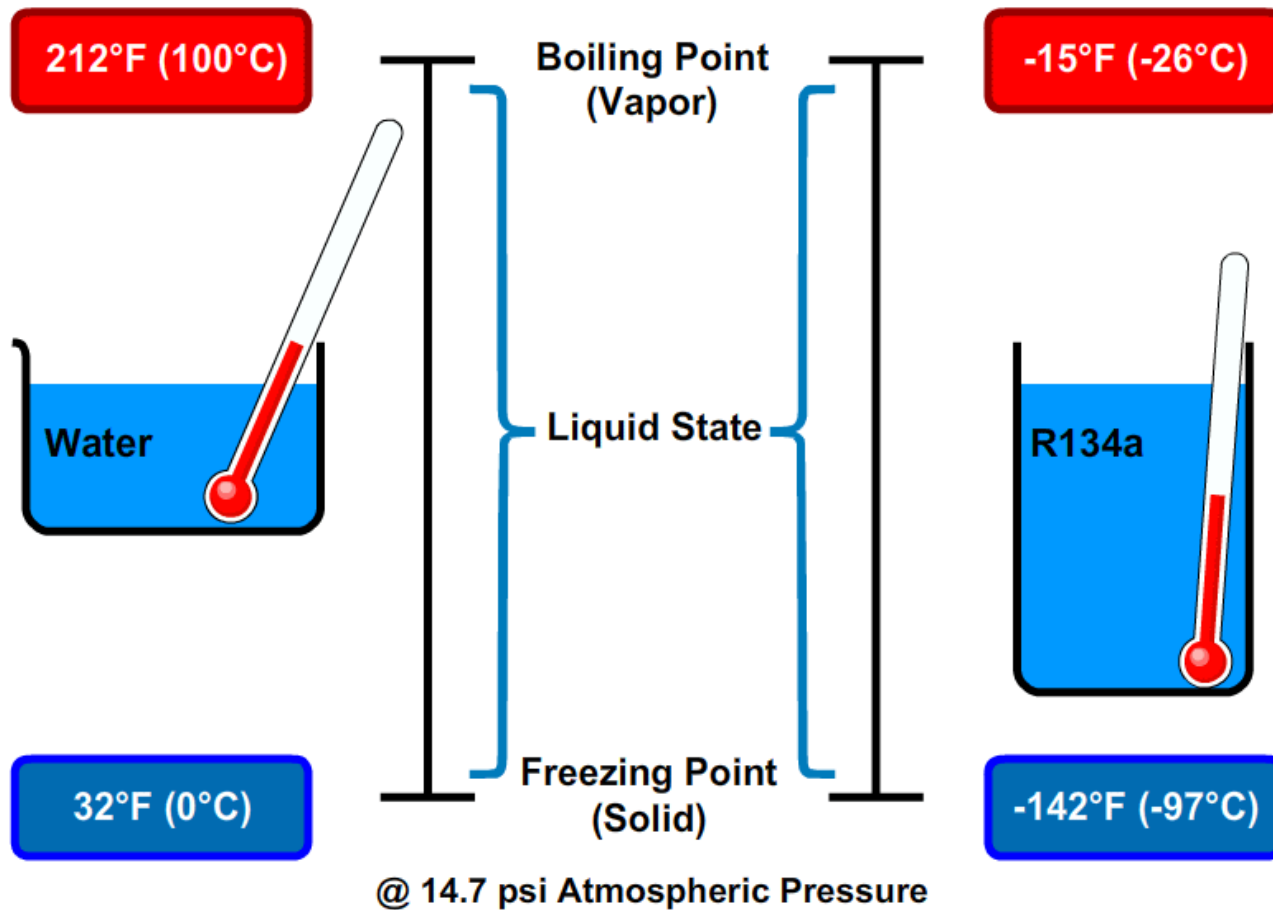
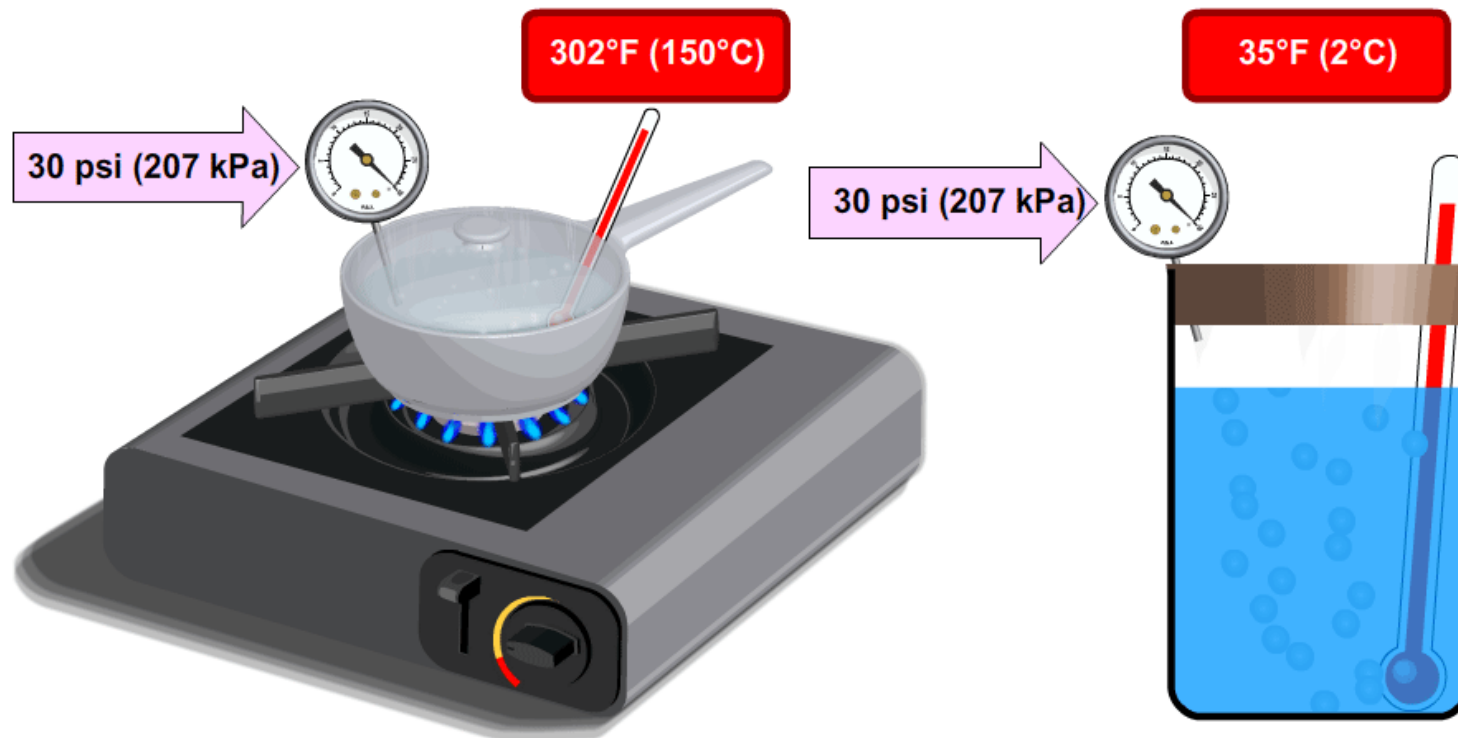


# Motor Vehicle Air Conditioning (MVAC)

System operation and the refrigerant cycle



At Sea level - water boils at 212<sup>0</sup> F - R-134a boils at -15<sup>0</sup> F



**Water**

**R134a**

- At Sea level -      - R-134a boils at  $-15^{\circ}$  F
- At 30 psig -        - R-134a boils at  $35^{\circ}$

The Pressure of the evaporator will control its Temperature

### R134a Temperature-Pressure Chart

TEMPERATURE °F (°C)      PRESSURE PSI (kPa)      TEMPERATURE °F (°C)      PRESSURE PSI (kPa)

An R134a temperature-pressure chart shows what the refrigerant temperature should be at a specific pressure.

This can be helpful in A/C diagnosis.

28 (-2)	TOR	24 (166)	112 (44)	152 (1045)
30 (-1)		26 (177)	114 (46)	157 (1079)

MVAC systems that are low on refrigerant will have:

Low pressures in Evaporator (low side) and Condenser (high side)

40 (4)	CONDENSER RANGE	80 (200)	124 (51)	180 (1260)
45 (7)		40 (272)	126 (52)	188 (1298)
50 (10)		45 (310)	128 (53)	194 (1337)
55 (13)		51 (350)	130 (54)	200 (1377)
60 (16)		57 (390)	135 (57)	215 (1484)

MVAC systems that are overcharges with refrigerant will have:

High pressures in Evaporator (low side) and Condenser (high side)

85 (30)	95 (655)	160 (71)	301 (2079)
90 (32)	104 (718)	165 (74)	321 (2215)
95 (35)	114 (786)	170 (77)	342 (2358)

**R134a**  
**TEMPERATURE**  
 °F (°C)      **PRESSURE**  
 PSI (kPa)

22 (-6)	19 (134)
24 (-4)	21 (144)
26 (-3)	22 (155)
28 (-2)	24 (166)
30 (-1)	26 (177)
32 (0)	27 (188)
34 (1)	29 (200)
36 (2)	31 (212)
38 (3)	33 (225)
40 (4)	35 (238)
45 (7)	40 (272)
50 (10)	45 (310)
55 (13)	51 (350)

**EVAPORATOR  
RANGE**

Low charge can freeze the evaporator

High charge gives poor heat transfer at the evaporator

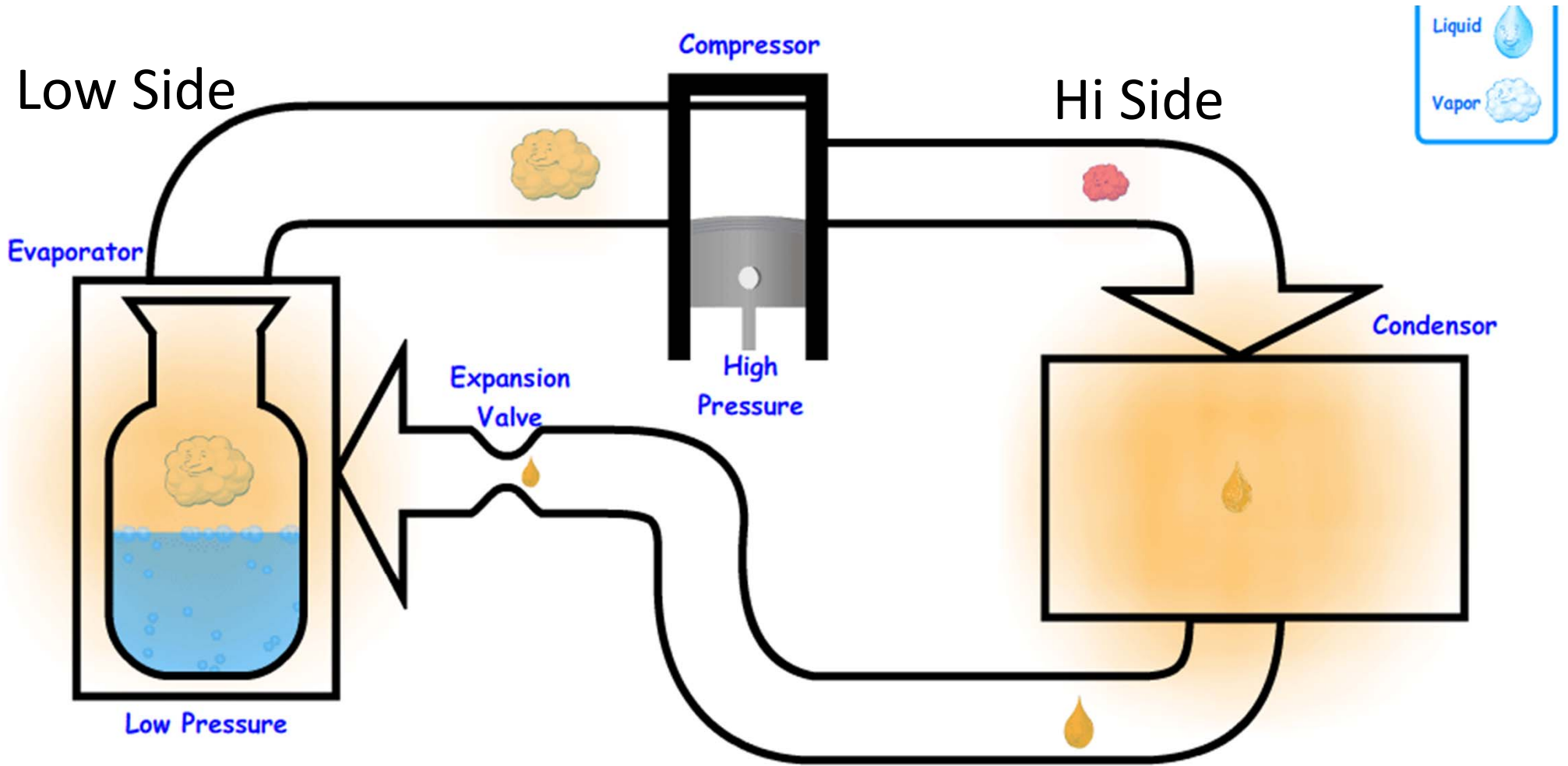
**R134a**  
**TEMPERATURE**  
 °F (°C)      **PRESSURE**  
 PSI (kPa)

110 (43)	147 (1012)
112 (44)	152 (1045)
114 (46)	157 (1079)
116 (47)	163 (1114)
118 (48)	169 (1150)
120 (49)	175 (1187)
124 (51)	183 (1260)
126 (52)	188 (1298)
128 (53)	194 (1337)
130 (54)	200 (1377)
135 (57)	215 (1481)
140 (60)	231 (1590)
145 (63)	247 (1704)
150 (66)	264 (1822)

**CONDENSE  
RANGE**

Low charge equals poor heat transfer

The correct refrigerant charge ensures maximum heat transfer from the passenger compartment.



