Engine knocking? Poor drivability? Reduced mpg? check your EGR

By RAY HILL

EGR. You've heard the term before. Exhaust Gas Recirculation has been a feature of most cars made in America since 1973, and of many foreign cars sold in the U.S. It plays a big role in engine driveability.

A malfunction in the EGR system can cause knocking, rough idle, no idle, poor acceleration, and decreased gas mileage, and can contribute to engine overheating. Yet it's one of the most neglected systems on a modern car," Steve Mercaldo told me recently. Steve is a former mechanic and garage owner, and for the past several years has been a highly respected automotive mechanics instructor in Lindenhurst, N.Y. His office is filled with

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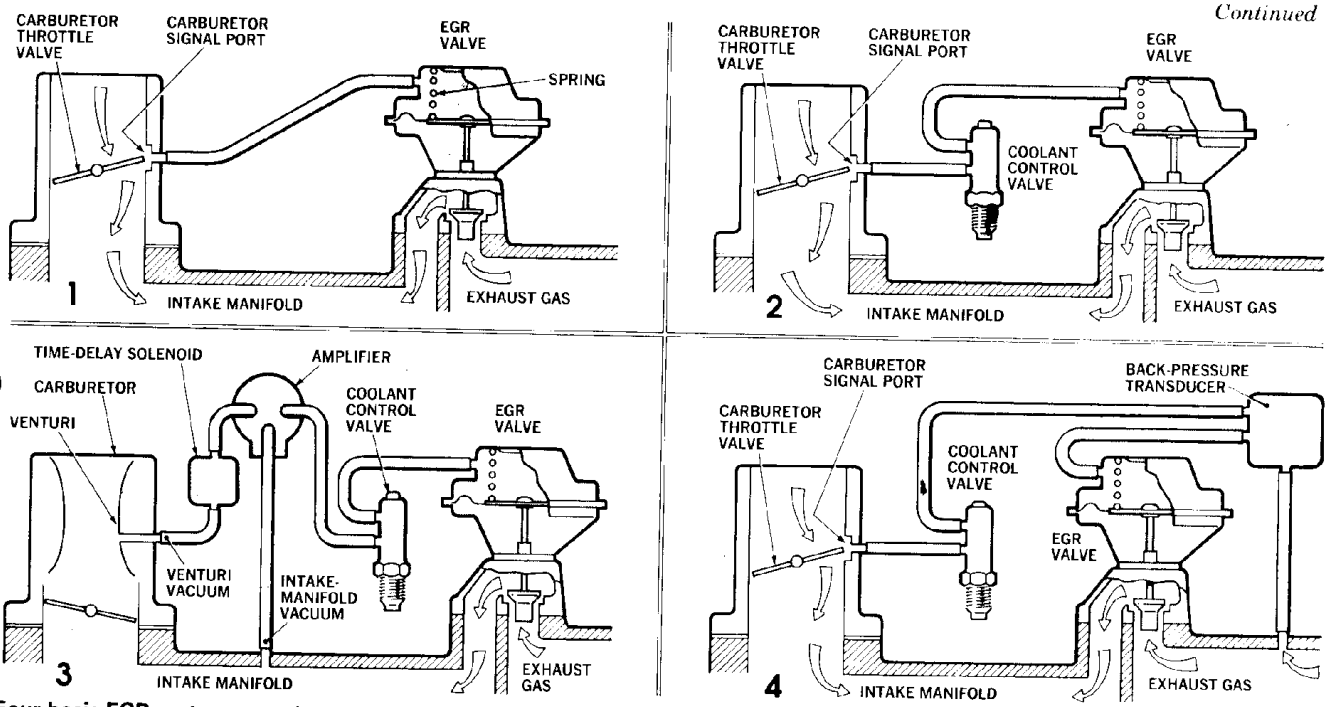


