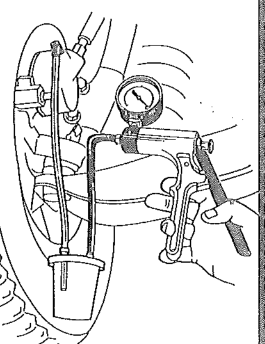
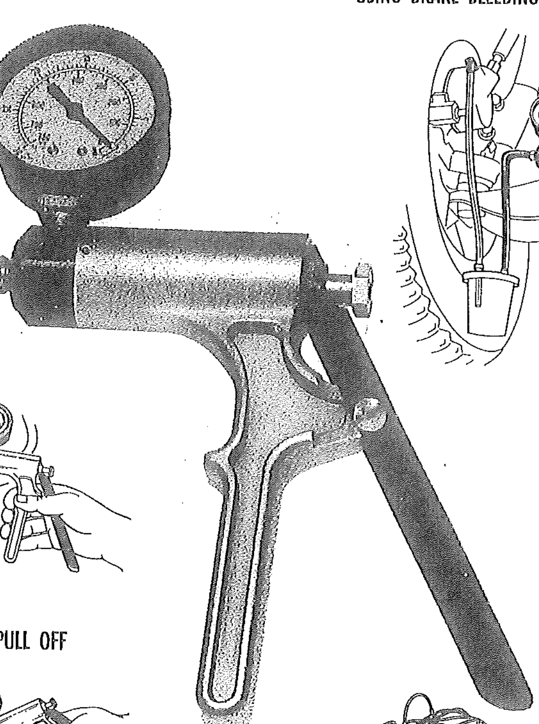
$1.95

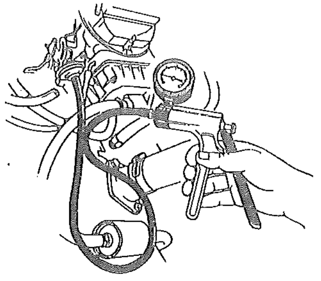
75000 VACUUM TESTING MANUAL

Lisle®

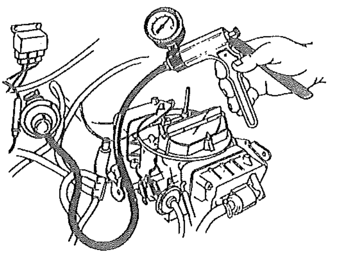
USING BRAKE BLEEDING ACCESSORIES



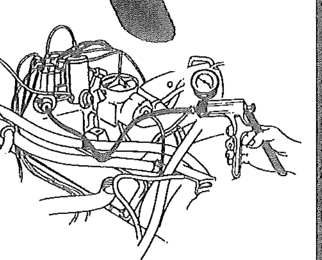




CHECKING CHOKE PULL OFF



CHECKING HEATER CONTROL VALVE



CHECKING VACUUM ADVANCE CHAMBER

#75160

⚠ WARNING: See manual for safety instructions.

SAFETY INSTRUCTIONS

1. Be sure to read this instruction manual carefully before testing with the vacuum/fuel pump gauge.

2. Protect your eyes when relieving fuel system pressure.

3. Keep clear of moving fan blades. Do not wear loose fitting clothes.

4. Avoid making contact with hot engine or exhaust components.

5. Route exhaust from test vehicle out of doors, if test area is not well ventilated.

6. Make sure all fuel system connections are leak free.

7. Do not use open flame or create sparks in presence of fuel vapor.

8. Wipe up fuel spills before proceeding with any tests.

9. Do not use carburetor sprays, cleaning solvents, etc., when performing tests.

10. Unless otherwise instructed, the parking brake should be set and the gear selector in neutral (standard transmission) or park (automatic transmission) and the drive wheels blocked before performing a test with the engine running. If vehicle has automatic parking brake, disconnect the release mechanism.

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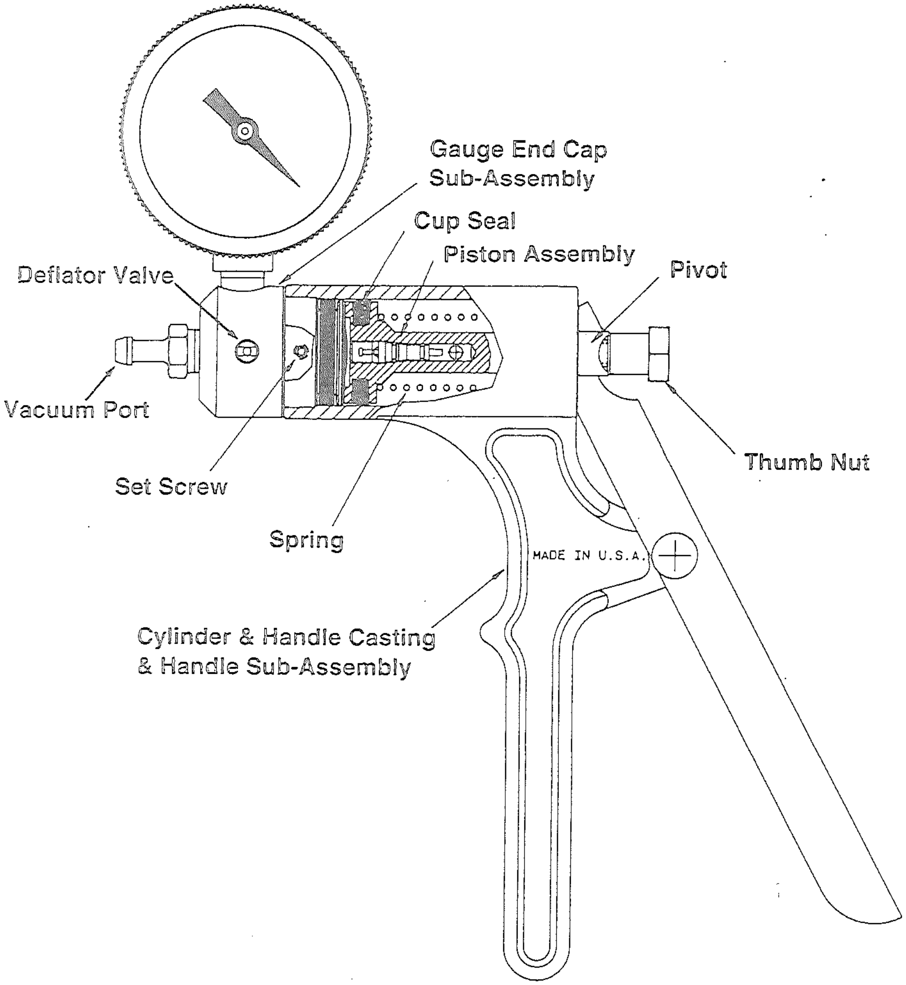


SEE INSIDE FRONT COVER FOR ACCESSORIES.

Figure 1.1.

Chapter 1 PREFACE

Introduction

Congratulations!

You just made a wise investment. You have purchased a durable *metal* vacuum pump. With normal care, this vacuum pump will give you years of trouble-free service.

Your vacuum pump is a multi-purpose tool. First, it is a hand-operated vacuum pump. Use it as a substitute vacuum source when testing or servicing vacuum-operated components on the car. To operate the tool, simply squeeze its handles until you see the desired vacuum reading on its gauge (Refer to Fig. 1.1). To release this vacuum, press the deflator valve below the pump's vacuum gauge (Refer to Fig. 1.1).

Second, your vacuum pump is also a vacuum gauge. To measure vacuum, just connect the vacuum pump to the vacuum source and read it directly on the pump's gauge.

Third, your vacuum pump can be used along with the accessories in this kit to bleed brakes and transfer liquids.

In this handbook, we will highlight many common practical uses for your new vacuum pump. However, this handbook cannot and will not replace a standard set of shop manuals. Today, there are literally hundreds of different vacuum devices on cars. Without good reference manuals — especially vacuum hose schematic manuals — you don't stand a chance of identifying or diagnosing these devices!

When we describe vacuum pump applications in this handbook, we are assuming that you have a current set of manuals in your shop. Inside these manuals, you will find dozens of highly specific tests that require a hand-operated vacuum pump and/or vacuum gauge.

Maintaining Your Vacuum Pump

With minimal care, your vacuum pump should give you long and satisfactory service.

It is most important to remember that the gauge on your vacuum pump is very sensitive. Any rough handling of the pump may damage the gauge. It is also important to remember that your vacuum pump is not intended for the direct transfer of liquids. DO NOT draw liquids directly into the pump. Always use the liquid transfer accessories when bleeding brakes or siphoning any liquid. (Refer to Fig. 7.3, page 41). If any liquid is accidently drawn into the pump, immediately flush the pump with *rubbing alcohol* and lubricate with a few drops of *mineral oil* . Do not use any lubricant other than mineral oil as internal damage to the pump may result. Mineral oil is available at your local pharmacy.

Vacuum

What is vacuum?

Vacuum is nothing more than negative pressure. This definition alone won't help you get the most out of the vacuum pump you just purchased. However, understanding the basics of pressure will.

Engineers, scientists, and gauge makers all use atmospheric pressure as a common reference point. What is atmospheric pressure? Believe it or not, the air or atmosphere around us weighs something. This weight exerts a downward pressure on us and on everything around us. This downward force, which we call atmospheric pressure, is always constant and equal in all directions. Atmospheric pressure (at sea level) is 14.7 pounds per square inch.

Any pressure *above* atmospheric pressure is called positive pressure. Positive pressure is sometimes referred to as gauge pressure, but usually it's just called *pressure*. Any pressure *below* atmospheric is called negative pressure or vacuum.

Note that the gauge on your vaccum pump reads vacuum only. The gauge is calibrated in inches of Mercury and in millimeters of Mercury (in/Hg and mm/Hg). Inches of Mercury and millimeters of Mercury are other ways to describe pressure. All you have to remember is the greater the negative pressure or vacuum, the higher in/Hg the vacuum gauge reads.

Pressure Differential

"Why the fuss over positive and negative pressure?" you ask. Because the *difference* between these two makes the engine work.

A law of nature says that all gases and liquids naturally flow *from a high pressure* point *toward a low pressure* point. The greater the difference in pressure between high point and low point, the faster gases and liquids flow from one to the other.

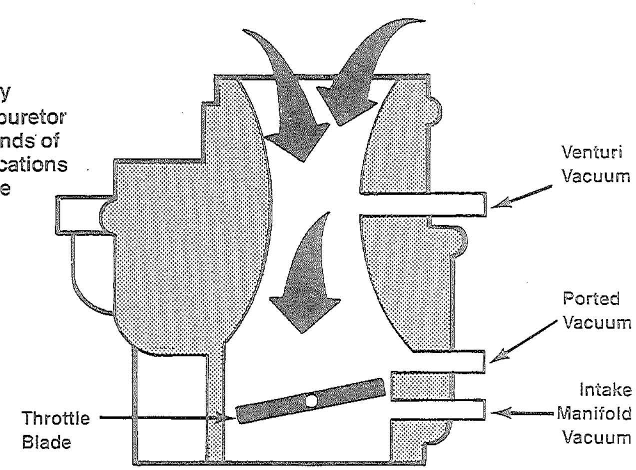
Mechanics often refer to vacuum as "suction." They say that the engine "sucks" in the fuel/air mixture. It's okay to call vacuum suction as long as you realize that pressure differential is what actually makes the mixture flow into the engine. Atmospheric pressure (14.7 psi) is constantly bearing down on the mouth of the carburetor. It also enters the bowl vent and presses down on the fuel inside the float bowl. During intake stroke, the intake valve opens and the piston moves downward. The downward piston movement creates a negative pressure (vacuum) inside the intake manifold. Now the air outside the carburetor and the fuel inside the carburetor have no choice but to flow toward the low pressure point — the intake manifold.

Therefore, atmospheric pressure — not suction — forces the fuel/air mixture into the engine's low-pressure intake manifold. And the stronger vacuum the engine pumps, the faster air flows into the engine.

Types Of Vacuum

To become a good troubleshooter, you must be familiar with three types of vacuum (Refer to Fig. 1.2):

Figure 1.2. A cutaway view of a typical carburetor showing the three kinds of vacuum and their locations relative to the throttle blade position.



- *Manifold vacuum.* This comes from below the carburetor throttle blades. When you uncover a manifold vacuum port, the engine will idle rough and/or speed up — depending upon the size of the port you open up.

Manifold vacuum ranges from about 18 in/Hg at idle to almost 0 at wide-open throttle. When the throttle blades slam shut during deceleration, manifold vacuum climbs to about 25 in/Hg. Generally speaking, manifold vacuum drops as you push down on the accelerator. In other words, manifold vacuum drops as you load the engine.

- *Ported vacuum*. This comes from a port just above the throttle blades. Ported vacuum increases during normal acceleration. It ranges from 0 at idle to about 18 in/Hg at cruising speeds. As you load the engine from cruising speed to wide-open throttle, ported vacuum drops to 0.
- *Venturi vacuum*. This comes from a port that's drilled into the carburetor throat or venturi area. Venturi vacuum is the weakest of the three vacuum signals. Unlike manifold and ported vacuum, venturi vacuum does *not* drop to 0 at wide-open throttle. Venturi vacuum ranges from 0 at idle to about 6 in/Hg at cruising speed and wide-open throttle.

Know these three types of vacuum by heart. Not only do we refer to them repeatedly in this handbook, but any repair manual or textbook you read refers to them too.

The easiest way to learn how vacuum behaves is to observe it on your own engine. Tie or tape a vacuum gauge to your dashboard so you can watch it without taking your eyes off the road. Route a length of vacuum hose from the gauge to the engine compartment and tee it into a manifold vacuum port. During your routine driving, note manifold vacuum readings under the following conditions:

- starting
- idle
- light acceleration
- heavy acceleration
- steady cruising speed
- deceleration

When you are confident that you understand how manifold vacuum reacts, move your underhood tee to a ported vacuum source and repeat the procedure. Do likewise with a venturi vacuum port.

Chapter 2 ENGINE MECHANICS

Basic Engine Tests

In this section, we explain some tests that help determine the basic mechanical condition of the engine. Whether they are idling or cranking, engines always pump more vacuum per intake stroke when their rings and valves are sealing well.

You should perform cranking vacuum and idle vacuum tests when the engine is at operating temperature. Always connect your vacuum pump to one of the larger vacuum fittings on the carburetor or manifold. Whenever possible, take *all* vacuum readings from a centrally located vacuum port. Suppose you are testing a V8. Given the choice of a vacuum fitting on number 8 intake runner or a port directly below the carburetor, use the one under the carburetor.