Absorbing latent heat  
turns liquid to vapor

Releasing latent heat  
turns vapor to liquid

## 2 types of MVAC systems

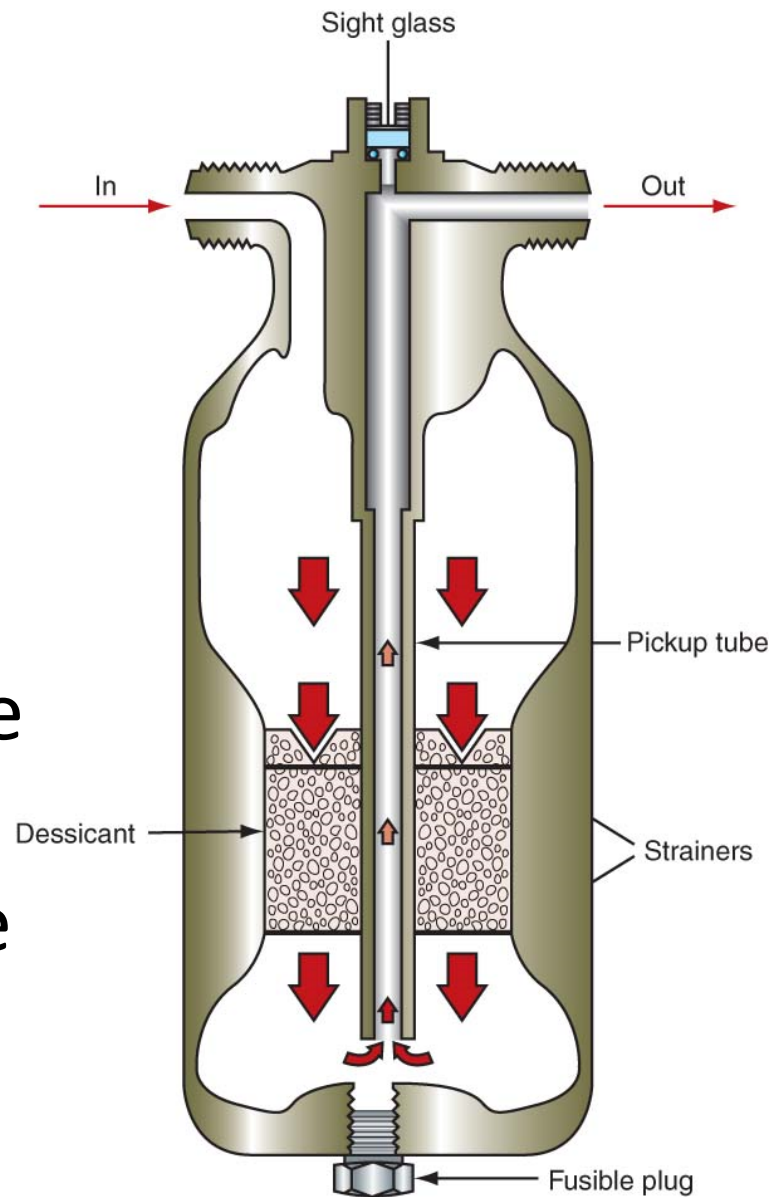
All A/C systems use a compressor, condenser, evaporator

Some systems use the **Expansion Valve** with **Receiver/Drier**

Some systems use the **Fixed Orifice Tube** with **Accumulator**

# Receiver-Drier

send high pressure liquid to expansion valve





Receiver Drier will separate liquid from vapor refrigerant

Receiver Drier will send liquid refrigerant (high pressure) to the expansion valve

Receiver drier will have desiccant bag.

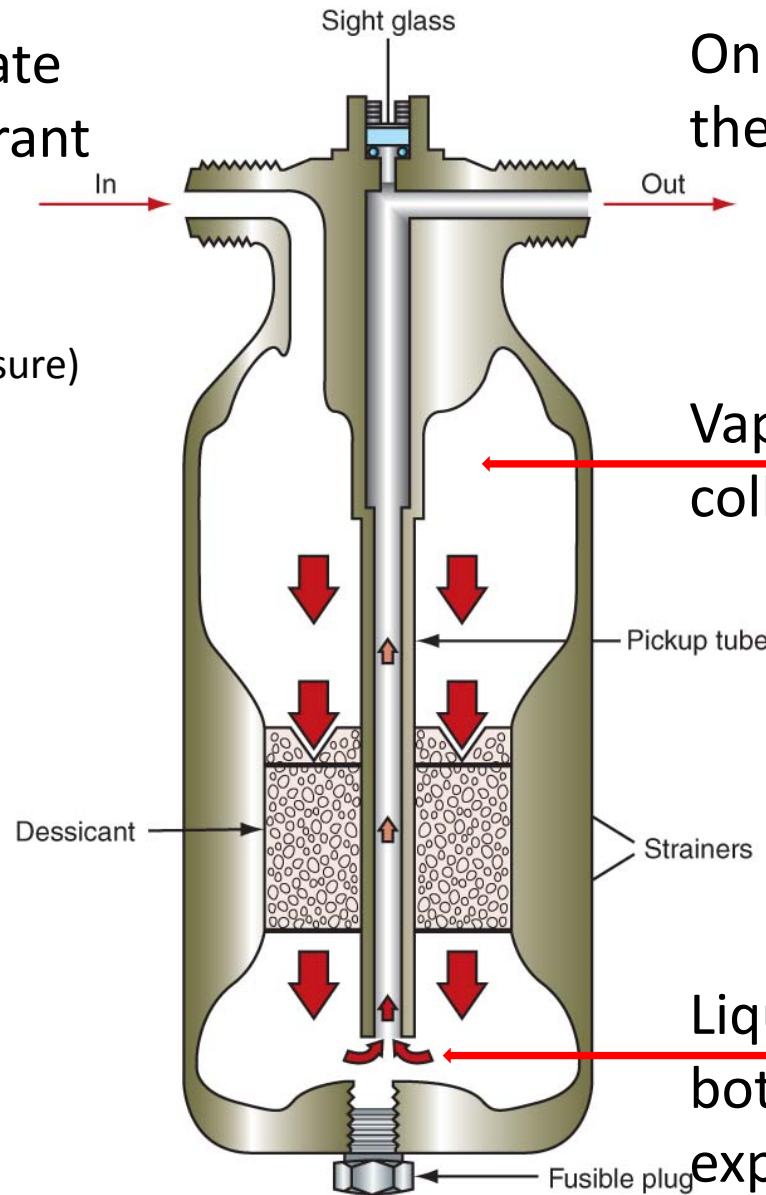
Some desiccant bags can be changed

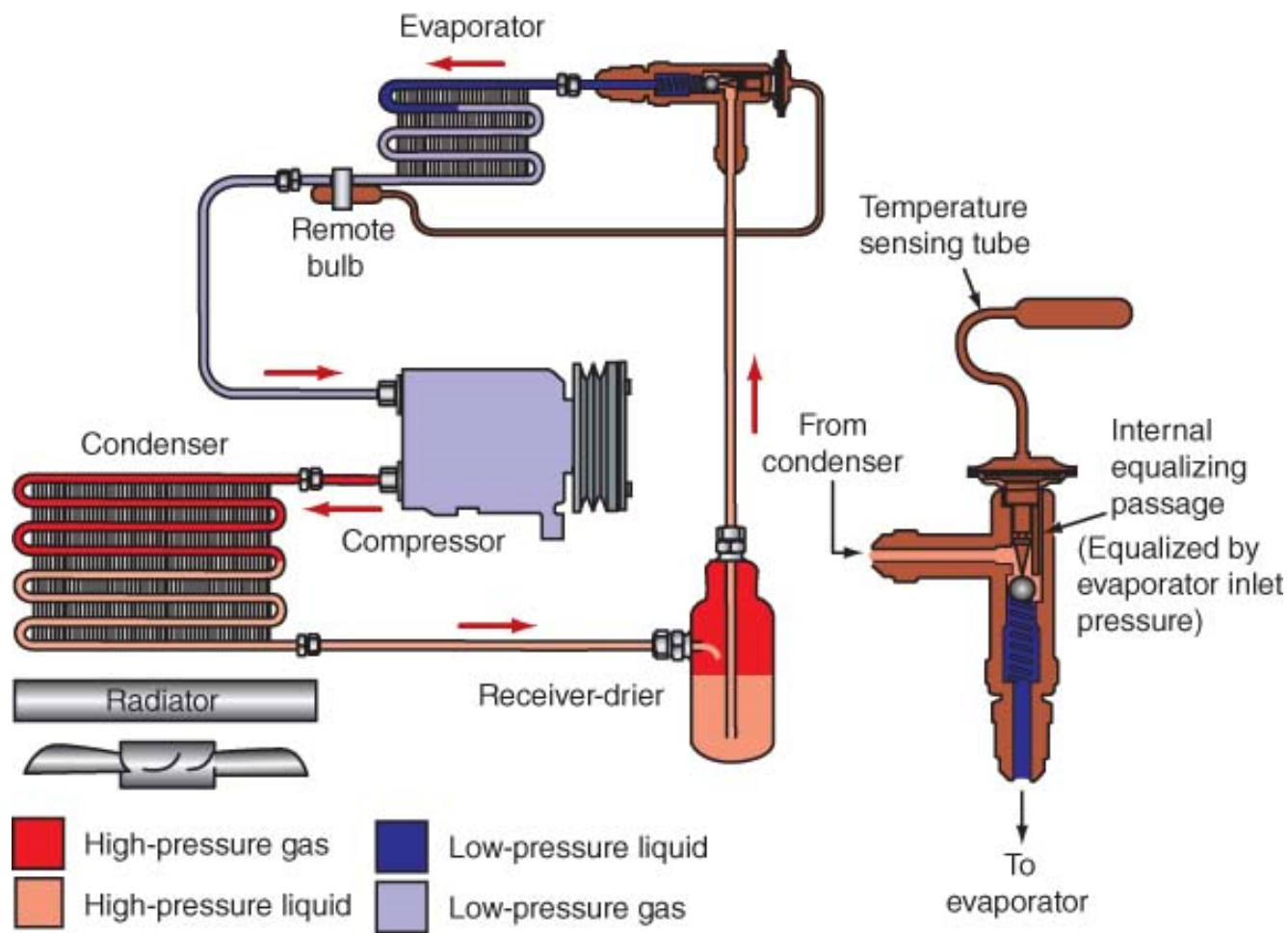
Other designs require component replacement

Only older R-12 systems use the sight glass

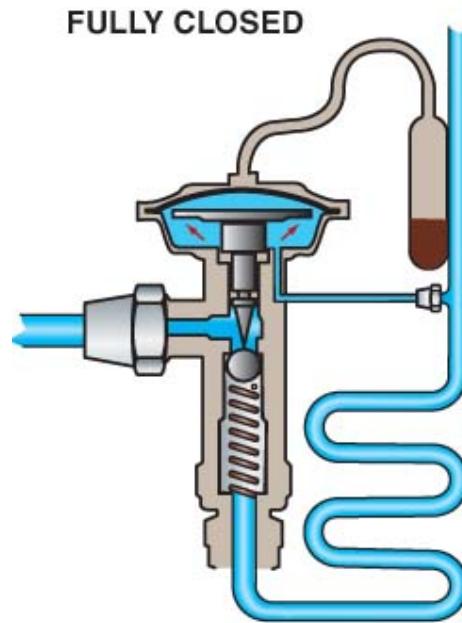
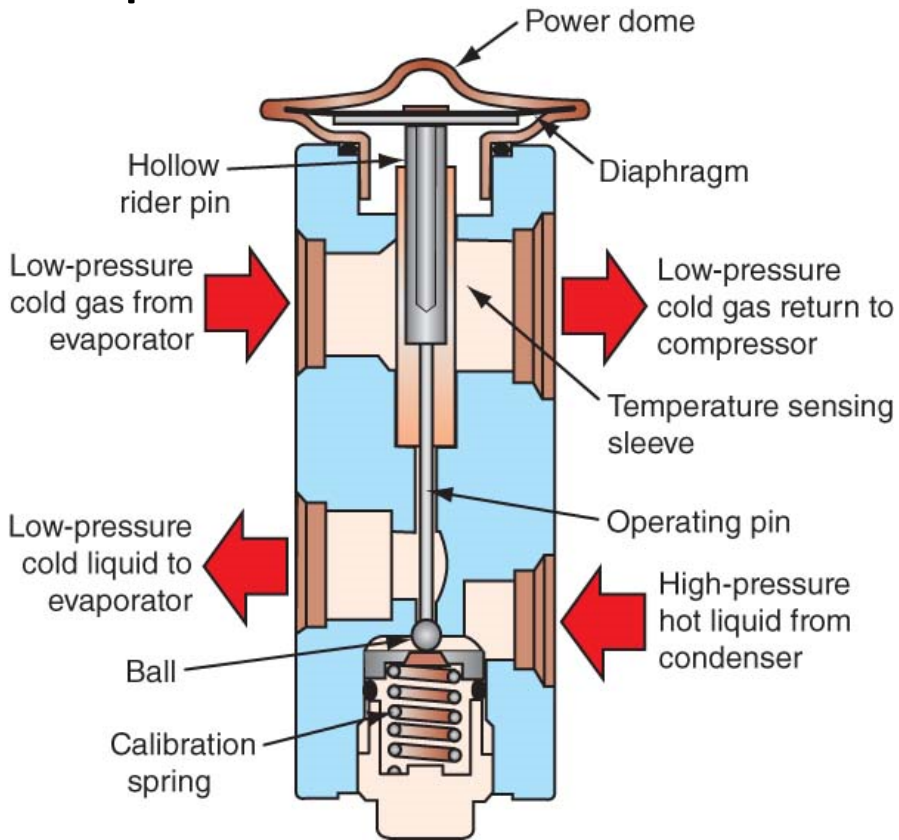
Vaporized refrigerant collects at top of receiver

Liquid refrigerant sinks to bottom and is sent to expansion valve

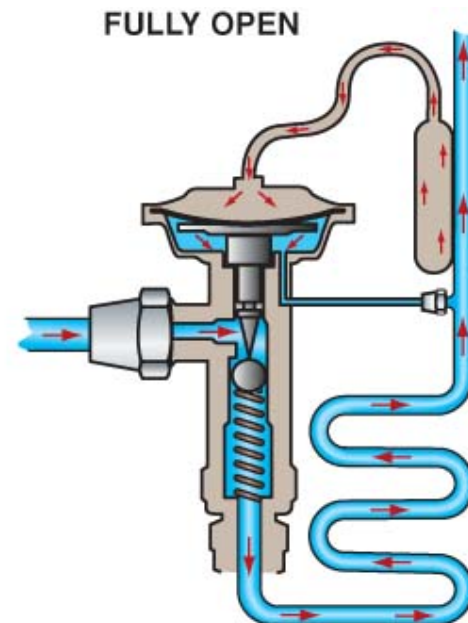




Expansion valve CLOSES when evaporator is too COLD  
 Expansion valve OPENS then evaporator is too WARM



