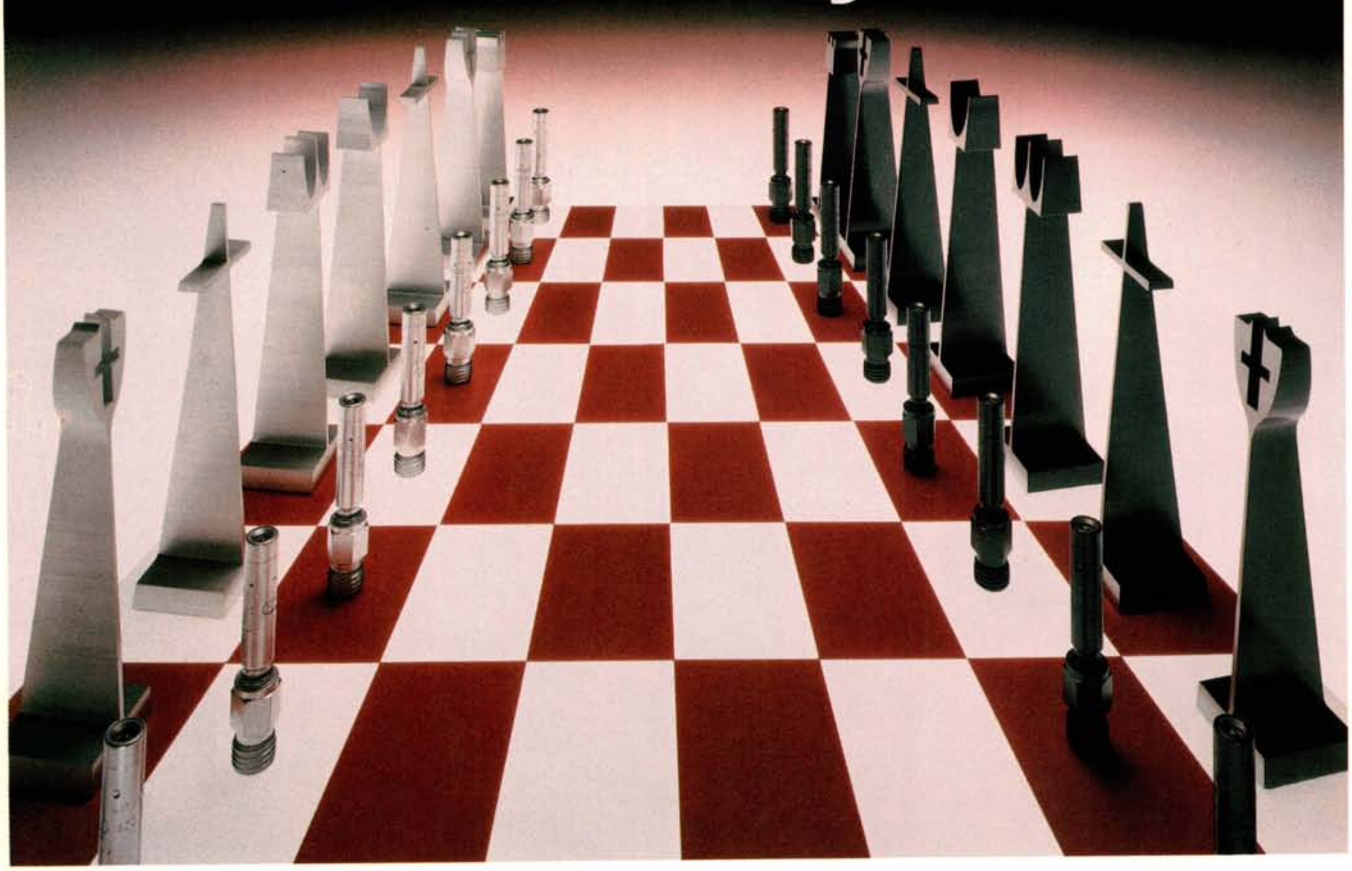
Advanced KE-Jetronic



At the end of our "KE-Jetronic Strategies" article in the December 1988 issue of *Import Service*, we mentioned that there were ways of interrogating the KE system. Since the system has no on-board diagnostics, we need to listen in on signals sent by the ECU Commander as he works with the Differential Pressure Regulator to keep control of fuel delivery.