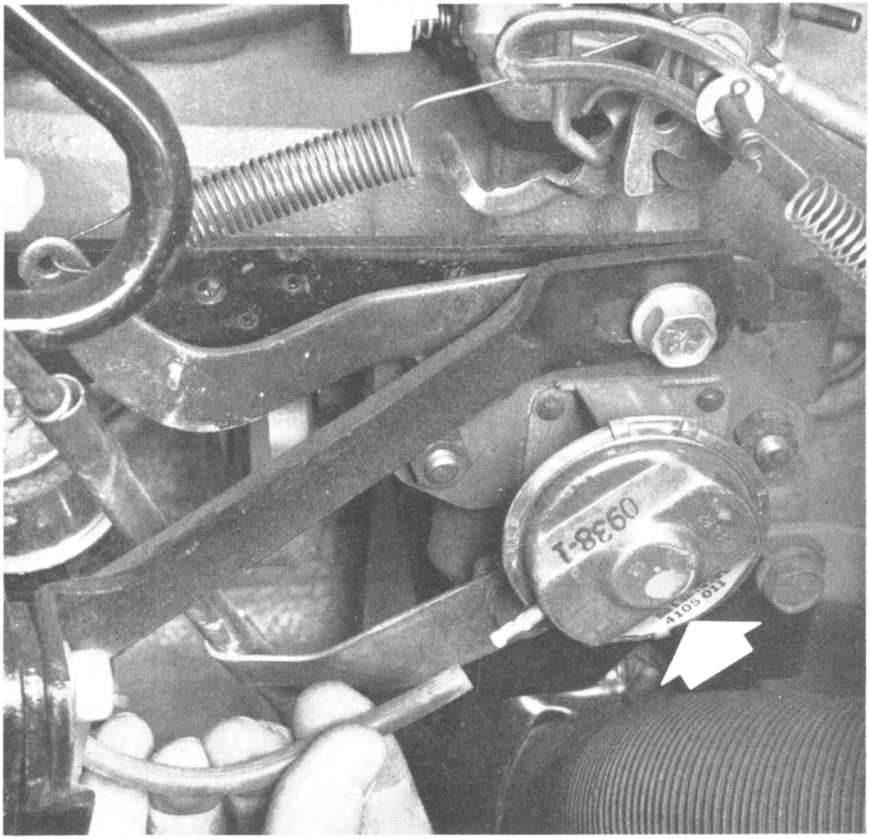
Four basic EGR systems are shown above. The EGR valve does the same job in all four; systems differ in how the valve is triggered. Your EGR system may be exactly like one of the four.

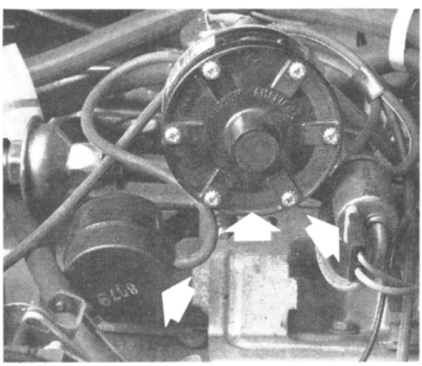
1. Basic system consists of the EGR valve, connected to a calibrated port just above the carburetor throttle-plate pivot. At idle the throttle is closed, so no vacuum reaches the signal port. When the throttle is opened, and an increased amount of fuel-air mix rushes down the carb throat past the signal port, vacuum is created in the hose connecting the EGR valve to the signal port—thus opening the EGR valve and allowing exhaust gas to recirculate into the combustion chambers to do its job.

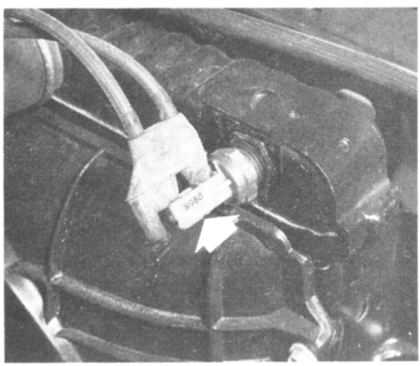
2. With coolant control valve (CCV), the system works like system 1, except that the coolant control valve (sometimes called a coolant-temperature override valve) acts as an intermediary between carburetor signal port and EGR valve. The CCV prevents vacuum from reaching the EGR valve until engine coolant reaches a certain temperature (which varies on different engines). Because EGR isn't allowed until the engine warms up, driveability is improved. Sometimes an ambient temperature-control valve may be added, which works much like the CCV, except that it is sensitive to under-hood temperature.

