



# ELECTRICAL

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## BATTERY/STARTING/CHARGING SYSTEMS DIAGNOSTICS

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### GENERAL INFORMATION

For Battery, Starter or Generator Replacement, refer to Group 8B, Battery/Starter/Generator Service. Group 8A, Battery/Starting/Charging Systems Diagnostics will cover diagnostics only.

The Battery, Starting, and Charging Systems operate in conjunction with one another, and must be thoroughly tested as a complete system. To enable the vehicle to start and charge properly, it must have a battery that will perform to specifications. The starter motor, generator, wiring, and electronics also must perform within specifications. Group 8A will cover Starting (Fig. 1) and Charging System (Fig. 2) diagnostic procedures. These will be covered from the most basic conventional methods to On Board Diagnostics (OBD) built into the vehicle's electronics. The need for conventional testing equipment has not been eliminated by the introduction of OBD. Frequent use of an ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12 volt (low wattage) test light will be required.

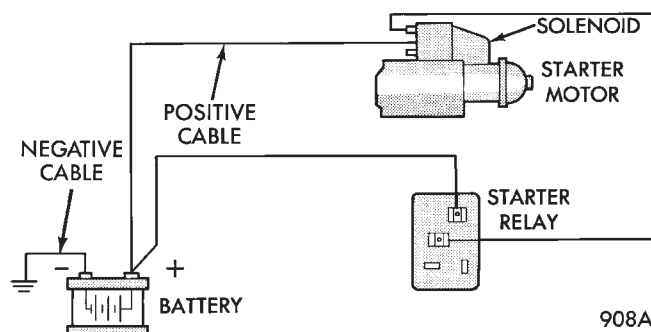


**Fig. 1 Starting System Components**

All front wheel drive vehicles are equipped with OBD and all OBD sensing systems are monitored by the powertrain control module. The powertrain control module will store in electronic memory, any detectable failure within the monitored circuits. It will retain this information for a period of 50 engine starts, then erase the

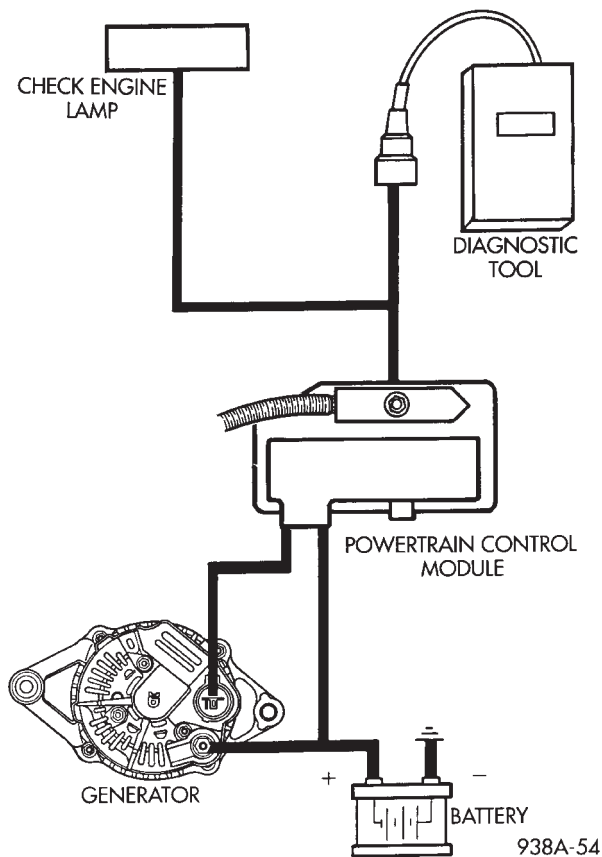


**Fig. 2 Charging System Components**

memory if the failure does not reoccur during that period. This also will translate a monitored failure in the form of a FAULT CODE when a readout command is given. A readout command can be made by turning the ignition switch to ON-OFF-ON-OFF-ON without starting the engine. The CHECK ENGINE LAMP on the instrument cluster will flash in predetermined sequences to show Fault Codes. However, the Check Engine Lamp cannot express fault codes for all failures. Fault codes are easier to obtain and more complete with the use of Diagnostic Tool (DRB II). This tool is plugged into the diagnostic connector located in the engine compartment (Fig. 2). Refer to the instructions provided with the (DRB II) tool being used.

For numbered Fault Codes pertaining to components within this particular Group, refer to Failure Codes—On Board Diagnostics in Group 8A. For other numbered Fault Codes not pertaining to this Group (8A), refer to On Board Diagnostics in the General Diagnosis section of Group 14, Fuel System for more information.



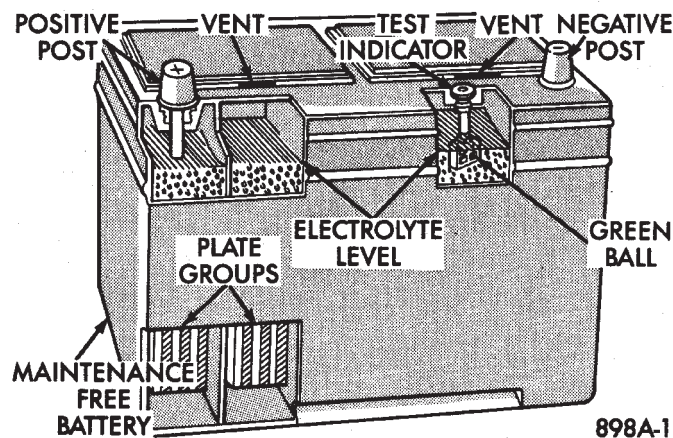
## BATTERY TEST PROCEDURES ON-VEHICLE

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## GENERAL INFORMATION

The battery stores, stabilizes, and produces electrical current to operate various electrical systems in the vehicle. The determination of whether a battery is good or bad is made by its ability to accept a charge. It also must produce high-amperage current output over an extended period to be able to start the vehicle. The capability of the battery to store electrical current comes from a chemical reaction. This reaction takes place between the sulfuric acid solution (electrolyte) and the lead +/- plates in each cell of the battery. As the battery discharges, the plates react with the acid from the electrolyte. When the charging system charges the battery, the water is converted to sulfuric acid in the battery. The amount of acid (specific gravity) in the electrolyte can be measured with a hydrometer. The factory installed battery is equipped with a built-in hydrometer (test indicator) (Figs. 3, 4 and 5) to assist in determining the batteries state of charge. The factory installed battery is also sealed. Water cannot and should not be added.

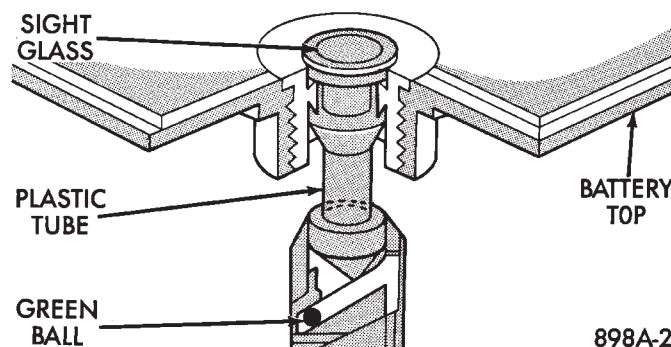


898A-1

Fig. 3 Battery Construction and Test Indicator

The battery is vented to release gases that are created when the battery is being charged and discharged. The battery top, posts, and terminals should be cleaned when other under hood maintenance is performed (Fig. 3).

**WARNING: DO NOT ASSIST BOOST, CHARGE, ADD WATER, OR LOAD TEST BATTERY WHEN ELEC-**



898A-2

Fig. 4 Built in Test Indicator

**TROLYTE LEVEL IS BELOW THE TOP OF THE PLATES. PERSONAL INJURY MAY OCCUR.**

When the electrolyte level is below the top of the plates (yellow or bright color indicator in sight glass) (Figs. 4 and 5), the battery must be replaced. Refer to Test Indicator. The battery must be completely charged (green color in sight glass). The top, posts, and terminals should be properly cleaned before diagnostic procedures are performed. Also refer to Group 8B, Battery/Starter/Generator Service for additional information.

| TEST INDICATOR/STATE OF CHARGE |       |        |                 |
|--------------------------------|-------|--------|-----------------|
| 100% ←                         | 75% ← | ○      | REPLACE BATTERY |
|                                |       |        |                 |
| GREEN                          | BLACK | YELLOW | 898A-3          |

Fig. 5 Test Indicator Sight Glass

## TEST INDICATOR

A test indicator (hydrometer) viewed through a sight glass, is built into the top of battery case (Figs. 3, 4 and 5). This provides visual information for battery testing. The test indicator sight glass is to be used with diagnostic procedures described in this Group.



It is important when using the Test Indicator that the battery be level and have a clean top to see the correct indications. A light may be required to view the Indicator.

**WARNING: DO NOT USE OPEN FLAME NEAR BATTERY. EXPLOSIVE GASES FORM ABOVE BATTERY.**

## STATE OF CHARGE TESTS

### USING TEST INDICATOR

The built-in test hydrometer (Figs. 3, 4 and 5) measures the specific gravity of the electrolyte. Specific Gravity (SG) of the electrolyte will show state-of-charge (voltage). The test indicator **WILL NOT** show cranking capacity of the battery. Refer to Battery Load Test for more information. Look into the sight glass (Figs. 4 and 5) and note the color of the indicator (Fig. 5). Refer to the following description of colors:

- GREEN = 75 to 100
- state-of-charge

The battery is adequately charged for further testing and may be returned to use. If the vehicle will not crank for a maximum 15 seconds, refer to BATTERY LOAD TEST in this Group for more information.

BLACK OR DARK = 0 to 75  
state-of-charge

The battery is **INADEQUATELY** charged and must be charged until green dot is visible, (12.4 volts or greater) before the battery is tested or returned to use. Refer to Causes of Battery Discharging in this Group for more information.

YELLOW OR BRIGHT COLOR = Battery must be replaced.

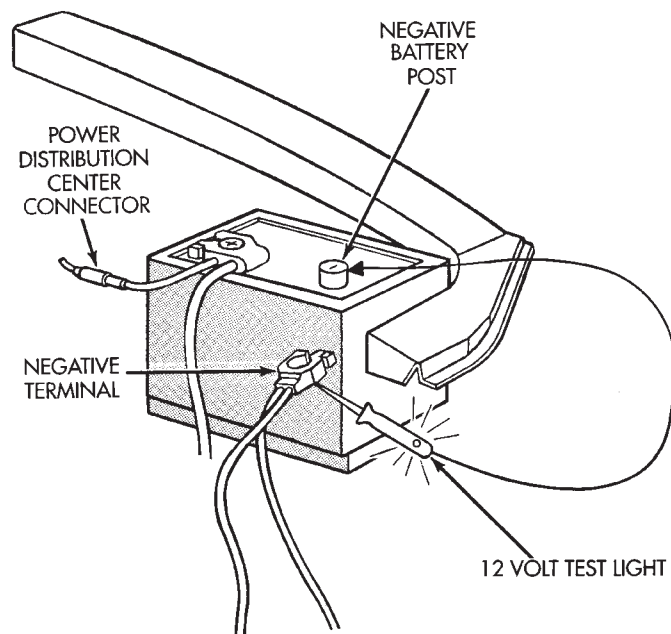
**WARNING: DO NOT CHARGE, ASSIST BOOST, LOAD TEST, OR ADD WATER TO THE BATTERY WHEN YELLOW OR BRIGHT COLOR DOT IS VISIBLE. PERSONAL INJURY MAY OCCUR.**

A yellow or bright color dot shows electrolyte level in battery is below the test indicator (Fig. 5). Water cannot be added to a maintenance free battery. The battery must be replaced. A low electrolyte level may be caused by an over charging condition. Refer to Generator Test Procedures on Vehicle.

## CAUSES OF BATTERY DISCHARGING

It is normal to have a small 5 to 30 milliamperes continuous electrical draw from the battery. This draw will take place with the ignition in the OFF position, and the courtesy, dome, storage compartments, and engine compartment lights OFF. The continuous draw is due to various electronic features or accessories that require electrical current with the

ignition OFF to function properly. When a vehicle is not used over an extended period of approximately 20 days the Main Fusible Link Connector (Fig. 6) should be disconnected. This is located near the battery on the engine wiring harness. Disconnection of this connector will help prevent battery discharging. Refer to Fig. 7 Battery Diagnostics.



938A-55

**Fig. 6 Ignition OFF Draw Test**

### ABNORMAL BATTERY DISCHARGING

- (1) Corroded battery posts, cables or terminals.
- (2) Loose or worn generator drive belt.
- (3) Electrical loads that exceed the output of the charging system due to equipment or accessories installed after delivery.
- (4) Slow driving speeds in heavy traffic conditions or prolonged idling with high-amperage electrical systems in use.
- (5) Defective electrical circuit or component causing excess Ignition Off Draw (IOD). Refer to Ignition Off Draw (IOD).
- (6) Defective charging system.
- (7) Defective battery.

