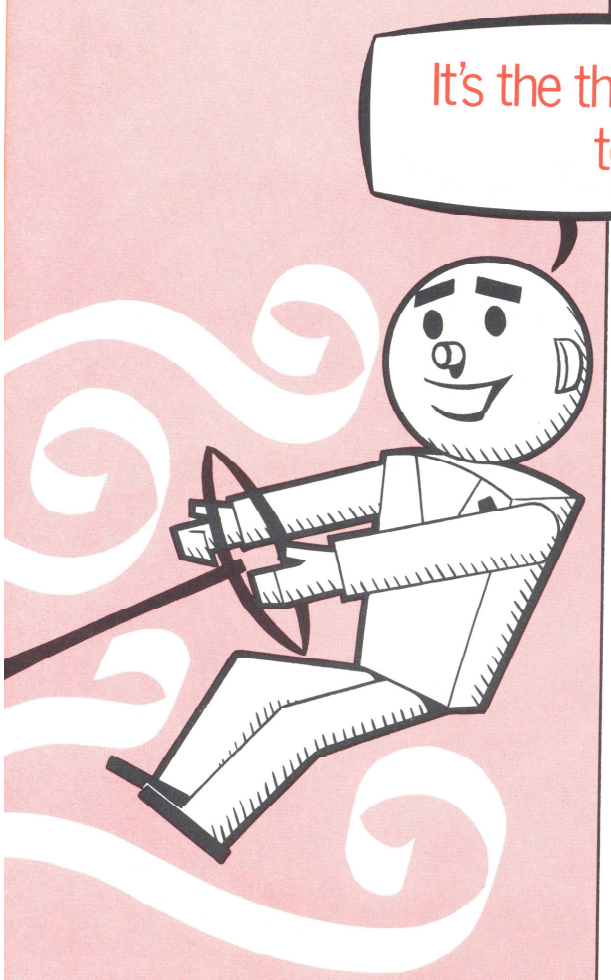
MASTER
TECHNICIANS
SERVICE
CONFERENCE

REFERENCE BOOK 69-10

AIR-CONDITIONING DIAGNOSIS... REFRIGERATION

PLYMOUTH
DODGE
CHRYSLER
IMPERIAL
DODGE TRUCK

CHRYSLER
MOTORS CORPORATION



By now, the need for air-conditioning service know-how should be obvious to all Master Technicians. The reasons are simple enough—more cars now have this equipment, and all car air-conditioning equipment needs some form of periodic service to keep it in top operating condition.

For a long time, the refrigeration part of car air conditioning has been "Off-Limits" to many technicians because it's a closed system which they're reluctant to disturb, or in some cases, because they're afraid of refrigerant. They've heard about frozen eyes and that an open flame changes refrigerant to poisonous gas. As in all such tales, these stories contain an element of truth, but you'll also notice that carelessness and not refrigerant, is usually the real villain. Simply handle refrigerant with respect and it won't bite you.

As many of you know, car air-conditioning refrigeration systems are serviced safely and successfully in gas stations by people with only minimum training, a fact which shows that the day of the specialist is passing. Obviously, there's more to air-conditioning service than charging the system and fixing leaks, but like other unfamiliar service operations, once the strangeness wears off, the whole thing becomes routine.

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INTRODUCTION

If you want the real lowdown on servicing air-conditioning refrigeration systems, ask a specialist. You'll soon find out that there's nothing really mysterious about the operation of the system, once you have the functions of the parts sorted out in your mind. In fact, you'll probably get the impression that trouble-shooting the air-conditioning system is as simple as checking out an automatic transmission, or any other job where you begin the diagnosis by checking the liquid level and reading the system operating pressure.

YOU'VE BEEN THERE BEFORE

Charging the refrigeration system also follows a familiar servicing pattern. In a way, it's a lot like filling and bleeding the brake hydraulic system because everything must be kept extra clean, and no air or water is permitted in the system with the refrigerant.

IT COOLS BY ABSORPTION

To understand what the different parts of the refrigeration system do, the first points to consider are that a cool object absorbs heat from the surrounding air, and when heat is absorbed faster than it is replaced, the surrounding air also becomes cool. To keep the cooling process going, the heat must also be carried away from the cool object as it is absorbed.

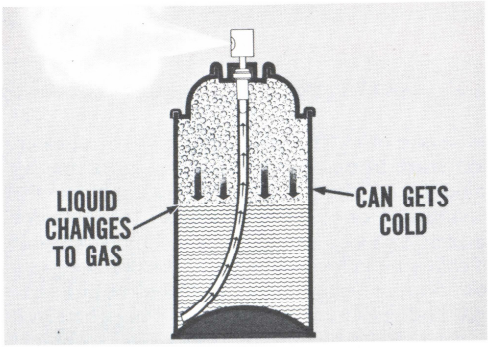


Fig. 1—Refrigerant expands and absorbs heat

AROUND AND AROUND IT GOES

The cool object in the car refrigeration system is the evaporator. Here, we make the refrigeration process work by taking advantage of the fact that when liquid vaporizes, it expands, and as the vapor expands, it absorbs heat. The liquid in this case is the refrigerant, which passes through the evaporator where it absorbs heat from the air inside the car. To continue the refrigeration cycle, the compressor pumps the refrigerant around the system through the condenser, where the absorbed heat passes off to outside air. The refrigerant then flows back to the evaporator.

REFRIGERANT IS SAFE

In the film, we saw that the familiar spray can also uses refrigerant, but as a propellant instead of a cooling agent. However, refrigerant reacts to pressure changes in the can the same as in a car system evaporator, so we can use it to provide a simple demonstration of the refrigeration process.

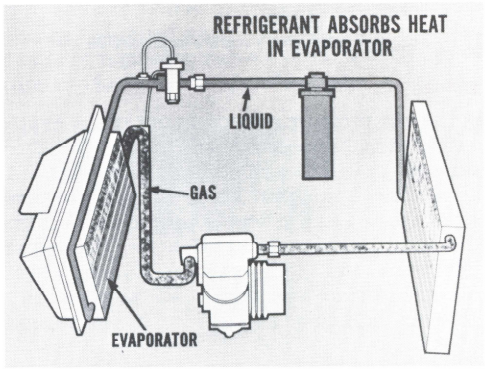


Fig. 2—Refrigerant expands in evaporator

IT'S LIQUID OR GAS

When refrigerant is under pressure in the can it is a liquid, but when the pressure drops as the spray valve is opened, the liquid vaporizes and changes to gas. You'll recognize these as the conditions we just described for absorbing heat. In other words, as the refrigerant changes from liquid to gas, it expands and absorbs heat . . . which is the reason why the can gets cold as you spray.