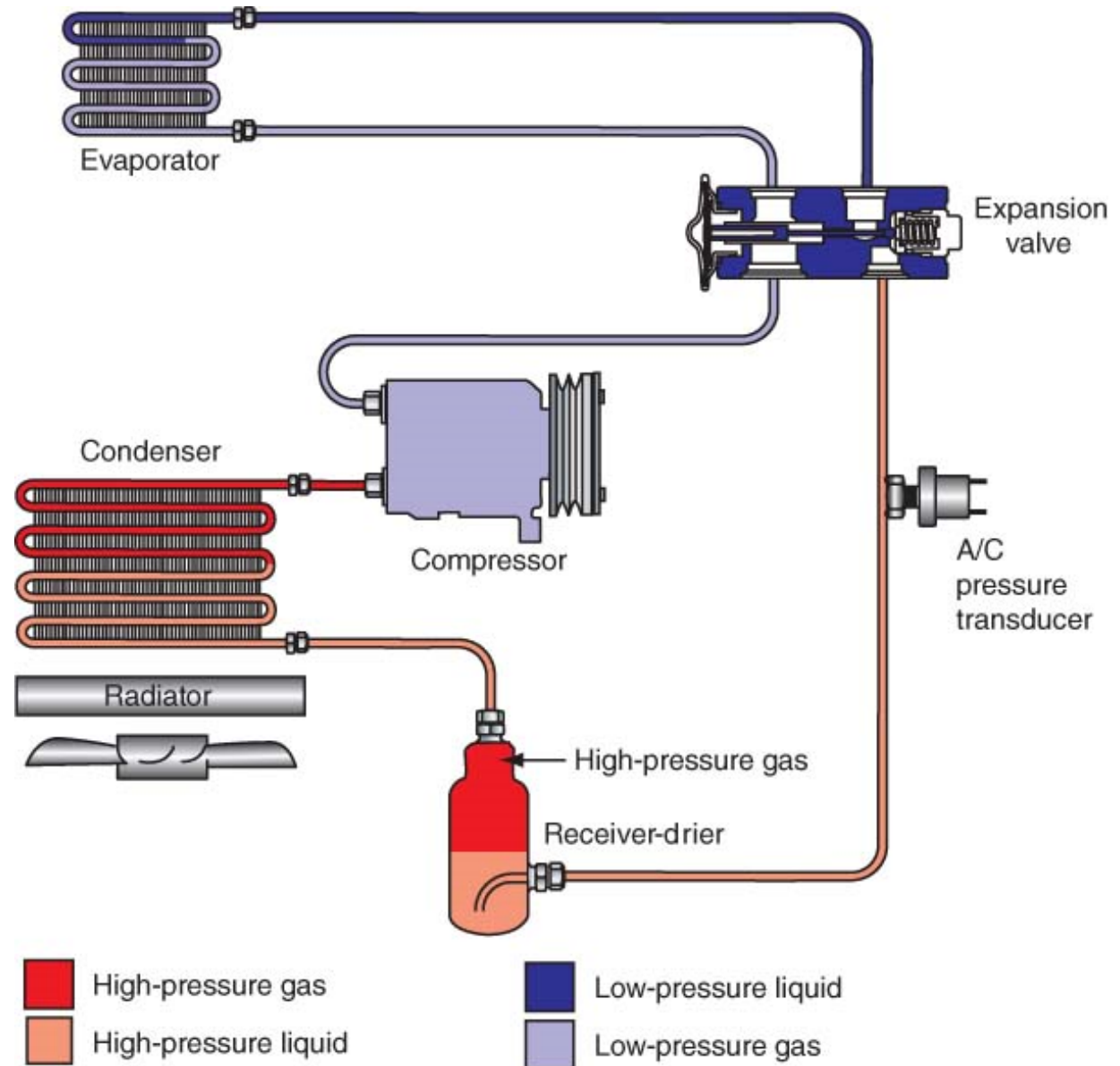
Closed  
 Desired temperature reached  
 Low  
 High



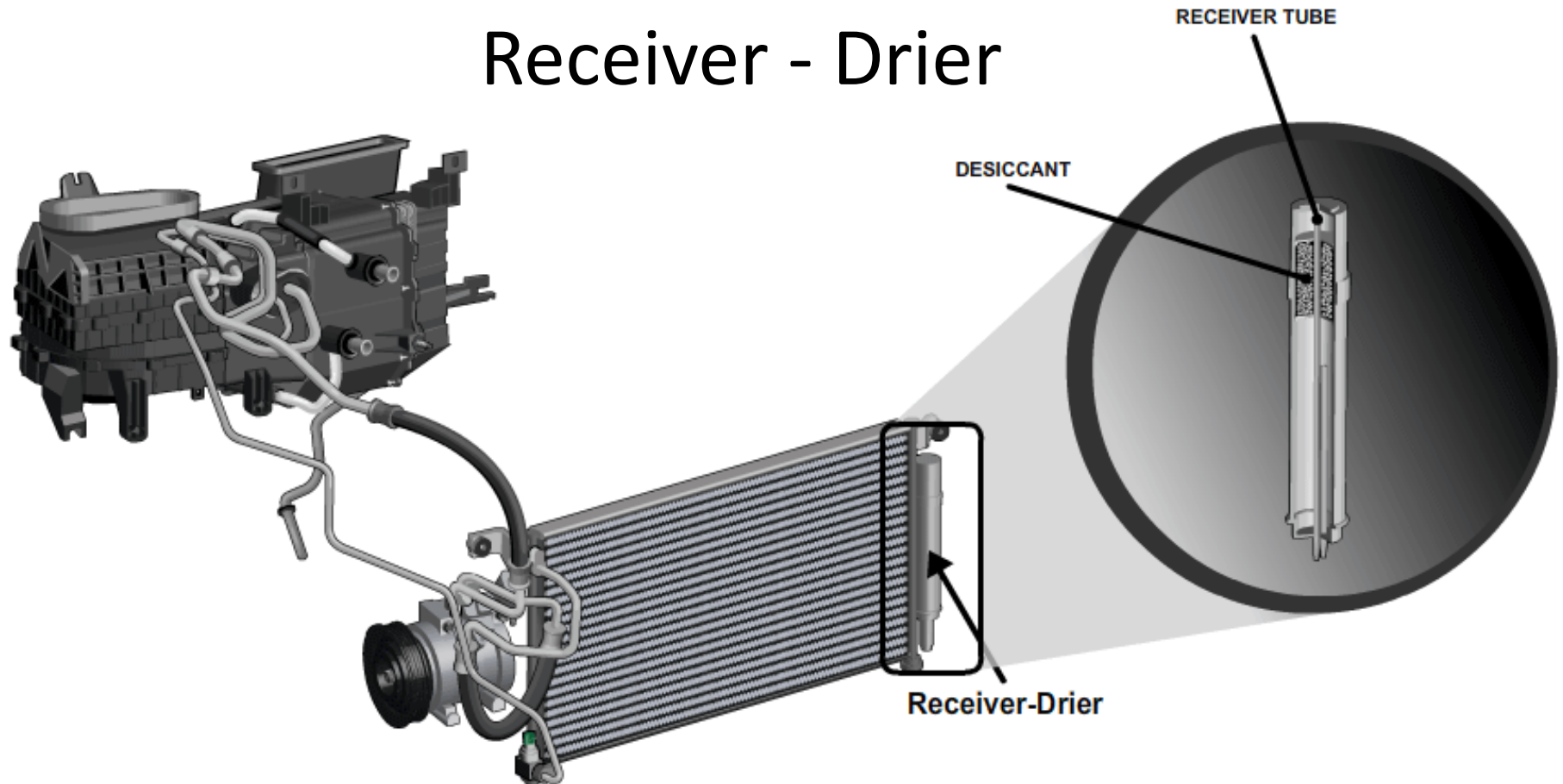
Open  
 Heat soaked  
 High  
 Low

Valve position  
 Pass. compartment  
 Sensing element temperature  
 Evaporator pressure

Expansion Valves sense evaporator pressure and will open or close to maintain ideal pressure/temperature

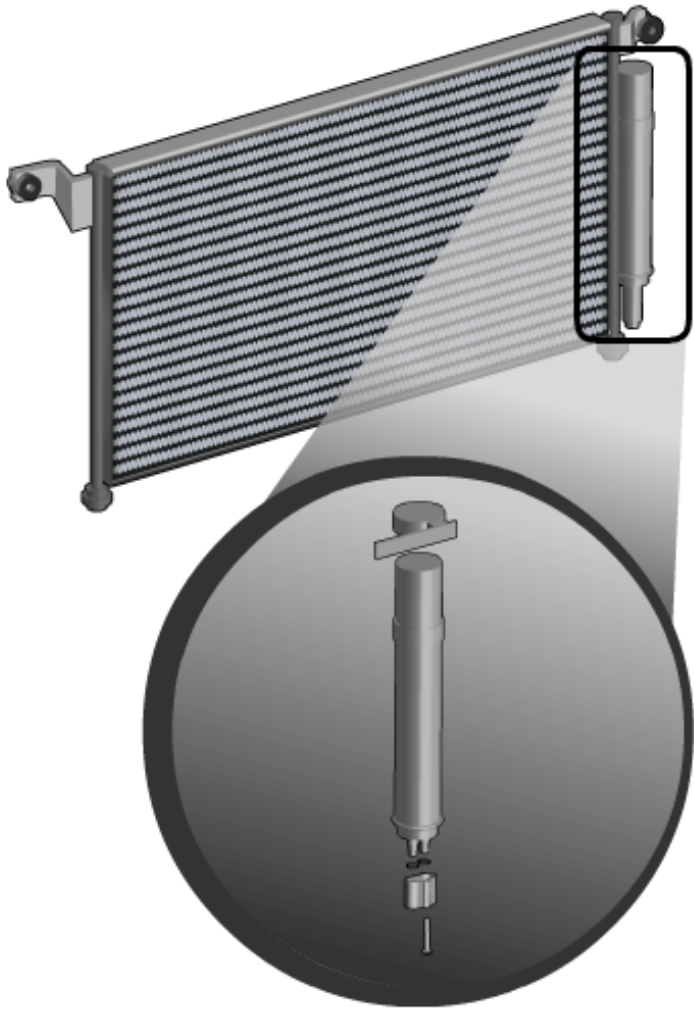


# Receiver - Drier



- Stores liquid refrigerant to supply the expansion valve
- Filters dirt and debris from the system to prevent its circulation.
- Desiccant removes moisture left in system due to improper service.

