SHOP TIPS

Autolite Ford

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Technical parts and service information published by the Autolite-Ford Parts Division and distributed by Ford and Lincoln-Mercury dealers to assist servicemen in Service Stations, Independent Garages and Fleets.

ALL ABOUT AIR CONDITIONING OPERATION, DIAGNOSIS AND TESTING PLUS . . . EXCITING OPPORTUNITY TO GET IN ON THE NEW "MUSCLE PARTS" PROGRAM!

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AIR CONDITIONING . . .

IN THIS ISSUE

Be sure and file this and future bulletins for ready reference. If you have any suggestions for additional information that you would like to see included in this publication, please write to: Autolite-Ford Parts Division of Ford Motor Company, Merchandising Services Dept., P.O. Box 3000, Livonia, Michigan 48151.

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VOL. 69 MSD 64 LITHO IN U.S.A.

INTRODUCTION

It may come as a surprise that more than 30% of today's new car buyers order factory-installed air-conditioners. In the southern states this percentage can rise as high as 90%! Combined with the increasing availability and popularity of the many "hang-on" units now on the market, this volume of specialized equipment dictates that you be prepared to service units brought to you by your customers. Every technician should at least be able to *diagnose* trouble, in order to route the unit to the best source for repair.

You can save your customers time and trouble during the summer months by learning about air conditioning *now!* This article will acquaint you with some fundamentals to help you explain air conditioning service to your customers, and will help you diagnose and test air conditioning systems . . . whether they are simple hang-on units or the more sophisticated "integral-with-heater" types.

AIR CONDITIONING PRINCIPLES

WHAT IS "CONDITIONED" AIR?

Conditioned air—as the term is used here—is air that has been cooled and partially dehumidified. To cool the air, the air-conditioner simply removes the heat from it... since cold is the absence of heat.

HEAT AND STATES OF MATTER

All substances exist as one of the three natural forms of matter; solid, liquid, or gas. The specific form depends on the amount of heat contained by the substance. A familiar example of this is water. When it contains very little heat (below 32° F.) it is a solid—ice. As heat is absorbed (above 32° F. but below 212° F.) it changes to a liquid. As the absorbed heat raises the temperature to 212° F., the liquid changes to a gas—steam.

When water changes from one form to another, i.e., solid to liquid, it absorbs great quantities of heat. This, of course, was the principle of the old-fashioned icebox, in which a block of ice cooled the food until the heat changed all the ice to water. The heat needed to change the state of a substance is called *latent* or *hidden* heat.

Operation, Diagnosis and Testing

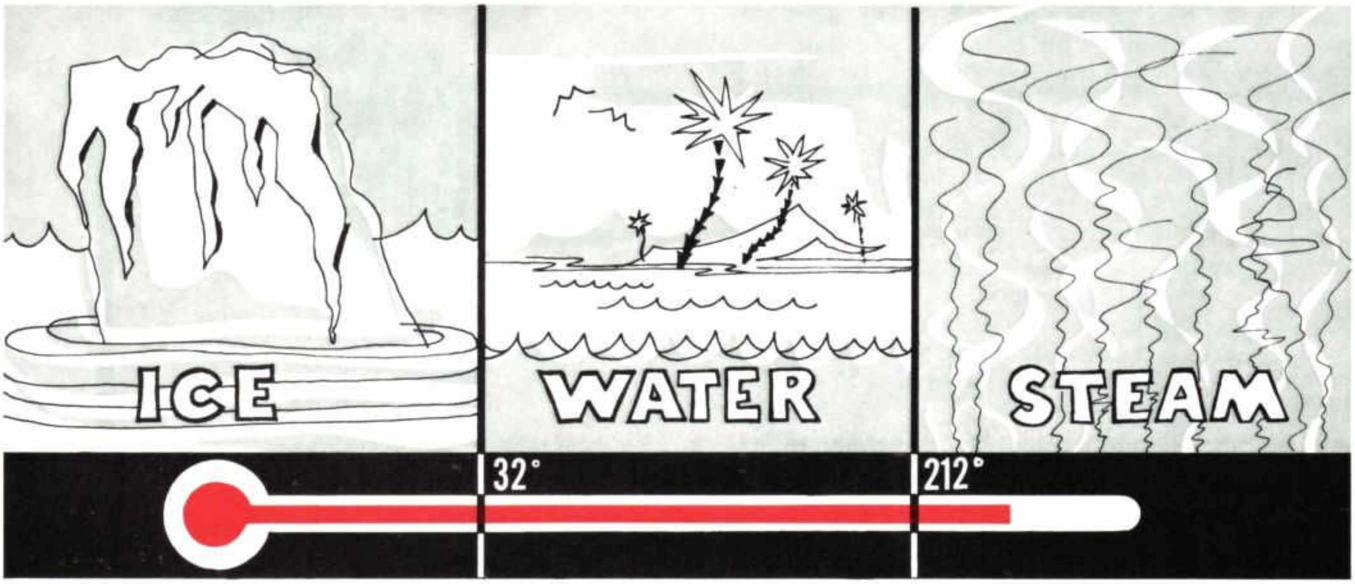


Figure 1—States of Water

LATENT HEAT

To illustrate latent heat, observe what happens when we put a thermometer into a beaker of water, and begin to add heat. If the beaker is at sea level where the normal atmospheric pressure is 14.7 psi, the temperature of the water will begin to rise *in direct relationship to the amount of heat that is applied*. This relationship is directly measurable with a thermometer. When the temperature reaches 212°, however, and begins to boil or vaporize (change state), the temperature of the water stabilizes at 212° F. NO MATTER HOW MUCH HEAT IS ADDED AFTER THE WATER REACHES 212° F., THE TEMPERATURE WILL RISE NO FURTHER (Fig. 2).

The temperature of the water remains constant because the *additional* heat is absorbed to change the water from a liquid to a gas. This absorbed heat cannot be measured in terms of temperature, and is therefore called latent or hidden heat. It is the basis for all refrigeration systems.

TEMPERATURE-PRESSURE RELATIONSHIPS

The latent heat discussion was based on boiling water in an *open* container. If we cover the container (Fig. 3) so that the steam cannot escape, we discover a fact which is the key to understanding air conditioning. As more and more vapor is released, with no room to expand, pressure above the liquid *increases*.

As the pressure increases, we find that the temperature of the liquid also increases. The same thermometer that registered a constant 212° when the container was open will now register 2½ to 3 degrees higher for each psi of pressure rise in the trapped steam. In other words, we raise the boiling point of the liquid by raising the pressure of the steam.

This, of course, is the principle behind the pressurized cooling system. By using a pressurized radiator cap, the water can be heated far above 212° F. without boiling the coolant. A sudden lowering of this pressure will cause the liquid to boil—as anyone who has inadvertently removed the radiator cap from a hot system will attest.

A similar thing happens in the air conditioning system, but under controlled conditions. A liquid refrigerant under high pressure (and at temperatures above its boiling point) is carefully metered into an area of low pressure, causing the refrigerant to boil (and take on heat) within a cooling unit called an *evaporator*. The evaporator is finned, so that it can pull heat from the surrounding air, thus cooling the air.

Figure 2—Latent Heat

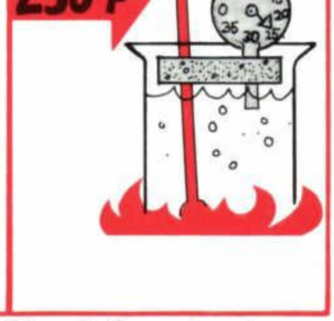
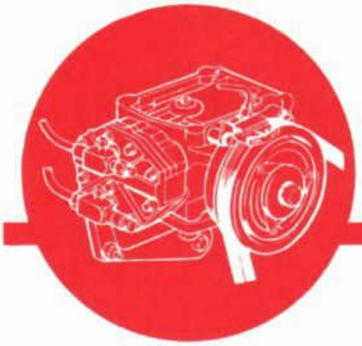