3. Venturi-vacuum control uses a vacuum tap at the carburetor venturi. Because the vacuum produced here is not strong enough to open the EGR valve, an amplifier is used. As the vacuum from the venturi tap reaches a predetermined level (depending on throttle opening) a diaphragm in the amplifier moves, permitting strong intake-manifold vacuum to reach the EGR valve—providing engine coolant is warm enough to open the coolant control valve, and also providing that the time-delay solenoid allows vacuum to pass to the coolant valve and to the EGR valve. The time-delay solenoid is designed to eliminate exhaust-gas recirculation for several seconds after the engine is started (from 30 to 90 seconds, depending on the engine). When the ignition is turned on, a timer in the ignition run circuit completes an electrical circuit to the time-delay solenoid, energizing it and closing a built-in vacuum valve in the solenoid. When the timer opens the circuit to the solenoid, the valve in the solenoid opens, permitting vacuum to pass. (On some engines the coolant valve is replaced with an electronic charge-temperature control that monitors temperature of the fuel-air charge in the inlet track—found on most 1979 Chrysler engines.)

4. Exhaust back-pressure system works like a number 2, except that an exhaust back-pressure transducer is added. It bleeds off vacuum to the EGR valve (the amount of bleed is determined by exhaust back pressure). At heavy engine loads, when combustion temperatures are higher and more EGR is needed, exhaust flow is greater, thus causing the back-pressure transducer to allow more vacuum to reach the EGR valve, which in turn allows more exhaust gas recirculation—providing, of course, that the engine coolant has warmed up enough to open the coolant control valve to allow vacuum to pass. Note: On some engines the back-pressure transducer concept is incorporated into the EGR valve itself—eliminating the transducer as a separate element in the system.







Typical EGR components: top photo—the EGR valve itself. Vacuum hose that attaches to the valve can easily be removed for checking. At bottom left, amplifier is in the center (arrow), time-delay solenoid to its left. Photo at right shows the coolant control valve, which monitors coolant temperature and controls vacuum.

EGR valve is shown removed from vehicle. The stem (shown by finger) connects the diaphragm (left of finger) to the valve at the end of the stem (right).

trophies won by past **students** in state and national automotive trouble-shooting competitions.

"Most do-it-yourselfers overlook the EGR because they don't know how it works," he says. "Unfortunately, it frequently gets neglected at the garage. too."

Steve and other pros suggest that the EGR system be checked every 12,000 to 15,000 miles and at every tuneup. You should specifically request that it be checked at tuneup, or check it yourself. We hope to demonstrate here how important it is to keep your EGR functioning.

What EGR does

To reduce hydrocarbons and carbon monoxide to an acceptable level. engineers have designed engines to run on leaner fuel mixtures. But that increases combustion temperatures, which increase furmation of nitrogen oxide (NOx), another pollutant. To keep NOx at an acceptable level, they developed the EGR system. It recirculates exhaust gases into the combustion chambers, reducing combustion temperatures, thus reducing NOx formation.

At engine idle, the EGR system

should be inoperative. It is designed to operate at cruise mode, in the 20-70-mph area. It, may rely on a variety of inputs-engine vacuum (carburetor venturi vacuum coupled with manifold, or ported, vacuum), coolant temperature, ambient temperature. and exhaust back pressure (see drawings).

If the EGR valve sticks partially open (a common malfunction), or if it opens too early, driveability will suffer.

This can be dramatically illustrated when the car is idling by manually opening the EGR valve with your fingers. The engine immediately dies or runs extremely rough.

On the other hand. it's important that the EGR valve not remain closed all the time. This way, engine driveability doesn't suffer. But detonation (spark knock or pinging) can occur. And because fuel mixtures are lean, the engine may run hotter than it should, since combustion-chamber temperatures are not being reduced by the exhaust gas. Eventually the result may be burned valves and blistered spark-plug electrodes.

Checking the EGR

How do you check the EGR system? Basically there are two ways.

Method one. Let's take the easier way first-using only a tachometer.

Identify the system in your car (see drawings). It may not be exactly like any of the four typical systems shown, but may incorporate some components from each. Use a shop manual if available. If not, check the vacuum-hose routing label on your car. Many later-model cars have this label attached.