Cranking Vacuum Test

This test helps you diagnose no-start and hard-start conditions. To perform an accurate cranking vacuum test, you need a minimum of 150-200 rpm cranking speed. If the battery and cranking circuit aren't up to the task, fix them first. In cases where the engine will start, disable the ignition so the engine won't start. Crank the engine, watch the gauge of your vacuum pump, and listen to the cranking rhythm.

Obviously, the more cranking vacuum the engine pumps, the easier it will start. Good engines will pump a steady 2-6 in/Hg and have a smooth cranking rhythm. A good rule of thumb is that an engine has to pump 1 in/Hg in order to start.

Sometimes the engine will crank smoothly but you won't see a reading on the gauge. Before you condemn anything, back out the idle speed screw enough to allow the throttle blades to close a little tighter. This should bring the cranking vacuum up to a readable level.

After the engine has spun over for a few seconds and the cranking speed has stabilized, the cranking vacuum shouldn't fluctuate more than 1 in/Hg. If the reading fluctuates, note how much it changes and how frequently it changes.

When you see the vacuum reading drop at regular intervals, look for a compression problem. This regular drop in cranking vacuum is usually accompanied by an increase in cranking speed. The momentary increase in cranking speed occurs in synch with the vacuum drop because the starter can spin a weak cylinder faster than it can spin a healthy one.

When you see the vacuum reading drop to 0 at regular intervals, look for a burned intake valve that's allowing pressure to enter the intake manifold.

When you see very erratic fluctuations in both cranking vacuum and cranking rhythm, the engine is dieseling or the valve timing is incorrect. When an engine is so hot that it diesels during cranking, allow it to cool off and then repeat the cranking vacuum test. If dieseling is not the cause of the erratic readings, check valve timing.

When you don't get any cranking vacuum at all and the cranking speed is much faster than normal, look for a worn timing chain or worn cam belt that has jumped its sprockets.

Quick Methods for Checking Valve Timing

When an engine lacks power and shows a low steady vacuum reading at idle, late valve timing may be the cause. Incorrect valve timing, as mentioned earlier, can also upset cranking vacuum and cranking rhythm. Here is an easy method for checking valve timing.

Turn the engine over until the crankshaft timing mark is near 0 on the timing pointer/indicator. Then remove the distributor cap so you can watch distributor rotor movement. Carefully turn the engine counterclockwise (opposite normal rotation) until you feel the slack go out of the timing chain. As soon as you feel the chain tighten up, turn the engine clockwise again (Refer to Fig. 2.1). Note how many degrees of crank rotation it takes to make the rotor *begin* turning. If it takes more than 4 degrees of crank rotation to make the rotor move, inspect the timing chain.

Detecting Vacuum Leaks

Whenever a mechanic mentions a vacuum leak, he is really referring to an air leak. When atmospheric pressure forces its way into the system through an air leak, it raises the pressure inside the intake. Remember that raising the positive pressure is the same thing as lowering the vacuum.

All fuel systems are designed and calibrated on the premise

Figure 2.1. In order to detect timing chain slack, you must first turn the crankshaft counterclockwise and then turn it in the opposite direction.

that air enters the engine primarily from two points:

- through the throat of the carburetor or the air intake/throttle body on fuel injection systems;
- through the calibrated leak inside the PCV valve.

When air enters the engine from other points, it upsets the entire fuel system calibration. On computer-controlled fuel systems that use an oxygen sensor in the exhaust manifold, air leaks can really raise havoc. The oxygen sensor monitors fuel mixture. When unwanted extra air leaks in, it can easily trick the oxygen sensor into thinking the engine is running too lean. The system's control computer then drives the fuel metering full rich to compensate for the alleged lean condition. Before you attempt to diagnose any computer-controlled fuel system, be sure you check for air leaks first.

Always start looking for air leaks at the carburetor itself. Heat and vibration combine to make loose carburetors a common problem. The carburetor doesn't have to be sloppy loose for an air leak to exist. Check carburetor bolt tightness as a matter of habit.

When an air leak seems to be elusive, examine the carburetor bowl casting or bowl body closely. Although the carburetor base many be bolted snugly to the intake, the bowl-to-base screws may be very loose. Sometimes the screws are loose enough that when you pull on a corner of the carburetor or on the fuel line, you can see the bowl move.

Use hose pinchers to seal off vacuum hoses to potential leaks such as the PCV valve, power brake booster, speed control servo, canister purge valve, etc.

Spraying a liquid onto an air leak makes both the vacuum reading and idle speed jump. Keep a squirt can or spray bottle of 10-weight oil, light oil, or a 50/50 mixture of light oil and kerosene handy. Avoid using carburetor/choke cleaner sprays to locate air leaks. Experience has shown that these sprays are too volatile to be reliable leak finders. Squirt or spray light oil around the base of the carburetor, the base of the EGR valve, around vacuum fittings, and onto the intake manifold gaskets.

Most engines today are equipped with one or more thermal vacuum switches (TVSs). Squirt the body of the TVS. Sometimes an air leak develops where the plastic part of the TVS is crimped onto the metal base of the TVS.

On engines equipped with port fuel injection, remember to squirt around the injection nozzles themselves. Air leaks often occur at the o-rings that seal the nozzles to the intake manifold.

Testing O-Ring Valve Stem Seals

Many popular engines are equipped with o-ring valve stem seals. These o-rings form a seal between the valve stem and the valve retainer/valve cap. They prevent oil from running *directly* down the valve stem into the combustion chamber and causing excessive oil consumption.

To test these o-ring seals, attach your vacuum pump to the top of the valve retainer/valve cap using the umbrella-shaped adapter (Refer to Fig. 2.2). Remember to lightly lubricate the umbrella adapter. When you pump a vacuum against the valve retainer, it should hold a vacuum. If it doesn't hold a vacuum, check for a worn or damaged o-ring and inspect the inside of the retainer. If the lower surface of the retainer is damaged or uneven, replace it. Also check the undercut portion of the valve stem that the o-ring seals against for a possible leak source. When you replace an o-ring seal, oil it and be sure it sits squarely in its groove. Retest after assembly.

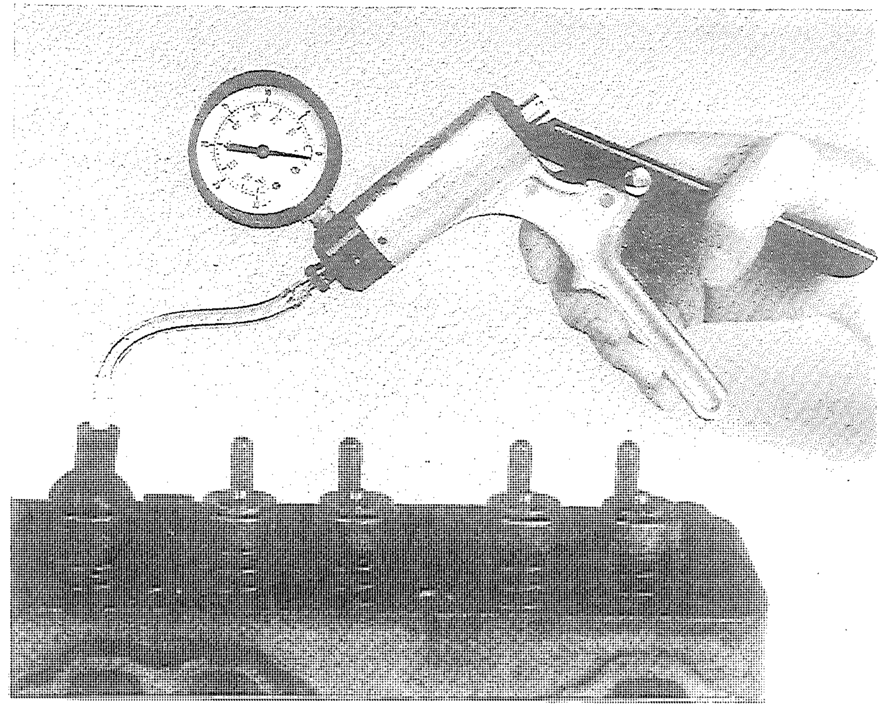


Figure 2.2. When testing valve stem seals, always lube the adapter with a film of motor oil to prevent air leaks between the valve spring retainer and the umbrella adapter.

O-Ring Valve Seal Installation Tip

When installing o-ring valve stem seals on any engine, dip the entire seal in motor oil.

Always install the valve spring and valve retainer/valve cap *first*. Then compress the spring with your spring compressor. After compressing the spring, slip the oiled o-ring into its groove in the valve stem. The o-ring must sit squarely in its groove. Fit the keepers into their groove on the valve stem. Now slowly release the spring compressor. Test the o-ring with your vacuum pump.

If you install the o-ring first and compress the spring second, the spring retainer often forces the oiled o-ring out of its groove and ruins your seal job.

Chapter 3 FUEL SYSTEM

Fuel System Applications

Carburetor adjustment is one of the most popular applications for the vacuum pump. Before you try to adjust a carburetor, check for and repair any air leaks. Be sure the PCV system is working and be sure the ignition timing is set to spec. On carburetors that have two idle mixture screws, lightly seat both screws and then back them out an equal number of turns. This step insures that the mixture setting will be uniform side-to-side. Warm the engine to operating temperature.

Adjust the mixture screw(s) to get the highest vacuum reading possible at curb idle speed with the leanest mixture possible. In other words, turn the mixture screws in as far as possible without lowering the vacuum reading at curb idle.

CAUTION: If exhaust emission inspection is required in your area, always verify your carburetor adjustments with an accurate emission analyzer.

Choke Service

Choke pull-off diaphragms or vacuum break diaphragms control choke blade opening after cold start up. If the pull-off opens the choke blade too far too quickly, it leans out the engine and causes hesitation and stalling. If the pull-off doesn't open the choke blade far enough or doesn't open it at all, the engine runs extremely rich, loads up, and spews black smoke.

Many pull-off diaphragms are equipped with a calibrated bleed hole. Unless you locate the bleed hole and plug it, the pull-off will always test bad (Refer to Fig. 3.1). Consult your repair manual, carburetor service book, or the literature inside the carburetor overhaul kit for the location of the air bleed hole on the unit you are testing.

Your vacuum pump is essential for making choke adjustments because at some point during the procedure, you have to pump down the pull-off diaphragm. First, check for a bleed hole. If you find one, plug it shut. Usually, the service manual instructs you to pump down the pull-off until its plunger is seated. Sometimes you have to apply a specified amount of vacuum to the pull-off. Then you measure the choke blade-to-choke wall clearance and make the appropriate adjustments. Figures 3.2 and 3.3 show typical

choke pull-off testing procedures. Some carburetors are equipped with *dual* pull-off diaphragms (Refer to Fig. 3.6). Always adjust these dual units in the sequence described in your shop manual.

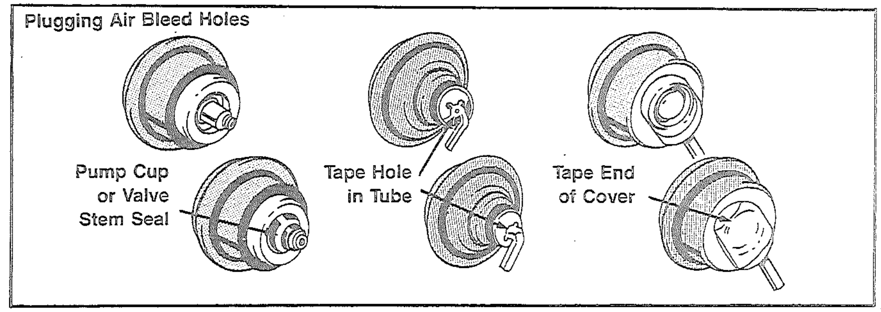


Figure 3.1. Here are the common locations of air bleeds on GM choke pull-offs. Use a valve stem o-ring or an accelerator pump cup to seal off the type shown on the left. Seal the other types with tape.

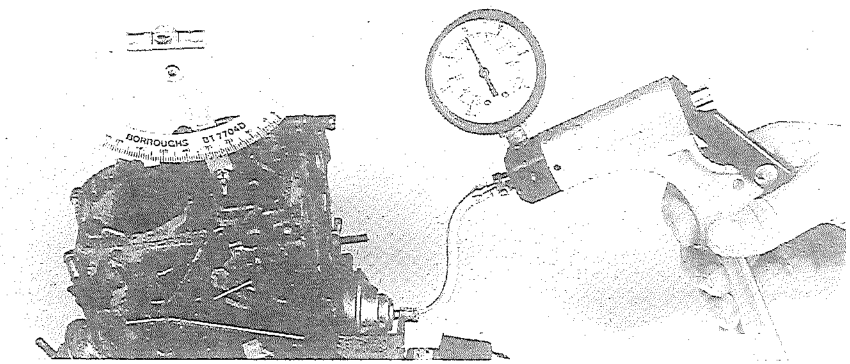


Figure 3.2. Since the late '70s, GM has specified use of a choke angle gauge instead of a pin gauge or drill bit to set choke blade opening. With choke blade closed, set scale to specified choke angle. Apply a vacuum and adjust pull-off until gauge's bubble is centered.

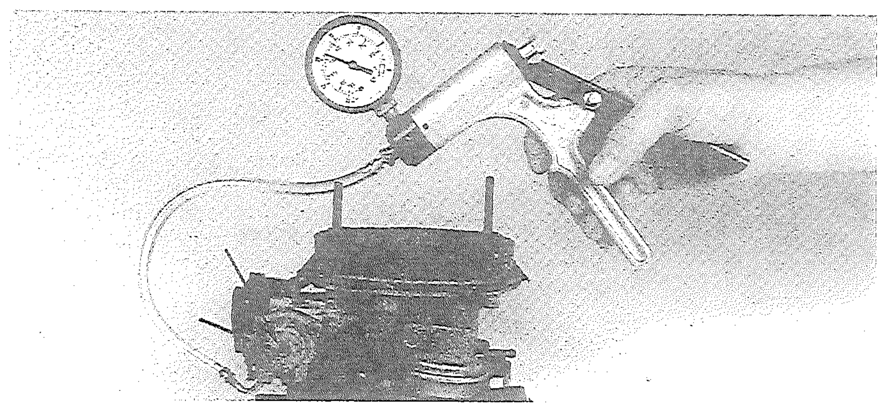


Figure 3.3. On this Holley/Chrysler carb, apply a vacuum to the pull-off and then turn the set screw (arrow) until the specified-size drill fits between the top of the choke blade and the air horn wall.

