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AUTOMOTIVE AIR CONDITIONING SYSTEMS

Main Category:	Mechanical Engineering
Sub Category:	-
Course #:	MEC-162
Course Content:	22 pgs
PDH/CE Hours:	2

OFFICIAL COURSE/EXAM

(SEE INSTRUCTIONS ON NEXT PAGE)

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MEC-162 EXAM PREVIEW

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Exam Preview:

1. R-12 is classified as a safe refrigerant because it is nonexplosive, nonflammable, and noncorrosive; however, you must observe certain precautions when using and handling it.
   a. True
   b. False
2. According to the reference material, refrigerant-12, otherwise known as R-12, Freon-12, or F-12, boils at -___°C when at sea level.
   a. 21.7
   b. 29.8
   c. 31.2
   d. 38.7
3. According to the reference material, to prevent accidents or damage to the system, use hot water or rags saturated with water at temperatures not to exceed ___°F when refrigerant containers must be warmed for system charges.
   a. 75
   b. 100
   c. 125
   d. 150
4. The temperature of the evaporator must be kept above 32°C. Should the temperature fall below 32°C, moisture condensing on the evaporator would freeze and prevent air from passing through the fins.
   a. True
   b. False

5. The propane torch detector works by burning small amounts of R-12. In doing so, phosgene gas is produced. Phosgene gas can result in fatal injury; therefore, use this device in well-ventilated areas only.
    a. True
    b. False
6. Each air-conditioning system must have a receiver/drier, an expansion valve or metering device, an evaporator, a compressor, and a condenser. Which of the following components matches the description: is designed to absorb heat from the airstream directed into the driver's compartment?
    a. Compressor
    b. Condenser
    c. Drier
    d. Evaporator
7. Sometimes a compressor discharge pressure switch is used to protect against a low refrigerant condition. This switch disengages the compressor drive to protect the system when discharge pressure drops below approximately __ psi.
    a. 35
    b. 45
    c. 55
    d. 65
8. According to the reference material, hoses of an R-12 system will not withstand the chemicals in a system using R-134A. Also, the lubrication oils are not compatible and must not be mixed.
    a. True
    b. False
9. The condenser is designed to remove heat from the compressed refrigerant, returning it to a liquid state. They are made of aluminum and can encounter pressures of approximately 150 to 300 psig and temperatures ranging from 120°F to ___°F
    a. 160
    b. 180
    c. 200
    d. 220
10. Functional testing is required to establish the condition of all components in the system. Check the temperature of the air exiting the cooling duct. It should be close to __°F with the blower running on low speed.
    a. 30
    b. 40
    c. 50
    d. 60

AIR-CONDITIONING SYSTEMS

Air conditioning is the treatment of air to ensure control of temperature, humidity, and dust (or foreign particles) at levels most suitable to personal comfort. A good example is the air-conditioning system used by astronauts; their air-conditioning units must supply all life-sustaining conditions to support their existence. In this chapter, we examine the basic principles of refrigeration, system components, troubleshooting, and the repair of these systems. Furthermore, in closing, the changes to automotive air systems and how they may affect you as a mechanic are also examined.

PRINCIPLES OF REFRIGERATION

Refrigeration is the process of producing low temperatures. It is usually associated with refrigerators or freezers rather than with vehicles. An understanding of heat transfer, basic refrigeration, pressure-temperature relationship, and the qualities of refrigerants is essential for a working knowledge of the air-conditioning system.

HEAT TRANSFER

It may seem a bit silly to cover heat transfer in connection with air conditioning. Keep in mind, however, that heat, like light, is a form of energy. As you remove light, a room grows darker. Likewise, when you remove heat, an area becomes colder. The process of transferring heat is the basis for air conditioning. Generally, when two objects of different temperatures are close to each other, heat energy will leave the warmer object and travel to the cooler. This is quite clearly illustrated in North America each fall and winter. As the rays of the sun become less direct and consequently give off less heat, we experience a drop in temperature. Cooler weather (refrigeration) results from this removal of heat.

Refrigeration applies a physical principle that is known to most of us through our everyday experiences. We have experienced the application of rubbing alcohol and its cooling effect. This example illustrates that an evaporating liquid absorbs heat. The evaporating moisture in the air on a hot day soaks up heat like a sponge. This removal of heat is exactly the same process used in automotive air conditioning. Heat is removed from the vehicle by an evaporating refrigerant and transferred into the atmosphere.

PRESSURE TEMPERATURE RELATIONSHIP

Different liquids have different boiling evaporating points; however, the boiling pint of any liquid increases when pressure is increased. When pressure is decreased, the boiling point is then decreased. This process of removing the pressure and allowing the coolant to boil is a vital part of any refrigeration system.

REFRIGERANT

With the exception of changes in state, gases used in refrigeration are recycled much like engine coolant. Different pressures and temperatures cause the gas to change state from liquid togas and back to a liquid again. The boiling point of the refrigerant changes with system pressure. High pressure raises the boiling point and low pressure reduces it. These gases also provide good heat transfer qualities and do not deteriorate system components. Two gases commonly used in the refrigeration process are Refrigerant-12 and Refrigerant-22. Use extreme caution when handling them. Refrigerant-12, otherwise known as R-12, Freon-12, or F-12, boils at –21.7°F (–29.8°C) when at sea level. Because of this low boiling point and its ability to pass through the system endlessly, R- 12 is almost the ideal refrigerant. (R-12 is currently being replaced by a refrigerant that is less harmful to our environment).

WARNING

When you are working with R-22, keep in mind that this refrigerant contains methyl alcohol which can be a fire hazard. For this reason, automotive air-conditioning systems contain R-12.

HANDLING REFRIGERANT

R-12 is classified as a safe refrigerant because it is nonexplosive, nonflammable, and noncorrosive; however, you must observe certain precautions when

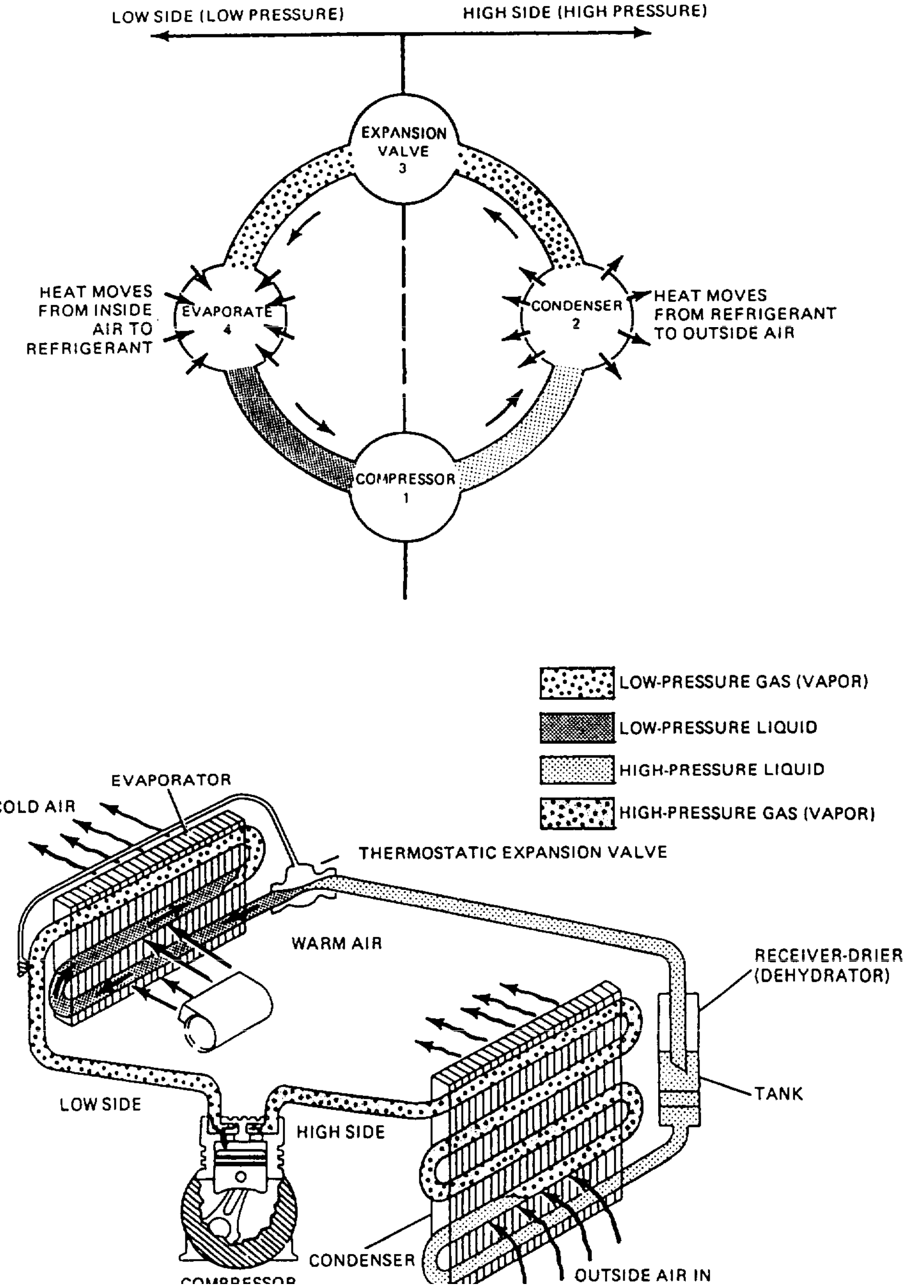

Figure 13-1.—The closed circuit refrigeration cycle.

using and handling it. At normal atmospheric temperatures, R-12 evaporates so rapidly that it freezes anything it contacts. For this reason, always wear rubber gloves and safety goggles when servicing a charged refrigeration system. Good ventilation in the working area must be ensured. Any sizable quantity of R-12 escaping into the atmosphere will displace the surrounding air and could result in suffocation. R-12 discharged near an open flame could produce a poisonous gas. Do not weld or use excessive heat of any kind near the air-conditioning system or refrigerant supply tanks. The heat will cause increased pressure inside the system and could result in an explosion. You should exercise great care to maintain the refrigerant under pressure in the supply tanks, in the air-conditioning system, and during servicing procedures.

