CHARGING SYSTEM

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GENERAL INFORMATION

OVERVIEW

The battery, starting, and charging systems operate with one another, and must be tested as a complete system. In order for the vehicle to start and charge properly, all of the components involved in these systems must perform within specifications.

Group 8A covers the battery, Group 8B covers the starting system, and Group 8C covers the charging system. Refer to Group 8W - Wiring Diagrams for complete circuit descriptions and diagrams. We have separated these systems to make it easier to locate the information you are seeking within this Service Manual. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used in these groups include the most basic conventional diagnostic methods to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of an induction ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. See the On-Board Diagnostics Test in Group 8C - Charging System for more information.

DESCRIPTION AND OPERATION

CHARGING SYSTEM OPERATION

The charging system consists of:

- Generator
- Electronic Voltage Regulator (EVR) circuitry within the Powertrain Control Module (PCM)
- Ignition switch (refer to Group 8D, Ignition System for information)
- Battery (refer to Group 8A, Battery for information)
- Battery temperature sensor
- Voltmeter (refer to Group 8E, Instrument Panel and Gauges for information)
- Wiring harness and connections (refer to Group 8W, Wiring for information)

The charging system is turned on and off with the ignition switch. When the ignition switch is turned to the ON position, battery voltage is applied to the generator rotor through one of the two field terminals to produce a magnetic field. The generator is driven by the engine through a serpentine belt and pulley arrangement.

The amount of DC current produced by the generator is controlled by the EVR (field control) circuitry, contained within the PCM. This circuitry is connected in series with the second rotor field terminal and ground.

A battery temperature sensor located on the front bumper beam is used to sense battery temperature. This temperature data, along with data from monitored line voltage, is used by the PCM to vary the battery charging rate. This is done by cycling the ground path to control the strength of the rotor magnetic field. The PCM then compensates and regulates generator current output accordingly and to maintain

DESCRIPTION AND OPERATION (Continued)

the proper voltage depending on battery temperature.

All vehicles are equipped with On-Board Diagnostics (OBD). All OBD-sensed systems, including the EVR (field control) circuitry, are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. See On-Board Diagnostic System Test in this group for more information.

GENERATOR

The generator is belt-driven by the engine. It is serviced only as a complete assembly. If the generator fails for any reason, the entire assembly must be replaced.

As the energized rotor begins to rotate within the generator, the spinning magnetic field induces a current into the windings of the stator coil. Once the generator begins producing sufficient current, it also provides the current needed to energize the rotor.

The Y type stator winding connections deliver the induced AC current to 3 positive and 3 negative diodes for rectification. From the diodes, rectified DC current is delivered to the vehicle electrical system through the generator, battery, and ground terminals.

Noise emitting from the generator may be caused by:

- Worn, loose or defective bearings
- Loose or defective drive pulley
- Incorrect, worn, damaged or misadjusted drive belt
- Loose mounting bolts
- Misaligned drive pulley
- Defective stator or diode

BATTERY TEMPERATURE SENSOR

The battery temperature sensor is used to determine the battery temperature. This temperature data, along with data from monitored line voltage, is used by the PCM to vary the battery charging rate. System voltage will be higher at colder temperatures and is gradually reduced at warmer temperatures.

The sensor is located forward of the vehicle battery, and is attached to the battery tray (Fig. 1).

ELECTRONIC VOLTAGE REGULATOR

The Electronic Voltage Regulator (EVR) is not a separate component. It is actually a voltage regulating circuit located within the Powertrain Control Module (PCM). The EVR is not serviced separately. If replacement is necessary, the PCM must be replaced.

Operation: The amount of DC current produced by the generator is controlled by EVR circuitry contained within the PCM. This circuitry is connected in series with the generators second rotor field terminal and its ground.

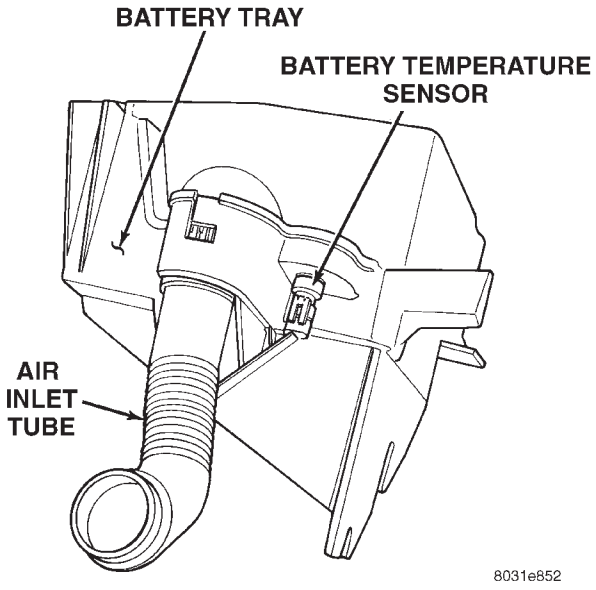


Fig. 1 Battery Temperature Sensor

Voltage is regulated by cycling the ground path to control the strength of the rotor magnetic field. The EVR circuitry monitors system line voltage and battery temperature (refer to Battery Temperature Sensor for more information). It then compensates and regulates generator current output accordingly. Also see Charging System Operation for additional information.

DIAGNOSIS AND TESTING

CHARGING SYSTEM

When the ignition switch is turned to the ON position, battery potential will register on the voltmeter. During engine cranking a lower voltage will appear on the meter. With the engine running, a voltage reading higher than the first reading (ignition in ON) should register.

The following are possible symptoms of a charging system fault:

- The voltmeter does not operate properly
- An undercharged or overcharged battery condition occurs.

Remember that an undercharged battery is often caused by:

- Accessories being left on with the engine not running
- A faulty or improperly adjusted switch that allows a lamp to stay on. See Ignition-Off Draw Test in Group 8A, Battery for more information.

DIAGNOSIS AND TESTING (Continued)

The following procedures may be used to correct a problem diagnosed as a charging system fault.

INSPECTION

(1) Inspect condition of battery cable terminals, battery posts, connections at engine block, starter solenoid and relay. They should be clean and tight. Repair as required.

(2) Inspect all fuses in the fuseblock module and Power Distribution Center (PDC) for tightness in receptacles. They should be properly installed and tight. Repair or replace as required.

(3) Inspect the electrolyte level in the battery. Replace battery if electrolyte level is low.

