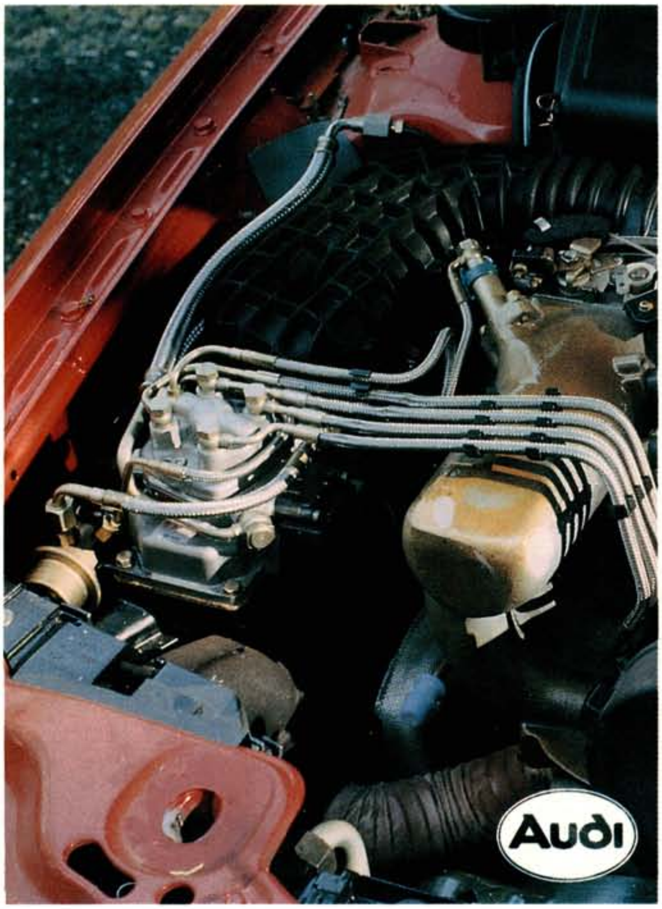


CIS Motronic

PART ONE

Some of you automatically think of BMW when you think of Motronic. The BMW system is based on L-Jetronic and has been used for about eight years. Now Audi and Volkswagen both have systems they call Motronic that are based on KE-Jetronic. The Audi version is found on the 80 and 90 series four cylinder cars. The Volkswagen version is found on the new Passat, GTI, and Jetta GLI; all of which are equipped with Volkwagen's 2-liter 16-valve engine. How can they all be Motronic?

No, the term Motronic is not from a secret language meaning "magic box." It refers more to a computerized engine management system than it does to the specific hardware controlled by that system. One central computer controls the fuel and ignition systems, as well as idle stabilization. Instead of having separate control modules for fuel and ignition, this digital computer coordinates injection quantities and ignition timing to improve driveability, increase engine power, reduce emissions, and improve fuel economy.

Surprisingly, the use of this computer system may actually make these cars easier to work on than earlier systems that used separate fuel and ignition control modules. That's right, easier.

Consider the following:

- The computer has its own permanent fault memory that can be accessed to retrieve fault codes. The computer is its own tester.
- The computer can make adjustments and corrections to compensate for conditions that made "dumber" systems go crazy in the past. It goes through an ongoing learning process, storing information and fine tuning its response to things like small vacuum leaks, a change in altitude, or the changes that occur due to normal engine wear.
- We don't need to check separate sensors for fuel and

ignition systems when a problem occurs. Since all information goes to the same computer, many input sensors are shared.

• With the computer doing so much of the work, we can relax a bit, and go back to the basics when troubleshooting a problem. As a result, this article will look at some of the mechanical components, testing procedures, and adjustments for the CIS-Motronic system. We'll also spend time pointing out the differences between the Audi and the Volkswagen.

