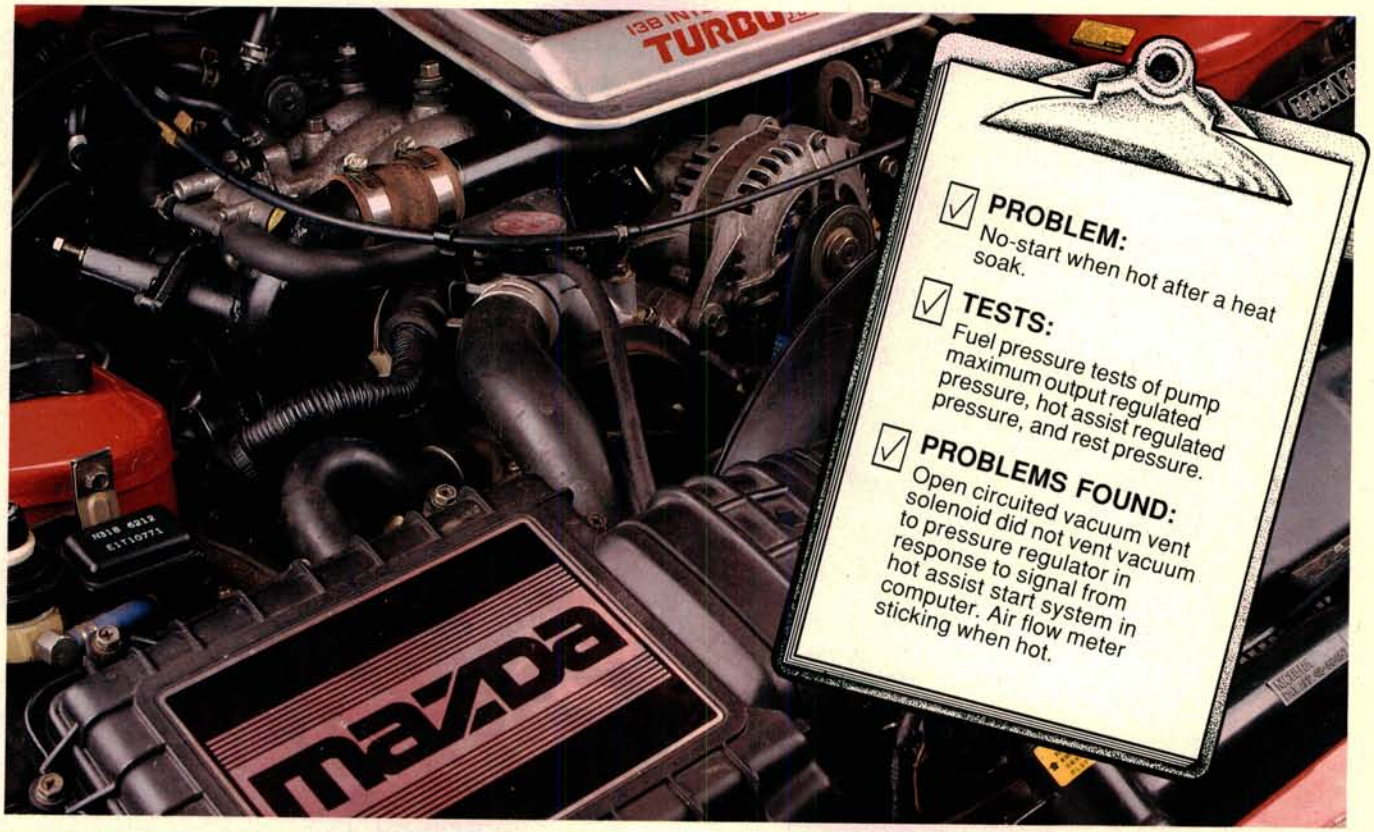


Mazda RX7 Turbo

PART TWO

Last month we tangled with a turbocharged Mazda RX7 which had a number of ailments. Sticking with the basics, we eliminated as many obvious causes as we could for a warm high idle with occasional misfire, and an intermittent no-start when the engine was hot.

The biggest problem with this car was a bad sensor ground—a main sensor ground shown in last month's Driveability Clinic. But we'd like to go a bit beyond that part of the repair this month, and point out the importance of fuel pressure testing. This is a commonly overlooked problem when diagnosing a no-start or hard-start hot problem, and led us to another related problem.

