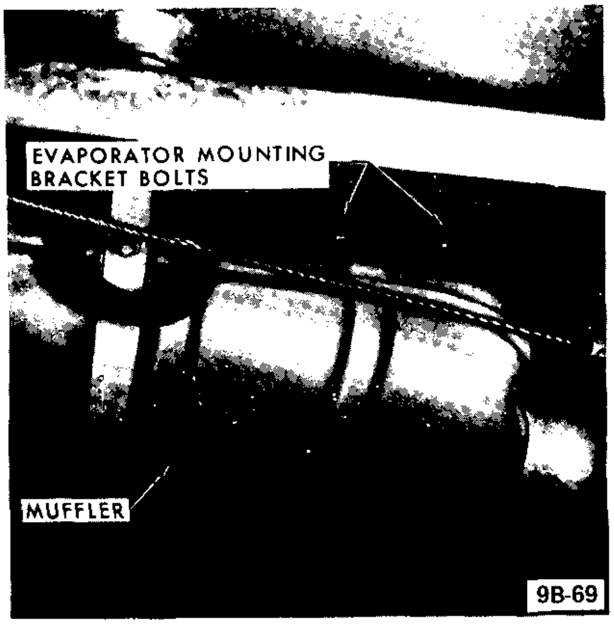

Figure 9B-206 Evaporator Mounting Bracket Bolts
Passenger Side

8. Remove inlet and outlet pipes from evaporator and tape closed the refrigerant lines and also the open ends of the inlet and outlet pipes of the evaporator. See Figure 9B-208.