Stop, Look, Listen, and Learn

The computer in the Motronic system works a lot like you do. It looks and listens. It compares the information received to information already stored in its memory. Then it makes decisions about how to handle changing circumstances. If it receives information that just doesn't make sense, it takes that into account too. If it determines that something is really wrong, it chooses a limp home course of action that may not be the best choice, but gets the job done just the same.

Most importantly, it remembers and learns as it goes along, and includes that learned information in its next decision. If you ask it nicely, it will share some of its secrets with you.

Computer Maps—Digital Gray Matter

To understand how Motronic can make all of these adjustments, you need to be familiar with something called a computer map. Maps are three-dimensional charts stored in the computer's memory. The map controlling the ignition timing, for example, can make far more adjustments than the old advance mechanisms we used to see. These maps aren't limited to adjusting timing based on engine speed and load. Instead, they contain an encyclopedia of information about all sorts of driving conditions, and can select from a number of different advance curves to compensate for things like cold engine operation, or changes in the air intake temperature.

Back To Basics

If you aren't familiar with this system's family history, we should point out that it's a descendant of the old K-Jetronic continuous injection system.

CIS, or K-Jetronic, evolved into KE-Jetronic. The final step is CIS-Motronic, which borrows most of its hardware from the earlier systems. Anyone familiar with KE will see a lot of old friends under the hood, and will find many of the test procedures to be similar.

The evolutionary process may continue from here. Until it does, CIS-Motronic occupies the top rung on the CIS evolutionary ladder.

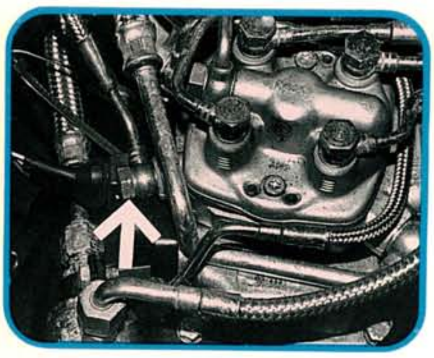
Remember, the Motronic system consists of fuel and ignition system controls, along with idle and canister purge controls. With all subsystems working together, Motronic can control each system for better response and economy.

Audi vs. Volkswagen

Many of the components under the hood of the Audi or Volkswagen will look familiar to you if you have ever looked under the hood of either car. Many are the same. But don't be fooled. Although both systems are very similar, there are some important differences.

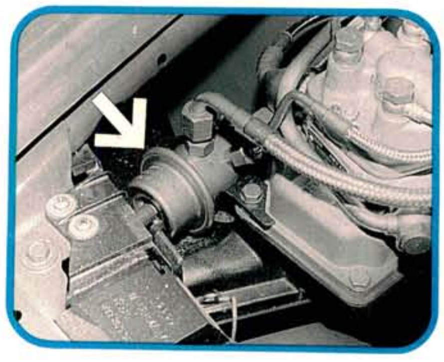
We can't fit everything on this Motronic system into one article. Come back next time for part two.

—By Ken Styer and George Donaldson



1

To check system fuel pressure, unplug the connector at the differential pressure regulator. Connect your gauge between the lower chamber test port (arrow) on the fuel distributor, and the line to the cold start injector. Open the valve on the gauge and run the fuel pump. This system runs at 6.1 to 6.5 bar.



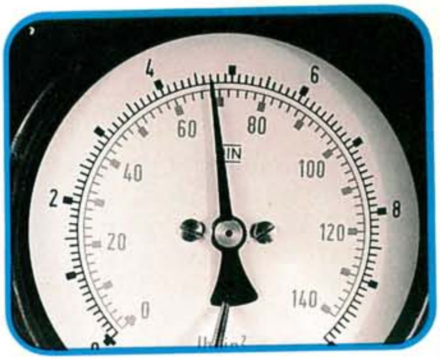
2

If the system pressure is below specifications, start by making sure there's gas in the tank. Then check for a plugged fuel filter, or kinked or blocked fuel lines. Finally, check fuel pump delivery rates. If the system pressure is still too low, the fuel pressure regulator (arrow) may be defective.