Figure 3—Temperature-Pressure Relationship



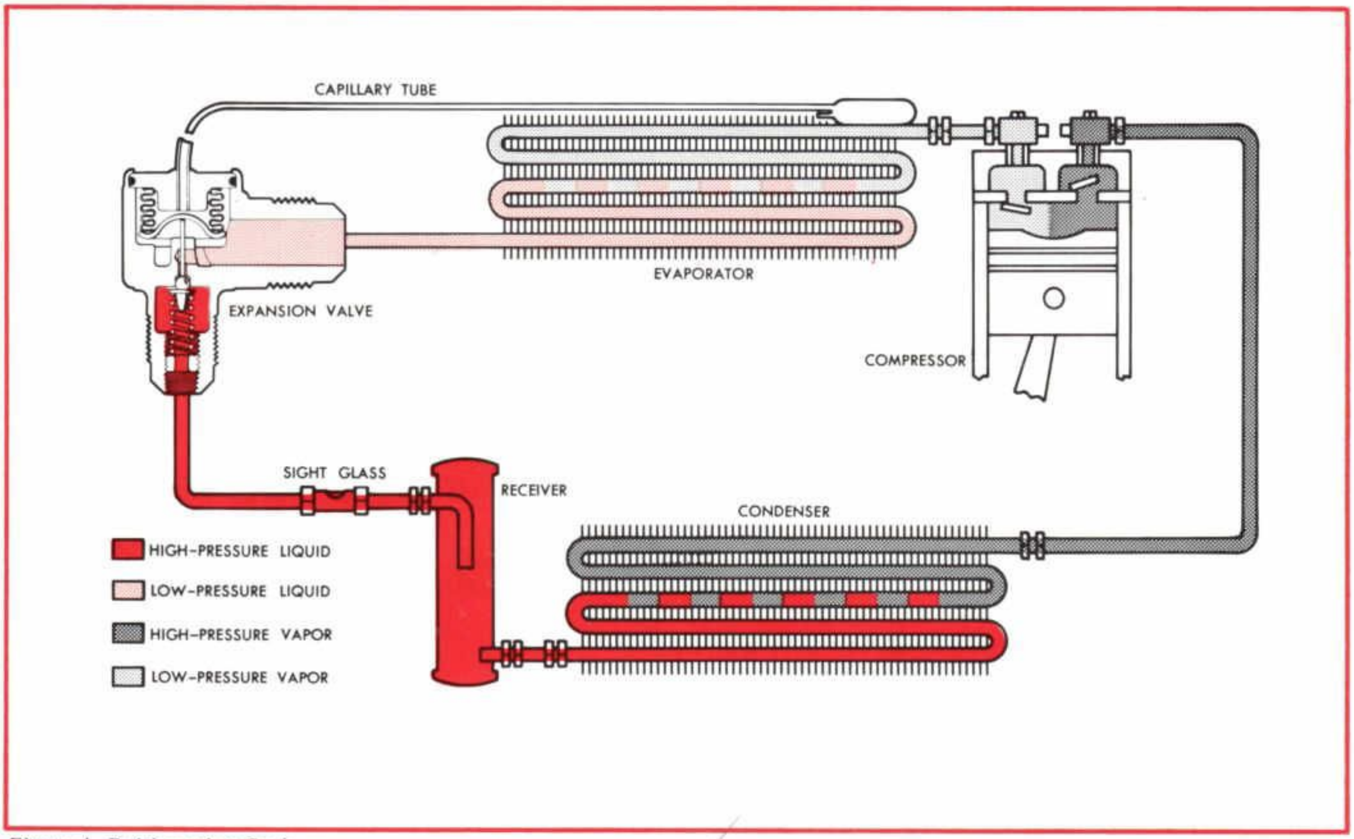


Figure 4–Refrigeration Cycle

REFRIGERANT SELECTION

Each substance has two points on the thermometer where it can absorb great quantities of heat. Water, for example, absorbs latent heat at 32° F., where it changes from a solid to a liquid, and at 212° F., where it changes from a liquid to a gas. A solid refrigerant–such as ice–is not practical because of recycling problems. So, the first requirement of the refrigerant is that it be a liquid. The second important point to be considered is that the refrigerant can only absorb heat quickly if its boiling point is *lower* than the heat available from the surrounding air. Since we wish to lower the temperature of the passenger compartment of the car to the human comfort zone of approximately 70° to 80° F., the boiling point must be lower than this range.

Within this temperature range, all substances that exist normally as a liquid at atmospheric pressure are automatically eliminated. However, *Freon*–which exists normally as a gas–has a boiling point well below this range (−21.7° F.), and more than meets our requirements. If we use it in a closed, pressurized system, it can be changed from a liquid to a gas and back again by expansion and compression–straight mechanical principles. This gas, when used in an air conditioning system, is known as "Refrigerant-12," and will be called that in this article.

REFRIGERATION CYCLE

The typical automobile air-conditioner has two "sides"–the expansion side, where the Refrigerant-12 expands and takes on heat; and the compression side, where the gas is pressurized again and the heat is taken out. Air to the passenger compartment goes through the expansion side (evaporator) and outside air flows across the compression side (condenser). In between, the compressor (driven by the engine) forces the gas back into a high-pressure environment,where it changes back into a liquid as the heat is removed from it.

EVAPORATOR

The evaporator is usually located within the passenger compartment, either as a separate unit, or as an integral part of the heating-air conditioning system. On trucks it is located outside on the cab roof. It acts as a heat exchanger to transfer heat from the air in the passenger compartment to the vaporizing refrigerant. Several coils of copper tubing pass through many, closely spaced aluminum fins (Fig. 4). When liquid refrigerant is metered into the evaporator under low pressure (about 1/9 the high pressure) the refrigerant boils and absorbs great quantities of heat from the copper tubing and aluminum fins. An airstream, produced by a blower, is directed over the fins and tubes.This air is warmer than the evaporator and gives up

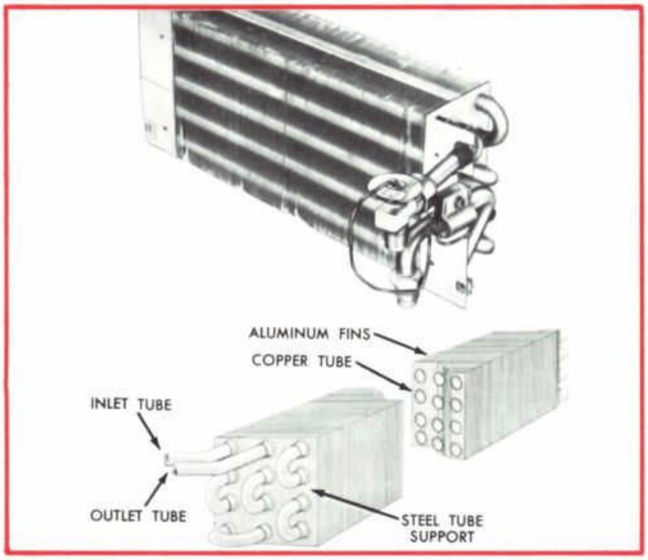


Figure 5—Typical Evaporator

its heat to the fins, tubes, and finally to the refrigerant. The air on its way to the passenger compartment is cooled. Because cooler air cannot contain as much moisture as hotter air, water vapor from the cooled air condenses on the fins and tubes. A water-collecting pan with a drain hole and drain tube in the housing under the evaporator gets rid of the condensed moisture. This is why a pool of water sometimes collects under an air-conditioned car when the system is in operation.

If the temperature of the evaporator is allowed to go below 32° F. (the freezing point of the condensed water), the ice thus formed will block the flow of air. For this reason, each air conditioning system is pressurized to a point where the boiling point of the Refrigerant-12 is raised (as in Fig. 5) to above 32° F. Pressure in the system is regulated by a sensor which reads evaporator temperature, never allowing the pressure to fall low enough to freeze the water. This control is exerted by regulating the compressor for the proper pressure.

COMPRESSOR

Ford-built vehicles use a two-cylinder reciprocating compressor (Fig. 6). It is mounted at the front of the engine, and is belt-driven. The compressor pulley is integral with an electric clutch (Fig. 7) which connects and disconnects the compressor from the engine.

With the air conditioning system off, the magnetic clutch is disengaged from the compressor and the compressor pulley freewheels on its shaft. Turning the A/C system on energizes the clutch, which in turn causes the compressor to begin turning. On the downward stroke of the piston, a vacuum is created in the cylinder.