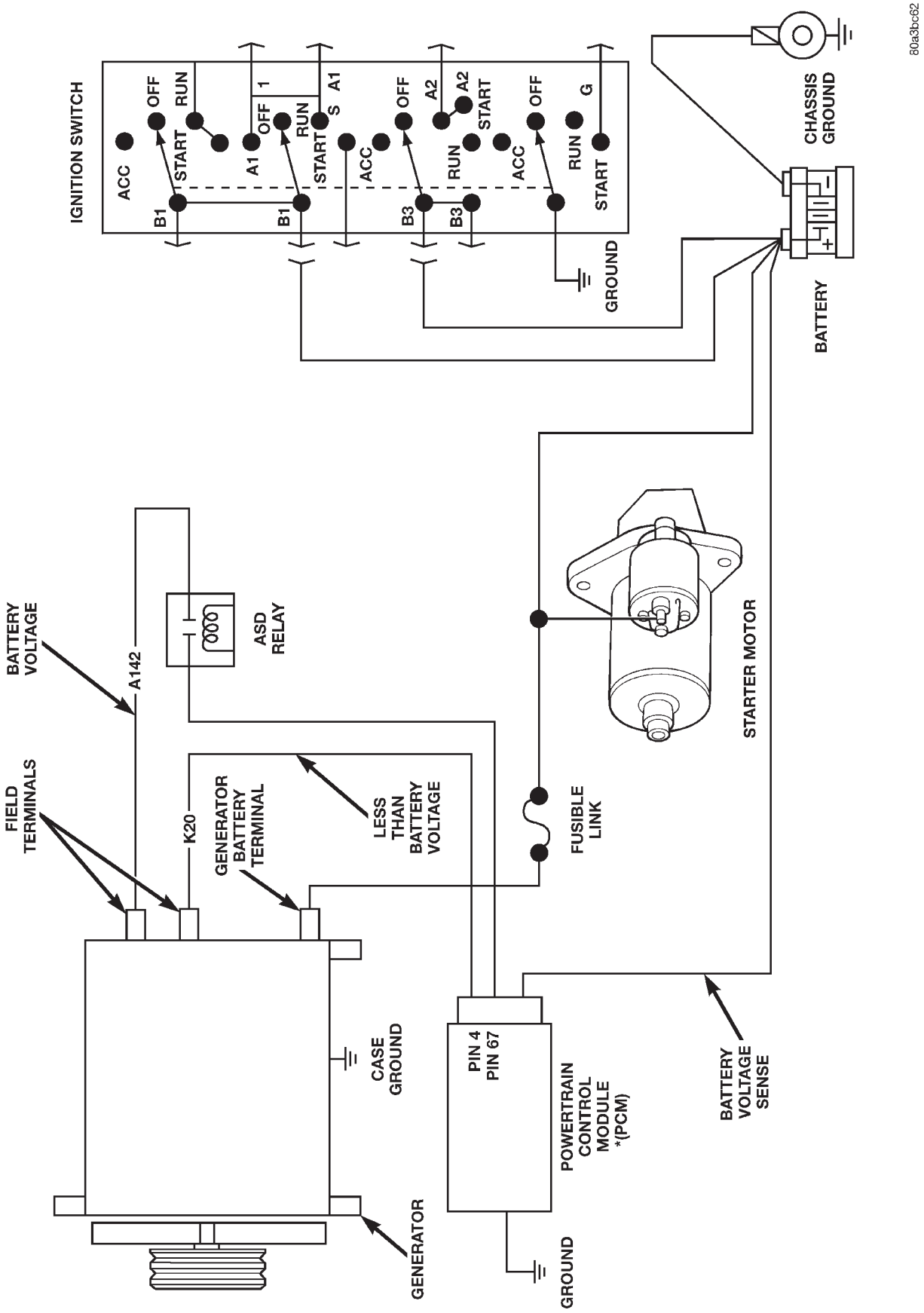
(4) Inspect generator mounting bolts for tightness. Replace or tighten bolts if required. Refer to the Generator Removal/Installation section of this group for torque specifications.

(5) Inspect generator drive belt condition and tension. Tighten or replace belt as required. Refer to Belt Tension Specifications in Group 7, Cooling System.

(6) Inspect automatic belt tensioner (if equipped). Refer to Group 7, Cooling System for information.

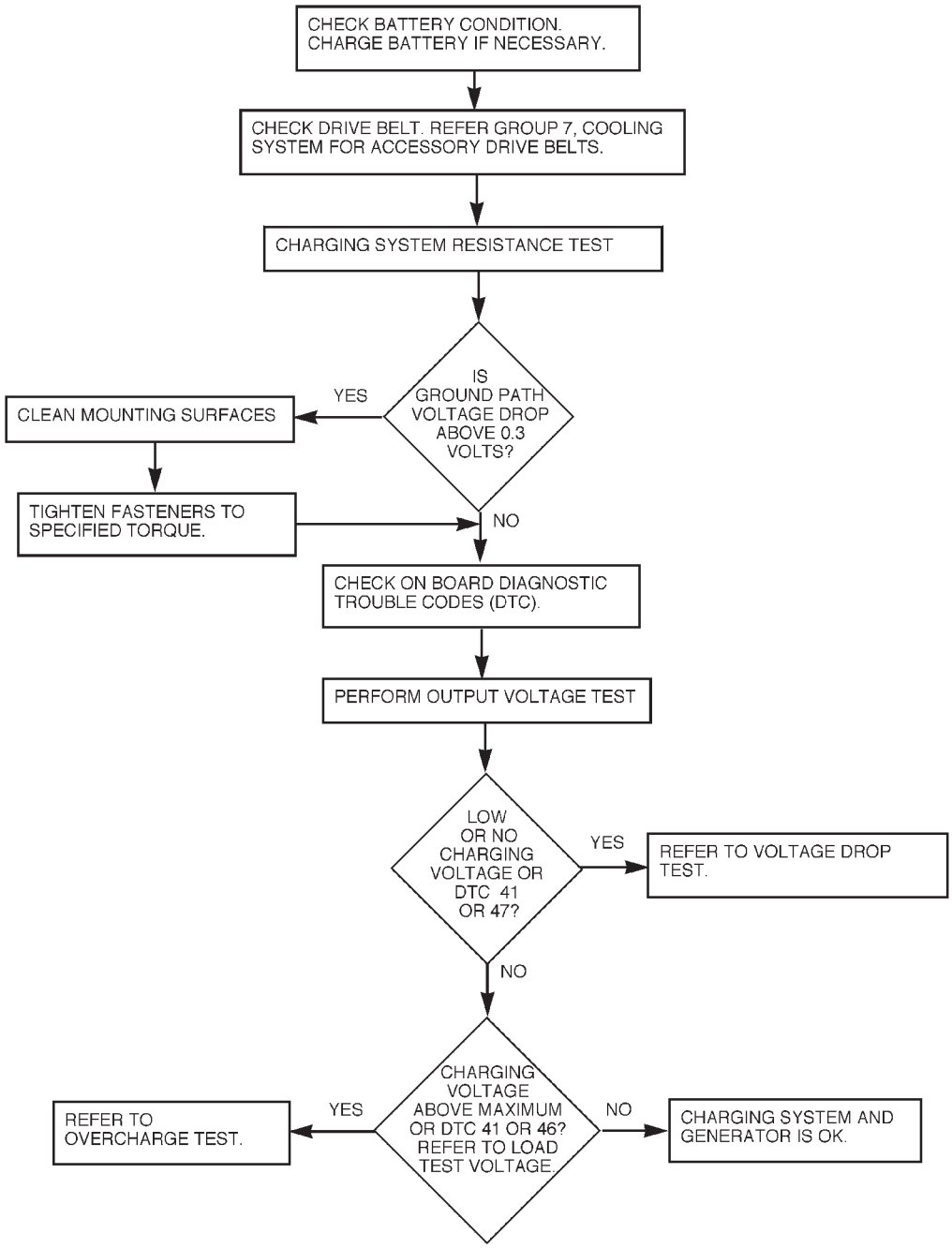
(7) Inspect connections at generator field, battery output, and ground terminals. Also check ground connection at engine. They should all be clean and tight. Repair as required.