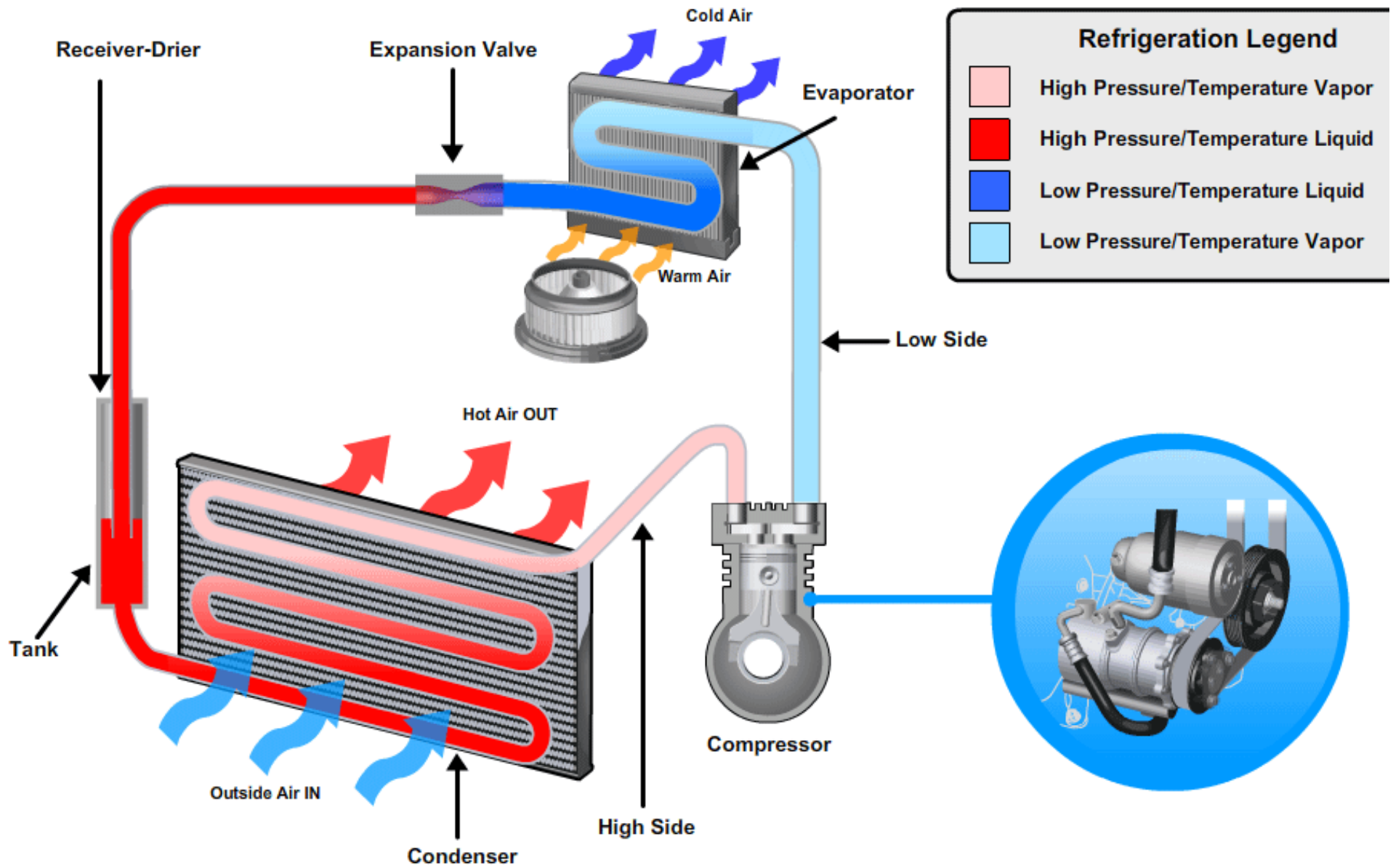




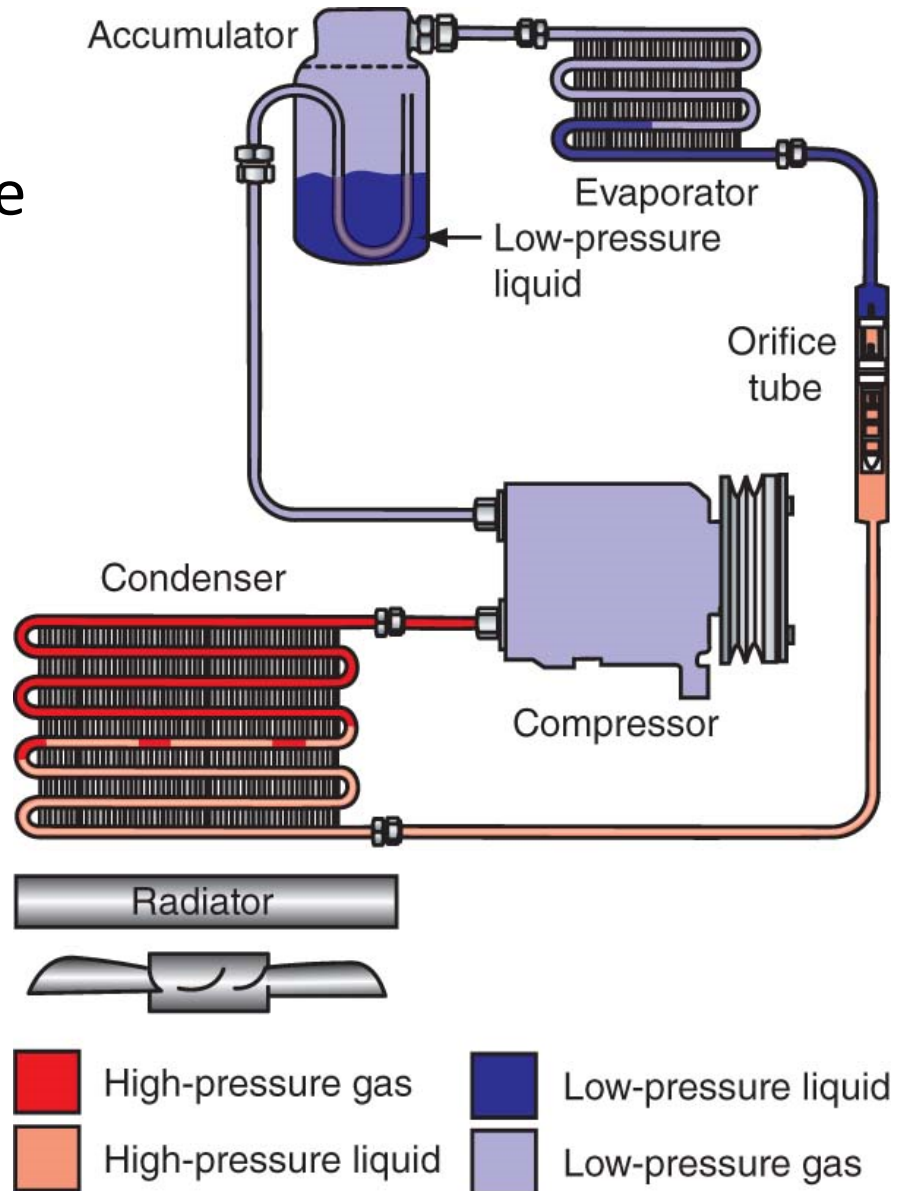
**Integrated Receiver-Drier**



**Separate Receiver-Drier (Older Vehicles)**



Some systems use a fixed orifice tube and Accumulator

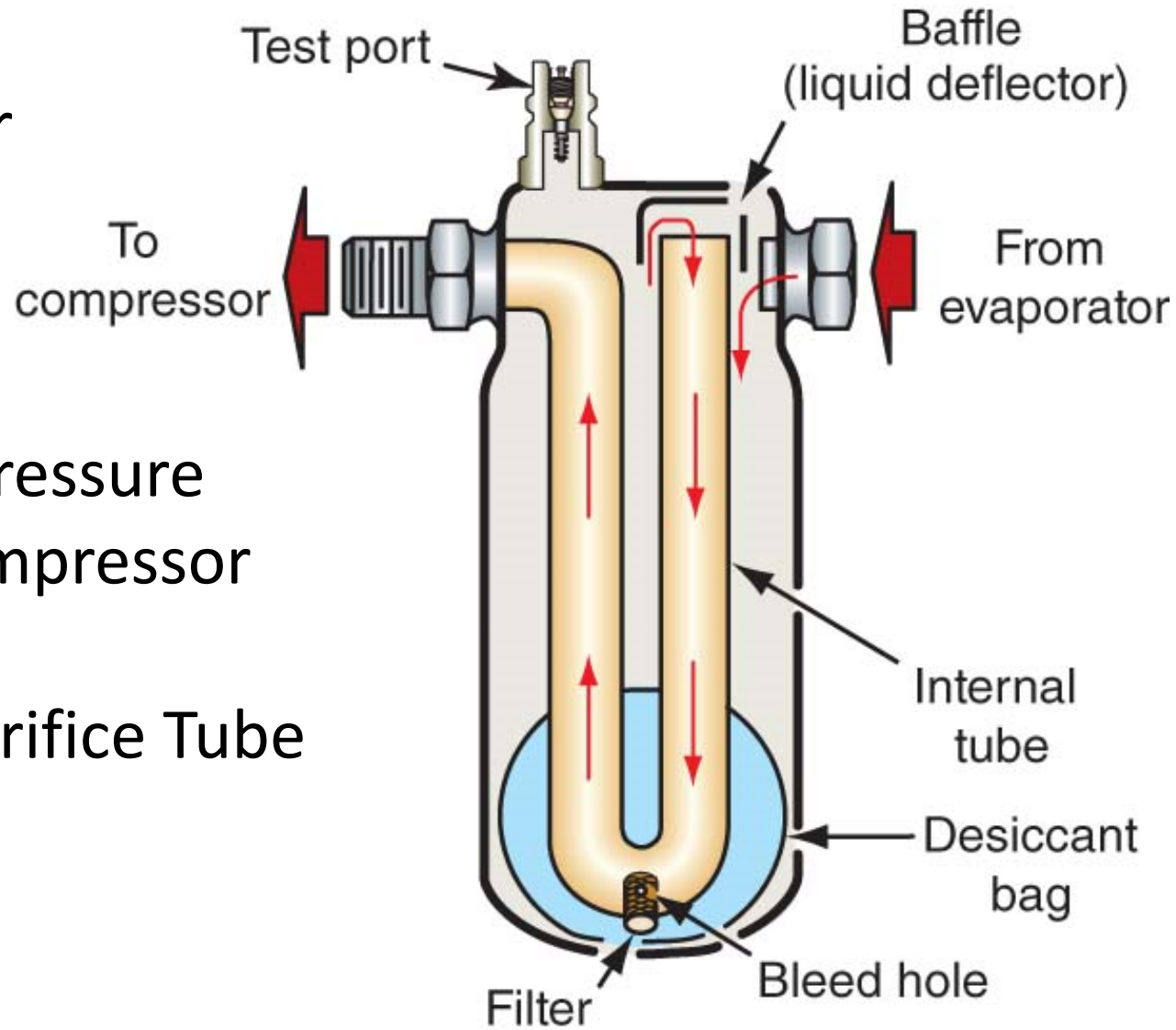


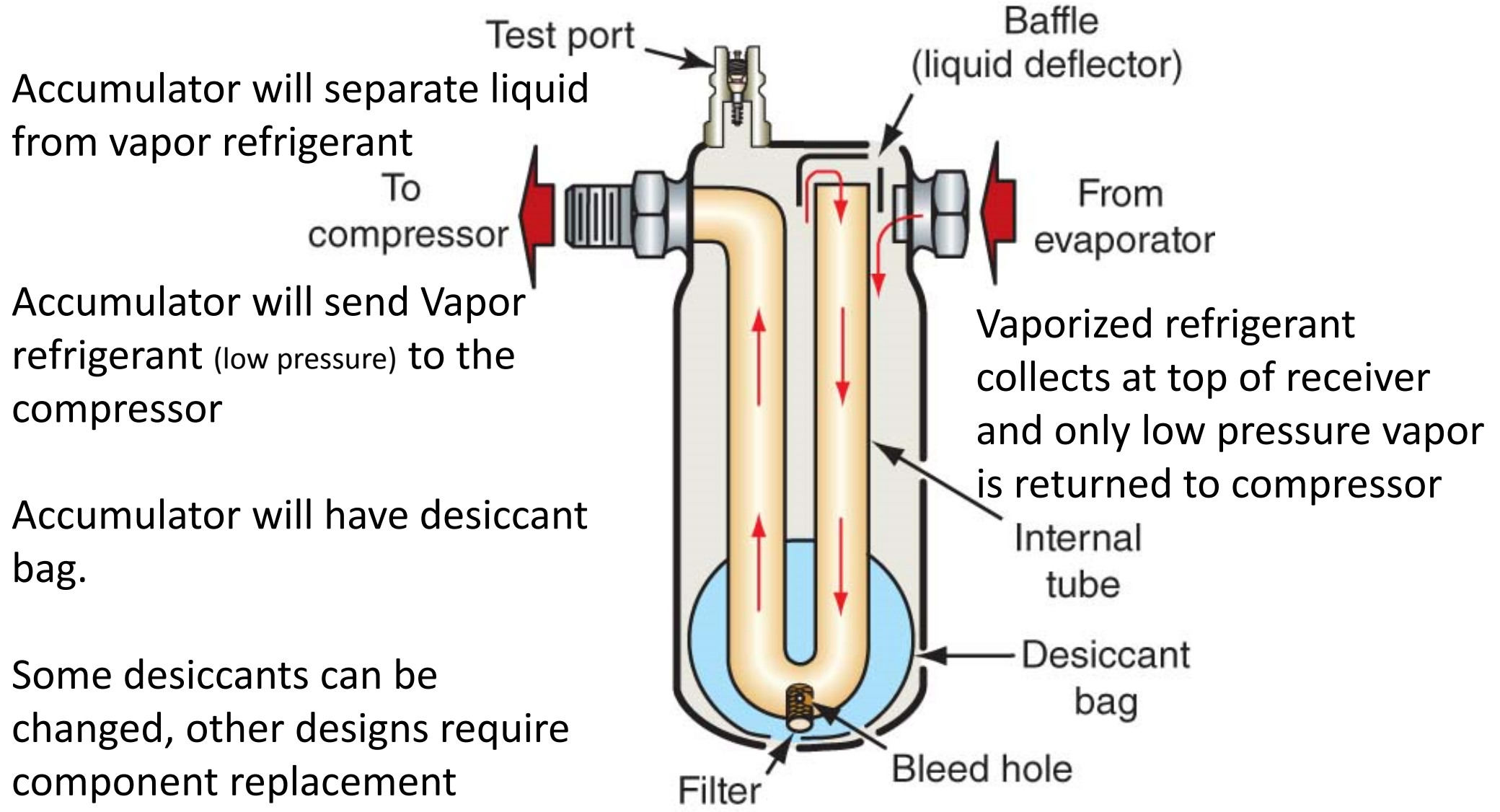


# Accumulator

Sends low pressure  
Vapor to compressor

Used with Orifice Tube





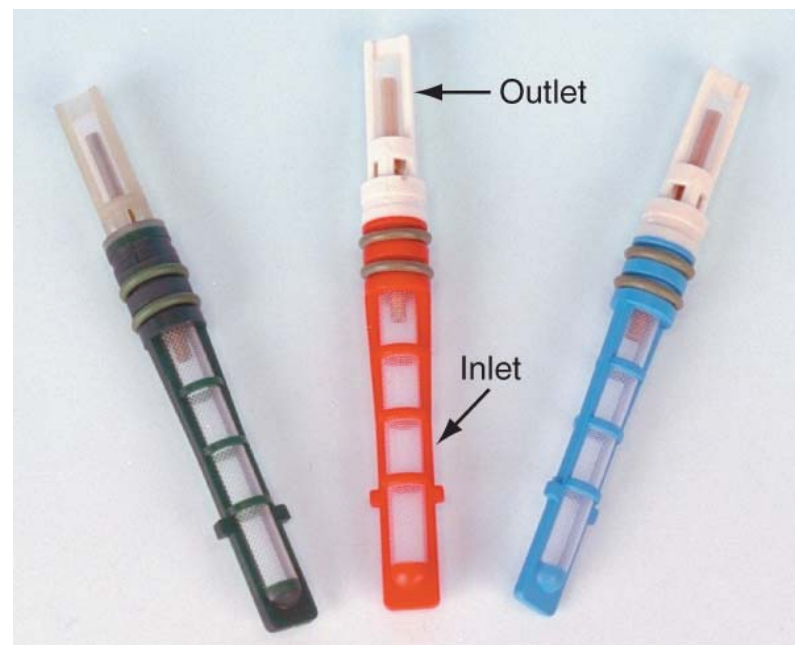
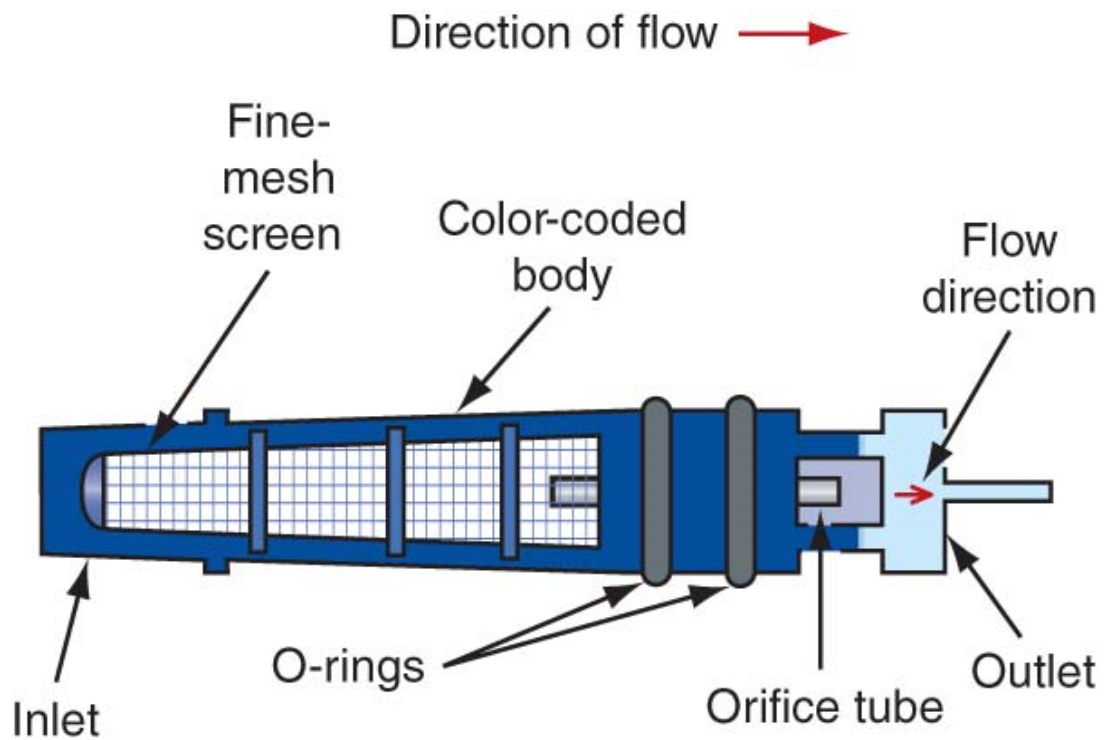
Accumulator will separate liquid from vapor refrigerant

