ELECTRICAL

GROUP INDEX

BATTERY/STARTING/CHARGING SYSTEMS DIAGNOSTICS

CONTENTS

GENERAL INFORMATION

The Battery, Starting, and Charging Systems operate with one another, and therefore, must be thoroughly tested as a complete system. In order for 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 covers Starting (Fig. 1) and Charging (Fig. 2) System diagnostic procedures. These procedures include the most basic conventional methods to On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of an ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12 volt test light will be required.

All OBD sensing systems are monitored by the PCM. The PCM will store in memory any detectable failure in the monitored circuits. Refer to Using On-Board Diagnostic System in this group for more information.

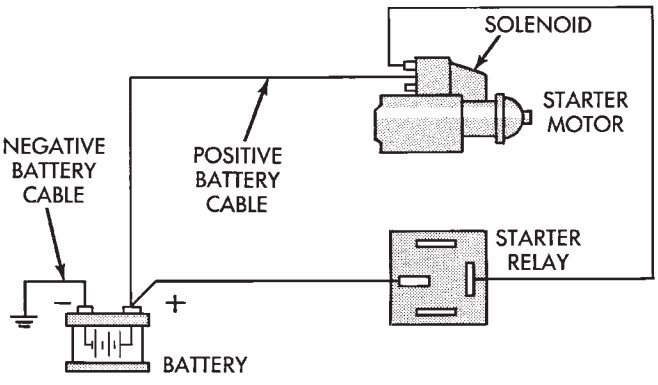

Fig. 1 Starting System Components (Typical)

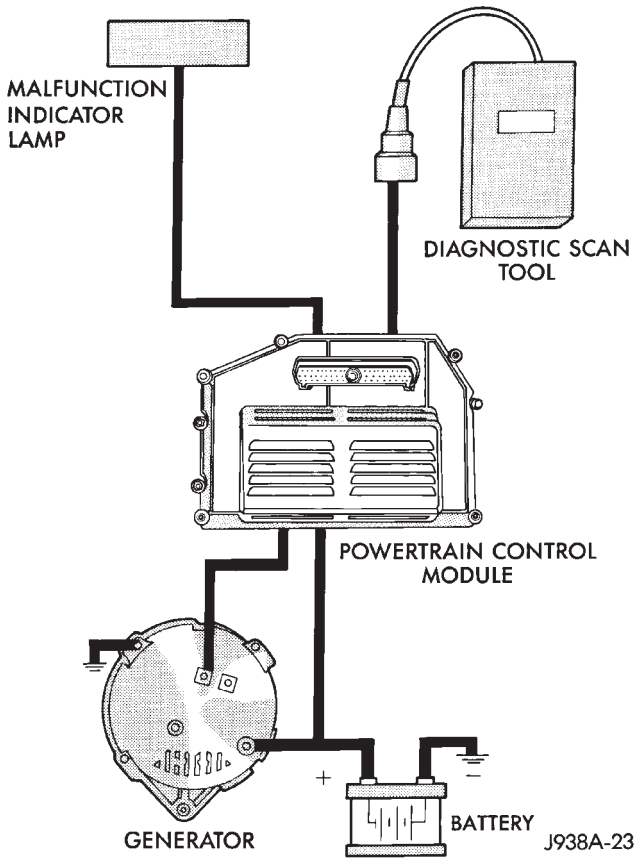

Fig. 2 Charging System Components

BATTERY TEST PROCEDURES

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GENERAL INFORMATION

The battery stores, stabilizes, and produces electrical current. A battery must be able to accept a charge and produce high-amperage current over an extended period. A chemical reaction takes place between sulfuric acid solution (electrolyte) and lead+/-plates in each cell of the battery. As the battery discharges, the plates collect acid from the electrolyte. When the charging system charges the battery, water is converted to sulfuric acid in the battery. The amount of acid (specific gravity) in the electrolyte can be measured with a hydrometer. A factory installed battery has a built-in test indicator to help determine state-of-charge. Specific gravity can also be measured with a hand held hydrometer. The battery is vented to release gases that are created when the battery is being charged. The battery top, posts, and terminals should be cleaned when other underhood maintenance is performed (Fig. 3).

WARNING: DO NOT ATTEMPT TO ASSIST BOOST, CHARGE, OR TEST BATTERY WHEN ELECTROLYTE LEVEL IS BELOW THE TOP OF THE PLATES (YELLOW OR BRIGHT COLOR IS VISIBLE). PERSONAL INJURY MAY OCCUR.