### BATTERY OPEN CIRCUIT VOLTAGE TEST

An open circuit voltage no load test shows the state of charge of a battery. Also, if it will pass a load test of 50 percent of the battery cold crank rating. Refer to Battery Load Test. If a battery has a voltage reading of 12.4 volts or greater, and will not endure a load test, it is defective and replacement would be required. To test open circuit voltage, perform the following operation:

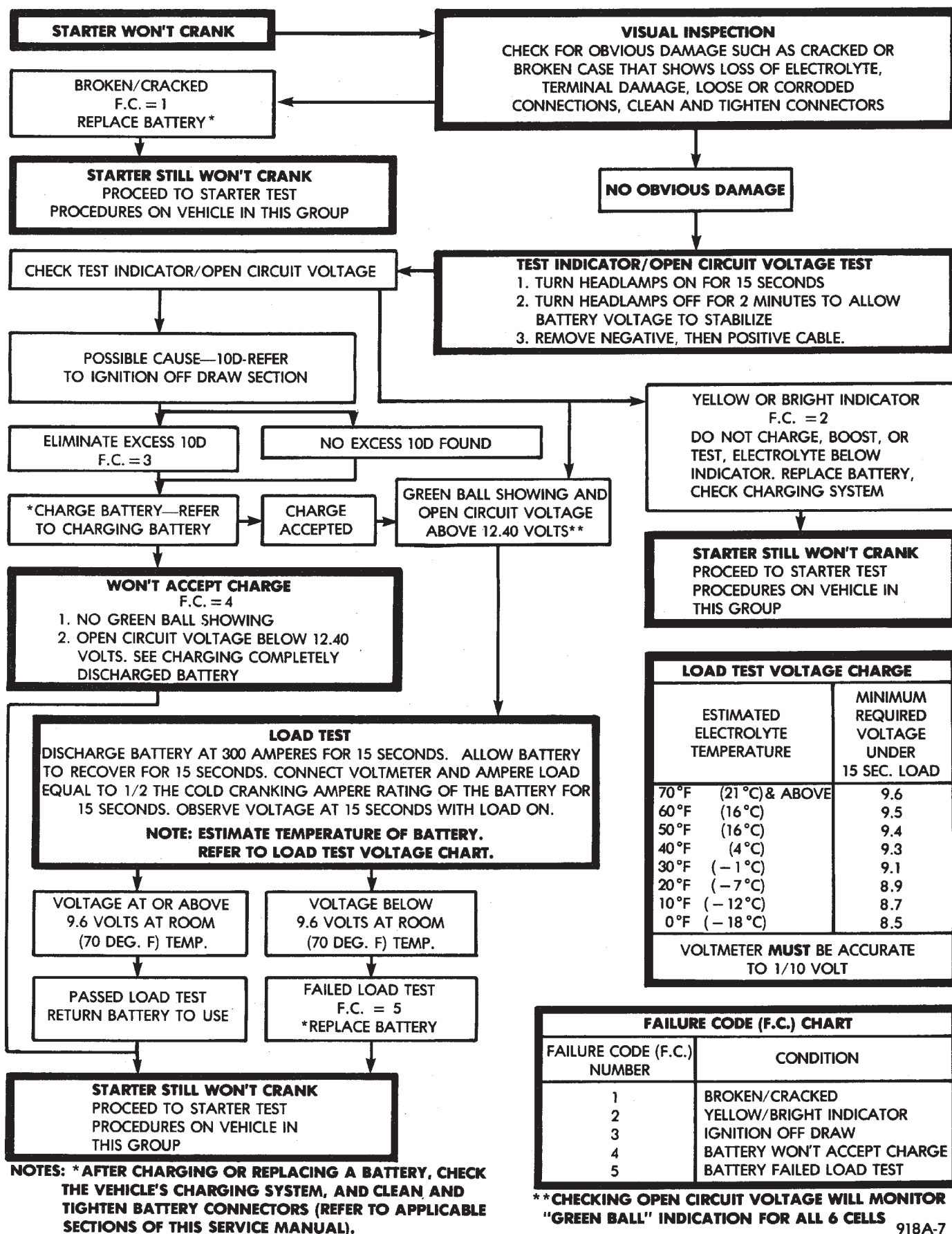
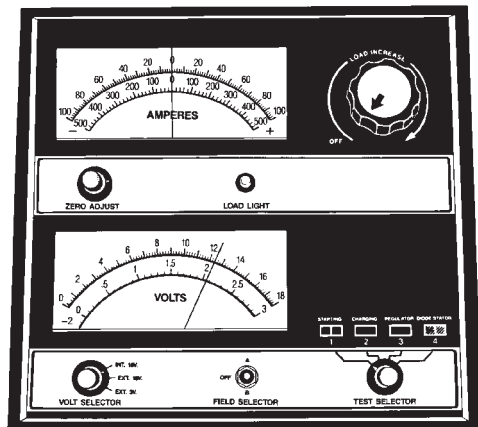


Fig. 7 Battery Diagnostics



(1) Remove both battery cables, negative first. If the battery has been boosted, charged, or loaded just prior to this operation, allow the battery a few minutes to stabilize.

(2) Using a voltmeter connected to the battery posts and measure the open circuit voltage (Fig. 8).



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**Fig. 8 Testing Open Circuit Voltage**

This voltage reading will show the state of charge of the battery. It will not reveal battery cranking capacity (Fig. 9).

| Open Circuit Volts | Percent Charge |
|--------------------|----------------|
| 11.7 volts or less | 0%             |
| 12.0               | 25%            |
| 12.2               | 50%            |
| 12.4               | 75%            |
| 12.6 or more       | 100%           |

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**Fig. 9 Battery Open Circuit Voltage**

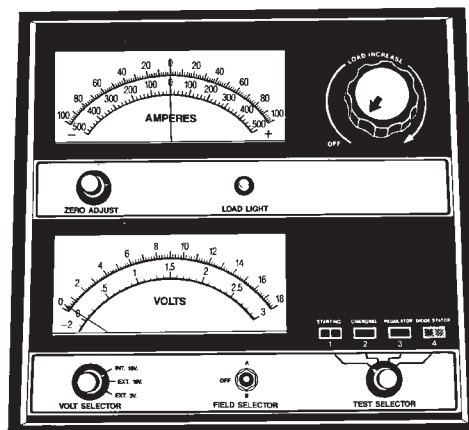
### BATTERY LOAD TEST

A fully charged battery must have reserve cranking capacity. This will enable the starter motor and ignition system enough power to start the engine over a broad range of ambient temperatures. A battery load test will verify the actual cranking performance based on the cold crank rating of the battery.

**WARNING: IF BATTERY SHOWS SIGNS OF FREEZING, LEAKING, LOOSE POSTS, OR EXCESSIVELY LOW ELECTROLYTE LEVEL, DO NOT TEST. ACID BURNS OR AN EXPLOSIVE CONDITION MAY RESULT.**

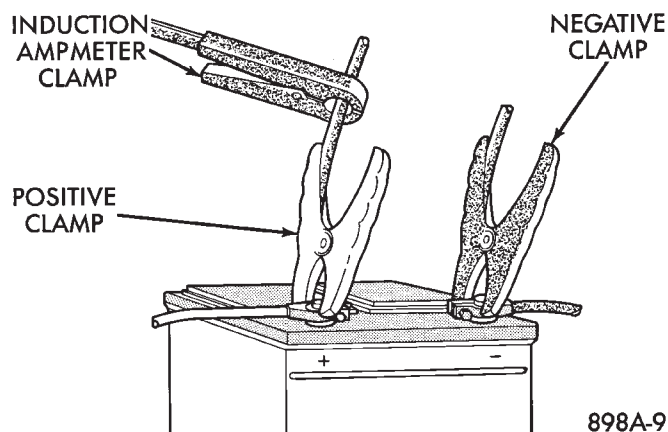
(1) Remove both battery cables, **NEGATIVE** first. Battery top, cables and posts should be clean. If green dot is not visible in indicator, charge the battery. Refer to Battery Charging Procedures.

(2) Use a suitable Volt/Ammeter/Load tester (Fig. 10) connected to the battery posts (Fig. 11). Check the open circuit voltage of the battery. Voltage should be equal to or greater than 12.4 volts with the green dot visible in test indicator.



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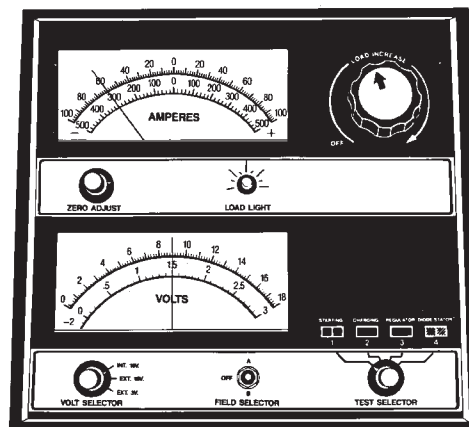
**Fig. 10 Volt-Ammeter-Load Tester**



898A-9

**Fig. 11 Volt-Ammeter-Load Tester Connections**

(3) Rotate the load control knob of the Carbon pile rheostat to apply a 300 amp load. Apply this load for 15 seconds to remove the surface charge from the battery, and return the control knob to off (Fig. 12).



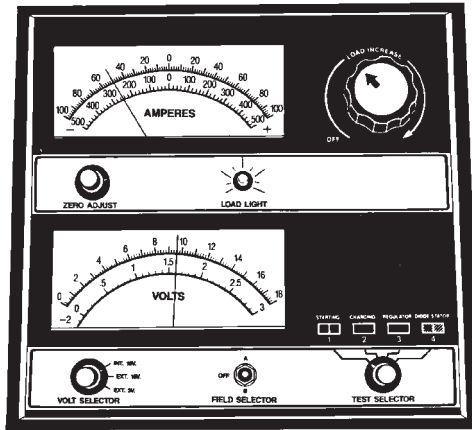
898A-10

**Fig. 12 Remove Surface Charge from Battery**



(4) Allow the battery to stabilize for 15 seconds, and then verify open circuit voltage.

(5) Rotate the load control knob on the tester to maintain 50% of the battery cold crank rating for a minimum 15 seconds (Fig. 13).

**898A-11****Fig. 13 Load 50% Cold Crank Rating**

After 15 seconds, record the loaded voltage reading and return the load control to off.

(6) Voltage drop will vary according to battery temperature at the time of the load test. Battery temperature can be estimated by the temperature of exposure over the preceding several hours. If the battery has been charged, boosted, or loaded a few minutes prior to the test, the battery would be slightly warmer. Refer to Fig. 14 for proper loaded voltage reading.

| Minimum Voltage | Temperature  |
|-----------------|--------------|
|                 | C°           |
| 9.6             | 21 and above |
| 9.5             | 16           |
| 9.4             | 10           |
| 9.3             | 4            |
| 9.1             | -1           |
| 8.9             | -7           |
| 8.7             | -12          |
| 8.5             | -18          |

**918A-4****Fig. 14 Load Test Temperature**

(7) If battery passes load test, it is in good condition and further tests are not necessary. If it fails load test, it should be replaced.

## BATTERY CHARGING

A battery is considered fully charged when it will meet all the following requirements:

- It has an open circuit voltage charge of at least 12.4 volts (Fig. 9).

- It passes the 15 second load test (Fig. 14).
- The built in test indicator dot is GREEN (Fig. 5).

The battery cannot be refilled with water, it must be replaced.

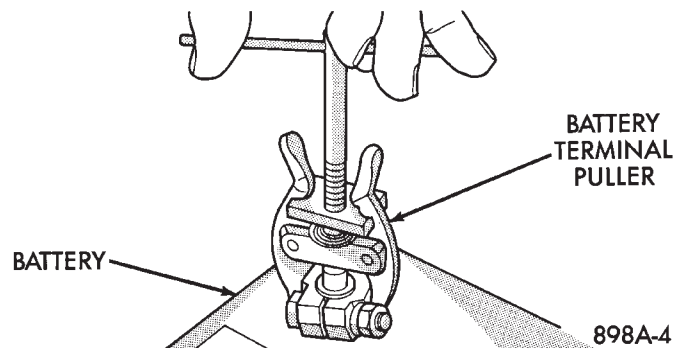
**WARNING: DO NOT CHARGE A BATTERY THAT HAS EXCESSIVELY LOW ELECTROLYTE LEVEL. BATTERY MAY SPARK INTERNALLY AND EXPLODE.**

**EXPLOSIVE GASES FORM OVER THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR BATTERY.**

**DO NOT ASSIST BOOST OR CHARGE A FROZEN BATTERY. BATTERY CASING MAY FRACTURE.**

**BATTERY ACID IS POISON, AND MAY CAUSE SEVERE BURNS. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL PHYSICIAN IMMEDIATELY. KEEP OUT OF REACH OF CHILDREN.**

**CAUTION: Disconnect the battery NEGATIVE cable first (Fig. 15) before charging battery to avoid damage to electrical systems. Do not exceed 16.0 volts while charging battery. Refer to the instructions supplied with charging equipment**

**898A-4****Fig. 15 Disconnect Battery Negative Cable**

Battery electrolyte will bubble inside of battery case while being charged properly. If the electrolyte boils violently, or is discharged from the vent holes while charging, immediately reduce charging rate or turn off charger. Evaluate battery condition. Battery damage may occur if charging is excessive.

