THE MASTER TECHNICIAN'S

SERVICE REFERENCE BOOK

SESSION NO.

63-4

ELECTRICAL DIAGNOSIS

MASTER TECHNICIANS SERVICE CONFERENCE
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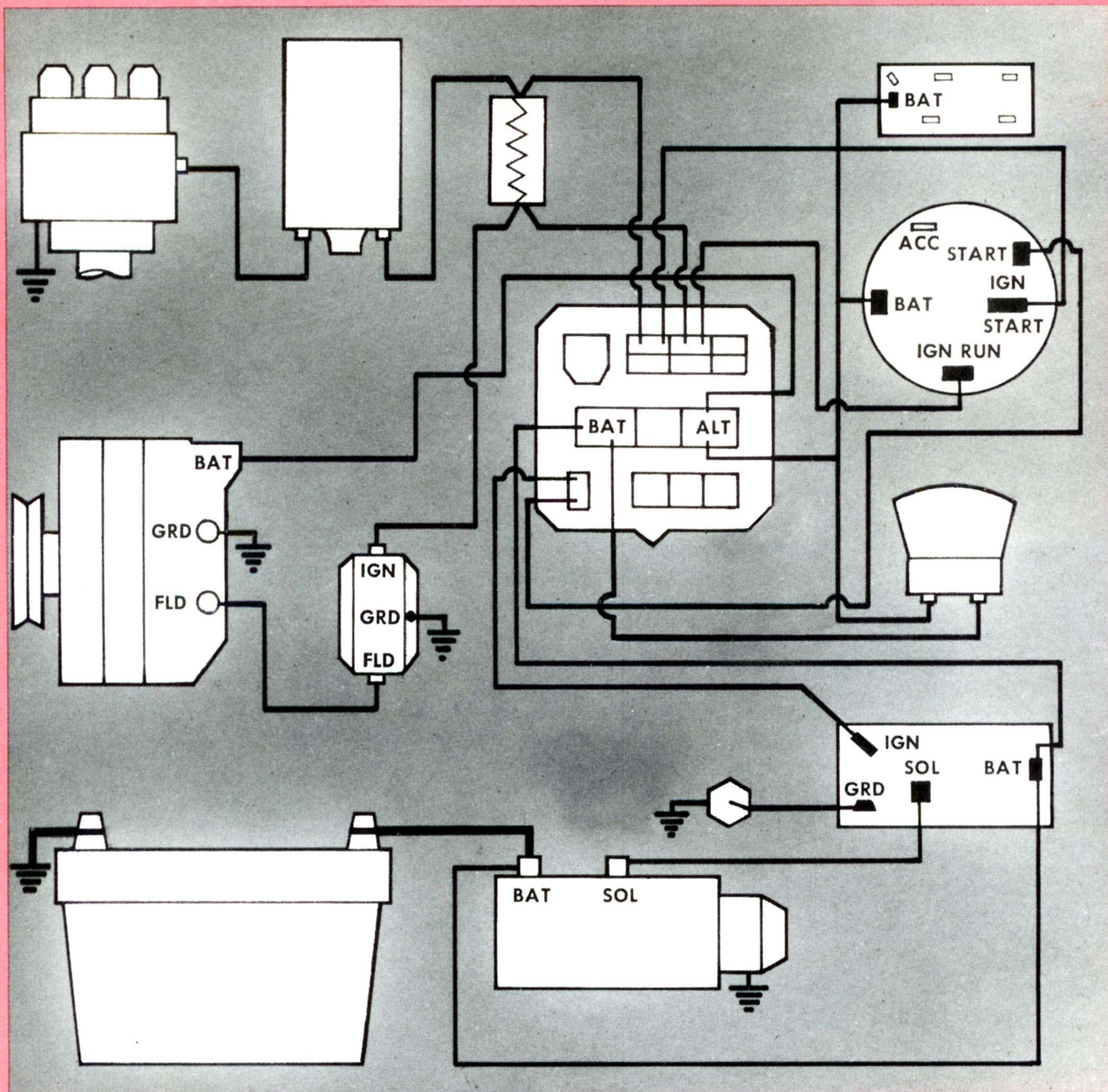

Fig. 1—Charging, starting motor and primary ignition circuits.

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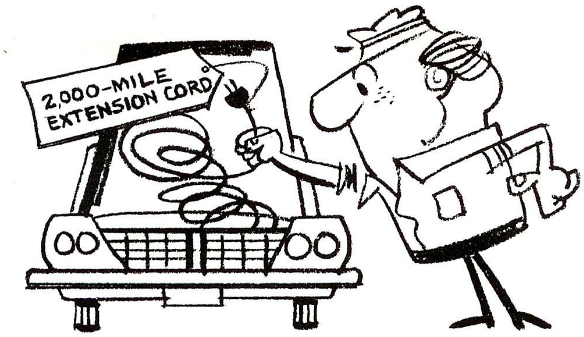
BASIC CIRCUIT AND BATTERY FACTS

In the past few years automotive electrical circuits have become increasingly complex. Few simple series circuits are used. Almost every circuit in the car is in parallel with some other circuit or some part of another circuit.



In electrical troubleshooting it is important to know which units are included in the circuit being tested and whether these units are connected in series or in parallel. Sometimes it is also important to know whether or not the circuit you are testing is in parallel with some other circuit.

CHARGING, STARTING MOTOR AND IGNITION CIRCUITS

The accompanying circuit diagram (Fig. 1) is a simplified representation of the combined charging, starting motor and ignition primary circuits. This circuit diagram will help you determine which circuits and portions of circuits are in parallel and which are in series.

For example, trace the basic supply circuit from the battery, to the starting motor, to the junction terminal of the starter relay, through the multi-connector, and through the ammeter. This portion of the main supply circuit from the battery is a series circuit. However, beyond the ammeter, the circuit branches into several parallel circuits.

One branch feeds or supplies the ignition switch and everything connected to it. Another branch goes back through the multi-connector and leads to the alternator output terminal completing the charging system circuit. A third branch supplies or feeds the light switch and all circuits connected to it. From this you can see that high resistance anywhere in the series circuit from the battery to the output side of the ammeter will affect the performance of all circuits branching off from this basic battery supply circuit. That's one reason why it is particularly important that all connections to this part of the circuit be clean and tight.

PARALLEL CIRCUITS CAN AFFECT VOLTAGE DROP

It is quite easy to test for high resistance in a series circuit by taking a voltage drop reading across the circuit and comparing the results with voltage drop specifications. It wouldn't seem that current flow in a parallel circuit branching off a series circuit would affect voltage drop readings in the series circuit being tested . . . but it does. Here is why.