The engine should be cold. First

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Check your EGR

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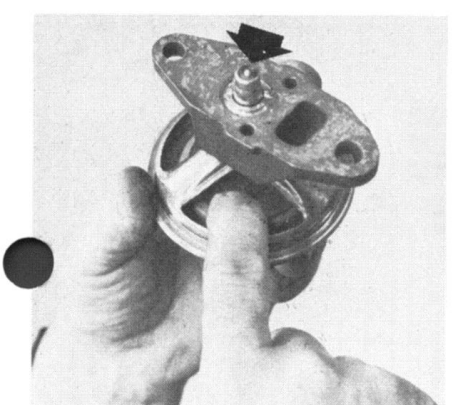

A poppet valve **(top photo) controls the EGR. Unit in bottom photo.uses a tapered valve to do the job. Both valves work okay--just two different ways of doing the same job. By depressing the diaphragm, bottom photo, you can see if the stem between the diaphragm and valve is broken (the valve should open).**

check all the hoses, using the routing label, to make sure they're all attached at the proper places, and are not loose or cracked.

Connect the tachometer, and start the engine. If the EGR system has a time delay, wait a couple of minutes until it deactivates. (If the engine has a coolant control valve, allow time for the engine to warm up.1

Have a friend accelerate the engine to 2500 (don't exceed 3000 rpm) and hold at this speed for a second or so. Observe the stem on the EGR (that's the slim rod that connects the diaragm in the EGR valve to the poppet, or tapered valve). The stem should move 1/8 inch or more when you accelerate.

If you can't see the stem, put your fingers on it or on the back of the valve

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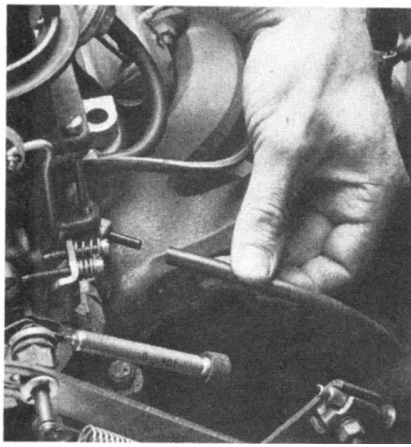
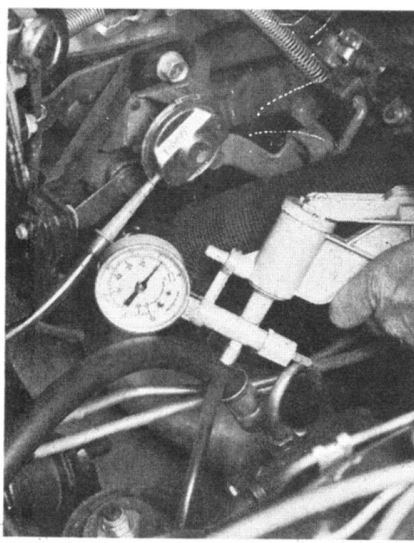


Typical manifold vacuum tap at the base of the carb is shown. When removing the vacuum hose from any tap, especially with older hoses, rotate the hose back and forth with your fingers until it breaks free of the tap-before pulling the hose off.' Any vacuum hoses that don't fit snugly should be replaced.



Vacuum pump can be used to test some EGR valves. The pump pictured above is sold by Azusa Engineering, 1542 Industrial Park St., Covina, Calif. 91722.

diaphragm and see if you can feel it move. (Be careful: you may burn your fingers if the engine is hot.)

If you can neither see nor reach the stem, remove the vacuum hose attached to the EGR valve and put your finger over the end of the hose. You should be able to feel suction when the engine accelerates.

If the valve stem moved, the EGR valve is working. But is it doing its job? To find out, disconnect the vacuum line that goes to the air cleaner at the ax-cleaner connection. On older cars, where the hose has hardened and doesn't come off easily, take care that you don't damage the nipple it's at-

tached to. Let the engine idle and place this hose over the vacuum-hose connection on the EGR valve. The engine should either die or run very rough.

Method two. This method, which uses tach, vacuum pump, and vacuum gauge, is a little more thorough and accurate. The engine must be cold for this test. Begin as you did earlier. Identify the system and inspect the hoses.

Next, check the coolant control valve—sometimes referrred to as a coolant temperature override—if there is one. Disconnect the vacuum hose to the EGR valve and install a vacuum gauge in the hose. Connect your tachometer.

Now run the cold engine at a steady 2500 rpm. Check the vacuum reading; it should be zero. (If the EGR system has a time delay, allow a couple of minutes for it to go off before performing this test.)