This vacuum causes the refrigerant to be drawn through the intake valve of the compressor, and creates the low-pressure condition in the evaporator. For this reason, the intake valve is often referred to as the "suction" valve. This side of the compressor is also called the "low-pressure" side. On the upward stroke, the piston compresses the vapor, thereby increasing its temperature and pressure. The vapor is forced past the outlet valve. *This* valve is sometimes called the "discharge" valve,

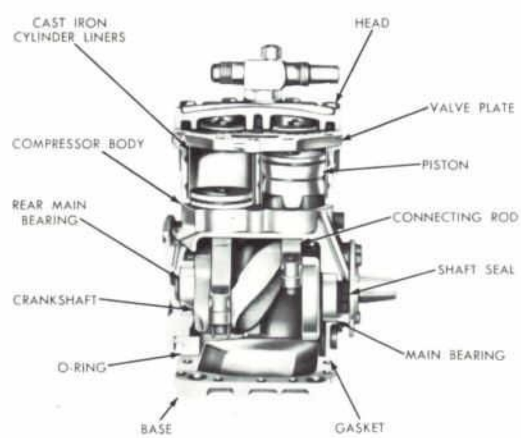


Figure 6—Typical Piston-type Compressor

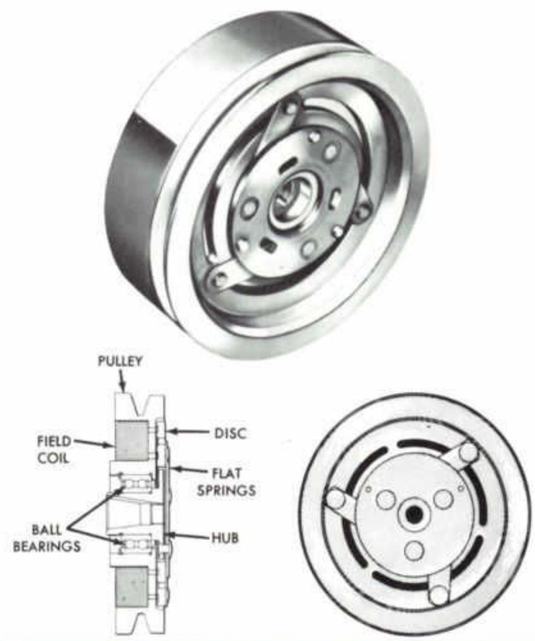


Figure 7—Typical Magnetic Clutch

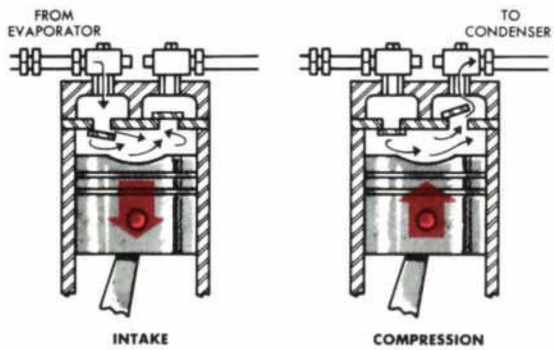


Figure 8–Compressor Action

and this side of the compressor is referred to as the "high-pressure" side. The compressor is lubricated by vaporized oil which moves along with the refrigerant.

From the compressor the hot, pressurized vapor flows to the *condenser.*

CONDENSER

The condenser (Fig. 9) also acts as a heat exchanger, in much the same manner as the evaporator, so its construction is much the same.

Figure 9–Typical Condenser

The function of the condenser, however, is the reverse of the evaporator. It removes the heat that was absorbed in the evaporator so that the refrigerant condenses back to a liquid. The condenser is usually mounted in front of the radiator to take advantage of the high-speed air flow. This tends to reduce air flow through the radiator, and pre-heats the radiator-cooling air. For these reasons, a higher capacity radiator and cooling fan are usually part of the air conditioning package.

The air around the condenser is much cooler than the hot, pressurized refrigerant vapor. The vapor enters at the top of the condenser, and cools as it goes through the coils. As it gives up heat to the surrounding air, the vapor condenses back to a liquid. The liquid refrigerant then flows into the receiver-dehydrator.

RECEIVER-DEHYDRATOR

The receiver-dehydrator (Fig. 10) stores the liquid refrigerant and removes moisture which could cause freezing within the system. The amount of refrigerant stored is greater than that needed for normal operation. Thus, small refrigerant losses will not affect operation of the air-conditioner.

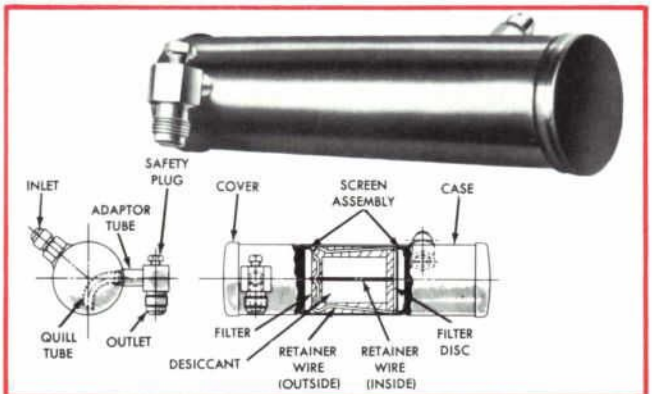


Figure 10–Receiver-Dehydrator

The dehydrator or dryer portion consists of two screens, filter discs, and a drying agent. In most systems, the drying agent is calcium sulphate.

A fusible plug, designed to open the system if temperatures rise above 232° F., is incorporated into all receiver-dehydrator assemblies. This vents the system if the temperature rises above what is considered a "safe" storage factor.

SIGHT GLASS

A sight glass, which permits inspection of the refrigerant, is installed in the high-pressure line between the receiver and expansion valve, or in the expansion valve itself. Bubbles–or foaming–in the sight glass indicate that refrigerant is low. Some bubbling is normal, when the system is first started, but a solid stream of refrigerant should show in the glass after a minute or so of operation.

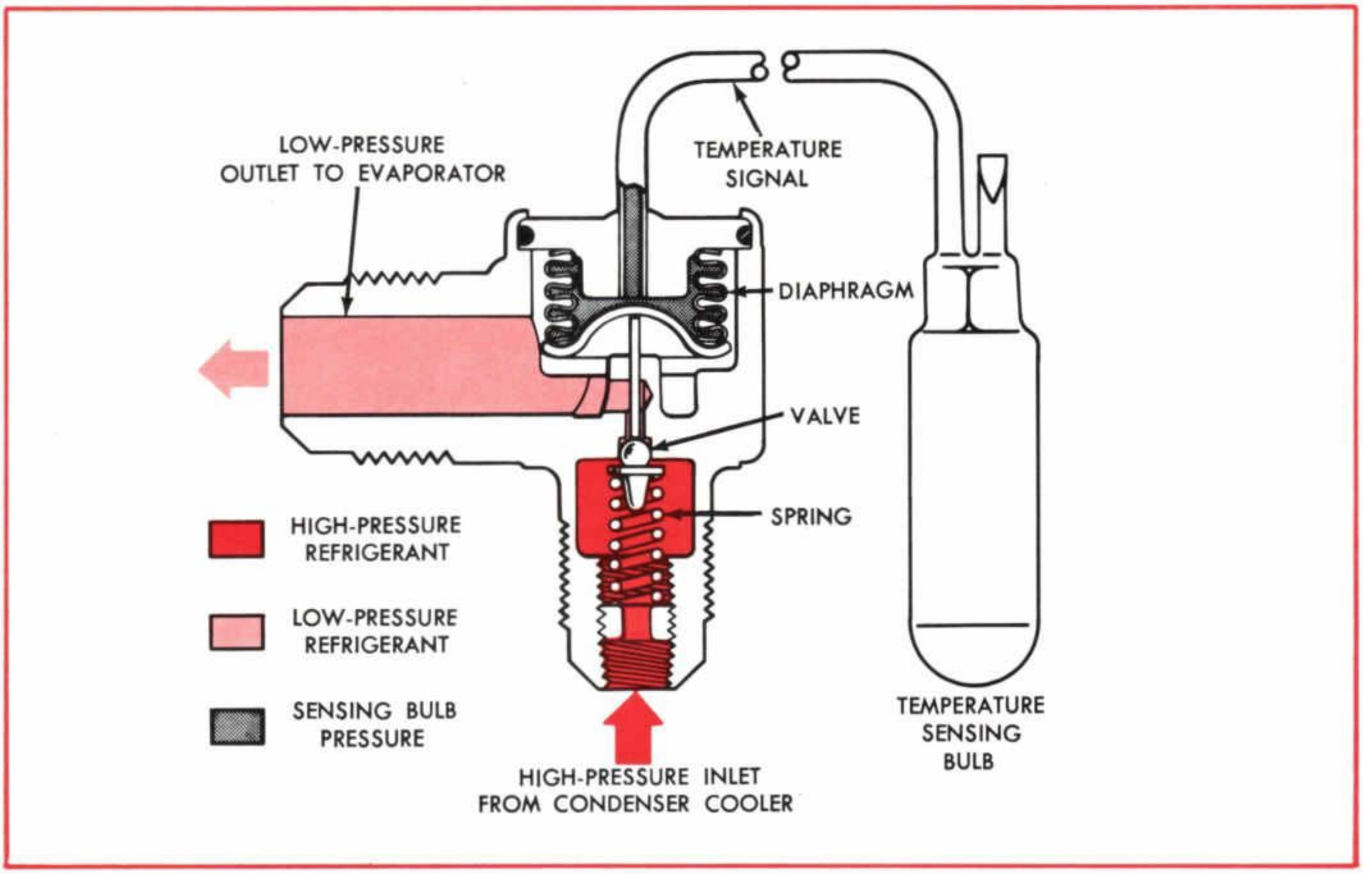


Figure 11—Expansion Valve and Temperature Sensing Bulb

EXPANSION VALVE

The expansion valve meters liquid refrigerant under high pressure into the low-pressure area of the evaporator (See Fig. 11).