There is a brand new Motronic form of KE-Jetronic now in production that has onboard diagnostics and fault code memory. But for now, we'll stick with the older system and its step by step troubleshooting procedures.

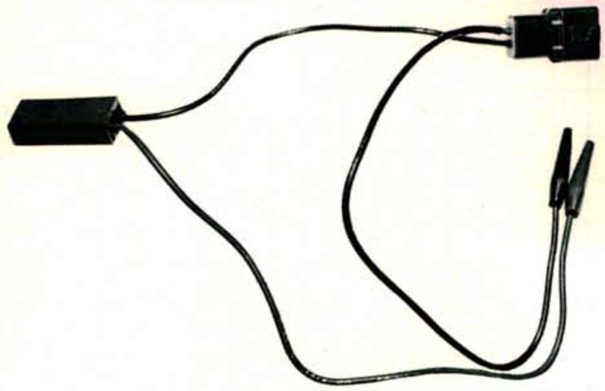
We mentioned earlier that some folks call the DPR the Electro-hydraulic Pressure Actuator. But that seemed like quite a mouthful to remember. So we're going to stick with the term Differential Pressure Regulator in this article.

Listening In

This part is important. In our first article, we talked briefly about listening in on the electrical conversation between the ECU Commander-in-Chief and the Differential Pressure Regulator. This eavesdropping can tell us volumes when we're troubleshooting.

To listen in, we need to make a phone tap. Thexton's tool, P/N 391, can be modified to look like our photo. A little solder, a length of heat-shrink tubing, and some heat, and we end up with a tool like the one shown. Hook this patch harness between the carside harness and the DPR. Then hook your milliamp tester in series with the alligator clips on the patch harness. Watch polarity when you hook up. Later on, we'll discuss the difference between positive and negative milliamp readings, but for now, you should have positive readings with the key on and the engine not running when you first hook up.

Now we can listen in—without a court order.



Modify the Thexton 391 patch harness as shown to make a handy phone tap. Hook your milliamp tester in series with the two alligator clips to take your milliamp readings.

Fluctuation is Important

Gentlemen, start your engines. The first thing we want to determine is whether or not the signals to the DPR are fluctuating when the car is in CLOSED LOOP. Readings will vary depending on the make and model car being tested, but the readings should fluctuate in CLOSED LOOP.

If readings stay at a fixed reading regardless of engine and oxygen sensor temperatures, the Commander has decided to keep things in OPEN LOOP. Trying to "tune up" any car that is stuck in OPEN LOOP is a waste of everyone's time.

The reasons for this decision from headquarters may vary, but the culprit creating the abnormal condition must be hunted down and made to talk. We'll cover interrogation procedures in a moment.