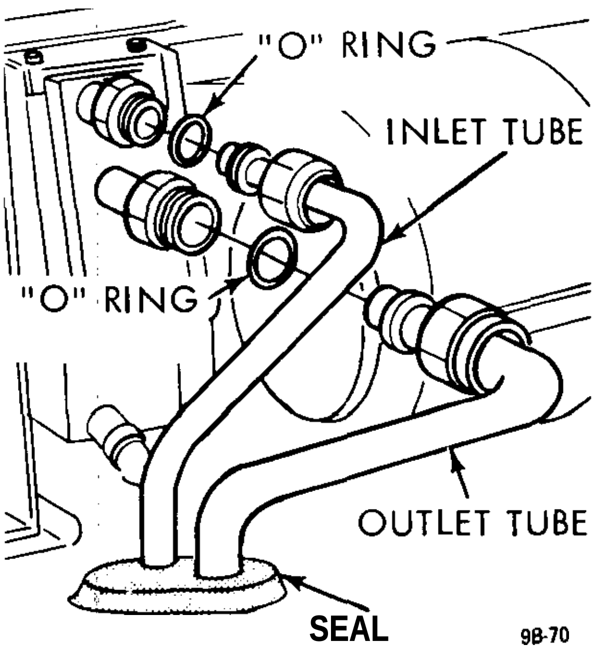

Figure 9B-208 Inlet and Outlet Pipes and O-Rings

9. Lift off the mounting bracket and remove the evaporator assembly from the car.

10. Remove the resistor assembly. See Figure 9B-203.

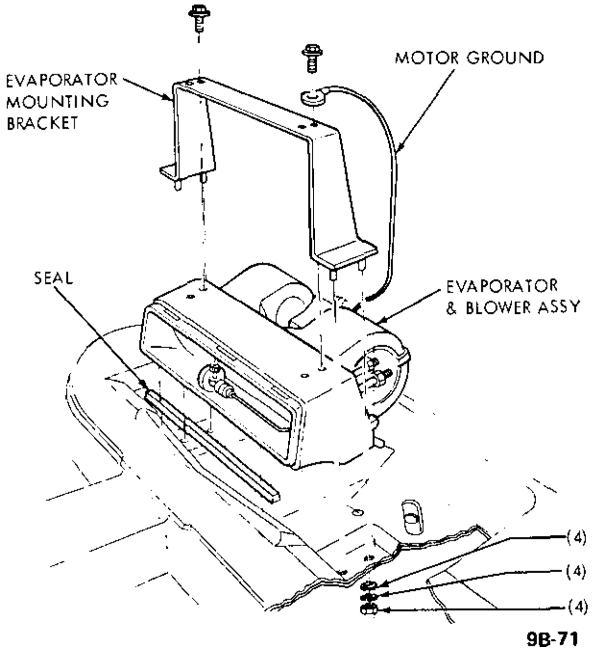

Figure 98.209 Evaporator and Blower Assembly

11. Remove blower case and blower motor attaching screws and remove assembly.

Installation

1. Install blower motor assembly in the bracket with

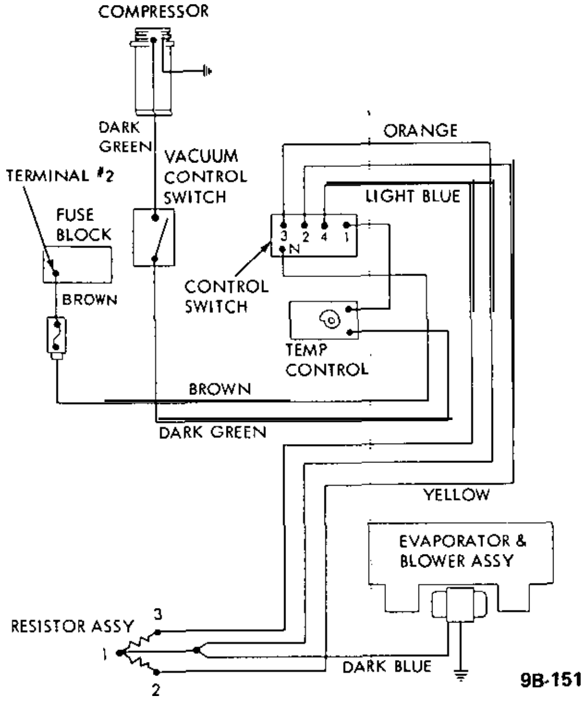

Figure 9B-210 Electrical Schematic

the electrical connector side of the motor to the right side of the bracket.

2. Assemble the fan housing case halves and attach the cover plate.

3. Install the resistor assembly.

4. Install the evaporator assembly into the car and install mounting bracket. See Figure 9B-209.

5. Untape the refrigerant lines and the inlet and outlet pipes from the evaporator and install using new o-rings on line fittings.

6. From under the car, install 4 nuts securing evaporator mounting bracket to floor. See Figures 9B- 205 and 9B-206.

7. Evacuate system. Refer to EVACUATING SYSTEM in REFRIGERANT COMPONENTS Section.

8. While system is being evacuated:

9. Connect 2 drain hoses underneath the evaporator housing.

10. Plug in the resistor assembly electrical connector plug and connect the blower motor connection and install ground wire and 2 mounting bracket to case screws using the rearward holes. See Figure 9B-209.

11. Install the evaporator cover and all cover screws. See Figure 9B-202.

12. Install luggage tray and attaching screws. See Figure 9B-202.

13. Connect the negative battery cable.

14. Charge system. Refer to CHARGING SYSTEM in Refrigerant Components Section.

SPECIFICATIONS

Blower Motor Type .... 12 VDC
Blower Fan Type .... Squirrel Cage

RADIO

GT

CONTENTS

DIAGNOSIS

RADIO TROUBLE DIAGNOSIS

Because radio problems are most often repaired at United Delco authorized warranty repair stations, the tendency for many dealer servicemen is to remove the set when a problem is reported, without any preliminary diagnosis. This results in a large number of radios showing up as "NO TROUBLE FOUND" units when received by the warranty repair stations. This indicates that the trouble can often be corrected without removal of the radio.

The inconvenience to an owner of driving without a radio while his set is being serviced at a warranty station can frequently be avoided if the following quick checks are used to eliminate external radio system problems before removing the radio for repair.

Always determine from the owner the exact nature of the radio problem as an aid to diagnosis. Knowing whether the condition is intermittent or constant, whether it occurs with engine off or running, with car stationary or moving, will help to pinpoint the problem. Never turn on radio with speaker disconnected.

Radio Is Inoperative

1. Turn on the radio. The dial should light and a thump should be heard from the speaker.

a. If a thump is heard, go to Step No. 2 for antenna check.

b. If no thump is heard, check the fuse.

(1) If fuse is bad, replace and try radio again. Race engine and, if fuse blows again, remove the radio and speaker assembly for repair by a trained radio technician.

(2) If fuse is good, check to see that the speaker-to-receiver interconnecting cable is connected securely. If there is still no thump when the radio is turned on, remove the receiver and speaker for repair.

2. Check the antenna by substituting with one held out the car window.

a. If radio is still dead with substitute antenna, remove the receiver and speaker for repair.

b. If radio operates near normal with substitute antenna, some part of the car antenna or lead-in is at fault.