Voltage drop specifications are based on normal current flow in the circuit being tested. Current flow in a parallel circuit branching off from a series circuit will increase the amount of current flowing in at least part of the circuit being tested. This will raise the circuit temperature, and increase both the resistance and the voltage drop. In some of the tests covered in this session it is necessary to disconnect wires or turn off switches to eliminate current flow in parallel circuits. Be sure and follow these instructions to the letter. They are important!

THE COMMON GROUND CIRCUIT

All too frequently the importance of good, low resistance ground connections is overlooked. The engine, body, battery ground cable and ground connections at electrical units are just as important as the "positive side" wires and connections.

A good, low resistance circuit must be provided between every ground symbol shown in Fig. 1 and the negative battery terminal. This means clean, tight connections at both ends of the battery ground cable and at every electrical unit ground connection represented by a ground symbol.

BATTERY CONDITION AND STATE OF CHARGE

It's a good idea to test battery condition and state of charge on every electrical trouble-shooting job. If the battery isn't up to par, test the charging system to make sure it is capable of keeping the battery charged. Just one word of caution:

CHARGING-SYSTEM TEST RESULTS ARE NOT CONCLUSIVE IF THE BATTERY IS PARTIALLY CHARGED OR SULPHATED. INSTALL A FULLY CHARGED BATTERY BEFORE MAKING ANY CHARGING SYSTEM TESTS.

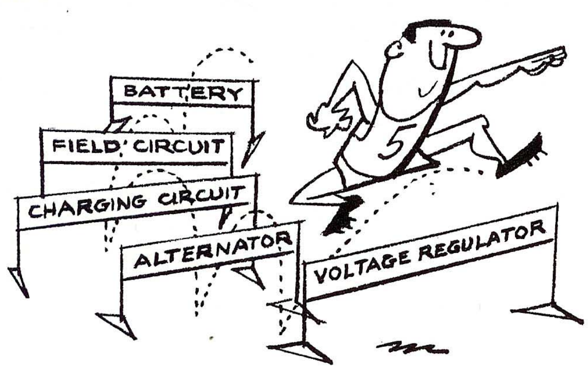
2 CHARGING-SYSTEM DIAGNOSIS

The battery, the alternator, the regulator, the field circuit and the charging circuit are all parts of the charging system. The charging system cannot function properly unless every one of these five segments of the system is up to specifications. Charging-system diagnosis is not difficult, but it is extremely important that all five segments of the system be tested in the following order:

1. Battery—State of Charge and Capacity
2. Field Circuit—Resistance
3. Charging Circuit—Resistance
4. Alternator—Current Output
5. Voltage Regulator—Output Voltage Control

DIAGNOSIS BY LOGICAL ELIMINATION

Each of the above elements of the charging system is an unknown until it is tested. It is quite possible to have trouble in more than one of these charging-system elements. Obviously, correcting only one cause of trouble where two exist is bound to result in a dissatisfied customer and a "comeback".



One of the easiest ways to get into trouble is to jump into the middle of the recommended test sequence. For example, test specifications for alternator output and regulator operation are based on the assumption that field circuit and charging-circuit resistance are within specifications. The regulator test specifications are based on the performance of the alternator and its ability to deliver rated current output. In the long run, you can save time and be sure of your test results by following the recommended test sequence.

TEST THE BATTERY

We have already pointed out that a fully charged battery is a *must* for complete and accurate charging-system diagnosis. If the battery is not fully charged, install one that is, before making any charging-system tests.

FIELD CIRCUIT RESISTANCE TEST PREPARATION

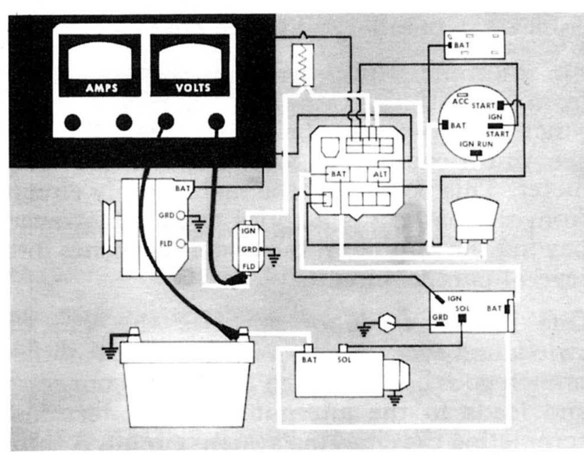


Fig. 2—Field circuit resistance test.

There are two reasons for testing field-circuit resistance before charging-circuit resistance. In the first place, this test is made by connecting a voltmeter in parallel. None of the charging-system connections are disturbed so you eliminate the chance of destroying resistance clues. In the second place, it's a good idea to test field-circuit resistance before the circuit is heated by the higher current flowing in part of the circuit during later tests.

Here's how the test connections are made:

1. Disconnect either of the ignition leads from the ballast resistor to prevent current flow in the ignition circuit.
2. Turn the ignition switch on.
3. Connect the positive lead of a DC voltmeter to the positive battery post, and the negative lead to the voltage regulator field terminal.
4. Check your test connections with those shown in Fig. 2.
5. Turn the voltmeter selector to the lowest voltage scale.

FIELD CIRCUIT TEST RESULTS

Read the voltage drop registered on the voltmeter. The voltage drop should not exceed .55 volt. A voltage drop exceeding .55 volt indicates high resistance in the field circuit somewhere between the battery and the regulator field terminal. To pinpoint the high resistance, move the negative voltmeter lead to each successive connection in the circuit leading to the battery. Continue testing until a sharp decrease in voltage drop is registered. This decrease tells you that the high resistance is between that terminal and the last point tested.

When trying to locate high resistance, it is helpful to wiggle wires and connectors. Any movement of the voltmeter needle indicates a loose or dirty connection, or possibly a broken wire. And, don't forget to test the drop across the ignition switch and the ammeter since the field circuit goes through these units. Clean and tighten all loose connections. Retest circuit voltage drop before going on to the next test.

CHARGING CIRCUIT RESISTANCE

There is never any current flow from the battery through the alternator stator windings. The only time that current flows through the entire charging circuit is when the alternator is sending a charging current into the battery. For this reason, charging system resistance must be measured with the engine running, a known current flowing in the circuit and field regulation removed so that current flow can be controlled by controlling engine speed.

CHARGING CIRCUIT TEST PREPARATION

Disconnect the battery ground cable. There is a direct connection between the battery and the alternator output terminal at all times. There is also a direct electrical connection between the alternator output terminal and the alternator heat sink. Shorting the alternator output terminal or heat sink to ground puts full battery voltage through the external charging circuit. This will damage the alternator and charging circuit wiring. The battery ground cable must be disconnected before any charging circuit wires are disconnected or before connecting test equipment.

Accidental Short Circuits. Refer to Fig. 1 and note that both the battery terminal and the alternator terminal of the multi-connector are located in series between the battery and the alternator output terminal. These two terminals are also "hot" at all times. Shorting either of them can result in serious damage. Do not remove either of these terminal connections without first disconnecting the battery ground cable.