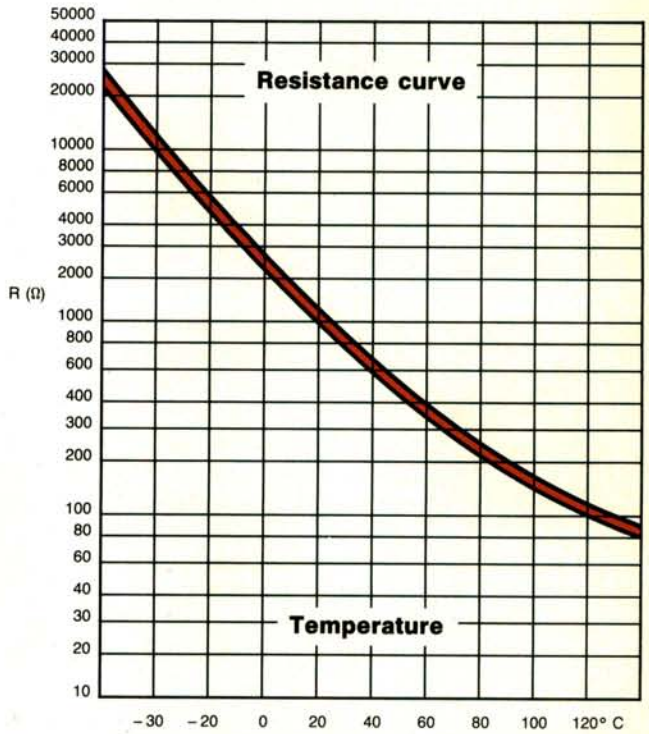
Electrical and Mechanical

Tune up and adjustment procedures will vary depending on the make and model car you're working on. Generally, both DPR current and CO should be within specifications. With the engine in CLOSED LOOP, some makes call for you to check both DPR current and CO at the same time. Some will ask that you unplug the oxygen sensor to place the car in OPEN LOOP. CO is then adjusted, the oxygen sensor plugged back in, and DPR current is checked again.

In addition to checking DPR current and CO, you'll also need your trusty K-Jetronic fuel gauges. To connect the gauges, start by finding the fuel supply hose to the cold start injector. This hose carries System Pressure. Connect this line to the side of the gauge with the control valve.

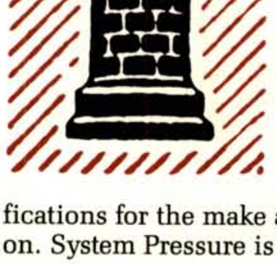
Now remove the plug from the lower chamber of the fuel distributor and connect the other hose from the gauge to the test port. If your gauge didn't come with an assortment of adaptors, you'll have to purchase the correct adaptor to make your connection.

With the gauge connected in this fashion, the control valve open, and the DPR disconnected, we can energize the fuel pump and read System Pressure.



This graph shows how resistance changes very gradually to provide even, stumble-free warm-ups. Remember that this is a negative temperature coefficient sensor. Resistance *decreases* as the engine coolant gets hotter.

System, Rest, and Differential Pressures



There are three separate pressure readings that need to be checked. System Pressure and Rest Pressures are checked with the valve on the pressure gauge OPEN. Differential Pressure is checked with the valve CLOSED.

- **System Pressure** will vary depending on the specifications for the make and model car you're working on. System Pressure is not adjustable on this system.

Some possible causes of low System Pressure include a fuel pump that isn't delivering enough fuel due to an electrical or mechanical malfunction, or a restriction in the fuel supply plumbing, like a plugged fuel filter or a kinked supply hose. If pump delivery rates are good and there are no restrictions, the pressure regulator may be defective. Make sure the fuel pump is receiving at least 11.5 volts. See our accompanying chart.

• **Rest Pressure** readings tell us how well the system can maintain residual pressure after the fuel pump shuts down. The pressure remaining in the system 10 minutes after shutting the pump off will also vary by application and should be higher on systems with higher System Pressures.

If Rest Pressure drops too quickly, check for external fuel line leaks, a defective pressure regulator, a bad fuel pump check valve, or improper sensor plate adjustment. Remember too, that we have the cold start injector unplugged in order to connect the pressure gauges. To make sure the cold start injector isn't leaking down, simply remove it, reattach the fuel line, and energize the fuel pump. Then watch the tip of the injector to be sure it isn't dripping like an old faucet.