The refrigerant must evaporate to provide a cooling effect, yet cannot be allowed to escape into the atmosphere. R-12 must circulate through a closed system (fig. 13-1), just as coolant circulates through the engine cooling system. R-12 is available in tanks and cans. The disposable can is the most convenient refrigerant container and it is widely used for servicing

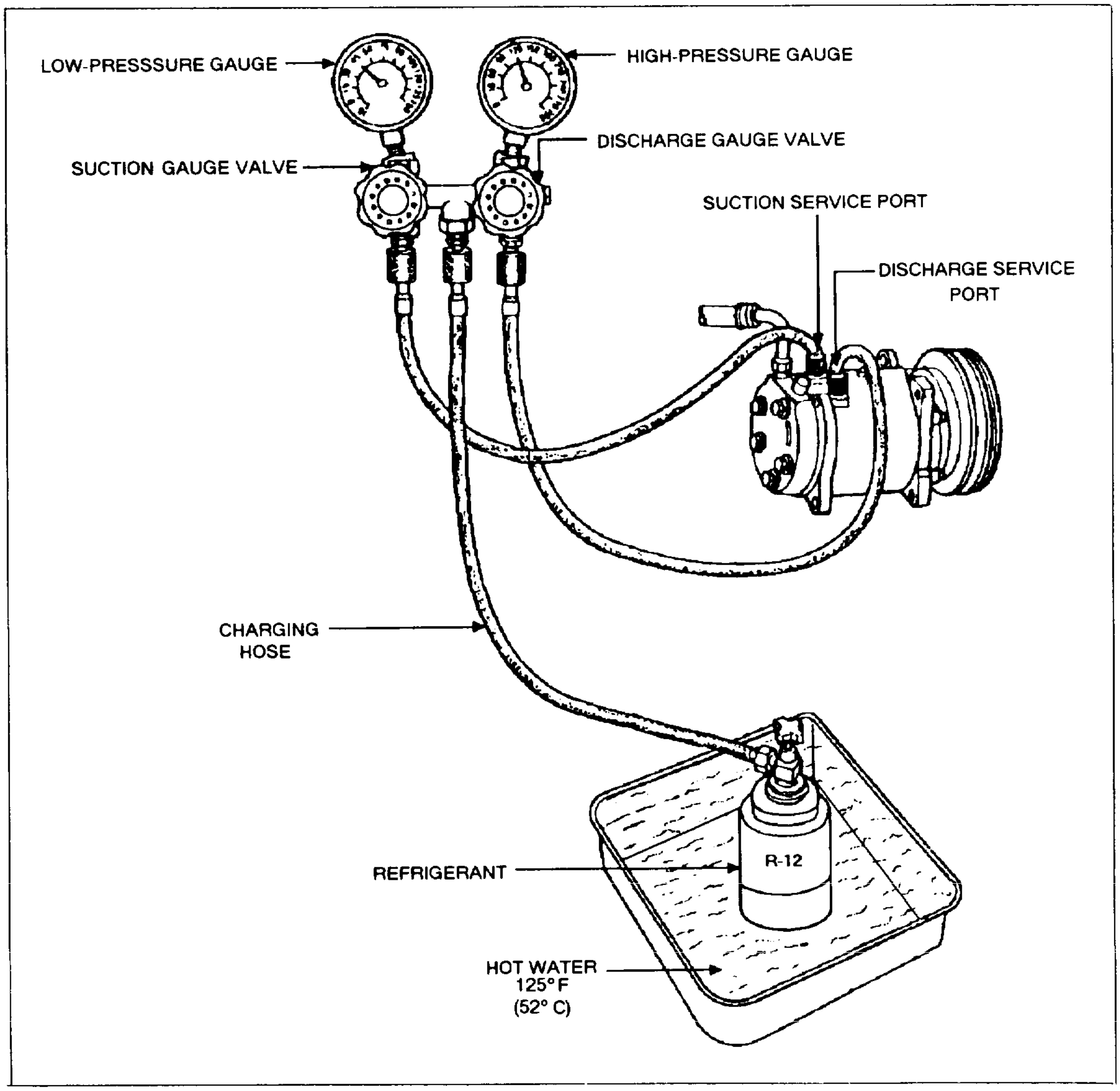

Figure 13-2.—Warming the refrigerant by using hot water.

and charging the system. Although R-12 is considered the safest refrigerant for automotive air-conditioning systems, the containers are under considerable pressure at ordinary temperatures. To prevent accidents or damage to the system, you must observe the following precautions:

- Do not subject the containers to excessive heat and do not store them in direct sunlight or near a shop heater.
- Use hot water (fig. 13-2) or rags saturated with water at temperatures not to exceed 125°F when refrigerant containers must be warmed for system charges.
- Never use a direct flame or a heater to warm containers or cans.
- Do not subject refrigerant containers to rough handling.
- Do not drop or strike containers.
- Keep refrigerant tanks upright, and be sure the metal cap is installed to protect the valve and safety plug when the tank is not in use.
- Do not transport refrigerant tanks or cans in vehicle passenger compartments.
- Cover the containers to protect them from direct sunlight when they are carried in an open truck.
- When you dispense refrigerant from cans, use the specified can valve that has provisions for puncturing the can only after the valve is installed.

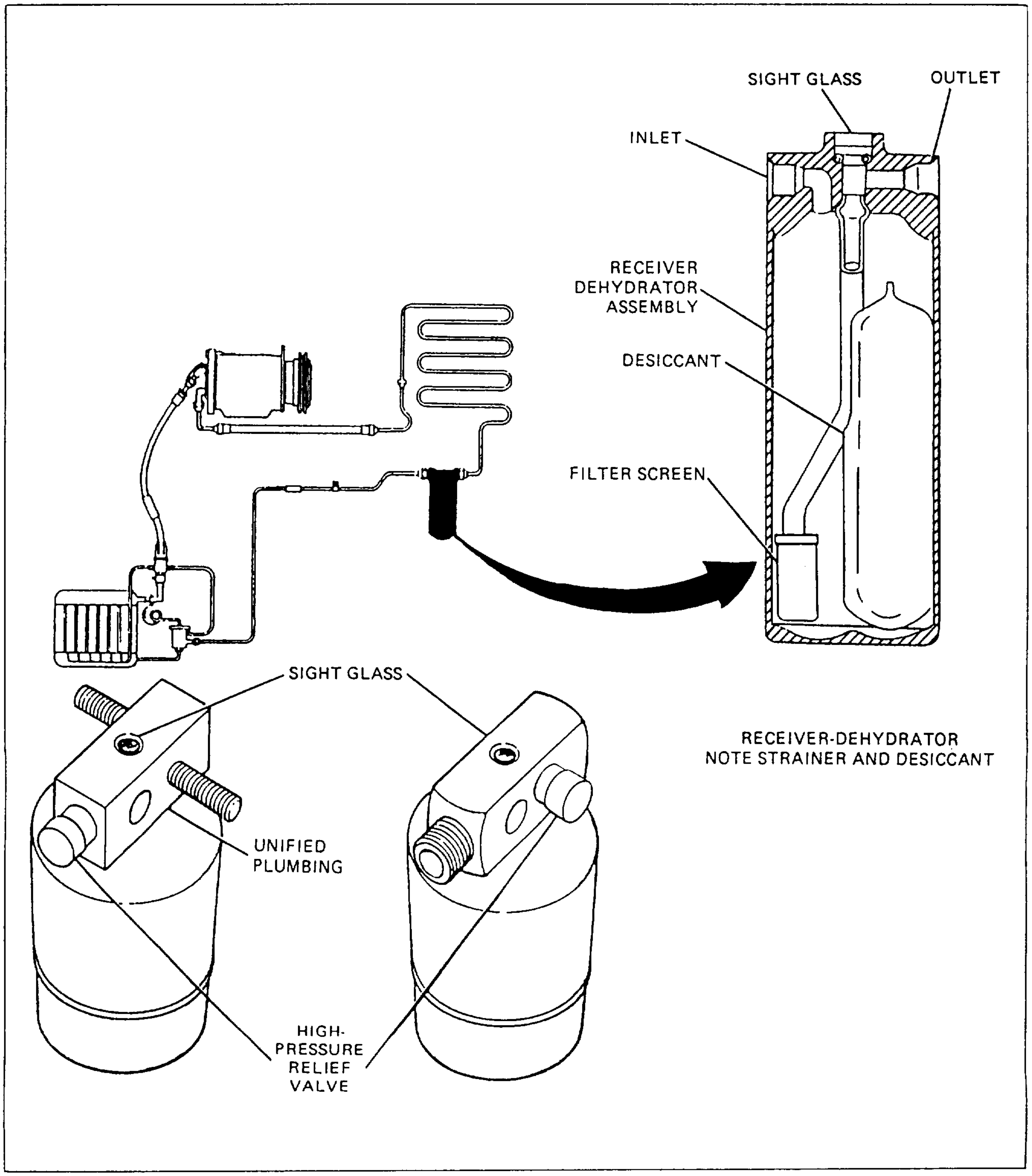

Figure 13-3.—Receiver and components.

REFRIGERATION CYCLE

The refrigeration cycle is a continuous closed-loop system. The refrigerant is pumped constantly through the components in the system. By changing the refrigerant pressure and by removing and adding heat, the refrigeration cycle is completed. The refrigeration cycle operates as follows:

1. The receiver/drier collects high-pressure refrigerant in a liquid form. Also, moisture and impurities are removed at this point.

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2. The refrigerant is routed to the expansion valve through high-pressure lines and hoses.

3. The expansion valve reduces refrigerant pressure to the evaporator by allowing a controlled amount of liquid refrigerant to enter it.

4. A stream of air is passed over the coils in the evaporator as refrigerant enters.

5. As the low-pressure refrigerant moves through the coils in the evaporator, it absorbs heat from the airstream, which produces a cooling effect.

6. As the refrigerant nears the end of the coils in the evaporator, greater amounts of heat are absorbed. This causes the low-pressure liquid refrigerant to boil and change to a gas as it exits the evaporator.

7. As the refrigerant enters the compressor, the pumping action increases refrigerant pressure, which also causes a rise in temperature.

8. The high-pressure, high-temperature gas enters the condenser, where heat is removed by an outside ambient airstream moving over the coils. This causes the gas to condense and return to a liquid form again.

9. The high-pressure liquid refrigerant now enters the receiver again to begin another cycle. This continuous cycle, along with the dehumidifying and filtering effect, produces a comfortable atmosphere on hot days.

Figure 13-1 shows the refrigeration cycle. You should trace the order of the cycle to understand it fully.

COMPONENTS OF THE AIR-CONDITIONING SYSTEM

Each air-conditioning system must have a receiver/drier, an expansion valve or metering device, an evaporator, a compressor, and a condenser. Without these components, an air-conditioning system will not function. Additionally, the system must have some means of control. The following information briefly covers each air-conditioning component and the controls involved.

THE RECEIVER/DRIER

The receiver (fig. 13-3), otherwise known as a filter-drier or accumulator-drier, is a cylindrical-shaped metal tank. The tank is hollow with an inlet to the top of the hollow cylinder. The outlet port has a tube attached to it that extends to the bottom of the receiver. This tube assures that only liquid refrigerant will exit the receiver, because any gas entering will tend to float above the liquid.

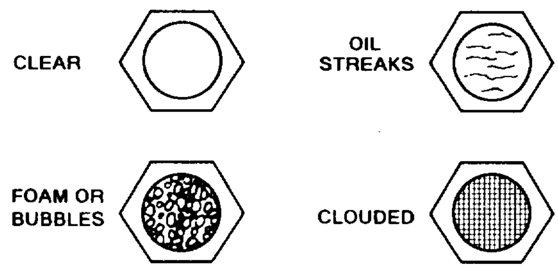

Figure 13-4.—Possible sight glass conditions.

- Filter–The filter is mounted inside the receiver on the end of the outlet pipe. This filter removes any impurities from the refrigerant by straining it.

- Desiccant–A special desiccant or drying agent, also, is located inside the receiver. This agent removes any moisture from the system.

- Relief Valve–Some systems use a relief valve mounted near the top of the receiver. This valve is designed to open when system pressure exceeds approximately 450 to 500 psi. As the relief valve opens, it vents refrigerant into the atmosphere. As soon as excess pressure is released, the valve closes again so the system will not be evacuated completely.

- Sight Glass–A sight glass is a small, round, glass-covered hole, sometimes mounted on the outlet side of the receiver near the top. This observation hole is a visual aid you use in determining the condition and amount of refrigerant in the system. If bubbles or foam is observed in the sight glass while the system is operating (above 70°F [21°C]) (fig. 13-4), it may indicate that the system is low on refrigerant. Some systems have a moisture-sensitive element built into the sight glass. If excessive moisture is present, the element turns pink. If the system moisture content is within limits, the element remains blue. In many later automotive air-conditioning systems, the sight glass has been eliminated. In such applications, you must depend on the system pressures.

THE EXPANSION SYSTEM

The refrigerant expansion system is designed to regulate the amount of refrigerant entering the evaporator and to reduce its pressure.