DIAGNOSIS AND TESTING (Continued)



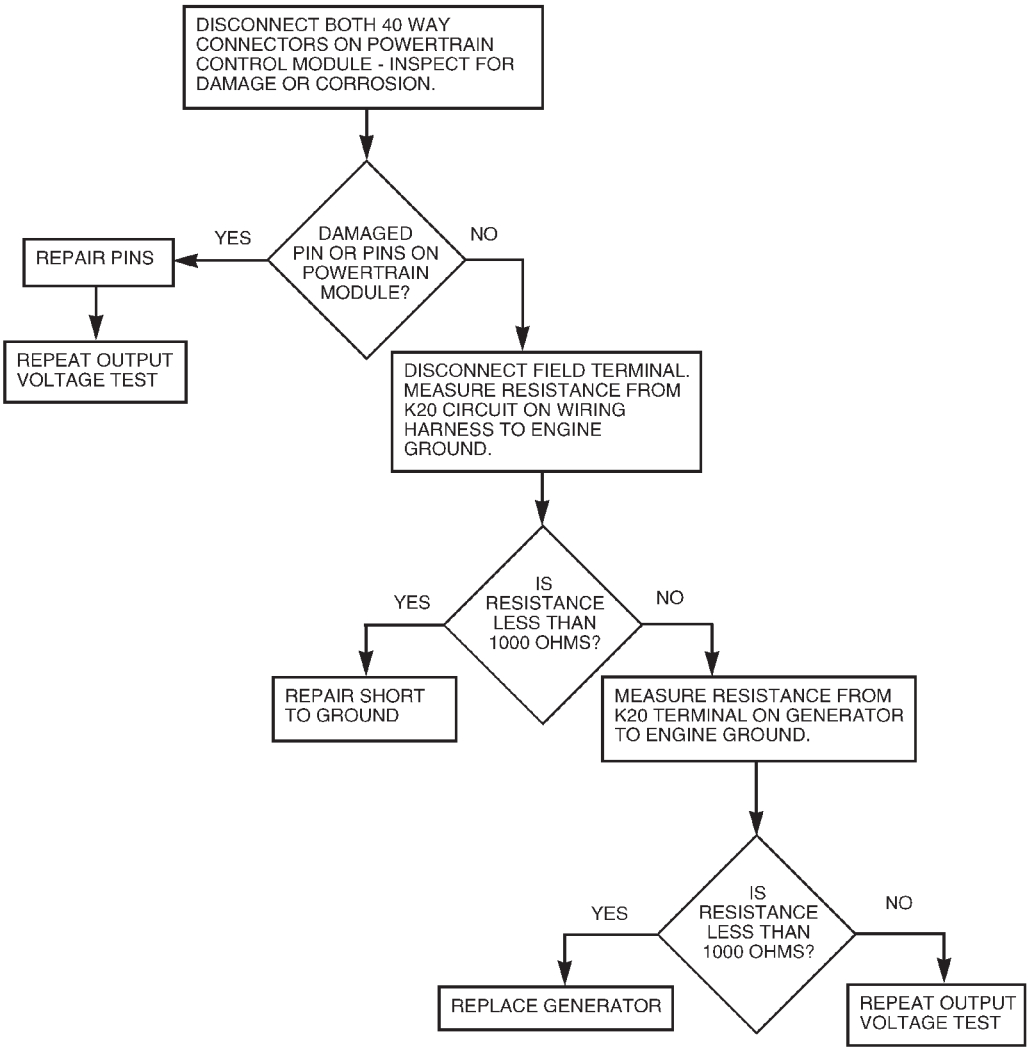
Charging System Schematic—Typical

DIAGNOSIS AND TESTING (Continued)



Charging System Test

DIAGNOSIS AND TESTING (Continued)



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Overcharge Test

DIAGNOSIS AND TESTING (Continued)

CHARGING SYSTEM RESISTANCE TESTS

These tests will show the amount of voltage drop across the generator output wire from the generator output (B+) terminal to the battery positive post. They will also show the amount of voltage drop from the ground (-) terminal on the generator (Fig. 2) to the battery negative post.

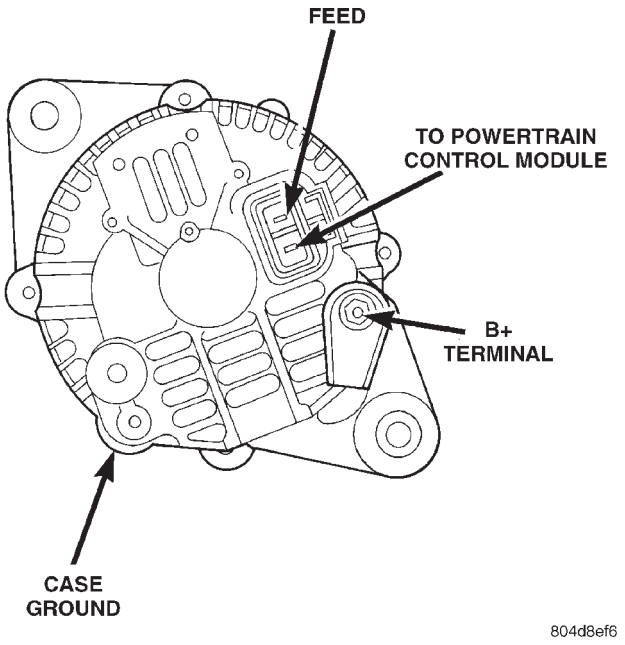

Fig. 2 Generator Terminals

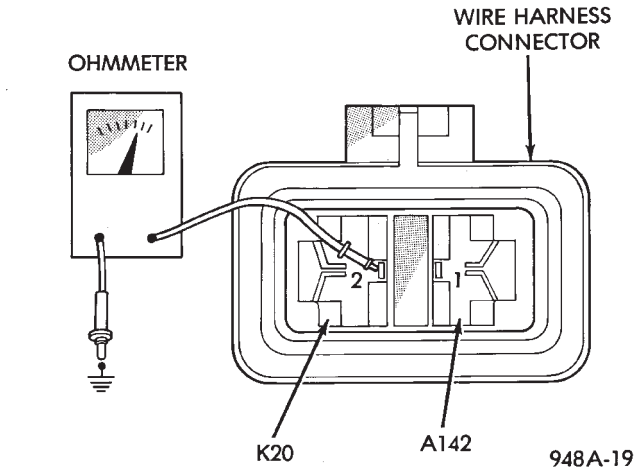

Fig. 3 Electrical Resistance Test

A voltmeter with a 0–18 volt DC scale should be used for these tests. By repositioning the voltmeter test leads, the point of high resistance (voltage drop) can easily be found.