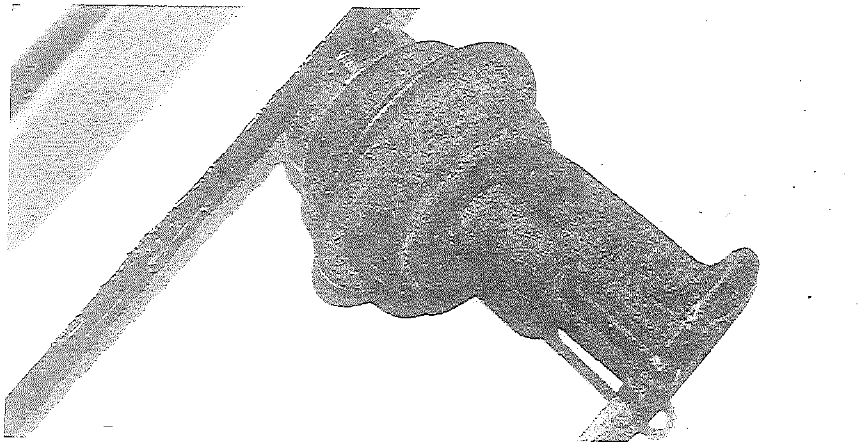


Figure 3.4. To minimize tampering, some Motorcraft choke pull-offs have a concealed adjustment screw. To reach it, you have to cut off or grind off the end of the pull-off housing.

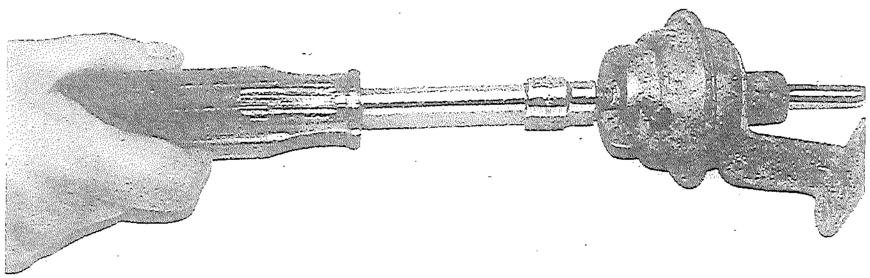


Figure 3.5. If the adjuster screw on a Motorcraft choke pull-off doesn't budge, don't force it. Heat the screw with the tip of your soldering iron in order to soften the factory-applied thread-locking sealer.

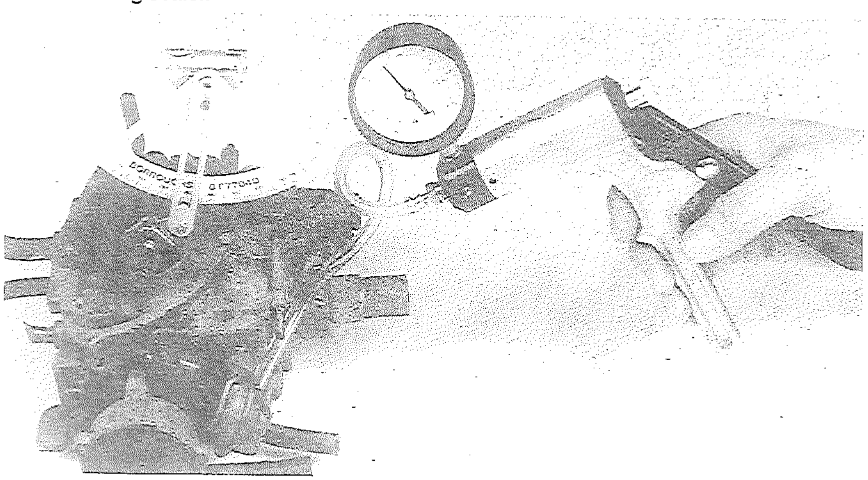


Figure 3.6. On this GM Dualjet carburetor, the auxiliary pull-off is used to fine-tune how quickly the choke blade opens. Auxiliary takes over *after* the main pull-off and is often controlled by a thermal vacuum switch.

Fuel Pump Draw Test

Mechanics often use the volume/pressure test to check a suspect fuel pump. But a fuel pump vacuum test can help you solve some fuel starvation cases too. Disconnect the fuel line from the inlet side of the fuel pump. Connect your vacuum pump to the inlet side of the fuel pump and start the engine. Let the engine idle and note the maximum vacuum reading. A good fuel pump will draw at least 10 in/Hg and hold this vacuum for about 20 seconds after you shut the engine off.

If the fuel pump pumps sufficient vacuum, reconnect the fuel line to its inlet. Then disconnect the fuel line from the gas tank. Connect your vacuum pump to the fuel line and idle the engine again. You should see the same vacuum reading you saw at the fuel pump inlet. If the vacuum at the tank-end of the fuel line is lower than the vacuum reading at the pump inlet, look for a crack or hole in the fuel line. If you don't get *any* vacuum reading at the tank-end of the line, the fuel line is crimped shut or completely clogged or has a large hole in it.

Testing Power Valves

Many Motorcraft and Holley carburetors are equipped with a vacuum-operated, screw-in power valve. When the diaphragm in this type of power valve leaks, the engine suffers from a constant overrich condition and poor fuel economy. The engine often idles roughly and spews black smoke from the tailpipe.

To test the power valve, attach the vacuum pump to it using the umbrella-shaped adapter (Refer to Fig. 3.7). Remember to lightly lubricate the adapter first. Apply vacuum to it with the vacuum pump. Replace the power valve if it does not hold a vacuum.

Diagnosing Repeated Power Valve Failure

Whenever a Motorcraft or Holley carburetor suffers repeated power valve failure, the cause is usually engine backfiring. Check the engine for problems such as improper timing, burned intake valves — problems that would make the engine backfire through the intake. Fix these things *before* you install the next power valve.

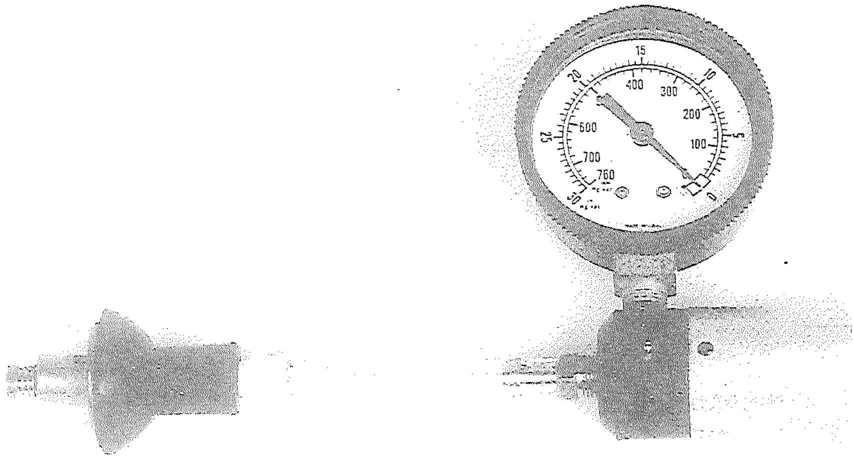


Figure 3.7. This power valve does not hold a vacuum and must be replaced. A common cause of ruptured Holley/Motorcraft power valves is engine backfiring. Eliminate the backfiring before you replace the power valve.

Testing Distributor Vacuum Diaphragms

When a vacuum advance unit fails, an engine can show symptoms such as hesitation, poor fuel economy, premature spark plug failure, and generally poor performance. To test a vacuum advance unit, connect your vacuum pump to the unit and start the engine (Refer to Fig. 4.1). Apply a vacuum. If the vacuum advance diaphragm is good, it will hold a vacuum. Applying vacuum to a good vacuum advance will also advance the timing. Advancing the timing will make the engine speed up.

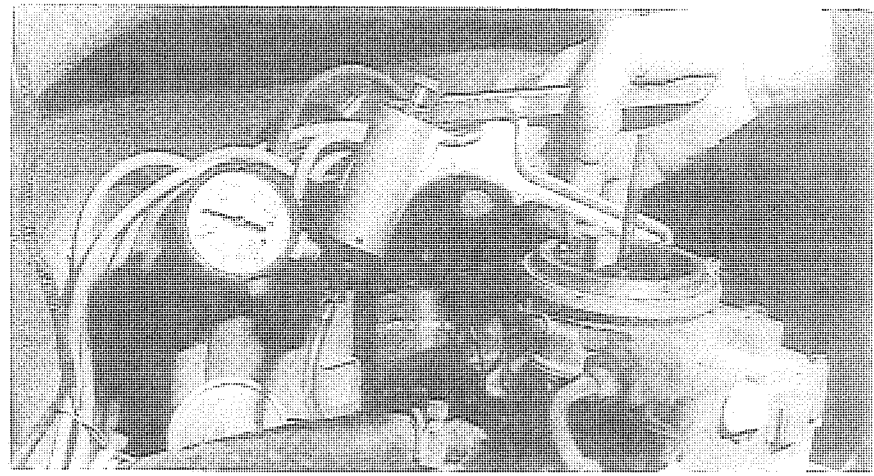


Figure 4.1. Vacuum advance failure causes a drastic drop in fuel economy.

Some engines are equipped with dual-diaphragm advance/retard units. The advance/retard unit has two vacuum nipples on it. The inner nipple, the one closest to the distributor housing, is always the retard side of the dual diaphragm. This side retards the timing under certain conditions in order to control hydrocarbon emissions.

To test the dual-diaphragm vacuum unit, remove both vacuum hoses from the unit and plug them both. Connect your vacuum pump to the advance side of the unit. The advance side is the *outer* vacuum nipple. Start the engine. When you apply vacuum, the timing should advance and the engine should speed up. Shut off the engine and connect your vaccum pump to the retard side of the diaphragm. Restart the engine and apply a vacuum. The timing should retard and the engine rpm should drop slightly.

Sometimes it is easier to hear these rpm changes when you hold the engine at a fast idle. Try placing the throttle on the second step of the fast idle cam for this test.

Always check your vacuum schematic manual to be sure the vacuum hoses for the advance/retard setup are properly routed.

Testing GM HEI Pickup Coils

Introduced in 1975, the General Motors HEI is the most popular electronic ignition on the road. At the heart of the HEI is a magnetic pickup assembly. This assembly triggers the HEI module to break the primary circuit, allowing the coil energy to collapse and fire the spark plugs. You can liken the action of the pickup coil to that of the distributor cam lobes on a breaker-point distributor.

When the fine wire windings inside the pickup coil break, they can cause an intermittent misfire, an intermittent shut-off condition, or a loping idle condition. When you encounter these symptoms on an HEI-equipped engine, remove the distributor cap and unplug the green wire and the white wire from the module. Connect an ohmmeter across these wires. The pickup coil should measure 500-1500 ohms. If the resistance is within spec, connect your vacuum pump to the vacuum advance unit and apply a vacuum (Refer to Fig. 4.2). Watch the ohmmeter. Apply and release the vacuum several times. If the ohmmeter reading fluctuates when you advance and retard the position of the pickup coil, replace the pickup assembly.

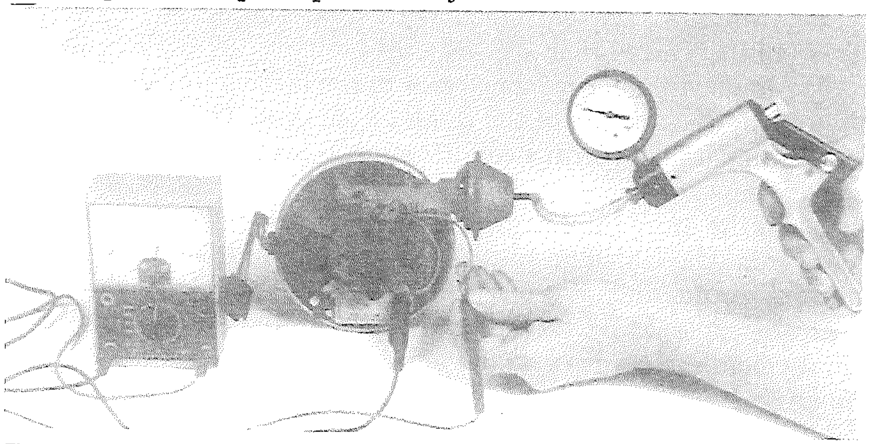


Figure 4.2. Apply a vacuum to the GM vacuum advance and then release the vacuum. When you do this, the pickup coil resistance must remain steady.

Reducing Part-Throttle Detonation

It is common for motorists to complain about pinging that occurs during light-throttle or part-throttle driving. Most Ford and Chrysler products have adjustable vacuum advance units. Therefore, you can reduce or eliminate light-throttle ping on these vehicles with a simple adjustment on the vacuum diaphragm. But before you touch this adjustment, always troubleshoot the common causes of detonation (this is a list of the common causes, there are others):

- poor quality fuel
- EGR system failure (see page 31)
- over-advanced initial timing
- engine overheating
- air cleaner snorkel flap stuck closed (see page 27)
- stuck heat riser in closed position

If all these items are in order, grab a 3/32 hex wrench and road test the vehicle. To reduce vacuum advance, remove the hose from the vacuum advance unit and slide the hex wrench into the vacuum nipple (Refer to Fig. 4.3). Engage the wrench into the adjusting screw inside it. Turn the screw in (clockwise) about 1/8 turn at a time until the pinging *just* disappears.

NOTE: GM vacuum advance units are non-adjustable, but adjustable aftermarket units are available for GM engines.