The Mazda has four separate fuel pressures to test, and each is important:

(1) Fuel Pump Dead Head Pressure—This test tells us whether the pump is weak, if voltage to the pump is low, or whether there's an obstruction in the line between the pump and the fuel rail. It's the maximum pressure the pump is capable of delivering before the pressure is regulated.

(2) Residual or Rest Pressure--That's the pressure that stays trapped in the fuel rail between the fuel pump check valve and the pressure regulator after the fuel pump stops running. It's the pressure available at the injectors. A rapid loss of rest pressure in a hot underhood situation can increase the possibility of a hot start problem.

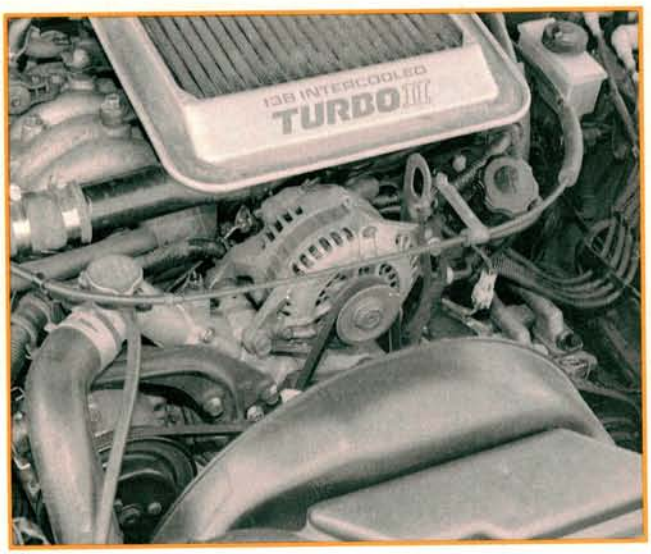
(3) Normal Regulated Pressure—Vacuum to the pressure regulator controls pressure in the fuel rail. A diaphragm in the regulator moves in response to vacuum to keep rail pressure at about 28 PSI at idle. Above idle, reduced vacuum increases fuel rail pressure as manifold vacuum drops.

(4) Hot Start Regulated Pressure—There's a vacuum vent solenoid valve in the vacuum line between the engine and the pressure regulator. Normally it lets manifold vacuum pass straight through from the engine to the pressure regulator.

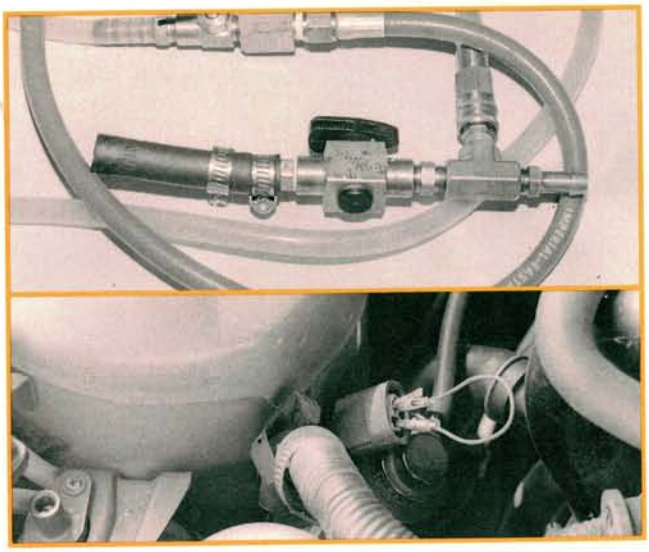
When the underhood sensors tell the computer that temperatures are very high, the computer energizes the solenoid. This dumps some of the vacuum to the atmosphere, increasing fuel pressure long enough to let the engine normalize. At the same time, engine speed is increased.

If you've ever started a carbureted engine after a heat soak, and just barely gotten it running, you know what you did next—you opened the throttle to normalize the engine. Same thing happens here, only the computer controls it. As you can see, fuel pressure becomes very important.