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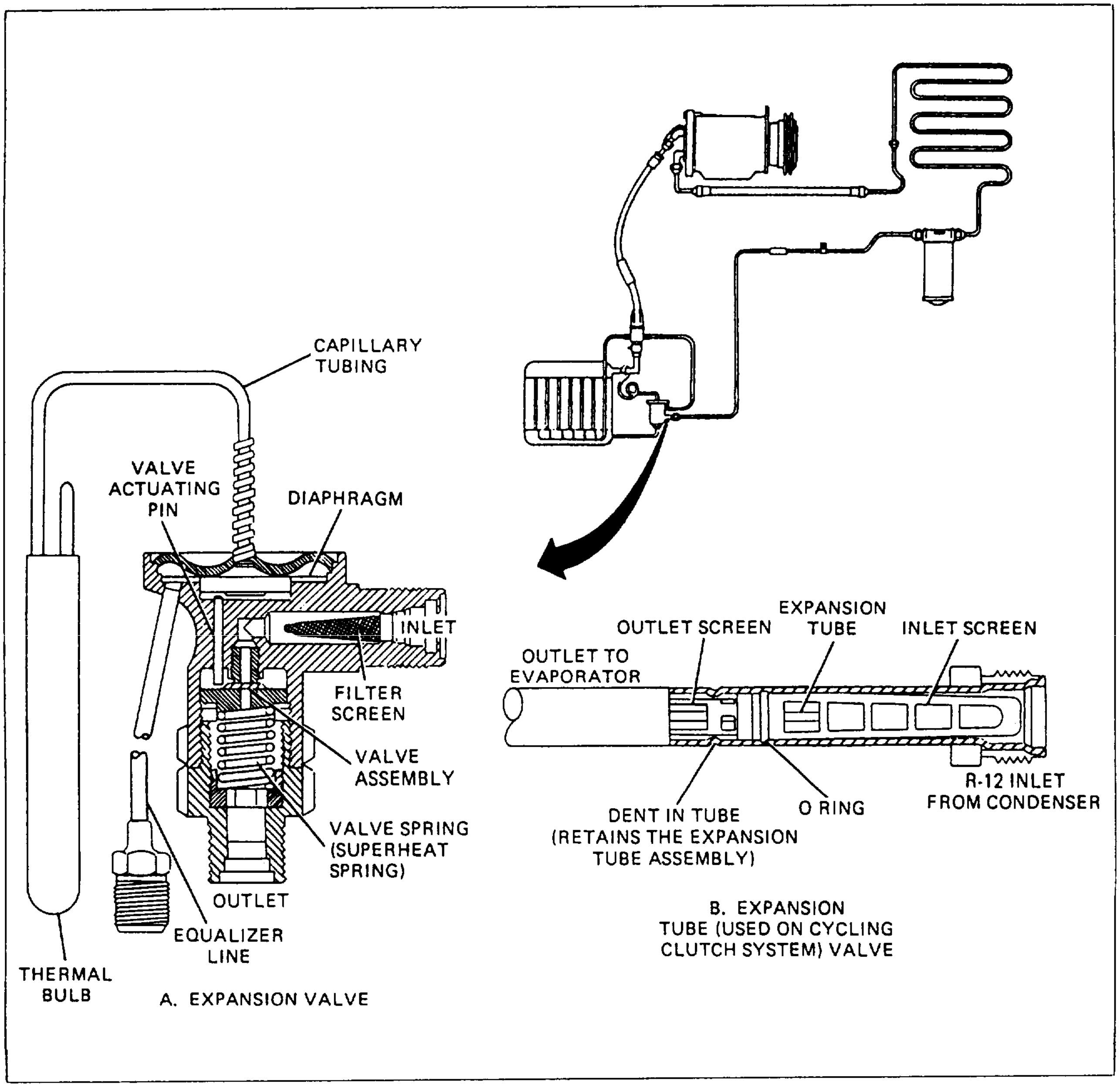

Figure 13-5.—Expansion valve and expansion tube.

Expansion Valve

One type of expansion system used on modem vehicles is the expansion valve (view A, fig. 13-5). The valve action is controlled by the valve spring, suction manifold, and pressure exerted on the diaphragm from the thermal bulb. Operation of the valve is as follows:

1. High-pressure liquid refrigerant flows into the valve and is stopped at the needle seat.

2. If the evaporator is warm, pressure is developed in the thermal bulb and transferred to the diaphragm through the capillary tube.

3. The diaphragm overcomes the pressure developed in the equalizer tube and valve spring pressure, causing it to move downward.

4. This movement forces the valve-actuating pin downward to open the valve.

As the refrigerant flows, it cools the evaporator and therefore reduces pressure in the thermal bulb. This allows the valve to close and stop refrigerant from flowing into the evaporator. By carefully metering the amount of refrigerant with the expansion valve, the evaporator cooling efficiency is increased greatly.

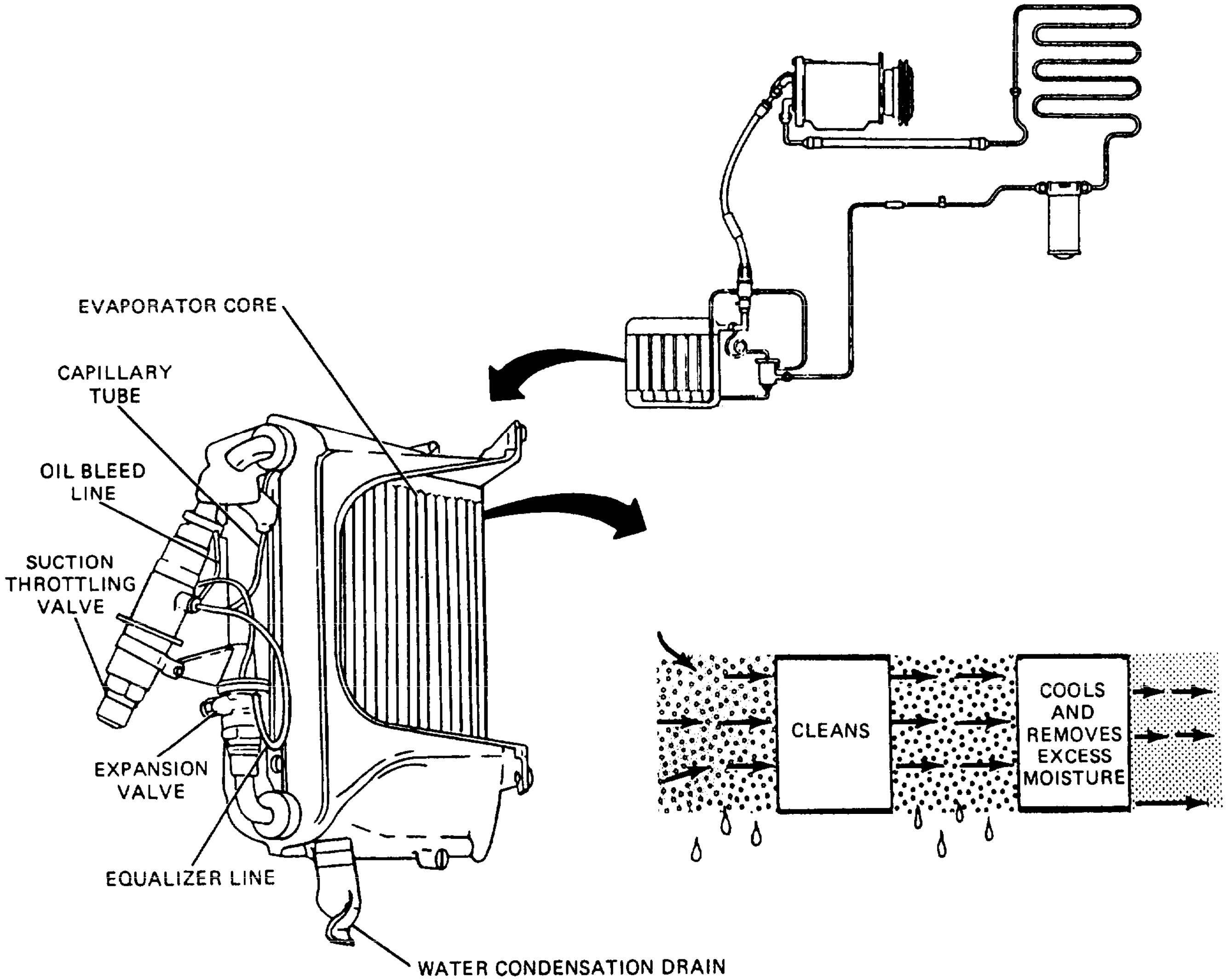

Figure 13-6.—Typical evaporator.

Expansion Tube

The expansion tube (view B, fig. 13-5) provides the same functions as the expansion valve. A calibrated orifice is built into the expansion tube. The tube retards the refrigerant flow through the orifice to provide the metered amount of refrigerant to the evaporator. The tube, also, has a fine screen built in for additional filtration.

THE EVAPORATOR

The evaporator is designed to absorb heat from the airstream directed into the driver's compartment. It is a continuous tube looped back and forth through many cooling fins firmly attached to the tube. The evaporator dehumidifies the air by passing an airstream over the cooling fins. As this happens, the moisture condenses on the fins and drips down to collect and exit under the vehicle. Also, dust and dirt are collected on the moist fins and are drained with the moisture. The temperature of the evaporator must be kept above 32°F. Should the temperature fall below 32°F, moisture condensing on the evaporator would freeze and prevent air from passing through the fins. A typical evaporator is shown in figure 13-6. There are basically three methods of regulating evaporator temperature; each is examined below.

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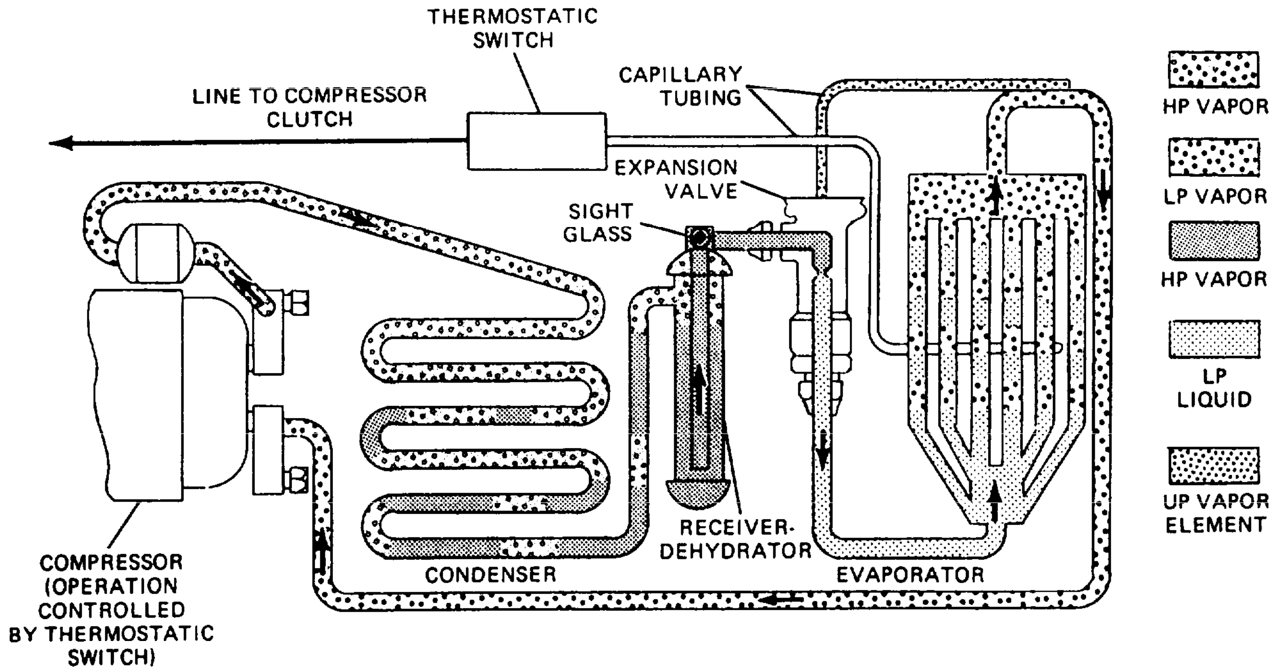

Figure 13-7.—Thermostatic switch.