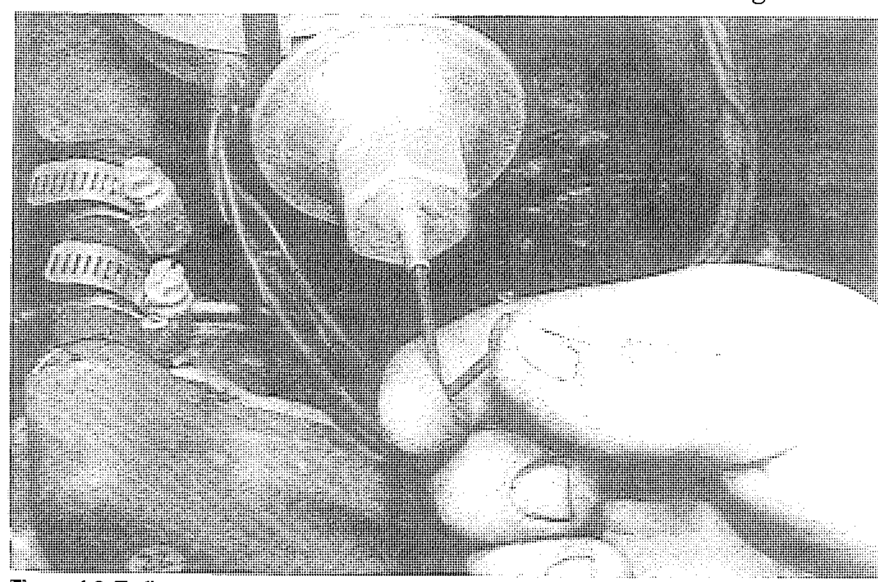


Figure 4.3. To fine-tune a Ford or Chrysler vacuum advance unit, all you need is a 3/32 hex wrench. Road test after each adjustment.

Collapsed PCV Hoses

Beware of soggy PCV hoses. Whenever a PCV hose feels or looks questionable, replace it. PCV hoses can work fine while you're looking at them, but manifold vacuum can easily suck a soggy hose shut when the customer drives away. Besides creating oil leaks, a clogged PCV system can affect engine performance. Because the PCV valve is a calibrated air leak, all fuel systems are designed to operate with a certain amount of air flow from the PCV system. Whenever this air flow is altered, fuel mixture changes.

Testing Thermal Vacuum Switches

Vacuum switches are known by many different names and come in different shapes and sizes. For the sake of simplicity, we'll call it a thermal vacuum switch if it:

- is controlled by engine coolant temperature, intake fuel mixture temperature, or by intake air temperature;
- is a simple, on/off, open/closed switch.

Thermal vacuum switches have two or more vacuum ports or vacuum nipples on them (Refer to Fig. 5.1). Vacuum of some kind goes into the inlet port(s) of the switch. The switch may be threaded into a coolant passage, threaded into an intake runner, or clipped to the air cleaner. When the switch reaches a designated temperature, it opens and vacuum flows through the outlet port(s) to the vacuum device(s) the switch controls or it allows vacuum to bleed to the atmosphere, thus deactivating the vacuum device.

Many thermal vacuum switches are multi-purpose, multi-chambered types. This means that vacuum for one circuit flows in and out of one set of ports on the switch while vacuum for a different circuit flows in and out of another set of ports on the same switch. The upper two ports on a switch, for example, may control manifold vacuum for the vacuum advance while the lower two ports control ported vacuum for the EGR system.

Another possibility is a three-port switch where vacuum enters one port and flows out of the other *two* ports when the switch opens. Always refer to your shop manual or to the underhood decal showing the vacuum schematic before you attempt any troubleshooting.

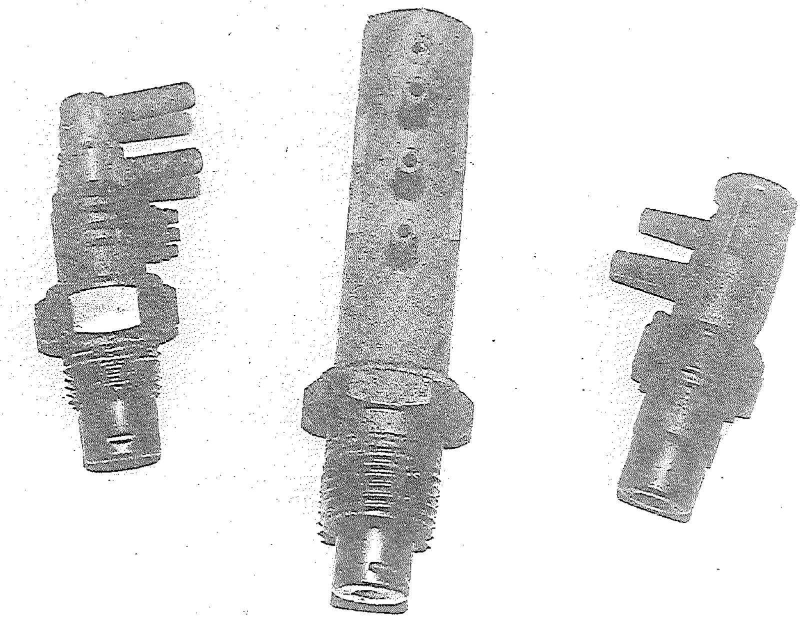


Figure 5.1. Thermal vacuum switches may have many ports or just two. Switches sense coolant temperature, carburetor inlet air temperature, or fuel mixture temperature inside the intake manifold.

You can test thermal vacuum switches on or off the vehicle. Regardless of which way you choose to test a thermal switch, you must first consult your shop manual to determine:

- what the opening temperature of the switch is;
- which port is the switch's inlet;
- which port is the switch's outlet.

On-Car Test

When checking a thermal switch on the vehicle, always verify that the switch's inlet port(s) is receiving the correct vacuum. Connect your vacuum pump to the hose feeding vacuum to the thermal switch and start the engine. If the circuit uses ported or venturi vacuum, remember that you have to rev the engine in order to see a vacuum reading. If you don't get a vacuum reading — or you don't get the right kind of vacuum reading — trace the vacuum hose back to the carburetor port or manifold port. Look for crimped, cracked, or misrouted hoses. Be sure the vacuum source port is not clogged with dirt or carbon.

Once you know that the switch is receiving vacuum, connect your vacuum pump to the switch's *outlet* port. Warm the engine up to the switch's opening temperature. Sometimes you'll have to block the radiator with cardboard or a fender cover in order to get the coolant to the correct temperature. Where necessary, monitor the coolant temperature with a radiator thermometer. When the engine reaches the specified temperature, you should see a vacuum reading on the vacuum pump. Where ported or venturi vacuum is used, rev the engine to get a vacuum reading. Replace the thermal switch if you don't get a vacuum reading at its outlet port.

Another method for on-car testing of thermal vacuum switches utilizes the vacuum pump as the vacuum source. Attach the vacuum pump to the thermal switch's inlet port. Attach a vacuum gauge to the switch's outlet port. Apply a vacuum. When the switch opens, a vacuum should register on the vacuum gauge (Refer to Fig. 5.2).

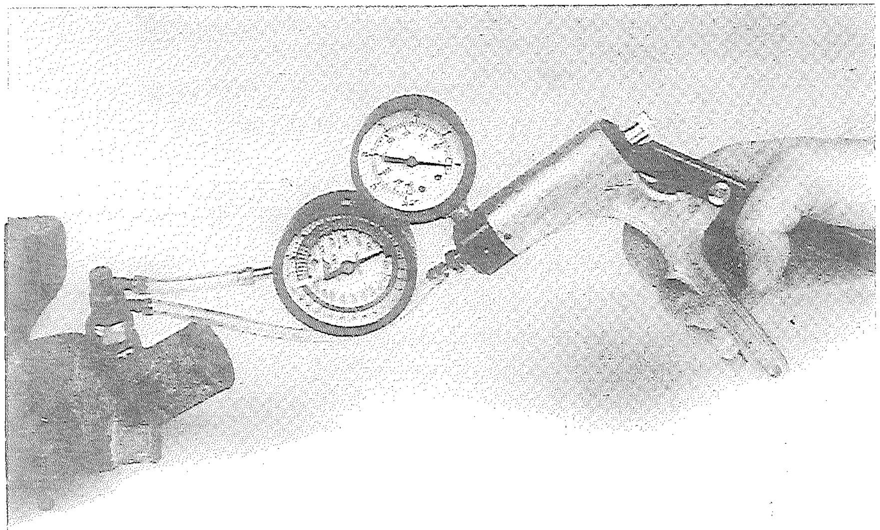


Figure 5.2. Testing thermal switch on the car with vacuum pump and vacuum gauge.

Off-Car Test

Assuming there are no hose or hose routing problems on the engine, you can test a thermal vacuum switch off the car. First, chill the temperature-sensing end of the thermal switch with ice or with cold tap water. Connect your vacuum pump to the inlet port of the switch and attach a vacuum gauge to the outlet port. Apply a vacuum. If the switch is supposed to pass vacuum, it should register on the vacuum gauge at the outlet port (Refer to Fig. 5.3). If it passes vacuum but bleeds down, suspect a leak. If it

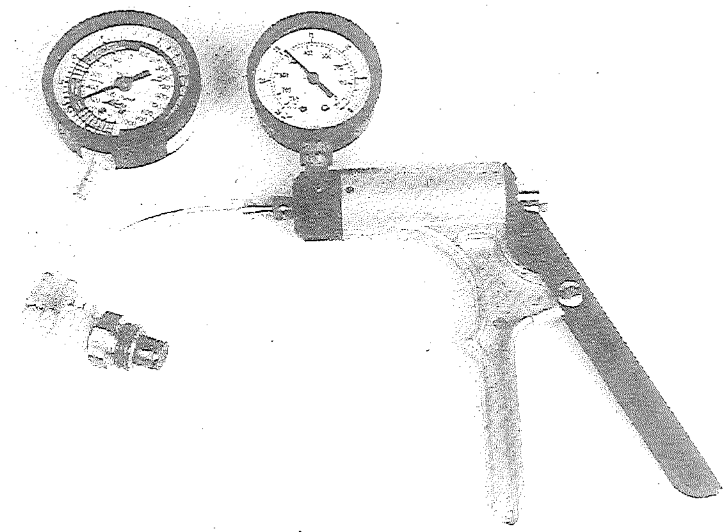


Figure 5.3. This switch is good — it's supposed to pass vacuum when it's cold! When you suspect a switch is popping open at the wrong time, tee a vacuum gauge into its circuit. Road test the car hot *and* cold and watch the vacuum gauge.

doesn't pass vacuum to the outlet port, replace the switch. If a switch passes vacuum only when its temperature is increased to engine operating temperature, test the switch by connecting the vacuum pump to the inlet port and a vacuum gauge to the outlet port. Heat a small container of water to the switch's opening temperature. Carefully hold the sensing end of the switch in hot water - do not submerge the entire switch in the water. The switch should open immediately and a reading should appear on the gauge (Refer to Fig. 5.4). On multi-purpose thermal switches, remember to test each set of ports.

Testing Vacuum Delay Valves

Vacuum delay valves do exactly what their name implies: they delay operation of a vacuum device. Instead of letting the device respond immediately to the vacuum source, the valve holds back vacuum flow for a designated number of seconds. Delay valves are often found in vacuum circuits such as the vacuum advance, the EGR, and the choke pull-off.

Delay valves are color-coded for two reasons. First, some manufacturers identify the vacuum source-side of the valve with a color. For example, the vacuum source-side on most delay valves is black. Some manufacturers also mark the vacuum source-side

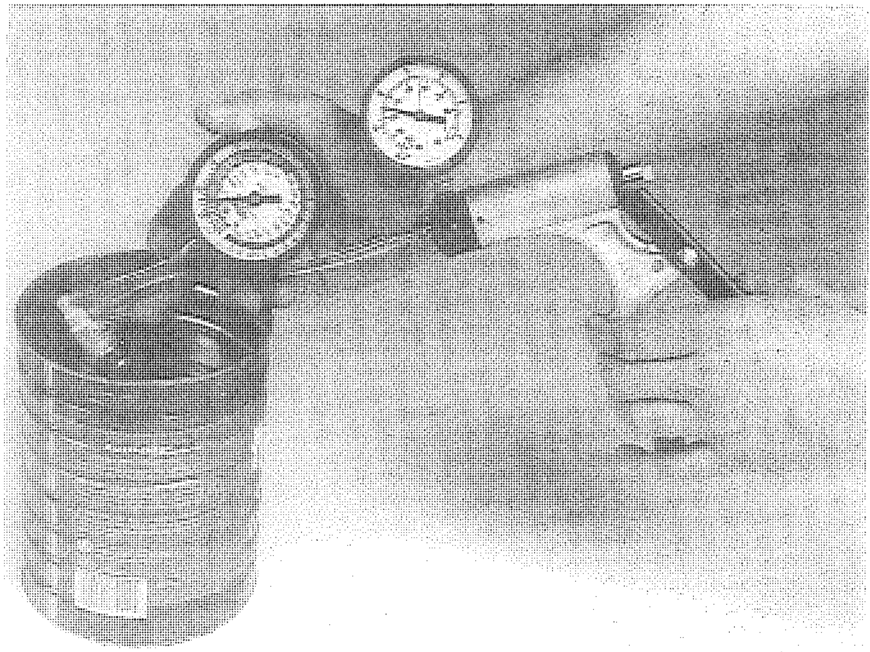


Figure 5.4. To test a thermal switch off the car, apply a vacuum to the inlet port. Heat water to switch's opening temperature and quickly dip just its sensing bulb in the water. If switch opens, vacuum will register on outlet port vacuum gauge.

of their delay valves VAC or CARB. Second, the color-coding indicates the length of time that the valve delays vacuum flow. For example, Ford has used a yellow/black valve that delays vacuum flow 7-14 seconds.

Before you do any testing, be sure the delay valve isn't installed backwards. The tiny valves inside the delay valve often clog up with dirt and shut off vacuum flow completely. To check for a clogged valve, remove the valve from the circuit and connect your vacuum pump to the black side or CARB side of the valve. When you apply a vacuum here, the vacuum should bleed off. If the vacuum doesn't bleed off, the delay valve is clogged.

Look up the delay time for that delay valve in your shop manual. Keep the vacuum pump connected to the black side of the valve and connect a vacuum gauge to the opposite side of the valve (Refer to Fig. 5.5). Apply the specified vacuum (usually about 10 in/Hg) to the black side of the valve. Time how long it takes to get the specified vacuum reading (usually about 6 in/Hg) on the opposite side of the delay valve. If the recorded time is not within the specified time for that delay valve, replace the valve.

