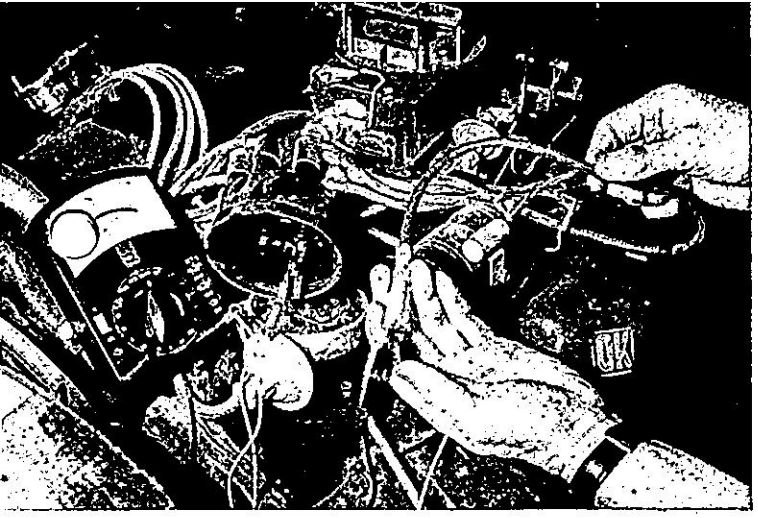
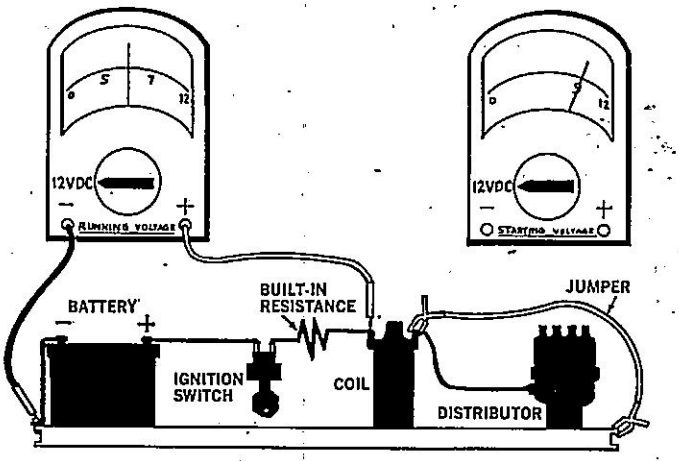


This simple test of spark-plug cables could save you time and money you'd otherwise waste on unnecessary plug changes.



PRIMARY VOLTAGE TEST

That Versatile VOM— Now It Troubleshoots Your C_

Keep running costs down by keeping performance up with these sure-fire checks

By RICHARD DAY

There's a real tiger for troubleshooting and maintaining the ignition system of your car—and you can own it for $20 or less. It's a volt-ohm-milliammeter—VOM for short.

With a VOM you can make go/no-go checks of primary wiring (nontransistorized ignitions only), coil, distributor points, spark cables, ignition switch, ground circuit, distributor cap, rotor, built-in primary resistance, and more. Without a VOM, problems in any of these areas can run undetected, costing you money because of poor performance from your engine.

Along with the VOM (if you're not sure how to use one, check Nov. '70 PS); you'll need a short No. 16 (AWG) jumper wire with alligator clips.

These testing instructions apply to nearly all U.S. cars with 12-volt negative-ground electrical systems. If your car has a positive-ground system, reverse the red and black lead hookups shown in the drawings.

One caution: *Never try to make primary circuit tests on an engine with transistorized ignition.* Even many pros pale at the thought. One wrong hookup can blow the system in a flash. The *secondary* circuit tests, however, will be okay on any ignition system.

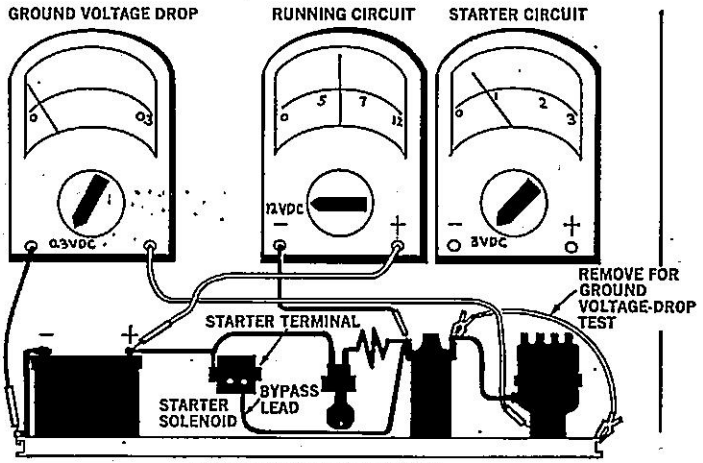
Before you start testing, measure the voltage across the battery with the ignition on, but the engine not running. If it's within the 12-15-volt range, you're ready to begin.