Test points on the generator may be reached by either removing the air cleaner housing or below by raising the vehicle on a hoist.

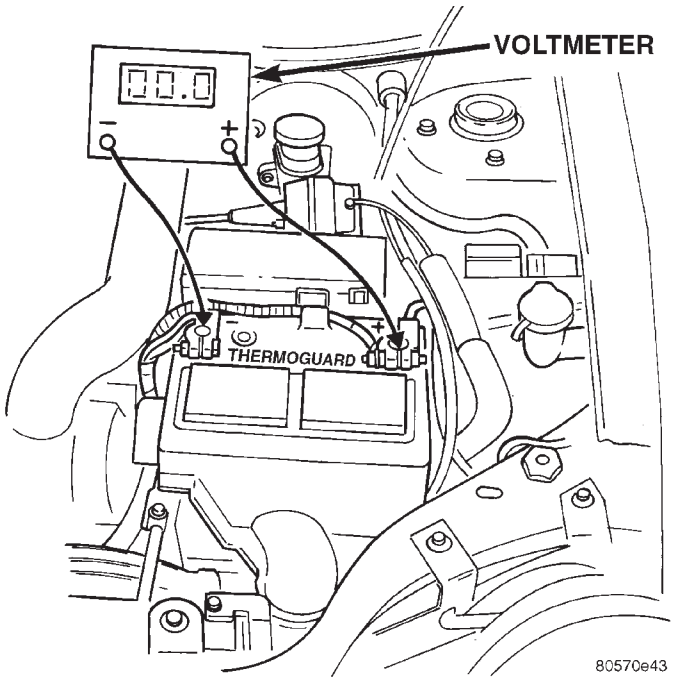

Fig. 4 Battery Voltage Test

PREPARATION

(1) Before starting test, make sure battery is in good condition and is fully-charged. See Group 8A, Battery for more information.

(2) Check condition of battery cables at battery. Clean if necessary.

(3) Start the engine and allow it to reach normal operating temperature.

(4) Shut engine off.

(5) Connect an engine tachometer.

(6) Fully engage the parking brake.

TEST

(1) Start engine.

(2) Place heater blower in high position.

(3) Turn on headlamps and place in high-beam position.

(4) Turn vehicle interior lamps on.

(5) Start engine. Bring engine speed up to 2400 rpm and hold.

(6) Testing (- ground) circuitry:

(a) Touch the negative lead of voltmeter directly to battery positive **POST** (Fig. 4).

(b) Touch the positive lead of voltmeter to the B+ output terminal stud on the generator (not the terminal mounting nut). Voltage should be no higher than 0.6 volts. If voltage is higher than 0.6 volts, touch test lead to terminal mounting stud nut and then to the wiring connector. If voltage is now below 0.6 volts, look for dirty, loose or poor connection at this point. Refer to Group 8, Wiring for connector location. A voltage drop test may be

DIAGNOSIS AND TESTING (Continued)

performed at each (- ground) connection in this circuit to locate the excessive resistance.

(7) Testing (+ positive) circuitry:

(a) Touch the positive lead of voltmeter directly to battery negative **POST** .

(b) Touch the negative lead of voltmeter to the ground terminal stud on the generator case (not the terminal mounting nut). Voltage should be no higher than 0.3 volts. If voltage is higher than 0.3 volts, touch test lead to terminal mounting stud nut and then to the wiring connector. If voltage is now below 0.3 volts, look for dirty, loose or poor connection at this point. A voltage drop test may be performed at each (+ positive) connection in this circuit to locate the excessive resistance. This test can also be performed between the generator case and the engine. If test voltage is higher than 0.3 volts, check for corrosion at generator mounting points or loose generator mounting.

CURRENT OUTPUT TEST

The current output test will determine if the charging system can deliver its minimum test current (amperage) output. Refer to the Specifications section at the end of this group for minimum test current (amperage) requirements.

The first part of this test will determine the combined amperage output of both the generator and the Electronic Voltage Regulator (EVR) circuitry.

PREPARATION

(1) Determine if any Diagnostic Trouble Codes (DTC) exist. To determine a DTC, refer to On-Board Diagnostics in this group. For repair, refer to the appropriate Powertrain Diagnostic Procedures manual.

(2) Before starting test, make sure battery is in good condition and is fully-charged. See Group 8A, Battery for more information.

(3) Check condition of battery cables at battery. Clean if necessary.

(4) Perform the previous Output Wire Resistance Test (voltage drop test) (Fig. 5). This will ensure clean and tight generator/battery electrical connections.

(5) Be sure the generator drive belt is properly tensioned. Refer to Group 7, Cooling System for information.

(6) A volt/amp tester equipped with both a battery load control (carbon pile rheostat) and an inductive-type pickup clamp (ammeter probe) will be used for this test. Refer to operating instructions supplied with tester. When using a tester equipped with an inductive-type clamp, removal of wiring at the generator will not be necessary.

(7) Start the engine and allow it to reach operating temperature.

(8) Shut engine off.

(9) Turn off all electrical accessories and all vehicle lighting.

(10) Connect the volt/amp tester leads to the battery. Be sure the carbon pile rheostat control is in the OPEN or OFF position before connecting leads. See Load Test in Group 8A, Battery for more information. Also refer to the operating instructions supplied with test equipment.

(11) Connect the inductive clamp (ammeter probe). Refer to the operating instructions supplied with test equipment.

(12) If volt/amp tester is not equipped with an engine tachometer, connect a separate tachometer to the engine.

TEST

(1) Perform the previous test Preparation.

(2) Fully engage the parking brake.

(3) Start engine.

(4) Bring engine speed to 2500 rpm.

(5) With engine speed held at 2500 rpm, slowly adjust the rheostat control (load) on the tester to obtain the highest amperage reading. Do not allow voltage to drop below 12 volts. Record the reading. **This load test must be performed within 15 seconds to prevent damage to test equipment.** On certain brands of test equipment, this load will be applied automatically. Refer to the operating manual supplied with test equipment.