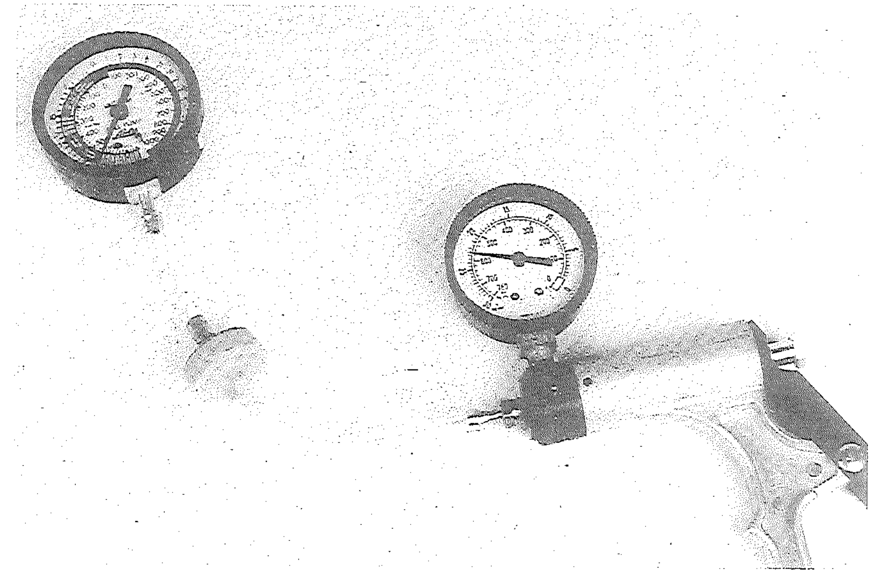


Figure 5.5. Apply vacuum to inlet side of delay valve. Valve should delay gauge reading on its outlet side by the specified number of seconds.

Testing Vacuum Check Valves

A vacuum check valve keeps the vacuum in a circuit constant while vacuum at the source is changing. During cold-engine operation, for example, a vacuum-controlled heat riser valve should have a constant supply of vacuum. If the vacuum supply to the heat riser drops too low, the valve may make an annoying noise. To prevent this problem, some vacuum heat riser circuits use check valves to keep the vacuum constant at the heat riser diaphragm.

Vacuum check valves are usually black and white and the black side of the valve is the vacuum source side of the valve.

When troubleshooting a vacuum circuit equipped with a check valve, be sure the valve isn't installed backwards. To test the check valve, remove it from the circuit and connect your vacuum pump to the black (vacuum) side of it. Connect a vacuum gauge to the white side of the valve (Refer to Fig. 5.6). If you apply 15-20 in/Hg vacuum to the black side of the valve, you should see 15-20 in/Hg on the gauge on the white side of the valve. When you remove the vacuum from the black side of the check valve, the vacuum on the white side of the valve should remain steady. If the vacuum on the white side of the valve leaks off at this point, replace the check valve.

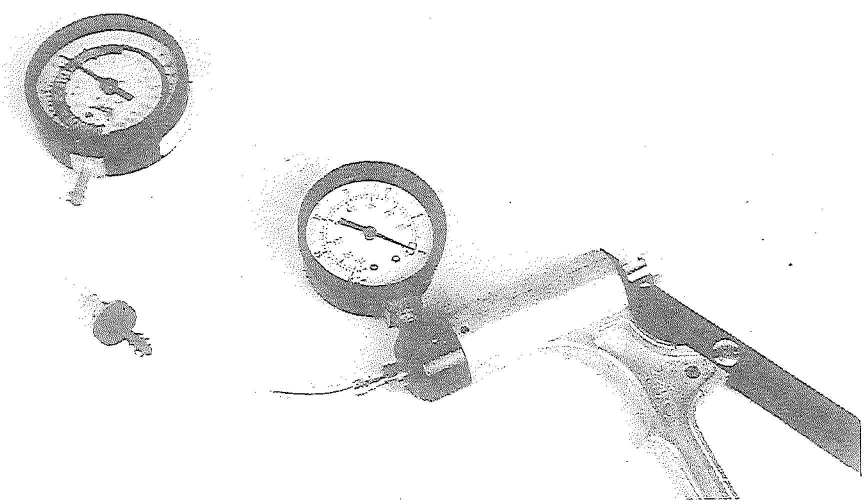


Figure 5.6. Apply vacuum to black (CARB) side of check valve, watch gauge reading on white side of valve. When vacuum is released through the vacuum pump's deflator valve, check valve should hold vacuum gauge reading.

Next, reverse the hookup. When you apply a vacuum to the white side of the valve, you should *not* see a vacuum reading on the black side of the valve (Refer to Fig. 5.7). Replace the valve if you see a vacuum reading on the black side of the valve.

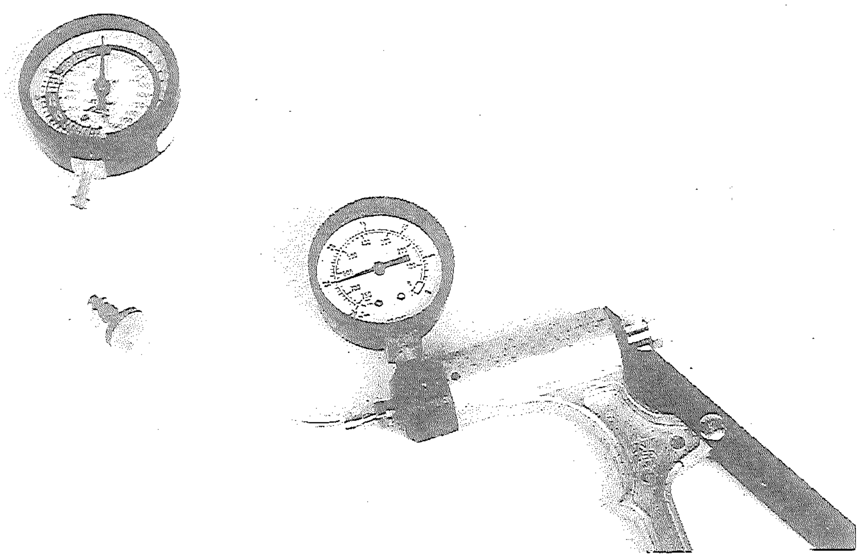


Figure 5.7. Apply vacuum to the white side of vacuum check valve. Valve should hold vacuum reading on vacuum pump. Gauge on valve's black (CARB) side should remain zero.

Testing Heated Intake Air Systems

In the late 1960s, emission laws forced car designers to lean out most carburetor calibrations. In order to preserve cold driveability, engines were outfitted with systems that preheat the air entering the carburetor. During cold engine operation, the preheat system closes a flap inside the air cleaner snorkel. When the snorkel flap closes, it forces the carburetor to draw heated air from around the exhaust manifold. When the temperature inside the air cleaner reaches about 100°F, the flap opens and the carburetor begins drawing outside air again.

Cold engine performance suffers whenever the snorkel flap does not close or doesn't *remain* closed long enough. In fact, carburetor icing can occur when the preheat system fails. If the flap closes and sticks closed, the engine usually begins pinging when it gets hot.

To test the preheat system, start the engine cold. Immediately after cold start-up, the flap should close. If the engine is already warm, chill the temperature sensor inside the air cleaner with ice or a cold wet rag. If the snorkel flap doesn't close, pull the hose off the vacuum motor mounted above the snorkel. Use your vacuum pump to check for vacuum at this hose (Refer to Fig. 5.8). If vacuum is present at this hose, connect your vacuum pump to the vacuum motor itself (Refer to Fig. 5.9). When you apply vacuum to the motor, it should close the snorkel flap and it should hold a vacuum. Replace the vacuum motor if it doesn't close the snorkel flap and hold a vacuum. Sometimes the vacuum motor does hold a vacuum but it doesn't close the snorkel flap. If this happens, the link connecting the motor to the snorkel flap is binding up.

If vacuum is not present at the vacuum motor hose on a cold engine, check the vacuum hose routing. If the hose routing is correct, replace the temperature sensor inside the air cleaner.

Preheat System Sensor Failure

Sometimes the preheat system appears to work fine but the engine still performs poorly when cold. This condition may be caused by an air cleaner temperature sensor that's opening the snorkel flap too soon. To double-check a suspect sensor, remove the air cleaner lid and place a thermometer inside the air cleaner (Refer to Fig. 5.10). Put the lid back on but don't install the wing

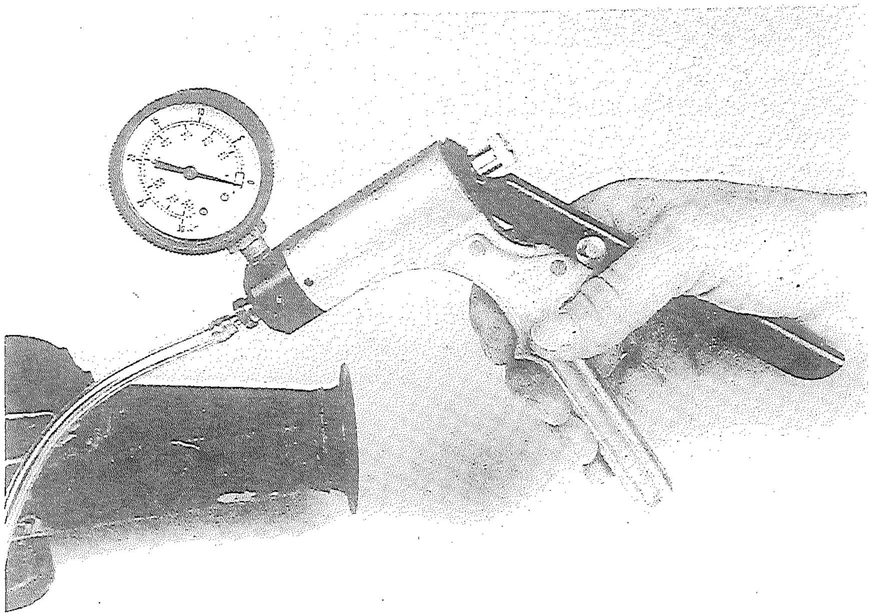


Figure 5.8. If you don't get a vacuum reading at the snorkel motor when the engine is cold, first check for broken or blocked vacuum lines. If the vacuum lines check OK, replace the temperature sensor inside the air cleaner.

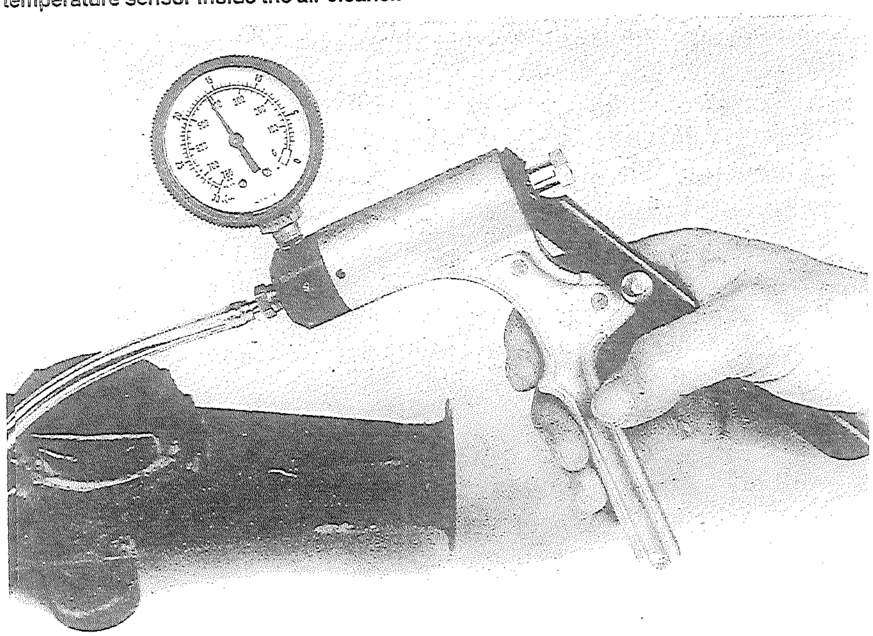


Figure 5.9. When you apply vacuum to the snorkel motor, snorkel flap should close quickly and the motor should hold a vacuum.

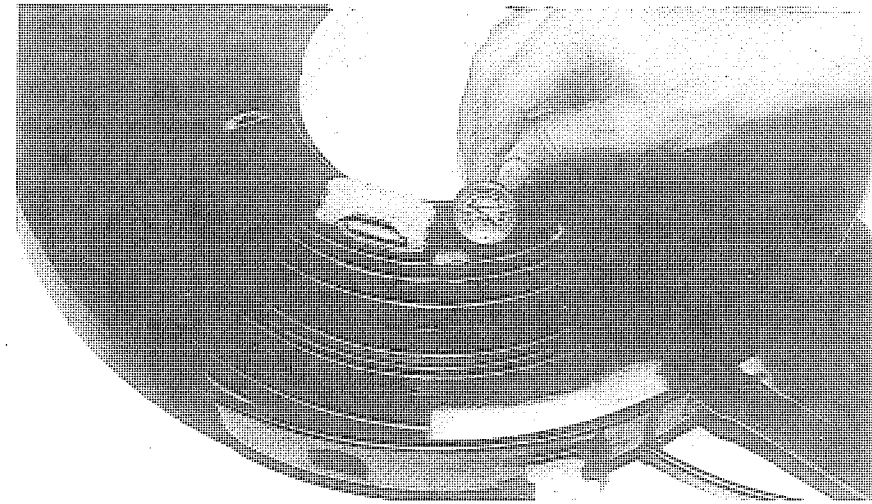


Figure 5.10. Air cleaner temperature sensor should hold snorkel flap closed until inlet air temperature reaches the specified opening temperature.

nut yet. Let the engine cool down for several hours. Start the engine and watch the snorkel flap. The moment the flap begins to open, lift the air cleaner lid and read the thermometer. Replace the temperature sensor if the thermometer reads less than the specified opening temperature of the unit being tested.

Testing Vacuum-Controlled Heat Riser Valves

During the 1970s, vacuum-controlled heat riser valves replaced most standard heat riser valves as original equipment. In the typical vacuum heat riser system, manifold vacuum is fed into a thermal vacuum switch. This switch is open when the engine is cold. Vacuum flows through the switch to a diaphragm mounted on the side of the heat riser valve. Therefore, manifold vacuum pulls the heat riser valve closed when the engine is cold. When the engine warms up, the switch closes, shutting off vacuum to the heat riser. A vent on the thermal switch bleeds off trapped vacuum between the switch and the heat riser diaphragm.

When the heat riser sticks open, the engine performs very poorly when cold. You may also notice that it takes an unusually long time for the choke to open. Fuel economy suffers. Sometimes, the choke will open but after several miles of driving, it will come back on again. When the heat riser sticks closed, the engine will begin pinging and/or overheating.