Thermostatic Switch

This system uses an electrically operated switch (fig. 13-7) to engage and disengage the compressor. The switch is operated by a sensing bulb placed in the airstream after the evaporator. As the evaporator temperature falls, the thermostatic switch opens to disengage the magnetic clutch in the compressor. When the coil temperature reaches the proper level, the switch again closes to engage the clutch and drive the compressor.

Hot Gas Bypass Valve

The hot gas bypass valve was used on some older models to control evaporator icing (fig. 13-8). The valve is mounted on the outlet side of the evaporator. The high-pressure gas from the compressor joins with the low-pressure gas exiting the evaporator. These two gases mix, causing a pressure increase. Also, the boiling point increases which results in a loss of cooling efficiency. This, in turn, causes the evaporator temperature to increase, thus eliminating freeze-up. The compressor is designed to run constantly (when it is activated) in the hot gas bypass valve system.

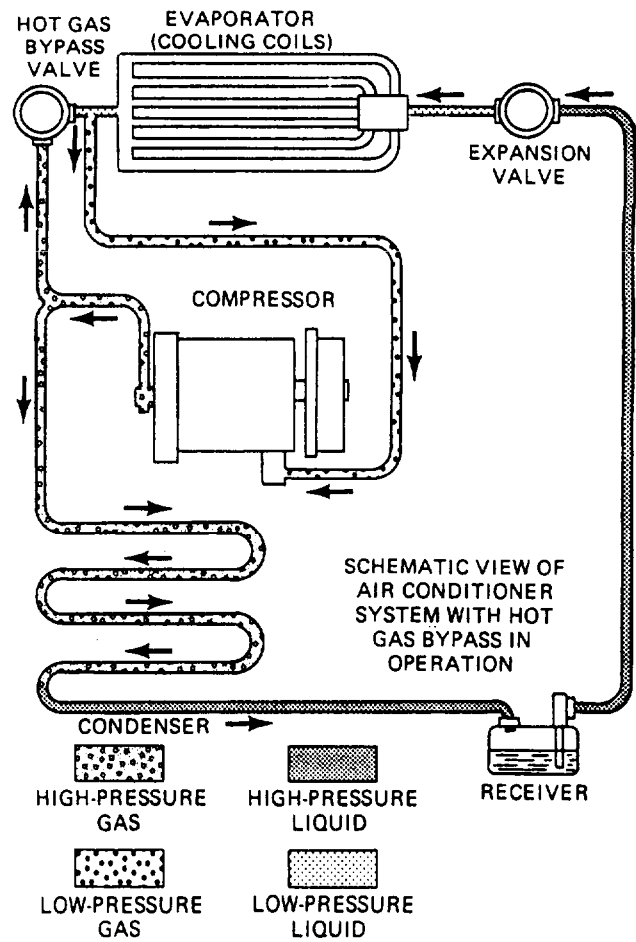

Figure 13-8.—Hot gas bypass valve.

Suction Throttling Valve

The suction throttling valve (fig. 13-9) is used now in place of the hot gas bypass valve system. It is placed

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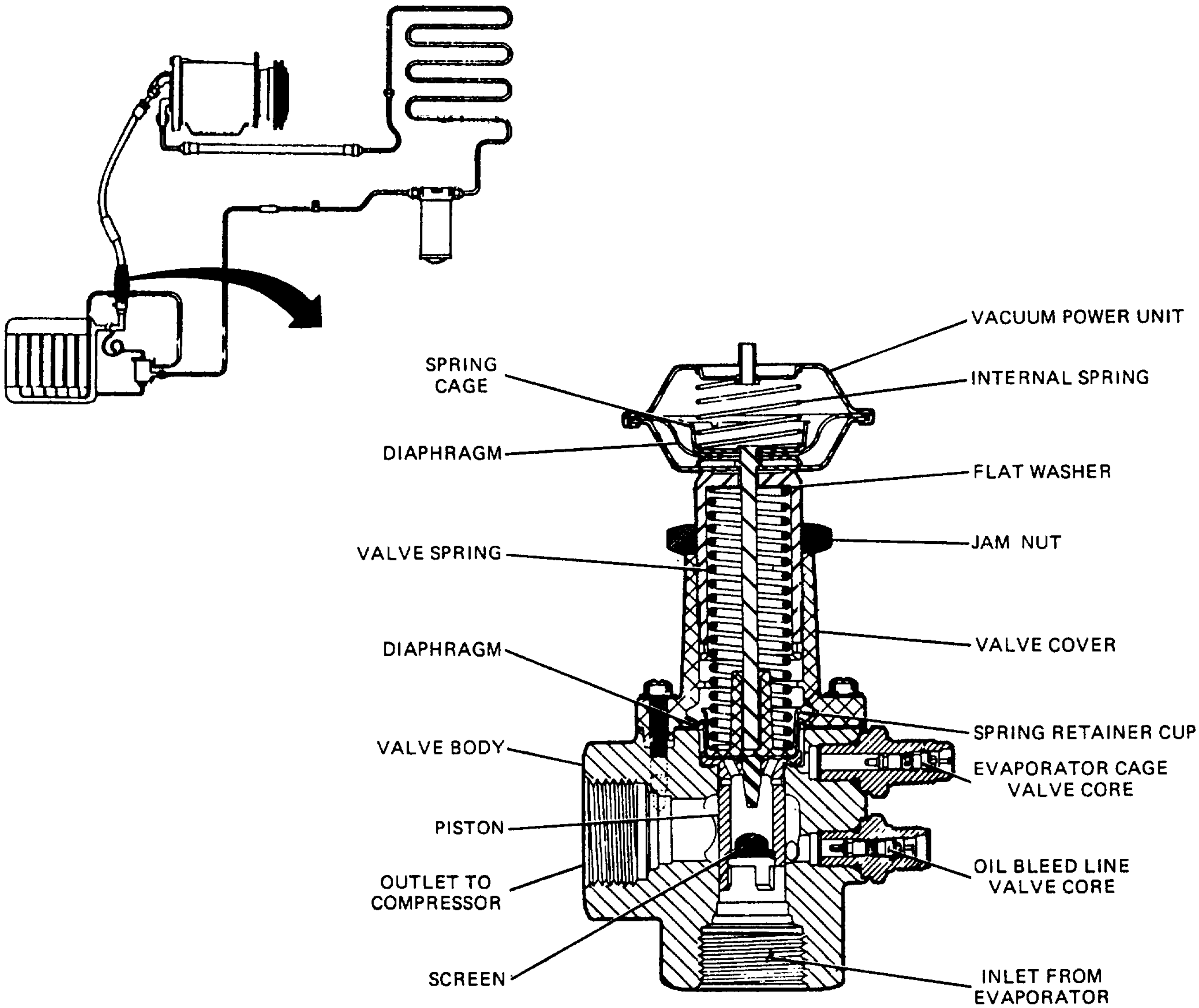

Figure 13-9.—Suction throttling valve.

in line with the outlet of the evaporator. This system is designed to limit the amount of low-pressure vapor entering the compressor. The suction throttling valve operates as follows:

1. The outlet pressure enters the valve on the bottom.

2. The gas pressure passes through a fine screen and small bleeder holes to act on a diaphragm.

3. The valve spring and atmospheric pressure oppose the gas pressure on the opposite side of the diaphragm.

4. As the outlet pressure of the evaporator overcomes the opposing forces, the diaphragm and piston move upward, allowing low-pressure gas to flow through the valve and flow to the inlet of the compressor.

As pressure again drops on the inlet side of the valve, atmospheric pressure and valve spring pressure close the valve again. A vacuum power unit is mounted to the top of the valve to help reduce valve spring pressure and prevent icing at high elevations.

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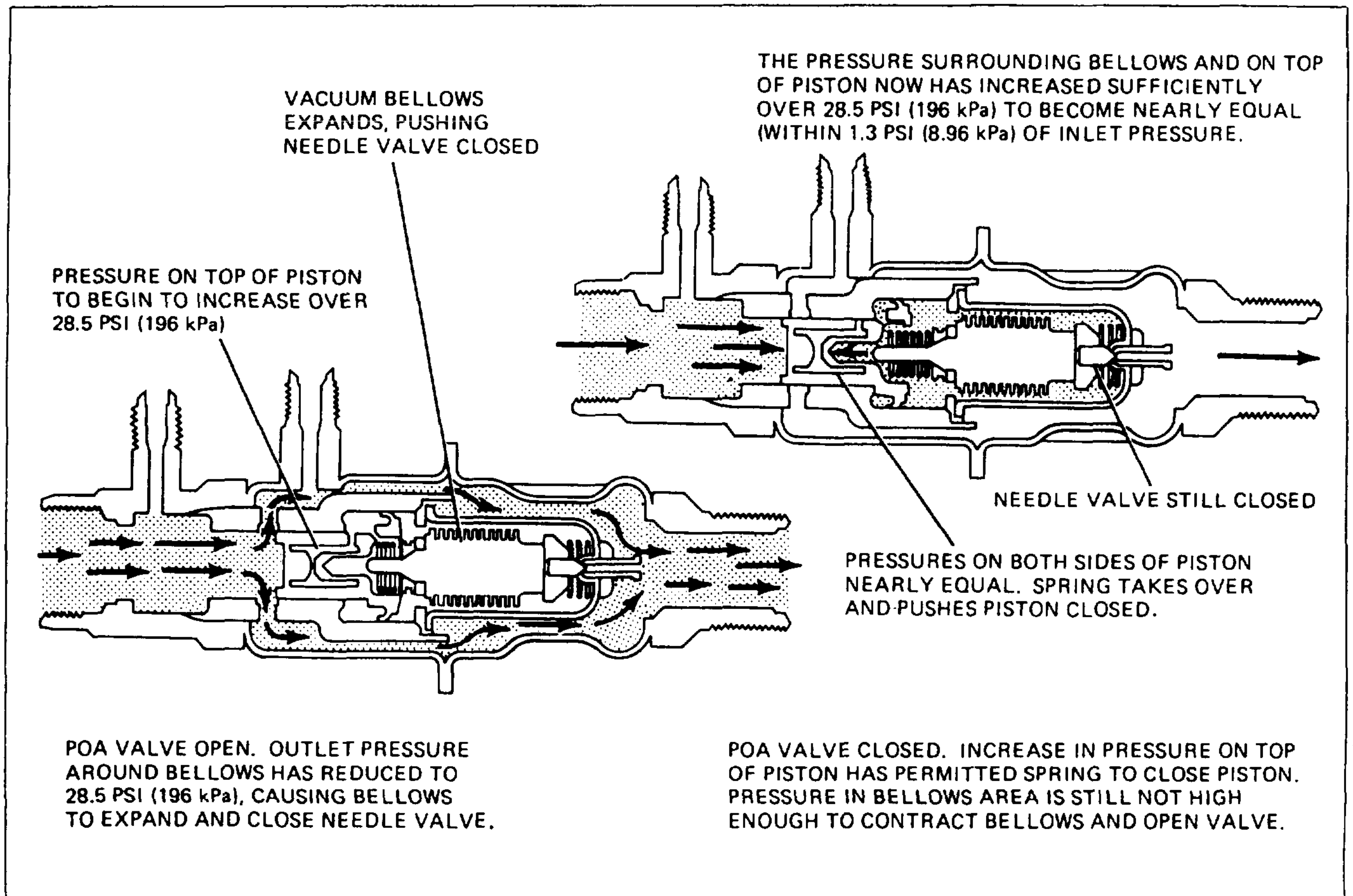

Figure 13-10.—Pilot-operated absolute (POA) suction throttling valve.