Radio Reception Is Weak

1. Check to see if antenna trimmer is peaked.

a. Position antenna at a height of 31 inches.

b. Tune radio to weak station at or near 1400 KHz on the dial, and turn volume control to maximum.

c. Adjust trimmer screw for maximum volume.

d. If antenna trimmer does not have a definite peak, check for defective antenna by substitution.

2. Check that the speaker connection is plugged in securely.

3. If the radio is still weak, remove the receiver and speaker assembly for repair.

Radio Is Noisy

1. Radio is noisy all the time:

a. Check for defective antenna by striking antenna with hand. If static is heard while tapping, replace antenna.

b. If antenna is not defective, remove receiver and speaker for repair.

2. Radio is noisy only when jarred:

a. Check antenna as in Step No. 1 above.

b. Check speaker connection. If speaker connection is not at fault, remove receiver and speaker for repair.

3. Radio is noisy when engine is running:

a. Check noise suppressor by substituting on generator with known good one.

b. Check to see that antenna is mounted securely, grounding the antenna base to the fender. The antenna lead-in wire is shielded and the shield should have good ground connection at the receiver and the antenna base.

c. Check for other car wiring, passing too close to radio receiver case.

d. If engine noise is still present, remove receiver and speaker for repair.

4. Radio is noisy when car equipment is operated, such as directional lights or brake lights:

Check for defective antenna lead-in wire or, loose antenna mounting, as in Step No. 3b above.

MAINTENANCE AND ADJUSTMENTS

ANTENNA TRIMMER ADJUSTMENT

An antenna trimmer adjusment screw is provided for matching of the antenna coil in the receiver to the car antenna. This adjustment must always be made after installation of a receiver or an antenna, or after repair to these units. This adjustment should also be performed whenever radio reception is unsatisfactory.

1. Position antenna to a height of 31 inches.

2. Tune receiver to a weak station at or near 1400 KHz that can barely be heard with volume turned fully up.

3. Insert a small-bladed screwdriver in antenna trim-

Figure 9C-1 Location of Access Trim Plug

Figure 9C-2 Removing Hex Head Screw

mer screw and rotate screw until maximum volume is achieved.

MAJOR REPAIR

REMOVING AND INSTALLING RADIO

Removal

1. Disconnect battery.

2. Remove access trim plug from right side of console. See Figure 9C-1.

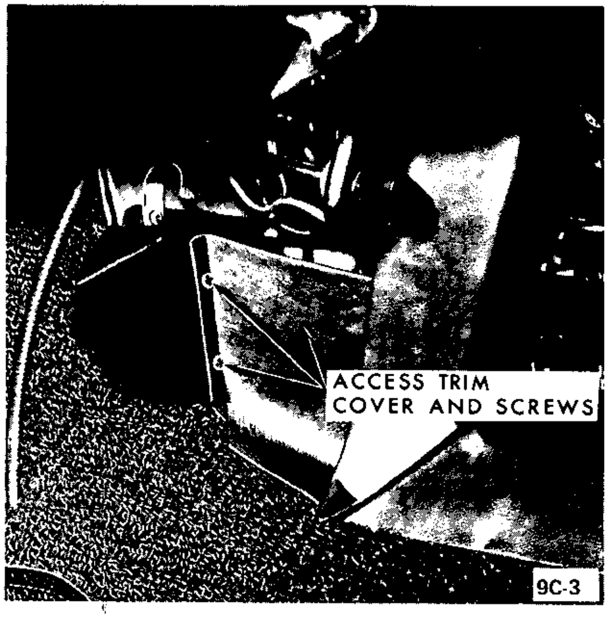

Figure 9C-3 Location of Access Trim Cover

Figure SC-4 Location of Hex Head Screw and Flasher Unit

3. Using a 8mm socket, remove hex head screw. See Figure 9C-2.

4. Remove access trim cover on left side of console. See Figure 9C-3.

5. Using a 4mm socket, remove hex head screw. See Figure 9C-4.

6. Remove tear lock bolts by first drilling a 3/16 inch pilot hole and, using a 1/4 inch bolt extractor, remove bolts. See Figure 9C-5.

