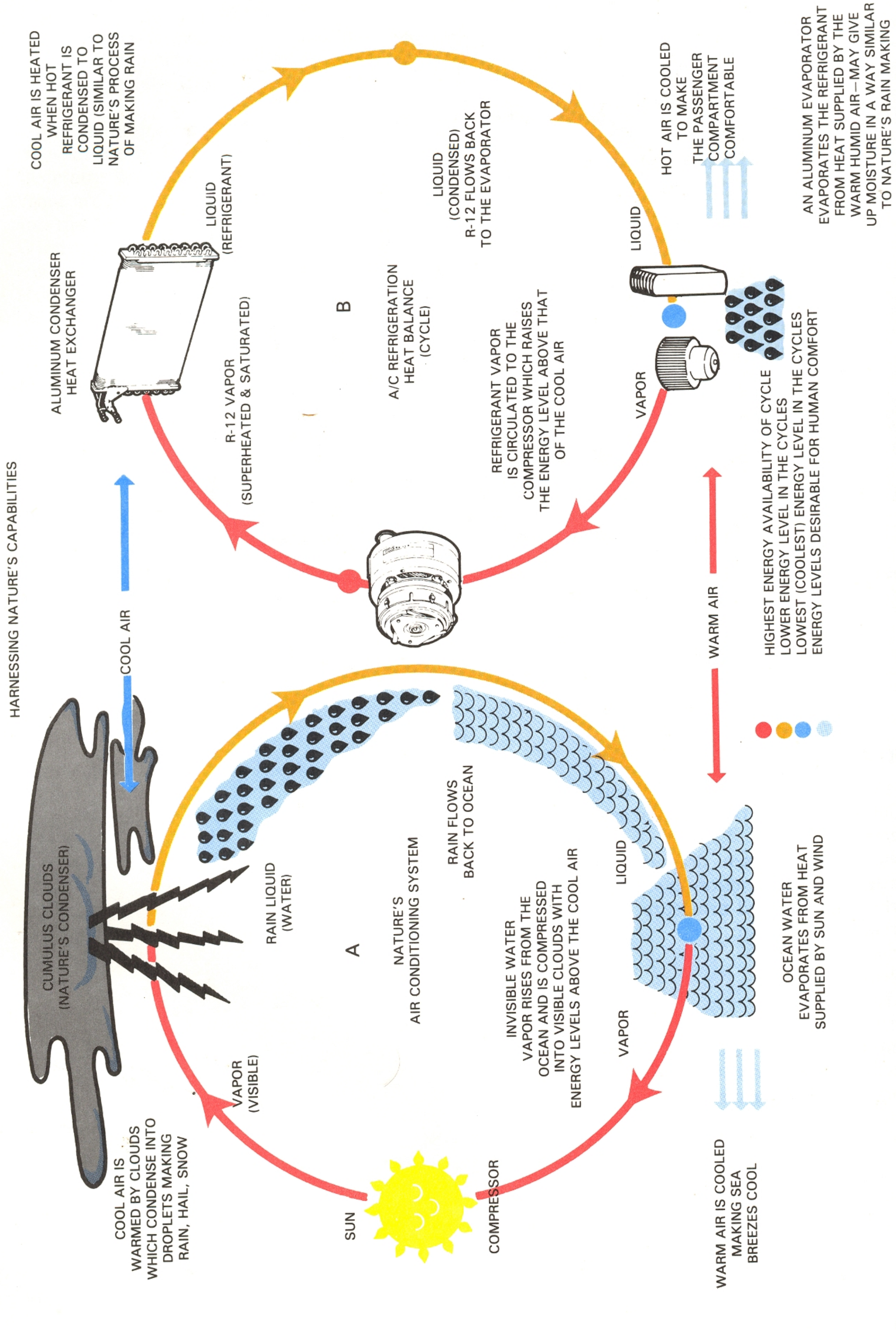

The refrigeration principles employed by automotive air conditioning system B, are very similar to those found in nature's own air conditioning, A. Study each cycle. (GM)

PRESSURE AFFECTS BOTH VAPORIZATION AND CONDENSATION TEMPERATURES

Water boils at sea level (unconfined) at 212°F (100°C). If water at 20,000 feet in the air is heated, it will boil at a lower temperature. The pressure on the water at 20,000 feet is less, so the boiling point will be lower. When pressure is raised above normal atmospheric pressure, the boiling point will also rise. The condensation point is likewise affected.