VALVE LOWERS PRESSURE

In the car refrigeration system, we use the expansion valve to drop pressure in the evapo-

rator so the liquid refrigerant can change to gas and expand to absorb heat. The main difference here is that the valve is automatically controlled to meter the correct amount of refrigerant into the evaporator, and the refrigerant is reused by circulation in a closed system instead of escaping to the air.

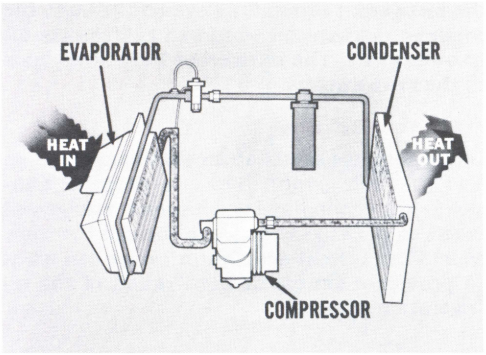


Fig. 3—Refrigerant transfers heat outside car

COMPRESSOR PUMPS AND PRESSURIZES

As the low pressure gas comes out of the evaporator, the compressor raises the gas pressure and temperature as it pumps the refrigerant though the condenser. Here, the gas changes back to liquid as the heat is carried away from the condenser fins to outside air. From the condenser, the high-pressure liquid passes through the receiver-drier to remove any moisture, and then flows on to the expansion valve to complete the refrigeration cycle.

EXTRA CONTROL IS NEEDED

A basic car refrigeration system using an evaporator, compressor, condenser, receiver-drier, and expansion valve will do an adequate job of cooling. However, with only an expansion valve to control refrigerant flow, this basic system can cool below the freezing point. If evaporator temperature drops too low, moisture in the air freezes and blocks the air flow through the evaporator fins. This, in turn, reduces the air-conditioning cooling output.

SWITCH CYCLES COMPRESSOR

Two methods are used in our air-conditioning systems to prevent freezing. In one, a thermoelectric switch senses evaporator temperature and "cycles" the compressor clutch, turning the whole system on or off to keep the evaporator from dropping below the freezing point.

VALVE CONTROLS FLOW

The second method of preventing evaporator freezing uses a pressure-sensitive Evaporator Pressure Regulator Valve in the suction side of the compressor to control the flow of refrigerant in the system. The valve reacts to variations of refrigeration suction pressure which result from changes in the temperature of the refrigerant coming out of the evaporator.

LIQUID TO GAS TO LIQUID

These, then, are the functions of the parts that make up the refrigeration system. Simply described, you have a low-pressure section where the refrigerant liquid can vaporize, expand, and absorb heat; and a high-pressure section where the expanded refrigerant is compressed and heat is removed to change it back to liquid for another trip around the system.

HOTTER IS HIGHER

As you will note in the pages which follow, refrigeration system operating pressures are affected by temperature, increasing or decreasing in a direct relation to changes in the system temperature. From this it is easy to see that testing pressures can vary upward or downward, but still be correct if the pressure relationship between the high- and low-pressure sections is normal.

REFRIGERATION SYSTEM TROUBLESHOOTING

As in any other troubleshooting job on the car, you start in on air conditioning problems by making a general check . . . looking for the obvious. It only takes a minute to check for broken or loose drive belts, so make a habit of checking belt condition and tension on every job. Slippage can really cut down cooling output, and will quickly ruin belts if not corrected in time. Belts also wear faster than normal if pulleys are out of line, another point to remember in checking. For best results, use the belt checking and adjustment procedures in the Service Manual.

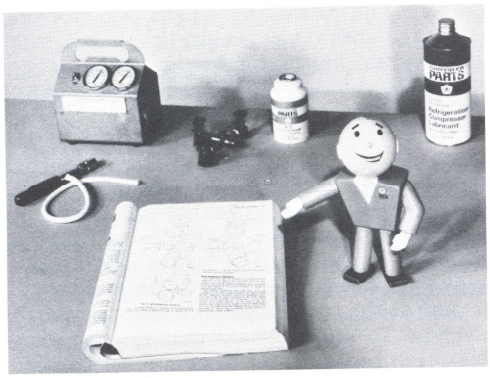


Fig. 4—Adjust belt tension as specified

LOOK IT OVER

In addition to checking the drive belts, make sure the compressor clutch engages properly, and look over the system connections for traces of compressor oil which could indicate leaks. Also work the air-conditioning controls so you can tell whether the air doors move to the proper positions for the various operating modes, and remember that the water flow valve must close properly when the heater section is not in use. If your visual check fails to turn up any obvious trouble causes, you're ready to begin testing the refrigeration part of the air-conditioning system.

GAUGES BEAT GUESSING

You'll need the C-3740 Gauge Set to test or service the refrigeration system, so regardless of whether the system is charged or empty, the next step is to connect the gauges to the service ports at the compressor.

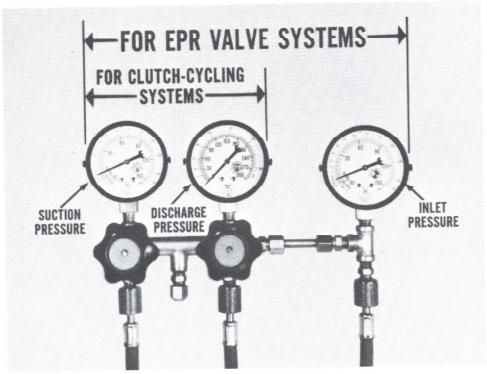


Fig. 5—Right-hand gauge checks EPR valve

READING FROM LEFT TO RIGHT

The test set consists of three pressure gauges, a valve manifold, and the connecting hoses. The evaporator suction pressure gauge at the left side of the set checks the low-pressure section of the system, the discharge pressure gauge in the center checks the high-pressure section, and the compressor inlet pressure gauge at the right checks the pressure drop at the EPR valve.