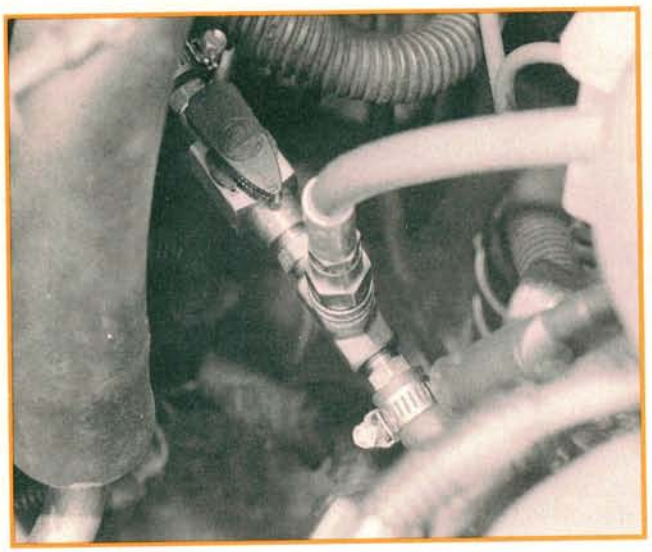
DRIVEABILITY CLINIC



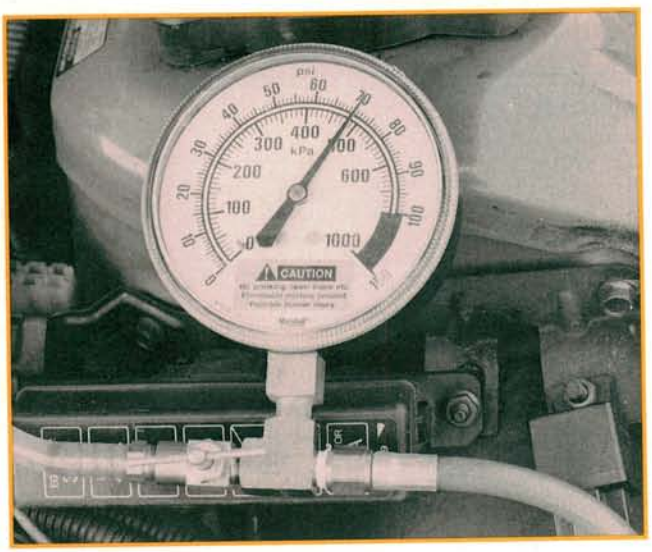
1 If you remember last month's thrilling episode, the Mazda suffered from a high idle when warm, and a reluctance to restart when hot. We hope last month's overview photo showing key underhood components was helpful to you. This month, with the high warm idle fixed, we'll concentrate on possible causes for our no-start hot, and look at some basic tests and adjustments which shouldn't be overlooked. Let's start by spending more time with fuel pressure tests, since hot start problems can often be caused when rest pressure falls too quickly. This allows the fuel in the lines to "percolate" or even boil.



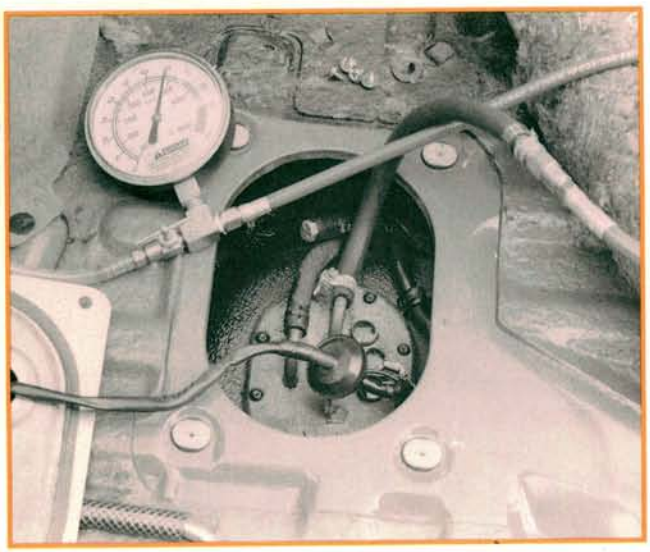
2 Mazda dealership techs have a fancy fuel pressure tester. Basically, it's just a pressure gauge with a shut off between the gauge and the fuel rail which lets you briefly "dead head" the fuel pump. This lets you test the pump's maximum output pressure. You can tap into the line between the fuel filter and the high pressure side of the fuel loop. Make sure your plumbing job includes a shutoff valve between the gauge and the inlet line on the fuel rail. Turn the ignition ON and jumper the fuel pump test connector leads (or open the air flap in the air flow meter about half an inch) to run the fuel pump.