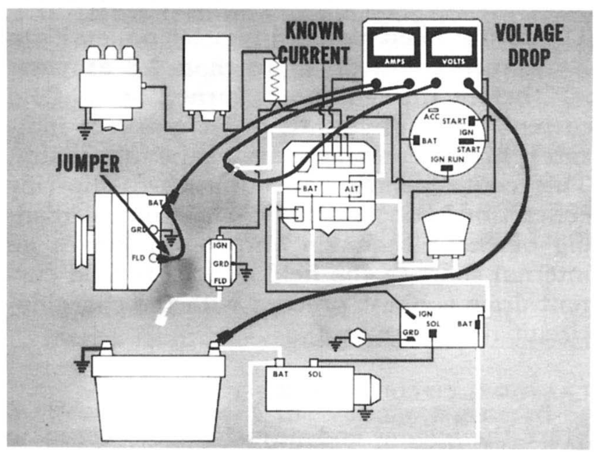


Fig. 3—Charging-circuit resistance test.

1. Disconnect the charging-circuit wire from the alternator "BAT" terminal.
2. Connect an ammeter in series between the alternator "BAT" terminal and the terminal of the disconnected charging-circuit wire.
3. Connect the negative lead of a DC voltmeter to the positive battery terminal. Connect the positive lead to the charging-circuit wire, as shown (Fig. 3) so that the voltmeter will not register voltage drop across the ammeter.
4. Disconnect the field lead from the alternator field terminal. Connect a special jumper between the alternator "BAT" terminal and the alternator field "FLD" terminal.
5. Reconnect the battery ground cable.

NOTE: Test equipment manufacturers have developed a special adapter which is connected to the battery. The test ammeter can be attached to this adapter. This eliminates the need for disconnecting the charging circuit at the alternator. If this adapter is used, be sure that no switches are turned on when taking field current draw readings. Any current flow, except through the alternator field windings, will affect test results. For example, an open car door would result in current flow to the dome or courtesy lights.

Read Field Current: When the instruments are connected for the circuit resistance test, the test ammeter will register the amount of current flowing in the alternator field windings. This is referred to as field current draw.

The test ammeter should register no less than 2.4 amperes and no more than 2.8 amperes . . . before the ignition is turned on. A field current draw of less than 2.4 amperes indicates high resistance inside the alternator. This could be caused by brush-to-slip-ring contact or loose field coil connections. A reading of more than 2.8 amperes indicates an internal short in the field circuit. If field current draw is okay, proceed with the charging-circuit resistance test.

CHARGING-CIRCUIT RESISTANCE TEST

Start the engine and adjust engine speed to get a reading of 10 amperes on the test ammeter. The voltmeter should not register a drop of more than .3 volt. If it does, clean and tighten all connections in the circuit, and retest. Circuit resistance must be within specifications before proceeding with the current output and voltage tests.

CURRENT OUTPUT TEST PREPARATION

The current output test is made with all field regulation removed. This test tells you whether or not the alternator is capable of delivering specified current output at a specific test speed.

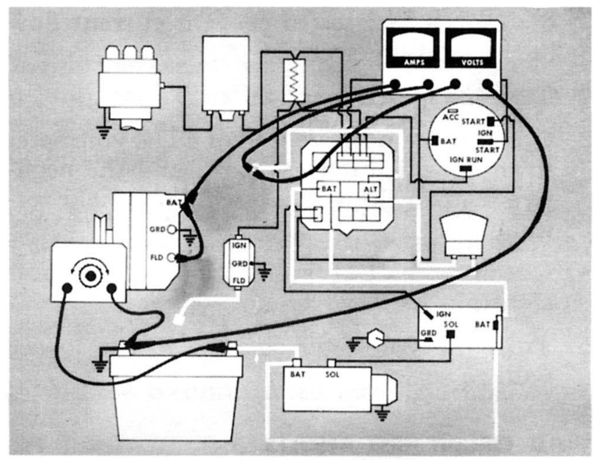


Fig. 4—Alternator current output test.

1. The test ammeter is connected in series as it was for the charging-circuit resistance test.
2. The field jumper is connected as it was for the resistance test.
3. The voltmeter is connected to register output voltage, not voltage drop. Simply move the negative lead of the voltmeter from the battery positive terminal to the battery negative terminal.
4. Connect a carbon pile rheostat across the battery. Be sure the rheostat is in the "Open" or "Off" position before connecting the leads. The carbon pile rheostat will be used to adjust and control the unregulated alternator output voltage to the value required for this test.
5. Since engine speed must be rigidly maintained during this test, connect a reliable tachometer.

6. Check your test connections with those illustrated in Fig. 4.

CURRENT OUTPUT TEST

Adjust engine speed to 1250 r.p.m. Carefully adjust the carbon pile rheostat to obtain the exact 15 volts specified for this test. Read the test ammeter, then, *turn off the carbon pile load*. Compare the amperage registered with the following specifications:

CURRENT OUTPUT SPECIFICATIONS	
Valiant and Dart	**25 ± 3 amperes**
Standard (except Valiant and Dart) .	**34.5 ± 3 amperes**
Special Equipment (H.D. and A/C) . . .	**39 ± 3 amperes**

The foregoing specifications are test standards, not a test of maximum output. The 3-ampere tolerance allows for variation in output depending on charging system temperature. If the alternator fails to pass the output test it must be removed from the car and tested further to locate the cause of trouble.

VOLTAGE REGULATOR TEST PREPARATION

The voltage regulator tests determine the regulator's ability to limit alternator output voltage. The circuit resistance tests, field current draw and alternator output test should always be made before attempting to test or adjust the regulator. Adjusting the regulator in an attempt to compensate for circuit resistance or alternator output performance is a sure-fire short cut to more serious charging circuit troubles and a "comeback".

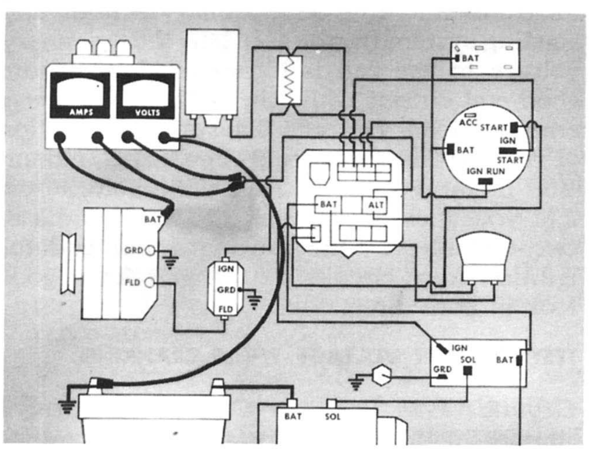


Fig. 5—Voltage regulator tests.