The refrigeration process makes use of this pressure affect on vaporization and condensation. The liquid used in the refrigeration system is generally referred to as REFRIGERANT-12. It is also called by trade names such as Freon-12, Isotron-12, Prestone-12, etc.

REFRIGERANT-12

Refrigerant-12 will boil or vaporize at minus 21.7°F (−30°C) when subjected to zero pounds of pressure (sea level). If the pressure is raised enough, the boiling point can be moved up well beyond the temperature encountered on the hottest day. This low boiling point, plus the fact that it can be passed through the system endlessly without loss of efficiency, makes Refrigerant-12 an ideal refrigeration medium. Fig. 22-3 illustrates the relationship between temperature and pressure.

DANGER!

REFRIGERANT-12 (DICHLORODIFLUOROMETHANE), DESPITE THE FACT THAT IT IS COLORLESS, NONEXPLOSIVE AND NONFLAMMABLE, MUST BE HANDLED WITH EXTREME CARE. STUDY THE FOLLOWING SAFETY PRECAUTIONS THAT A MECHANIC MUST ALWAYS OBSERVE!

1. KEEP SERVICE AREA WELL VENTILATED.

Remember: Refrigerant-12, at atmospheric pressure and room temperature, is heavier than air. It will displace the air in the room and can cause suffocation. Ample ventilation also helps to prevent poisoning from breathing the fumes caused by allowing refrigerant to contact an open flame.

2. ALWAYS WEAR PROTECTIVE GOGGLES WHEN YOU ARE WORKING ON OR NEAR AN AIR CONDITIONING SYSTEM.

Remember: Refrigerant-12 vaporizes so quickly, it will freeze anything it contacts. If it enters the eyes, serious damage may occur.

3. KEEP STERILE MINERAL OIL AND A WEAK BORIC ACID SOLUTION ON HAND.

Remember: If, by some chance, refrigerant enters the eyes, DO NOT PANIC! Splash large amounts of cold water into the eyes as a means of raising the temperature. Do not rub the eyes. Apply several drops of sterile (clean) mineral oil to the eye. The oil will absorb the refrigerant and help flush it from the eyes. This may be followed by a liberal application of boric acid solution. ALWAYS SEEK THE SERVICES OF A DOCTOR AT ONCE—EVEN IF THE PAIN SEEMS TO HAVE DISAPPEARED.

4. KEEP REFRIGERANT AWAY FROM SKIN.

Remember: If refrigerant contacts the skin, treat in the manner recommended for the eyes.

5. AVOID DISCHARGING REFRIGERANT DIRECTLY INTO SERVICE AREA.

Remember: Refrigerant will vaporize at room temperature and since it is heavier than air, it will settle down. If enough refrigerant is discharged into an area without excellent ventilation, it can displace the air and cause suffocation. When refrigerant is discharged into the service area, it may contact an open flame and produce poisonous phosgene gas.

Always discharge the system into the service area exhaust system. If no such facility is present, discharge the system OUTSIDE of the building.

6. NEVER DISCHARGE REFRIGERANT INTO AN AREA CONTAINING AN OPEN FLAME.

Remember: When Refrigerant-12 comes in contact with an open flame, it produces a poisonous gas (phosgene). In addition to being dangerous to humans, it will tarnish bright metal surfaces.

7. NEVER STEAM CLEAN, WELD, SOLDER, BAKE BODY FINISHES OR, IN ANY WAY,

REFRIGERANT — 12 PRESSURE — TEMPERATURE RELATIONSHIP

The table below indicates the pressure of Refrigerant — 12 at various temperatures. For instance, a drum of Refrigerant at a temperature of 80°F (26.6°C) will have a pressure of 84.1 PSI (579.9 kPa). If it is heated to 125°F (51.6°C), the pressure will increase to 167.5 PSI (1154.9 kPa). It also can be used conversely to determine the temperature at which Refrigerant — 12 boils under various pressures. For example, at a pressure of 30.1 PSI (207.5 kPa), Refrigerant — 12 boils at 32°F (0°C).