If the heat riser doesn't close when the engine is cold, remove the vacuum hose from the valve's diaphragm. Connect your vacuum pump to the heat riser diaphragm and apply a vacuum. (Refer to Fig. 5.11). The heat riser valve should close and its diaphragm should hold a vacuum. Replace the diaphragm if it doesn't hold a vacuum. If the diaphragm holds a vacuum but the valve doesn't close, try loosening up the valve with penetrating oil. Replace the heat riser valve if you can't loosen it up with penetrating oil.

NOTE: Graphite-based oils are excellent lubricants for *any* heat riser valve.

If no vacuum reaches the heat riser diaphragm when the engine is cold, check the vacuum hose routing. If the hose routing is correct, replace the thermal switch in the circuit.

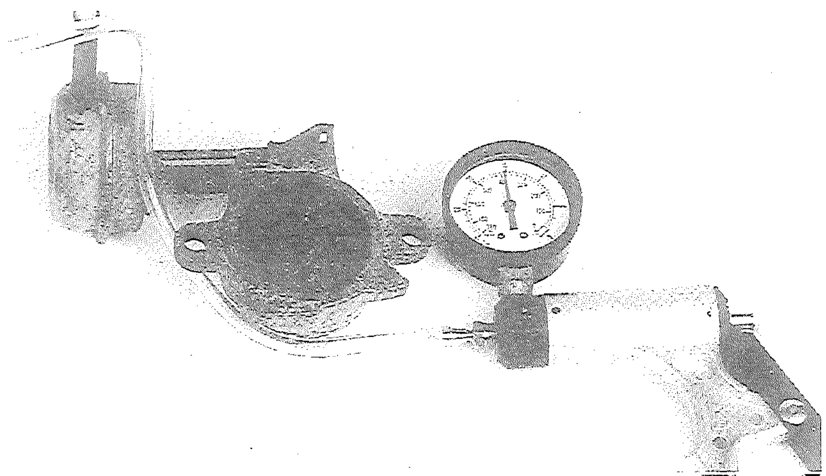


Figure 5.11. On some heat riser designs such as this GM Unit, the vacuum diaphragm *(left)* can be serviced separately from the heat riser valve itself *(right)*.

Testing EGR Systems

The EGR system recycles exhaust gas back into the engine in order to control combustion temperatures during part-throttle driving. Cooling the combustion chamber reduces oxides of nitrogen (NO_x) emissions. You can liken the action of the EGR system to throwing ashes on a roaring campfire — it partially quenches the fire without extinguishing it.

EGR systems are designed to only recycle exhaust gas during part-throttle driving. The EGR system should not operate during idle or wide-open throttle driving. *Most* EGR systems use a thermal vacuum switch to shut off their vacuum supply when the engine is cold.

The heart of the EGR system is a vacuum-controlled valve called the EGR valve. This valve regulates the flow of exhaust gas into the intake manifold. There are many different EGR valves in use today. There are also several different systems used to control the vacuum to the EGR valve. Always refer to your shop manual when troubleshooting an unfamiliar EGR system. In this section of the handbook, we'll describe some general test tips for EGR systems.

EGR Failure Symptoms

When any EGR valve closes, it shuts off the flow of exhaust gas into the intake. If an EGR valve is leaking, the engine will idle roughly, fuel economy will suffer, manifold vacuum will drop and the engine will tend to stall out easily. On a cold engine, a leaking EGR valve will cause persistent stalling. Remember that intermittent cold stalling can be caused by a bad thermal vacuum switch popping open. When the bad switch pops open, it allows vacuum to open up the EGR valve and stall the engine.

When the EGR valve does *not* open, the engine usually begins pinging. Besides controlling NO_x emissions, the EGR's cooling effect also minimizes detonation. Sometimes an engine begins pinging even though the EGR system seems to be working fine. If this happens, suspect a clogged EGR valve or clogged EGR passages inside the manifold (Refer to Fig. 5.12). With the engine warmed up and idling, open the EGR valve. Be careful! The EGR valve is hot. Protect your fingers with a shop towel or wear a glove. If the engine doesn't idle roughly or stall when you open the EGR valve, inspect the valve and the EGR passages.

EGR System Components

An EGR system may use any one of the three types of vacuum (manifold, ported, venturi) to control the EGR valve. However, some EGR circuits use a combination of two types of vacuum to control the EGR valve.

NOTE: If you have to refresh your memory on the types of vacuum, reread the first section of this handbook.

If you encounter an EGR system that uses a vacuum source called the EGR port on the carburetor, remember that this source reacts just like ported vacuum does.

EGR systems may use one or more of the vacuum devices we

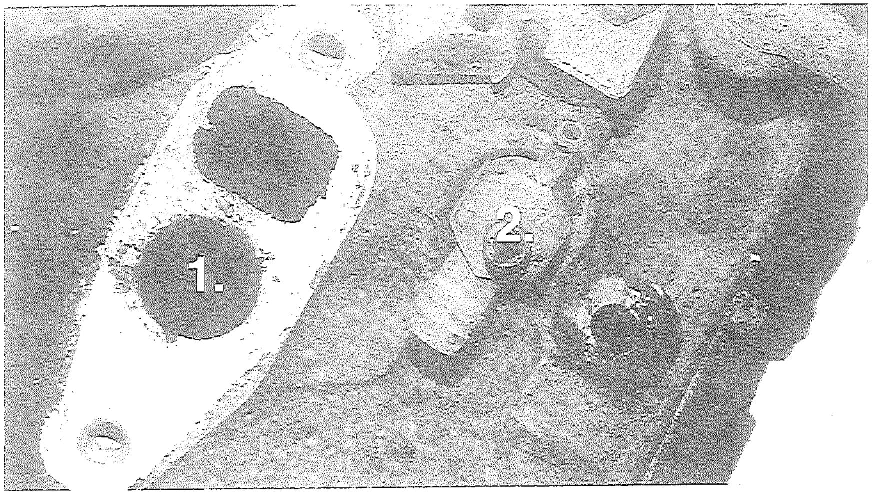


Figure 5.12. When manifold EGR passages (1) clog up with carbon, engine may begin pinging. Port that feeds transmission modulator (2) often suffers from carbon buildup too.

have already covered in this chapter. But among other components, an EGR system may use two important parts we haven't explained yet: the vacuum amplifier (Refer to Fig. 5.13) and the remote backpressure transducer. A vacuum amplifier, which has three or four vacuum ports on it, works like a vacuum relay. Manifold vacuum is fed into one of the amplifier ports. Venturi vacuum is fed into another port. When the carburetor sends venturi vacuum to the amplifier, the amplifier opens up, allowing manifold vacuum to flow through itself to the EGR valve. Remember, a venturi vacuum signal of 3-5 in/Hg turns on the amplifier. The amplifier then routes manifold vacuum directly to the EGR valve.

Testing Vacuum Amplifier

When testing an amplifier, check for a venturi vacuum signal first. Trace the hose from the carburetor venturi port to the amplifier and connect your vacuum pump to that hose. If you don't get at least 3-5 in/Hg at this hose when you rev the engine, check for a cracked hose or a dirty carburetor port. Next, idle the engine and check for manifold vacuum at the other amplifier port. When you know that you have both venturi and manifold vacuum reaching the correct ports on the amplifier, remove the hose from the EGR valve and connect your vacuum pump to it. If you don't get a manifold vacuum reading here when you rev the engine, replace the amplifier.

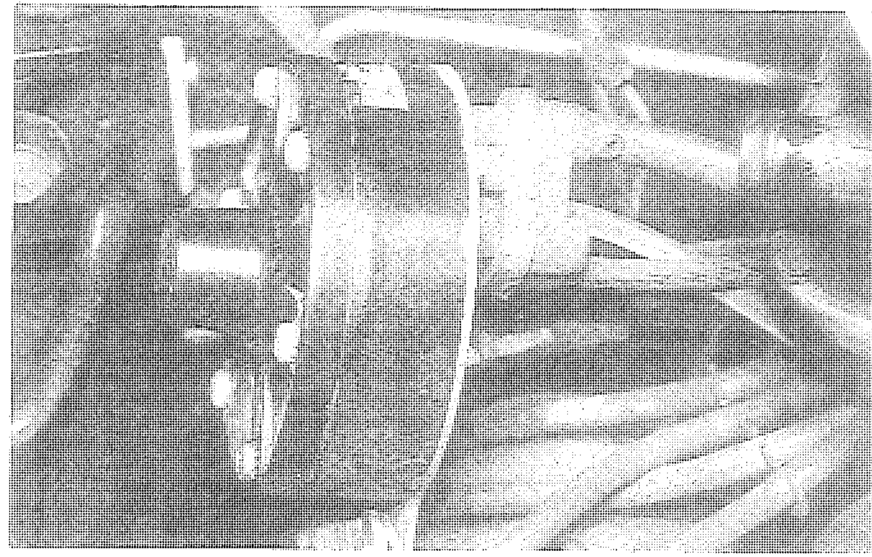


Figure 5.13. EGR vacuum amplifier acts like a vacuum relay: the weak venturi vacuum signal controlling amplifier swtiches the strong manifold vacuum signal on and off.

Some EGR valves are designed to modulate themselves according to changes in engine load. The valve senses engine load by sensing the backpressure in the exhaust system. Some EGR valves sense backpressure via an internal port. This type of valve is called an integral backpressure transducer type (Refer to Fig. 5.14). Other EGR valves rely on a separate device called a remote backpressure transducer (Refer to Fig. 5.15).

Testing Remote Transducer

To test a remote transducer, connect your vacuum pump to the hose that supplies vacuum to the transducer. If you don't get a vacuum reading here when you rev the engine, trace the vacuum circuit and correct the problem. If you do get a vacuum reading, reconnect the hose to the transducer. Then connect your vacuum pump to the opposite, or output, port of the transducer. If you don't get a vacuum reading at the output port when you rev the engine, replace the transducer.

Testing EGR Valves

Some EGR valves are tested with constant vacuum sources instead of with hand vacuum pumps. Always check your shop manual for the specific vacuum source.

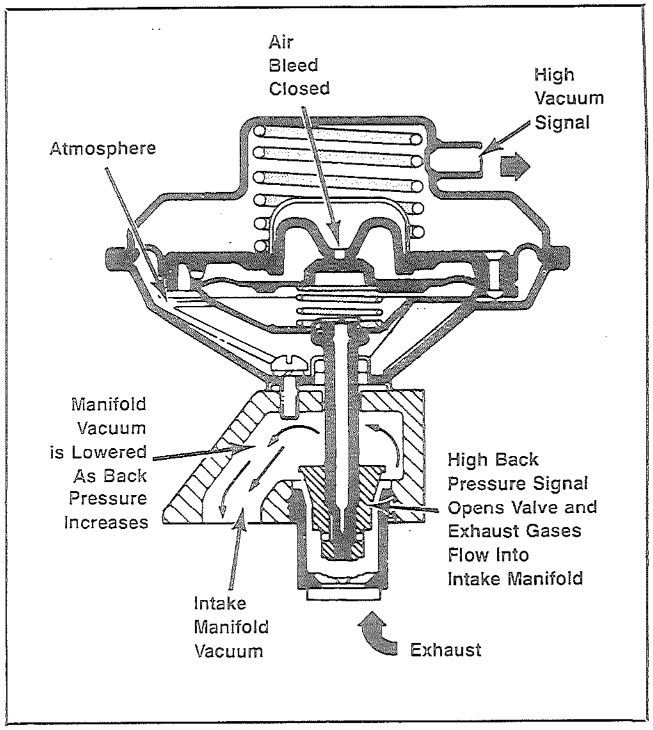


Figure 5.14. Here is one type of integral backpressure EGR valve. Unless exhaust backpressure is present—unless the engine is running—the air bleed in the center of the valve will remain open. You cannot pump open this EGR valve when the engine's not running. Check your manual for the specifications of the unit you are testing.

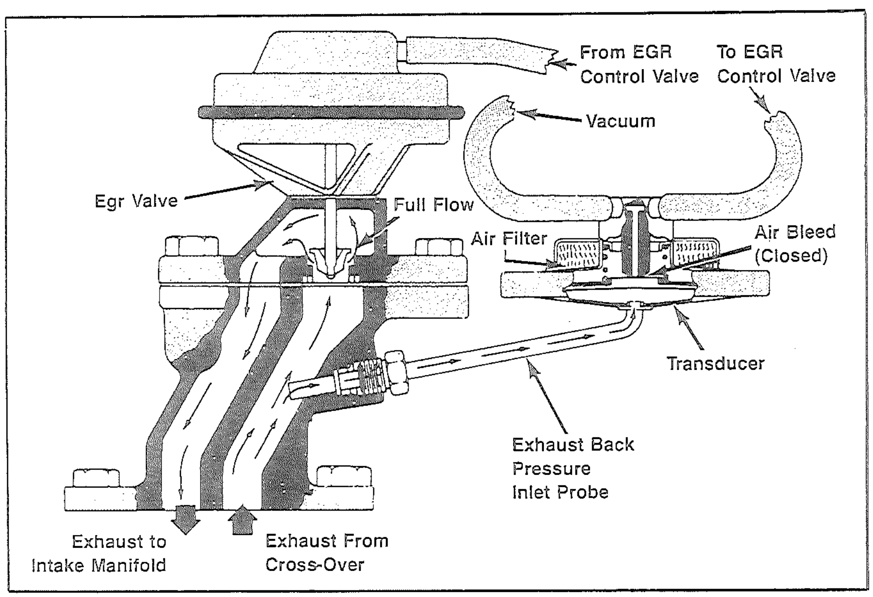


Figure 5.15. On a remote backpressure transducer EGR system, the EGR valve diaphragm should hold a vacuum. Exhaust backpressure enters the inlet probe and closes the air bleed inside the transducer. With the air bleed closed, control vacuum can pull the EGR valve open.

You can often diagnose a bad EGR valve by process of elimination. If the valve receives the correct vacuum signal but doesn't open when you rev the engine, the valve is bad 99% of the time.

Always refer to your shop manual before you test an EGR valve directly with your vacuum pump. You must know the type of EGR valve you are testing. Many EGR valve diaphragms are supposed to hold a vacuum. But many others will leak vacuum until exhaust backpressure closes a tiny air bleed inside the EGR valve.