Differential Pressure

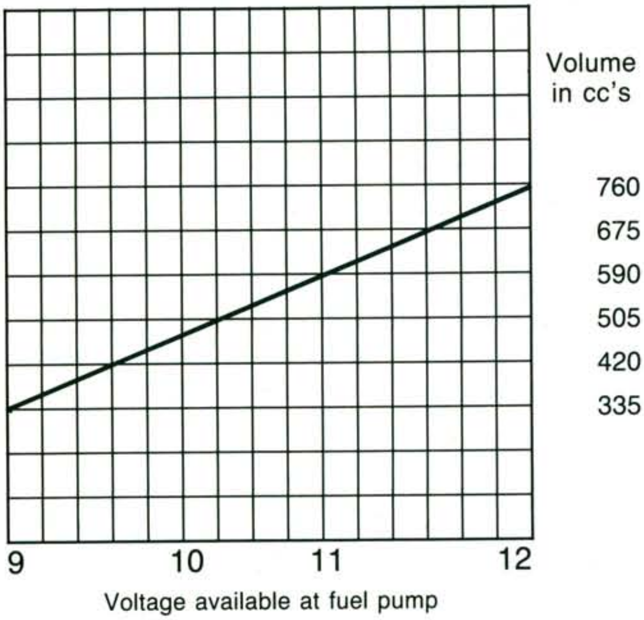
Now close the valve on the pressure gauge. The DPR wiring connector stays disconnected for this test. If we energize the fuel pump, we should get a Differential Pressure reading that's 0.2 to 0.5 bar LESS than our System Pressure reading. If our pressure readings are incorrect, we have a mechanical problem, since we should have some pressure differential even in the event of a power failure.

Replace the DPR and recheck Differential Pressure. If it's still not right, the fuel distributor is the problem.

Checking the Fuel Distributor

The lower chamber of the fuel distributor has a Spill Port Orifice that can get clogged. This calibrated leak allows Differential Pressure to return to the fuel tank through the diaphragm pressure regulator. If it gets clogged, the lower chamber will have too much pressure, leaning the mixture.

To check this, we have to do a little plumbing. Disconnect the hose that runs from the fuel distributor lower chamber to the pressure regulator. Place it in an accurate measuring container and grab your stopwatch. Energize the fuel pump and allow it to run for one minute. There should be a volume of 130 to 150 cm³ (4.4 to 5 ounces) in the container at the end of that minute. If not, replace the fuel distributor.



Anyone doubting the importance of proper voltage at the fuel pump should pay careful attention to this chart showing the relationship between available voltage and pump delivery rates.

Further Tests of the DPR

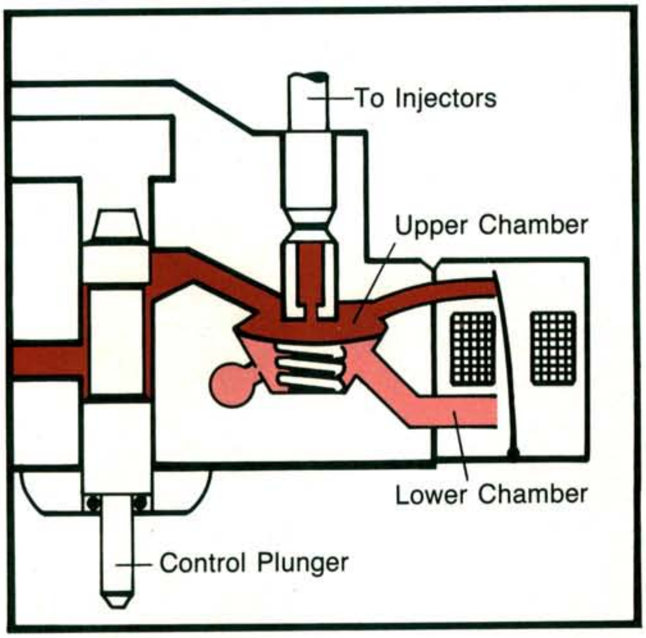
Since engine temperature is a very important consideration for the DPR, we need to do more counterintelligence to be sure he's getting the right current signals from the ECU, and performing his duty.