(°F)(°C)		(PSIG)(kPa)	
−21.7	−29.8C	O(ATMOSPHERIC PRESSURE)	O(kPa)
−20	−28.8C	2.4	16.5
−10	−23.3C	4.5	31.0
− 5	−20.5C	6.8	46.9
0	−17.7C	9.2	63.4
5	−15.0C	11.8	81.4
10	−12.2C	14.7	101.4
15	− 9.4C	17.7	122.0
20	− 6.6C	21.1	145.5
25	− 3.8C	24.6	169.6
30	− 1.1C	28.5	196.5
32	0C	30.1	207.5
35	1.6C	32.6	224.8
40	4.4C	37.0	255.1
45	7.2C	41.7	287.5
50	10.0C	46.7	322.0
55	12.7C	52.0	358.5
60	15.5C	57.7	397.8
65	18.3C	63.7	439.2
70	21.1C	70.1	482.7
75	23.8C	76.9	530.2
80	26.6C	84.1	579.9
85	29.4C	91.7	632.3
90	32.2C	99.6	686.7
95	35.0C	108.1	745.3
100	37.7C	116.9	806.0
105	40.5C	126.2	870.2
110	43.3C	136.0	937.7
115	46.1C	146.5	1010.1
120	48.8C	157.1	1083.2
125	51.6C	167.5	1154.9
130	54.4C	179.0	1234.2
140	60.0C	204.5	1410.0

Fig. 22-3. Chart illustrating relationship between pressure and temperature for Refrigerant-12. (Oldsmobile)

SUBJECT THE AIR CONDITIONING SYSTEM TO EXCESS HEAT.

Remember: Refrigerant when closed to the atmosphere, will build up high pressures with heat. These pressures may easily burst the system or blow out the safety plug, admitting the entire refrigerant charge into the atmosphere.

8. HANDLE REFRIGERANT-12 DRUMS (OR SMALL CANS) WITH CARE.

Remember: If exposed to excess heat (even direct rays from the sun), the drum may blow the safety plug. The protective screw cap should always be over the valve to prevent physical damage. Drums have been known to explode (even when equipped with a safety plug). If tank warming during servicing is needed, use nothing but warm water. Never use a torch, gas stove, steam cleaner, etc., to heat the tank. Never heat cans or drums above 125°F (52°C).

9. NEVER FILL A TANK COMPLETELY.

Remember: When filling a small tank from a larger one, never completely fill the tank. Allow ample space for refrigerant expansion due to heating. A full tank can be very dangerous.

HOW REFRIGERATION SYSTEM WORKS

Fig. 22-4 illustrates the four basic parts making up the typical refrigeration cycle. Study this schematic and note direction of refrigerant flow as well as the sequence of operations involved. Also note the color code introduced with this illustration for high and low pressure liquid and gas (vapor).

The basic refrigeration system used to air condition automobiles consists of a compressor, condenser, receiver, expansion valve, evaporator, and in many instances, a suction throttling valve. Mufflers may also be incorporated. These various units are connected by high pressure lines. Figs. 22-5 and 22-6 illustrate the fundamental parts of a refrigeration system. Study them carefully.

In order to understand just how a refrigeration system functions, start tracing the flow of refrigerant through the system. Keep in mind that the principle of refrigeration lies in the fact that by controlling the pressure on the refrigerant, we can make it boil, or condense, and thus absorb or give off heat. Start at the receiver.