For maximum cooling, the flow of liquid refrigerant must be precisely controlled so that all the liquid metered into the evaporator is vaporized. This assures vaporization is achieved throughout the entire unit, and makes for maximum cooling. To prevent excessive refrigerant from entering and remaining in the evaporator, there is a temperature-controlled diaphragm which controls the metering valve. The temperature sensing bulb is located next to the evaporator and is filled with Refrigerant-12 or with carbon dioxide gas. As the temperature around the sensing tube increases, the pressure on the gas within the tube increases. This is the signal that *not enough* refrigerant is being metered to the evaporator. This gas pressure pushes against the diaphragm and opposes the forces tending to hold the valve closed (spring pressure and high-pressure liquid refrigerant). When these pressures are overcome by the temperature-sensing tube pressures, the diaphragm moves down and opens the valve to meter refrigerant. This cools the evaporator, which cools the temperature-sensing tube. This results in less pressure within the tube and on the diaphragm, so the diaphragm moves up and closes the ball check valve. In actual practice, the valve is never completely closed when the air conditioner is operating because the cycle is repeated over and over again in a sort of "jiggle-pin" fashion.

DIAGNOSIS OF MALFUNCTIONS

An air conditioning malfunction most often results in (1) insufficient, erratic, or no cooling; (2) lack of cooling control; (3) noisy operation. The specific cause is usually found in the refrigeration system, compressor and magnetic clutch system, or the door operation of the air distribution system. Before inspecting for the specific cause, however, *every* technician should be aware of and practice the safety precautions listed on page 8.

AIR CONDITIONING . . .

SAFETY PRECAUTIONS

Refrigerant-12 is used in all Ford air conditioning systems because it is *nearly* an ideal refrigerant. It operates at low pressure and condenses easily in the temperature ranges encountered in automotive condensers, and is:

- odorless
- colorless
- tasteless
- non-corrosive
- non-toxic
- non-inflammable

This makes it a relatively safe refrigerant. However, it is used under pressure, and its low boiling point (−21.7°F.) combined with its chemical change when exposed to flame requires certain handling precautions for personnel safety.

Don't Spill or Touch Liquid

Liquid Refrigerant-12 vaporizes so quickly, and takes on so much latent heat in the process, that even a drop on your skin will cause severe frostbite. Open fittings very slowly to release pressure carefully. Operate all testing and service valves according to instructions. When charging the system, let the refrigerant enter as a vapor; don't try to *pour* it in. If skin areas are exposed to liquid refrigerant, treat as you would for frostbite.

Wear Safety Goggles

Always wear safety goggles when servicing the air conditioning system. Liquid refrigerant in your eyes could cause blindness. If liquid refrigerant should get in your eyes, rinse them immediately with mineral oil to absorb the refrigerant. Follow by flooding with a weak solution of boric acid and consult a physician immediately.

Avoid Heat

Pressure in a refrigerant container or in the system will rise with heat. The refrigerant should never be heated unnecessarily. Store containers upright, out of the sun, and away from building heat outlets. Always discharge the refrigerant from the system if the car is going into a paint oven; or if welding or steam cleaning are to be done near the system. Also watch the temperature and pressure when testing the system. Direct a fan on the condenser through the radiator grille to avoid overheating, and make sure the car's cooling system is filled and operating properly.

It is common practice to put a refrigerant bottle in a pan of warm water to raise the pressure and thus speed charging of the system . . . but NEVER, EVER use a blow torch to make it happen faster. It may happen so fast that the resulting pressure rise will destroy the container in an explosion.

Ventilation

Adequate ventilation is essential for several reasons. Though Refrigerant-12 is non-toxic, too much in a confined space can be suffocating as it doesn't contain the oxygen we need to breathe. Also, the presence of too much Refrigerant-12 in the air around the vehicle will make leak-detection almost impossible. Therefore, always discharge the refrigeration system into an exhaust fan or through an open window or door.

Avoid Flame

At all normal temperatures, Refrigerant-12 is non-toxic. When in contact with an open flame, however, it forms phosgene gas . . . a well known fumigator and highly toxic poison. Never discharge a system near an open flame. When a flame torch is used to detect leaks, don't breathe the fumes.

TESTS

Operating Conditions

All operational tests of the system should be made with the engine operating at between 1000 and 1500 rpm. Cooling controls should be set in the maximum cooling or "recirculating" position. The blower should be set at its highest speed. The system should be allowed to stabilize for at least 10 minutes.

AIR TEMPERATURE of the discharge air should be checked by holding any good thermometer in the cooling outlets. This will give you a fast, accurate indication of how efficiently the refrigeration system is operating. The discharge temperature should be 68° F., or less, in a 100° F. atmosphere, and should decrease to 58° F., or less, when the surrounding air is 80° F. If you're making the test indoors, make sure you use the shop temperature for reference, and not the outdoor temperature.

HUMIDITY has an adverse effect on air-conditioner efficiency. That's because part of the cooling capacity is used to convert the moisture in the air back to a liquid (latent heat again). In extremely humid weather, the discharge temperature will not be as high as it will be in extremely dry weather.

AIR VOLUME should be checked by holding your hand in front of the register outlets, with the blower control set to its highest position. Compare the air volume with a known good unit. If the volume is low, a leak or mispositioning of one of the distribution doors probably exists.

SIGHT GLASS CHECK

If the discharge air temperature leads you to believe that the refrigeration system could be operating more efficiently, check

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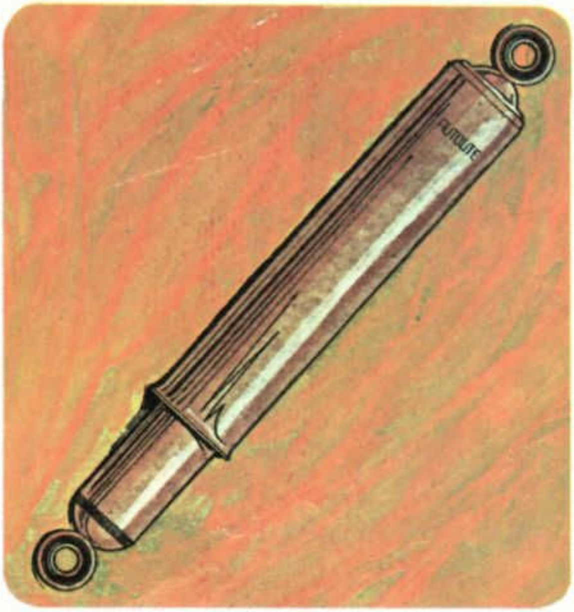