1. The ammeter is connected in series and the voltmeter in parallel, as it was for the current output test.
2. The carbon pile rheostat is not used for this test.
3. The field jumper wire must be removed and the field wire reconnected to the alternator field terminal.
4. Test connections are shown in Fig. 5.

CAUTION: The car's ignition switch must be turned off before removing the jumper and connecting the field lead to the alternator. If the field circuit is accidentally grounded while the ignition is on, the regulator and field circuit wires will be damaged.

Start the engine and adjust speed to 1250 r.p.m It is important to operate the engine at 1250 r.p.m. and to maintain a 15-ampere load for 15 minutes to make certain the entire charging system is temperature-normalized. If the charging current is too low, turn on lights and/or accessories to obtain and maintain a 15-ampere output as registered on the test ammeter.

VOLTAGE REGULATOR TEST NUMBER ONE

This test determines whether or not the regulator can control voltage under conditions of high electrical load and relatively low engine speed.

1. Check engine speed and test ammeter reading after the system is normalized. Readjust speed to exactly 1250 r.p.m and electrical load to obtain a 15-ampere reading.
2. Read and record the temperature two inches from the regulator cover . . . cover *installed*.
3. Read and record the voltage registered on the voltmeter. Compare this voltage with the following specifications.

VOLTAGE-TEMPERATURE SPECIFICATIONS (15-amp. Load, 1250 r.p.m.)					
Temperature Degrees F.	48	70	95	118	140
Minimum Voltage	13.8	13.7	13.6	13.5	13.4
Maximum Voltage	14.4	14.3	14.2	14.1	14.0

Test conclusions: If voltage is higher than the maximum specified, armature spring tension may be too great. If voltage is lower than the minimum specified, spring tension is probably too low. If voltage is within specifications, go on to test number two.

VOLTAGE REGULATOR TEST NUMBER TWO

This tests the ability of the regulator to control voltage at high speed, particularly when the electrical load is low.

1. Increase engine speed to 2200 r.p.m.
2. Turn off all lights and accessories and watch the voltmeter and ammeter.
3. Voltage should increase at least .2 volt but not more than .7 volt.
4. The ammeter should not register more than 5 amperes.

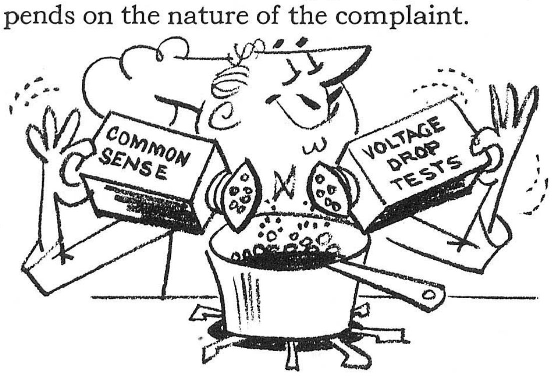
The minimum increase of .2 volt insures proper voltage control when the car is driven at high speed with a light electrical load. If the increase in voltage is less than .2 volt when engine speed is increased to 2200 r.p.m. and all lights and accessories are turned off, the armature air gap is probably too small. Voltage control will be erratic and the car's ammeter pointer may jump or oscillate.

The maximum increase of .7 volt insures that the regulator is capable of limiting alternator output at higher speeds. If voltage increases more than .7 volts, the armature air gap is probably too great.

If the regulator meets all test specifications, it is adjusted properly and requires no further attention. If it fails to pass any part of the test, it must be adjusted. Follow the adjustment procedure in the service manual.

3 IGNITION PRIMARY AND STARTING-SYSTEM DIAGNOSIS

Troubleshooting the ignition primary circuits and the starting circuits is one part common sense and one part accurate voltage drop tests. The common sense applies to deciding what to test first. The starting point, of course, depends on the nature of the complaint.



A cranking voltage test is a good starting point for troubleshooting both primary ignition and starting system troubles. It tells if the primary voltage to the coil is high enough to insure good coil output while the battery is under a cranking load. It also checks on the condition of the starting motor and the starting circuit. You might say that the cranking voltage test lets you stick your head into the middle of two circuits . . . the starting motor and the ignition-start circuits . . . and take a good look in both directions!

TEST IGNITION VOLTAGE WHILE CRANKING

Ground The Primary Circuit: Connect a jumper to the distributor side of the ignition coil to ground out the primary circuit. This will keep the engine from starting while you are testing. *Do not* pull the secondary ignition wire from the coil or distributor to prevent the engine from starting. High voltage in an open secondary circuit can damage the ignition coil or produce sparks which could start a fire.

Connect The Voltmeter: The purpose of this test is to measure voltage to the coil. Connect the positive voltmeter lead to the input side of the coil. That's the terminal marked (+). The negative voltmeter lead is grounded.

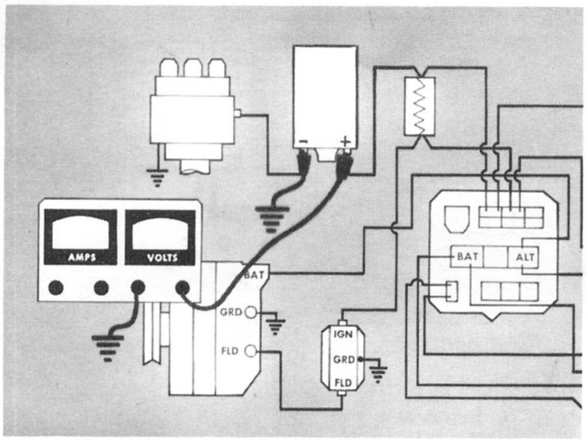


Fig. 6—Cranking voltage test.

The Cranking Voltage Test: Crank the engine for about fifteen seconds and watch the voltmeter. If cranking voltage is 9.6 volts or higher, ignition-start circuit resistance is within specifications. A voltage reading of less than 9.6 volts indicates high resistance in the ignition-start circuit, a questionable battery or starting motor circuit troubles.

WHAT TO TEST NEXT

The 9.6 voltage specification is based on voltage available from a fully charged battery, and a normal "warmed-up-engine" cranking load. A cold or mechanically "tight" engine will reduce voltage below that specified. If the cranking voltage is less than 9.6, test the battery or install a fully charged battery and repeat the test.

If the battery is okay but cranking speed seems to be slow, check out the starting motor circuit. Of course, if the starter solenoid doesn't close, the trouble is in the starting motor control circuit. If cranking speed is good and the battery is fully charged, but ignition voltage is low, better check out primary ignition circuit resistance.

IGNITION CIRCUIT VOLTAGE DROP TESTS

The cranking voltage tests determine whether or not voltage to the coil, while cranking, is okay. It does not measure resistance from the coil through distributor, resistance in the ignition-run circuit, or ballast resistor condition. The following tests will pinpoint any high resistance in the ignition circuit.