Some battery chargers are equipped with polarity sensing devices to protect the charger or battery from being damaged if improperly connected. If the battery state of charge is too low for the polarity sensor to detect, the sensor must be bypassed for charger to operate. Refer to operating instructions provided with battery charger being used.

**CAUTION: Charge battery until test indicator appears green. Do not overcharge.**

It may be necessary to jiggle the battery or vehicle to bring the green dot in the test indicator into view.



After the battery has been charged to 12.4 volts or greater, perform a load test to determine cranking capacity. Refer to BATTERY LOAD TEST in this Group. If the battery will endure a load test, return the battery to use. If battery will not endure a load test, it must be replaced. Properly clean and inspect battery hold downs, tray, terminals, cables, posts, and top before completing service. Also refer to Group 8B, Battery/Starter/Generator Service.

#### CHARGING TIME REQUIRED

The time required to charge a battery will vary depending upon the following factors:

- **SIZE OF BATTERY**

A completely discharged of a large heavy-duty battery requires more than twice the recharging time as a completely discharged small capacity battery (Fig. 16).

| Charging Amperage    | 5 Amps                                     | 10 Amps | 20 Amps  |
|----------------------|--------------------------------------------|---------|----------|
| Open Circuit Voltage | Hours Charging at 21°C                     |         |          |
| 12.25 to 12.39       | 6 Hrs.                                     | 3 Hrs.  | 1.5 Hr.  |
| 12.00 to 12.24       | 8 Hrs.                                     | 4 Hrs.  | 2 Hrs.   |
| 11.95 to 12.09       | 12 Hrs.                                    | 6 Hrs.  | 3 Hrs.   |
| 10.00 to 11.95       | 14 Hrs.                                    | 7 Hrs.  | 3.5 Hrs. |
| 10.00 to 0           | See Charging Completely Discharged Battery |         |          |

928A-19

**Fig. 16 Battery Charging Time**

- **TEMPERATURE**

A longer time will be needed to charge a battery at -18°C (0°F) than at 27°C (80°F). When a fast charger is connected to a cold battery, current accepted by battery will be very low at first. In time, the battery will accept a higher rate as battery warms.

- **CHARGER CAPACITY**

A charger which can supply only five amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

- **STATE OF CHARGE**

A completely discharged battery requires more charging time than a partially charged battery. Electrolyte is nearly pure water in a completely discharged battery. At first, the charging current amperage will be low. As water is converted to sulfuric acid inside the battery, the current amp rate will rise. Also, the specific gravity of the electrolyte will rise, bringing the green dot (Fig. 5) into view.

**WARNING: NEVER EXCEED 20 AMPS WHEN CHARGING A COLD -1°C (30°F) BATTERY. PERSONAL INJURY MAY RESULT.**

#### CHARGING COMPLETELY DISCHARGED BATTERY

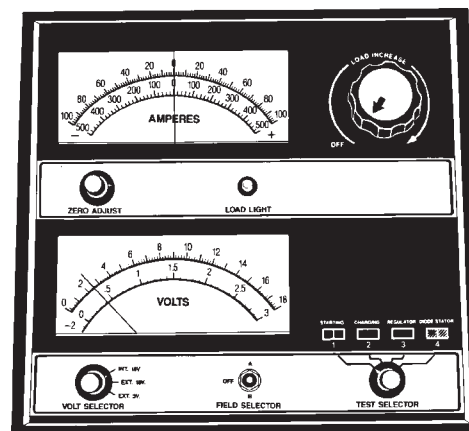
The following procedure should be used to recharge a completely discharged battery. Unless procedure is properly followed, a good battery may be needlessly replaced (Fig. 17).

| Voltage            | Hours         |
|--------------------|---------------|
| 16.0 volts or more | up to 4 hrs.  |
| 14.0 to 15.9 volts | up to 8 hrs.  |
| 13.9 volts or less | up to 16 hrs. |

918A-6

**Fig. 17 Charge Rate**

(1) Measure the voltage at battery posts with a voltmeter accurate to 1/10 volt (Fig. 18). If below 10 volts, charge current will be low, and it could take some time before it accepts a current in excess of a few milliamperes. Such low current may not be detectable on amp meters built into many chargers.



898A-12

**Fig. 18 Voltmeter Accurate to 1/10 Volt (Connected)**

(2) Connect charger leads. Some chargers feature polarity protection circuitry that prevents operation unless charger is connected to battery posts correctly. A completely discharged battery may not have enough voltage to activate this circuitry. This may happen though the leads are connected properly.

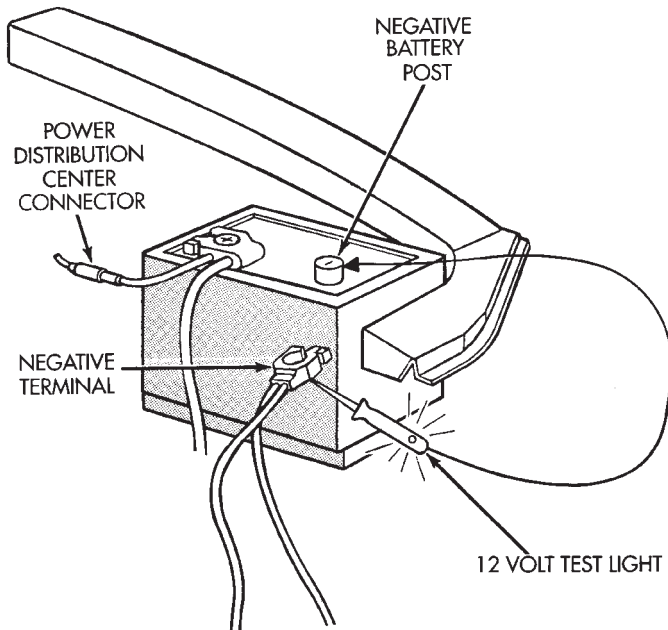
(3) Battery chargers vary in the amount of voltage and current they provide. For the time required for the battery to accept measurable charger current at various voltages, refer to Fig. 17. If charge current is still not measurable after charging times, the battery should be replaced. If charge current is measurable during charging time, the battery may be good, and charging should be completed in the normal manner.



## IGNITION OFF DRAW (IOD)

## GENERAL INFORMATION

A completely normal vehicle will have a small amount of current drain on the battery with the key out of the ignition. It can range from 15 to 25 milliamperes after all the modules time out. If a vehicle will not be operated for approximately a month, the MAIN Feed Connector should be opened to eliminate the vehicle electrical drain on the battery. The Main Feed Connector is between the battery and the power distribution center (Fig. 19).



938A-55

**Fig. 19 Ignition OFF Draw (IOD) Test**

## IGNITION OFF DRAW (IOD) TESTS

High current draw on the battery with the ignition OFF will discharge a battery. After a dead battery is serviced the vehicle ignition off draw (IOD) should be checked. Determine if a high current draw condition exists first check the vehicle with a test light.

(1) Verify that all electrical accessories are OFF.

- Remove key from ignition switch
- Turn off all lights
- Trunk lid and glove box door is closed
- Sun visor vanity lights are OFF
- All doors are closed
- Allow the Illuminated Entry System to time out in approximately 30 seconds, if equipped.

(2) Disconnect negative battery cable (Fig. 15).

(3) Connect a 12-volt test light, with a cold resistance of 5-7 ohms, between the negative cable clamp and the negative battery post (Fig. 19). The test light will remain lit for approximately a minute and then go out.

Each time the test light or milliamp meter is disconnected and connected, all electronic timer functions will be activated for approximately one minute.

## BULB LIGHTS AND STAYS ON

There is either a short circuit or a fault in an electronic module. Two fuses in the power distribution center feed the electronic control modules with ignition off draw.

- Interior/brake lamp fuse J (20 Amp)
- Engine controller fuse A (20 Amp)

(1) Remove both fuses (A and J). By removing these fuses all ignition off draw from the electronic control modules will be disconnected. The test light should go out. If test light goes out go to step 2. If test light does not go out there is a short circuit. Refer to Group 8W, Wiring Diagrams.

(2) Install the powertrain and transmission control modules fuse A. If test light lites, there is a short circuit or faulty powertrain/transmission control module.

(a) Disconnect powertrain control module.

(b) If test light goes out, replace powertrain control module.

(c) If light does not go out, disconnect the transmission control module.

(d) If test light goes out, replace transmission control module.

(e) If test light does not go out, there is a short circuit to one of the modules. Refer to Group 8W, Wiring Diagrams.

(3) Install the interior/brake lamp fuse J. If test light lites, go to the junction block and remove two fuses #4 and #13.

- Stop lamp fuse #4 (20 amp)

- Interior lighting fuse #13 (10 amp)

(4) If test light goes out, go to step 5. If the test light stays on, there is a short circuit in the wiring between the power distribution center and the junction block. Refer to Group 8W, wiring diagrams.

(5) Install the stop lamp fuse #4. If test light lites, there is a short circuit between the fuse and the stop lamps. Refer to Group 8W, Wiring Diagrams. If test light does not lite, go to step 6.

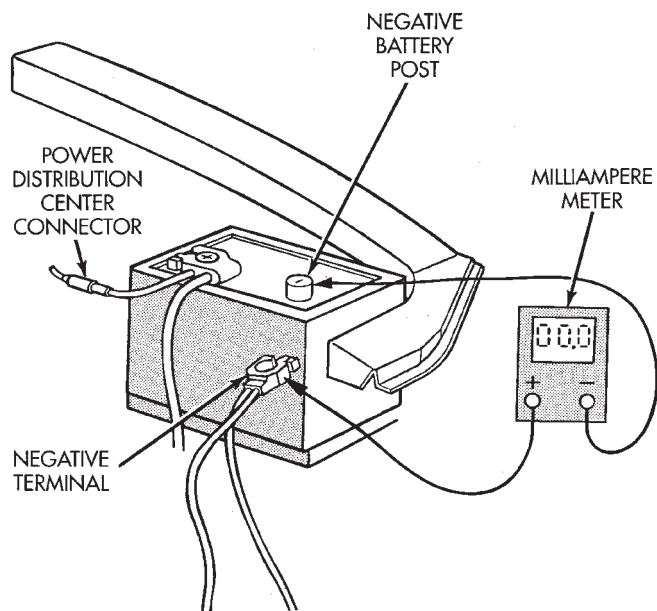
(6) Install the interior lighting fuse #13. Close all doors. If test light lites, there is a short circuit or a faulty:

- Radio
- Body controller
- Remote keyless entry module

(7) Disconnect the three components. If test light goes out, go to step 8. If test light does not go out, with all components disconnected there is a short circuit between the fuse and the components. Refer to Group 8W, Wiring Diagrams. Set meter to the highest mA range.



(8) Using an multi-meter, that has least a milliampere range of 200 mA. Install meter between the battery negative cable and battery negative post (Fig. 20). Carefully remove the test light without disconnecting the meter. After all modules time-out the total vehicle IOD should be less than 25 milliamperes. If ignition off draw is more than 25 milliamperes go to step 9.



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**Fig. 20 Milliampere Meter Connection**

Each time the test light or milliampere meter is disconnected and connected, all electronic timer functions will be activated for approximately one minute. The body controller ignition off draw can reach 90 milliamperes.

(9) Remove both fuses (J and A).

- Interior/brake lamp fuse J (20 Amp)
- Engine controller fuse A (20 Amp)

If there is any reading, with fuses removed there is a short circuit in the wiring. Refer to Group 8W, wiring diagrams. If reading is less than 25 mA go to step 10.

(10) Install interior/brake lamp fuse J. After installing fuse, the current can reach 90 mA. After time-out the reading should not exceed 20 mA. If OK go to step 11. If not, disconnect:

- Radio
- Body controller
- Remote keyless entry module

Disconnect one component at time, to see if any component is at fault. If the high reading is not eliminated there is a short circuit in the wiring. Refer to Group 8W, wiring diagrams.

**CAUTION:** Always disconnect the meter before opening a door.

(11) Remove interior/brake lamp fuse J and install the powertrain control module (engine controller) fuse A. The milliampere reading should be 2-4 mA. If reading is higher than 4 mA:

- (a) Disconnect powertrain control module.
- (b) If reading is OK, replace powertrain control module.
- (c) If reading does not change, disconnect the transmission control module.
- (d) If reading is OK, replace transmission control module.
- (e) If reading stays, there is a short circuit to one of the modules. Refer to Group 8W, Wiring Diagrams.