Testing Transmission Modulators

Many automatic transmissions use a vacuum modulator as one means of sensing changes in engine load. Because a bad vacuum modulator can cause such a long list of shifting problems, check it first when a transmission misbehaves.

Pull the hose off the modulator. If you find transmission fluid or gasoline inside the modulator's nipple, replace the modulator. When you find gasoline here, check the engine for an overly rich mixture problem. Also, blow out the entire modulator hose with compressed air before you connect it to the new modulator. Check the hose routing at the engine. Be sure the hose runs steeply uphill toward the firewall before it turns downhill toward the transmission. A steep up-slope allows gasoline to run harmlessly back into the intake manifold.

If the modulator nipple is dry, apply a vacuum to it with your vacuum pump (Refer to Fig. 6.1). Replace the modulator if it doesn't hold vacuum.

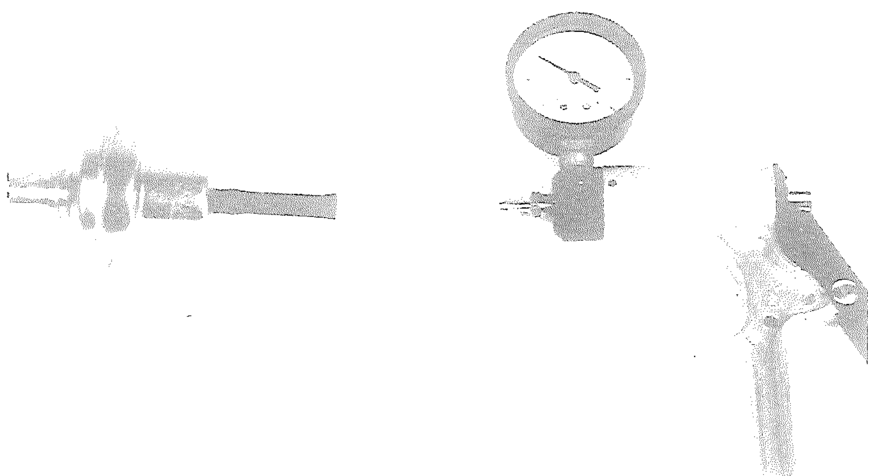


Figure 6.1. Modulator diaphragm should hold vacuum. Be sure it's the correct modulator for the application.

Whenever the modulator checks good and the transmission still shifts poorly, check the vacuum signal at the modulator before you troubleshoot elsewhere. Using a long piece of vacuum hose and a tee, connect your vacuum pump to the hose *at* the modulator. Then connect a vacuum gauge to an intake manifold

port on the engine (Refer to Fig. 6.2). Road test the vehicle. If the two readings aren't the same and don't react the same during the road test, trace the modulator line back to the engine. Look for cracks, crimps, or improper routing. Be sure the manifold vacuum port fitting that feeds the modulator is not clogged with dirt or carbon (Refer to Fig. 6.3).

Figure 6.2. Erratic shifts? Road test vehicle and compare vacuum signal at intake manifold with signal down at the modulator. Two signals should read the same and react the same during road test.

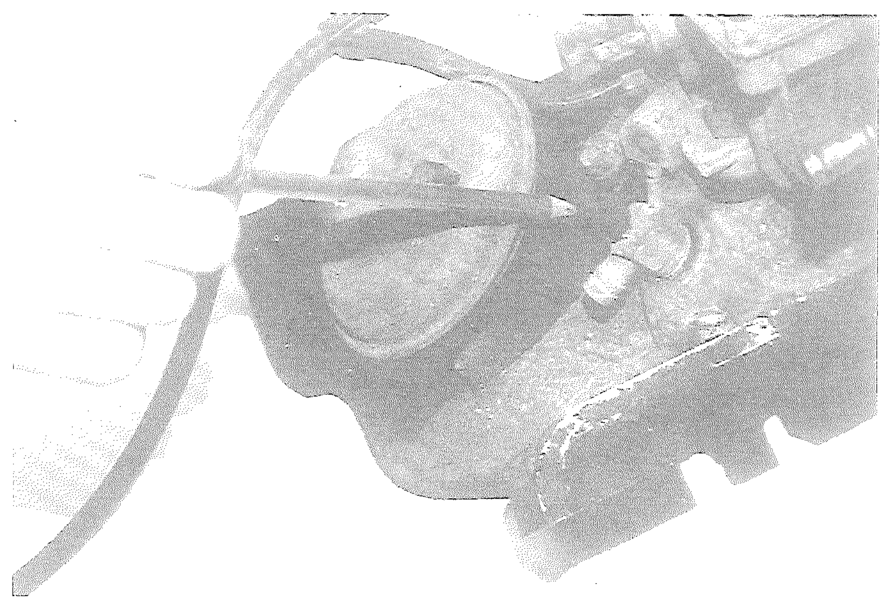


Figure 6.3. Carbon and dirt can accumulate inside intake manifold ports such as this one and restrict vacuum supply to the modulator.

Whenever you're troubleshooting an erratic shifting condition on a modulator-equipped transmission, look for these problems:

- misrouted hose. You may find that the last person to work on the vehicle connected the modulator supply hose to a ported vacuum source or worse yet — connected it to a vacuum reservoir.
- soggy hose. A strong manifold vacuum signal can suck shut an old, soft modulator hose.
- short hose. When the hose between the steel modulator line and the engine vacuum port is too short, engine movement can collapse the hose during normal acceleration. Remember that soggy motor mounts will aggravate this short-hose condition.

Chapter 7 BRAKE SYSTEM

Testing Power Brake Boosters

Vacuum-operated power boosters reduce the amount of brake pedal effort the driver must exert in order to stop his vehicle. When a driver complains that he has to step down a lot harder to stop his car, always check the power booster system first.

Begin by pumping the brake pedal slowly a few times to empty the power booster. Press lightly on the brake pedal and then start the engine. If the booster is working, the pedal will drop slightly and then hold. You'll now notice that it takes less effort to hold the pedal down.

If the power brakes don't react this way, remove the engine-to-brake booster hose from the booster and take a vacuum reading with your vacuum pump. If you don't get at least 14 in/Hg at idle, check for leaks or a basic engine problem. If you do get a healthy vacuum reading at this hose, the booster itself is at fault.

Even if the power booster passes the first test described above, *always* perform a vacuum leak check on it too. Connect your vacuum pump directly to the booster's check valve and apply a vacuum (Refer to Fig. 7.1). The booster should hold the vacuum. If the vacuum leaks down, remove the check valve and apply a vacuum to the booster-side of the valve. Replace the check valve if it leaks vacuum. If the power booster still doesn't hold a vacuum with a new check valve in place, the booster is bad.

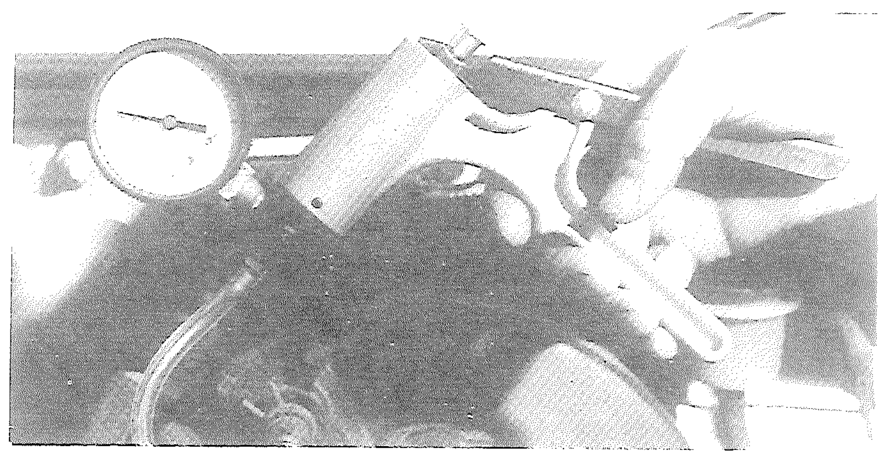


Figure 7.1. Poor-running engine with low manifold vacuum can affect power booster operation. Leaking power booster check valve is common condition. *Always* retest the booster after you've replaced a check valve.

You can use your vacuum pump to perform one-man brake bleeding operations. Before you attempt this operation, remove the bleeder fittings and clean them thoroughly. If you don't clean them, an air leak may occur at the bleeder fitting and ruin the operation.

Select the black 90° adapter fitting that best fits the outer end of the bleeder fitting (Refer to Fig. 7.2). Note, if none of the 90° adapters properly fit the bleeder fitting, use the conical brake bleeder adapter by inserting the conical adapter into the bleeding screw. Connect the bleeder fitting adapter to the 24″ vinyl hose. Note that the bleeder reservoir lid has two hose fittings through it and that from one of these hose fittings a 2″ vinyl hose extends into the bleeder reservoir. Connect the other end of the 24″ vinyl hose to the hose fitting that also connects to the 2″ vinyl hose (Refer to Fig. 7.3). Connect one end of the 12″ vinyl hose to the other hose fitting in the lid and connect the other end of the 12″ vinyl hose to your vacuum pump. Put a light coating of the kit's lubricant on the bleeder fitting's threads (Refer to Fig. 7.4). Reinstall the bleeder fitting.

Remove the clear reservoir from the white cap. Put a film of the special lubricant around the rim of the reservoir (Refer to Fig. 7.5) and then screw it snugly back into the white cap. If any air leaks past the reservoir-cap seal, you won't be able to siphon fluid into it.

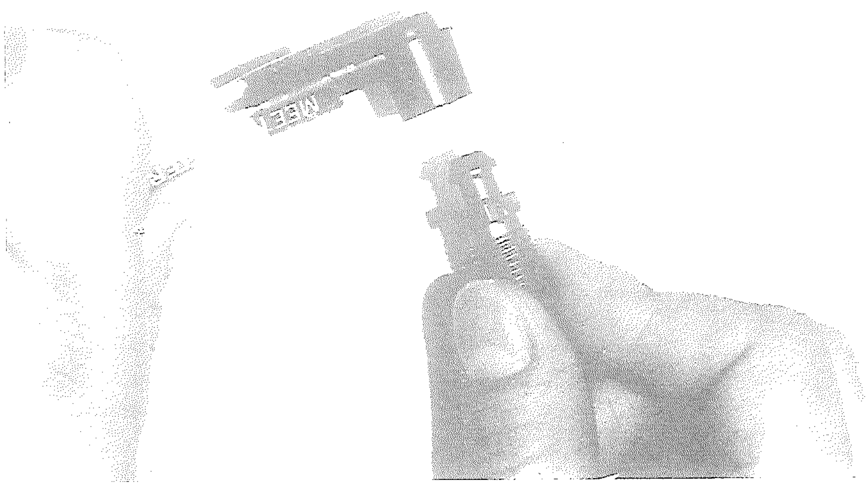


Figure 7.2. Black 90° adapter must fit snugly onto the bleeder fitting. Thoroughly clean bleeder fitting before applying the 90° adapter.

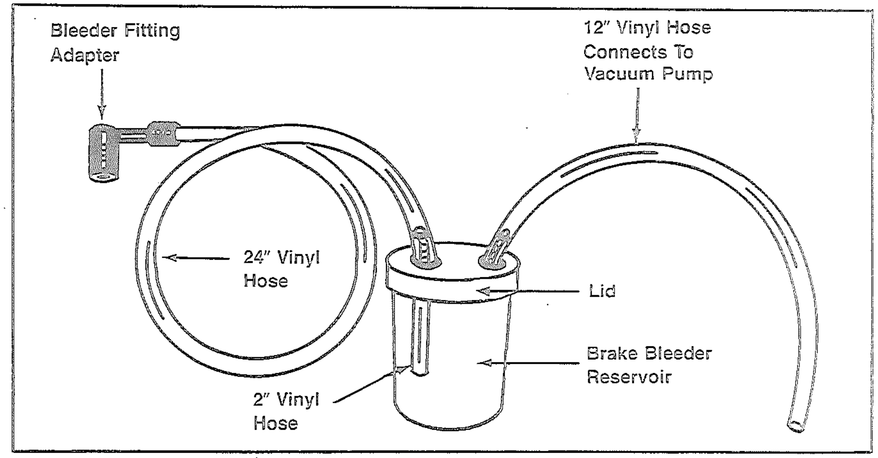


Figure 7.3. Whether you're bleeding brakes or siphoning another fluid, connect the hose that attaches to the bleeder fitting or the liquid being siphoned to the lid fitting that also has the 2″ vinyl hose extending into the brake bleeder reservoir. Connect the hose that goes to the vacuum pump to the other lid fitting.

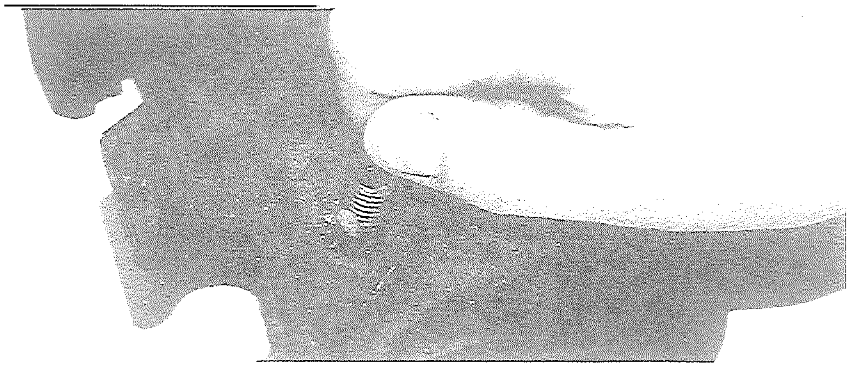


Figure 7.4. Air leaks can occur at the bleeder fitting threads. Lube them with the special grease provided before you begin bleeding brakes.

Figure 7.5. Lubricating the lip of the bleeder reservoir prevents air leaks. Be sure to apply grease around the entire lip.

Place your bleeder wrench on the bleeder fitting that's farthest from the master cylinder. Always bleed the wheel cylinder or caliper farthest away from the master cylinder *first*. Dab some lubricant into the black adapter (Refer to Fig. 7.6) and then snap the adapter onto or into the bleeder fitting. Apply a vacuum to the bleeder vessel (Refer to Fig. 7.7). Watch the fluid flowing into the reservoir. When you see a solid stream of bubbleless fluid flowing into the reservoir, retighten the bleeder fitting. Discard this fluid and proceed to the bleeder that's next-closest to the master cylinder. Top off the master cylinder with fresh fluid and then repeat the bleeding procedure described above.