Let the engine warm up to a temperature above that at which the temperature control valve operates (see shop manual specs). Operate the warmed engine at about 2500 rpm and observe the vacuum gauge. It should indicate some vacuum, usually more than 2½ inches.

Now check the EGR valve. Let the hot engine idle, and attach your hand vacuum pump to the EGR valve. Apply the same amount of vacuum to the valve as you noted when the engine was running at around 2500 rpm. (This test doesn't work on recent GM cars and others that use exhaust back pressure in the EGR valve.)

The engine should now die or lose speed and idle roughly.

Disconnect the vacuum gauge and vacuum pump. Reconnect the EGR hose to the EGR valve.

Now connect the vacuum gauge to a source of manifold vacuum. It should read between 17 to 21 inches, and the needle should be steady. If everything checks out so far, you have good manifold vacuum and the EGR system is working okay. If the rest of the engine is tuned to specs, you know you're set up for maximum driveability and performance.

Troubleshooting

If the system doesn't check out, take it to a garage or troubleshoot it yourself.

Let's say you get no EGR—the EGR valve doesn't open when the engine is warm and revved to 2500 rpm.

First check the vacuum lines. Make sure they're routed and connected correctly, and that they are not cracked or deteriorated. Replace any that are in poor shape.

Make sure the lines aren't obstructed by removing each line and blowing through it. If an obstruction can't be removed, replace the line.

Check the coolant control valve. Remove the line from the vacuum source where it connects to the valve. Attach a vacuum gauge to the line and accelerate to 2500 rpm. You should get a reading above 2½ inches when you do this.

If you get no vacuum, check back to see why. Depending on the system, the cause could be such things as a plugged carb port, a bad amplifier, or a bad time-delay solenoid (check the latter by removing the hose from the vacuum source that attaches to the solenoid). Attach the vacuum gauge to the hose and accelerate to 2500 rpm. You should get a reading of more than 2½ inches on the gauge. If so, reattach the hose to the solenoid, and attach the vacuum gauge to that hose that comes out the other side of the solenoid. Accelerate to 2500 rpm. If you get no vacuum, it's either the solenoid or the delay timer, which attaches electrically to the solenoid and operates the valve inside the solenoid. (Check your service manual for specs on further solenoid and timer checking.)

Now check the vacuum at the EGR valve. If you don't get vacuum here, either the line is clogged or the coolant valve is bad. If the line isn't clogged, replace the coolant valve.

The amplifier?

If you suspect a bad amplifier, follow service-manual specs for checking your particular model. Basically, though, the check goes like this. You determine if you have manifold vacuum to the amplifier at idle. And when you accelerate you should get about ½ inch of vacuum from the line connecting the carb to the amplifier. If you get this, then suspect a bad amplifier (assuming the coolant control valve is okay).

Hook up your vacuum gauge to the vacuum line running from the amplifier to the EGR valve. If you get no vacuum when accelerating to 2500 rpm, you know you have a bad amplifier; replace it.

If the EGR valve doesn't move when you accelerate to 2500 rpm and everything is okay up to the EGR valve, shut the engine off. Connect a hand vacuum pump to the valve and draw about 10 inches of vacuum. The valve should hold this. If it leaks down, the