THREE FOR EPR

We use all three gauges for checking the Evaporator Pressure Regulator Valve systems. With clutch-cycling systems, however, you only need the left side and center gauges. Basically, we only need two gauges for testing; one for the high-pressure section and another for the low-pressure section of the system. But, since the EPR valve is in the low pressure section, another gauge is added so you can compare regulator valve inlet and outlet pressure to check valve operation.

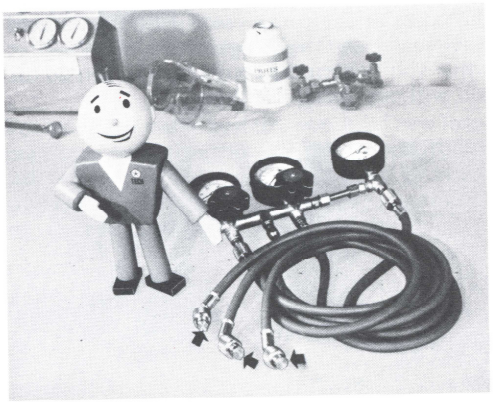


Fig. 6—Plug couplings when not in use

KEEP 'EM CLOSED

When the gauge set is not connected, be sure the coupling plugs are installed to keep dirt and moisture out of the couplings and hoses. And make a habit of keeping the manifold valves closed so you won't lose a lot of refrigerant when you connect the hoses to a partly- or-fully-charged system.

CHECK THE HOSES

Before you connect the gauge set, give the hoses a quick look to check their condition. Also check the coupling seal inserts because the couplings will leak if the seals are damaged or missing.

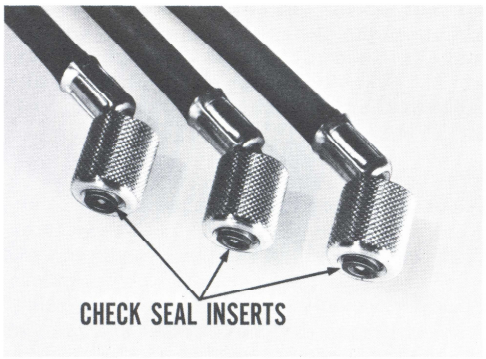


Fig. 7—Seals must be in good condition

DON'T LET IT ESCAPE

The valve stem depressors in the hose couplings can release refrigerant as you connect the hoses at the compressor. But, if you hold each seal insert tight against its service port while you tighten the coupling, you can do the job without losing refrigerant.

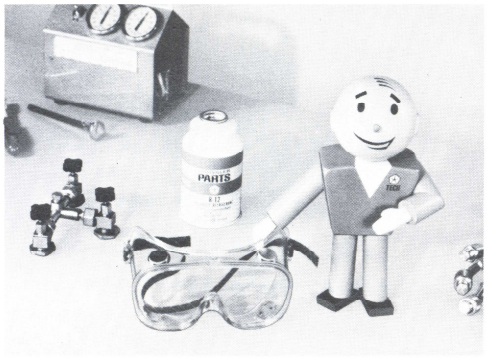


Fig. 8—Protect your eyes with goggles

GAS CAN GET COLD

Always remember to be careful when you connect the gauge set or handle refrigerant. Escaping refrigerant causes freezing on contact, so play it safe by wearing goggles and protecting your hands. Once again, if you hold the coupling seal inserts tight against the service ports while you tighten or loosen the couplings, very little refrigerant should escape.

READ EACH GAUGE IN TURN

If the system contains any refrigerant, you can compare gauge indications to make a quick calibration check before connecting the gauges for system testing. All you do is connect each gauge hose in turn to the same service port at the compressor and note the gauge readings. To make certain that the checking pressure is constant, the system must be shut down long enough for the pressure to stabilize.

INDICATIONS SHOULD AGREE

Each gauge should indicate the same pressure. If one gauge is off slightly, you can adjust it to agree with the other two. But, when you get wide variations in the readings, all three gauges probably need a calibration check.

CALIBRATION BY THE CHART

You can check the calibration of the gauges by comparing their indications against the Pressure-Temperature Relationship Chart in the Service Manual. No special equipment is required for accurate calibration checking. All you need is a nearly full can of refrigerant and an accurate thermometer. The dial thermometer used for the Overall Performance Test is ideal for this purpose.

TAKE THE TEMPERATURE

Tape the dial thermometer to the can so the

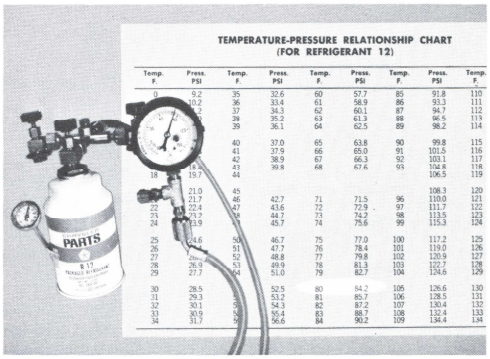


Fig. 9—Check pressure-temperature relationship

sensing element at the end of its stem is below the liquid level. Then, connect the refrigerant can to the hose of the gauge to be tested, and purge the air from the hose.

LET IT SETTLE DOWN

Set the whole rig aside somewhere overnight where the temperature is stable. In the morning, compare the thermometer and gauge readings against the Service Manual chart to check the accuracy of the gauge. Adjust the gauge pointer position if necessary, and then use the newly calibrated gauge as a master for checking the other two gauges.

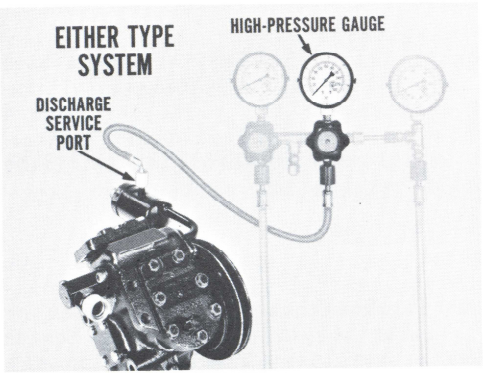


Fig. 10—Discharge pressure gauge connection

ONE'S THE SAME FOR ALL

It's easy to remember which gauge hose connects to what service port after you connect the gauge set a few times. To get the connections right, just remember that on either the clutch-cycling or the EPR type system, the high-pressure center gauge *always* connects to the discharge service port, which is located near the *front* of the compressor.