Pilot-Operated Absolute Suction Throttling Valve

The pilot-operated absolute (POA) suction throttling valve (fig. 13-10) maintains the proper minimum evaprator pressure regardless of compressor speed, evaporator temperature, and changes in altitude. The POA suction throttling valve is operated by a bellows containing an almost perfect vacuum. The expanding and contracting action of the bellows operates a needle valve, regulating its surrounding pressure. As inlet and outlet pressure are equalized, spring pressure closes the valve. The pressure differential across the valve then forces the piston toward the lower pressure, therefore, opening the valve to allow refrigerant to flow.

THE COMPRESSOR

The compressor increases the pressure of vaporized refrigerant exiting the evaporator. When the system is activated, a coil produces a magnetic field that engages the drive pulley to operate the compressor (fig. 13-11). Some compressors tie protected from overheating by a superheat switch located inside the compressor (fig. 13-12). Should the compressor develop an excess amount of heat due to a loss of refrigerant or oil, the superheat switch disengages the compressor by completing a circuit and opening a thermal fuse. Sometimes a compressor discharge pressure switch is used to protect against a low refrigerant condition. (See fig. 13-10.) This switch disengages the compressor drive to protect the system when discharge pressure drops below approximately 35 psi (241 kPa). Often a muffler is used on the outlet side of the compressor (fig. 13-11). The muffler helps reduce compressor pumping noise and line vibrations.

Two-Cylinder Reciprocating Compressor

The two-cylinder reciprocating compressor (fig. 13-13) has two reciprocating pistons fitted into cylinders. A special valve plate, operated by differential pressures, is used to control gas flow.

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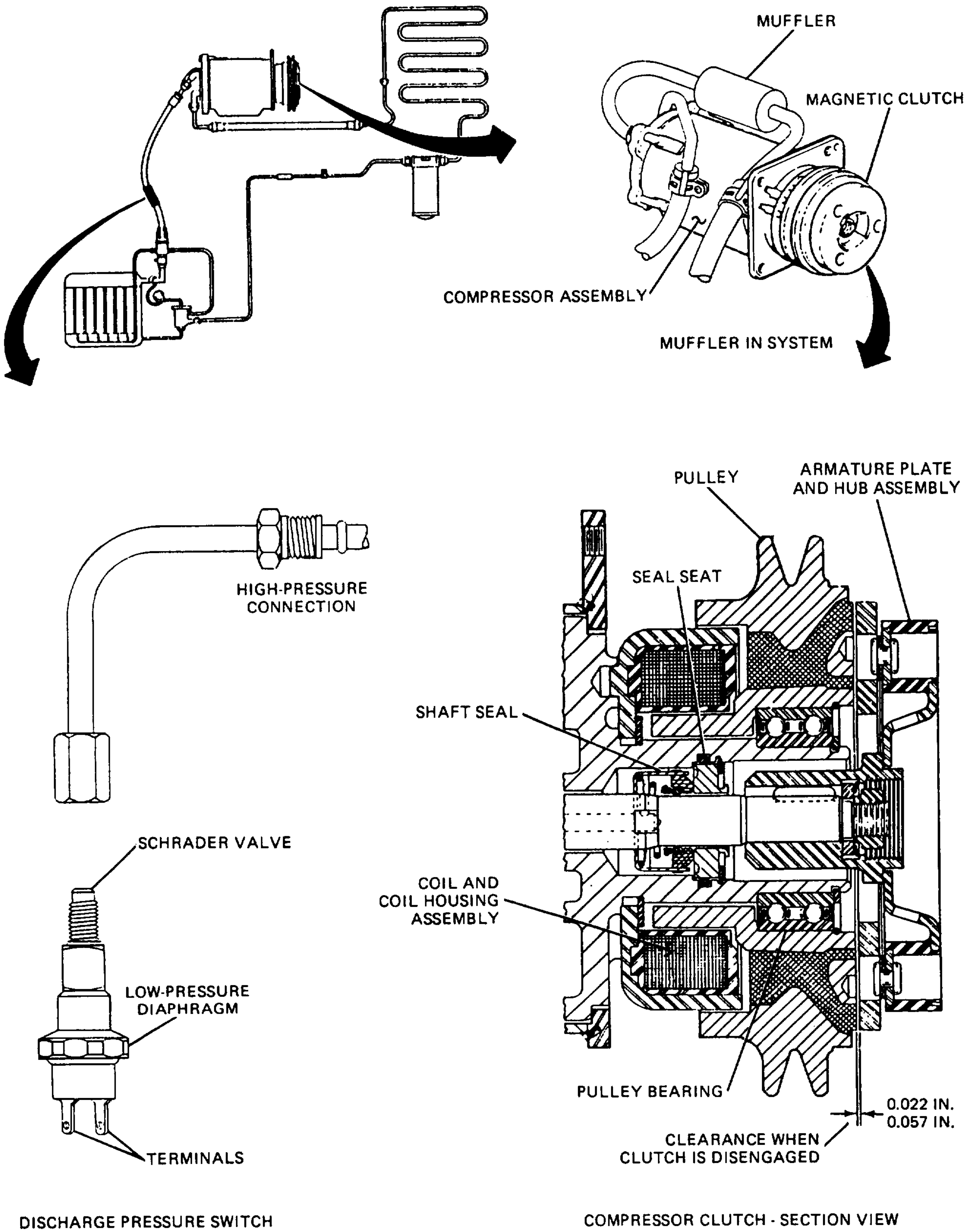

Figure 13-11.—Compressor components.

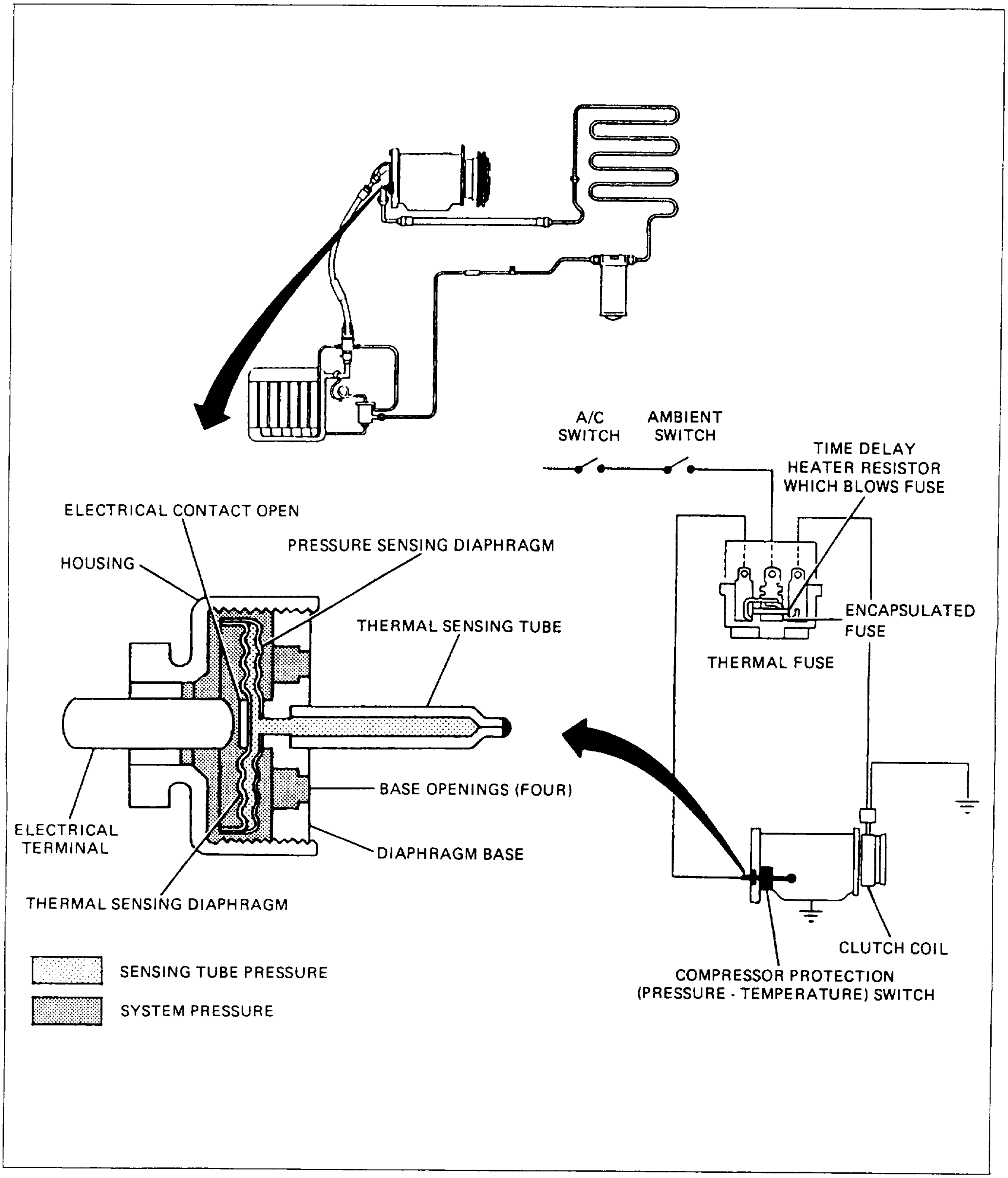

Figure 13-12.—Compressor superheat switch.

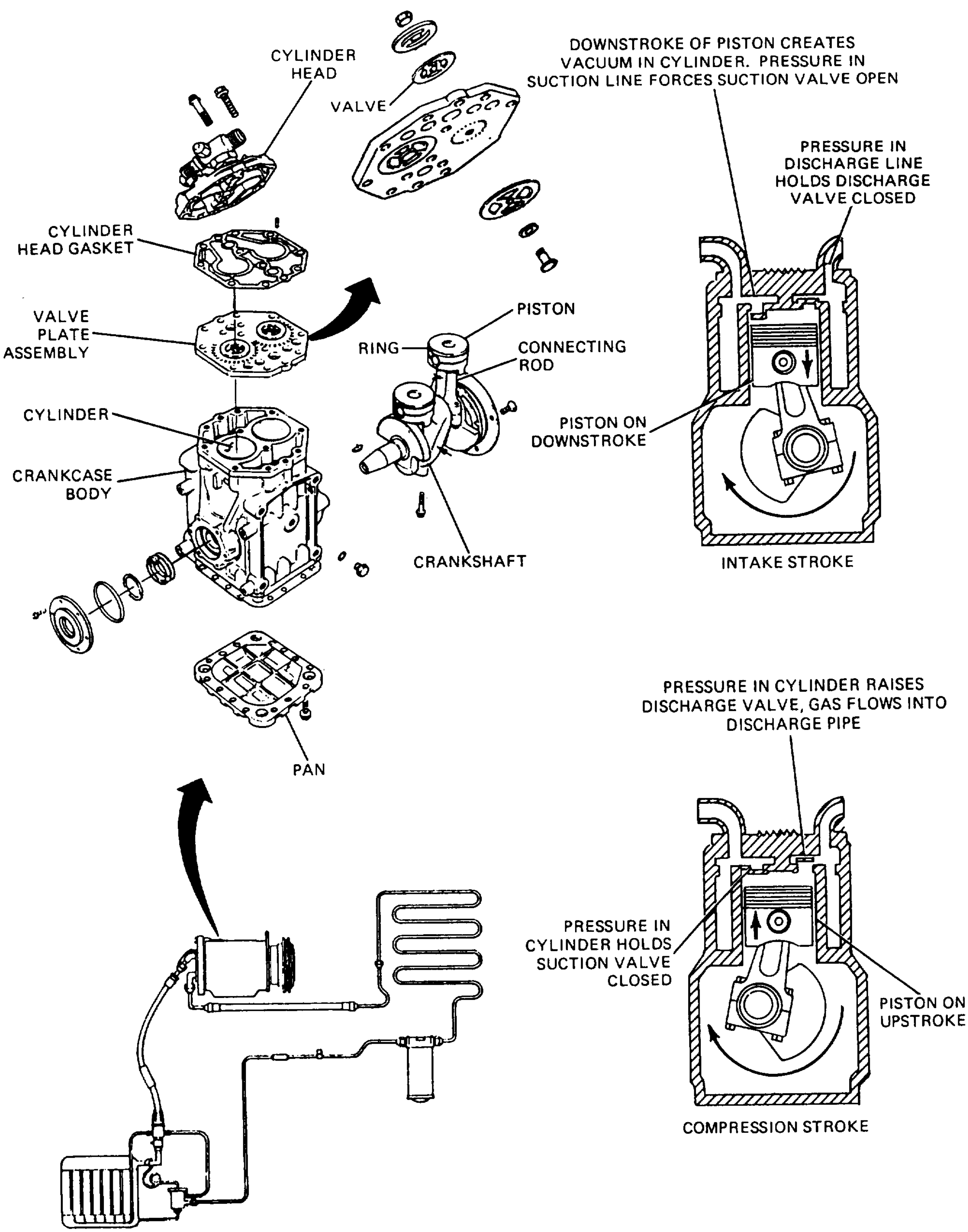

Figure 13-13.—Two-cylinder reciprocating compressor.