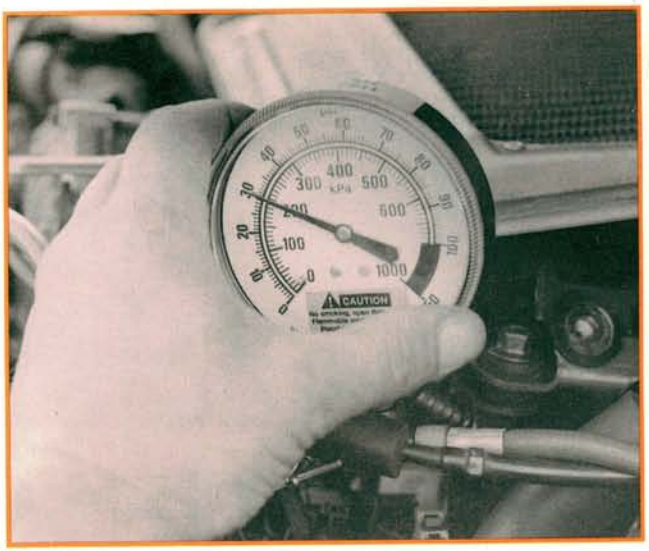
3 The shop manual doesn't mention rest pressure specs, but a later tech bulletin gave test procedures and specs for testing rest pressure. The rest pressure tests include checks of the fuel pressure regulator, fuel pump check valve, and injectors. Leave the valve on the pressure tester hook up open, and run the pump to pressurize the fuel rail. Wait 15 minutes. If pressure drops more than 3 PSI during that time, pinch off the return line hose coming from the pressure regulator. Then repeat the test. The return line is next to the high pressure line from the fuel filter.



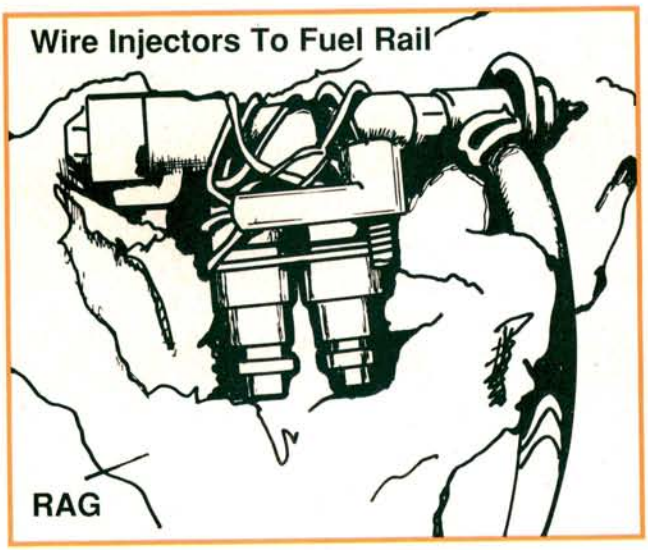
4 If rest pressure holds this time, we know two things: (1) the injectors aren't leaking down, and (2) the check valve in the fuel pump is also holding pressure. Replace the pressure regulator and retest. If the rest pressure didn't hold with the return line pinched off, either the fuel pump check valve, or the injectors are leaking. On the turbo, the pump is a lot easier to check than the injectors. Dead head the pump by closing the shutoff valve between the gauge and the fuel loop. Run the pump just long enough for the gauge to reach a maximum reading. Shut the pump off. Max pressure should be 64 to 85 PSI.