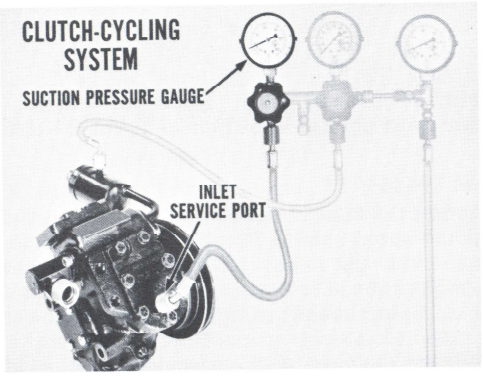


Fig. 11—Clutch-cycling system connections

ONLY ONE MORE HERE

The clutch-cycling system has only one other service port so you can't go wrong. All you do is connect the low-range suction pressure gauge at the left side of the set to the inlet service port on the compressor cylinder head.

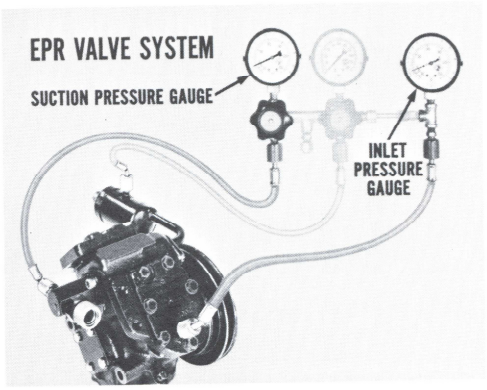


Fig. 12—EPR-valve system needs three connections

EPR SYSTEM HAS TWO

For the EPR valve system, you need *two* low-pressure gauges, so the connections are different. Here you connect the suction pressure gauge at the left side to the suction pressure service port at the *rear* of the compressor. The

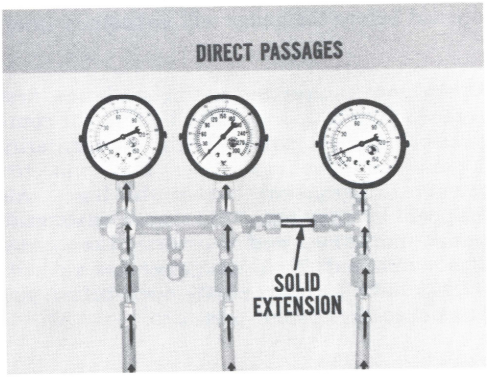


Fig. 13—Right-hand gauge is separate

inlet pressure gauge at the right side connects to the cylinder head inlet port.

THEY CONNECT DIRECTLY

The left side and center gauges have direct passages through the manifold so they can indicate pressure with the valves open or closed. The inlet pressure gauge at the right side connects directly to its hose. The solid extension from the manfold is only an attaching mount for the gauge.

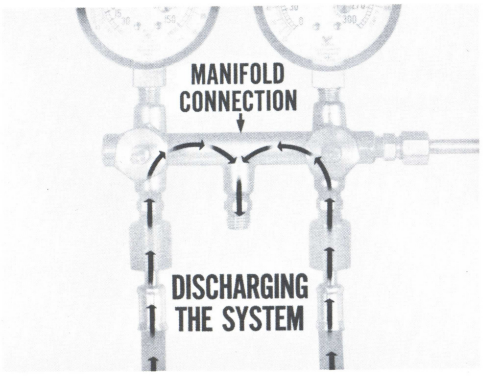


Fig. 14—Valves control flow through manifold

VALVES CONTROL FLOW

Actually, the valves only control the flow to and from the center manifold connection, which is used for charging or discharging the refrigeration system. Some gauge sets also have an adjustable needle valve in the discharge gauge line to slow down gauge pointer movement. This valve, of course, must be opened before the gauge will indicate.

LET OUT THE AIR

When you connect the testing set hoses, first screw on the couplings fingertight at the compressor service ports. Then, momentarily loosen the couplings under the connected gauges to purge air out of the hoses. Air trapped in the hoses can cause inaccurate gauge indications and may enter the system if not removed. If the gauge set has a needle valve, make sure it's partly open before you start checking system pressures.

ALLOW PRESSURE TO EQUALIZE

You begin testing with the engine shut off. Remember that system pressures gradually equalize and become static when the system is not operating, so test gauge pressures should read the same after the system stands long enough to stabilize.

LOW PRESSURE = LOW LEVEL

When you find that the static pressure of the stabilized system is lower than normal, as shown on the Temperature-Pressure Relationship Chart in the Service Manual, the refrigerant level is probably low. Zero pressure indicates an empty system, usually due to a leak. Obviously, the first step in this case is to repair the system so it will hold refrigerant.

SOME READ DIRECTLY

For testing convenience, some gauges have red-colored temperature markings in addition to the regular pressure graduations. The red and black markings indicate the temperature-pressure relationship directly so there's no need to consult a separate chart.

READ 'EM WHILE YOU WAIT

If the gauge readings show that the static pressures are okay, you can make a Preliminary Pressure Check while you warm up the engine and the system for the regular Service Manual Tests. In fact, if the discharge pressure comes up to at least 140, and the evaporator suction pressure is above 20, the system refrigerant level is probably okay, so you can skip directly to the Overall Performance Test.

TEST CHECKS AIR TEMPERATURE

The setup for the Overall Performance Test is essentially the same as for pressure tests, but we also check the temperature of the cooled air. With the gauges connected, you arrange the hoses so the hood can be closed without pinching them. Room air temperature must not be lower than 75°F. for the test.

SET THE STAGE

To test the system performance, set the engine at the speed specified in the Service Manual and close the hood. Then open all the car windows and air outlet grilles. The A/C button must be in, the heat control off, and the blower control set at high speed. Run the system for at least 5 minutes so the parts will be at operating temperature before you make the test.

CHECK THE COOL

Prepare the C-3704 Psychrometer for use and set it near the air inlet opening on the cowl. Inside the car, you insert the stem of a C-3623 Dial Thermometer all the way into the center air outlet, at the right side of the grille.

HOLD THE PRESSURE

Take the temperature readings with the system stabilized and the discharge pressure indication between 190 and 210. If the pressure is lower, you can raise it by temporarily blocking the condenser air flow. However, if the pressure is higher, cool the condenser with external floor fans.

Fig. 15—Compare psychrometer-thermometer readings

COMPARE THE TEMPERATURES

Write down the dry- and wet-bulb temperatures shown on the psychrometer, and do the same for the dial thermometer inside the car. Compare the figures against each other on the appropriate Performance-Temperature Chart in the Service Manual to determine if the system is operating properly.