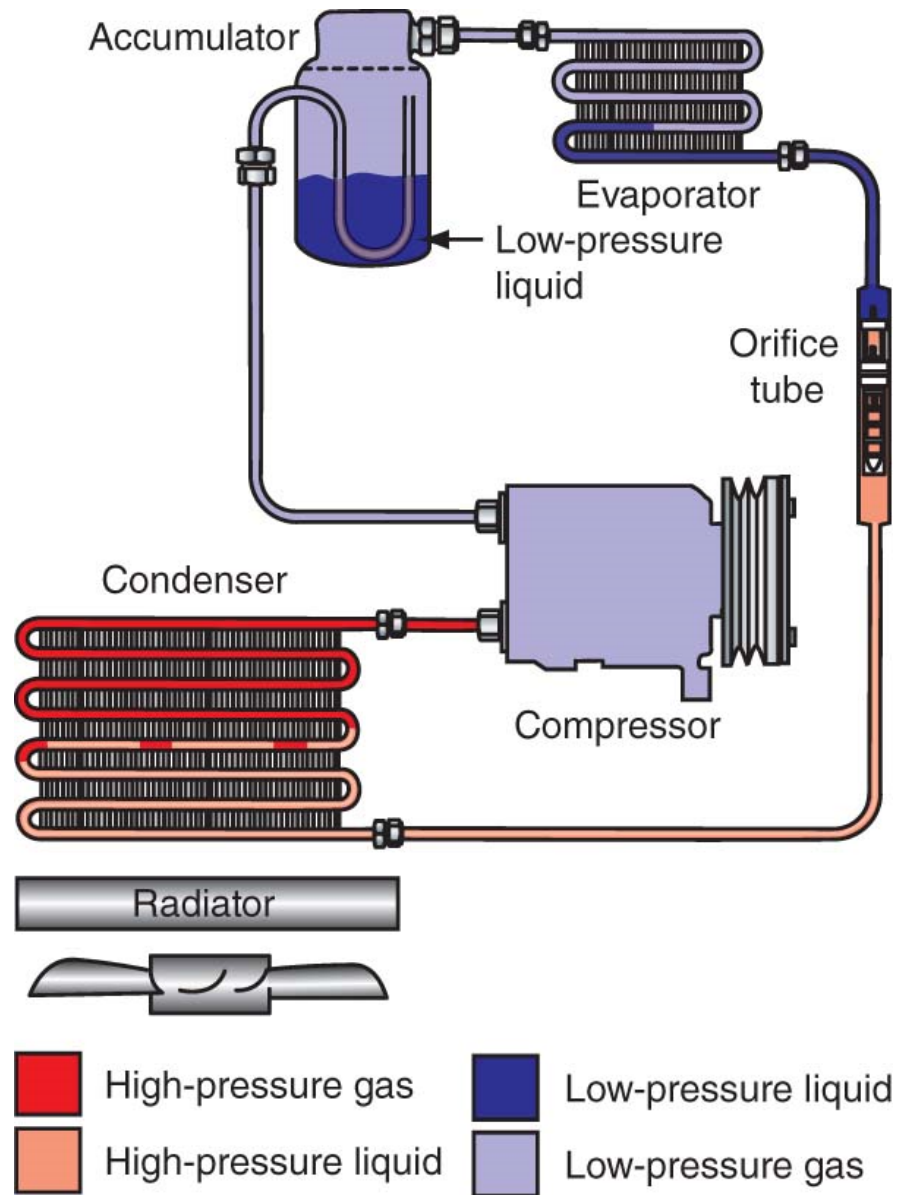
Accumulator will send Vapor refrigerant (low pressure) to the compressor

Accumulator will have desiccant bag.

Some desiccants can be changed, other designs require component replacement

# Fixed Orifice Tube

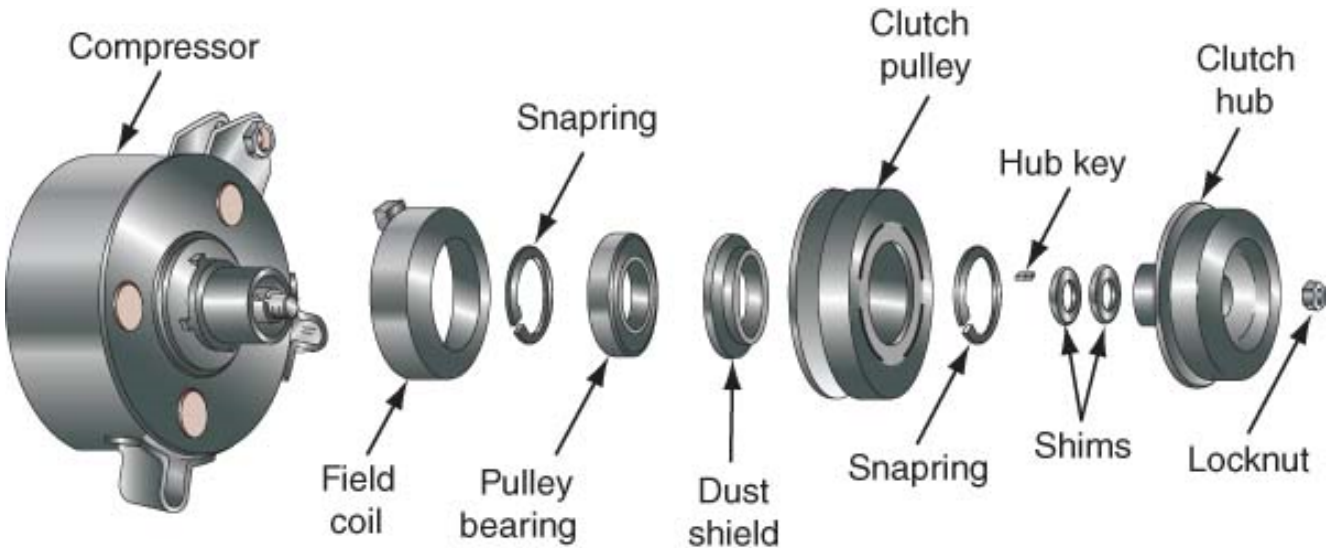




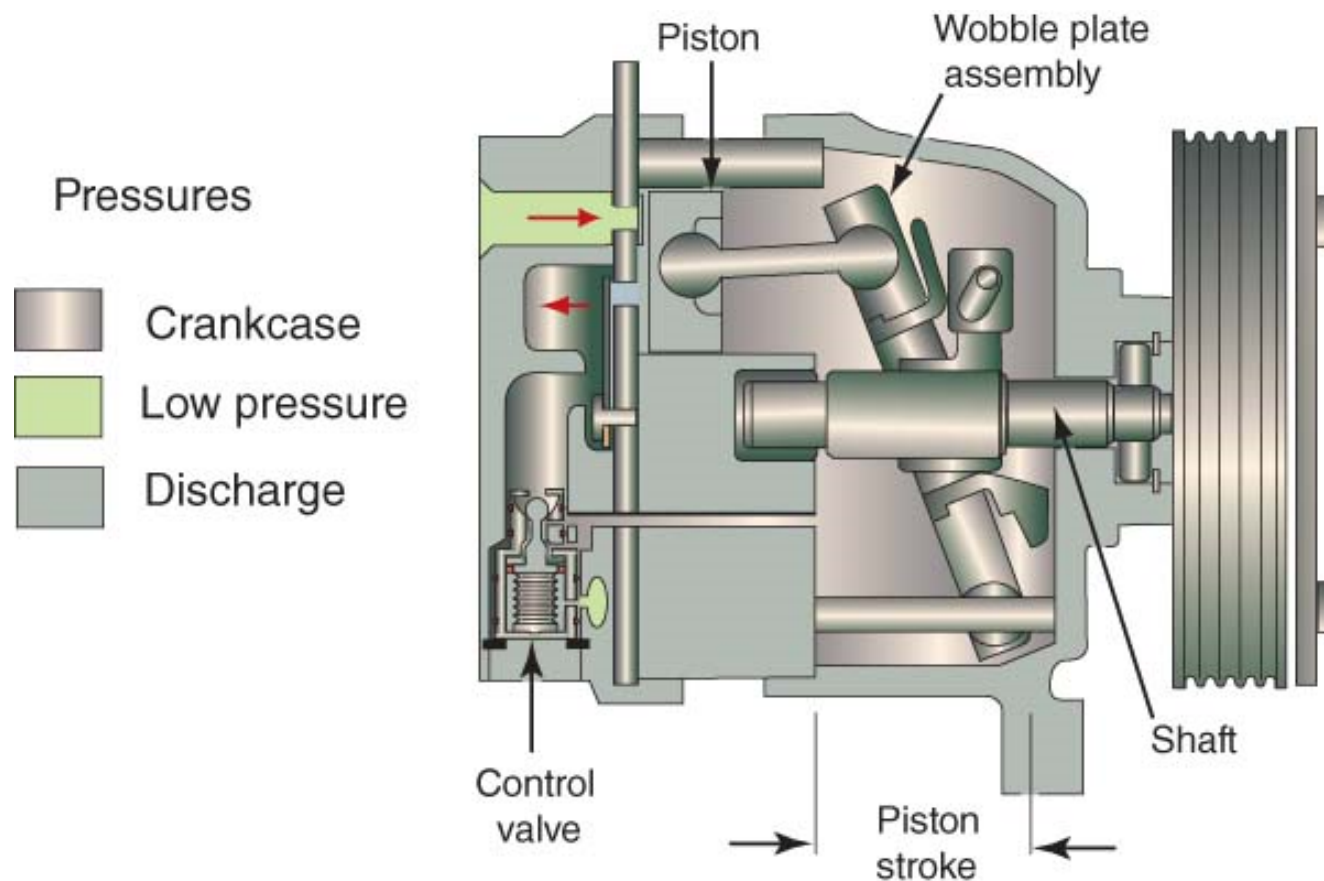
Many different types of compressors are used



Most compressors use an electric clutch to cycle compressor ON and OFF to maintain proper evaporator pressure



Some compressors will not cycle ON/OFF and will vary the piston stroke to maintain evaporator pressure

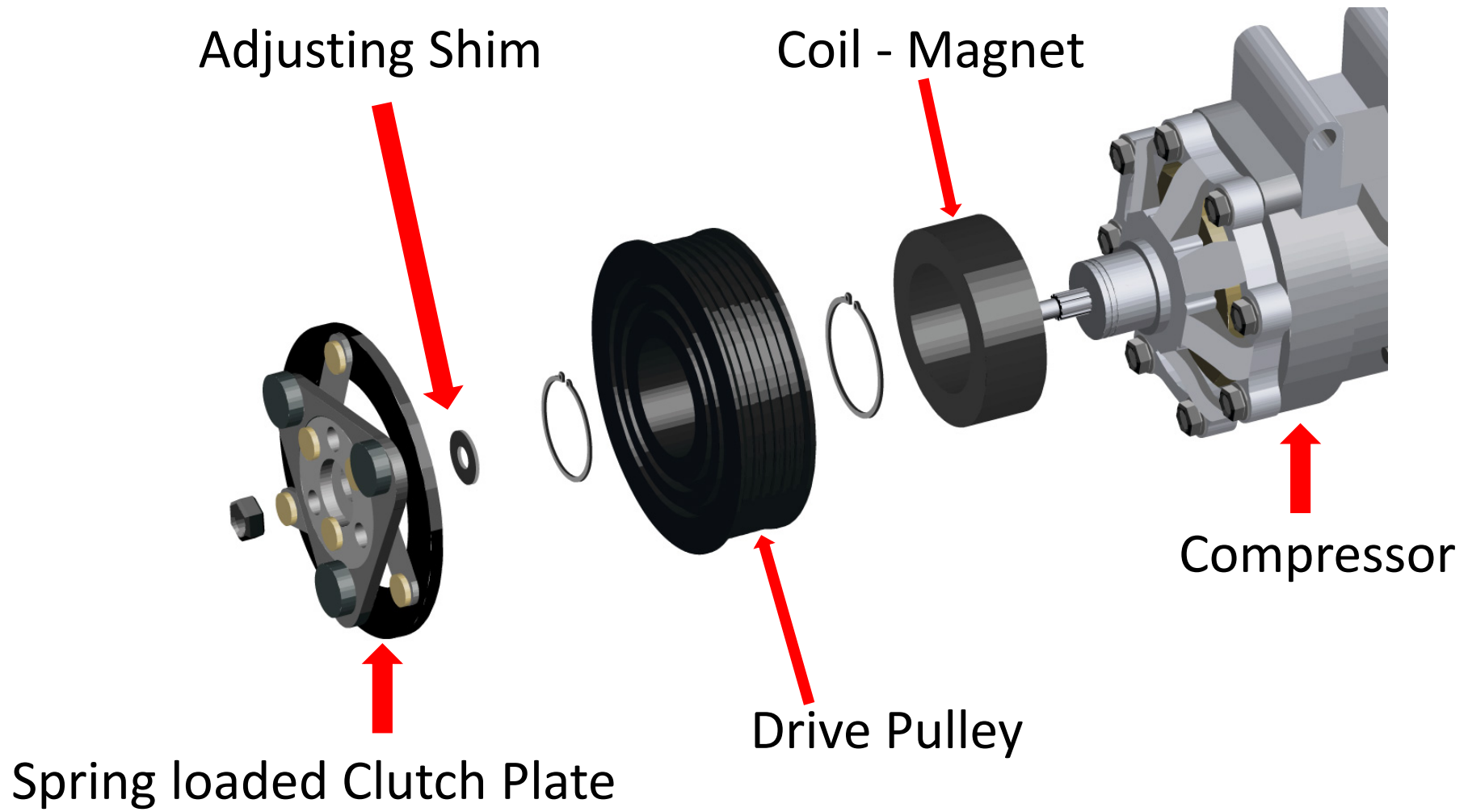




Most Clutches are checked using a feeler gauge.







Any time you replace a compressor or clutch,  
the clearance must be checked.

Loose clearance will cause clutch to make noise, slip, and overheat.

Tight clearance can cause the clutch to stay mechanically engaged

This will raise pressure too high and may cause the pressure relief valve to open.

Most Clutches are checked using a feeler gauge.

Shims available in several thicknesses to adjust the clearance.



A/C Compressors require lubricating oil carried by the refrigerant  
Refrigerant oil specifications vary between A/C compressor designs  
and manufacturers.

Always look up and use the correct oil for your system.

The oil type can be identified by a tag located on the compressor body  
or in the service manual.

Using the wrong type of compressor oil may cause excessive noise and shorten the A/C compressor's life.

Refrigerant oil can damage the vehicle's paint!

Wash off any spilled oil immediately. (wiping up spill will press oil into paint and NOT protect the vehicle)

An open oil can absorbs moisture. Keep any remaining oil tightly sealed.

# Component Replacement

Completely discharge/recover ALL refrigerant BEFORE opening any line

Tightly plug any open line or component IMMEDIATELY  
(Moisture will immediately begin to contaminate system when opened)

Use clean refrigerant oil (proper type) to lubricate any O-Rings

O-rings are not interchangeable with other types of O-Ring  
(such as fuel injector O-Rings)

# Component Replacement

The receiver drier's desiccant only holds a couple tablespoons of moisture.