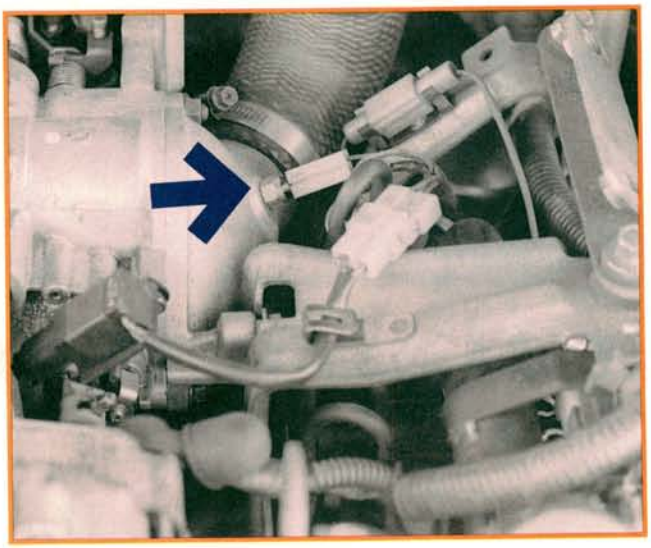
5 If main fuel pump dead head pressure is below specs, lift the carpeting in the cargo area and remove the inspection plate above the fuel pump. Check fuel pressure right at the pump. If fuel pressure is within specs at the pump, then it's time to look for an obstruction in the line from the pump to the fuel rail. The obstruction may be something as simple as a plugged fuel filter. If pressure is still too low, check voltage to the pump. A voltage drop in the pump circuit will reduce fuel delivery. And don't forget to check for dirt or debris at the pump inlet before installing a new pump.



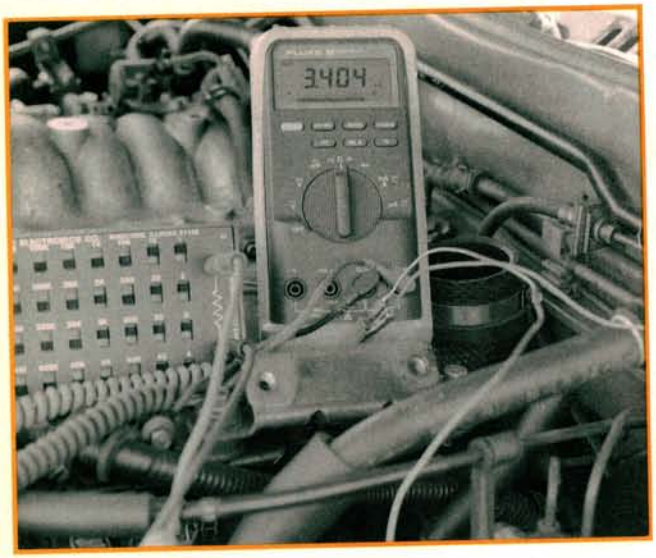
6 The pump and hoses running to the inlet side of the fuel rail should hold the pressure for 10 minutes. If there are no external leaks, and pressure falls more than 6 PSI, then the pump is bad. Okay. So far we've eliminated the fuel pressure regulator and the fuel pump feed circuit as possible causes for a loss of rest pressure. If rest pressure in the entire fuel circuit is still dropping more than 3 pounds in 15 minutes (after the pump is shut off), there's only one place left to look—the injectors themselves. Occasionally an injector will stick open. This reduces rest pressure, and in extreme cases it can foul the plugs.



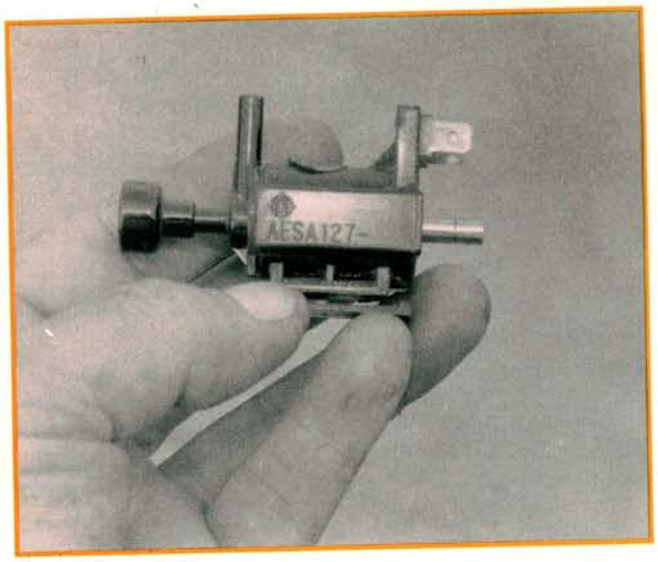
7 Getting to the injectors requires removal of the intake plenum. Removing the plenum is no fun. That's why you'll want to eliminate everything else first. The injectors are held in place by the injector rail attachments. If you remove the injectors to watch for leaks, you'll need to wire them to the rail, or fuel pressure will blow them off. (Please be careful here, fuel explosions make a nasty noise.) With the injectors removed, run the fuel pump long enough to pressurize the rail. Mazda says that one drop of fuel in 5 minutes is acceptable. Note: The air bleed sockets for the primary and secondary injectors are not the same.