We also want to do a preliminary check of the wiring in the DPR. Check across the terminals of the DPR with your ohmmeter. Resistance should be 17-22 ohms across the terminals and 0 ohms between each terminal and ground.

In addition to our milliamp tester and pressure gauges, we need to enlist the help of a set of test resistors or a resistance wheel from an electronics store. Our resistors will allow us to impersonate the coolant temperature sensor and "trick" the Commander into answering our questions by making him think the engine is either hot or cold.

With your pressure gauges still hooked up, your phone tap and milliamp tester connected, and the fuel pump running (engine off), disconnect the coolant temperature sensor connector. It's located where the coolant leaves the engine to return to the radiator. Dial in 15K ohms on the resistance wheel and connect it to the sensor harness using the proper sized spade terminals. (Oversized connector leads can damage the female connectors in the plug and leave you with a bad connection, so be careful.)

DPR current readings should go to the 50-80 mA range, and Differential Pressure should be 0.7 to 1.2 bar (10 to 17 PSI) LESS than System Pressure. If pressures are wrong, replace the DPR and retest. If both the pressure and current readings are wrong, check all electrical connections between the DPR, the ECU, and also the connections between the coolant temperature sensor and the ECU. If you don't have a wiring problem, the Commander needs to be replaced.



When current to the Differential Pressure Regulator increases, the plate valve deflects toward the pressure port in the upper chamber, restricting flow. Pressure in the upper chamber increases. This causes the pressure regulating valves to bend down, increasing the flow of fuel to the injectors. More current results in a richer mixture.

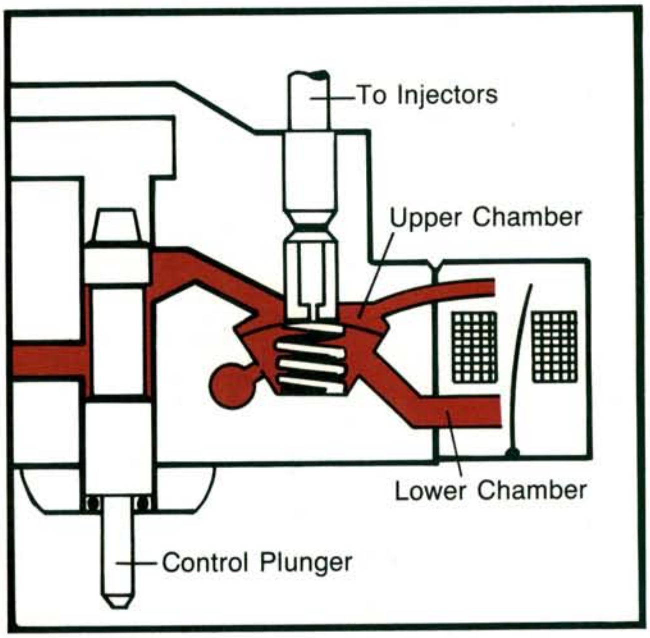
Testing Mercedes

If the car in your bay has the Mercedes three-corned star on it, the interrogation procedure is slightly different. Start by disconnecting the oxygen sensor. Then turn the key to the **on** position and observe your milliamp readings which should be 7-9 mA.