3

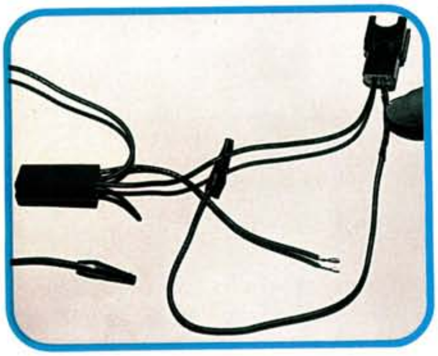
Close the valve on the pressure gauge. Leave the differential pressure regulator unplugged. The plate in the differential pressure regulator should deflect enough to give you a pressure differential between the upper and lower chambers. Pressures should be 0.3 to 0.5 bar below system pressure.

4



Reconnect the harness plug to the differential pressure regulator and crank the starter for about three seconds. This activates the regulator and sets differential pressure at its initial controlled operating pressure. Pressure should read approximately 1.3 to 1.6 bar below system pressure.

5

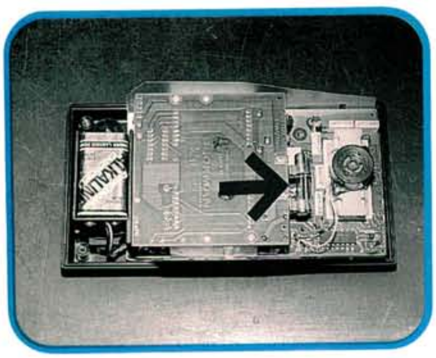


Milliamp readings can tell us a lot about how the system is working. We made a harness out of a Thexton 391 fuel injection harness tester. This photo shows our modified harness. As you can see, we can hook our milliammeter in series using this harness, and take our readings with the car running.

6

Observe correct polarity when you hook up your ammeter. With the key on and the engine not running, you should have a positive reading. If not, reverse your meter leads. Remember that plus readings mean a richer mixture is needed. You'll get negative readings when the differential regulator needs to lean the mixture, as in deceleration fuel cut-off.

7



If the engine won't start after connecting the meter, check for loose connections or a bad meter. The meter is now in series with the ECU and the differential pressure regulator. An open circuit in the meter may stop the engine from running, or cause it to run very poorly. Our meter had a bad fuse, creating an open circuit.

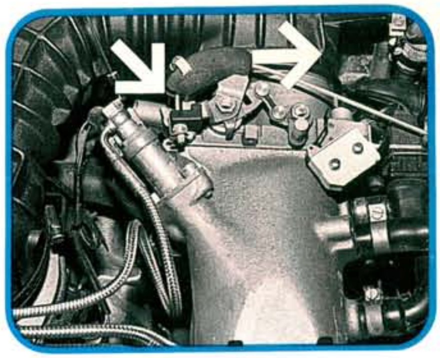
8

The system remembers differential pressure regulator and oxygen sensor readings. To find the last average reading, drive the car, vent the crankcase breather system and the charcoal canister. Then disconnect the oxygen sensor to get the average reading of the most recent mA operating range.

9

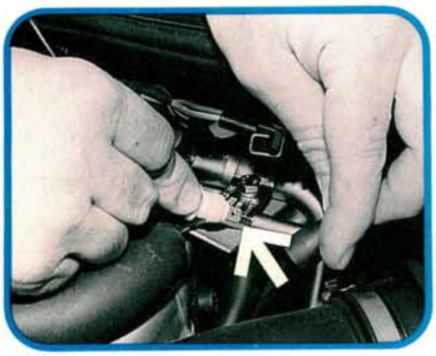
The reading of 2mA in the previous step is just about in the middle of the zero to +5mA operating range for this car. But a small air leak may result in an average reading more like this one, as the system richens the mixture to compensate for a leaner running mixture.