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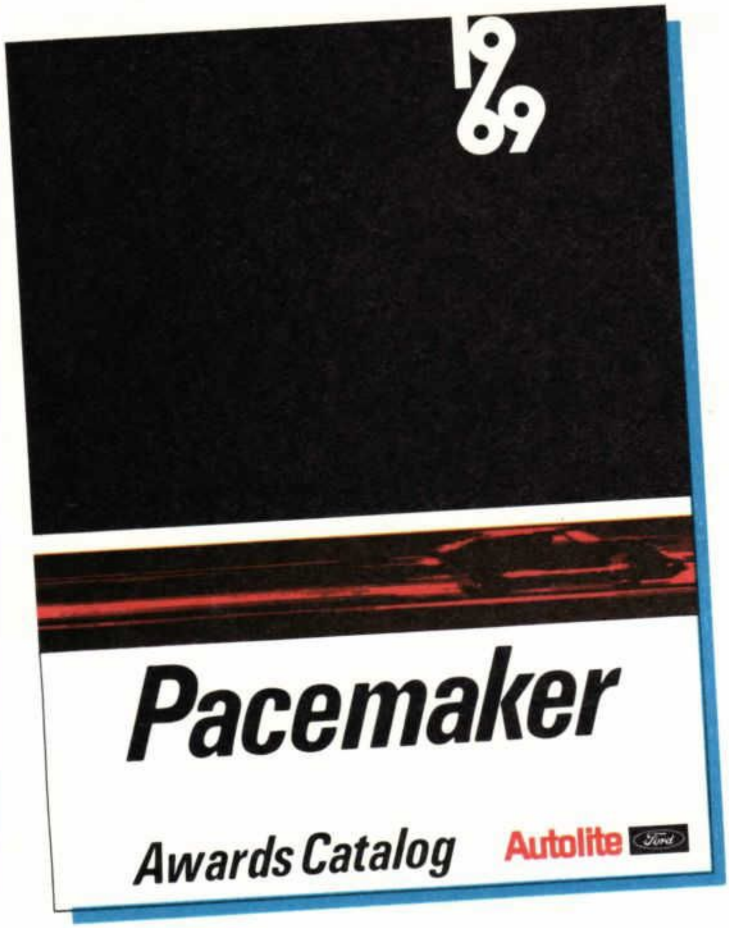

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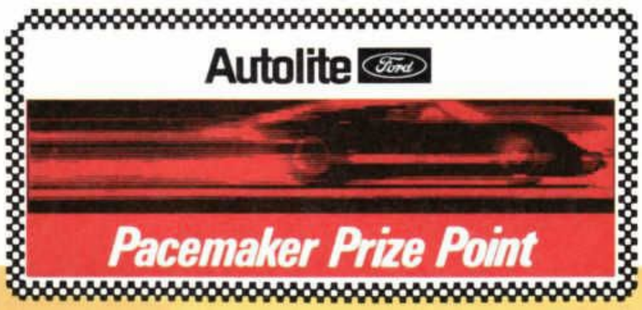

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the sight glass. Continuous bubbles or foam in the sight glass (Fig. 12) indicate that the system has lost some of its charge; that is, that some of the refrigerant has leaked out. Some bubbling is normal, remember, when the unit is first turned on. However, if the system has a full charge there should be a solid stream of clear refrigerant, with perhaps an occasional bubble at very high temperatures.

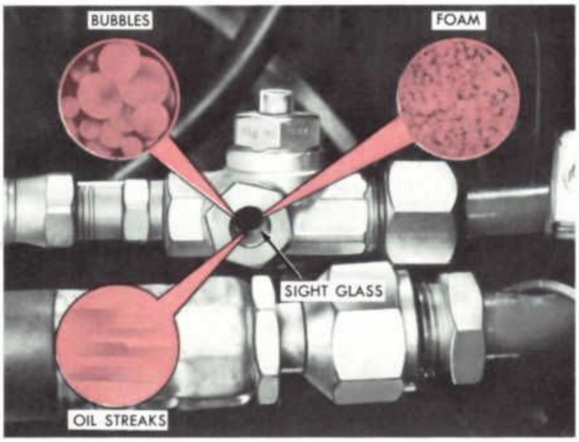


Figure 12–Sight Glass

CYCLE THE CLUTCH–Since the refrigerant is clear, it is possible to mistake a completely discharged system for one that is fully charged. To make sure you are reading the indications properly, turn the cooling knob to the "off" position. If there is refrigerant in the system, you'll see bubbles during the off-cycle. The bubbles should disappear and the sight glass become clear again during the on-cycle.

LOOK FOR COMPRESSOR OIL–Another trouble indication is the presence of oil in the sight glass. It may appear in streaks, or as a constant flow. Either way, it indicates that part of the charge has been lost.

DON'T PARTIAL CHARGE–Simply recharging the system to get a good sight glass reading is not recommended for two reasons. First, a lost charge means that a leak exists in the system. If not repaired, the leak will cause the charge to be lost again. Second, a partially-charged system is easy to overcharge, since you don't know how much refrigerant will fill it to the recommended weight. Overcharging can cause extensive damage to the system. So, in any instance where the system is undercharged, overcharged, or has air in it, perform a leak test, discharge the system, and recharge to the specified refrigerant weight.

"SLUGGING" NOISES – Sometimes a "slugging" noise, which sounds like engine pre-ignition, may be heard in the refrigeration system. It's caused by a faulty operation of the expansion valve. If you hear the noise, check the contact between the expansion valve's sensing bulb and the evaporator tube.

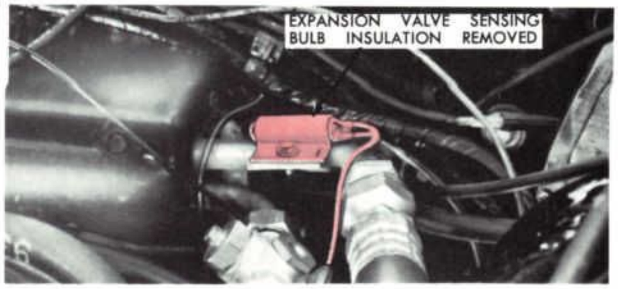


Figure 13–Checking Expansion Valve Bulb Contact

The surface must be clean and corrosion-free, and the bulb must be clamped tightly in the tube. If the bulb is properly clamped and the "slugging" noise doesn't stop, the expansion valve should probably be replaced. NOTE: Some slugging can occur in a normally operating system. If the noise is not extreme, it will not harm the system.

Condenser Checks

Anything that restricts air flow through the condenser can reduce the efficiency of the refrigeration system. The air flow should be unobstructed by dust, leaves, paper, dried mud, or bug screens to avoid high pressures and provide maximum heat transfer. If necessary, clean with a stiff brush and compressed air.

Refrigerant Lines and Service Valve Checks

REFRIGERANT LINES should be visually checked for proper positioning of clamps and brackets which keep the lines separated and anchored. Loose clamps and brackets introduce the possibility of damage due to vibration, or heat from manifolds. Typical refrigerant lines are routed to prevent kinks. Kinked lines reduce refrigerating capacity and should be replaced. (See Fig.14.)

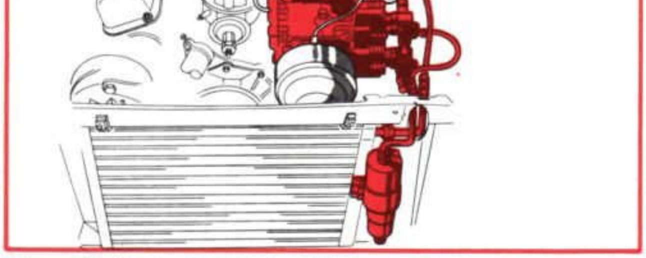


Figure 14–Typical 8-Cylinder Refrigerant Line Routing

SERVICE VALVES are installed in the compressor head to allow you to make connections to the condenser and evaporator, charge the system with refrigerant, and connect gauges for testing. When the system is operating, the service valves should be *back-seated* (Fig. 15).

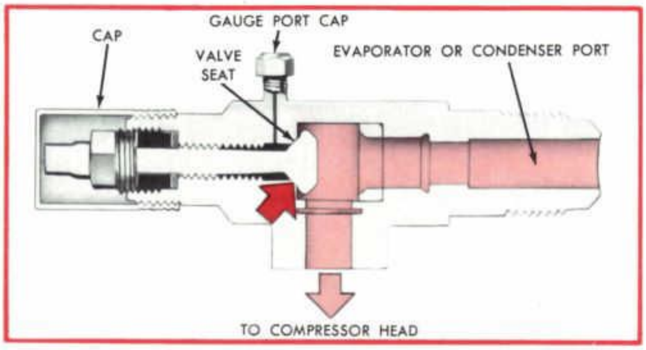


Figure 15—Back-seated Service Valve

When back-seated, the valves are screwed out . . . to open the condenser or evaporator port to the compressor and close the gauge port. Conversely, when the system is being serviced, the valves are front-seated by screwing them inward to close the condenser or evaporator port and open the gauge port for service connections. Check that the stems are screwed out (counterclockwise) until the valves are firmly seated for normal system operation.