NOTE: To siphon any liquid, always use the liquid transfer accessories. DO NOT draw liquids directly into the pump.

Equivalent Lubricants

Never substitute an oddball lubricant for the bleeder lubricant supplied with your vacuum pump. If you do, you risk damaging the rubber parts of the brake hydraulic system.

The lubricant supplied in the kit is Dow-Corning Molykote 111. Molykote 111 is commonly available at electronics stores and at industrial supply houses that distribute Dow-Corning products.

This type of lubricant is also packaged by some automotive parts manufacturers (Refer to Fig. 7.8). Examples of equivalent lubricants are Permatex's part number 67VR, Echlin's ML-3, and Motorcraft's WA-10.

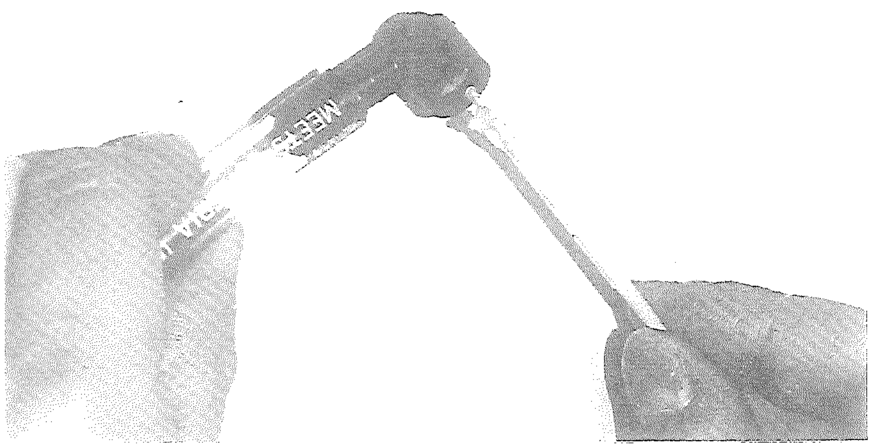


Figure 7.6. Dab a little grease inside the 90° black adapter to prevent air leaks between the adapter and the bleeder fitting.

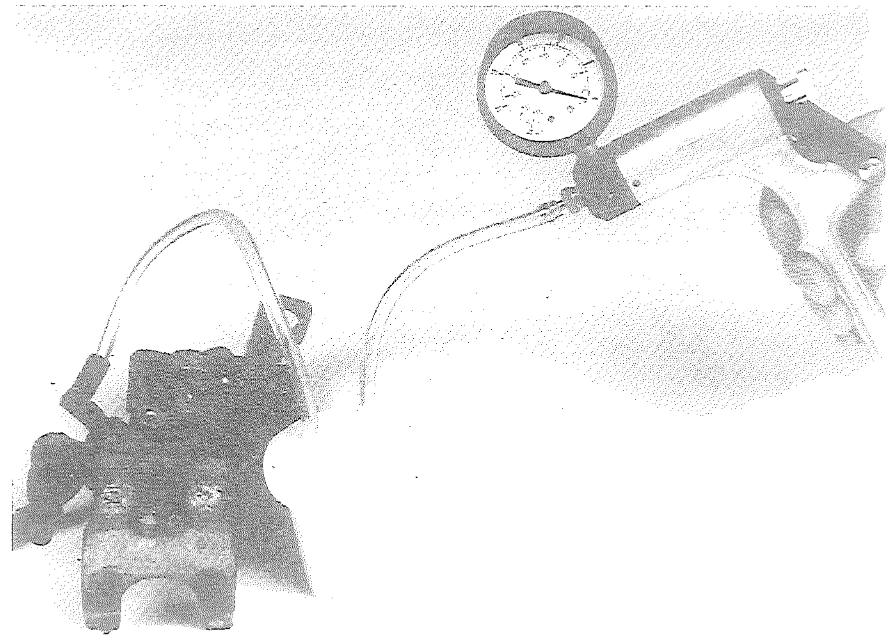


Figure 7.7. Plumbing completed, you're ready to bleed brakes. This is the same basic arrangement you'd use to siphon any fluid substance.

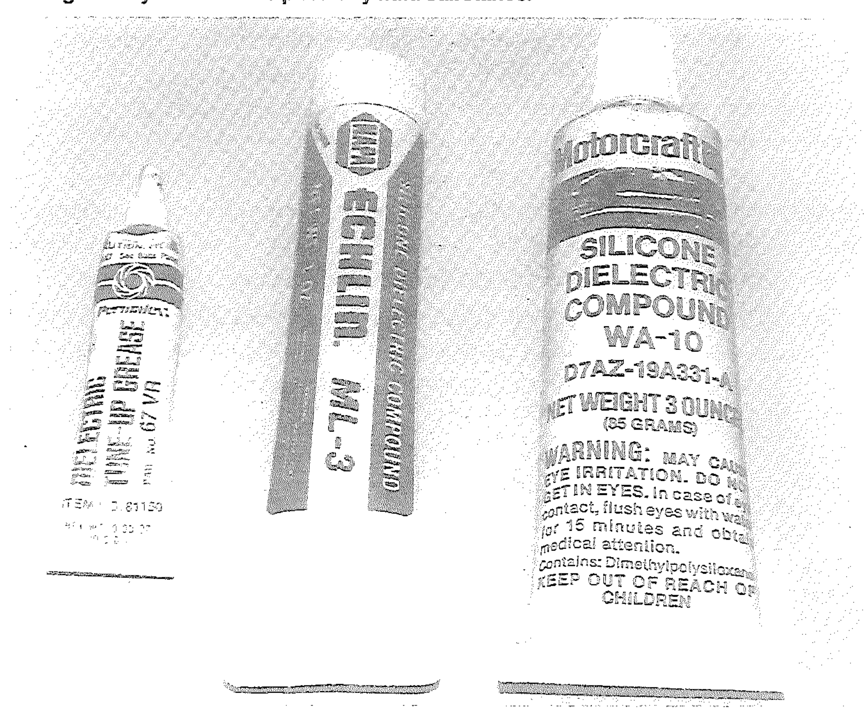


Figure 7.8. Some of the safe lubricants you can use in place of the Dow-Corning 111 grease. Oddball lubricants may damage rubber brake parts.

Heater Control Valve Check

The heater control valve is a vacuum-contolled water valve that shuts off coolant flow through the heater core when the air conditioner is turned on. A stuck-shut heater control valve causes a no-heat condition. A stuck-open heater control valve causes an insufficient cooling complaint when the customer uses the air conditioner.

No heat? Feel the heater hoses on both sides of the heater control valve. If the hose on the heater-side of the valve is noticeably cooler than the hose on the other side of the valve, the valve is stuck shut.

Insufficient cooling complaint? Perform the routine air conditioning checks. If the system pressures are normal and the system is fully charged with refrigerant, check for a stuck-open heater valve. When the air conditioner goes on, the heater control valve must close. If it doesn't close when you turn on the air conditioner, pull the vacuum hose off the heater valve.

Connect your vacuum pump to the heater valve and apply a vacuum to it (Refer to Fig. 8.1). If the heater control valve doesn't move when you apply the vacuum — or if its diaphragm doesn't hold vacuum — replace it.

If the heater control valve works fine when you apply the vacuum, you know the problem is in the vacuum circuit between the dashboard controls and the heater valve itself. Open your shop manual and trace the problem in the circuit.

Remember that your vacuum pump is essential for troubleshooting vacuum circuits and vacuum motors under the dashboard that control heating/air conditions functions.

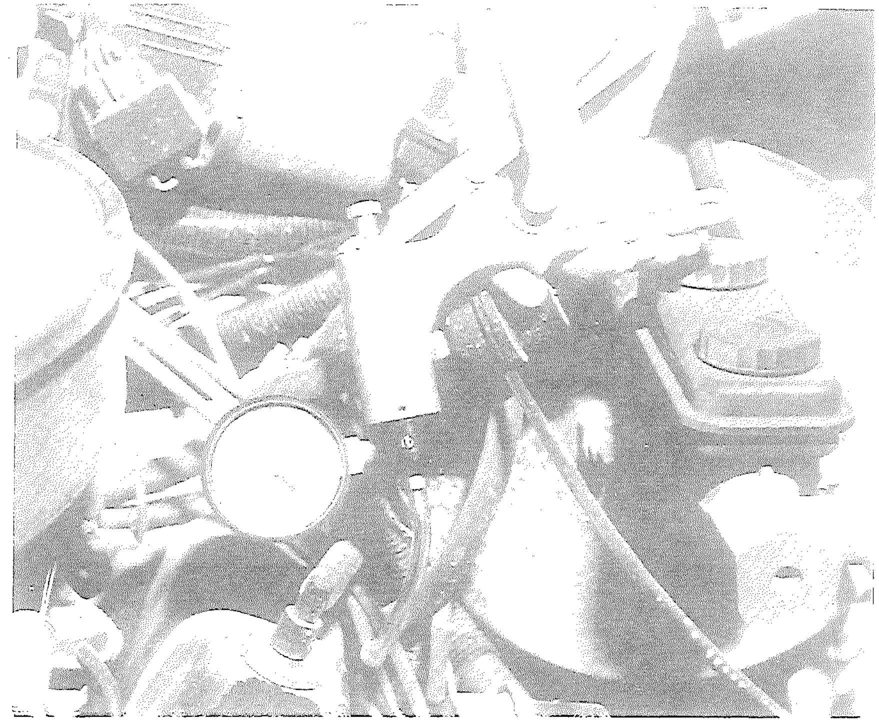


Figure 8.1. To prevent the heater from competing with the air conditioner, heater control valve shuts off water flow through heater core whenever the air is turned on.

Testing Computer Sensors

Most engine control computer systems use a sensor that senses manifold vacuum and converts the vacuum reading into a voltage. The computer reads this voltage and adjusts the ignition timing and fuel mixture accordingly. The sensor may be called a vacuum sensor, a MAP (manifold absolute pressure) sensor, or it may be a combination MAP/barometric sensor.

Usually, you test the voltage going into the sensor first. This is called input voltage or reference voltage. If the reference voltage is correct, apply a specified vacuum (usually 10-15 in/Hg) to the sensor (Refer to Fig. 9.1). When you apply the vacuum, the output voltage or sensor voltage should vary a specified amount. If the voltage doesn't vary the specified amount, the sensor is bad.

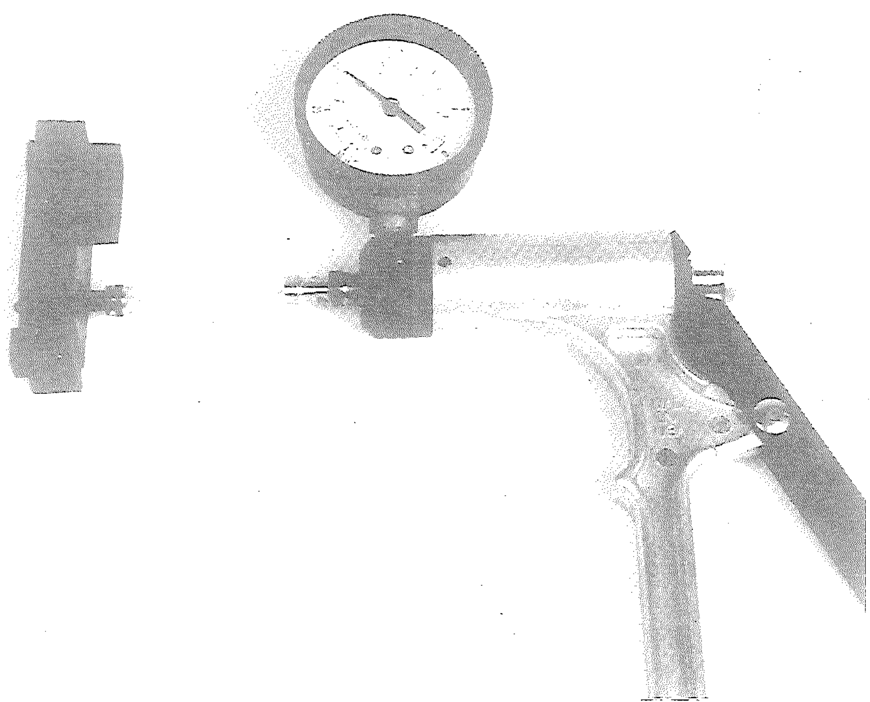


Figure 9.1. When you apply a vacuum to the typical vacuum sensor (GM MAP sensor shown here), the sensor should vary its output voltage.

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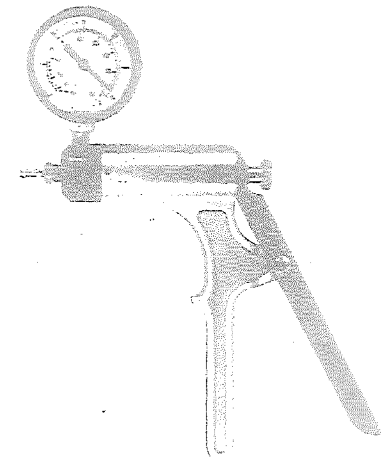
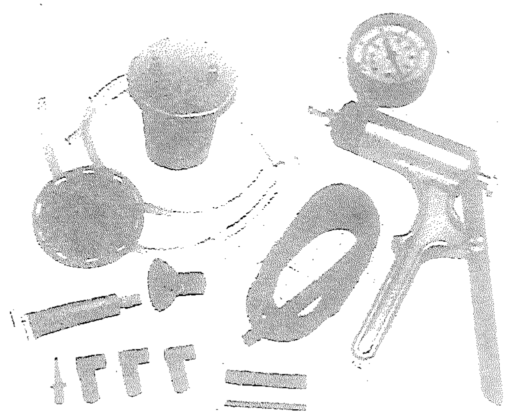
Vacuum Pump Includes:
2" x .250 ID Hose
2" x .109 ID Hose
Hose & Cone S/A
Users Manual



Vacuum Pump Kit Includes:
Vacuum Pump
Sealing Grease
Storage Lid
12" Vinyl Tube
24" Vinyl Tube
Storage Case
Transfer Bottle S/A
Hose & Cone S/A
Hose
Users Manual



Vacuum Pump Repair Kit Includes:
Cup Seal
Check Valve (Clear Seal)
Deflator Valve (Red Seal)
Umbrella Check Valve
O-Ring