## STARTER TEST PROCEDURES ON VEHICLE

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## GENERAL INFORMATION

The starting system (Fig. 1) has:

- Ignition switch
- Starter relay (Fig. 2)
- Neutral starting and back-up switch with automatic transmissions only
- Wiring harness
- Battery
- Starter motor with an integral solenoid

These components form two separate circuits. A high amperage circuit that feeds the starter motor up to 300+ amps, and a control circuit that operates on less than 20 amps.

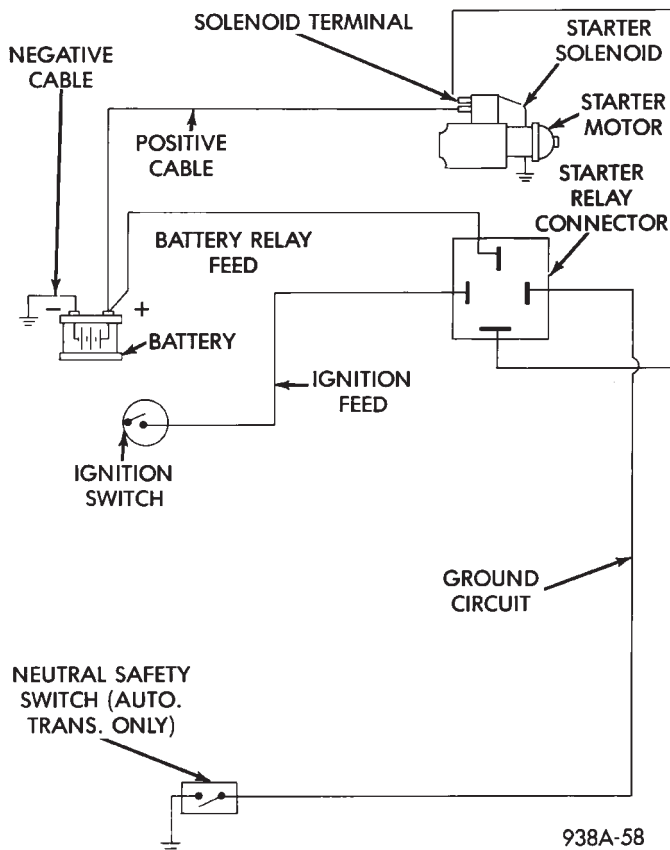


Fig. 1 Starting System

## DIAGNOSTIC PREPARATION

Before proceeding with starting system diagnostics, verify:

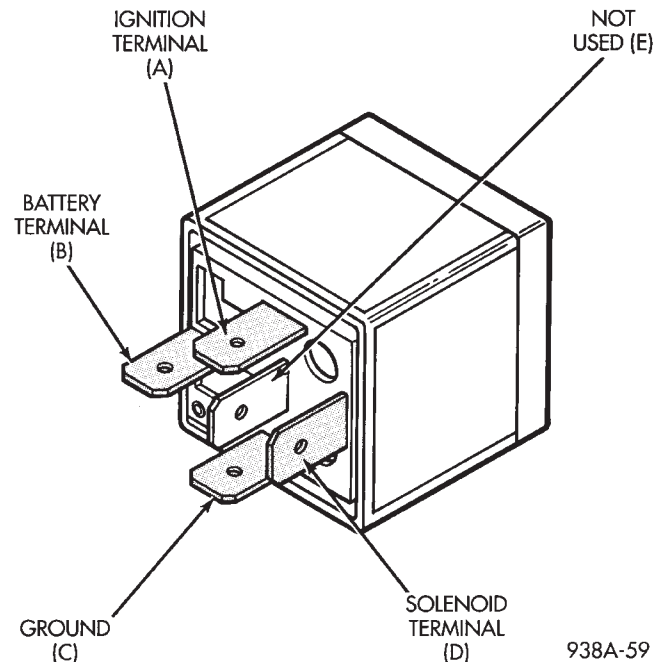


Fig. 2 Starter Relay

- (1) The battery top, posts, and terminals are clean.
- (2) The generator drive belt tension and condition is correct.
- (3) The battery state-of-charge is correct.
- (4) The battery will endure load test.
- (5) The battery cable connections at the starter and engine block are clean and free from corrosion.
- (6) The wiring harness connectors and terminals are clean and free from corrosion.
- (7) Proper circuit grounding.
- (8) Refer to Starter System Diagnostics (Fig. 3).

## STARTER FEED CIRCUIT TESTS

The following procedure will require a suitable volt-ampere tester (Fig. 4).

**CAUTION:** Ignition system also must be disabled to prevent engine start while performing the following tests.

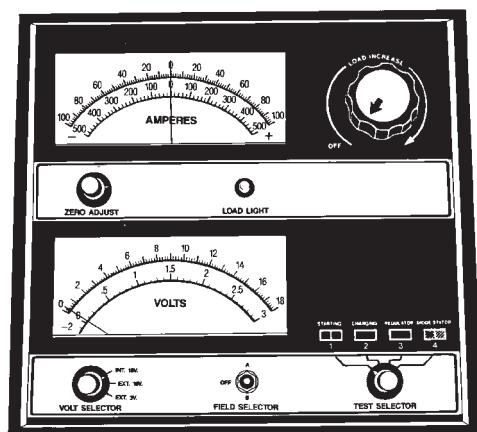
- (1) Connect a volt-ampere tester (Fig. 4) to the battery terminals (Fig. 5). Refer to the operating instructions provided with the tester being used.
- (2) Disable ignition system as follows:



- TEST CONDITIONS:**
- PLACE GEAR SELECTOR IN PARK OR NEUTRAL AND SET PARK BRAKE OR EQUIVALENT.
  - VERIFY BATTERY STATE-OF-CHARGE AND CRANKING CAPACITY, SEE BATTERY SECTION.
  - CLEAN BATTERY TOP, POSTS, AND TERMINALS.
  - VERIFY GENERATOR DRIVE BELT TENSION.
  - DISCONNECT AND GROUND COIL CABLE.

| SYMPTOM<br>STARTER FAILS TO ENGAGE. NO SOUNDS                                                                                                                                                                         | SYMPTOM<br>STARTER FAILS TO ENGAGE. SOLENOID OR RELAY CLICKS                                                                                                                | SYMPTOM<br>STARTER ENGAGES, FAILS TO TURN ENGINE. DOME LIGHT DIMS                                                                                                                                                                                          | SYMPTOM<br>STARTER ENGAGES, DRIVE CLUTCH SPINS OUT                                                             | SYMPTOM<br>STARTER DOES NOT DISENGAGE AFTER ENGINE STARTS                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| <b>POSSIBLE CAUSE</b><br>STARTER CONTROL CIRCUIT FAULTY<br> <br>IGNITION SWITCH FAULTY<br> <br>NEUTRAL SAFETY SWITCH (AUTO TRANS.) FAULTY OR MISADJUSTED<br> <br>STARTER RELAY FAULTY<br> <br>STARTER ASSEMBLY FAULTY | <b>POSSIBLE CAUSE</b><br>RESISTANCE TOO HIGH IN STARTER FEED CIRCUIT<br> <br>STARTER CONTROL CIRCUIT FAULTY<br> <br>STARTER SOLENOID FAULTY<br> <br>STARTER ASSEMBLY FAULTY | <b>POSSIBLE CAUSE</b><br>RESISTANCE TOO HIGH IN STARTER FEED CIRCUIT<br> <br>ENGINE SEIZED<br> <br>STARTER ASSEMBLY FAULTY<br><br>REFER TO APPROPRIATE GROUP AND SECTION OF THIS MANUAL FOR PROPER SERVICE AND TEST PROCEDURES FOR THE COMPONENTS INVOLVED | <b>POSSIBLE CAUSE</b><br>DRIVE CLUTCH FAULTY<br> <br>BROKEN TEETH ON RING GEAR<br> <br>STARTER ASSEMBLY FAULTY | <b>POSSIBLE CAUSE</b><br>IGNITION SWITCH FAULTY<br> <br>STARTER RELAY FAULTY<br> <br>STARTER ASSEMBLY FAULTY |
|                                                                                                                                                                                                                       |                                                                                                                                                                             |                                                                                                                                                                                                                                                            |                                                                                                                | 938A-57                                                                                                      |

Fig. 3 Starter System Diagnostics



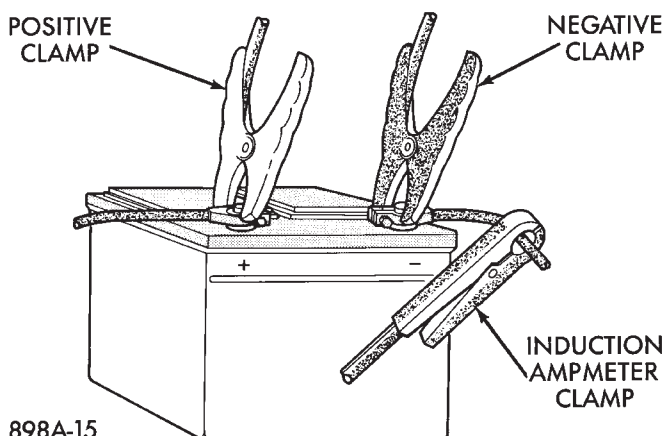
898A-8

Fig. 4 Volt Ampere Tester

VEHICLES WITH DIRECT IGNITION SYSTEM: Disconnect the ignition coils electrical connector (Fig. 6 and 7).

(3) Verify that all lights and accessories are OFF, and the transmission shift selector is in the PARK. Set parking brake.

(4) Rotate and hold the ignition switch in the START position. Observe the volt-ampere tester (Fig. 8).



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Fig. 5 Volt-Ampere Tester Connections

- If voltage reads above 9.6 volts, and amperage draw reads above 250 amps, go to the starter feed circuit resistance test.
- If voltage reads 12.4 volts or greater and amperage reads 0 to 10 amps, go to starter control circuit test.

**CAUTION:** Do not overheat the starter motor or draw the battery voltage below 9.6 volts during cranking operations.

(5) After the starting system problems have been corrected, verify the battery state-of-charge and

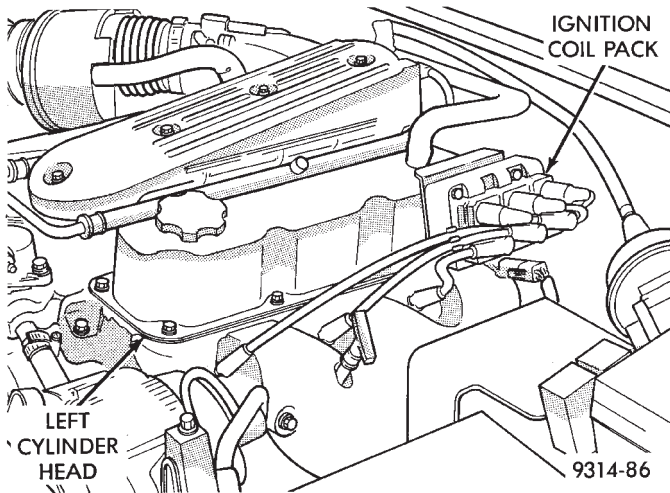


**Fig. 6 3.3L Engine Electrical Connection**

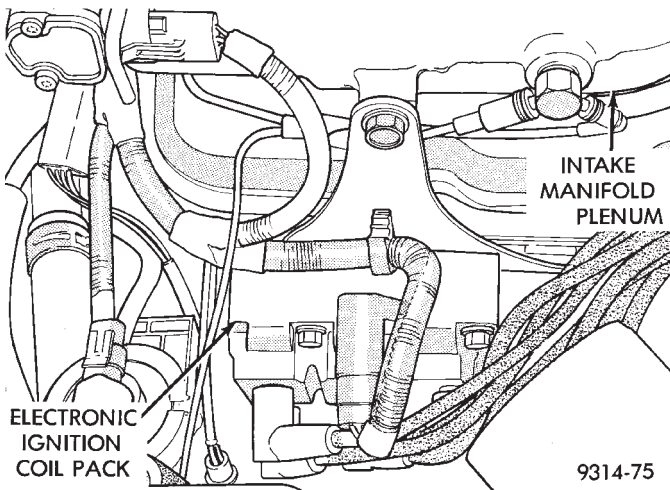


**Fig. 7 3.5L Engine Electrical Connection**

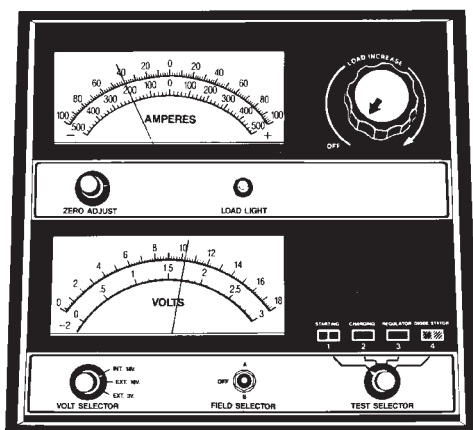


**Fig. 8 Starter Draw Tests**

charge battery if necessary. Disconnect all testing equipment and connect ignition coil cable or ignition coil connector. Start the vehicle several times to assure the problem has been corrected.