Figure 9C-5 Drilling Pilot Hole Into Tear Lock Bolts

7. Disconnect ignition (white) and direction signal (black) wire set plugs.

8. Support steering column assembly and remove both hex head bolts.

9. Disconnect speedometer cable.

10. Remove 6 instrument cluster retaining screws. See Figure 9C-6.

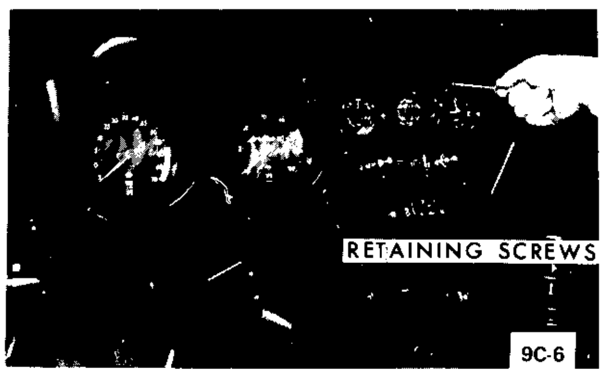

Figure SC-6 Removing Instrument Cluster Retaining screws

11. Grasp instrument cluster and pull straight **back,** being careful of wires, etc. See Figure 9C-7.

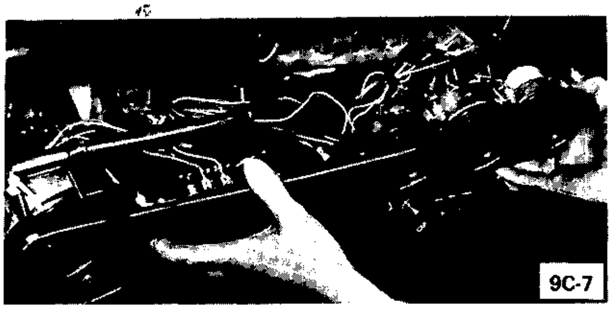

Figure 9C-7 Removing Instrument Cluster

12. Disconnect radio harness plug and antenna lead-in cable from back of radio. See Figure 9C-8.

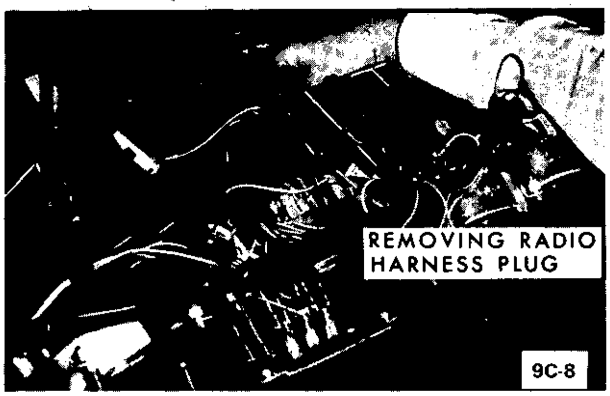

Figure 9C-8 Removing Radio Harness Plug

13. Remove radio knobs from radio.

14. While supporting radio, remove radio shaft retaining nuts. Remove radio. See Figure 9C-10.

Installation

CAUTION: ***Fasteners in Installation are important attaching parts in that they could affect the performance of vital components and systems, and/or could result in major repair expense. They must be replaced with one of the same part number or with an equivalent part, if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.***

Figure SC-10 Removing Radio Shaft Retaining Nuts

1. Install radio into instrument cluster and secure with retaining nuts. See Figure 9C-10.

2. Plug radio harness and lead-in cable into radio. See Figure 9C-8.

3. Install radio knobs and carefully push cluster back into instrument panel housing, making sure electrical wires, etc., are not pinched. See Figure 9C-7.

4. Install six (6) cluster retaining screws. See Figure 9C-6.

5. Support column assembly and install ground wire and hex head bolts, torquing to 14 lb.ft.

6. Install NEW tear bolts and tighten until head of bolt is twisted off.

7. Connect ignition and directional signal wire plugs.

8. Connect speedometer cable.

9. Install flasher unit and hex head screw. See Figure 9C-4.

10. Install hex head screw through opening on right side and install trim plug. See Figure 9C-2.

11. Install trim cover on left side. See Figure 9C-3.

RADIO

OPEL 1900 - MANTA

CONTENTS

DIAGNOSIS

RADIO TROUBLE DIAGNOSIS

Because radio problems are most often repaired at United Delco authorized warranty repair stations, the tendency for many dealer servicemen is to remove the set when a problem is reported, without any preliminary diagnosis. This results in a large number of radios showing up as "NO TROUBLE FOUND" units when received by the warranty repair stations. This indicates that the trouble can often time be corrected without removal of the radio.