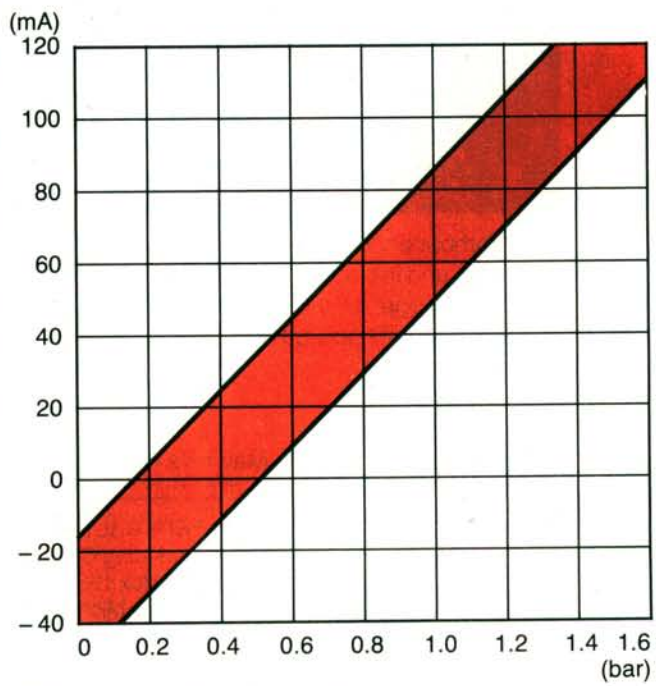
Then, with the coolant temperature switch disconnected, simulating a very cold engine, milliamp readings should be in the 114 to 132 mA range. Differential Pressure should be 1.1 to 1.3 bar (16 to 19 PSI) below System Pressure.

Now substitute a resistance value of 22-28K ohms at the coolant temperature sensor leads. Current should now read 9-14 mA with differential pressures about 0.4 bar (5.8 PSI).

With any resistance values less than 400 ohms, the current should still be 7 to 9 mA with differential pressure readings of about 0.4 bar (5.8 PSI).



The opposite happens when we need a leaner mixture. Current decreases. The plate valve allows more fuel from the upper chamber to pass to the lower chamber. As lower chamber pressure increases, the pressure regulating valves move upward, restricting fuel flow to the injectors. A leaner mixture results.



This representative graph gives you some idea of the relationship between DPR current and lower chamber pressures. The new fuel distributor responds very quickly to these changes in current to provide precise fuel metering.

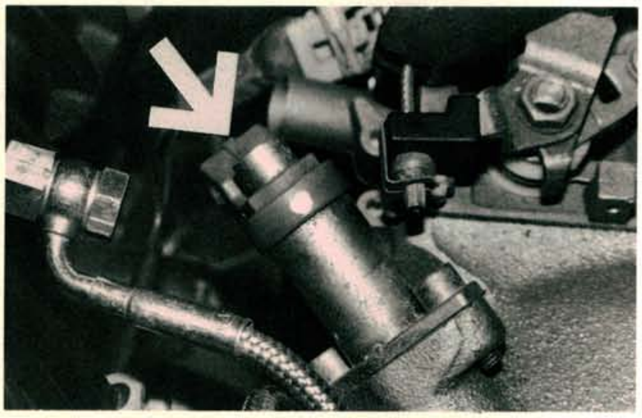
Coolant Temperature Sensor Checks

The CTS receives a 5-volt reference signal from terminal 21 of the ECU. The other wire at the CTS is connected to ground. Values for the CTS go from more than 20K ohms at −30 degrees C to less than 100 ohms at 120 degrees C.

If the CTS is stuck at a low resistance value, the resulting lean condition will cause driveability problems when the engine is cold. The symptoms will include stalling, hesitation, and even intake manifold backfiring.

Corrosion on the connectors at the CTS will cause the system to run rich due to the increase in circuit resistance. The rich condition will result in reduced fuel economy, sooty spark plug deposits, and in extreme cases, damage to the catalytic converter.

CTS resistance levels should be checked and compared for nominal levels at different temperature ranges. Check the reference 5-volt signal coming from the ECU as well as checking for a proper ground on the other harness terminal connected to ECU terminal number 2.



Since the cold start injector is disconnected during pressure tests, a leaking injector may cause Rest Pressure problems. When in doubt, remove the injector, reattach the fuel line and check for leaks at the injector tip.