(6) The ammeter reading must meet the Minimum Test Amps specifications as displayed in the Generator Ratings chart. This can be found in the Specifications section at the end of this group. A label stating a part reference number is attached to the generator case. On some engines this label may be located on the bottom of the case. Compare this reference number to the Generator Ratings chart.

(7) Rotate the load control to the OFF position.

(8) Continue holding engine speed at 2500. If EVR circuitry is OK, amperage should drop below 15–20 amps. With all electrical accessories and vehicle lighting off, this could take several minutes of engine operation. If amperage did not drop, refer to the appropriate Powertrain Diagnostic Procedures manual for testing.

(9) Remove volt/amp tester.

If minimum amperage could not be met, refer to the appropriate Powertrain Diagnostic Procedures manual for testing.

DIAGNOSIS AND TESTING (Continued)

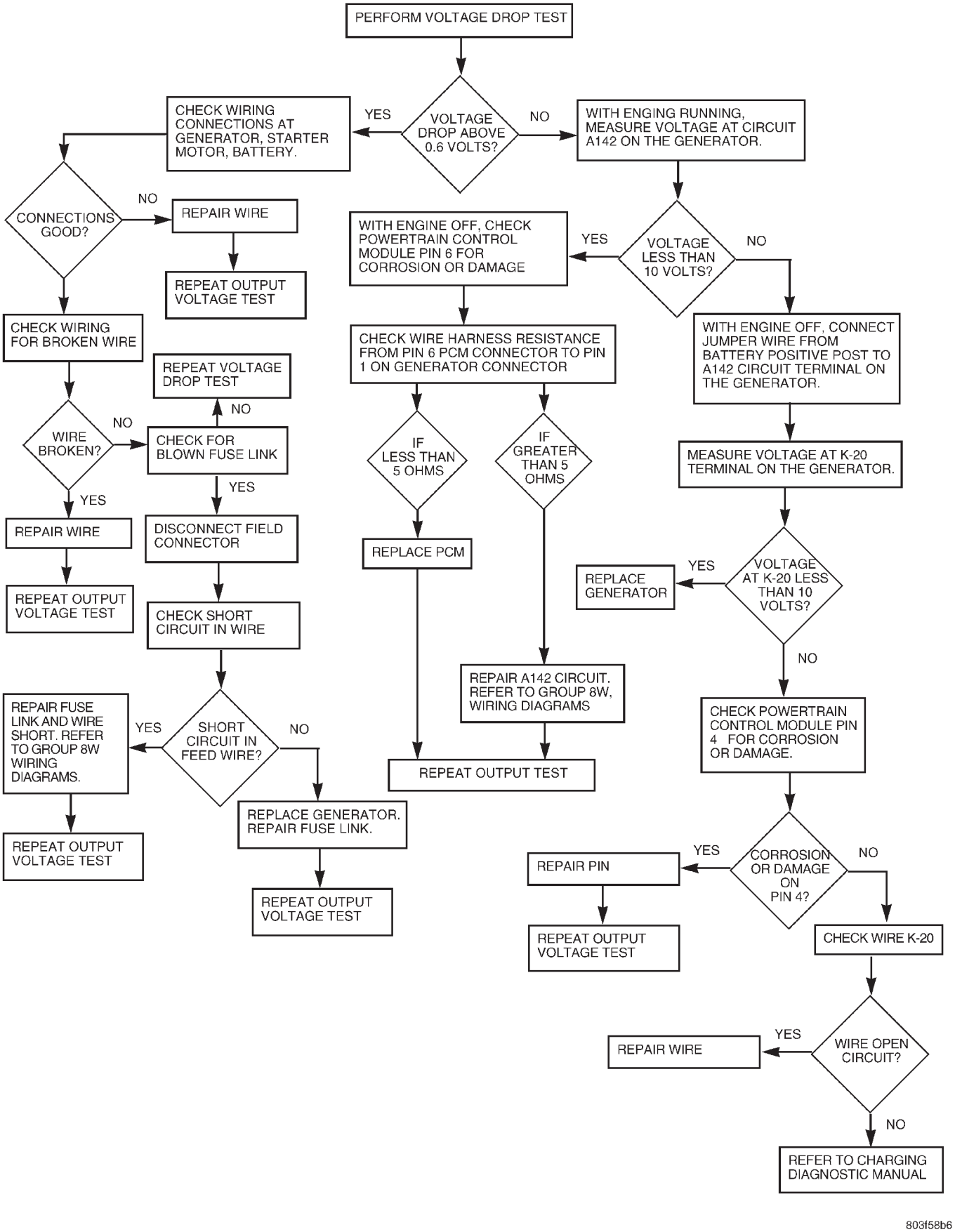

Fig. 5 Voltage Drop Test

DIAGNOSIS AND TESTING (Continued)

BATTERY TEMPERATURE SENSOR

To perform a complete test of this sensor and its circuitry, refer to the appropriate Powertrain Diagnostic Procedures manual. To test the sensor only, refer to the following:

(1) The sensor is located under the battery and is attached to the battery tray (Fig. 6). A two-wire pigtail harness is attached directly to the sensor. The opposite end of this harness connects the sensor to the engine wiring harness.

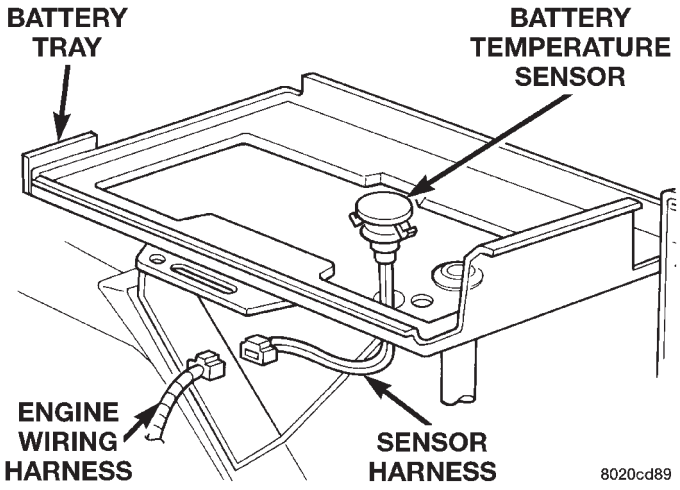

Fig. 6 Battery Temperature Sensor

(2) Disconnect the two-wire pigtail harness from the engine harness.

(3) Attach ohmmeter leads to the wire terminals of the pigtail harness.

(4) At room temperature of 25° C (75–80° F), an ohmmeter reading of 9,000 (9K) to 11,000 (11K) ohms should be observed.

(5) If reading is above or below the specification, replace the sensor.