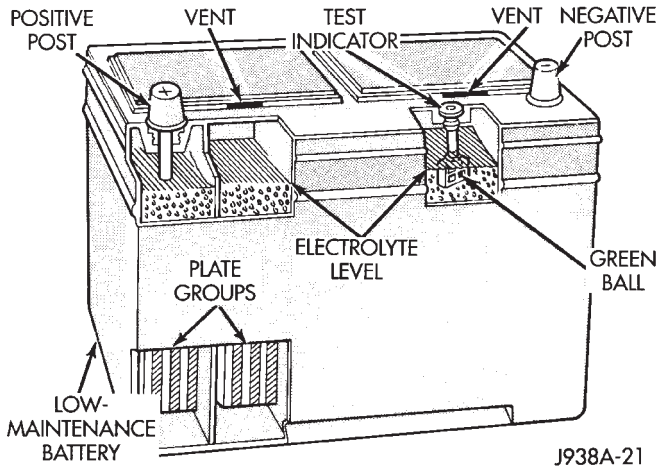

Fig. 3 Battery Construction and Test Indicator

When electrolyte level is below top of the plates (yellow or bright indicator), distilled water should be added. The battery must be completely charged (green indicator) and the top, posts, and terminals should be properly cleaned before diagnostic procedures are performed. Refer to Group 8B - Battery/Starter Service, for additional information.

All batteries are protected from high underhood temperatures by a thermal shield. Always install shield after removing the battery.

BATTERY TESTING GENERAL INFORMATION

Before testing a battery, clean the top of the battery case, posts and cable terminals.

Specific gravity is a ratio of the density of the electrolyte and the density of pure water. The electrolyte is composed of sulfuric acid and water. Acid makes up approximately 35% by weight or 24% by volume.

The condition of a battery may be determined from the results of 3 tests:

- state of charge, using test indicator
- hydrometer test
- ability to supply current (battery load test).

Use test indicator first. If battery condition is not certain then perform the Hydrometer test. If the specific gravity is less than 1.225, (with battery at room temperature) the battery must be charged before proceeding with further testing. A battery that will not accept a charge is defective and further testing is not necessary.

Completely discharged batteries may take several hours to accept a charge. See Charging A Completely Discharged Battery.

A battery that has been fully charged but does not pass the battery load test is defective.

A battery is fully charged when:

- all cells are gassing freely during charging
- 3 corrected specific gravity tests, taken at 1-hour intervals, indicate no increase in specific gravity.

TEST INDICATOR

A test indicator (hydrometer) built into the top of battery case, provides visual information for battery testing (Fig. 4). It is important when using test indicator that the battery be level and have a clean top to see correct indications. A light may be required to view indicator.

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

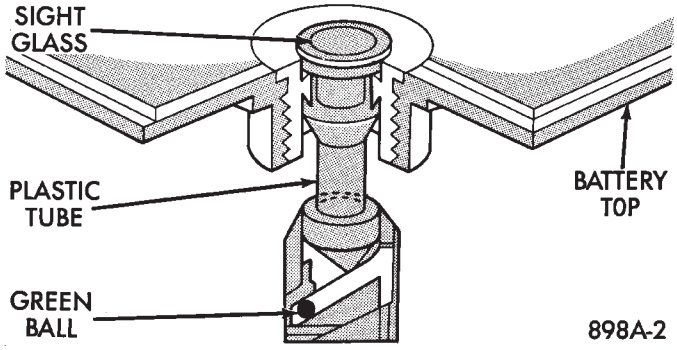

Fig. 4 Built in Test Indicator

STATE OF CHARGE TEST USING TEST INDICATOR

The built-in test indicator (hydrometer) measures the specific gravity of the electrolyte. Specific gravity (SG) will indicate state-of-charge (voltage); although, the test indicator will not indicate cranking capacity of the battery. Refer to Battery Load Test for more information. Look into the sight glass and note the color of the indicator (Fig. 5), refer to the following description as color indicates:

GREEN—75 to 100% state-of-charge

The battery is adequately charged for further testing or return to use. If the vehicle will not crank for a maximum 15 seconds, refer to Battery Load Test for more information.

BLACK OR DARK—0 to 75% state-of-charge

The battery is inadequately charged and must be charged until green indicator is visible (12.4 volts or more) before the battery is tested or returned to use. Refer to Causes of Battery Discharging for more information.

YELLOW OR BRIGHT COLOR

WARNING: DO NOT ATTEMPT TO CHARGE, TEST, OR ASSIST BOOST BATTERY WHEN YELLOW OR BRIGHT COLOR IS VISIBLE. PERSONAL INJURY MAY OCCUR.