The Accumulator desiccant only holds a couple tablespoons of moisture.

Replace the desiccant if the system was left open to the air for more than a few hours, such as after collision damage, or older systems that have leaked out all the refrigerant.

Check for contamination (use cotton swab) before deciding to make minor repairs on damaged or older systems.



# Diagnose the HVAC air handling system

Poor Heating or Cooling can be caused by the Heater/Evaporator air handling box.

Often called the Evaporator Housing or Heater Core Housing

Air doors are operated by:

Cables - Vacuum Motors - Electric Motors

Look, listen, feel, for changes in air flow as doors are moved

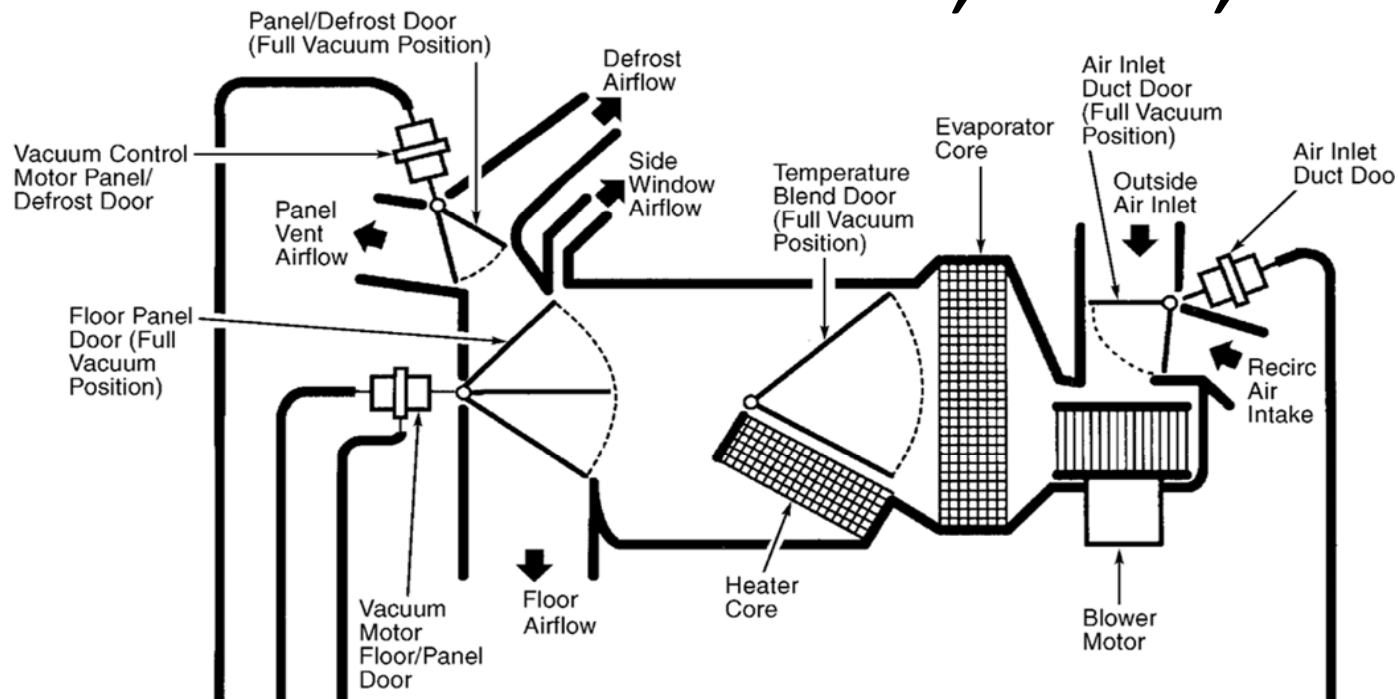


Air doors control:

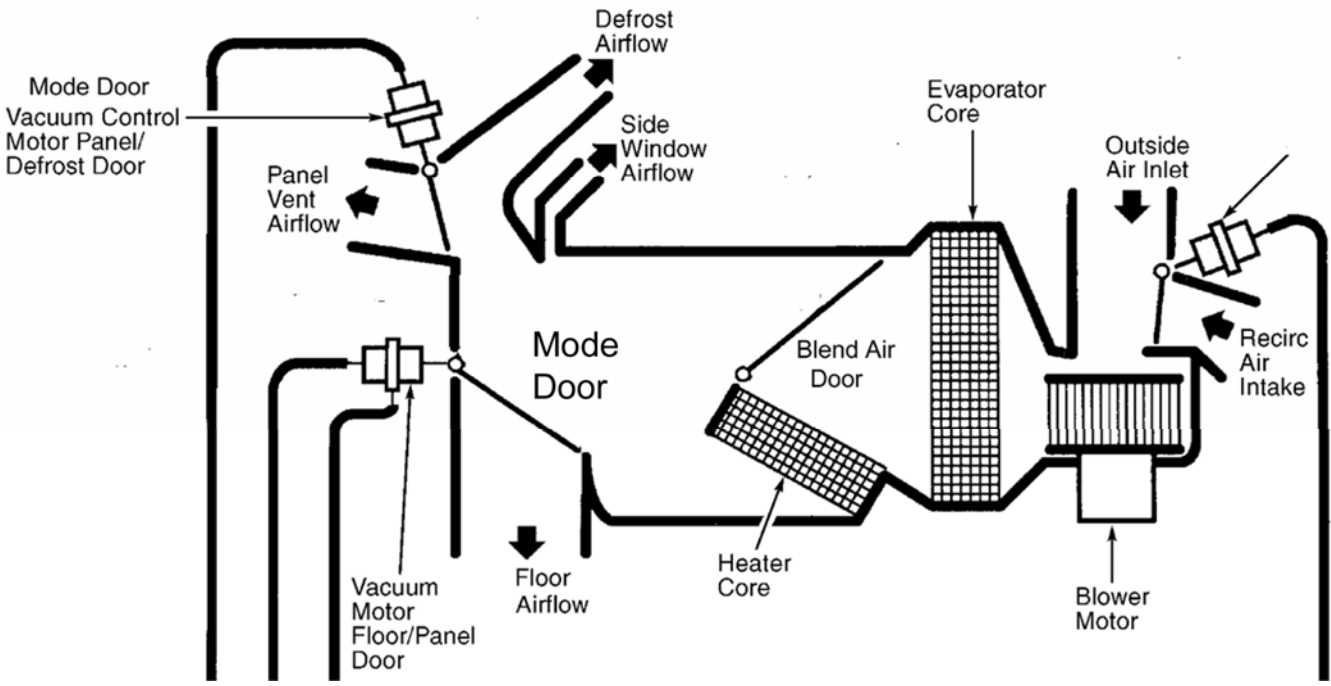
Temperature (**Blend Door**)

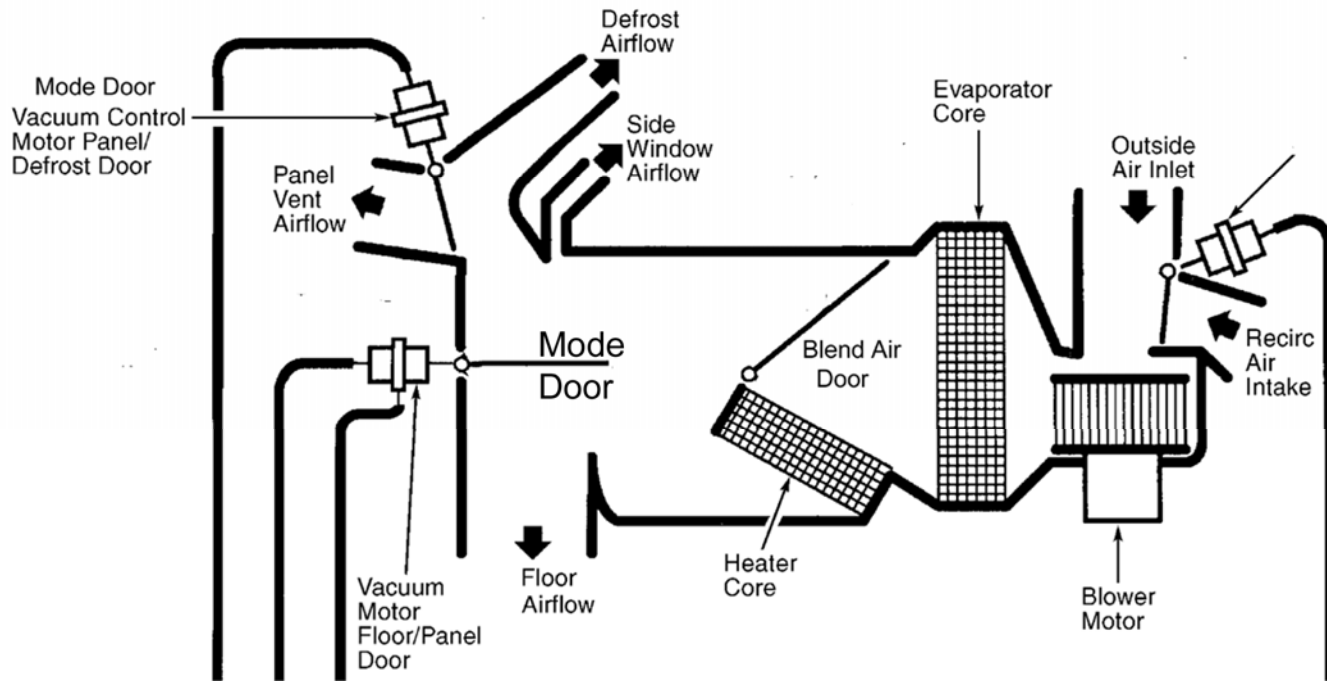
Fresh or Recirculate Air

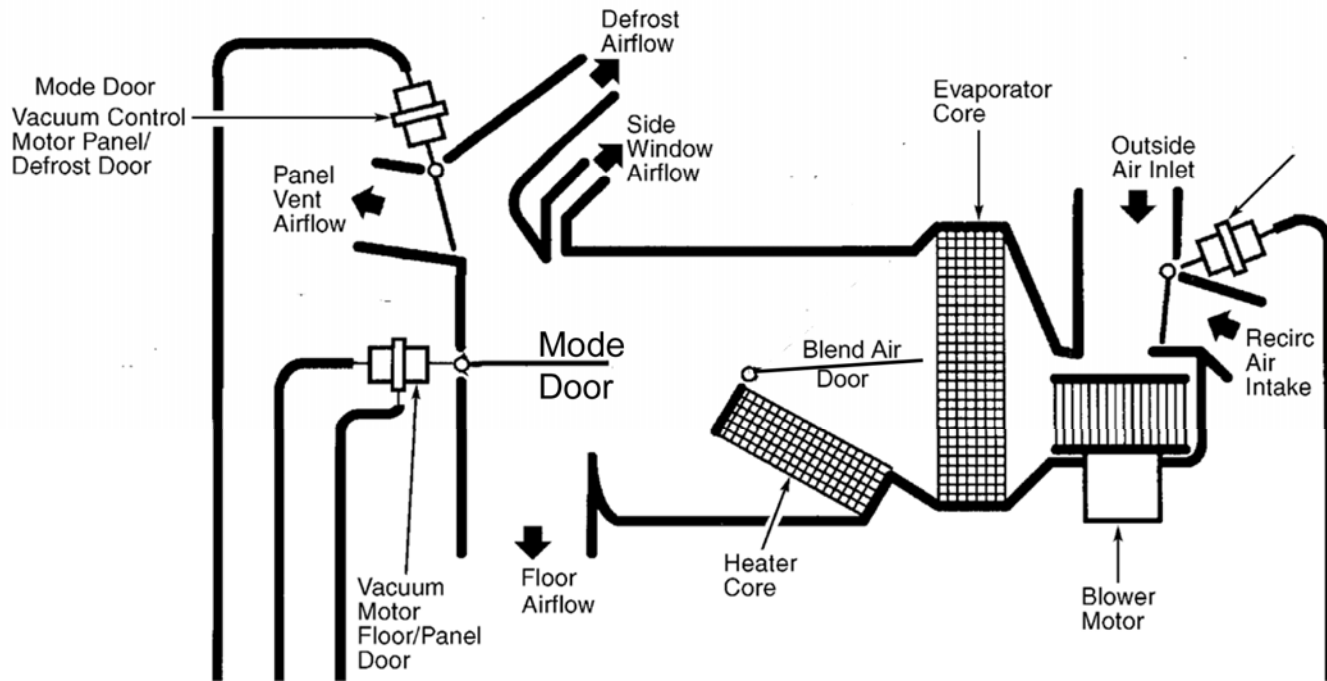
**Mode Doors** – Defrost, Floor, Panel

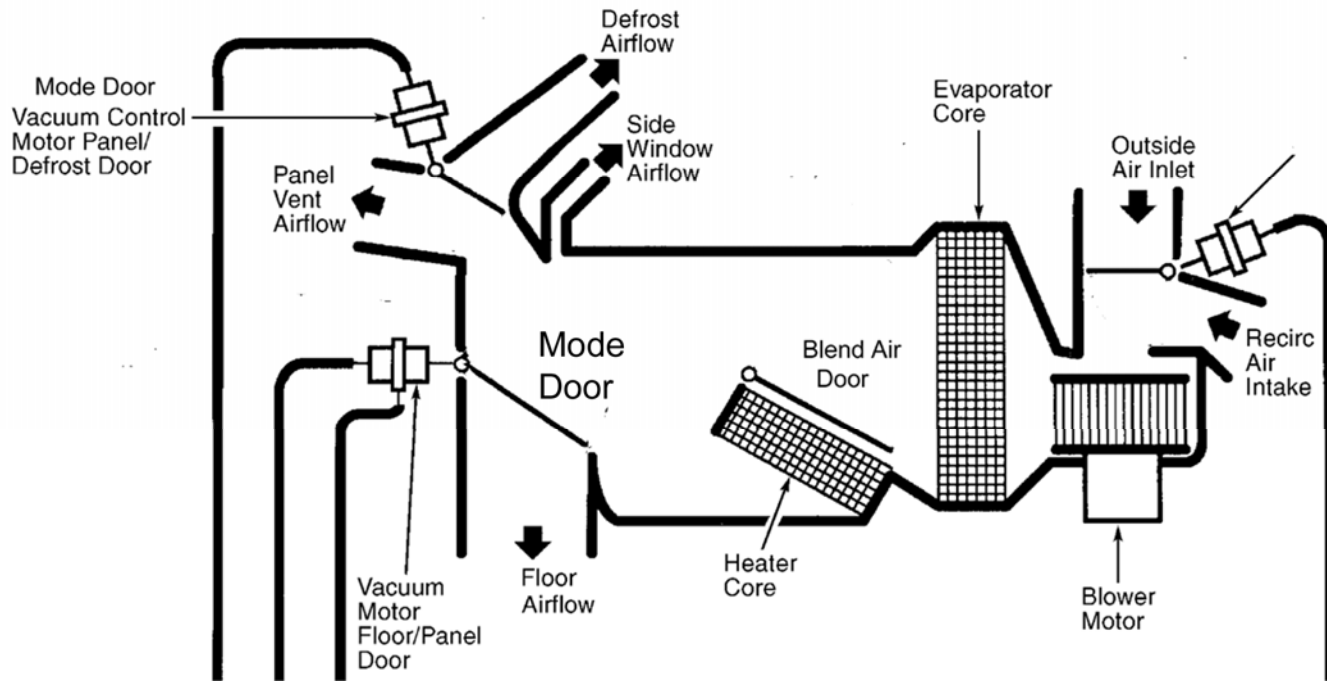


# Air Door Quiz









Proper air flow through Evaporator and Condenser is critical for proper cooling.