TEST PROVES SYSTEM CAPACITY

If the Overall-Performance Test turns out okay, it saves the need for further testing. Satisfactory test results here also prove that the system is operating at full capacity when there's any question about cooling output during hot, humid weather. When system performance is below par, you can usually narrow down the cause of trouble by analyzing the pressure gauge indications.

PRESSURE TEST PREVIEW

To make a Preliminary Pressure Check before the regular tests, you leave the engine running at the same test speed as before, but remove the psychrometer and raise the hood. Also, you leave the windows open, and the controls set as in the Performance Test . . . the A/C button is in, the heat control off, and the blower on high.

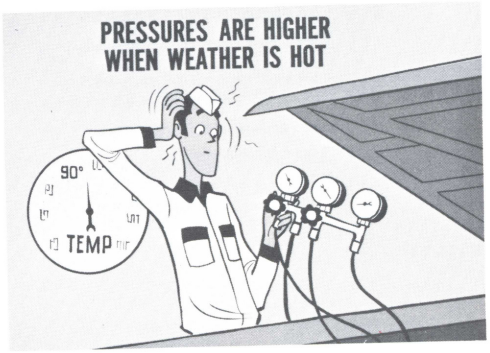


Fig. 16—Operating temperature affects indications

DON'T LET THE HEAT FOOL YOU

You'll notice that overall operating pressures are usually higher than average when the weather's hot. If there's any doubt about the pressures that should be expected with a system that is operating properly, check them out against a performance test. Simply note the stabilized pressures after you prove the system is okay with an overall performance test and use them as a guide for testing under average local conditions.

Pressure Indication Analysis

As a guideline for a Preliminary Pressure Check, we'll cover the reasons why the pressures can be higher or lower than normal, and then give the possible causes. These are, of course, general conclusions which must be verified by the regular Service Manual tests.

HIGH DISCHARGE PRESSURE

If discharge pressure on the center gauge is

REFRIGERATION SYSTEM TESTING

The preliminary pressure checks are intended to alert you to possible trouble causes and can be made while the system is warming up. When the system has stabilized, the next step is to make sure the refrigerant level is correct, so pressure-test indications will be reliable.

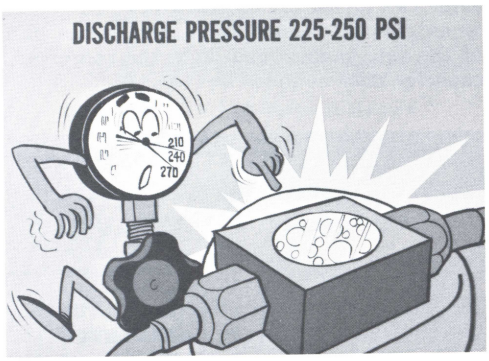


Fig. 23—Foam indicates low refrigerant level

FIRST CHECK THE LEVEL

To check the refrigerant level, you run the engine at the specified speed, and set the system controls as decribed for the Preliminary Pressure Check. In addition, you temporarily block the condenser air flow to raise refrigerant temperature and pressure. Do not attempt to make this check when the engine is idling because the results can be misleading.

RAISE THE PRESSURE

Blocking condenser air flow should raise the discharge pressure somewhere between 225 and 250 psi for testing. If foam shows in the receiver-drier sight glass at this pressure, the refrigerant level is low and must be corrected before making the remaining pressure tests.

MAKE IT FAST

The refrigerant level test should be made quickly to keep system pressures from climbing too high. Watch the discharge gauge pointer closely so you can unblock the condenser if the pressure goes above 250 psi. Too much pressure can damage the system, so whatever you do, don't forget and leave the condenser blocked.

TOO HIGH OR TOO LOW?

Refrigerant level can be too high as well as too low, and either condition will reduce air-conditioning system output. To correct the level in either case, some refrigerant is added to complete the level adjustment, so you leave the gauges connected and arrange a refrigerant source as for system charging.

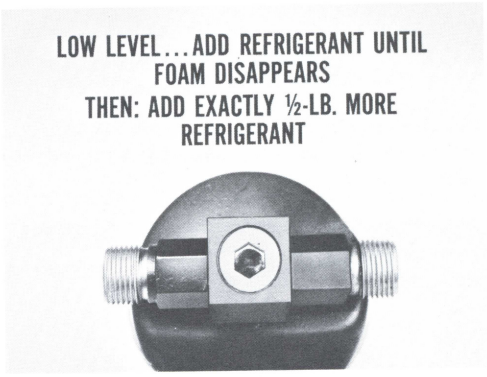


Fig. 24—Correcting low refrigerant level

STOP THE FOAM

To correct a *low* refrigerant level, you add refrigerant until foam disappears from the sight glass. Then you add exactly one-half pound more to get the correct level. The refrigerant must be fed into the system slowly because sudden addition of refrigerant can "slug" the compressor and damage its valves. Adjust the suction service valve on the manifold to meter the inward flow of refrigerant so the gauge reading does not go above 50 psi.

LET IT OUT SLOWLY

When refrigerant level is *high*, you first release excess refrigerant slowly through the manifold test hose until foam starts to appear in the sight glass. Then you connect the refrigerant source, purge the connecting hose at the manifold, and again add exactly one-half pound of refrigerant to correct the level.

DON'T LET IT LAY AROUND

Refrigerant gas is heavier than air and will collect in a layer on the floor, so be sure to release it into the building exhaust system or outdoors. If refrigerant is exposed to an open flame, it becomes poisonous, so get rid of it.

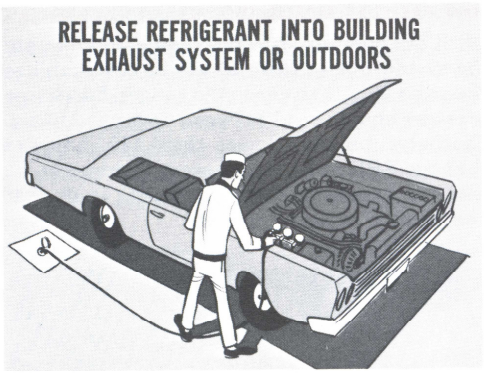


Fig. 25—Get rid of released refrigerant

TAKE IT EASY

When you release refrigerant from a car refrigeration system for any reason, do it slowly or you may lower the compressor oil level. If system pressure is released suddenly, the oil vaporizes and is carried out of the system by the escaping refrigerant.