As you go through each test in the order given, you'll eventually narrow down a general problem to a specific part in the ignition system:

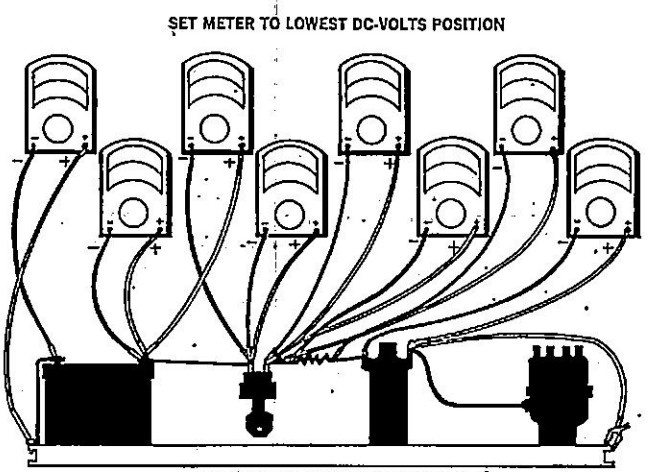
Primary voltage. One simple VOM hookup can give you an overall picture of how your engine's primary system is acting. You make it in two steps:

1. Nearly all U.S. cars use two-voltage primary ignition systems. Primary current for running is passed through a built-in resistance, reducing it enough to keep from overheating and burning distributor points. You can't see the built-in resistance because it's part of the car's wiring, but it's there. However, the second you turn the ignition key to start, the built-in primary resistance is bypassed. This feeds full battery voltage to the coil for a hot starting spark.

For the running voltage test, set the VOM to read 12v with the red (+)



PRIMARY VOLTAGE DROP



INDIVIDUAL VOLTAGE DROP

lead to the battery primary terminal of the coil (BAT or B) and the black lead to a good ground. Turn on the ignition switch and add a jumper lead between the coil's distributor primary terminal and ground. The jumper will complete the ignition circuit, but eliminate the points and other distributor parts as possible causes of trouble.

Voltage should be reduced by the built-in resistance to about 5v to 7v at the coil. Flip the ignition switch off and on several times. At each *on*, the meter should read the same voltage. If it varies intermittently, the ignition switch is faulty.

If the running voltage reading is constantly less than 5v, there may be a loose connection between battery and coil, or the built-in resistance is open or has too high a valve. The primary voltage-drop test coming later will pinpoint the problem.

If the reading exceeds 7v, there may be a loose connection between coil and distributor. The distributor voltage-drop test will check that. It's possible, too, that the built-in resistance isn't even in the circuit because of faulty wiring or a short. It is meant to be bypassed during starting, either by the starter solenoid or ignition switch. Most cars from Ford, GM, and AM use the solenoid-bypass system. Chrysler products all use the switch-bypass system. The individual primary voltage-drop tests coming later should show you where the trouble is.

2. Switch the ignition key to the start position and watch what happens to the meter reading. The needle should read about 9v, indicating the battery voltage while under starter load. If there's any doubt, put the VOM across the battery posts—POSTS, not terminals—while someone cranks the engine. Read the voltage under starter load. It should be about the same.

Ford primary voltage during cranking reads more like 7v—up about a volt from running voltage. The main thing during a starting-voltage test is that the volt reading should be greater than during the running test. If it isn't, the bypass switching system may not be working. The voltage-drop tests will help you find the trouble.

Other possibilities: The starter may be drawing too much current from the battery, or the battery may be too weak to hold a decent voltage during cranking. A direct test on the battery will tell. If the battery can't hold about 9v while starting, you have a battery-starter problem.

Primary ignition voltage drop. This test, performed as a check on the primary voltage-level tests, will help to narrow down any problems.

It's a three-part test—running circuit, starting circuit, ground circuit. Leave the jumper lead connected from the previous tests. To test the running ignition circuit's voltage drop, set the VOM selector at the 12 DC volts position. Connect the red lead to the battery's positive post; the black one to the battery primary terminal of the coil.

The voltmeter will try to read battery voltage. Turn the ignition switch on, everything else off. The voltmeter should then read around 5v to 7v, or as specified by your car's manufacturer. (Ford says 4.5 to 6.9 volts.)

If the voltage-drop reading exceeds maximum, there's excessive resistance in the circuitry between battery and coil. First look for loose or corroded terminals on the battery, starter solenoid, ignition switch, and coil. If visual inspection doesn't pick up the trouble, the individual voltage-drop test (performed later) will. If voltage drop is less than the spec, the primary built-in resistance is at fault. Have your mechanic replace it. Don't tackle it yourself.