The inconvenience to an owner of driving without a radio while his set is being serviced at a warranty station can frequently be avoided if the following quick checks are used to eliminate external radio system Problems **before** removing the radio for repair.

Always determine from the owner the exact nature of the radio problem as an aid to diagnosis. Knowing whether! the condition is intermittent or constant, whether it occurs with engine off or running, with car stationary or moving, will help to pinpoint the problem. Never turn on radio with speaker disconnected.

Radio Is Inoperative

1. Turn on the radio. The dial should light and a thump should be heard from the speaker.

a. If a thump is heard, go to Step No. 2 for antenna check.

b. If no thump is heard, check the fuse.

(1) If fuse is bad, replace and try radio again. Race engine and, if fuse blows again, remove the radio and speaker assembly for repair by a trained radio technician.

(2) If fuse is good, check to see that the speaker to receiver interconnecting cable is connected securely. If there is still no thump when the radio is turned on, remove the receiver and speak+ for repair.

2. Check the antenna by substituting with one held out the car window.

a. If radio is still dead with'substitute antenna, remove the receiver and speaker for repair.

b. If radio operates near normal with substitute antenna, some part of the car antenna or lead-in is at fault.

Radio Reception Is Weak

1. Check to see if antenna trimmer is peaked.

a. Position antenna at a height of 31 inches.

b. Tune radio to weak station at or near 1400 KHz on the dial, and turn volume control to maximum.

c. Adjust trimmer screw for maximum volume,

d. If antenna trimmer does not have a definite peak, check for defective ant&ma by substitution.

2. Check that the speaker connection is plugged in securely.

3. If the radio is still weak, remove the receiver and speaker assembly for repair.

Radio Is Noisy

1. Radio is noisy all the time:

a. Check for defective antenna by striking antenna with hand. If static is heard while tapping, replace antenna.

b. If antenna is not defective, remove receiver and speaker for repair.

2. Radio is noisy only when jarred:

a. Check antenna as in Step No. 1 above.

b. Check speaker connection. If speaker connection is not at fault, remove receiver and speaker for repair.

3. Radio is noisy when engine is running:

a. Check noise suppressor by substituting on generator with known good one.

b. Check to see that antenna is mounted securely, grounding the antenna base to the fender. The antenna lead-in wire is shielded and the shield should have good ground connection at the receiver and the antenna base.

c. Check for other car wiring passing too close to radio receiver case.

d. If engine noise is still present, remove receiver and speaker for repair.

4. Radio is noisy when car equipment is operated, such as directional lights or brake lights:

Check for defective antenna lead-in wire or loose antenna mounting, as in Step No. 3b above.

5. Radio is noisy only on dry days when car is moving:

Wheel and tire static will occur only during dry weather. To check to see if noise is wheel static or tire static, drive car until noise is noticed. Touch the brake. If noise disappears, it is wheel static. If noise persists, it is tire static. Static may be eliminated in two ways:

a. Wheel static may be eliminated by installation of static collectors in the front wheels. It is important to make sure the button on the end of the spiral collector rides evenly in the spindle. Grease and dirt can cause poor contact between static collector and the cap, which would result in wheel static, even with the collectors installed.

b. Tire static is eliminated by injecting graphite tire static powder in all five (5) tires. Either a special gun or a plastic squeeze bottle can be used to insert powder.

MAINTENANCE AND ADJUSTMENTS

ANTENNA TRIMMER ADJUSTMENT

An antenna trimmer adjustment screw is provided for matching of the antenna coil in the receiver to the car antenna. This adjustment must always be made after installation of a receiver or an antenna, or after repair to these units. This adjustment should also be performed whenever radio reception is unsatisfactory.