### STARTER FEED CIRCUIT RESISTANCE TEST

Before proceeding with this operation, review Diagnostic Preparation and Starter Feed Circuit Tests. The following operation will require a voltmeter, accurate to one tenth of a volt.

**CAUTION:** Ignition system also must be disabled to prevent engine start while performing the following tests.

(1) Disable ignition system as follows:

**VEHICLES WITH DIRECT IGNITION SYSTEM:** Disconnect the ignition coils electrical connector (Fig. 6 and 7).

(2) With all wiring harnesses and components properly connected, perform the following:

(a) Connect the negative lead of the voltmeter to the negative battery post, and positive lead to the negative battery cable clamp (Fig. 9). Rotate and hold the ignition switch in the START position. Observe the voltmeter. If voltage is detected, correct poor contact between cable clamp and post.

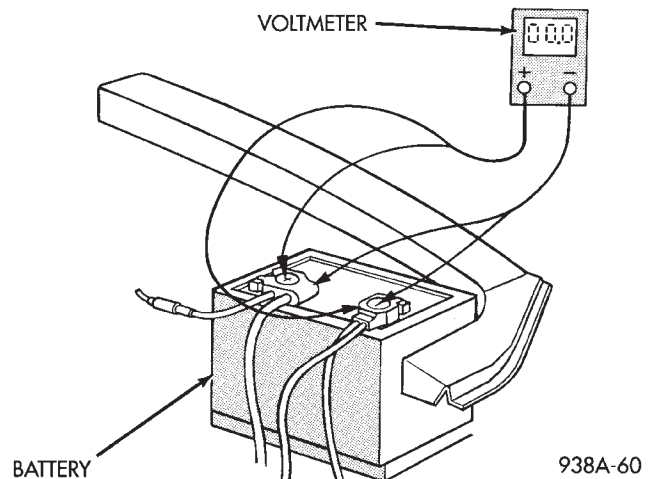


**Fig. 9 Test Battery Connection Resistance**

(b) Connect positive lead of the voltmeter to the positive battery post, and negative lead to the positive battery cable clamp. Rotate and hold the ignition switch key in the START position. Observe the voltmeter. If voltage is detected, correct poor contact between the cable clamp and post.

(c) Connect negative lead of voltmeter to negative battery terminal, and positive lead to engine block near the battery cable attaching point (Fig. 10). Rotate and hold the ignition switch in the START position. If voltage reads above 0.2 volt, correct poor contact at ground cable attaching point. If voltage reading is still above 0.2 volt after correcting poor contacts, replace ground cable.

(3) Connect positive voltmeter lead to the starter motor housing and the negative lead to the negative battery terminal (Fig. 11). Hold the ignition switch

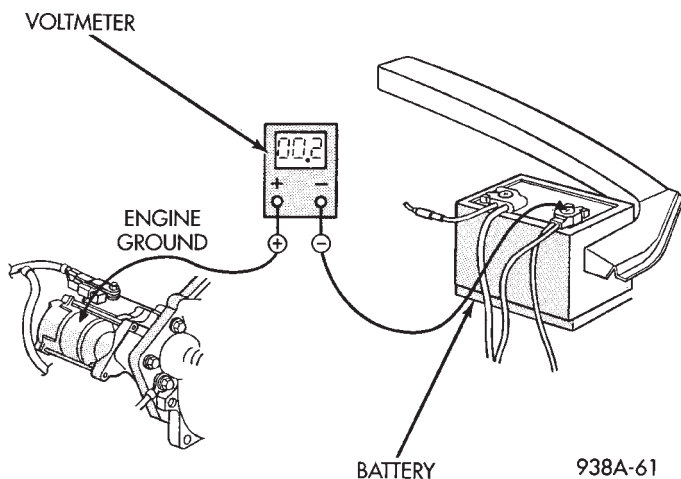


**Fig. 10 Test Ground Circuit Resistance**

key in the START position. If voltage reads above 0.2 volt, correct poor starter to engine ground.

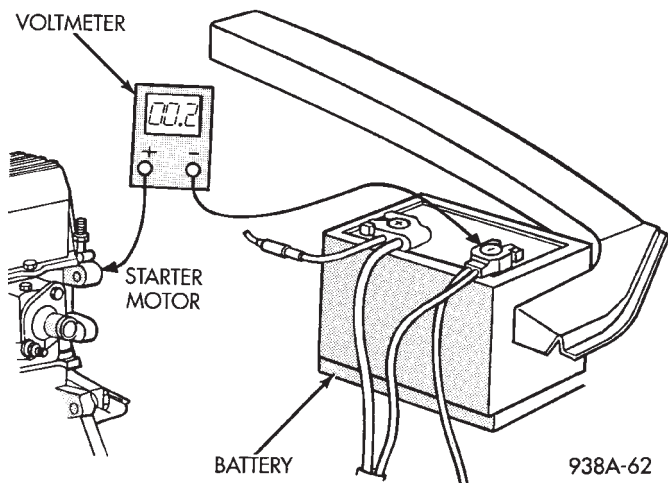


**Fig. 11 Test Starter Motor Ground**

(a) Connect the positive voltmeter lead to the positive battery terminal, and negative lead to battery cable terminal on starter solenoid (Fig. 12). Rotate and hold the ignition switch in the START position. If voltage reads above 0.2 volt, correct poor contact at battery cable to solenoid connection. If reading is still above 0.2 volt after correcting poor contacts, replace positive battery cable.

(b) If resistance tests do not detect feed circuit failures, remove the starter motor and go to Bench Testing Starter Solenoid in this Group.

## STARTER CONTROL CIRCUIT TESTS

The starter control circuit has:

- Starter solenoid
- Starter relay (Fig. 2)
- Neutral starting and back-up switch with automatic transmissions
- Ignition switch
- Battery

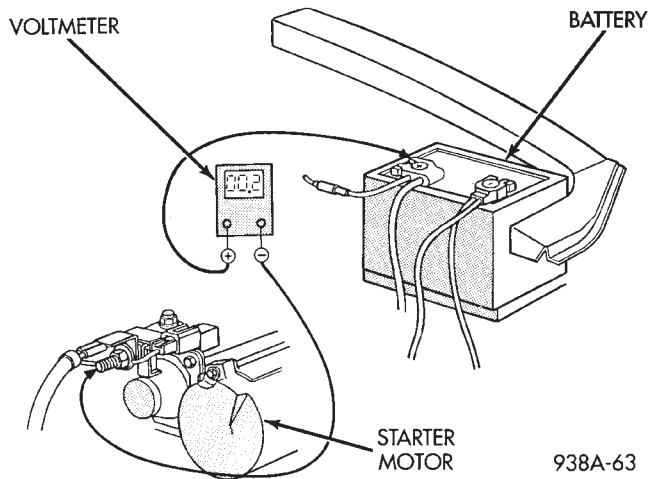


**Fig. 12 Test Positive Battery Cable Resistance**

- All related wiring and connections

**CAUTION:** Before performing any starter tests, the ignition system must be disabled.

- Unplug the ignition coil electrical connector (Fig. 6 and 7).

## STARTER SOLENOID TEST

**WARNING:** CHECK TO ENSURE THAT THE TRANSMISSION IS IN THE PARK POSITION WITH THE PARKING BRAKE APPLIED

(1) Verify battery condition. Battery must be in good condition with a full charge before performing any starter tests. Refer to Battery Tests.

(2) Perform this starter solenoid test BEFORE performing the starter relay test.

(3) Raise the vehicle.

(4) Perform a visual inspection of the starter/starter solenoid for corrosion, loose connections or faulty wiring.

(5) Lower the vehicle.

(6) Locate the starter relay (Fig. 13).

(7) Remove the starter relay from the power distribution center.

(8) Connect a remote starter switch or a jumper wire between the battery positive post and terminal D on the starter relay connector (Fig. 13).

• If engine cranks, starter/starter solenoid is good. Go to the Starter Relay Test.

• If engine does not or solenoid chatters, check wiring and connectors from starter relay to starter solenoid for loose or corroded connections. Particularly at starter terminals.

• Repeat test. If engine still fails to crank properly, trouble is within starter or starter mounted solenoid, and it must be removed for repairs. Refer to Group 8B, Battery/Starter/Generator Service, for Starter Replacement.

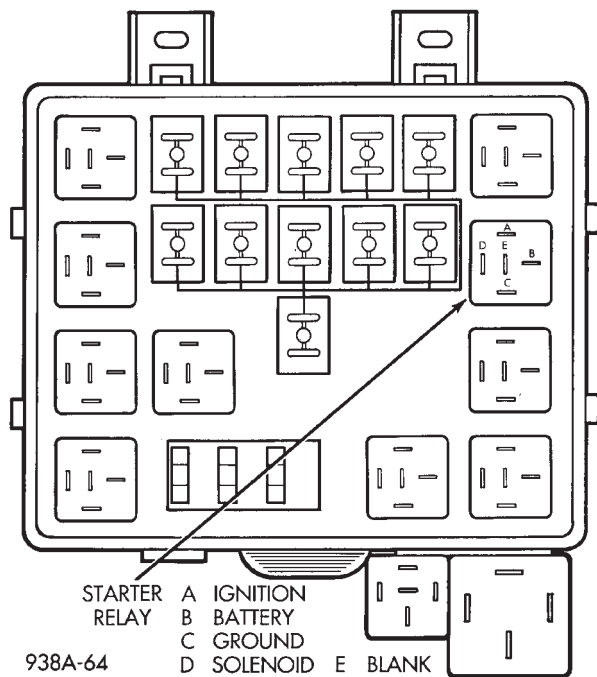


**Fig. 13 Starter Relay Location**

### STARTER RELAY TEST

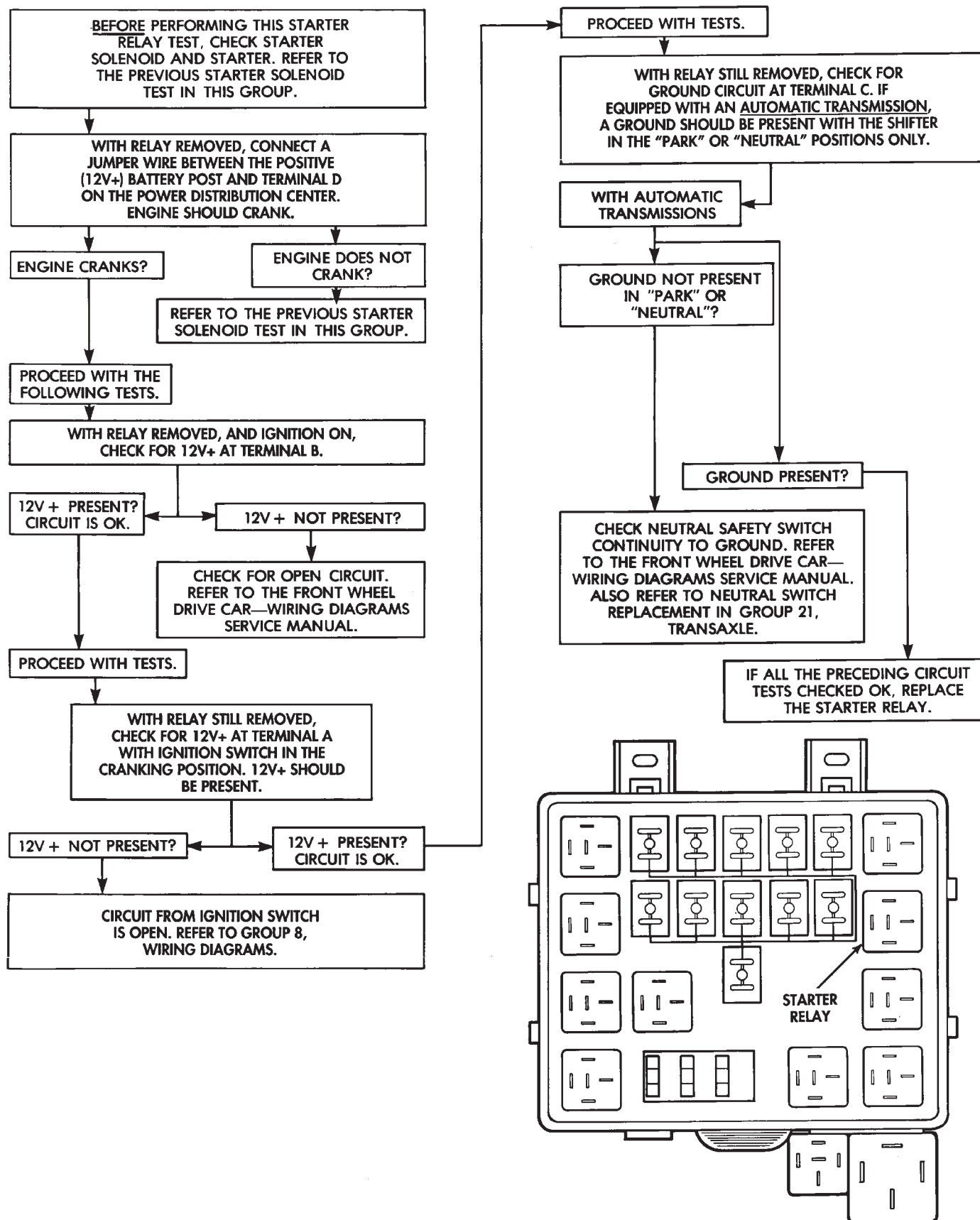
**WARNING: CHECK TO ENSURE THAT THE TRANSMISSION IS IN THE PARK POSITION WITH THE PARKING BRAKE APPLIED**

- (1) Verify battery condition. Battery must be in good condition with a full charge before performing any starter tests. Refer to Battery Tests.
- (2) Perform the preceding starter solenoid tests **BEFORE** performing starter relay tests. Refer to Starter Solenoid Test.
- (3) Locate and remove the starter relay (Fig. 13).
- (4) After the starter relay has been located and removed, refer to Starter Relay Tests (Fig. 14).