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Check your EGR

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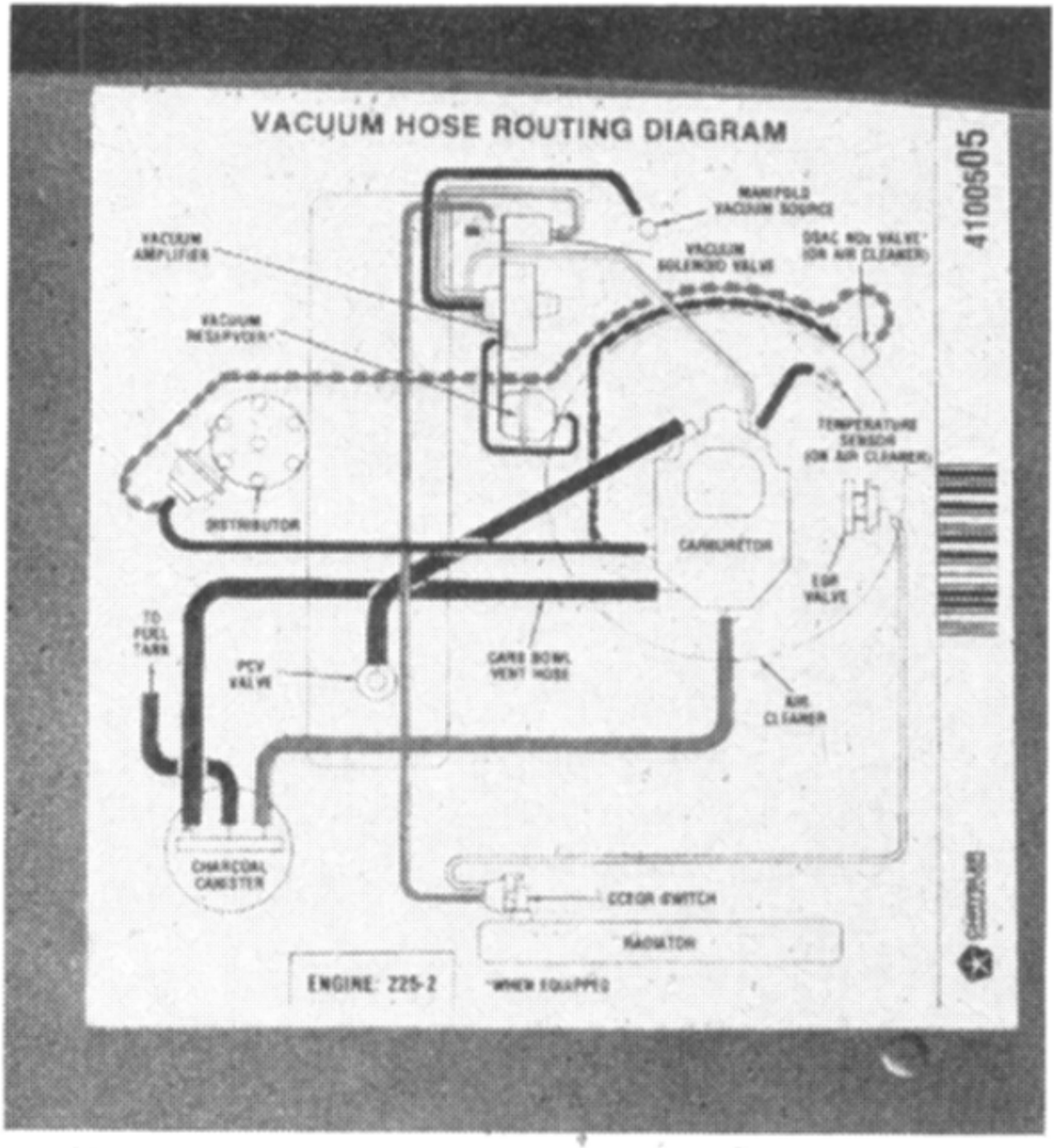

Vacuum-hose routing diagram—this one from a late-model six-cylinder Volare—is found on many newer cars; lets you see where each hose should be connected.

diaphragm inside the valve is had. Replace the valve. This test is no good on most Ford valves and some GM and AMC valves, they are designed to leak down. However, if the valve doesn't move when you accelerate to 2500, and everything seems okay up to the valve, chances are that the valve is faulty.

If the engine idles rough and everything checks out okay, including the EGR hnlding 10 inches of vacuum, then suspect the valve is not closing at idle. Remove and inspect it.

If the valve is clogged open with carbon and cannot be cleaned. or if for any other reason it can't be made to close. replace it. Also make sure the intake manifold passages arc clear. Use a new gasket (gasket sealer isn't necessary) when replacing the valve. And make sure both mating surfaces (the valve's and the engine's) are clean and smooth.

Also: Remove the valve if the valve stem moves at idle when an external source of vacuum is applied to it but the engine rpm doesn't change. Passageways in the engine or the valve may be clogged.

We can't overemphasize the importance of making sure all vacuum hoses are attached to their proper connections, and that they fit snugly and are not broken or cracked.

The proper technique for removing any vacuum hose is to rotate it back and forth until it breaks free. then pull it off. If you encounter a situation where a vacuum hose must be removed, but the hose is so hard that it won't break free without damaging its connection, cut it off with a single-edge razor blade, then replace it with a new hose.