EVAPORATOR air flow

Check to make sure the Blend Air door is operating

Check Cabin air filter and any intake air restriction (usually leaves building up at base of windshield)

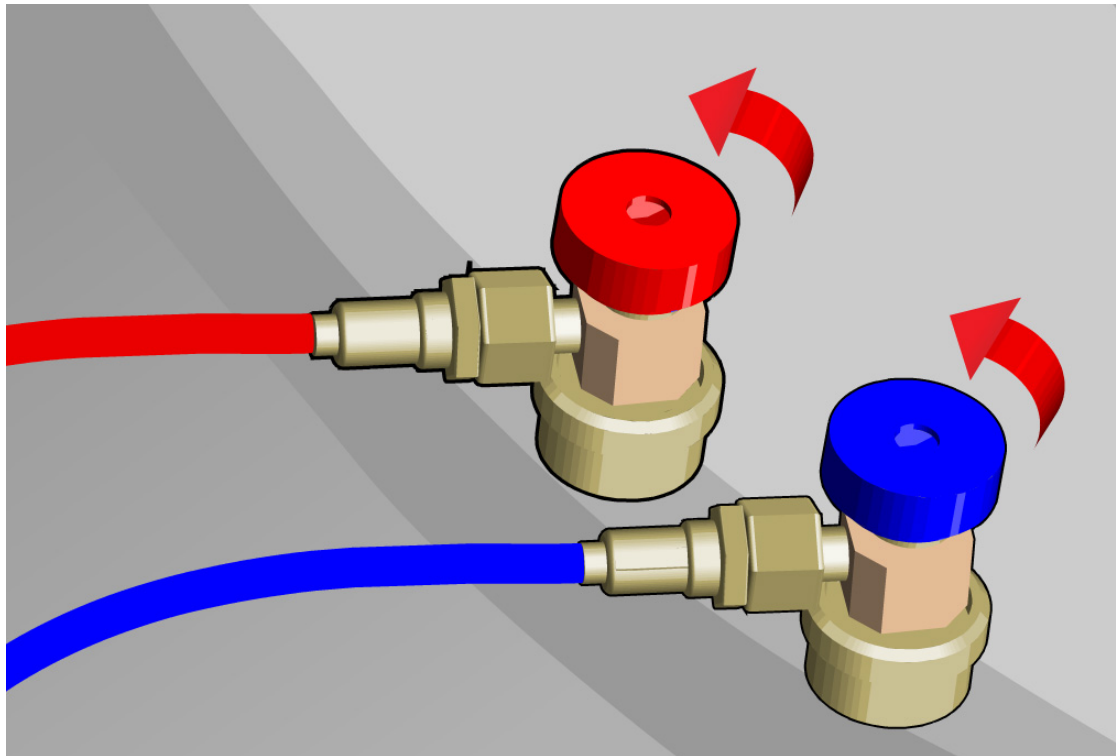
CONDENSER air flow

Check for bent fins or dirt, bugs leaves in front of evaporator

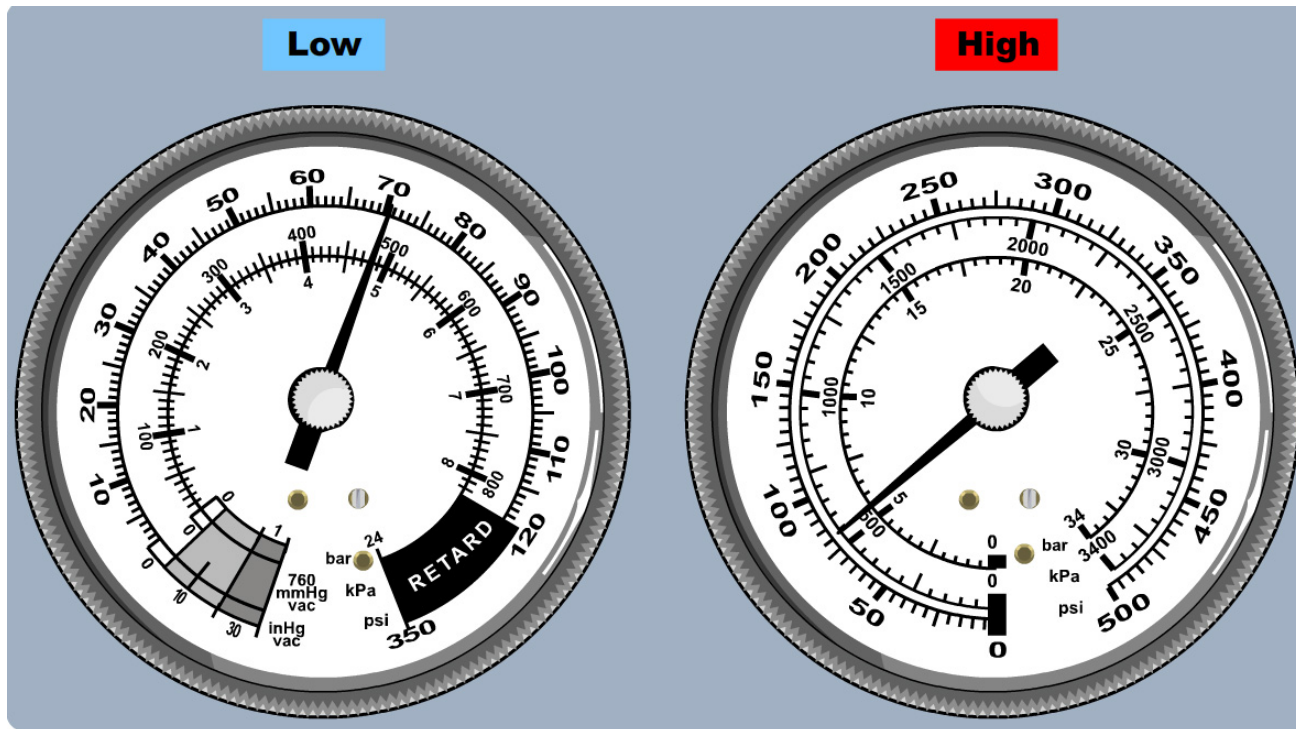
Check to make sure cooling fan is operating

# Pressure Testing Refrigerant

Move gauge or recovery valves fully counter clockwise (OFF position)  
to prevent refrigerant discharge when you connect or disconnect couplers



With proper charged\ and vehicle cold, the gauges should read close to 70 psi with a 70 degree ambient temperature.



Normal Static Pressures with Vehicle Cold @70°F

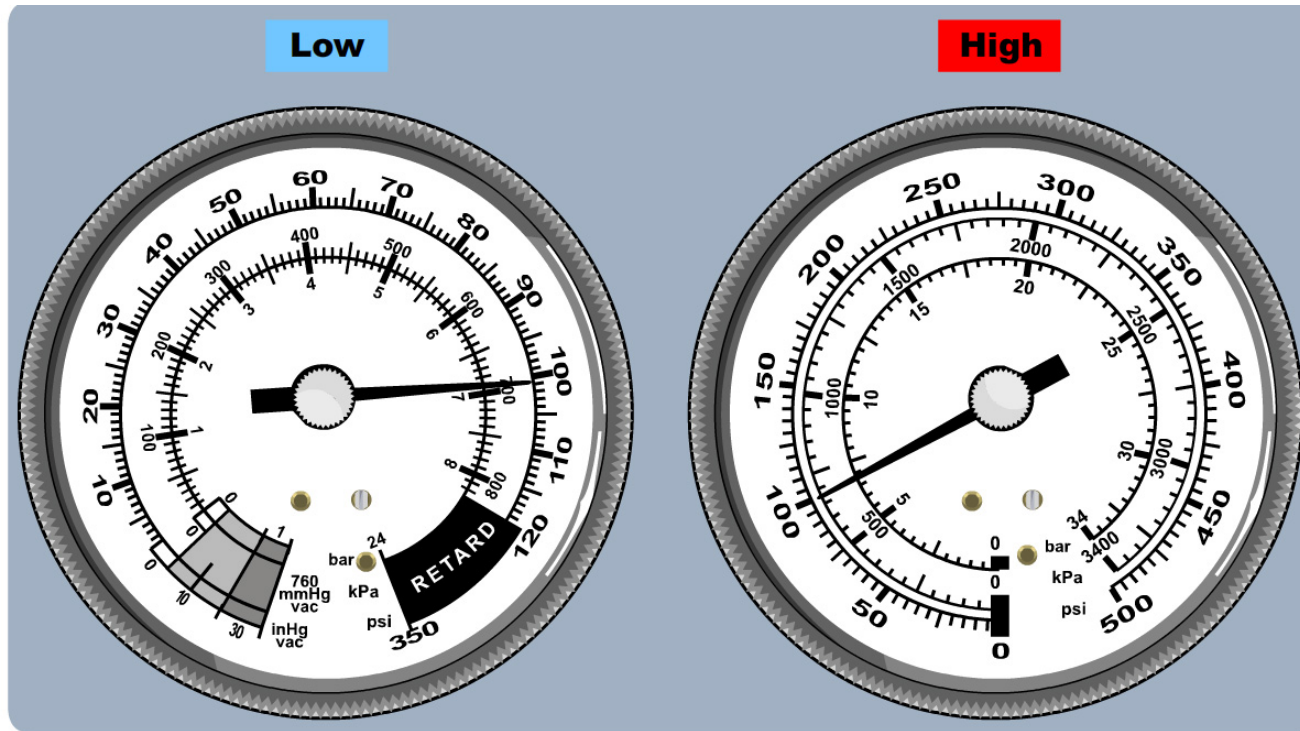


Compare Ambient temperature to Static Charge pressure

## R134a Temperature-Pressure

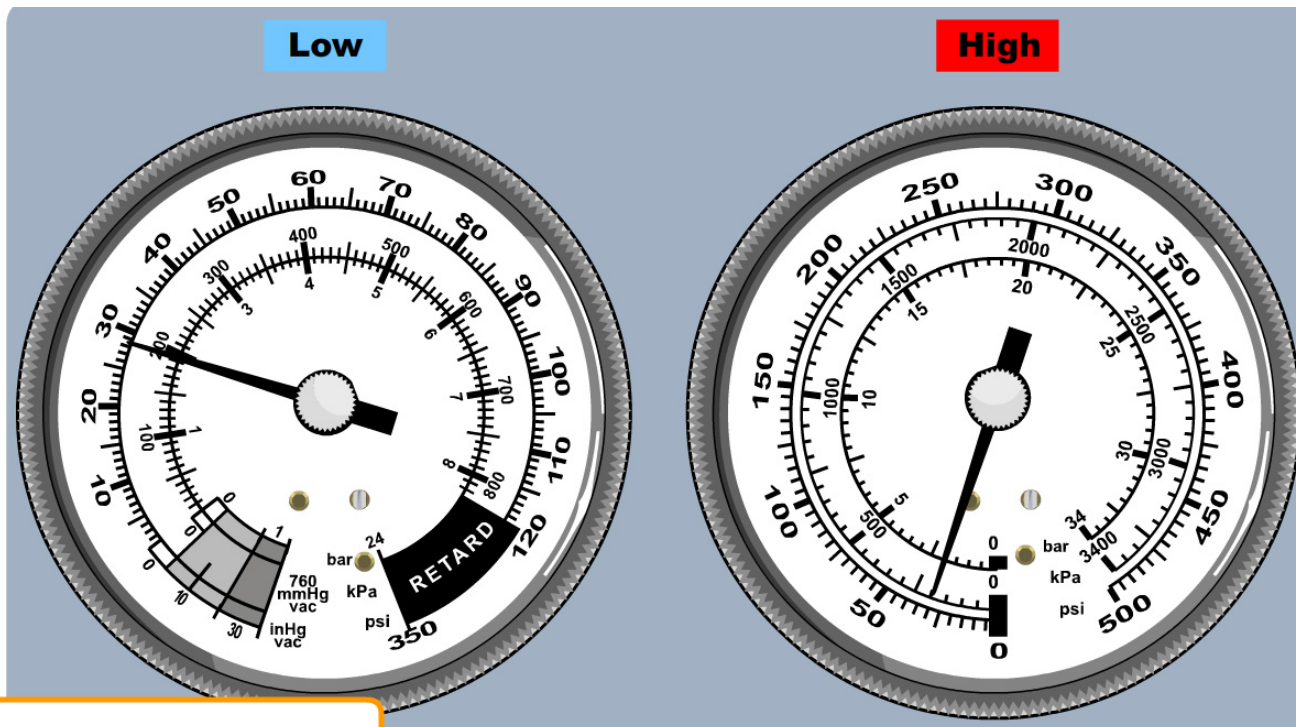
<b>TEMPERATURE</b>	<b>PRESSURE</b>
<b>°F (°C)</b>	<b>PSI (kPa)</b>
60 (16)	57 (392)
65 (18)	64 (438)
70 (21)	71 (487)
75 (24)	78 (540)
80 (27)	88 (609)
85 (30)	95 (655)

Static pressure significantly higher than the chart indicates contaminated refrigerant, too much refrigerant, or air in the system.