### NEUTRAL STARTING AND BACK-UP SWITCH

Refer to Starter Relay Tests for electrical diagnostics, when checking starter circuits (Fig. 14).

For removal and installation of neutral switch, refer to Neutral Starting and Back-up Switch in Group 21, Transaxle.



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Fig. 14 Starter Relay Tests



## IGNITION SWITCH TEST

After testing starter solenoid and relay, test ignition switch and wiring. Refer to Group 8D, Ignition Systems or Group 8W, Wiring Diagrams. Check all wiring for opens or shorts, and all connectors for being loose or corroded.

### BENCH TESTING STARTER SOLENOID

(1) Disconnect field coil wire from field coil terminal (Fig. 15 or 16).

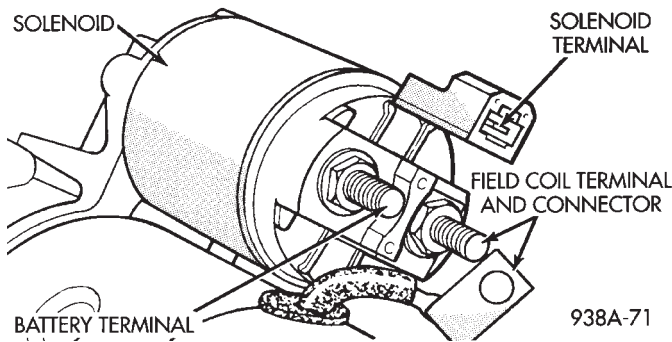


**Fig. 15 Field Coil Wire Terminal—Melco**

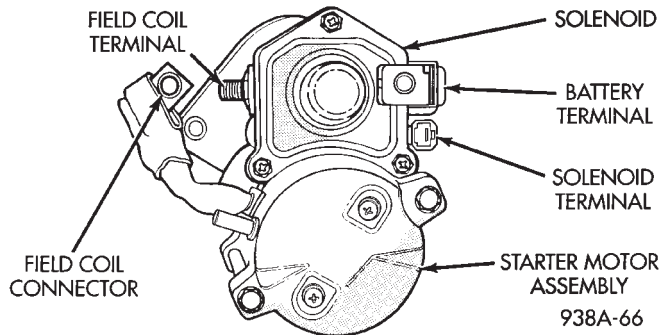


**Fig. 16 Field Coil Wire Terminal—Nippondenso**

(2) Check for continuity between solenoid terminal and field coil terminal with a continuity tester. Continuity should be detected (Fig. 17 or 18).

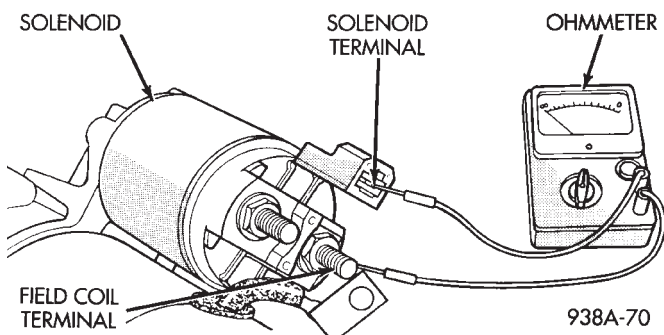


**Fig. 17 Continuity Test Between Solenoid Terminal and Field Coil Terminal—Melco**

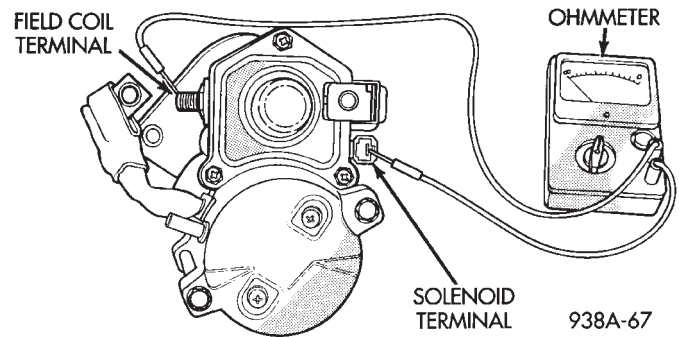


**Fig. 18 Continuity Test Between Solenoid Terminal and Field Coil Terminal—Nippondenso**

(3) Check for continuity between solenoid terminal and solenoid housing (Fig. 19 or 20). Continuity should be detected. If continuity is detected, solenoid is good.

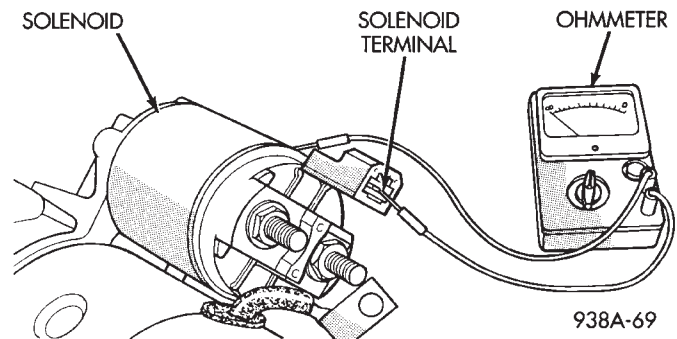


**Fig. 19 Continuity Test Between Solenoid Terminal and Solenoid Case —Melco**

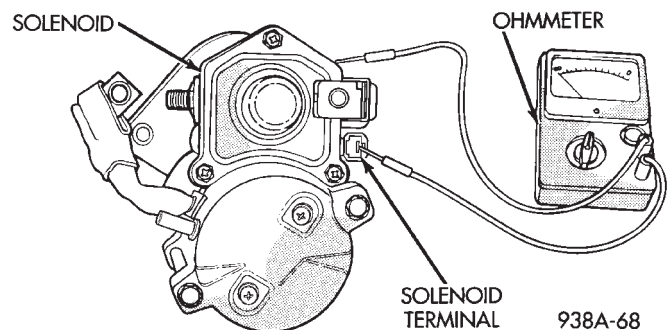


**Fig. 20 Continuity Test Between Solenoid Terminal and Solenoid Case —Nippondenso**

(4) If continuity is not detected in either test, solenoid has an open circuit and is defective.

- MELCO STARTERS: Replace the solenoid
- NIPPONDENSO STARTERS: Replace the starter assembly



## GENERATOR TEST PROCEDURES ON VEHICLE

**CHARGING SYSTEM DIAGNOSTICS (Fig. 1)****OUTPUT WIRE VOLTAGE DROP TEST**

The generator output wire voltage drop test shows the amount of voltage drop across the generator output wire between the generator B+ terminal and the positive battery post (Fig. 2).

**PREPARATION**

Before starting test, make sure the vehicle has a fully charged battery. Tests and procedures to check for a fully charged battery are shown in the Battery section of this Group.

Using an Ohmmeter, check generator ground path. Resistance between generator housing to engine should not exceed 0.3 ohms. If resistance is higher, thoroughly clean surfaces between generator and mounting bracket. Tighten all fasteners to specific torques.

**VOLTAGE DROP TEST**

(1) Using 0-18 volt scale voltmeter, connect the positive lead to the generator (B+) output terminal. Connect the negative lead to positive battery post.

- (2) Connect an engine tachometer.
- (3) Fully engage parking brake.
- (4) Place transmission in neutral position.
- (5) Start engine.
- (6) Allow ten minutes for engine warm-up.
- (7) Operate blower motor on high speed.
- (8) Turn headlamps ON high beam.
- (9) Increase engine speed to approximately 2,400 RPM.

(10) Observe voltmeter, the reading should not exceed 0.8 volts.

**RESULTS**

If a higher voltage drop is shown, inspect, clean and tighten all connections between generator B+ terminal and battery positive post. A voltage drop

test may be performed at each connection to locate a connection with excessive voltage drop. If voltage drop tests are satisfactory, reduce engine speed, turn OFF blower motor, headlamps and ignition switch.

**OUTPUT VOLTAGE TEST**

The output voltage test determines whether or not the generator is capable of delivering output current to satisfy the vehicle electrical load requirements.

**PREPARATION**

Before starting any tests, make sure the vehicle has a fully charged battery. Tests and procedures to check for a fully charged battery are shown in Battery section.

(1) Connect voltmeter leads across battery terminals (Fig. 3).

(2) Record base battery voltage which is with ignition switch OFF and all electrical loads OFF.

(3) Fully engage parking brake and place transmission in park.

**TEST**

Record the results of the output test.

(1) Start engine.

(2) With engine at operating temperature record battery voltage at engine speed of 1800 rpm with no other electrical loads. The battery voltage should not be more than 2.7 volts above base battery voltage. If battery voltage is higher than 2.7 volts, refer to Check For Overcharging (Fig. 4).

(3) Record battery voltage at engine speed of 2400 rpm with blower motor ON high and headlamps ON high beam. The battery voltage should be minimum of 0.4 volt above base battery voltage. If battery voltage is below 0.4 volt, refer to Check For Inadequate/low Charging.

(4) After output voltage tests are completed, turn OFF blower motor, head lamps and ignition switch.