Compressor Checks

Normally, the compressor operates quietly and efficiently. If excessive noise or vibration are encountered, check for a loose compressor clutch bolt, or an improperly installed clutch field, if so equipped. Check for this condition with the engine stopped. If the clutch field is rubbing against the clutch, make certain the proper field mounting screws are used to correctly locate the field on the compressor. Tighten the clutch field screws securely. If the clutch is loose, remove it and inspect the taper and keyway in the shaft.

Faulty brushes and/or slip rings can affect clutch operation, and should be checked as a cause of insufficient cooling.

Noisy operation with the clutch engaged may be caused by loose compressor mounting bolts, support bracket bolts, or clutch mounting bolts. Check to see that they are all tight. Also check the adjustment and alignment of the drive belt; and clutch runout.

DRIVE BELTS that are loose or slip cause compressors to run at less than full speed. This is usually the problem when there is *some* cooling, but not the amount specified.

Air conditioning drive belts should be tensioned with a gauge to 90 pounds when new. Used belts should also be tensioned to 90 pounds. A drive belt is considered "used" when it has run for 10 minutes.

The drive belt should also be checked for alignment. It should come off the pulley grooves perfectly straight. There should be no sideways binds in the belt as it approaches or leaves the pulleys.

CLUTCH RUNOUT can also cause noisy operation. Diagnose by mounting a dial indicator, and turning the clutch by hand with the ignition off. If total indicated runout is more than 1/32" (0.03125"), the clutch should be replaced.

ELECTRICAL TESTS

Malfunctions in the electrical circuit (Fig. 16) can cause the compressor or blower to be inoperative. The result is insufficient or no cooling. When the compressor does not appear to be cycling, the magnetic clutch may not be engaging. It may also be engaging but not holding because of excessive resistance in the circuit.

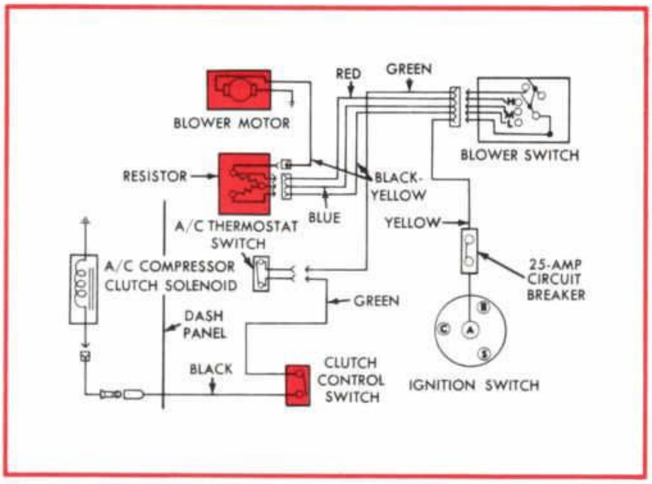


Figure 16—Typical Compressor Clutch and Blower Circuit

Clutch Operational Test

With the air-conditioner set for maximum cooling, you should hear a sharp "click" each time the ignition switch is turned to the "on" or "accessory" position. If you don't hear the click—on a brush-and-holder equipped clutch assembly, examine the clutch slip ring and brushes for good contact. If there is grease, dirt, or oily film on these parts, clean them and repeat the test. If the clutch still doesn't operate, turn the ignition and A/C unit on and apply 12 volts straight to the clutch leads. If the clutch still does not operate, the clutch lead wire or clutch field winding is defective. Replace or repair as necessary. If the clutch *does* engage, the open circuit (or high resistance) is either in the wiring, A/C thermostat, or the electrical controls for the unit. Trace the circuit back until the defect is found and repair or replace parts as required.

COMPRESSOR CLUTCH CIRCUIT TESTS

This test is performed with a 12-volt test light. Set the air conditioning controls on maximum cooling, and turn the ignition switch to the "accessory" position.

1. With one end of the test light connected to a good ground, touch the probe to the lead between the clutch control switch and the clutch solenoid (Fig. 17). If the light doesn't burn, move the probe to the switch connection. If it burns now, the lead wire requires repair or replacement.

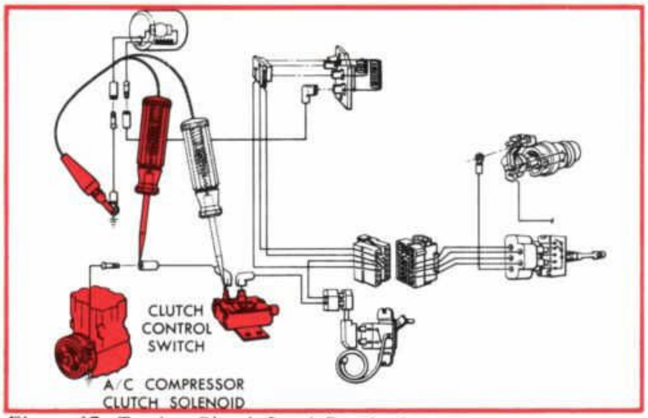


Figure 17—Testing Clutch Lead Continuity

2. If the light doesn't burn in step 1, move the probe to the opposite connection on the switch. Now if it burns, the switch must be misadjusted or damaged. Repair or replace.
3. If the light still doesn't burn, move the test probe to the connection between the thermostatic switch and the clutch switch (Fig. 18). A glowing light here tells you the lead between the switches is open or damaged. Repair or replace. If the light still doesn't burn, test for power to the thermostatic switch.
4. To test the thermostatic switch, move the probe to the input terminal (Fig. 19). If the light glows now, but did not before, the thermostatic switch isn't functioning and should be inspected and tested.

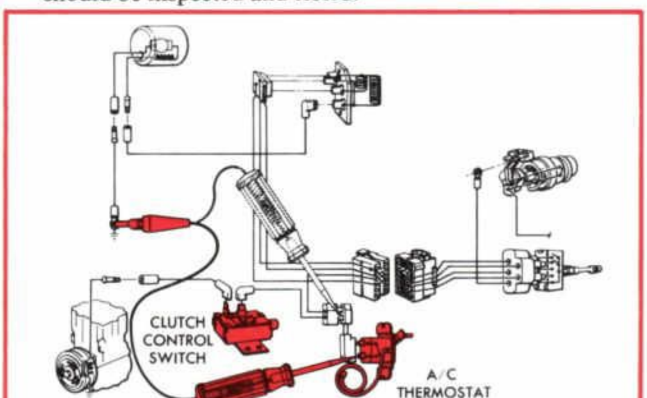


Figure 18—Testing Thermostatic Switch-to-Clutch Control Circuit

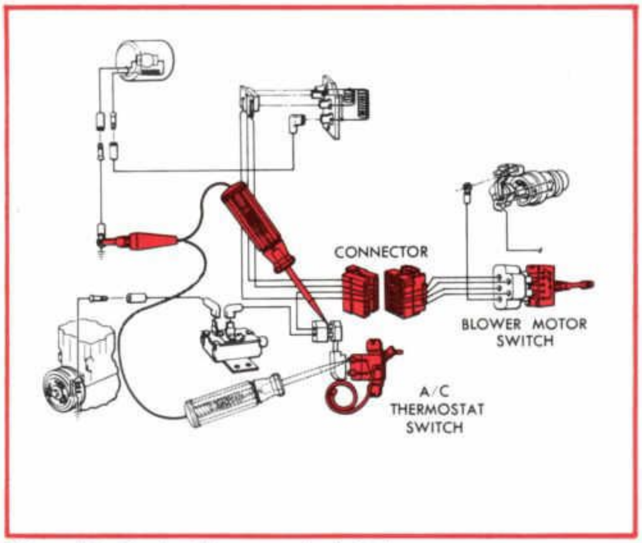


Figure 19—Testing Thermostatic Switch

5. The next test point is the blower switch output terminal which connects to the thermostatic switch (Fig. 20). If the light glows at this point, replace or repair the lead or its connection.
6. Next, move the probe to the opposite (ignition switch) side of the blower switch. A glowing light here indicates the blower switch isn't working properly. Repair or replace.
7. The final test of the clutch circuit is to move the probe to the circuit breaker terminal (Fig. 21). The circuit breaker is usually mounted on the accessory terminal of the ignition switch. Test for power output through the breaker and through the switch. If either isn't passing current, replace as required.