Point-By-Point Ignition-Start Circuit Test: Leave the ground jumper connected to the coil (—) terminal. Connect the voltmeter negative lead to the coil (+) terminal. Connect the positive voltmeter lead to the positive battery terminal. To prevent engine cranking while testing the ignition-start circuit, disconnect the starter control circuit lead from the starter relay ignition terminal.

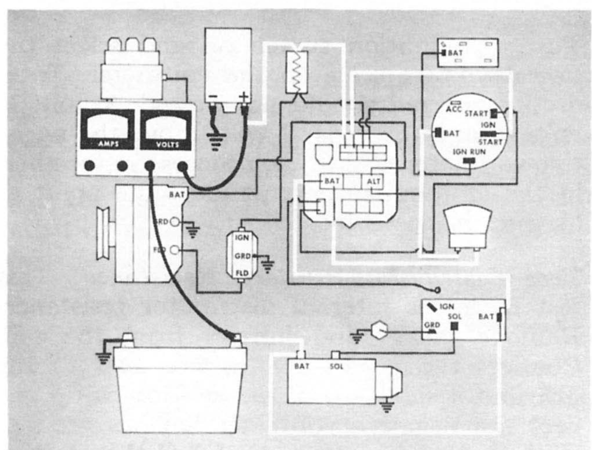


Fig. 7—Ignition-start circuit test.

Turn the ignition key all the way to the "start" position and select the lowest voltmeter scale setting. Voltage drop registered should not exceed .35 volt. If it does, move the negative voltmeter lead to each point in the ignition-start circuit until you locate the point of high resistance.

Point-By-Point Ignition-Run Circuit Test: Leave the jumper connected to the ignition coil and the positive voltmeter lead connected to the positive battery terminal. Move the negative voltmeter lead to the input side of the ballast resistor. Disconnect the alternator field lead from the ignition terminal of the voltage regulator to eliminate current flow through the field circuit.

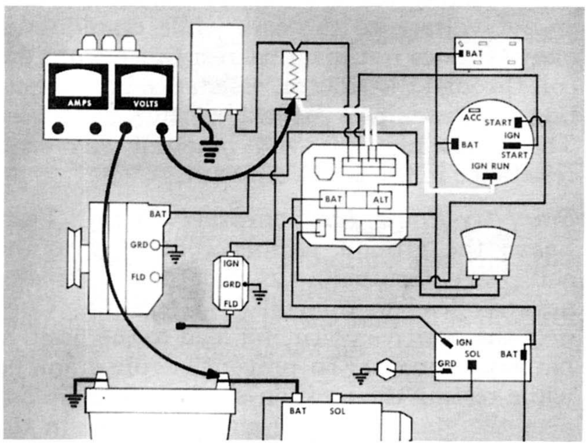


Fig. 8—Ignition-run circuit test.

Turn the ignition switch on and select the lowest voltage scale on the voltmeter. Total drop registered should not exceed .3 volt. If voltage drop exceeds .3 volt, move the negative voltmeter lead to each successive terminal in the ignition-run circuit until the point of high resistance is located.

Test Distributor Primary Resistance: This test measures internal distributor resistance. Remove the ground jumper from the coil. Connect the positive voltmeter lead to the distributor side (—) of the ignition coil. Connect the negative voltmeter lead to ground. With the ignition turned on and the *ignition points closed,* voltage drop should not be more than .1 volt. If voltage drop is more than that, the trouble is in the distributor lead wire or the ignition points.

Road Service Tip: If the ballast resistor is open-circuited, the engine will start but stall as soon as the ignition key is released to the run position. A jumper across the ballast resistor terminals will serve as an emergency fix. However, a new ballast resistor must be installed as soon as practical to prevent excessive arcing across the ignition points when the car is driven at low speeds.

STARTING MOTOR AND CABLE TEST

Connect a jumper to the distributor side of the ignition coil so the engine won't start when it is cranked. Connect the positive voltmeter lead to the positive battery post. Connect the negative voltmeter lead to the starting motor battery terminal. Turn the ignition switch to the start position and watch the voltmeter while cranking. If the voltage drop is more than .2 volt, test the drop across the cable connections. Be sure and check the drop across the battery ground cable and connections, too.

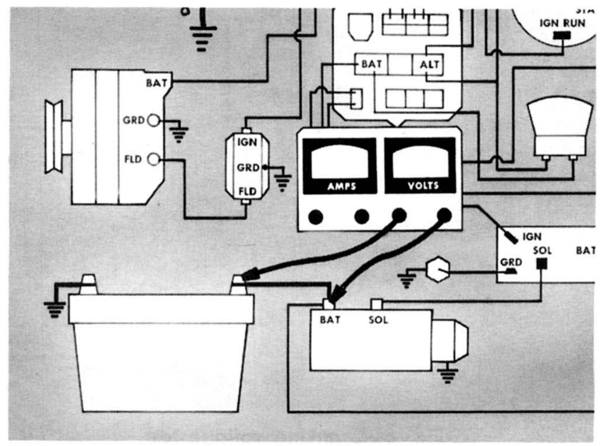


Fig. 9—Starting motor circuit test.

There should be no voltage drop across any of the cable terminals. Maximum drop across each of the battery cables should be no more than .2 volt.

If cranking is slow and the voltage drop in the starting motor circuit is less than .2 volt, the trouble is in the starting motor. It should be removed for inspection and bench tests. Be sure and follow the instructions in the appropriate service manual to avoid damage during disassembly.

THE STARTING MOTOR CONTROL CIRCUIT

Tracking down control circuit trouble is primarily checking out the continuity of the circuit. This can be done with a jumper.

Connect a jumper from the battery terminal of the relay to the ignition terminal of the relay. If the engine cranks with the jumper in place you'll know that the relay and the starter solenoid are okay. The trouble is either in the ignition switch or in the circuit between the relay and the switch.

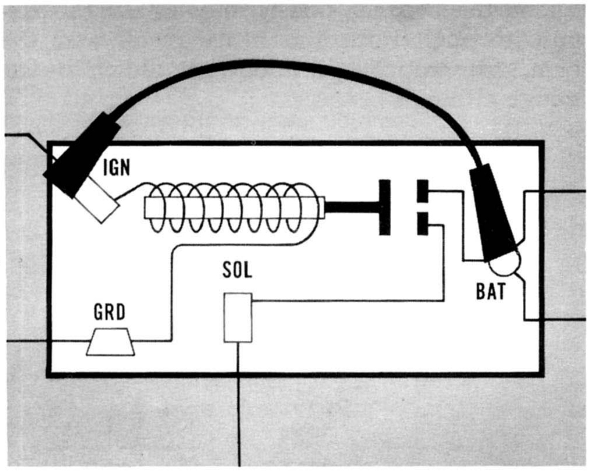


Fig. 10—Starter relay continuity detail.