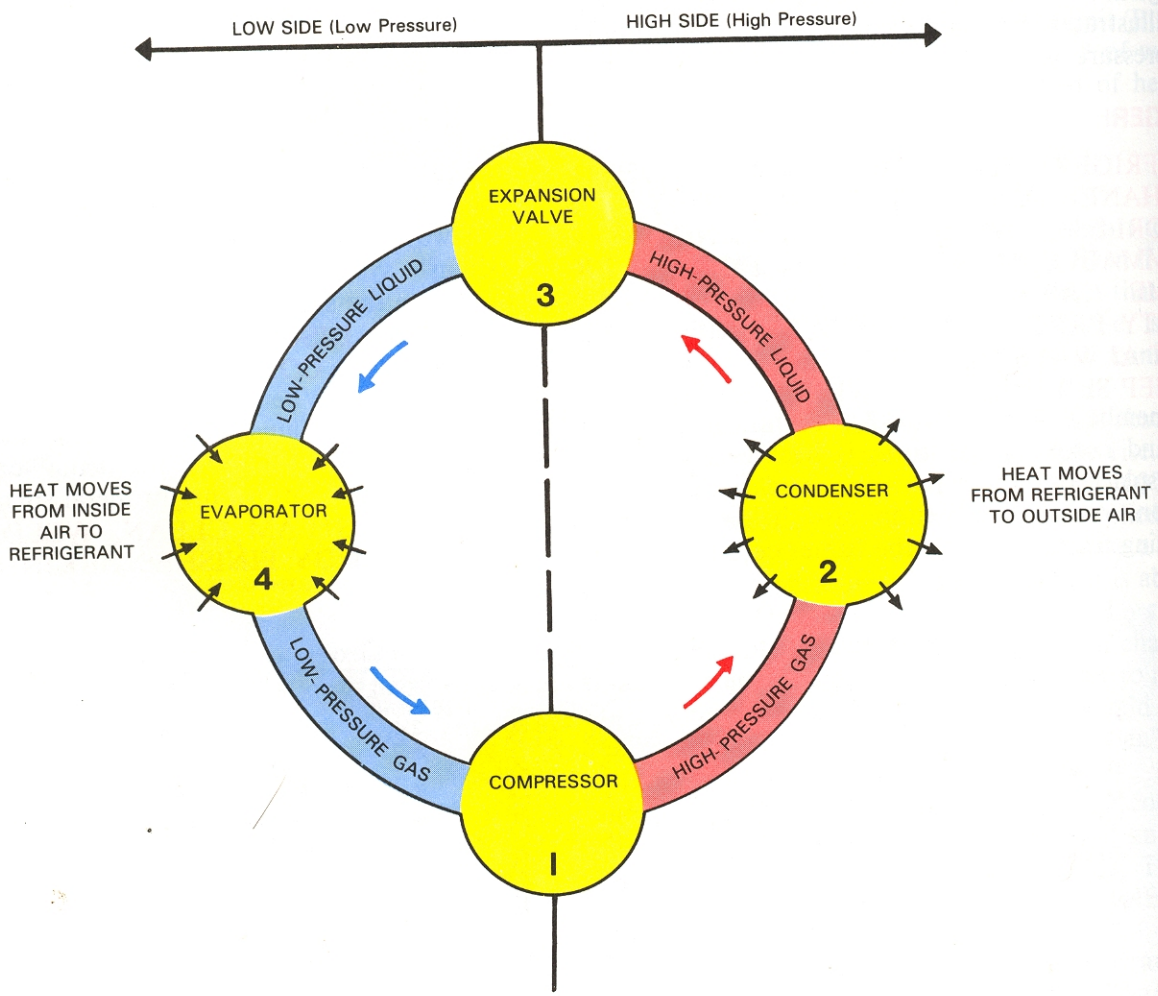

Fig. 22-4. Schematic illustrating the four basic parts employed in the refrigeration cycle. Note refrigerant flow direction. (Deere & Co.)