8 So much for basic fuel pressure tests. But leave your pressure gauges hooked up for now. There's one more thing to check—the solenoid controlling vacuum to the pressure regulator. You see, Mazda knew things would be hot under the hood of this turbo, so they used a number of temperature sensors and added a hot assist start system. In addition to radiator and water pump sensors and the normal air intake temp sensor in the air flow meter, they added an extra temp sensor in the intake plenum near the throttle (arrow). Sensor resistance should drop from about 40 K ohms at 68 degrees F to 3.5 K ohms at 176 degrees F.



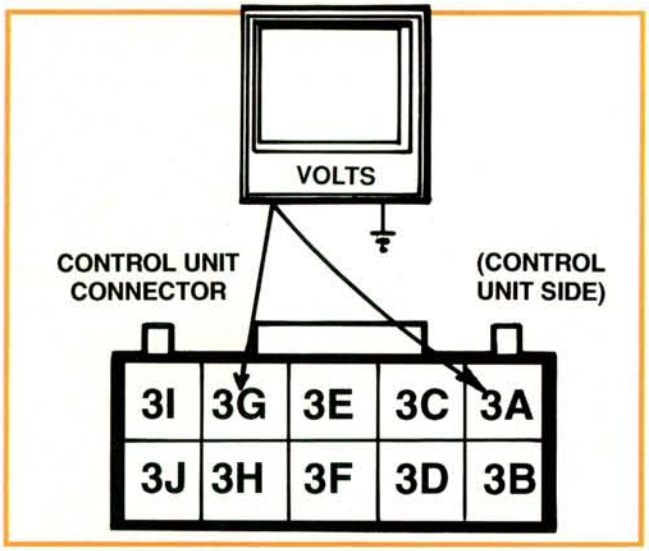
9 When sensors send along messages that the engine compartment is HOT, the computer activates the hot assist start system. This increases engine speed and fuel pressure to normalize the engine. You can test the system with a fuel pressure gauge, a tachometer, and a 3.5 K ohm resistor. Warm the engine. Unplug the harness at the sensor and substitute 3.5 K ohms of resistance across the harness terminals. Start the engine. The system is working if fuel pressure increases from a normally regulated pressure of 28.4 to about 34-40 PSI, and the engine speed increases to about 850 RPM. This should last for about 50 seconds.



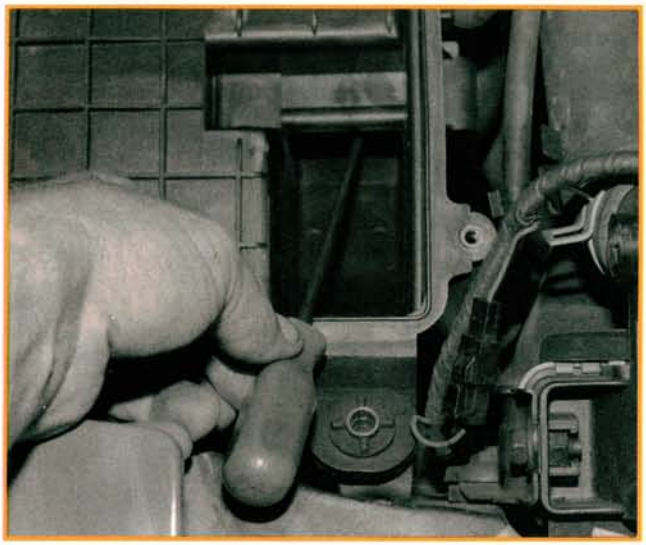
10 If the hot assist system doesn't operate as it should, ask yourself two questions: (1) Is any part of the system working? Example: higher idle but no increase in fuel pressure, or (2) does the hot assist system fail to respond at all. Let's concentrate on the first for now. Higher idle, but no increase in fuel pressure. Check for keyed hot at one terminal of the orange solenoid. The solenoid ground should be provided by the computer for 50 seconds after start up if the hot assist is working. Check to see if the solenoid vents vacuum through its tiny air filter when it's energized.