(6) Refer to the Removal and Installation section for procedures.

ON-BOARD DIAGNOSTIC SYSTEM TEST

GENERAL INFORMATION

The Powertrain Control Module (PCM) monitors critical input and output circuits of the charging system, making sure they are operational. A Diagnostic Trouble Code (DTC) is assigned to each input and output circuit monitored by the OBD system. Some circuits are checked continuously and some are checked only under certain conditions.

If the OBD system senses that a monitored circuit is bad, it will put a DTC into electronic memory. The DTC will stay in electronic memory as long as the circuit continues to be bad. The PCM is programmed to clear the memory after 50 engine starts if the problem does not occur again.

DIAGNOSTIC TROUBLE CODES

Diagnostic Trouble Codes (DTC) are two-digit numbers flashed on the malfunction indicator (Check Engine) lamp that identify which circuit is bad. Refer to Group 25, On Board Diagnostic for more information. A DTC description can also be read using the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures manual for information.

A DTC does not identify which component in a circuit is bad. Thus, a DTC should be treated as a

Diagnostic Trouble Code	DRB Scan Tool Display	Description of Diagnostic Trouble Code
12*	Battery Disconnect	Direct battery input to PCM was disconnected within the last 50 key-on cycles.
41**	Generator Field Not Switching Properly	An open or shorted condition detected in the generator field control circuit.
46**	Charging System Voltage Too High	Battery voltage sense input above target charging voltage during engine operation.
47**	Charging System Voltage Too Low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of generator output.
55*	N/A	Completion of fault code display on Check Engine lamp.

* Check Engine lamp will not illuminate at all times if this Diagnostic Trouble Code was recorded. Cycle ignition key as described in manual and observe code flashed by Check Engine lamp.

** Check Engine lamp will illuminate during engine operation if this Diagnostic Trouble Code was recorded.

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Fig. 7 Generator Diagnostic Trouble Code

DIAGNOSIS AND TESTING (Continued)

symptom, not as the cause for the problem. In some cases, because of the design of the diagnostic test procedure, a DTC can be the reason for another DTC to be set. Therefore, it is important that the test procedures be followed in sequence, to understand what caused a DTC to be set.

See the Generator Diagnostic Trouble Code chart (Fig. 7) for DTC's which apply to the charging system. Refer to the Powertrain Diagnostic Procedures manual to diagnose an on-board diagnostic system trouble code.

RETRIEVING DIAGNOSTIC TROUBLE CODES

To start this function, cycle the ignition switch ON-OFF-ON-OFF-ON within 5 seconds. This will cause any DTC stored in the PCM memory to be displayed. The malfunction indicator (Check Engine) lamp will display a DTC by flashing on and off. There is a short pause between flashes and a longer pause between digits. All DTC's displayed are two-digit numbers, with a four-second pause between codes.

An example of a DTC is as follows:

(1) Lamp on for 2 seconds, then turns off.

(2) Lamp flashes 4 times pauses and then flashes 1 time.

(3) Lamp pauses for 4 seconds, flashes 4 times, pauses, then flashes 7 times.

(4) The two DTC's are 41 and 47. Any number of DTC's can be displayed, as long as they are in memory. The lamp will flash until all stored DTC's are displayed, then it will flash a DTC 55 to indicate the test is complete.

ERASING DIAGNOSTIC TROUBLE CODES

The DRB Scan Tool must be used to erase a DTC.

REMOVAL AND INSTALLATION

GENERATOR

REMOVAL

(1) Disconnect battery negative cable (Fig. 8).

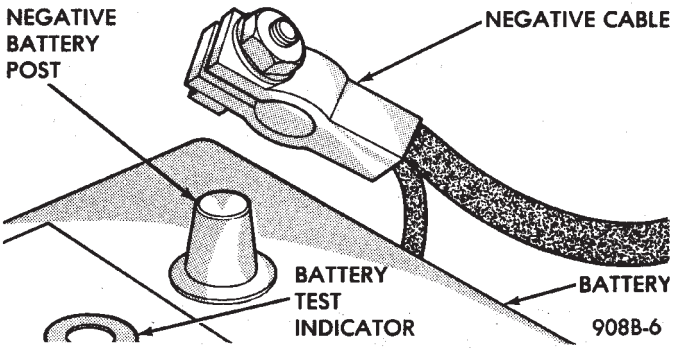

Fig. 8 Removal/Installation of Battery Cables

(2) Loosen but DO NOT remove the generator adjustment nut.

(3) Raise vehicle with front wheels turned fully to the right.

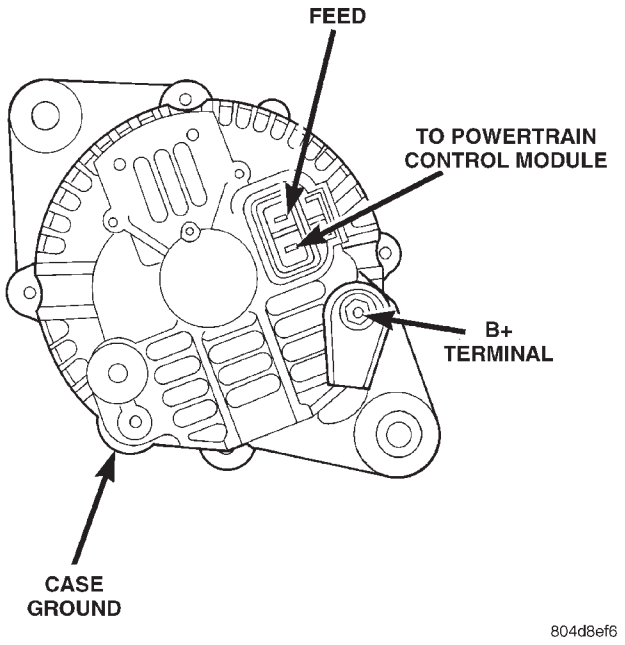

Fig. 9 Wire Terminal Connection

(4) Remove the plastic lower splash shield.

(5) Disconnect the generator field circuit wiring connector (Fig. 11). Squeeze locking tab to release.

(6) Remove the B+ terminal nut and wire.

(7) Loosen pivot bolt, but do not remove (Fig. 10) and (Fig. 11).