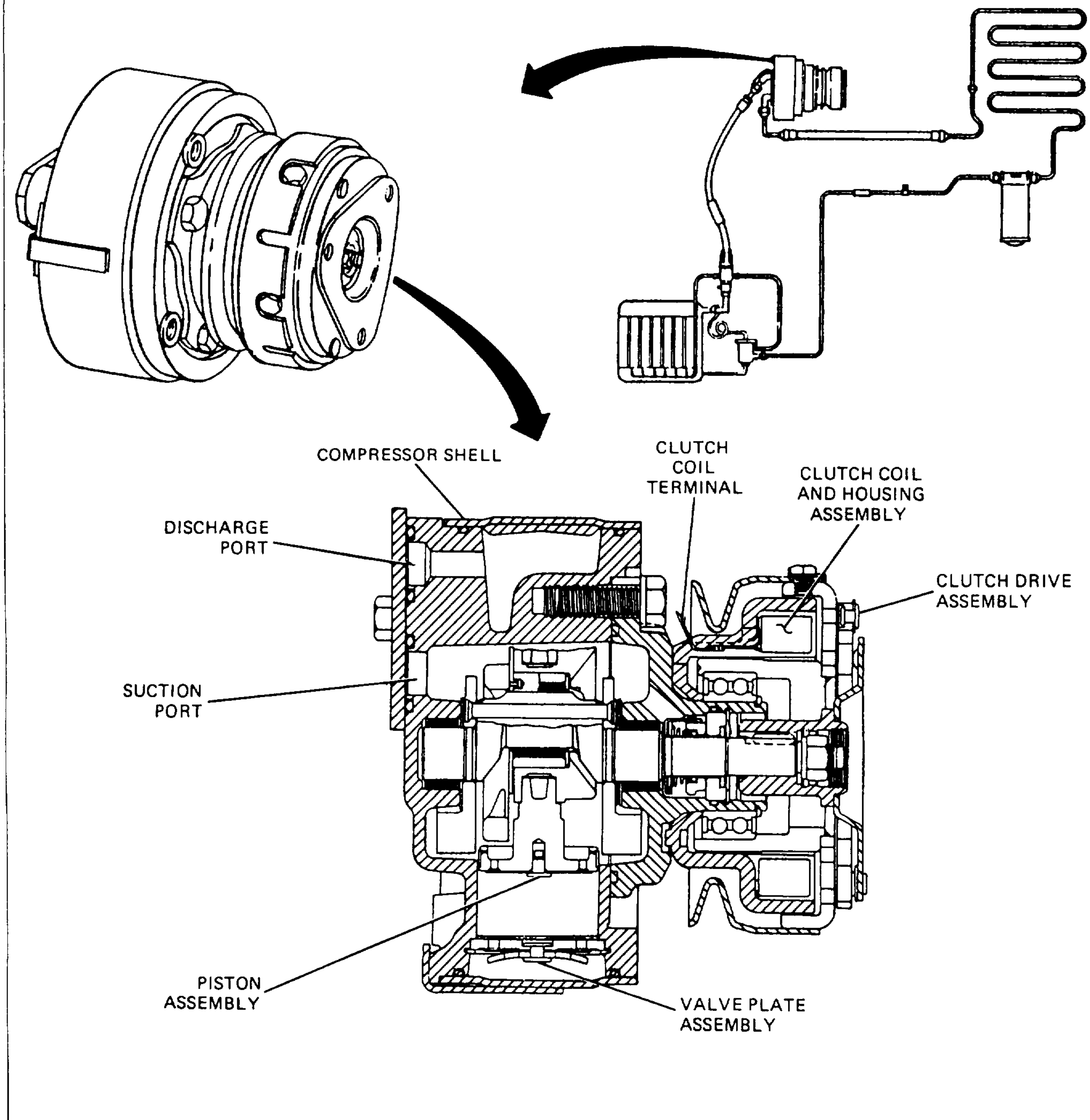

Figure 13-14.—Four-cylinder radial compressor.

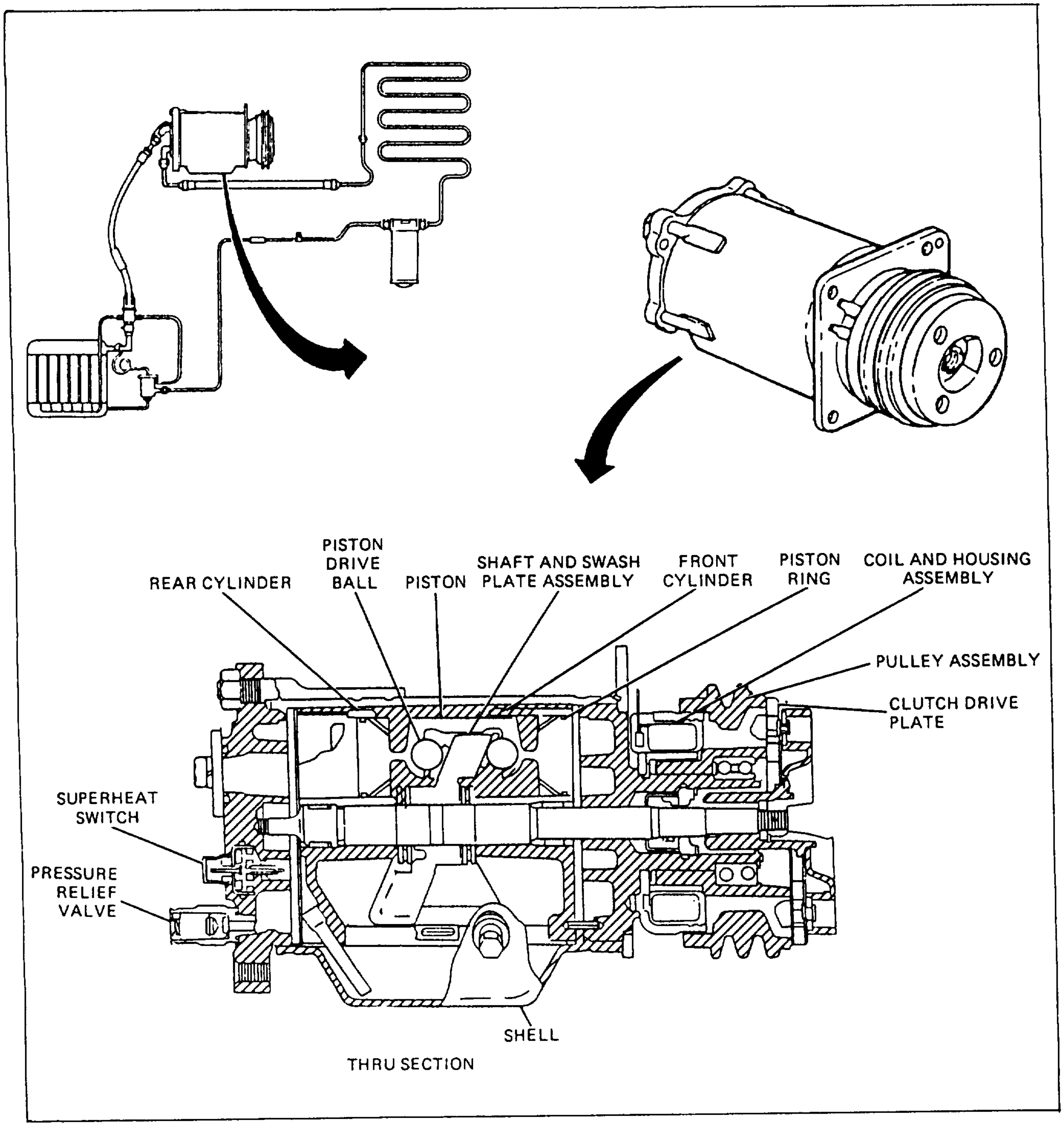

Figure 13-15.—Six-cylinder axial compressor.

Four-Cylinder Radial Compressor

The four-cylinder radial compressor (fig. 13-14) positions four pistons at right angles to each other. The pistons are driven by a central shaft connected to the engine by the electric clutch assembly and V-belt. The radial compact design of the compressor is very popular on the vehicles of today.

Six-Cylinder Axial Compressor

This design uses three double-ended pistons driven by a wobble plate (fig. 13-15). The three cylinders effectively produce a six-cylinder compressor. As the shaft rotates, the wobble plate displaces the pistons perpendicular to the shaft. Piston drive balls are used to cut down friction between the wobble plate and pistons. Piston rings, also, are used to aid in sealing.

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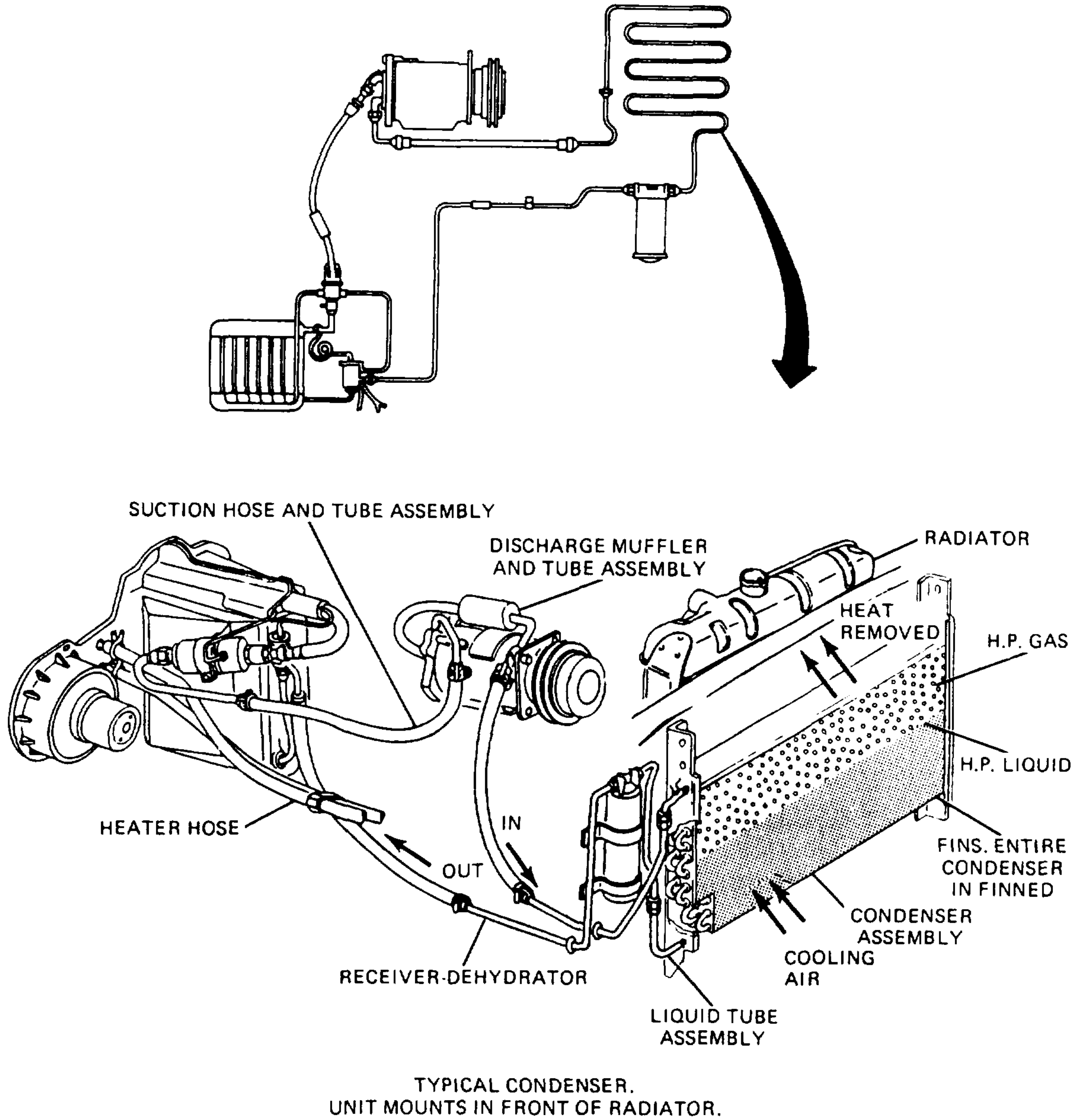