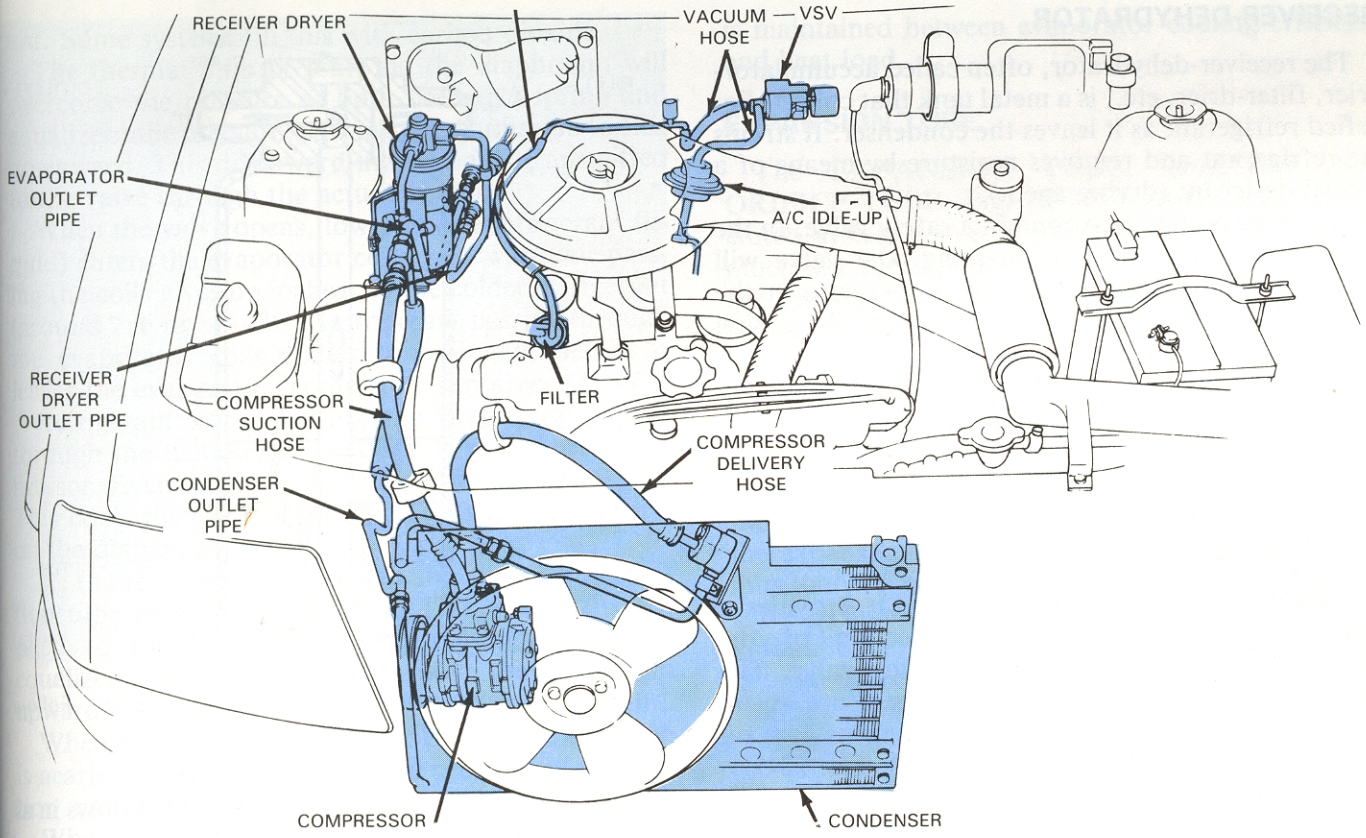

Fig. 22-5. Overall view of one type of air conditioning arrangement. (Chevrolet)