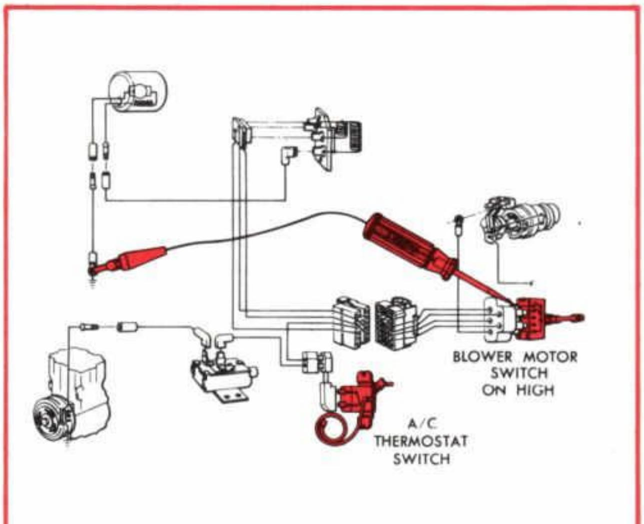
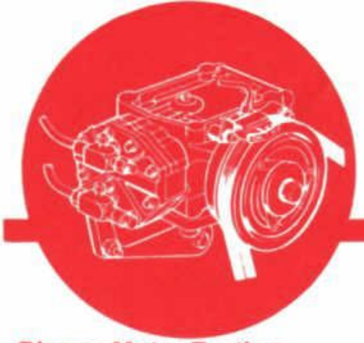


Figure 20—Testing Blower Switch to Thermostatic Switch Lead



AIR CONDITIONING . . .

Blower Motor Testing

As indicated in Figure 22, voltage to operate the blower motor is supplied to the blower switch from the ignition switch. The blower switch passes this voltage on full-strength to the blower resistor. The resistor determines the actual current draw in this part of the circuit, depending on which of its terminals receives the supply voltage. If the air volume is low or there is no air, or the motor doesn't operate properly at all three speeds, check the voltage supply and current draw in these three branches of the circuit.

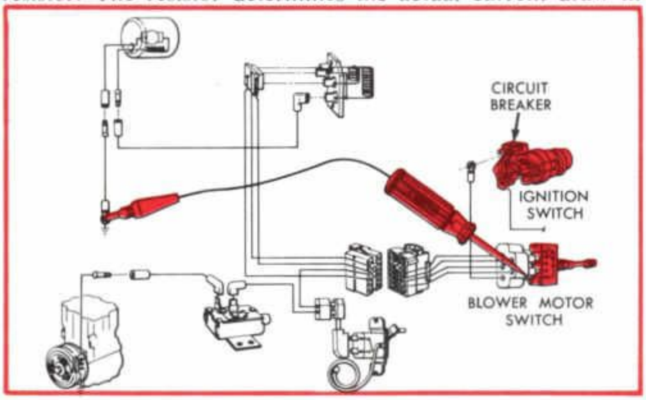


Figure 21—Testing Blower Switch

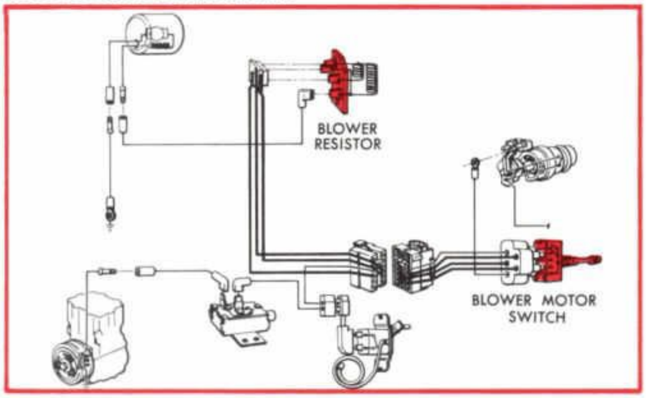


Figure 22—Testing Blower Supply Voltage

A/C OR HEATER DOOR POSITIONS

In the following charts, we have indicated the positions of air doors and the air flow that results when controls are moved to certain standard positions. This should be helpful when diagnosing trouble in a Ford vehicle system, and will give you a general understanding of other-make products you may encounter.

A/C-HEATER CONTROL—FORD, MERCURY AND METEOR

	TEMP. CONTROL LEVER (CABLE CONTROLLED)	FUNCTIONAL CONTROL LEVER (VACUUM CONTROLLED) A/C MAX	A/C FRESH	OFF	HEAT HI/LO	DEFROST FLOOR	(CABLE CONTROL) MAX
AIR DOOR: Cowl Air Inlet Door		Closed V	Open NV	Closed V	Open NV	Open NV	Open NV
AIR DOOR: Recirc. Air Door		Open V	Closed NV	Open V	Closed NV	Closed NV	Closed NV
VACUUM MOTORS: Heater Core Air Restrictor Door		Closed V		Open NV			
VACUUM MOTORS: MODE DOOR Redport		A/C Position Full Vacuum		Heat Position NV	Mid Position V	Heat Position NV	
VACUUM MOTORS: MODE DOOR Yel. Port					Mid Position NV		
Water Valve	Warm / Mod	Open—No Vacuum					
	Cool	Closed—Vacuum					
Water Valve Vacuum Switch	Warm / Mod	Open—No Vacuum					
	Cool	Closed—Vacuum					
Blower Switch		Manually On L-M-H		Turn Off Manually	Manually On Low-Medium-High Off—Ram Air		
A/C Clutch Switch		On		Off			
Temperature Blend Door	Cool	All Cold Air By-Passes Heater Core			Outside Air By-Passes Heater Core		
	Mod	Cold Air Passes Thru and Around Heater Core—Then Mixed			Outside Air Passes Thru and Around Heater Core—Then Mixed		
	Warm	All Cold Air Passes Thru Heater Core			Outside Air Passes Thru Heater Core		
Defroster Door (Cable Controlled)	Min / Mod / Max				Partial Bleed to Defroster Nozzles	Min. Def. Modulated Max. Def.	

V—Vacuum NV—No Vacuum Mod—Modulated Def—Defrost

A/C-HEATER CONTROL—THUNDERBIRD AND MARK III

		TEMP. CONTROL LEVER (BOWDEN CABLE CONTROLLED)	FUNCTIONAL CONTROL LEVER (VACUUM CONTROLLED): A/C MAX	A/C FRESH	POWER VENT	OFF	HEAT	PARTIAL DEF	FULL DEF
AIR DOOR VACUUM MOTOR	Fresh Air—Recirc.		Recirc. Pos. V	Fresh Air Pos. NV	Fresh Air Pos. NV	Recirc. Pos. V	Fresh Air Position NV	Fresh Air Position NV	Fresh Air Position NV
	Register Air		Open V	Open V	Open V	Closed NV	Closed NV	Closed NV	Closed NV
	Heat—Defrost		Defrost Position NV	Defrost Position NV	Defrost Position NV	Defrost Position NV	Heat V	Mid. Pos. Part V	Def. Pos. NV
	Heater Core Air Restrictor		Closed V	Closed V	Closed V	Open NV	Open NV	Open NV	Open NV
Water Valve		Warm / Mod	Open NV	Open NV	Open NV	Closed	Open NV	Open NV	Open NV
		Cool	Vacuum	Vacuum	Vacuum	Vacuum	Vacuum	Vacuum	Vacuum
Water Valve Vacuum Switch		Warm / Mod	Open NV	Open NV	Open NV	NV See Note*	Open NV	Open NV	Open NV
		Cool	Closed—Vacuum	Closed—Vacuum	Closed—Vacuum	Closed—Vacuum	Closed—Vacuum	Closed—Vacuum	Closed—Vacuum
Blower Switch			Manually On	Manually On	Manually On	Turn Off Man.	Manually On L-M-H Off-Ram Air	Manually On L-M-H Off-Ram Air	Manually On L-M-H Off-Ram Air
A/C Clutch Switch			On	Off	Off	Off	Off	Off	Off
Temperature Blend Door		Warm	All Cold Air Passes Thru Heater Core	All Cold Air Passes Thru Heater Core	All Cold Air Passes Thru Heater Core		Outside Air Passes Thru Heater Core	Outside Air Passes Thru Heater Core	Outside Air Passes Thru Heater Core
		Mod	Cold Air Passes Thru and Around Heater Core Then Mixed	Cold Air Passes Thru and Around Heater Core Then Mixed	Cold Air Passes Thru and Around Heater Core Then Mixed		Outside Air Passes Thru and Around Heater Core—Then Mixed	Outside Air Passes Thru and Around Heater Core—Then Mixed	Outside Air Passes Thru and Around Heater Core—Then Mixed
		Cool	All Cold Air By-passes Heater Core	All Cold Air By-passes Heater Core	All Cold Air By-passes Heater Core		Outside Air By-passes Heater Core	Outside Air By-passes Heater Core	Outside Air By-passes Heater Core