Testing the Cold Enrichment Mode

Assuming the CTS and its related wiring are all okay, next test the cold enrichment mode. With your milliammeter still connected, plug in your resistance wheel and set it for 20K ohms. Current readings should be 80-110 mA or 114-132 mA on Mercedes-Benz cars. Now gradually reduce the resistance and watch the milliamp readings drop.

If you don't have a resistance wheel, you can get a rough idea how things are going in this mode by simply unplugging the CTS connector to simulate a very cold engine, or by jumping the CTS plug terminals to simulate a warm engine. This is admittedly less precise than the resistance wheel, but may save you in a pinch.

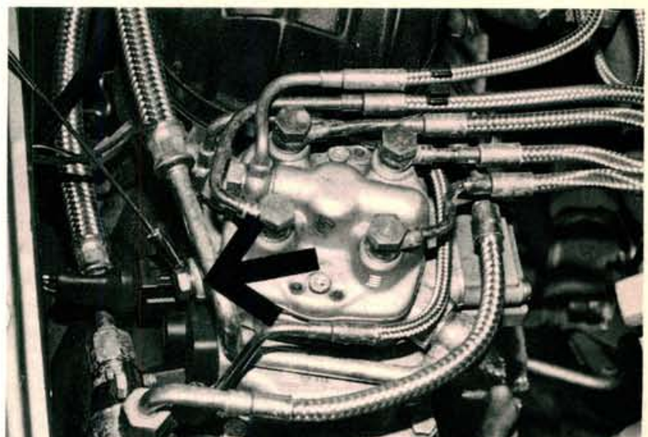
Deceleration Fuel Cut-Off

Early constant injection systems had no way to cut off fuel on deceleration. More stringent emission and fuel economy requirements have made this feature necessary. The addition of the DPR made this possible.

Based on information about coolant temperature and engine speed, the ECU is programmed to shut off fuel by sending a reverse current to the DPR. You will actually get negative readings on your milliammeter when this occurs. The reverse current causes the plate in the DPR to allow more pressure from the upper or System Pressure side to enter the lower chamber. This pressure plus the springs in the lower chamber cause the pressure regulating valves to close the lines to the injectors.

The engine speed at which fuel shut-off begins and ends will vary depending on coolant temperature. As the engine warms up, the start and end of fuel shut off occurs at lower and lower engine speeds.

At 30 degrees C, for instance, fuel shut-off begins at 2600 RPM and ends at 2200 RPM. At operating temperature, these will drop to about 1600 and 900 RPM, respectively.

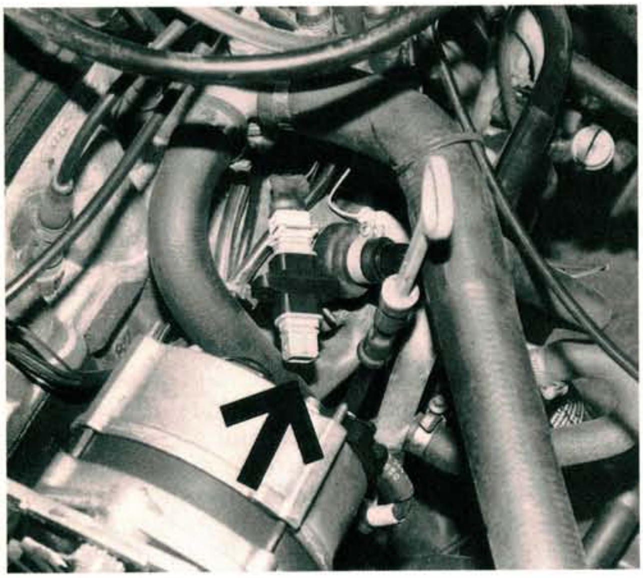


Remove this plug on the fuel distributor and attach the line from your pressure gauge set to this port. Use the line away from the control valve. When you're finished with your tests, replace the sealing washers.