10



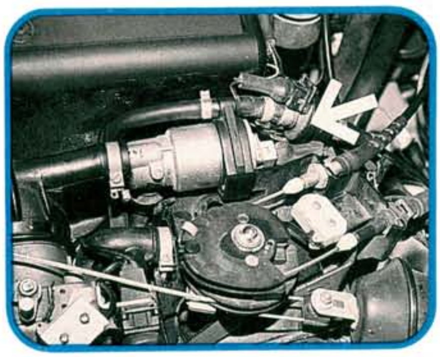
To test the deceleration fuel cutoff, briefly raise the engine speed above 3000 RPM. Close the throttle and watch for the mA reading to momentarily show a negative current. Don't hold the engine above 3000 RPM for an extended period of time. Free revving can be hard on an engine.

11



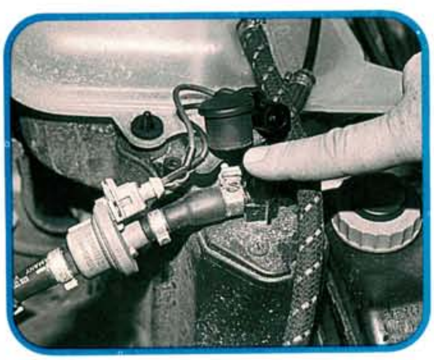
Check the oxygen sensor with the engine at normal operating temperature. Remove a vacuum line and watch for the mA readings to change. If the readings don't change, disconnect the oxygen sensor and ground the carside harness. If the readings change, replace the sensor and retest.

12



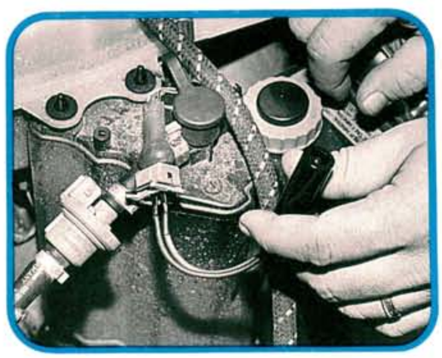
The Audi charcoal canister is controlled by two solenoid valves. The valve closer to the engine is a simple on/off valve (arrow). The valve at the canister is a duty cycle controlled frequency valve. On a warm engine, the valve operates for 120 seconds then stops for 60 seconds.

13



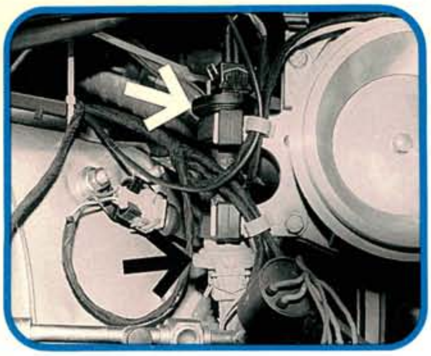
When setting base fuel mixture, vent the canister to atmosphere. Test for suction with your finger. You should be able to feel the air intake pulsing if the valve is working properly. A drastic change in mA readings when you reconnect the canister may indicate a fuel saturated canister.

14



If you can't feel the air pulsing, a simple LED tester connected between the terminals of the carside harness will tell you if the duty cycle signal is being sent. If the signal and valve are good, but there isn't a pulsing suction at the canister, check the on/off solenoid and the hose to the intake.

15



On the VW system both the frequency control valve and the on/off valve for the canister are located in the purge line, next to the fuel distributor. The frequency control valve is the one closer to the canister. To vent the VW's canister, pull the hose between the canister and the frequency control valve.