If the engine does not crank with the jumper installed, the trouble is in the relay, the relay ground circuit, or the starting motor itself.

To make certain that the trouble is not in the relay ground circuit, connect a second jumper from the relay ground terminal to a good ground. On TorqueFlite-equipped cars don't overlook the possibility of an inoperative neutral safety switch.

STARTER RELAY TEST

To test continuity through the relay, leave both jumpers connected. Use a voltmeter to test for voltage at the solenoid terminal of the relay. Connect the voltmeter positive lead to the relay solenoid terminal. Connect the negative voltmeter lead to ground.

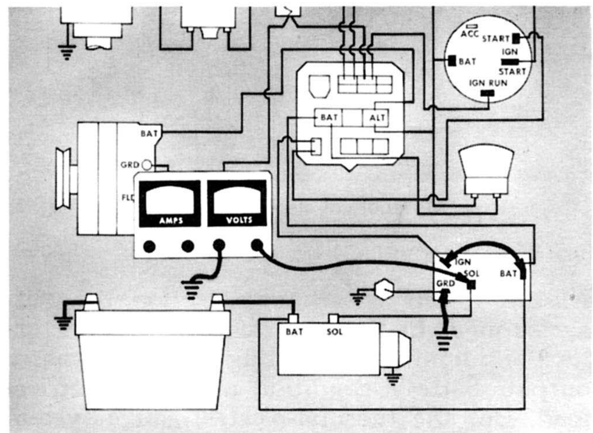
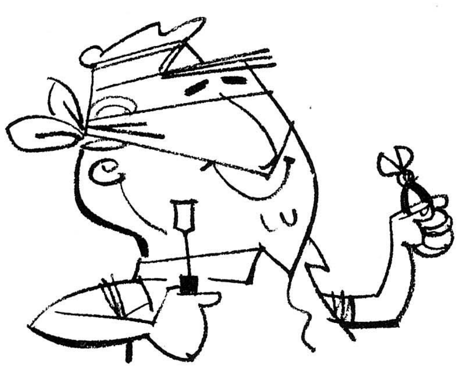


Fig. 11—Starter relay continuity test.

If the voltmeter does not show battery voltage when the ignition switch is turned to start, the relay is open-circuited and must be replaced. If the voltmeter shows battery voltage, the trouble is in the starting motor and it must be removed for inspection and tests.

4 THERMAL-ELECTRIC GAUGE OPERATION



Thermal-electric fuel and temperature gauges are used in all 1963 Chrysler Corporation cars. In addition, the '63 Imperial and Dodge 880 have a thermal-electric oil pressure gauge. The gauges in these cars are not difficult to service; however, it's always easier to troubleshoot a system that you're familiar with. To understand the thermal-electric gauge system, you've got to consider not only the gauge itself, but the entire gauge circuit—the voltage limiter, the gauge, the sending unit and the connecting wires.

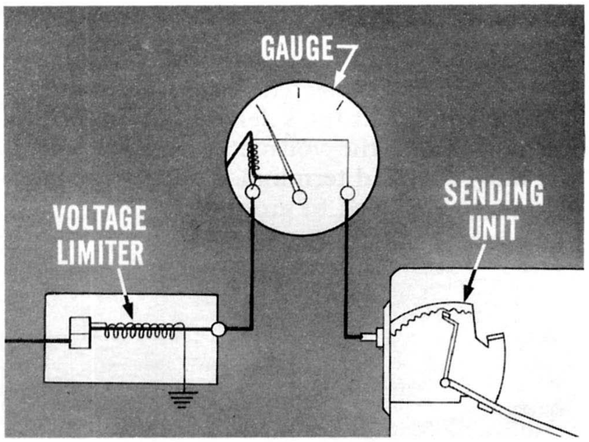


Fig. 12—Thermal-electric gauge circuit.

VOLTAGE LIMITER

Function: During normal operation, the voltage supplied by the car's electrical system varies considerably, depending upon alternator output, battery condition and the electrical load. But the thermal-electric gauge system requires an average voltage that *doesn't* vary if gauge indications are to be accurate. So in effect, the voltage limiter takes the voltage available from the battery or alternator and reduces it to five volts for the gauge circuits.

Operation: If you could see through the cover of a voltage limiter, you'd find an electric heating coil wrapped around a bimetallic arm. The bimetallic arm opens and closes a set of contact points. When the ignition switch is on, current from the car's electrical system flows through the closed contact points and the bimetallic arm to the rest of the gauge circuit.

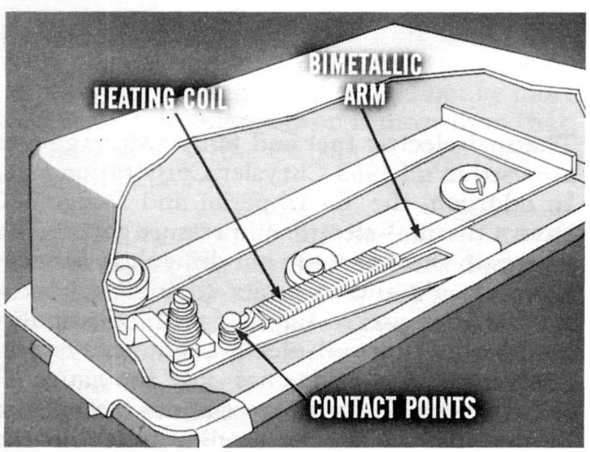


Fig. 13—Voltage limiter details.

At the same time, some current also flows through the heating coil to the ground. The current flowing through the coil heats the bimetallic arm so that the arm bends. This opens the contact points and breaks the circuit through both the heating coil and the arm, interrupting the current flow to the gauge circuit.

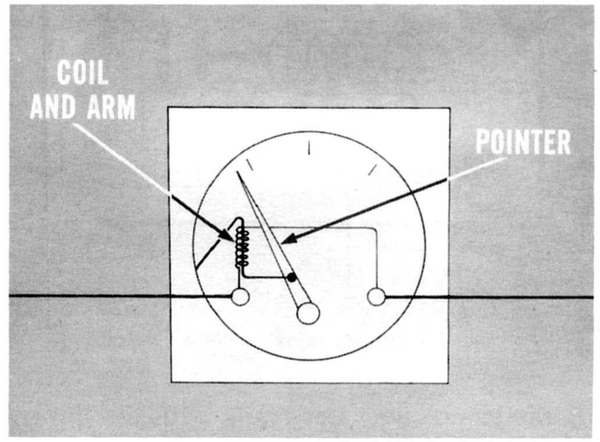


Fig. 14—Thermal-electric gauge details.

When the heating coil cools, the arm straightens out, closing the points and starting the cycle all over again. The rapid opening and closing of the points provides a pulsating current at a controlled voltage.