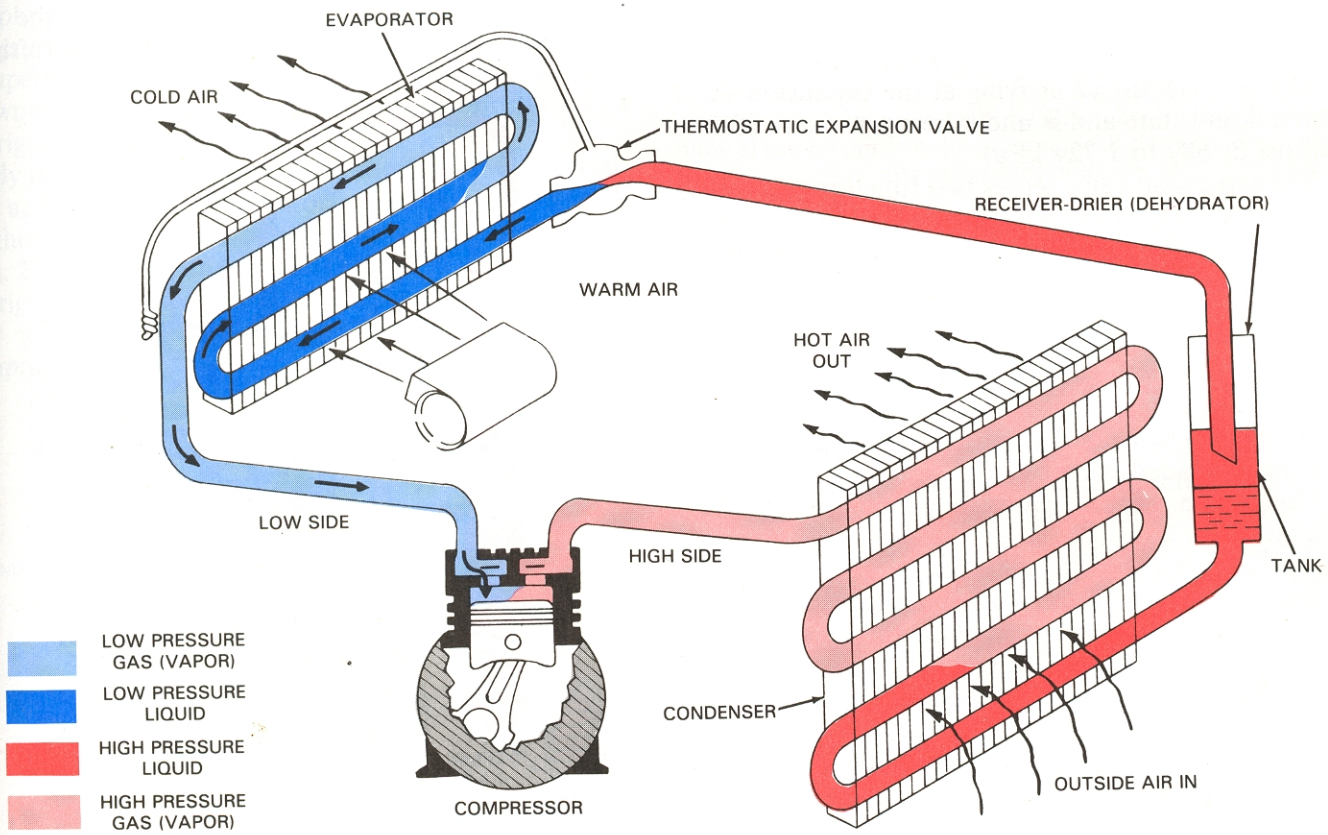

Fig. 22-6. Schematic of a typical air conditioning system showing refrigerant flow. Study each phase. (Deere & Co.)