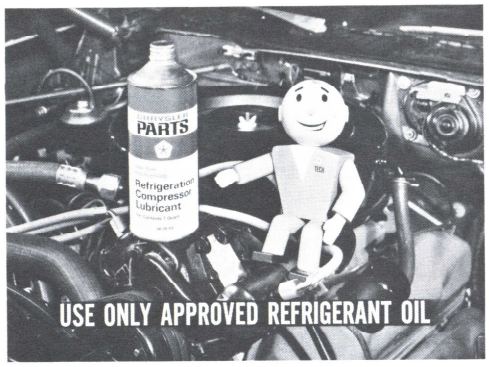


Fig. 26—Check oil level before recharging system

KEEP IT ON THE LEVEL

Be sure to check the compressor crankcase oil level before you charge an empty system after fixing a leak because low oil level will quickly ruin a compressor. And use only approved refrigerant oil to correct the crankcase level. Engine oil is not suitable and must never be used in a refrigeration system.

KEEP MOISTURE OUT

When a refrigeration system comes into the shop empty, or is left open for repairs more than 15 minutes under high-humidity conditions, you'll have to install a new receiver-drier. However, there's no need to disturb the unit if you only replace some other part and immediately vacuum and recharge the system. Always cap open fittings to keep dirt and other contaminants out of the system.

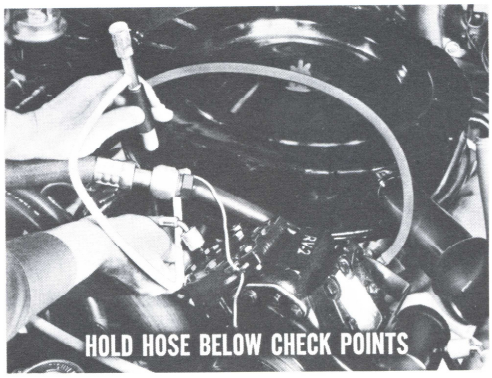


Fig. 27—Leaking refrigerant flows downward

LOOK FOR LEAKS

When the refrigerant level is okay, turn the engine off and check for leaks at all tube connections and other possible leak points. As you check for leaks, be sure to hold the sampling hose end or the detector probe directly below the check points because refrigerant is heavier than air and will flow downward from a leak point.

CONTINUE TESTING

If you find a leak, mark it and leave the repair wait until you check out the expansion valve, EPR valve and the compressor. Any leak you find in a system that holds pressure is probably a very slow one, so you can usually make accurate pressure tests before the refrigerant level drops too low.

VALVE TESTS ARE NEXT

After you make the refrigerant level and leak tests, you can move on to check the operation of the expansion valve, EPR valve, and compressor. Room temperature must be at least 75°F. for accurate checking. If the temperature is lower, the pressure test indications can be misleading.

SET UP THE TEST

For the valve and compressor test, you begin by adjusting engine speed as specified in the Service Manual. Set the controls for maximum air conditioning and high-blower speed. Also move the temperature control lever to full-heat position and close the car doors and windows.

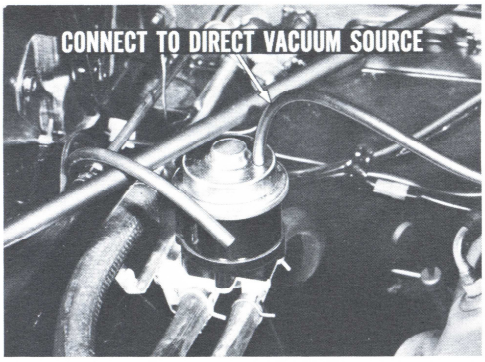


Fig. 28—Check for vacuum at detached hose

YOU MAY NEED VACUUM

On some of our 69's with EPR valve systems, the vacuum-actuated water flow valve does not open when the MAX A/C button is pushed in. Where there is no vacuum at the vacuum hose when the control button is in, you'll have to connect the water valve to a direct vacuum source to open it for the EPR and expansion valve tests.

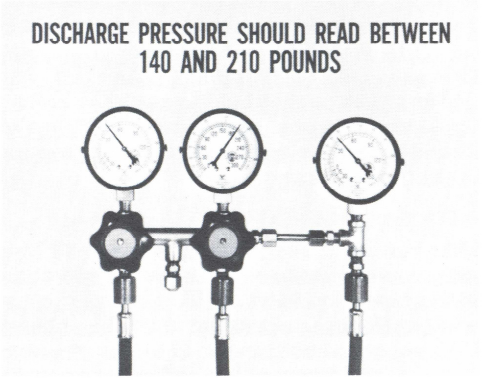


Fig. 29—Normal average discharge pressure

LOW PRESSURE MEANS TROUBLE

With the hood up, run the engine and operate the system for at least 10 minutes to stabilize the parts, and then check the gauges. Discharge pressure should read between 140 and 210 psi. Discharge pressure lower than 140 indicates that the EPR valve does not open properly . . . that the expansion valve is closed . . . or that compressor capacity is low.

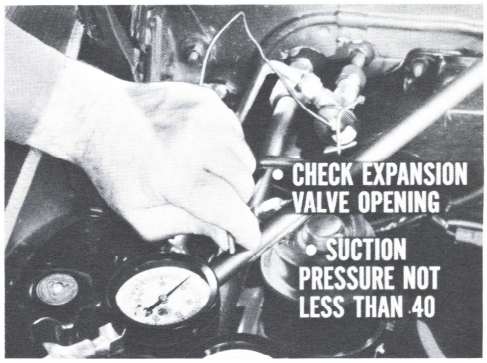


Fig. 30—Test for expansion valve opening

OPEN THE EXPANSION VALVE

To find the cause of low discharge pressure, you first check the expansion valve for proper opening by warming its thermal bulb in your hand. With the expansion valve open, the suction pressure reading should not be less than 40 psi. Low pressure here points to a faulty expansion valve.