1. Position antenna to a height of 31 inches.

2. Tune receiver to a weak station at or near 1400 KHz that can barely be heard with volume turned fully up.

3. Insert a small-bladed screwdriver in antenna trimmer screw and rotate screw until maximum volume is achieved.

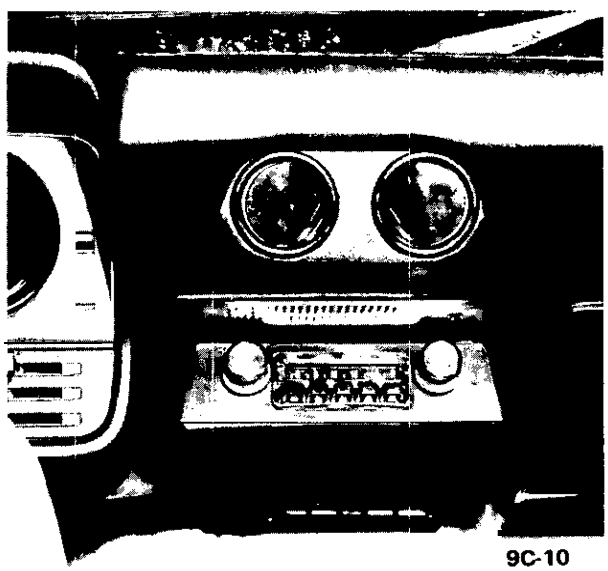

Figure 9C-15 Radio Control Knobs

MAJOR REPAIR

REMOVING AND INSTALLING RADIO

Removal

1. Remove control knobs and ornamental cover plate. See Figure 9C- 15.

2. Unscrew two (2) hex. nuts behind and remove ornamental cover plate.

3. Unscrew support bracket from back of radio housing and air distribution housing. See Figure 9C-16.

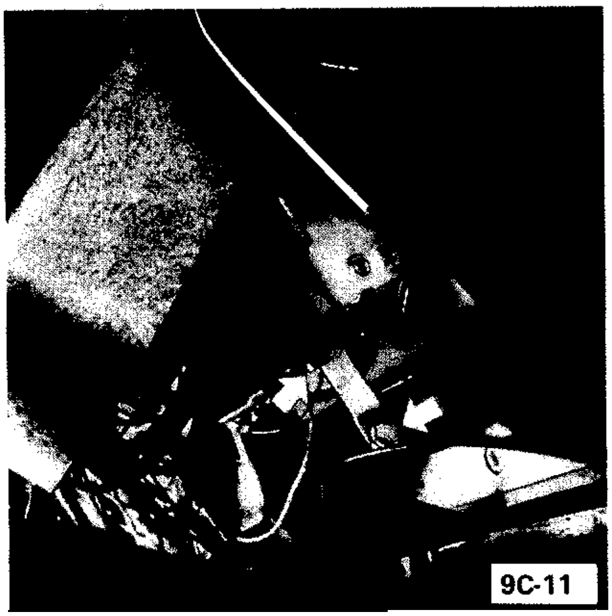

Figure 9C-16 Support Bracket

4. Remove radio.

Installation

1. Install in reverse sequence to removal.

2. Trim radio.

REMOVAL AND INSTALLATION OF ANTENNA

Removal'

1. Pull antenna cable out of radio socket.

2. Pull rubber grommet and antenna cable out of cowl panel. See Figure 9C-17.

3. Unscrew antenna from fender.

Installation

1. Install in reverse sequence to removal.

Figure 9C-17 Antenna and Cable · Under Fender

2. Seal antenna lead-in to antenna mast area with silastic sealer or equivalent. See' Figure 9C-18.

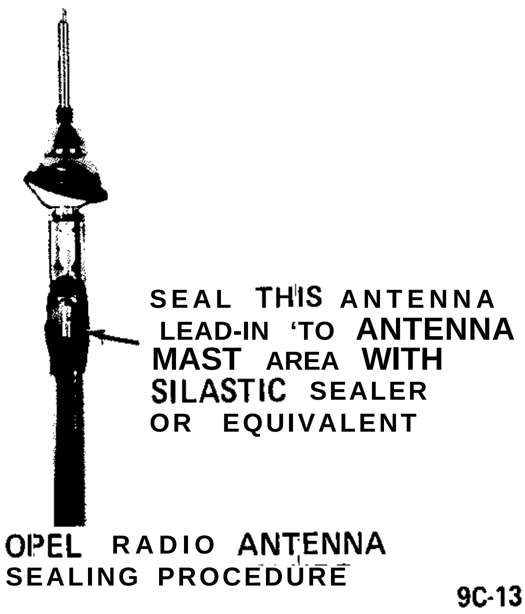

Figure 9C-18 Sealing Antenna Lead-in to Antenna Mast

3. Clean antenna contacting area at fender underside to a bright surface.

4. After installation of antenna, protect fender against corrosion by spraying with a rustproof paint or similar product.

5. Trim radio.