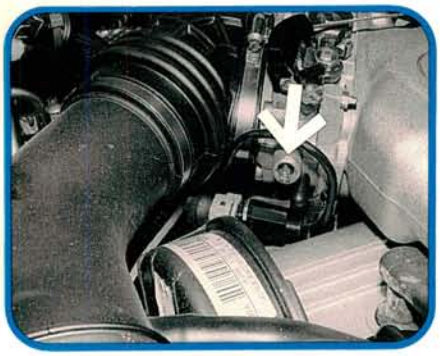
16

You also want to disconnect the crankcase breather system from the engine and allow fresh airflow before setting the fuel mixture. If you get a drastic change in mA readings when reconnecting the breather system, look for gas-diluted oil in the crankcase.

17

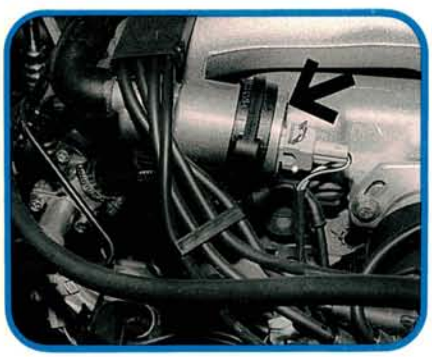
Check milliamp specifications for the car you're working on. Not all KE cars are the same. This differential pressure operates in a range of −16 to +23mA with a base setting of zero to +5mA. This one is operating within allowable limits. Make sure the readings fluctuate.

18



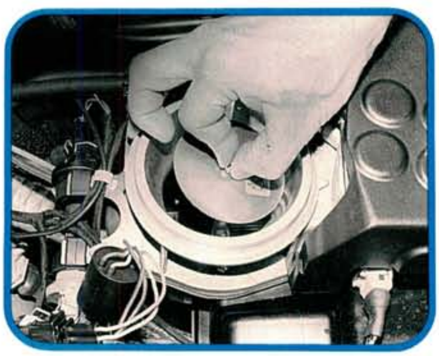
Don't touch that screw. What we used to call an idle bypass screw is still in the VW's throttle housing, but it needs to be turned all the way in. There is no idle adjustment. If the screw is backed out the idle will surge. To smooth the idle, tighten the screw, then stop and restart the engine.

19

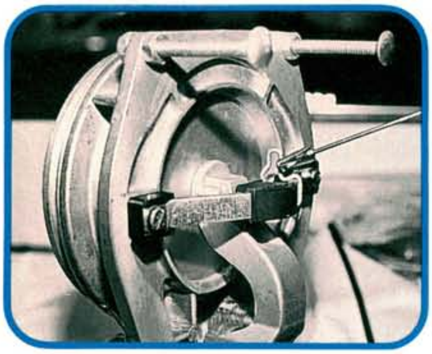


Idle speed is controlled by a rotary airflow valve. The airflow valve is operated by a duty cycle signal from the ECU. If the duty cycle signal or valve fails, the valve should open to a preset position to maintain an acceptable warm, no-load idle. Expect the car to stumble or stall when cold, however.

20

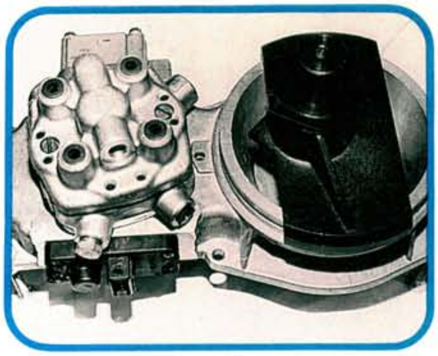


The sensor plate and control plunger must move freely. Crank the starter for ten seconds, then move the sensor plate upward through its entire range. A light, even resistance should be felt. No resistance should be felt as the plate is moved quickly to the rest position.