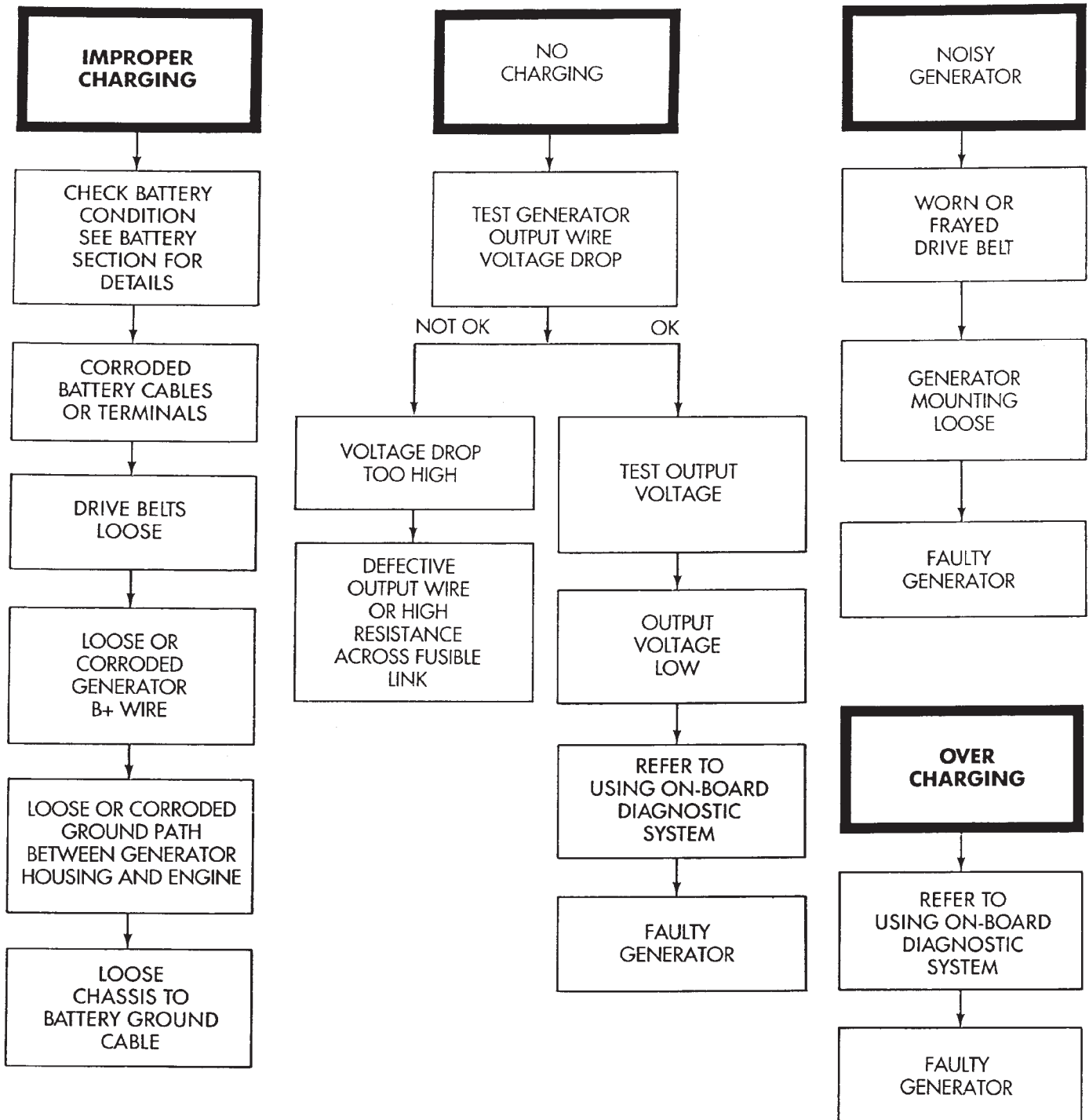


Fig. 1 Charging Diagnostics

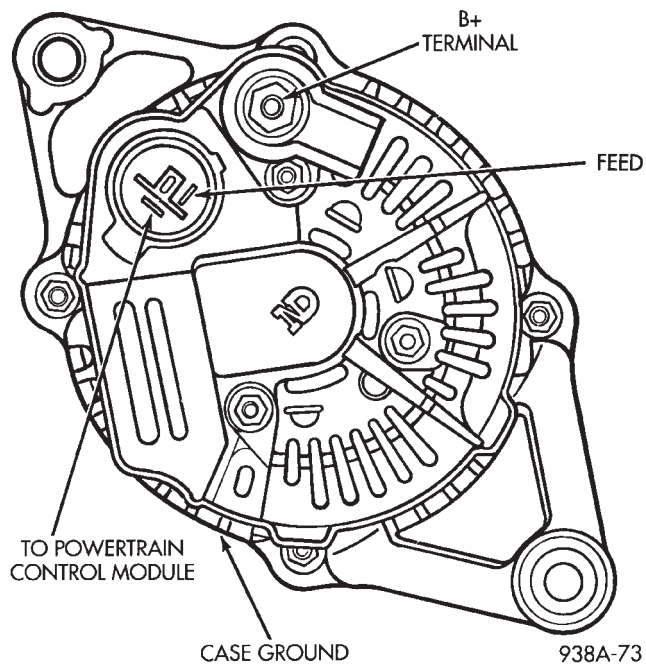


**Fig. 2 Wiring Connections**

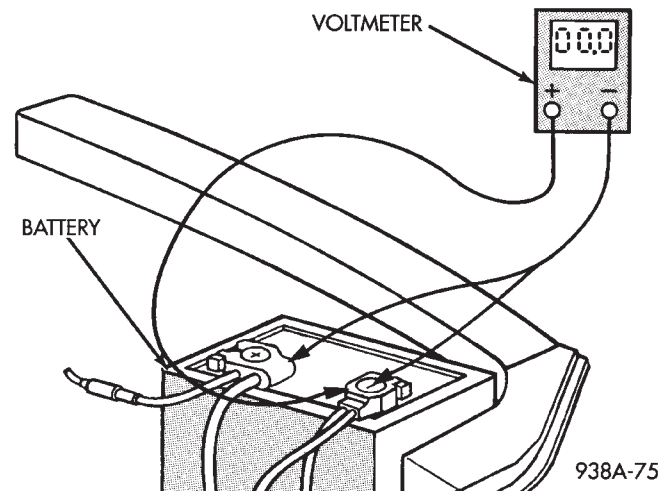


**Fig. 4 Battery Voltage Test**

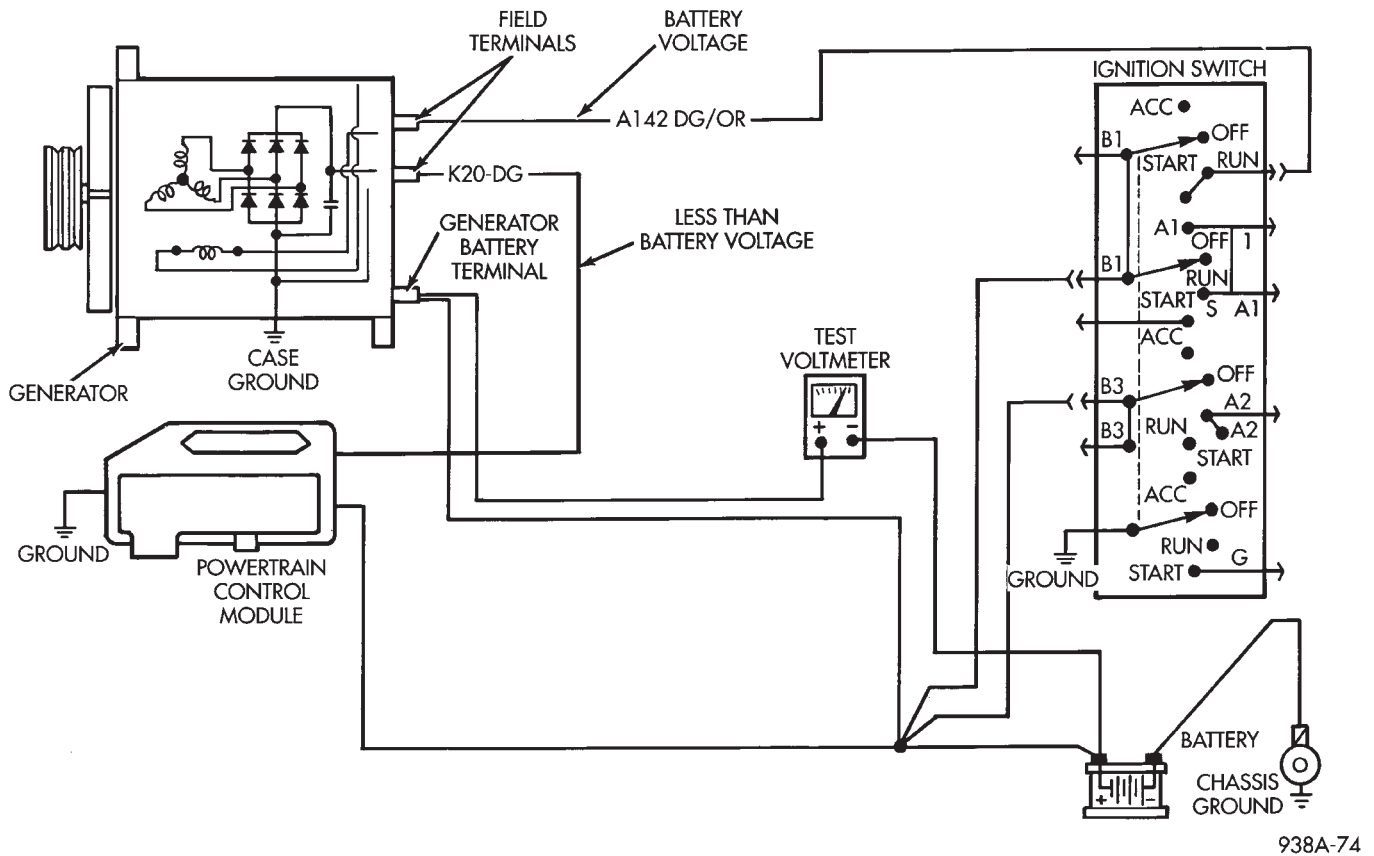


**Fig. 3 Output Voltage Test**



## FAULT CODES—ON BOARD DIAGNOSTICS

## INDEX

|                                      | page |                                 | page |
|--------------------------------------|------|---------------------------------|------|
| Diagnostic Testing Using Fault Codes | 21   | General Description/Information | 21   |
| DRB II Diagnostic Tester             | 21   |                                 |      |

**GENERAL DESCRIPTION/INFORMATION**

Another way of diagnosing charging system problems can be accomplished using the On-Board Diagnostic System Fault Codes.

A Fault Code shows a potential problem in a monitored circuit, or a condition caused by a faulty component. A Fault Code can be retrieved by turning the ignition switch ON-OFF-ON-OFF-ON without starting the engine, and counting the possible number of flashes of the CHECK ENGINE LAMP in the instrument cluster.

**EXAMPLES:**

- If the Check Engine Lamp flashes four times, pauses, and flashes one more time, a Code 41 is shown. The first set of four flashes indicates the number four. The second set of one flash indicates one.
- If the Check Engine Lamp flashes four times, pauses, and flashes six more times, a Code 46 is shown. The first set of four flashes indicates the number four. The second set of six flashes indicates six.
- If the Check Engine Lamp flashes four times, pauses, and flashes seven more times, a Code 47 is indicated. The first set of four flashes indicates the number four. The second set of seven flashes indicates seven.

**POWERTRAIN CONTROL MODULE**

The power control module is equipped with On-Board Diagnostic features and monitors all engine control circuits during a run/drive period. If a circuit or system does not perform properly, the powertrain control module will file in memory a predetermined Fault Code. This can be used to help in diagnosing a problem. After 50 to 100 ignition switch ON/RUN cycles, the memory will be erased if the fault does not reoccur.

The powertrain control module is located below the air cleaner housing (Fig. 5).

16 Refer to Fig. 6 Generator Fault Code chart for relationships of generator/charging system Fault Code numbers.

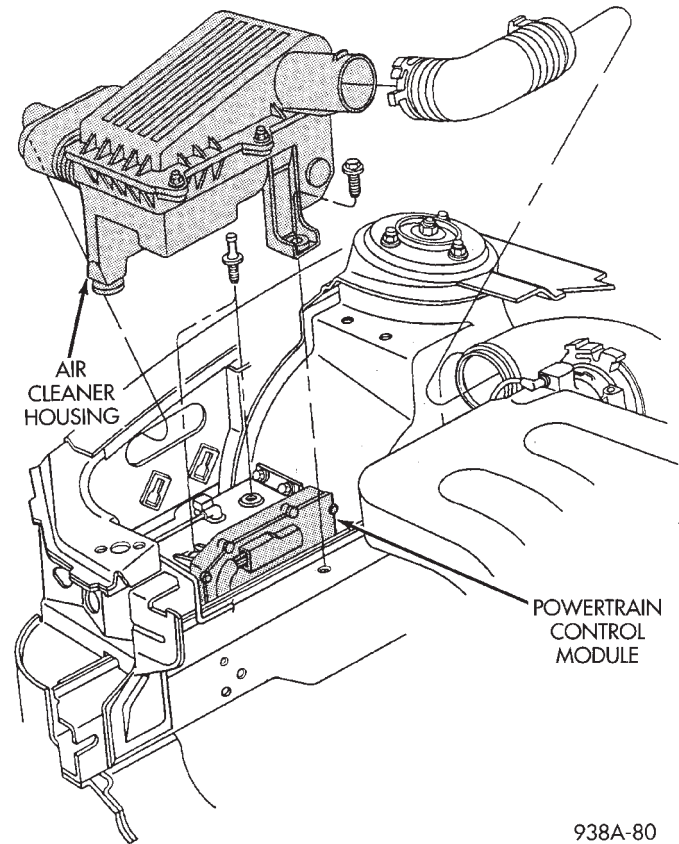


**Fig. 5 Powertrain Control Module**

**DIAGNOSTIC TESTING USING FAULT CODES**

For diagnostic testing when using the fault codes, refer to Fig. 7 through 10.

**DRB II DIAGNOSTIC TESTER****TESTING FAULT CODES**

A more accurate device to retrieve fault codes is the Diagnostic Tool (DRB II). The diagnostic tool is plugged into the diagnostic connector (Fig. 11) located on the right lower side of the steering column. The DRB II will display fault descriptions. The DRB II can also test various circuits and component functions. Refer to the instructions provided with the DRB II tool being used. Descriptions of Fault Codes for other vehicle systems can be found in the General Diagnosis section of Group 14, Fuel System.