*In OFF position water valve is closed by selector and overrides temp. lever switch

L—Low M—Medium H—High Man.—Manually V—Vacuum NV—No Vacuum Mod —Modulated
Def —Defrost

A/C-HEATER CONTROL—MUSTANG AND MERCURY COUGAR

			FUNCTIONAL CONTROL LEVER POSITION: A/C MAX.	A/C FRESH	OFF	HEAT HI/LO	HEAT FLOOR	DEF FOG	DEF ICE
AIR DOOR	Outside Recirc.		Open to Recirc. V.	Open to Outside NV	Open to Recirc. V	Open to Outside NV	Open to Outside NV	Open to Outside NV	Open to Outside NV
VACUUM MOTORS	A/C Heat Door	Partial Red	NV	Open Position	Open Position	Mid Position V	Heat Position V	Mid Position V	Open Position NV
		Full Yellow	Open Position	Open Position	NV	Mid Position NV	Heat Position V	Mid Position NV	Open Position NV
	A/C Defrost		A/C Position V	A/C Position V	Defrost Position NV	A/C Position V	Defrost Position NV	Defrost Position NV	Defrost Position NV
	Reheat		Reheat Position V	Reheat Position V	Heat Position NV	Heat Position NV	Heat Position NV	Heat Position NV	Heat Position NV
Clutch Switch			On	On	Off	Off	Off	Off	Off
Blower Switch			On—L-M-H	On—L-M-H Off-Ram Air	Off *	On—L-M-H Off—Ram Air	On—L-M-H Off—Ram Air	On—L-M-H Off—Ram Air	On—L-M-H Off—Ram Air
Water Valve Vacuum Switch		Cool	Open	Open	Open	Open	Open	Open	Open
		Mod Warm	Sealed	Sealed	Sealed	Sealed	Sealed	Sealed	Sealed
Water Valve		Cool	Closed V	Closed V	Closed V	Closed V	Closed V	Closed V	Closed V
		Mod Warm	Open NV	Open NV	Open NV	Open NV	Open NV	Open NV	Open NV
Temperature Door		Cool	All Cold Air By-Passes Heater Core	All Cold Air By-Passes Heater Core		Outside Air By-Passes Heater Core	Outside Air By-Passes Heater Core	Outside Air By-Passes Heater Core	Outside Air By-Passes Heater Core
		Mod	Cold Air Passes Through And Around Heater Core	Cold Air Passes Through And Around Heater Core		Outside Air Passes Through and Around Heater Core—Then Mixed	Outside Air Passes Through and Around Heater Core—Then Mixed	Outside Air Passes Through and Around Heater Core—Then Mixed	Outside Air Passes Through and Around Heater Core—Then Mixed
		Warm	All Cold Air Passes Through Heater Core	All Cold Air Passes Through Heater Core		Outside Air Passes Through Heater Core	Outside Air Passes Through Heater Core	Outside Air Passes Through Heater Core	Outside Air Passes Through Heater Core

L—Low M—Medium H—High V—Vacuum NV—No Vacuum Mod—Modulated
A/C—Air Conditioning Def—Defrost *On—Recirc. Defrost Air

A/C HEATER CONTROL—FAIRLANE, FALCON AND MERCURY INTERMEDIATE

			FUNCTIONAL CONTROL LEVER POSITION				
			A/C		OFF	HEAT	
			MAX. COOL (RECIRC.)	FRESH (OUTSIDE)		HEAT	DEFROST
AIR DOOR	Outside—Recirc.		Open to Recirc V	Open to Outside NV	Open to Recirc V	Open to Outside NV	
	A/C—Heat		A/C Position V		Heat Position NV		NV
	Heat—Defrost		NV				Defrost Position V
Clutch Switch			On—See Vacuum Diagram		Off		
Blower Switch			On-L-M-H	On-L-M-H Off-Ram Air	Off On-Recirc Condition	On-L-M-H Off-Ram Air	
Water Valve Vacuum Switch		Cool	Open		Vacuum Switch By-passed by Selector Switch Circuit NV		
		Mod	Closed				
		Warm					
Water Valves	Left—(Blue Dot)	Cool	Closed V		Selector Switch Circuit Opens Water Valve by Closing Off Vacuum NV		
		Mod	Open NV				
		Warm					
	Right—(Yellow Dot)	Cool	Closed V				
		Mod					
		Warm					
Temp Door		Cool	All Cold Air By-passes Heater Core			Outside Air By-passes Heater Core	
		Mod	Cold Air Passes Thru and Around Heater Core—Then Mixed			Outside Air Passes Thru and Around Heater Core—Then Mixed	
		Warm	All Cold Air Passes Thru Heater			Outside Air Passes Thru Heater Core	

L—Low M—Medium H—High V—Vacuum NV—No Vacuum Mod —Modulated

A/C-HEATER CONTROL—MAVERICK

			FUNCTION CONTROL LEVER POSITION						
			MAX	FRESH	OFF	HI/LO	FLOOR	FOG	ICE
			A/C			HEAT		DEF	
AIR DOOR	Outside Recirc.		Open to Recirc. V	Open to Outside NV	Open to Recirc. V	Open to Outside NV			
	A/C Heat Door	Partial Red	NV	Open Position		Mid Position V	Heat Position V	Mid Position V	Open Position NV
	A/C Heat Door	Full Yellow			NV	Mid Position NV	Heat Position V	Mid Position NV	Open Position NV
	A/C Defrost		A/C Position V		Defrost Position NV	A/C Position V	Defrost Position NV		
Clutch Switch			On		Off				
Blower Switch			On—L-M-H	On—L-M-H Off—Ram Air	Off *	On—L-M-H Off—Ram Air			
Water Valve Vacuum Switch #		Cool	Open						
		Mod Warm	Sealed						
Water Valve Green #		Cool	Closed V		Open NV				
Water Valve Brown ▲		Mod Warm	Partially Open V ■						
Temperature Door		Cool	All Cold Air By-Passes Heater Core			Outside Air By-Passes Heater Core			
		Mod	Cold Air Passes Through and Around Heater Core			Outside Air Passes Through and Around Heater Core—Then Mixed			
		Warm	All Cold Air Passes Through Heater Core			Outside Air Passes Through Heater Core			

* On— Recirc. Defrost Air # Controlled by Temperature Lever ▲ Controlled by Selector Switch on Control Head
■ Bleed Thru Orifice L—Low M—Medium H—High V—Vacuum NV—No Vacuum
Mod—Modulated A/C—Air Conditioning Def—Defrost

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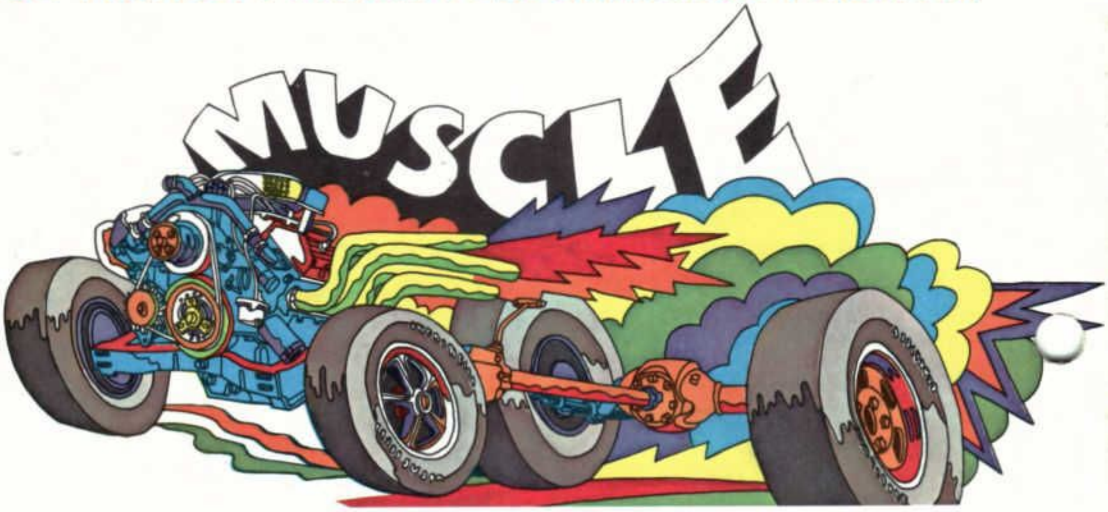

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