GAUGE OPERATION

Inside the gauge, there's another heating coil wrapped around a bimetallic arm. This arm is linked to the gauge pointer so that the pointer's position is determined by the temperature of the arm. When there's only a slight current flowing through the gauge heating coil, the arm doesn't bend very much. Consequently, the gauge pointer moves only slightly. But with increased current, the heating coil gets warmer and the arm bends more, moving the pointer toward the other side of the gauge dial.

SENDING UNIT FUNCTION

We've seen how the gauge system is supplied with a controlled average voltage by the voltage limiter, and how the gauge responds to the current flow through the system. Now the question arises — how is the current flow through the gauge regulated so that the gauge will show the proper reading? The answer—it's done by a variable resistance in the sending unit. The sending unit resistance is connected in a series with the gauge. Its resistance varies according to the pressure, temperature or level that the sending unit is sensing.

FUEL LEVEL SENDING UNIT

Inside the fuel level sending unit a grounded contact arm moves along a coil of resistance wire. The position of the movable contact arm is controlled by the fuel tank float. When the tank is full, the float rises and the contact arm is positioned so that the current passes through only a few turns of the resistance wire before it goes to ground. This low resistance permits a relatively high current flow which raises the temperature of the fuel gauge heating coil. As a result, the gauge reads "Full".

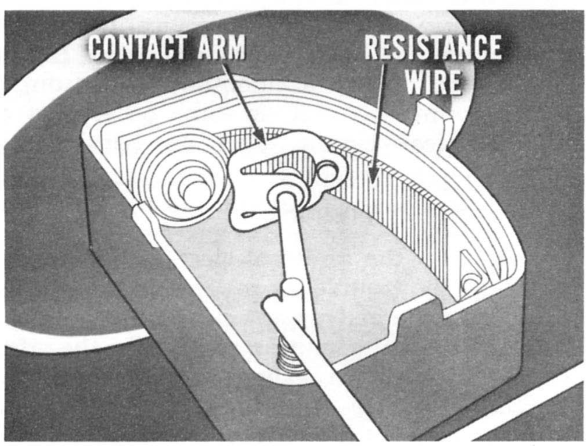


Fig. 15—Fuel level sending unit details.

As the tank empties, the float moves the contact arm so that the current passes through nearly all of the resistance wire before it goes to ground. This increased resistance results in only a slight current flow through the circuit. So the fuel gauge heating coil stays cool and the gauge indicates a low fuel level.

ENGINE TEMPERATURE SENDING UNIT

The engine temperature sending unit also varies the resistance to current flow in the circuit—but it does the job in a different manner! Inside the temperature sending unit is a resistor made of a special material which has a high electrical resistance when it's cold and low resistance when it's hot. This resistor is located where it can sense engine coolant temperature. It is connected in a series with the temperature gauge.

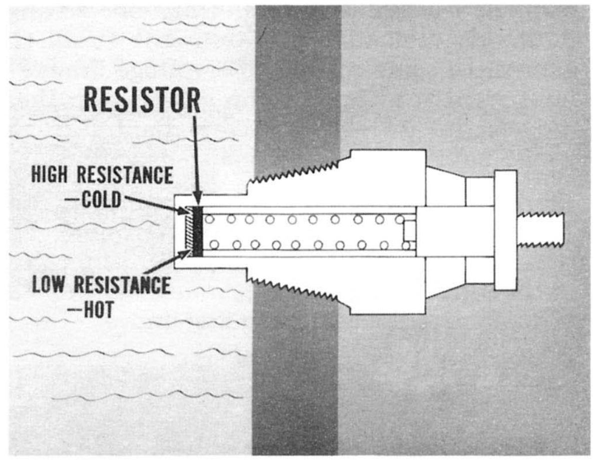


Fig. 16—Engine temperature sending unit.

OIL PRESSURE SENDING UNIT

The oil pressure sending unit in the 1963 Imperial and Dodge 880 also operates on the principle of varying electrical resistance. Inside the sending unit, a diaphragm senses oil pressure and controls a rheostat to vary circuit resistance. The resistance is high when oil pressure is low, and the resistance becomes low when the oil pressure is high. The oil pressure gauge reacts to the resulting current flow to give the proper oil pressure indication.

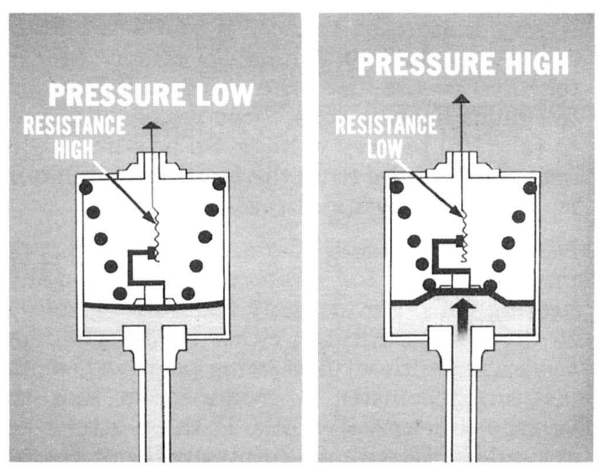


Fig. 17—Engine oil pressure sending unit.

5 THERMAL-ELECTRIC GAUGE DIAGNOSIS

GAUGE CIRCUIT SERVICE PRECAUTIONS

Built-in Voltage Limiters: Only one voltage limiter is used to provide current to all the gauges. In some models, the voltage limiter is built right into one of the gauges. On these models the voltage limiter is built into the gauge having three terminals.

Terminal Identification: The terminal marked "I" is the voltage limiter input terminal. The terminal marked "A" is the output connection to the other gauges. The terminal marked "S" is the connection to the sending unit.

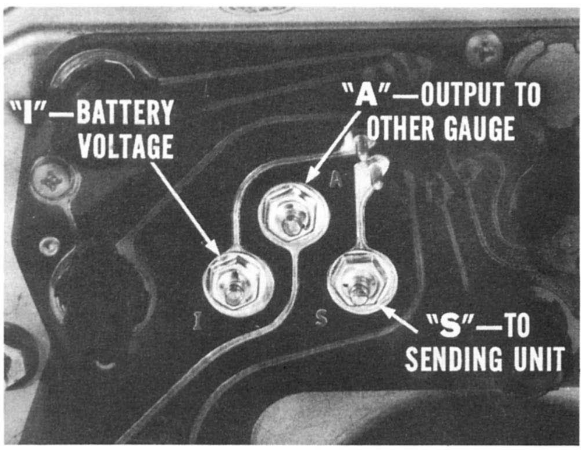


Fig. 18—Built-in voltage limiter terminals.

Proper identification of these three terminals is very important because if you accidentally apply full battery voltage to either the "A" terminal or the "S" terminal, you'll burn out the gauge heating coils. They weren't designed to take full battery voltage. So be sure to connect the hot wire from the ignition switch only to the input terminal marked "I".