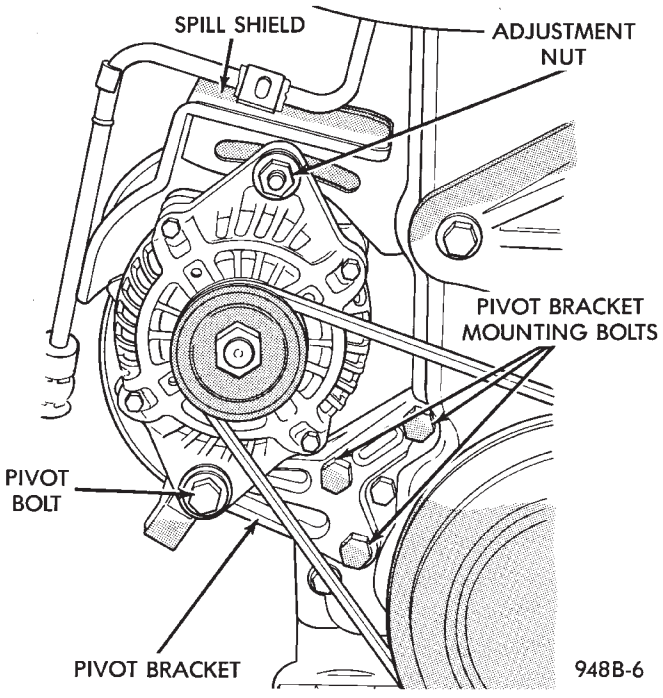

Fig. 10 Generator Front View

REMOVAL AND INSTALLATION (Continued)

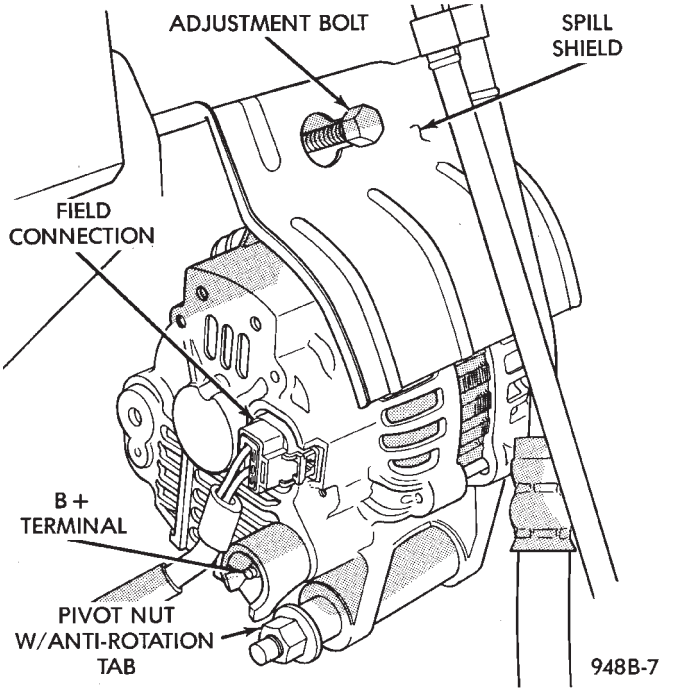

Fig. 11 Generator Rear View

(8) Remove the generator drive belt. The generator spill shield does not need to be removed.

(9) Remove three mounting pivot bracket bolts.

(10) Remove pivot bolt and bracket.

(11) Holding the generator in one hand, remove adjustment nut and slide the generator off the T-bolt. The T-bolt does not need to be removed.

(12) Lower the generator and remove through the wheel well.

INSTALLATION

(1) For installation, reverse above procedures. The generator field connector has a locking tab and will snap when fully installed. Refer to group 7 Cooling System, Belt Removal/Install Adjust. Tighten all fasteners to the proper torque. Refer to the Torque Specifications chart in Group 8A, Battery/Starter/ Charging Systems Diagnostics.

BATTERY TEMPERATURE SENSOR

REMOVAL

(1) Make sure ignition switch is in OFF position and all accessories are OFF.

(2) Remove battery negative cable first then the positive cable (Fig. 12).

(3) Remove battery thermoguard (Fig. 13).

WARNING: TO PROTECT THE HANDS FROM BATTERY ACID, A SUITABLE PAIR OF HEAVY DUTY RUBBER GLOVES, NOT THE HOUSEHOLD TYPE, SHOULD BE WORN WHEN REMOVING OR SERVICING A BATTERY. SAFETY GLASSES ALSO SHOULD BE WORN.

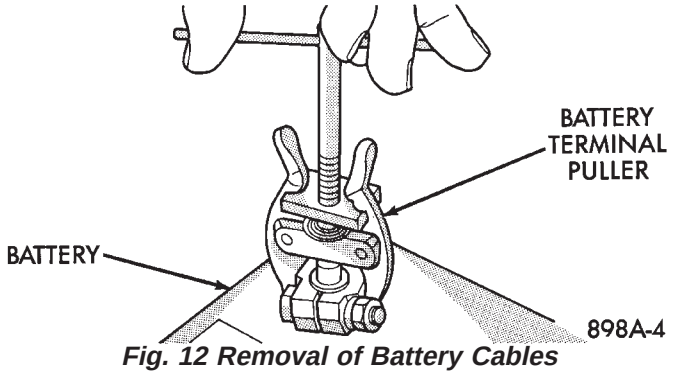

Fig. 12 Removal of Battery Cables

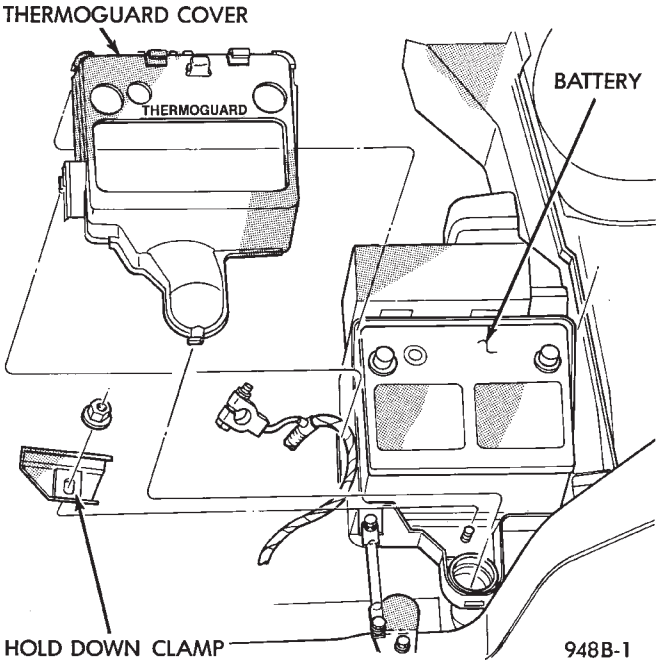

Fig. 13 Battery Thermoguard

(4) Remove temperature sensor mounting nut from battery tray (Fig. 14).