Figure 13-16.—Condenser.

THE CONDENSER

The condenser (fig. 13- 16) is designed to remove heat from the compressed refrigerant, returning it to a liquid state. Generally, condensers are made from a continuous tube looped back and forth through rigidly mounted cooling fins. They are made of aluminum and can encounter pressures of approximately 150 to 300 psig and temperatures ranging from 120°F to 200°F (48°C to 93°C), Usually, the condenser is mounted in front of the radiator and subjected to a steady stream of cooling air.

Refrigeration oil provides lubrication for the compressor. Each system has a certain amount of refrigeration oil (usually approximately 6 to 10 oz (177 to 296 Ml)) added to the system initially. If the system stays sealed, the oil will not break down or need to be changed. Refrigeration oil is highly refined, must be free of moisture, and is designed for use in automotive air-conditioning systems.

MALFUNCTIONS OF COMPONENTS IN THE AIR-CONDITIONING SYSTEM

Problems in automotive air-conditioning systems are not uncommon. An ordinary industrial system does not have to contend with the vibration that a mobile unit does. What follows is a list of common problems and possible causes associated with each air-conditioning component. This is by no means a complete list, so you should have the manufacturer's vehicle repair manual handy.

COMPRESSOR

A thumping noise in the compressor or a cool and sweating compressor suction line accompanied by no cooling is usually caused by too much refrigerant in the system. If there is no moisture in the system, the excess refrigerant should be removed and stored for proper disposal. If moisture is present, you must discharge, evacuate, and recharge the system.

CONDENSER

The condenser unit could have clogged fins that limit the cooling ability of the unit. This could be caused by bugs, leaves, or other debris caught in the tins. This can be corrected by using air pressure to blow out the coils, Check for any icy or frosty spots on the condenser. An abnormally cold spot usually indicates partial restriction inside the condenser coils at that point. Restrictions are normally caused by foreign matter. Correct this condition by discharging and purging the system.

EVAPORATOR

The evapator is normally maintenance free for the life of a vehicle. If the evaporator does develop a leak, it will be necessary to remove the assembly for repair. An evaporator is repaired in the same manner as a radiator. If the evaporator does not get the right amount of refrigerant, the expansion valve is most likely at fault.

EXPANSION VALVE

The most common malfunction in the expansion valve is icing caused by moisture in the air-conditioning system. The system must be discharged and evacuated to remove all moisture. On occasion, the expansion valve may stick open or closed; in this case, you must replace the valve.

RECEIVER/DRIER

The receiver/drier may become saturated with moisture or the filter may become restricted. If the receiver/drier is saturated or restricted, replace it. For any of these repairs, comply with the appropriate maintenance manual.

INSPECTING THE AIR-CONDITIONING SYSTEM FOR LEAKS

Approximately 80 percent of all air-conditioning service work consists of your inspecting for and repairing leaks. Many leaks will be located at points of connection and are caused by vehicle vibration. They may only require the retightening of a flare connection or a clamp. Occasionally, a hose will rub on a structural part to create a leak, or a hose may deteriorate and require replacement. The compressor shaft seal may also require. occasional replacement. Anytime the system requires more than one-half pound of refrigerant after operating during one season, a serious leak is indicated that you must locate and repair. The following information covers a few of the various means of detecting leaks.

CAUTION

When any tests or repairs are being made on a charged air-conditioning system, always wear adequate eye protection.

INTERNALLY CHARGED DETECTOR

This detector is a specially colored leak detector available in a pressurized can and mixed with R-12. It can be introduced into the air-conditioning system with regular charging equipment. When a leak occurs in the system, a bright red-orange spot appears at the point of leakage and remains until it is wiped off. The internal leak detector remains in the system and will spot future leaks in the same manner. A sticker is usually placed under the vehicle hood to indicate that the system is charged with a leak detector.

BUBBLE DETECTOR

The bubble detector is a solution applied externally at suspected leak points. Leaking refrigerant will cause the detector to form bubbles and foam.

ELECTRONIC DETECTOR

This instrument indicates leaks electronically by flashing a light or sounding an alarm. There are several different types of electronic detectors. Directions for using the instruments are furnished by the manufacturer.

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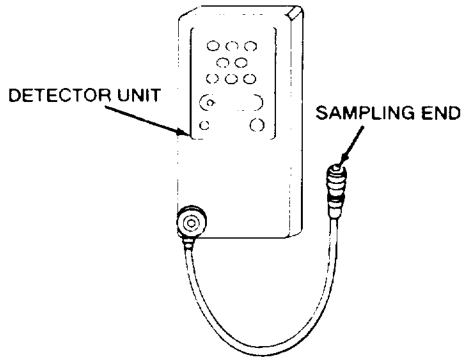

Figure 13-17.—Typical electronic leak detector.

This type of leak detector is the one most widely used today (fig. 13-17).

PROPANE TORCH DETECTOR

The propane torch detector shown in figure 13-18 is still used in the air conditioning field; however, it is rapidly being replaced by electronic devices.

CAUTION

The propane torch detector works by burning small amounts of R-12. In doing so, phosgene gas is produced. Phosgene gas can result in fatal injury; therefore, use this device in well-ventilated areas only.

The propane flame draws the leaking refrigerant over a hot copper alloy reactor plate, and a marked color change of the flame occurs if refrigerant is present.

CAUTION

The vehicle's engine must not be running when making this test.

To conduct this test, you should take the following actions:

1. Open the propane valve and light the torch.

2. Adjust the flame just high enough to heat the reaction to a cherry-red color.

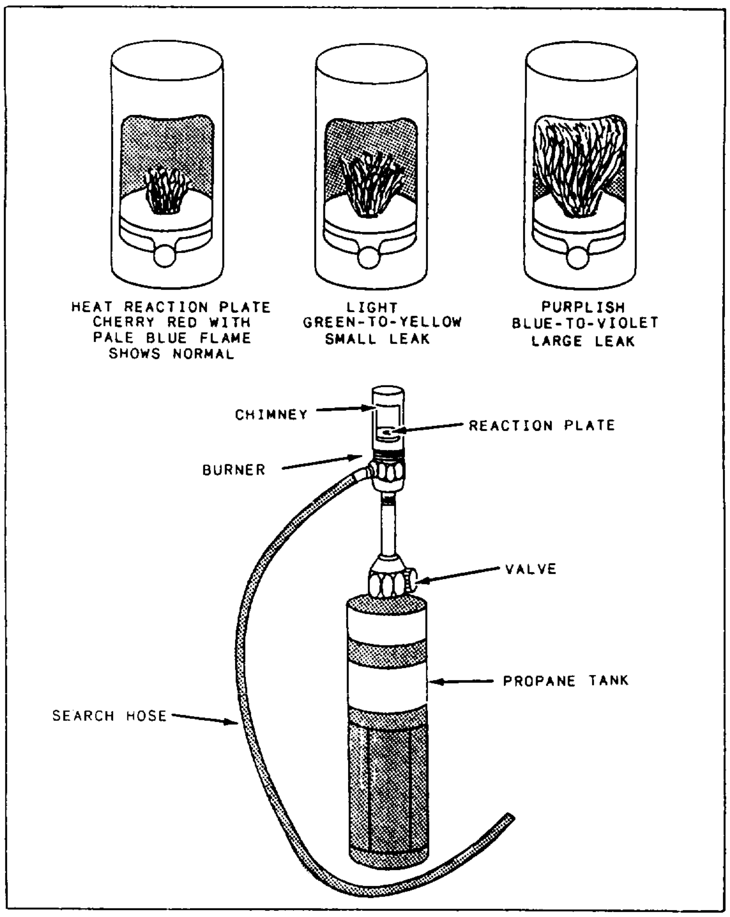

Figure 13-18.—Flame type of leak detector.

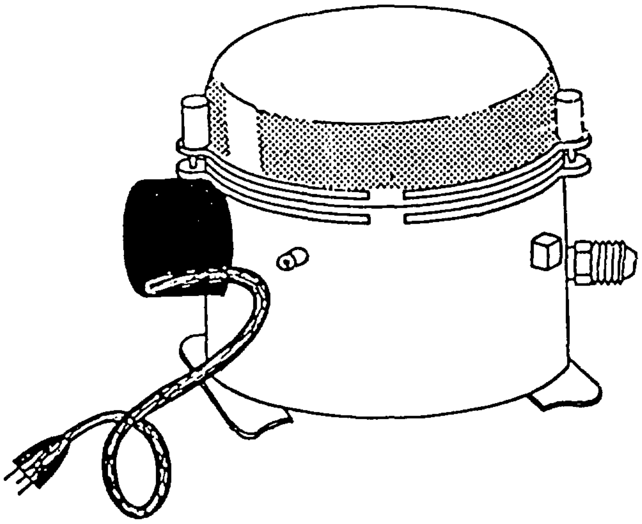

Figure 13-19.—Typical vacuum pump.

3. Reduce the flame when the reaction plate is red, and adjust the top of the flame even with, or slightly above, the reaction plate (just high enough to maintain the cherry-red color).

CAUTION

Too high a flame will soon burn out the reactor plate.

4. Move the search hose slowly around the system. Refrigerant R-12 is heavier than air, so move the search hose under all parts to ensure accurate detection and watch for the flame to change color. A pale blue color is normal and indicates that there is no refrigerant leak. Yellow or yellow-green indicates a small leak, purplish blue indicates a larger leak.

If you do not find a leak, increase the system charge by 50 percent. Add 1 pound to a 2-pound system; and 2 pounds to a 4-pound system. Repeat the detection check. It is often necessary for you to overcharge a system to locate a small or intermittent leak. If you find a leak discharge the refrigerant from the system, repair the damage, and recharge the system. Finally, recheck the system after completing repairs.

When searching for leaks in an air-conditioning system, you are looking very closely at all working parts. Do not waste this time. Check for cracked or worn hoses, loose electrical connections, broken wires, worn drive belts, and loose component mounts. When you detect any damage, make the needed repairs at the same time as the inspection.