High Static Pressures with Vehicle Cold @70°F

If static pressure is below about 30 psi the A/C pressure switch or sensor will prevent A/C compressor operation. (check for leaks)

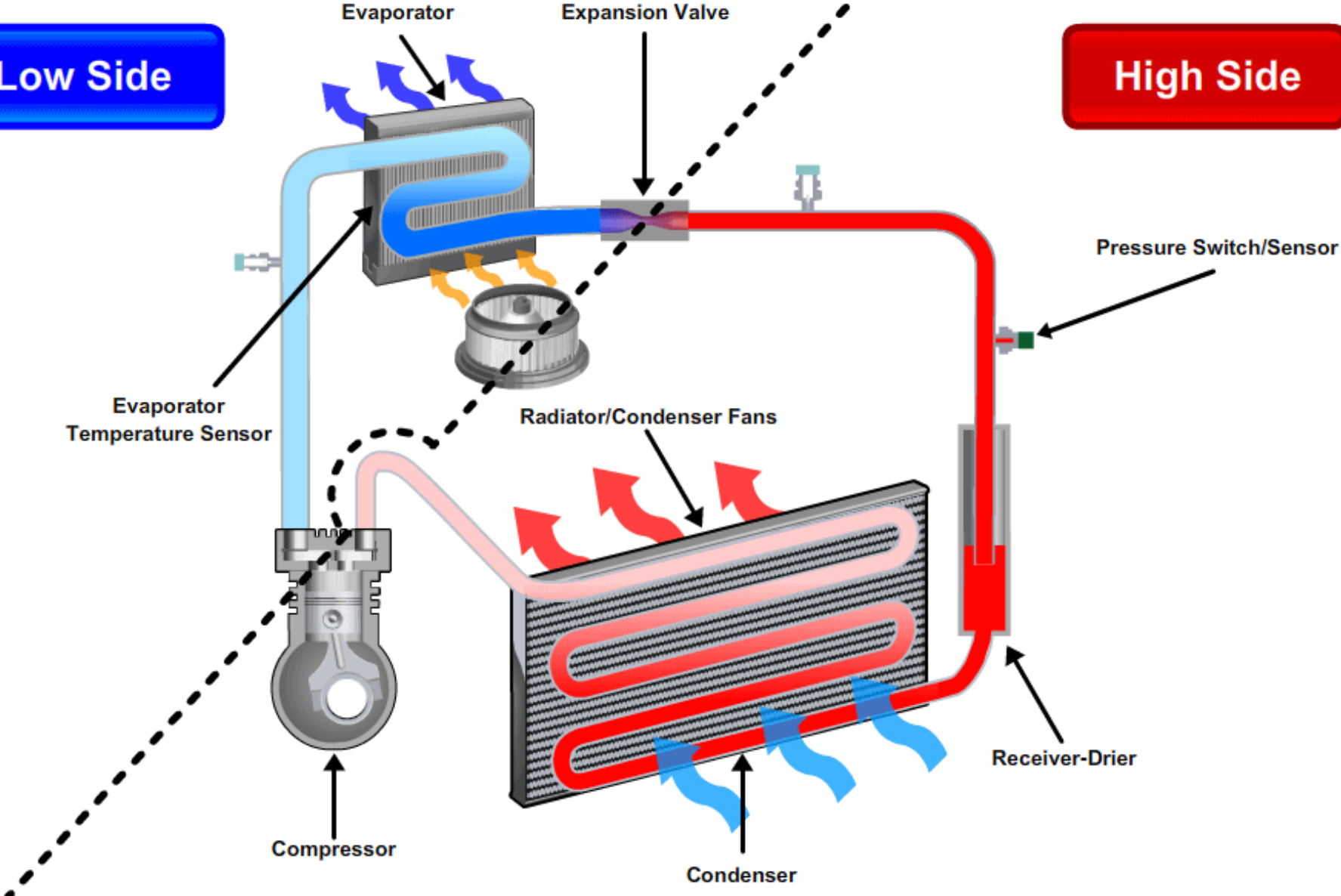


**Tech Note**

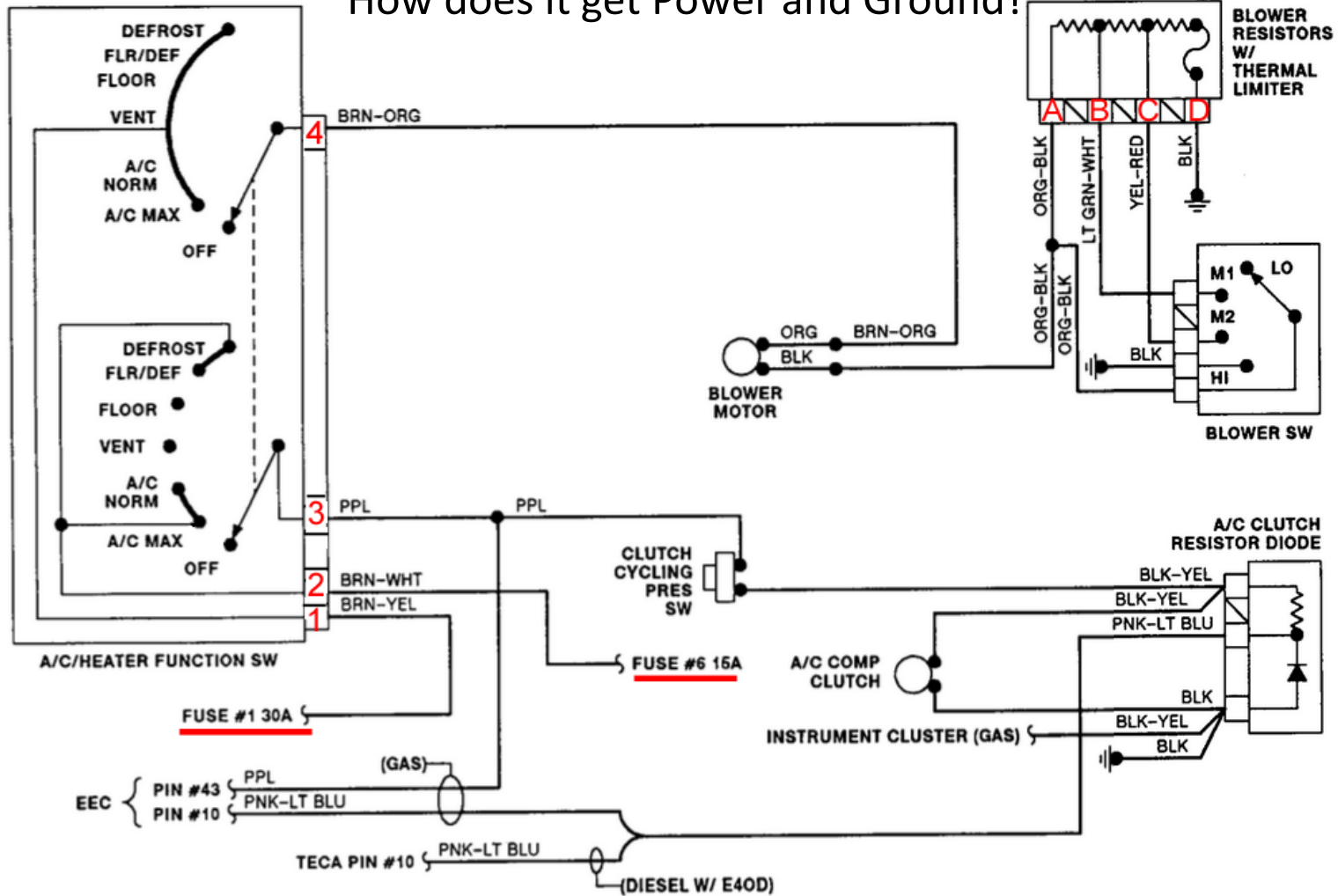
Never rely on static pressure readings as your only indication of the A/C system's state of charge.

**Low Side**

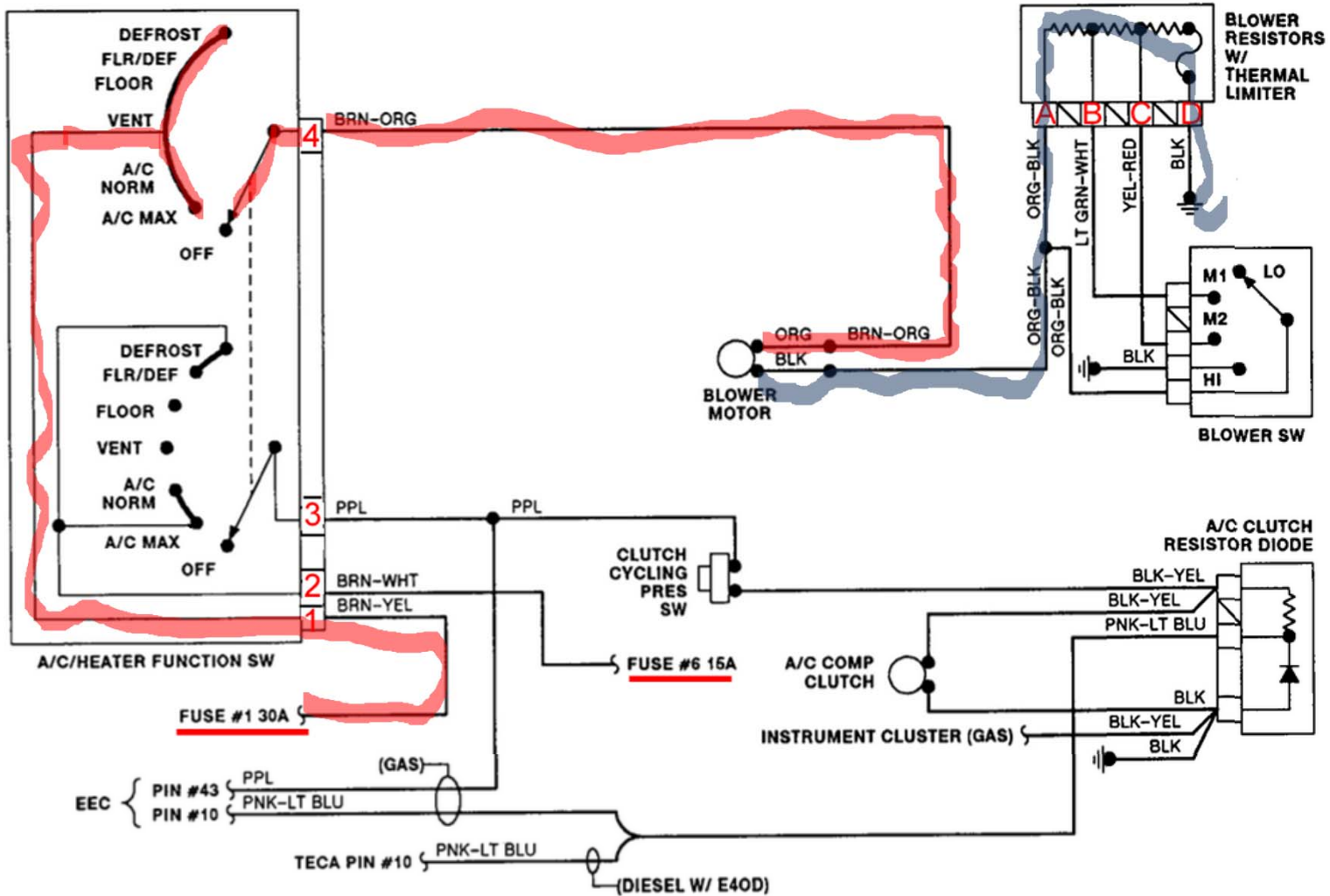
**High Side**



What does the Blower Motor do?  
 How does it get Power and Ground?

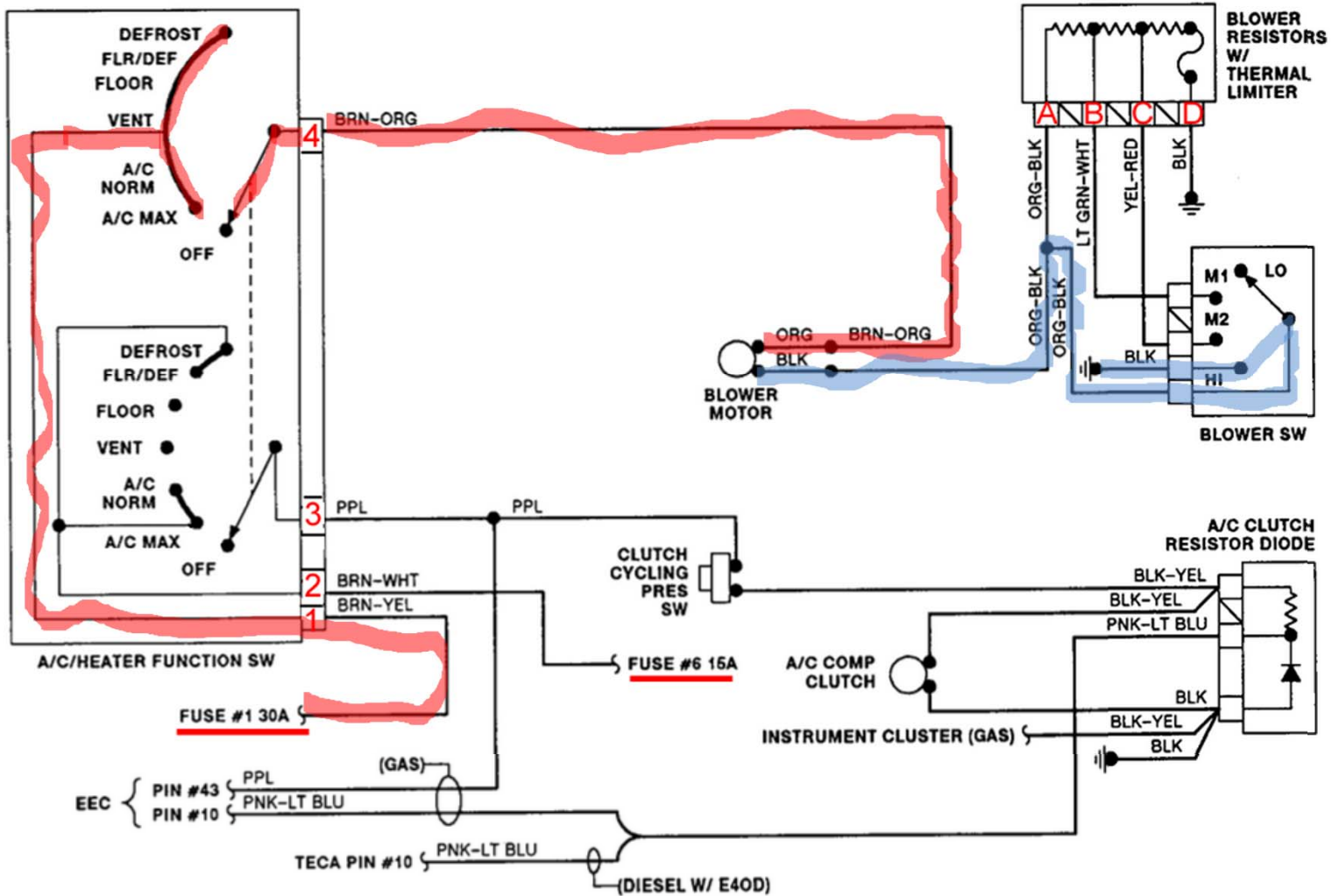


High resistance in the ground = low blower motor speed





Low resistance in the ground = high blower motor speed



What does the Compressor Clutch do?  
 How does it get Power and Ground?