The starter circuit is tested with no change in connections. Reset the me-

Continued

ter selector to the 3-VDC setting. The meter will read off scale to the right. Operate the starter and it should drop back to 1.5 volts or less. If the voltage drop is too much, there is a poor connection somewhere in the bypass switching circuit. Visually check for loose or corroded connections from ignition switch to coil or from solenoid to coil, depending upon the system in your car.

Voltage drop can also occur in the ground circuit between the distributor body and the battery negative post.

To make the ground-circuit test, first crank the starter until you're sure the points are closed, then remove the ground jumper. Reconnect the VOM —black prod on the battery negative post, red one on the distributor housing, as in the drawing.

The voltage-drop reading should be near zero. If not, check the individual voltage drops of distributor to engine, engine to ground cable, the ground cable itself, and ground cable terminal to battery post. Each should be near zero. If not, look for corrosion or loosening of terminals in the area you're checking.

Individual voltage drop. If you have found excessive voltage drop, these tests will narrow it down to the portion of the circuit that's causing it. You'll be measuring the voltage lost in each individual part of the ignition and starter circuit while under starter load.

Set the VOM to read at the lowest DC-volt scale. Reconnect the jumper wire from the coil's distributor terminal to ground and turn on the ignition switch. As shown in the drawing, place the test leads in turn across each connection, wire, and switch in the ignition circuit beginning at the positive battery post.

The red lead should always be on the side of the circuit leading toward the battery. Each test should be made with the engine cranking for maximum load on each individual circuit.

The portion of the circuit that gives a reading exceeding the following maximums is the offender:

Readings across all connections and terminals should be near zero. Battery cable-voltage drop shouldn't exceed 0.3v end to end, and the heavy wire from starter solenoid to ignition switch should show less than 0.05v drop. On Chevrolets and most other GM cars, the wires from battery positive post to ignition switch should not produce more than 0.4v drop. And reading across the two ignition-switch posts involved in the circuit should not show a voltage drop of more than 0.3 volts.

Repair or replace any faulty portions of the circuit, then retest.

Distributor voltage drop. Good electrical continuity is as important through the distributor as in the rest of the primary ignition circuit.

First you test for proper ground. Disconnect the jumper wire from the coil's distributor terminal and set the VOM selector to the 12-VDC position. Connect the red lead to the distributor primary terminal of the coil, the black lead to a good ground on the engine. Turn on the ignition switch, everything else off. Open the points by jigging the starter until the meter reads battery voltage. If it won't, the points aren't opening or there's a ground in the coil-to-distributor wire or in the distributor itself. You should be able to find it by careful inspection.

Next, work the starter until the points close and the meter swings back toward zero. You can then safely switch the selector to the next lower position. The needle still shouldn't move much from zero. Finally, switch down to the lowest DC volt position. Now the needle may move some, but the reading should not be more than 0.1v for a pair of new points.

The lower the reading the better, because it indicates voltage lost due to internal distributor resistance. Burned points, a poor inside-distributor connection, or a bad internal wire can cause too much voltage loss.

If distributor voltage drop is too high, check each part of the system separately. Test the coil-to-distributor wire, the lead-in wire (if there is one), across the closed points, stationary breaker point to breaker plate, breaker plate to distributor housing, and distributor housing to engine ground. All readings but those across the points should be zero. The faulty component will be the one that shows a high voltage drop.

Coil primary tests. So far you've checked up to the coil from both sides. Now check the coil itself. There are two tests on primary and one on secondary coil windings. All are ohmmeter tests made with the coil's primary wires disconnected for isolation. As you remove wires, tag them with tape for identification.

Coil primary ground. The coil primary windings should have no continuity with the body of the coil. To test, set your VOM to the highest ohm setting. Touch one test prod to either primary terminal of the coil and the other to the coil's metal body. The needle should not move. If it does, get rid of that coil.

Coil continuity. A coil with open primary windings has had it. Set the selector to the lowest ohm position. Touch a lead to each coil primary terminal; the reading should be less than two ohms.

Proper resistance in the secondary coil is essential for a good spark. With the VOM selector in Rx100 position, hold one test prod down into the coil tower so it's in firm contact with the metal terminal. Touch the other prod to one of the coil's primary terminals. Compare meter reading with specs.