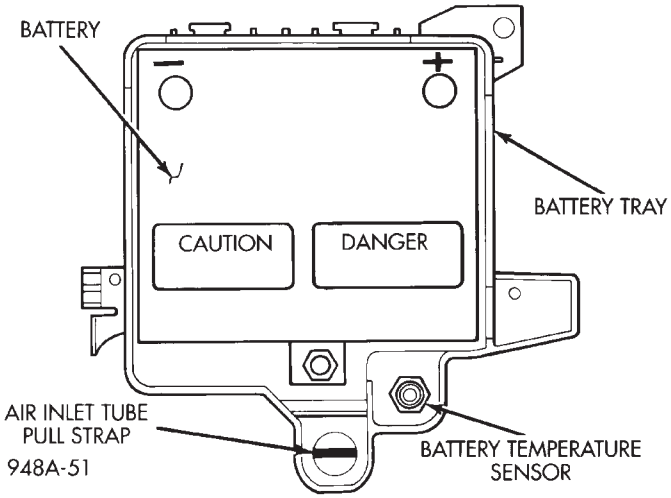

Fig. 14 Battery Temperature Sensor Location

REMOVAL AND INSTALLATION (Continued)

(5) Disconnect sensor wire connector (Fig. 15).

INSTALLATION

For installation reverse above procedures.

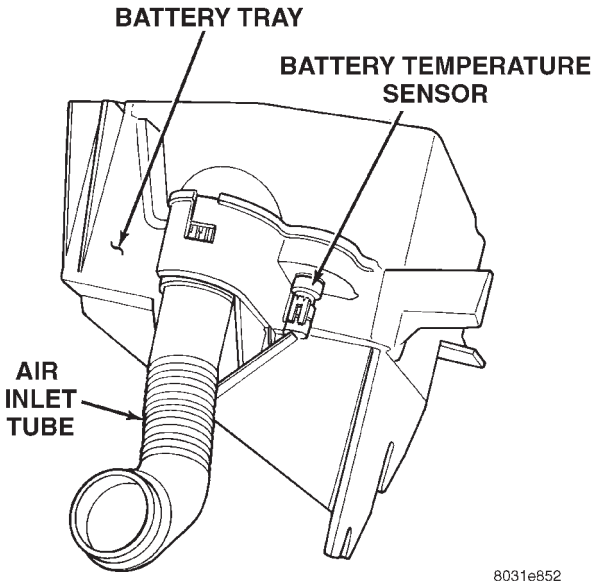

Fig. 15 Battery Temperature Sensor Connector

SPECIFICATIONS

GENERATOR RATINGS

TYPE	PART NUMBER	RATED SAE AMPS	ENGINES	MINIMUM TEST AMPS
MELCO	4793190	83 AMPS	2.0L SOHC/DOHC	75 AMPS

TORQUE SPECIFICATIONS

DESCRIPTION	TORQUE
Battery Terminal Nut	9 N·m (75 in. lbs.)
Battery Hold Down Clamp Bolt	9 N·m (75 in. lbs.)
Generator Mounting Bolt	54 N·m (40 ft. lbs.)
Generator Pivot Bolt	54 N·m (40 ft. lbs.)

CHARGING SYSTEM

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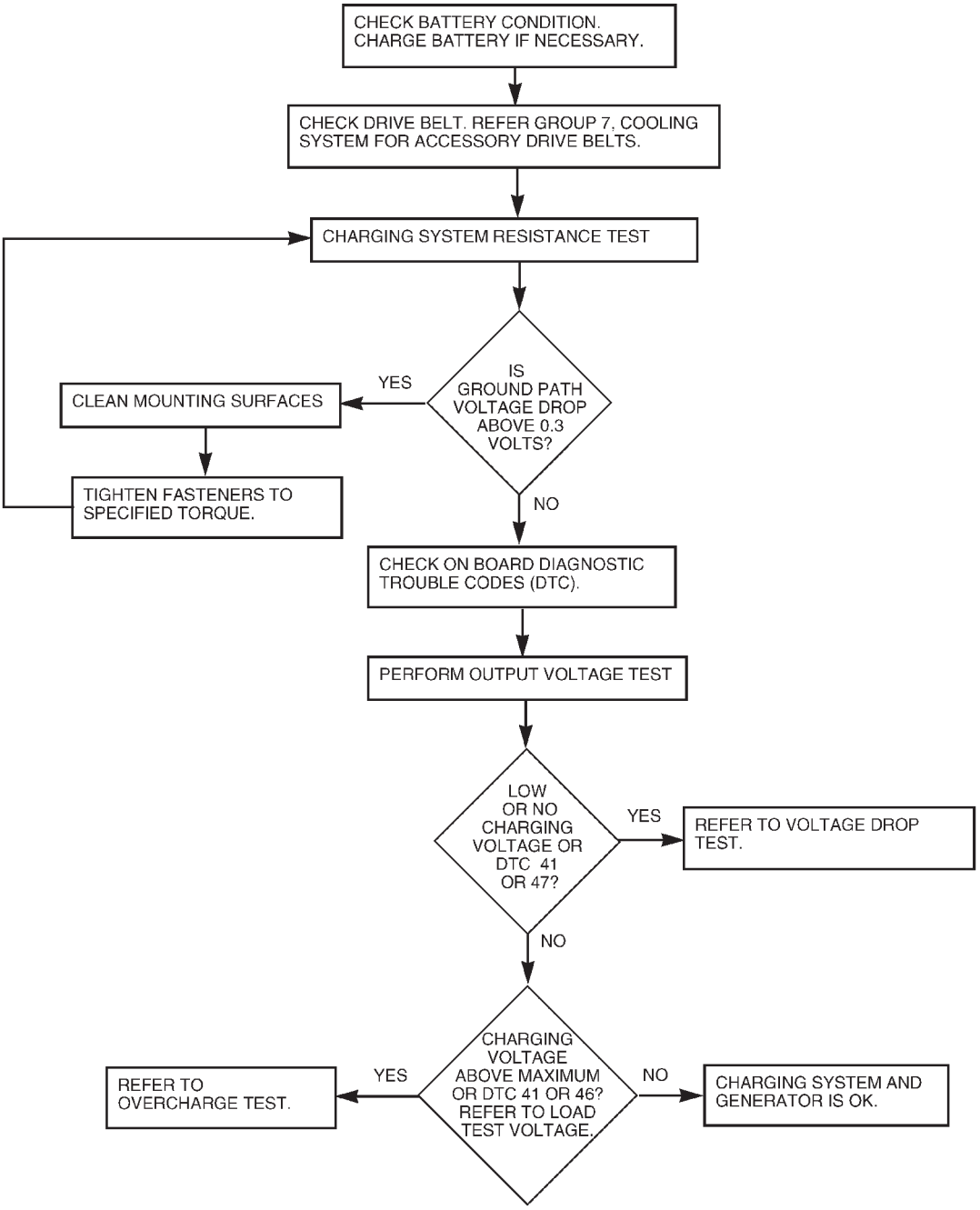
CHARGING SYSTEM 2

DIAGNOSIS AND TESTING

CHARGING SYSTEM

INSPECTION



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Charging System Test