As you might have already guessed, the deceleration fuel cut-off mode is controlled by the throttle, or idle position sensor. Remember that the idle switch tells the ECU that the throttle is *almost* closed. Its signals are sent just before the throttle switch opens or closes. This allows the ECU to better anticipate changes in throttle position.

The throttle position contact switch opens and closes very often, far more often than the wide-open throttle contacts, for instance. As a result, they do wear out. Bad contacts can result in stalling at stops, especially on cars with automatic transmissions.

Worn idle switch contacts can also cause a surge when coming to a stop, between 1000 and 1500 RPM. Generally, when coming to a stop, it should take a couple of seconds for the engine to smoothly settle down to idle speed.



This is Volkswagen P/N 1490 plugged into the CTS harness. You may choose to use a resistance wheel or the homemade tool we showed in our January Tech Tips. Any way you choose to go, be careful not to over-spread or otherwise damage the harness terminals.

Getting the Idle Switch to Talk

If you're suspicious of the idle switch contacts, check them with your ohmmeter. They should close just *before* the throttle reaches its stop. They should open just *before* the butterfly starts to move. The shop manual suggests that the switch be set with a protractor tool so that it closes 1 to 2½ degrees before the throttle stop.

To properly check the throttle switch, use your pressure gauges, milliammeter, and a tachometer. Start the engine and warm it.

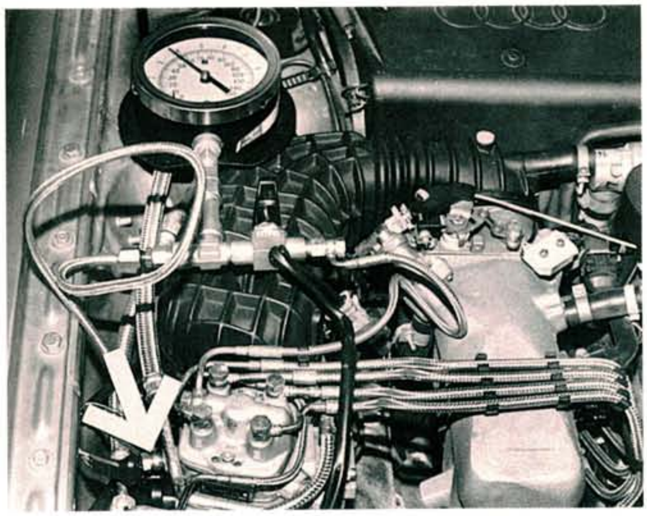
Accelerate the engine to about 2500 RPM and release the throttle. As engine speed drops, milliamp current should go in the minus direction (– 30 to – 60 mA). Differential Pressure should increase to 0.4 bar (5.8 PSI) above System Pressure.

At about 900 RPM, both DPR current and Differential Pressure should reverse. DPR current will read a positive current, and Differential Pressure will drop below System Pressure.

If these tests indicate a problem, check the following in addition to the throttle switch itself:

- The idle switch circuit to the ECU.
- The coolant sensor circuit to the ECU.

One connector at the idle switch goes to terminal 13 of the ECU. The other connector is supplied with battery voltage on all models except Mercedes Benz. On the MB, it's a ground wire.



On K-Jetronic, we used the pressure gauge control valve to separate System Pressure from Control Pressure. On KE systems, the valve is open for System and Rest Pressure tests, and closed for Differential Pressure tests.

Before starting these tests on this or any other fuel system, please remember to exercise extreme caution when working around gasoline. Fuel injection systems can be especially dangerous due to high fuel pressures involved.

It's also good practice to obtain an assortment of new sealing washers when working on these systems. You'll be removing and reattaching any number of high pressure fuel lines for testing purposes. New sealing washers are cheap insurance against needless damage or injury caused by a high pressure fuel leak.

More to Come

Our next installment of "Advanced KE-Jetronic" will look at other system components, some specific wiring harness tests, and some commonly found problems you may encounter on this system.

—By Dré Brungardt