Typical Big-Three specs: Ford coils, 7,600- to 8,800-ohms secondary

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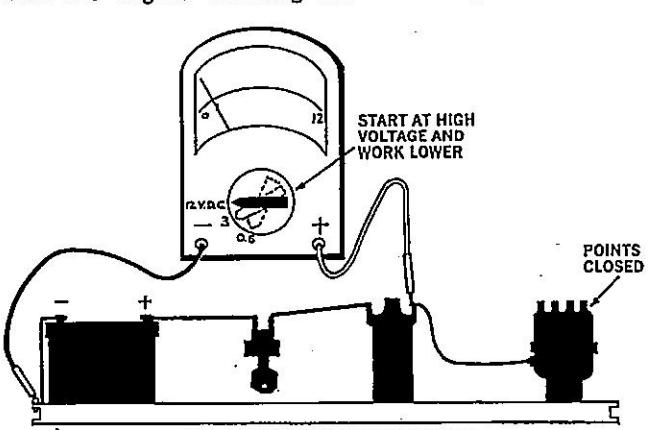
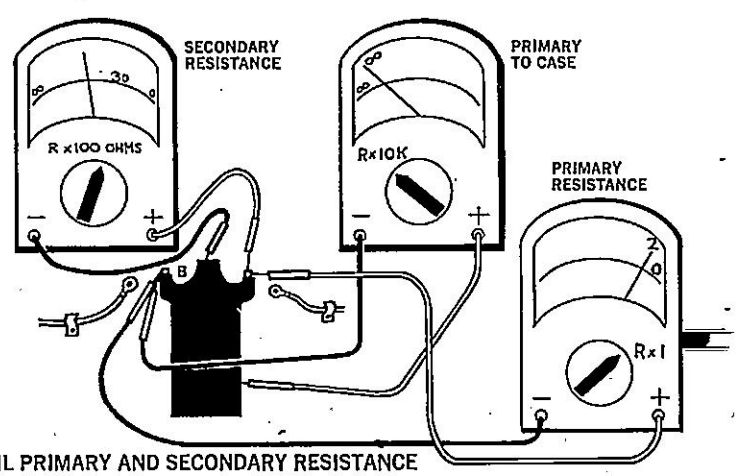


DISTRIBUTOR VOLTAGE DROP



COIL PRIMARY AND SECONDARY RESISTANCE

That Versatile VOM—Now It Troubleshoots Your Car

[Continued]

resistance at 75 degrees F; Chrysler coils, 9,200 to 11,700 ohms; Chevrolet, between 3,000 and 20,000.

If the coil secondary resistance tests outside specs, replace it.

Ignition cable resistance. Resistance was put into spark-plug cables to reduce continued sparking after the initial jump, thereby minimizing spark-plug electrode erosion. It also lessens radio-frequency interference. But these resistance cables deteriorate with age to the point where one or more cylinders misfire. This too-common problem can send you on a wild-goose chase, replacing plugs that are actually okay.

To measure spark cable resistance, remove the distributor cap with all its cables intact and pull the coil-to-distributor cable out of the coil tower. Set your VOM to measure ohms on the Rx100 scale and touch one test prod to the end of a spark cable up inside the boot. Touch the other prod to that cable's terminal inside the distributor cap. Scrape the prods on the metal terminals if it helps to lower an ohm reading.

Resistance specs for spark cables vary according to the make of car. Although generally the longer a cable is, the more resistance it will have (twice the length, twice the resistance), the average is about 20,000 ohms. After you've tested all the wires, if any one is far higher in resistance than the others, you'll know without looking at any specs that the wire needs replacement.

Every wire that you test should be snaked around while the VOM is connected to it. Movement may show up variations in resistance caused by a broken conductor. If this happens, get a new wire.

Solid-core nonresistance cables should be checked, too. Readings from end to end should be near zero ohms. If there is significant resistance, replace the cable or its terminals.

Resistor spark plugs. Resistor and Champion Booster Gap spark plugs can be checked with a VOM. Set the selector to Rx100 ohms. Touch one prod to the spark plug's outer terminal and the other to the center electrode. The reading on most resistor plugs should be between 10,000 and 20,000 ohms. Chevrolet says about 5,000 ohms. If it is higher, replace the plug no matter how good it appears.

Booster Gap plugs should show infinite resistance from end to end of the center electrode. VOM tests on standard spark plugs are meaningless. Don't bother.

Distributor cap/rotor continuity. Distributor cap and rotors can develop shorts through carbon tracking that's not apparent to the eye.

Set the VOM selector to highest ohm position. Touch one prod to the rotor's metal end and move the other around on the insulated rotor body. To test the distributor cap, touch one prod to a metal contact and move the other around on the distributor-cap body. Repeat for every contact and terminal, working from inside and outside the cap. All measurements should show infinite resistance.

If you find a crack or carbon track, replace the part. Otherwise the problem is sure to recur. Replace the affected spark cable, too, because the carbon track will also be inside the boot on the wire. Be sure the coil tower, distributor cap, and spark-plug insulators are wiped clean. Grease and salt deposits on these parts are a major cause of hard starting in damp weather. PS