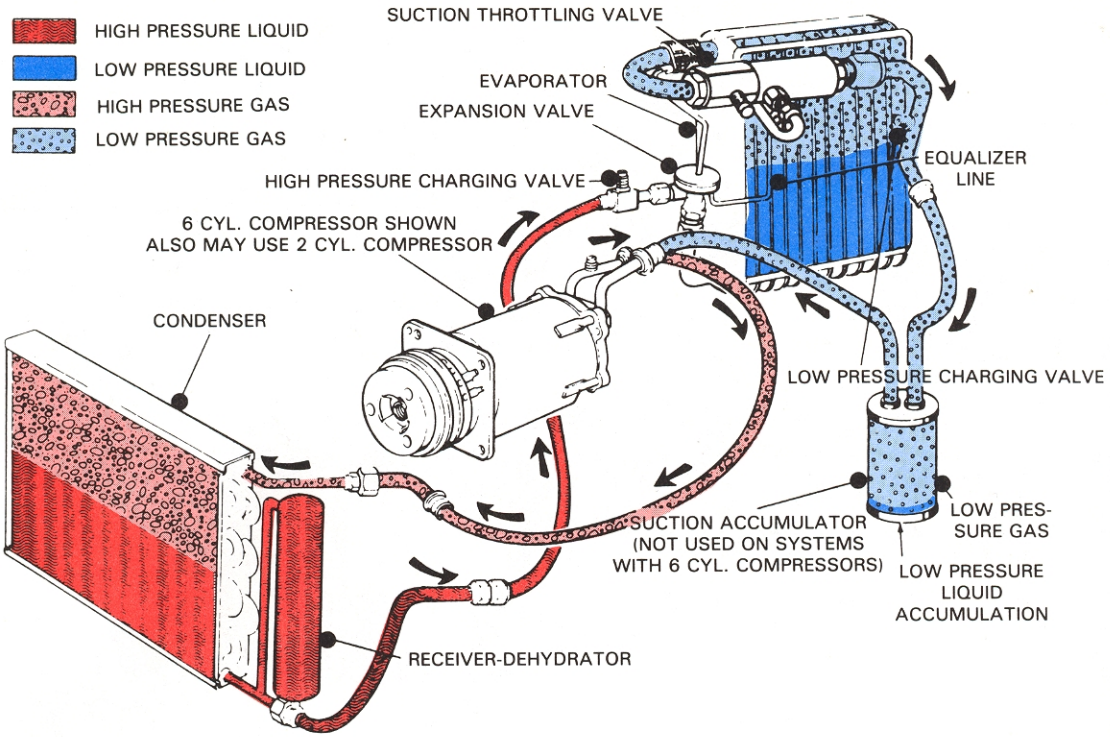

Fig. 22-25. Air conditioning system. Follow refrigerant flow from receiver-dehydrator, expansion valve, evaporator, suction accumulator (not always used), compressor, condenser, and to receiver-dehydrator. (Ford)

thermostatic cycling switch.

A capillary tube from the cycling switch relays evaporator temperature to the switch. The switch is designed to cycle the compressor on and off to maintain an evaporator temperature of approximately 32°F to 45°F (0°C to 7°C). This cycling action prevents condensation (moisture) from freezing on the evaporator core.

MAGNETIC CLUTCH

The compressor pulley turns whenever the engine is running. The compressor does not run until the pulley is engaged to the compressor driving shaft.

This engagement is accomplished through the use of a magnetic clutch. Fig. 22-29 pictures one type of magnetic clutch. When the system is turned on, cur-

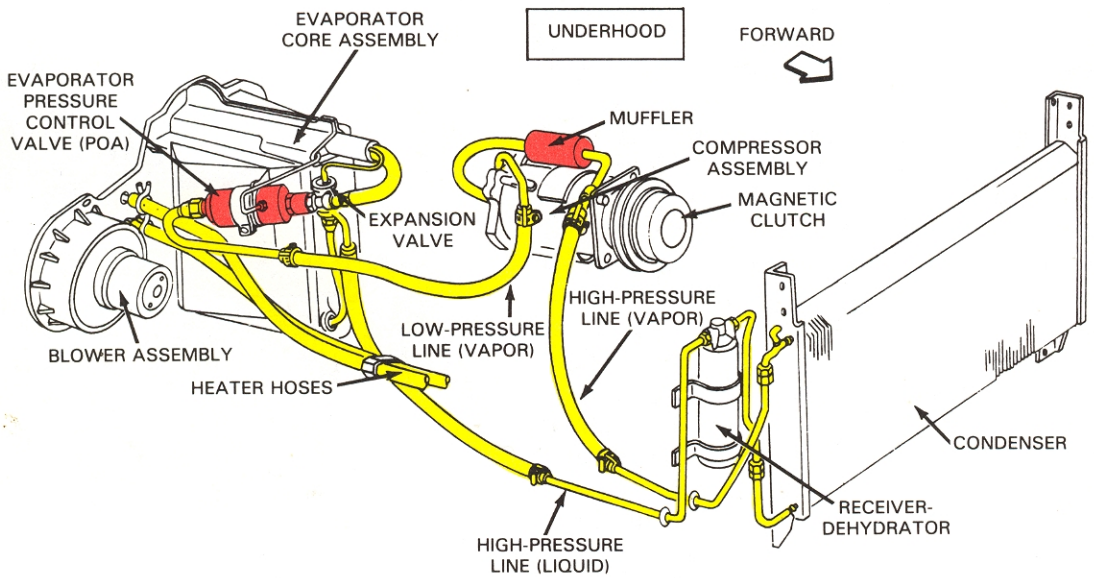

Fig. 22-26. This air conditioning system employs a POA evaporator pressure control valve (suction throttling valve) to control coil temperature. Note use of a muffler to quiet pumping noises. Sometimes a muffler is used on inlet or suction line as well. (GMC)