Instrument Cluster Ground: Here's a very important tip for protection of the gauge heating coils. Never apply full battery voltage to the voltage limiter, either in the car or on the bench, without first being positive that the instrument cluster is grounded so that the voltage limiter will work. If the cluster's not grounded, the voltage limiter will not control voltage and you'll burn out the gauges.

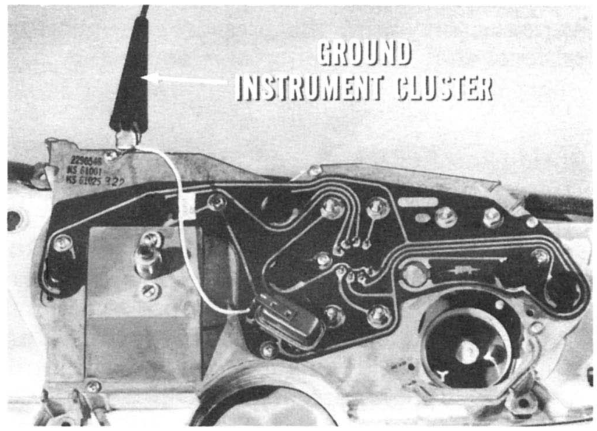


Fig. 19—Instrument cluster ground protects gauges.

Accidental Short Circuits: Before you remove the instrument cluster for service, be sure to disconnect the battery ground cable. If you don't, you might accidentally short out a gauge, printed circuit or some other part of an electrical circuit, and do considerable damage.

GAUGE CIRCUIT DIAGNOSIS

If none of the thermal-electric gauges are working, the trouble is probably in the voltage limiter, in the instrument cluster ground or in the lead from the ignition switch. On the other hand, if only one gauge is out, check the individual circuit—the gauge, the sending unit and the connecting wiring.

TEST EQUIPMENT

To test the thermal-electric gauge circuits, a good voltmeter and the C-3826 special electronic gauge tester are needed. It's also a good idea to have two 10-foot lengths of insulated 16-gauge wire with spring clips on both ends. These two test hookup wires will allow you to make the tests from the driver's seat.

VOLTAGE LIMITER TEST

To test the voltage limiter, connect one lead of the voltmeter to the terminal of the engine temperature sending unit, and connect the other lead to a convenient ground. When the ignition switch is on, the voltmeter needle will pulsate if the limiter is working correctly.

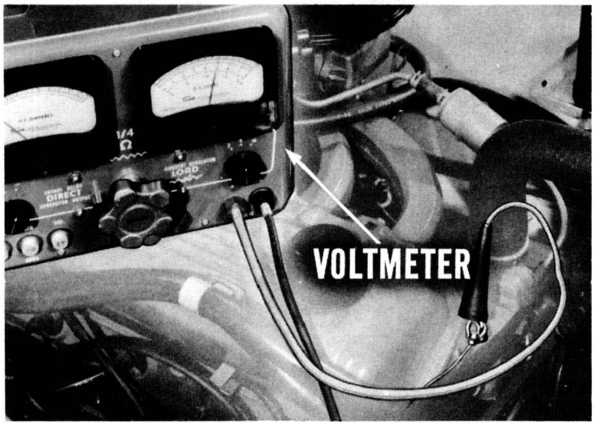


Fig. 20—Voltmeter tests voltage limiter.

A reading of approximately 12 volts indicates a defective voltage limiter or a break in the ground circuit. Check the voltage limiter, the instrument cluster printed circuit and the instrument circuit ground. A zero voltage reading indicates an open circuit in the wiring to the limiter.

INDIVIDUAL GAUGE CIRCUIT TEST

To test each individual gauge circuit, disconnect the gauge wire from the sending unit and connect it to one of the leads of the C-3826 tester. Connect the other tester lead to a good ground. Be very careful never to ground the sending unit wire when the ignition switch is on or you'll cause a high current flow through the gauge heating coil. This is very apt to ruin the gauge. Grounding the sending unit terminal when it is connected will cause the same kind of trouble.

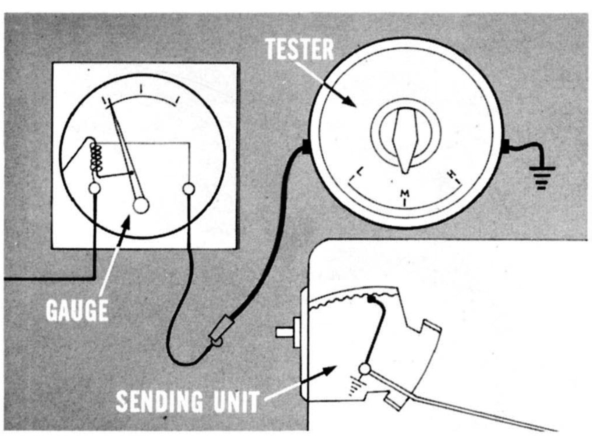


Fig. 21—Gauge tester connected into circuit.

When the C-3826 electronic gauge tester is connected in place of a sending unit, it applies *known* resistance values to the gauge circuit.

If the gauge reaction is correct when you're using the gauge tester, the trouble's in the sending unit. But if the gauge doesn't read correctly, the trouble is either in the gauge itself or in the wiring.

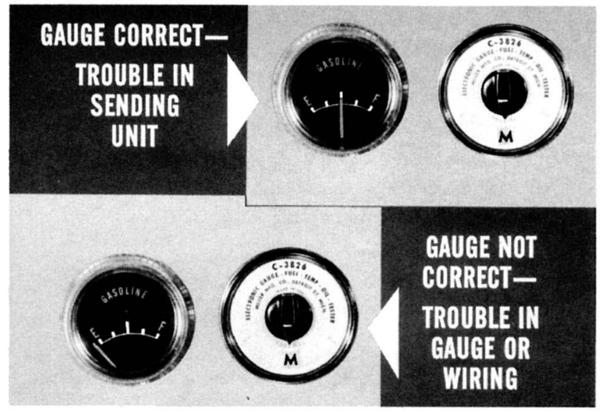


Fig. 22—Gauge tester pinpoints trouble.

To determine if the gauge is faulty, repeat the test with the gauge tester connected directly to the gauge terminal, bypassing the wire to the sending unit. When testing the gauges, give the gauge hands some time to come to rest—they're slow in changing from one reading to another. Here's how the gauges should read if they are in good condition.

THERMAL-ELECTRIC GAUGE TEST SPECIFICATIONS

GAUGE	TESTER POINTER POSITION	GAUGE READING (± 3/32-Inch)
TEMPERATURE GAUGE	L M H	COLD MIDWAY HOT
FUEL GAUGE	L M H	EMPTY HALF-FULL FULL
OIL PRESSURE GAUGE	L M H	LOW MIDWAY HIGH

Never attempt to repair a faulty gauge in the field; always replace it with a new one.

Litho in U.S.A.