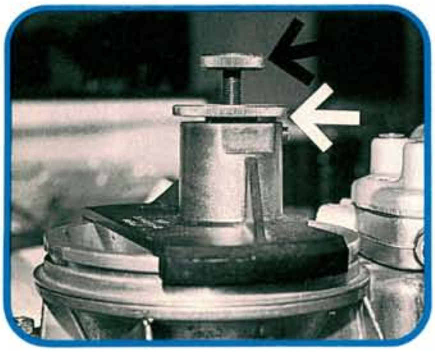
21

The base adjustment of the airflow sensor plate is made by bending this clip until the sensor plate rides 2 mm below the base of the cone. You can reach the clip with the airflow housing on the car by lifting the plate all the way up. Do not bend the spring plate to make the adjustment.



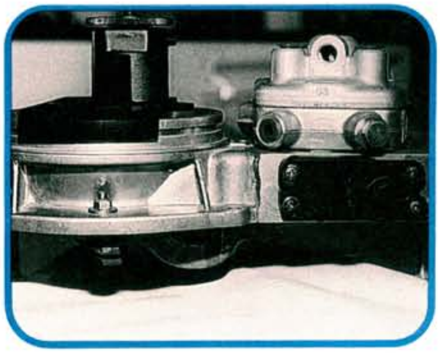
22

Those of you who have worked on KE systems before will be familiar with this tool, Volkswagen P/N 1348/1. This tool is used to position the airflow sensor for a number of tests. In this case, we'll use it to simulate the position of the airflow sensor at idle, allowing us to adjust the APS.



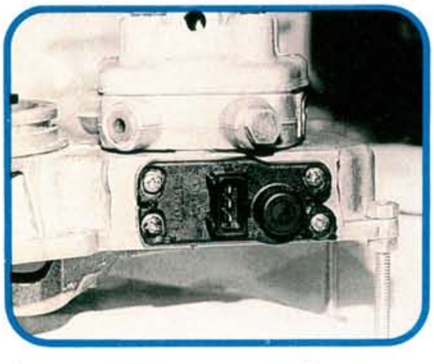
23

Position the tool as shown. Push the outer knurled ring (white arrow) downward against the tool. Screw the small knurled knob (black arrow) until the magnet at the base of the threaded rod contacts the airflow sensor plate. Keep screwing it in until the airflow plate is just level with the base of the cone.



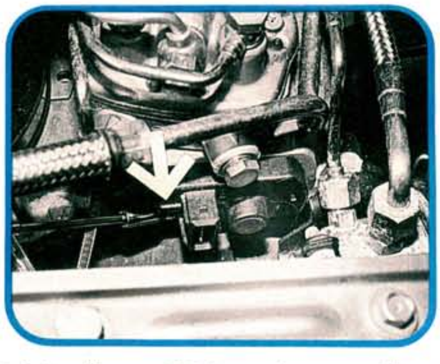
24

Now raise the outer ring until it stops at the first detent. The tool's calibrated stop places the sensor plate where it would ride in a running, idling engine. Make your base APS adjustment to correspond with values that will fall inside the shaded area on our chart. See number 30.



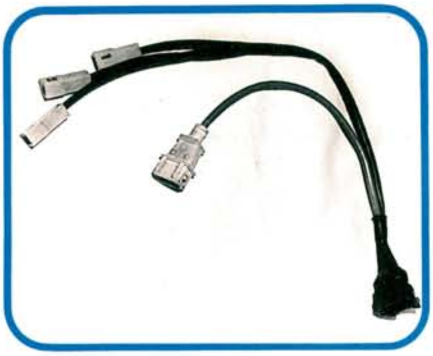
25

The potentiometer, or airflow position sensor (APS), is important in providing acceleration enrichment for a cold engine. The Motronic computer senses how far and fast the airflow sensor moves, and adjusts the mixture accordingly.