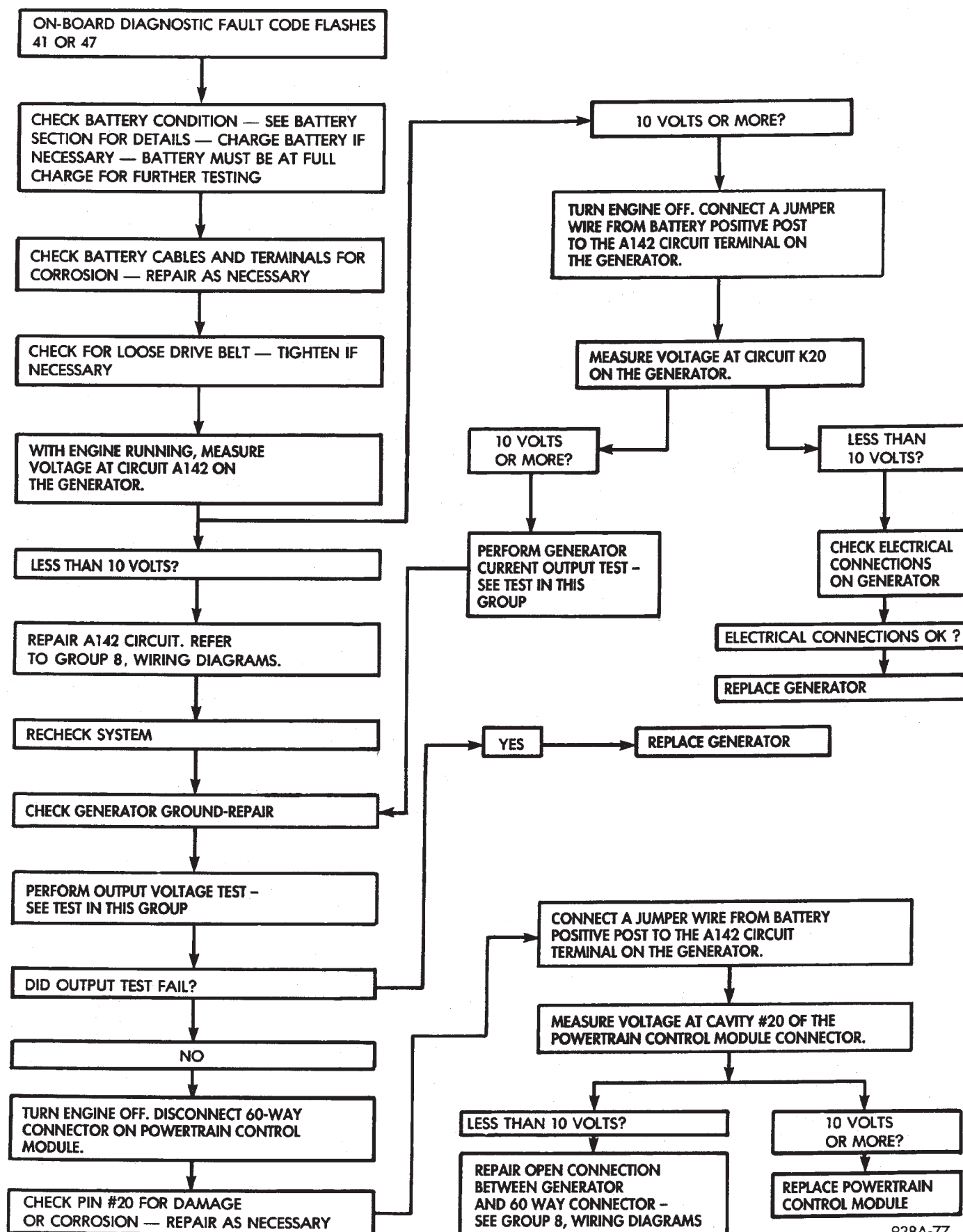
If using an DRB II, refer to the appropriate Powertrain Diagnostic Manual.



| <b>Fault Code</b> | <b>Type</b> | <b>Check Engine Lamp</b> | <b>Circuit</b>                                | <b>When Monitored By The Logic Module</b>    | <b>When Put Into Memory</b>                                                                                                                                |
|-------------------|-------------|--------------------------|-----------------------------------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12                | Indication  | No                       | Battery Feed to the Powertrain Control Module | All the time when the ignition switch is on. | If the battery feed to the Powertrain Control Module has been disconnected within the last 50-100 engine starts.                                           |
| 41                | Fault       | Yes                      | Generator Field Control (Charging System)     | All the time when the ignition switch is on. | Powertrain Control Module output for generator field does not respond to the voltage regulator control signal.                                             |
| 46                | Fault       | Yes                      | Battery Voltage Sensing (Charging System)     | All the time when the engine is running.     | If the battery sense voltage is more than 1 volt above the desired control voltage for more than 20 seconds.                                               |
| 47                | Fault       | Yes                      | Battery Voltage Sensing (Charging System)     | Engine rpm above 1,500 rpm.                  | If the battery sense voltage is less than 1 volt below the desired control voltage for more than 20 seconds and active test indicates a generator problem. |
| 55                | Indication  | No                       |                                               |                                              | Indicates end of diagnostic mode.                                                                                                                          |

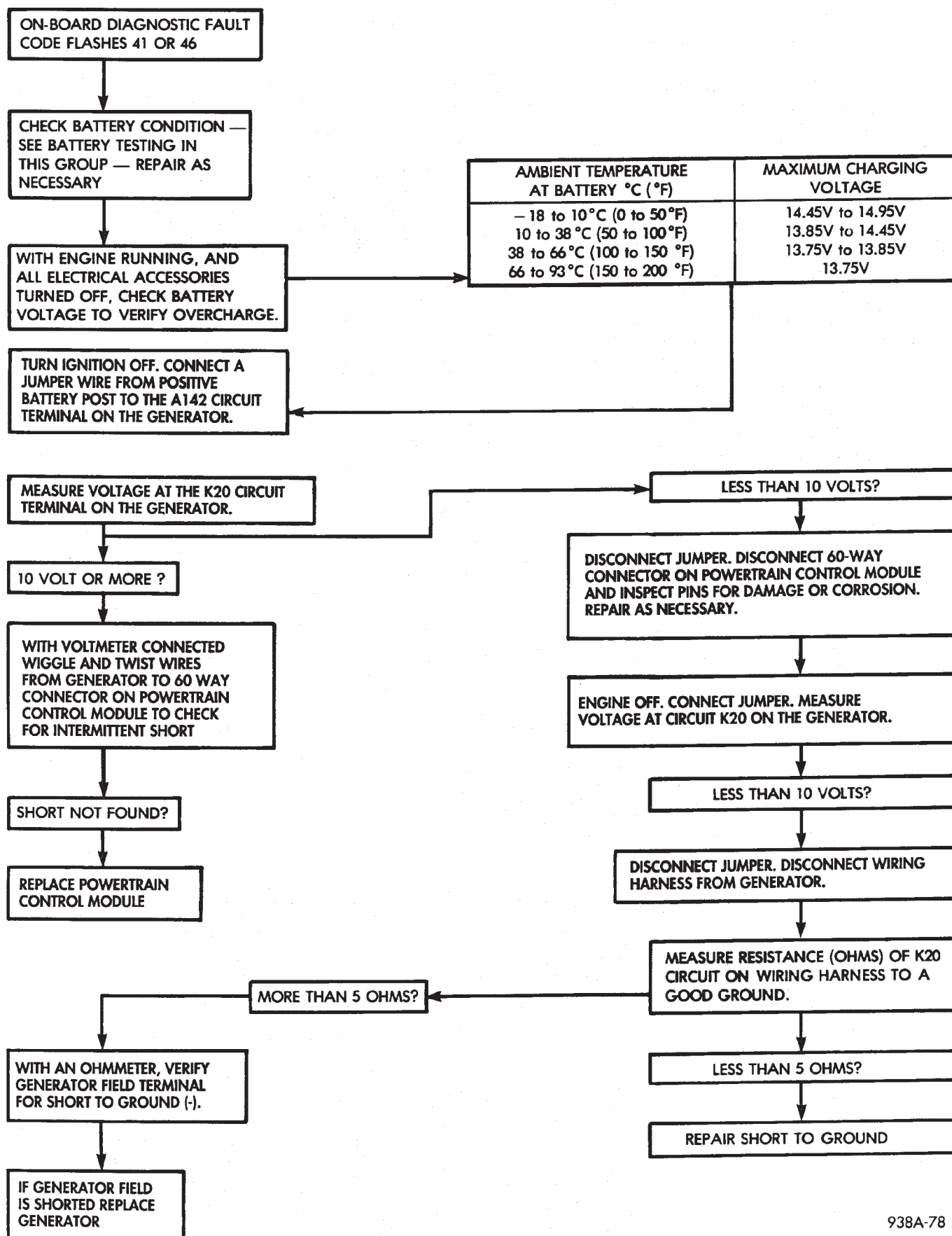
938A-76

*Fig. 6 Generator Fault Codes*



938A-77

Fig. 7 Check For Inadequate/Low Charging



938A-78

Fig. 8 Check For Overcharging

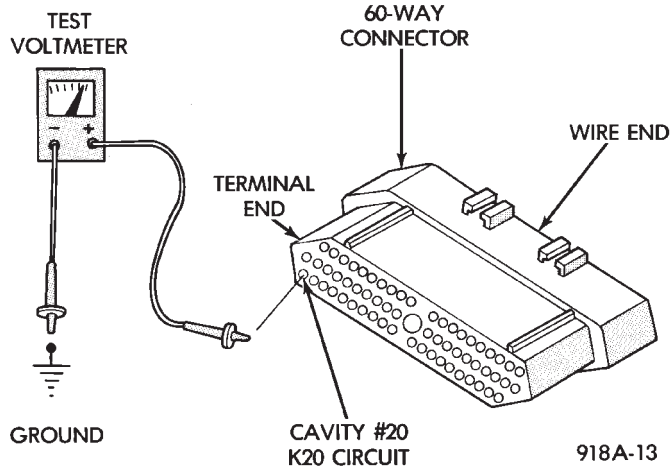


**Fig. 9 Powertrain Control Connector**

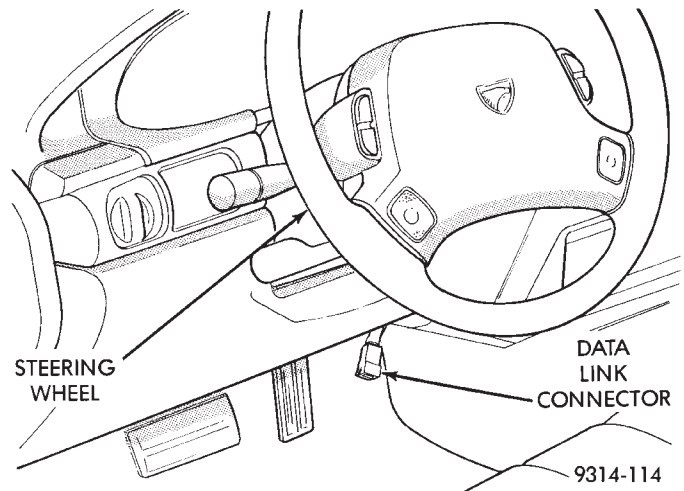


**Fig. 11 Diagnostic Connector Location**

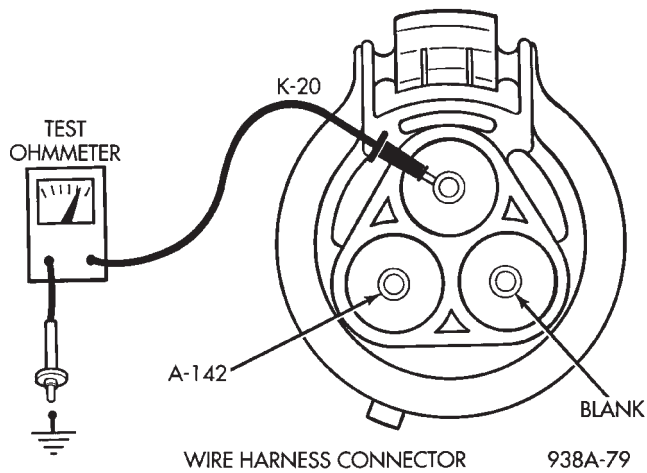


**Fig. 10 Electrical Resistance Test**



## SPECIFICATIONS

## BATTERY

| Load Test (Amps) | Cold Cranking Rating @ - 18 degrees C | Reserve Capacity |
|------------------|---------------------------------------|------------------|
|------------------|---------------------------------------|------------------|

250 Amps ..... 500 Amps ..... 110 Minutes

300 Amps ..... 600 Amps ..... 120 Minutes

345 Amps ..... 685 Amps ..... 125 Minutes

CRANKING RATING: is the current a battery can deliver for 30 seconds and maintain a terminal voltage of 7.2 volts or greater at a specified temperature.

RESERVE CAPACITY RATING: is the length of time a battery can deliver 25 Amps and maintain a minimum terminal voltage of 10.5 volts at 27 degrees C.

938A-52

## STARTER

|  | NIPPONDENSO | MELCO |
|--|-------------|-------|
|--|-------------|-------|

Engine Application ..... 3.3L ..... 3.5L

Power Rating ..... 1.2 Kw ..... 1.2 Kw

Voltage ..... 12 Volts ..... 12 Volts

Brushes ..... 4 ..... 4

Drive ..... Offset ..... Planetary

                                         Gear Reduced      Gear Train

Cranking Amperage Draw Test ..... 150-280 Amps\*

\*Engine should be up to operating temperature.

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## TORQUE SPECIFICATIONS

| DESCRIPTION | TORQUE |
|-------------|--------|
|-------------|--------|

Generator Mounting Bolts ..... 54 N·m (40 ft. lbs.)

Generator B+ Terminal ..... 9 N·m (75 in. lbs.)

Battery Hold Down Clamp Bolt ..... 14 N·m (125 in. lbs.)

Starter Mounting Bolts ..... 54 N·m (40 ft. lbs.)

938A-53