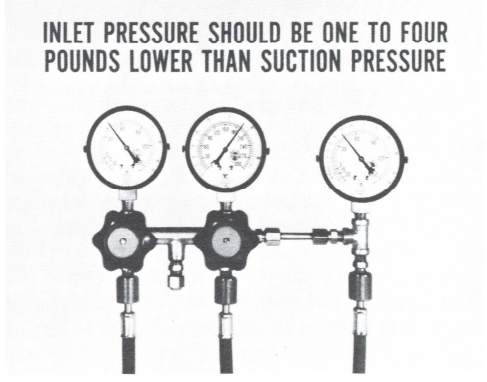


Fig. 31—Test for EPR-valve opening

LARGE DROP IS BAD NEWS

Assuming that the expansion valve opens, you then read compressor inlet pressure to check the EPR valve for proper opening. If the valve works properly, inlet pressure should read between one and four pounds lower than suction pressure. More than a four-pound pressure drop calls for a new EPR valve.

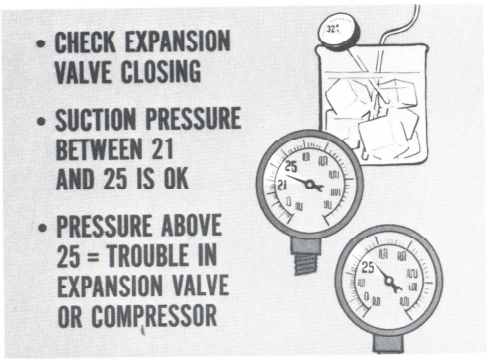


Fig. 32—Test for expansion valve closing

CLOSE THE VALVE BY COOLING

After checking both valves for proper opening, we then check the expansion valve for closing by immersing five inches of its thermal bulb in a container of ice and water at 32°. When the valve closes, a suction pressure between 21 and 25 psi is okay. If the pressure stays above 25, the trouble may be either in the expansion valve or in the compressor.

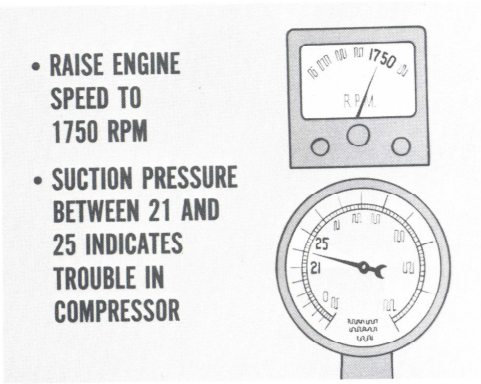


Fig. 33—Test for compressor output

EXPANSION VALVE OR COMPRESSOR?

To isolate the cause of high suction pressure at the expansion valve or in the compressor, raise the engine speed to 1750 r.p.m. and recheck the gauge indication. If the suction pressure is now between 21 and 25 psi, it indicates that the trouble is in the compressor.

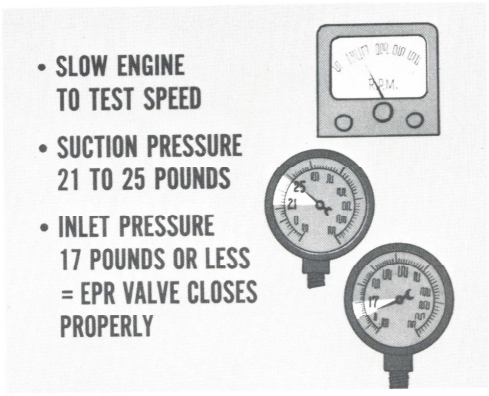


Fig. 34—Test for EPR-valve closing

LOOK AT THE INLET GAUGE

Finally, you complete the test by checking the EPR valve for proper closing. Keep the thermal bulb in the ice water and slow the engine to the original test speed. With the suction gauge indication between 21 and 25 psi, inlet pressure should be at 17 psi or less if the EPR valve closes properly.

ONE AFTER THE OTHER

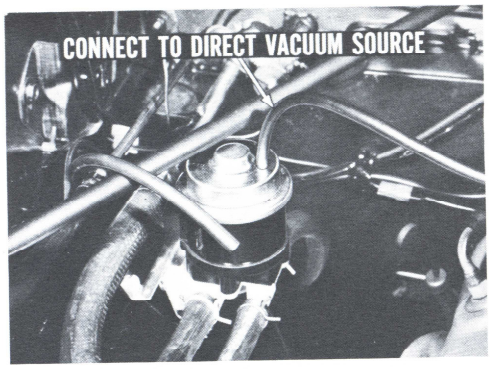
This completes the system tests as they are recommended for the EPR valve-type system. These tests must be performed in the sequence given above so you can separate the operating effects of the expansion valve, the EPR valve, and the compressor.

SOME SYSTEMS ARE SIMPLER

Since there is no EPR valve in the clutch-cycling systems, all you need are the tests for the expansion valve and the compressor. When you make these tests, you'll have to connect the compressor clutch lead directly with a jumper. This keeps normal clutch-cycling from interfering with the tests.

SET UP THE TEST

For the valve and compressor test, you begin by adjusting engine speed as specified in the Service Manual. Set the controls for maximum air conditioning and high-blower speed. Also move the temperature control lever to full-heat position and close the car doors and windows.



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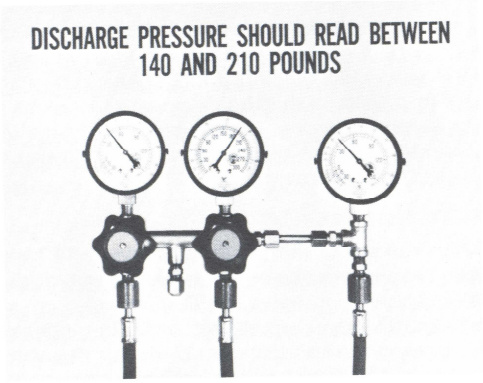

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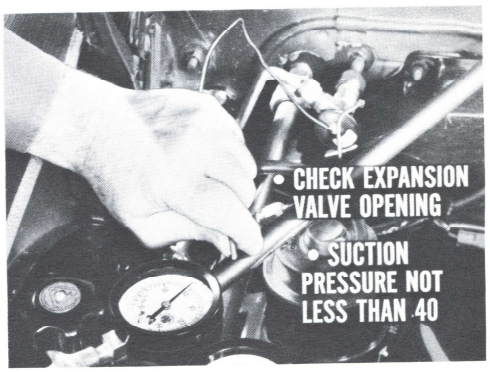