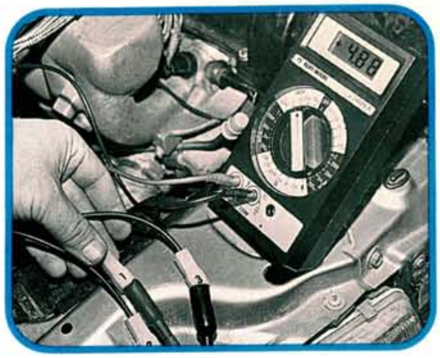
26

Originally, on KE-Jetronic cars, adjustment of the APS was done by loosening the four screws that hold the APS to the fuel distributor and rotating the APS slightly to get specific volt readings. This system uses an APS with a fine tuning adjustment screw, similar to an antenna trim screw (arrow).



27

This harness (Volkswagen P/N 1501) is used to check DC voltages at the APS. It plugs between the APS and the vehicle harness. Numbers on the wire ends correspond to the numbers on the APS. Use of the proper harness makes testing a lot easier, and avoids damaging the small APS terminals by backprobing.

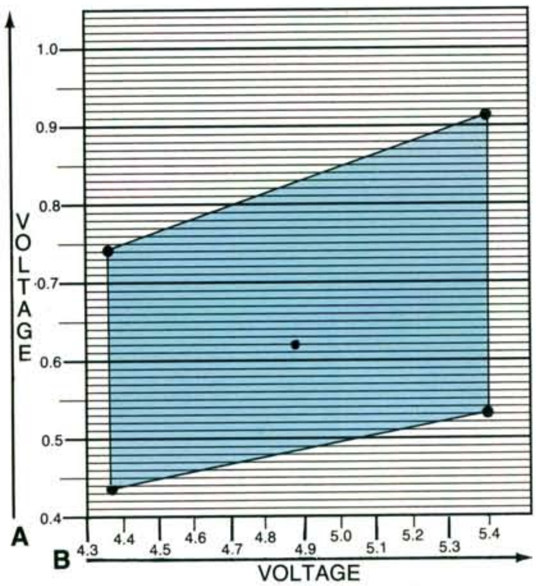


28

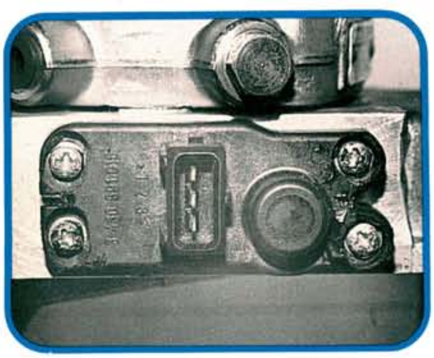
Take voltage readings between terminals 1 and 3, and between terminals 2 and 3 to use the chart on this page. In this test, our voltage reading is 4.88 between terminals 1 and 3, with the engine warm and running at idle. Reading across our scale marked B at the bottom put us almost in the middle of our scale.

29

Now check the voltage between terminals 2 and 3. It is 0.62 volts on this car. If we draw a line upward from 4.88 on the bottom scale, and over from 0.62 on the vertical, or A scale, they intersect in the shaded area on the chart. Any reading inside the shaded area of the chart is okay.

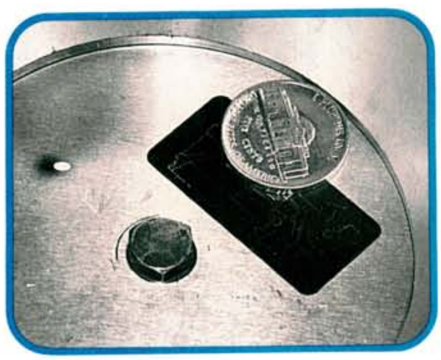


30



31

Adjust the APS only if the readings are outside the shaded area of the chart. The fine tuning screw on the APS will let you make small adjustments, but if you're replacing the APS, or if someone has tinkered and left it way out of adjustment, you'll have to start from scratch.



32

Before assuming that the APS is faulty or misadjusted, be sure the sensor plate isn't so far out of whack that it's causing problems. There's an air gap between the sensor arm and the control plunger on newer cars. You should be able to lift the plate a nickel's worth before feeling any resistance.