PURGING THE AIR-CONDITIONING SYSTEM

Anytime an air-conditioning system is discharged and opened before it is returned to service, it must be evacuated and recharged. To perform this operation, you need certain tools, such as a vacuum pump (fig. 13-19), a gauge manifold set (fig. 13-20), and a leak detector.

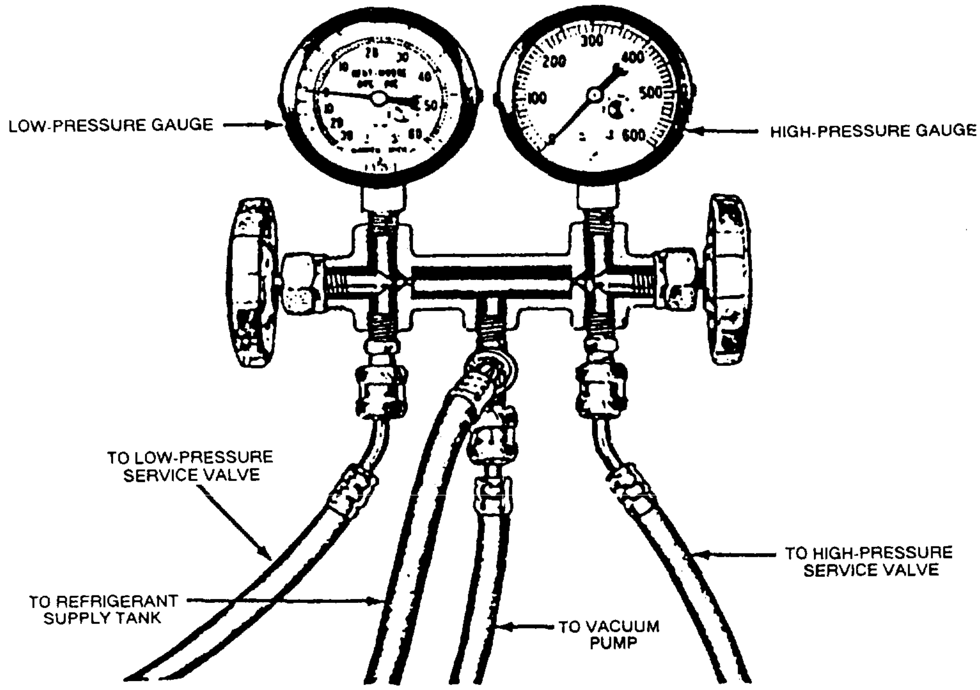

Figure 13-20.—Gauge manifold set.

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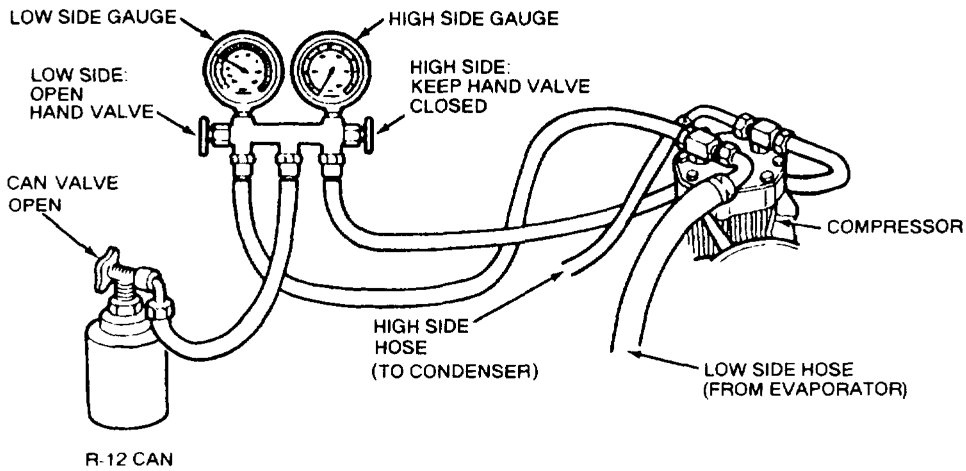

Figure 13-21.—Adding R-12 (low side) for system check.

Using the vacuum pump, draw the system down to at least 29 inches of mercury at sea level and hold it there for at least 30 to 45 minutes. This will remove all moisture from the system.

As the system is being pumped down, the vacuum should drop to the required inches of mercury. If it does not drop, this is an indication of a leak. In which case, you must recharge the system to detect the leak. After you detect the leak, repair the damage and re-evacuate the system.

Once the system is totally evacuated, again-close both valves on the gauge manifold set-disconnect the vacuum pump and connect the refrigerant source.

ATTENTION: Any oil lost during the discharge of refrigerant must be replaced or damage to the compressor will result.

ATTENTION: During discharge of an automotive air-conditioning system, the vehicle engine must NOT be running.

In the past, when a system was discharged before disassembly, the standard practice was to vent the refrigerant into the atmosphere. For environmental and legal reasons, this is no longer permissible. The proper procedure is to use a refrigerant recovery/recycling device (fig. 13-18) and reuse the refrigerant. You are to turn in excess used refrigerant to the defense recycling and management office (DRMO) for proper disposal.

ATTENTION: Disposal instructions for refrigerants may not be the same at different naval stations. Before you take any action concerning R-12 or any refrigerant, contact your supply department for proper disposal instructions.

ADDING REFRIGERANT TO THE AIR-CONDITIONING SYSTEM

Now that the system is pumped down, leave the gauge manifold set attached and attach your refrigerant source, as shown in figure 13-21. You are to take the following actions:

1. Loosen the center hose connection at the gauge manifold set.

2. Open the can valve for several seconds to purge air from the center hose.

3. Tighten the hose connection and close the can valve.

4. Start the vehicle engine and operate the air conditioner.

5. With the system operating, slowly open the low-side manifold hand valve to allow refrigerant to enter the system.

NOTE: The low side of the system is the suction side, and the compressor will pull the refrigerant from the can into the system.

6. With the container in an upright (vapor) position, add the refrigerant until the sight glass clears or the test set gauge readings are normal.

7. Rock the refrigerant can from side to side to increase the flow of refrigerant into the system.

CAUTION

Never turn a can into a position where liquid refrigerant will flow into the system.

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Table 13-1.—Temperature pressure relationship

Readings–Low Side		Readings–High Side	
Evap. Temp. (°F)	Low Side Gage	Ambient Temp. (°F)	High Side Gage
10	2	60	95-115
12	6	65	105-125
14	10	70	115-135
16	14	75	130-150
18	18	80	150-170
20	20	85	165-185
22	22	90	175-195
24	24	95	185-205
26	27	100	210-230
28	29	105	230-250
30	32	110	250-270
35	36	115	265-285
40	42	120	280-310
45	48		
50	53		
55	58		
60	62		
65	66		
70	70		
Temperature Pressure Relationship			

8. Close the low-side manifold valve and the refrigerant can valve.

9. Continue to stabilize the system, and check for normal refrigerant charge.

FUNCTIONAL TESTING OF THE AIR-CONDITIONING SYSTEM

Functional testing is required to establish the condition of all components in the system. The engine must be running and the air-conditioning system operating when performing this test. After the initial charge of refrigerant is installed into the system, watch the manifold gauge set. Correct pressure should be 15 to 30 psi for the low side and 175 to 195 psi for the high side. Evaluate the reading you receive against the standard chart in table 13-1. If the vehicle you are working on is equipped with a sight glass(fig. 13-4), the bubbles should disappear at the correct pressures. Close the low side gauge manifold set hand valve. Check the temperature of the air exiting the cooling duct. It should be close to 40°F with the blower running on low speed. Stop the engine and disconnect the gauge manifold set.

As you probably know, the refrigerant R-12 is no longer considered environmentally safe to use. As R-12 is being phased out, the new refrigerant R-134A is being brought on line, but not without a few problems.

Using anew refrigerant that works under higher pressure means changes in some of the components used with automotive air-conditioning systems. Some of the tools will no longer work with the new

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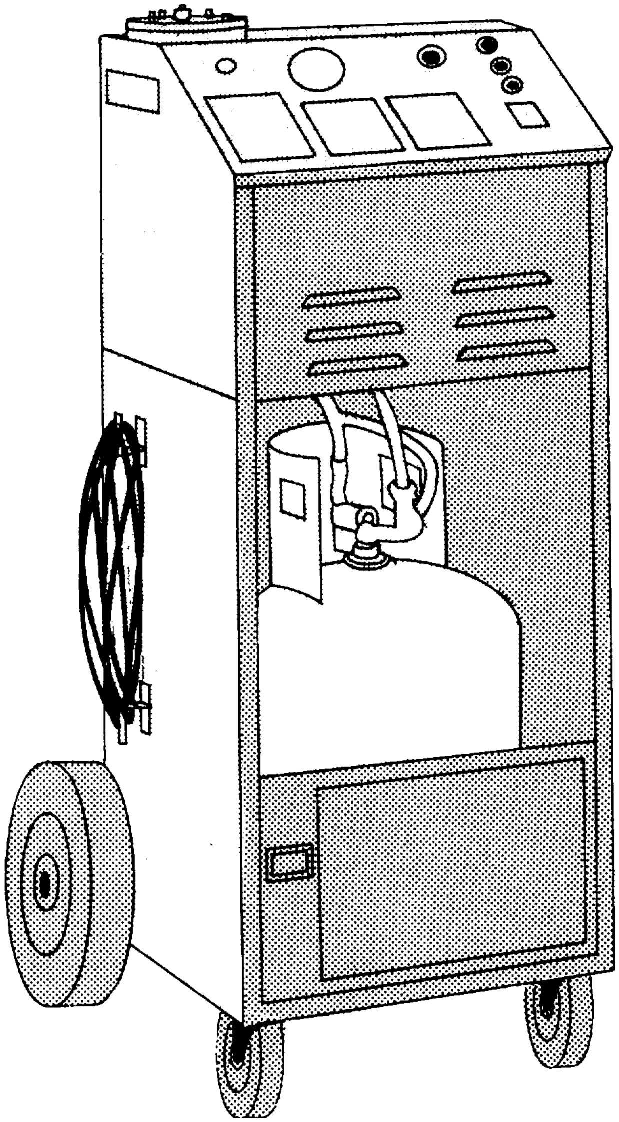

Figure 13-22.—Typical refrigerant recycling recovery device.

refrigerant; for example, the flame type of leak detector will not function, and your recovery, recycling systems (fig. 13-22) must be kept separate and not allowed to contaminate each other.

The components of the system also have some differences. Hoses of an R-12 system will not withstand the chemicals in a system using R-134A. Also, the lubrication oils are not compatible and must not be mixed.

Finally, to reduce the chances of a mix-up of parts, the threaded fittings of the new system components are purposely incompatible with the old.

The chance of a military shop having to convert an R-12 system to a R-134A system is slim. The information here is to make you aware of the changes only.

OTHER REFRIGERANTS

Now, we will simply say do not mix refrigerants, With all the changes in the air-conditioning industry, there are some refrigerants on the market that are not compatible with either system. These refrigerants are merely blends of existing refrigerants and, in some cases, are highly flammable. In other cases, these blend refrigerants may break down the desiccant in the receiver/drier and pass the debris into the rest of the system, clogging the expansion valve/orifice tube and possibly ruining the compressor.

DO NOT use any of these so-called blend refrigerants. For that matter, DO NOT manufacture your own adapters to cross match an R-12 to an R-134A system. You will only contaminate the system and cause damage to your equipment. Once again DO NOT mix refrigerants.

CERTIFICATION

Most states require or, before long, will require mechanic certification when working with automotive air-conditioning systems.

HAZARDOUS WASTE

When possible, recycle uncontaminated R-12 or R-134A for reuse. Return excess uncontaminated refrigerants to DRMO for disposition and disposal. Remember, any refrigerant blend is unusable and you should turn it in to DRMO, under applicable naval station instructions, as hazardous waste.

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