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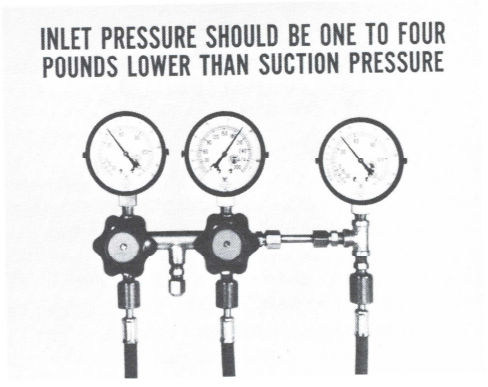

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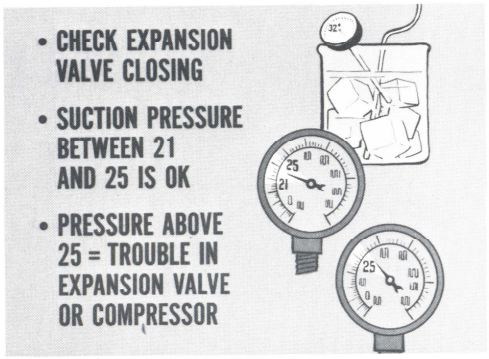

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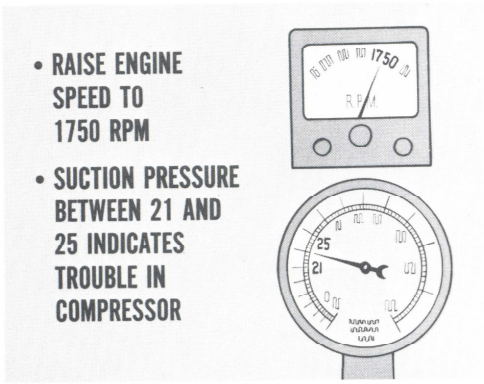

Fig. 33—Test for compressor output

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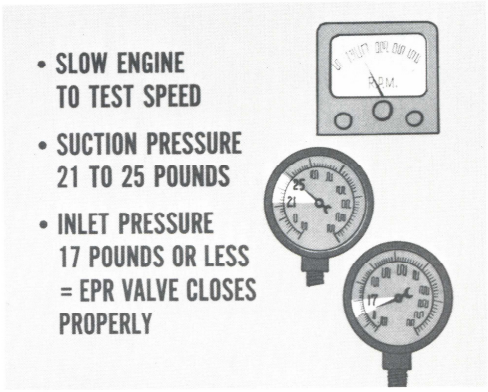

Fig. 34—Test for EPR-valve closing

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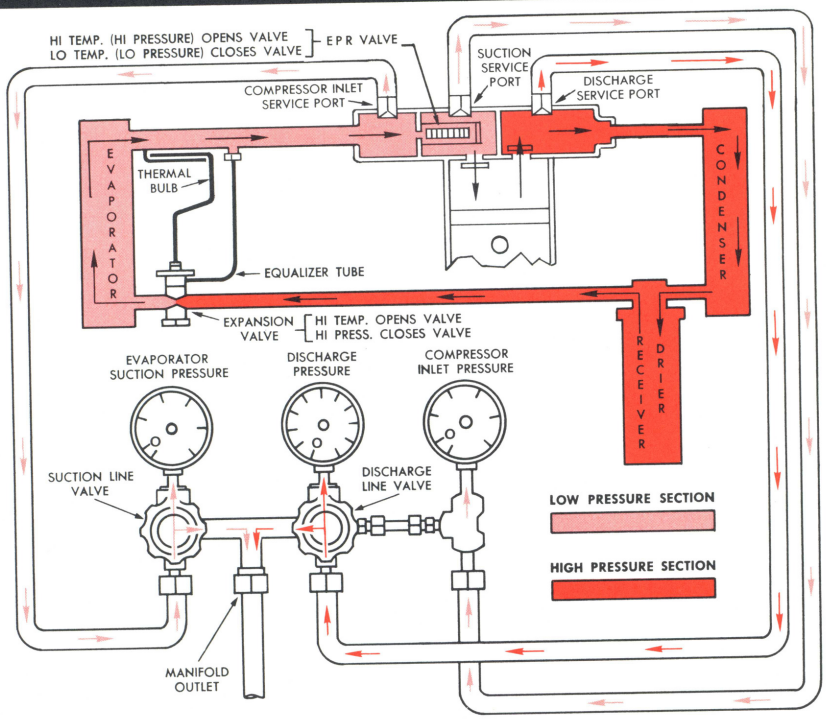
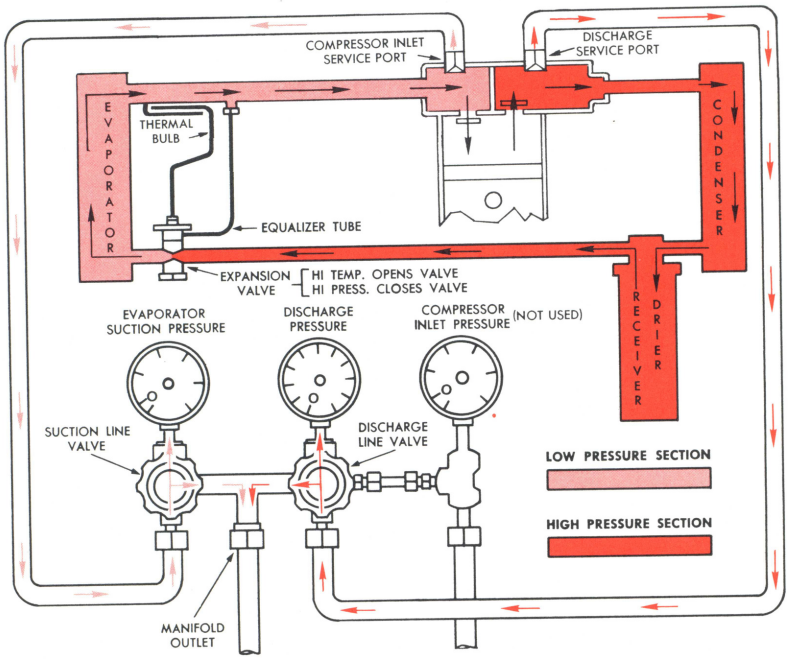
EPR-VALVE SYSTEM PRESSURE-TEST DIAGRAM



CLUTCH-CYCLING SYSTEM PRESSURE-TEST DIAGRAM



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