11 The control solenoid is known as a vacuum/vent solenoid. With no power applied, engine vacuum should pass through the solenoid to the pressure regulator. When the computer applies ground to the solenoid, it energizes, and vacuum is vented to atmosphere through the tiny filter cap. Less vacuum at the regulator increases fuel pressure. A voltmeter tells us that the signal is being sent from the computer, but the solenoid isn't responding. It's winding is open. We replace it and retest. Now pressures increase as they should during a hot start.

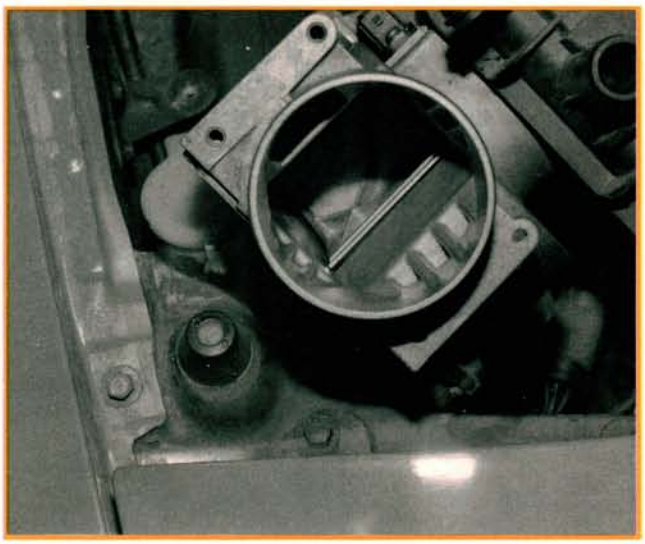
12 If the hot assist system isn't working at all, things get more complicated. There's a good chance that one or more of the sensor inputs is bad, or that there's a bad connection or ground somewhere. Control units are pretty reliable, so they're the last thing to blame. The sensors on this car are not easy to reach. That's where the whole breakout box excursion started. Piecemeal tests made by running back and forth between sensors and the computer's main connector would have been tedious. In fact, the only thing we found wrong (electrically) was the bad ground at terminal 24 on the engine.



13 A factory bulletin outlined some of the problems which can be caused by a bad number 24 ground. They include: • Engine cranks but won't start, or starts intermittently. • Poor engine performance, including hesitation, bucking or misfire. • Engine stalls • Crazy dash or dash illumination lights. • And there's a good possibility that there won't be any codes stored at all, or you may get several different codes. If you don't have the Mazda checker or a breakout box, you can check the 24 ground as shown in our illustration. Remember, check it both cold and hot.



14 After trying to duplicate the hot start problem for days, we decide that the car is fixed. It runs well and starts and idles properly, hot or cold, first time, every time. Then after one last test drive on a hot day, it decides it isn't fixed. It stalls coming down to idle from a high RPM, and refuses to start. Wow. We go back to tests of spark and fuel pressure immediately. Plenty of spark. But when we reach down to bump the air flap on the air flow meter to run the fuel pump, we can't see the flap. As it turns out, when the air flow meter got very hot, it warped. The flap stuck at about 2/3 of the way to wide open throttle.



15 As soon as the air flow meter cools down, the return spring pushes the air flap back against its stop with a bang. Since the engine stalled out at a high RPM (first time THAT had happened), we conclude that this is an entirely different problem from the original no-start when hot situation. It's just that the car had more than one problem caused by high under hood temperatures. But repeating the basic tests were the only way to catch the culprit(s) in the act. Just thought you'd like to know the bear gets us too. The car has run fine since then.

Resistance Values For Air Temp Sensor In The Intake

Air Temperature	Resistance
32 degrees F	110.9 K ohms
50 degrees F	66.6 K ohms
68 degrees F	41.4 K ohms
86 degrees F	26.5 K ohms
104 degrees F	17.5 K ohms
122 degrees F	11.8 K ohms
140 degrees F	8.2 K ohms
158 degrees F	5.8 K ohms
176 degrees F	4.2 K ohms

(All resistance specs +/- 10 percent of actual reading at a given temperature)