A yellow or bright color indicates electrolyte level in the battery is below test indicator (Fig. 5). Water can be added to a low maintenance battery. A low electrolyte level may be caused by an over charging condition. Refer to Generator Test Procedures On Vehicle in this group.

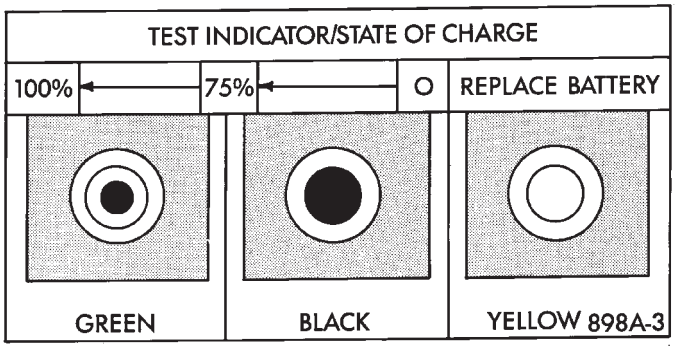

Fig. 5 Test Indicator Sight Glass

HYDROMETER TEST

Before performing a hydrometer test, remove the battery caps and check the electrolyte level. Add distilled water as required.

Before testing, visually inspect the battery for damage (cracked case or cover, loose post, etc.) that would cause the battery to be defective. To use the hydrometer correctly, hold it with the top surface of the electrolyte at eye level. Refer to manufacturers instructions for correct use of hydrometer.

Remove only enough electrolyte from the battery to keep the float off the bottom of the hydrometer barrel with pressure on the bulb released. Exercise care when inserting the tip of the hydrometer into a cell to avoid damage to the separators. Damaged separators can cause premature battery failure.

Hydrometer floats are generally calibrated to indicate the specific gravity correctly only at one fixed temperature, 80°F (26.6°C). When testing the specific gravity at any other temperature, a correction factor is required.

The correction factor is approximately a specific gravity value of 0.004, referred to as 4 points of specific gravity. For each 10°F above 80°F (5.5°C above 26.6°C), add 4 points. For each 10°F below 80°F (5.5°C below 26.6°C), subtract 4 points. Always correct the specific gravity for temperature variation. Test the specific gravity of the electrolyte in each battery cell.

Example: A battery is tested at 10°F (-12.2°C) and has a specific gravity of 1.240. Determine the actual specific gravity as follows:

- Determine the number of degrees above or below 80°F.

  80°F - 10°F = 70°F
- Divide the result above by 10.

  70°F/10 = 7
- Multiply the result from the previous step by the temperature correction factor (0.004).

  7 x 0.004 = 0.028
- The temperature at testing was below 80°F, therefore the temperature correction is subtracted.

  1.240 - 0.028 = 1.212

The corrected specific gravity is 1.212.

The fully charged battery should have a temperature corrected specific gravity of 1.260 to 1.290

If the specific gravity of all cells is above 1.235, but variation between cells is more than 50 points (0.050), it is a sign that the battery should be replaced.

If the specific gravity of one or more cells is less than 1.235, recharge the battery at a rate of approximately 5 amperes. Continue charging until 3 consecutive specific gravity tests, taken at one-hour intervals, are constant.

If the cell specific gravity variation is more than 50 points (0.050) at the end of the charge period, replace the battery.

When the specific gravity of all cells is above 1.235 and variation between cells is less than 50 points (0.050), the battery may be tested under heavy load.

CAUSES OF BATTERY DISCHARGING

It is normal to have a 5 to 20 milliamperes Ignition Off Draw (IOD) from the battery with all lamps OFF. Electronic features or accessories that have a memory circuit cause IOD. When a vehicle is not used for 20 days or more, remove IOD fuse in the Power Distribution Center to reduce battery discharging.

ABNORMAL BATTERY DISCHARGING

(1) Corroded battery posts and 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 (heavy traffic conditions) or prolonged idling with high-amperage draw systems in use.

(5) Defective circuit or component causing excess IOD. Refer to Ignition Off Draw in this Group.

(6) Defective charging system.

(7) Defective battery.

BATTERY OPEN CIRCUIT VOLTAGE TEST

A battery voltage (no load) test will show state of charge of a battery that will pass the Battery Load Test described in this section. **Before proceeding with this test or Battery Load Test, completely charge battery as described in Battery Charging in this section.**

If a battery has a no load voltage reading of 12.4 volts or greater and will not endure a load test, it is defective and should be replaced. Refer to Group 8B - Battery/Starter Service for instructions. To test battery no load voltage, perform the following operation:

(1) Before measuring open circuit voltage, the surface charge must be removed from plates. Turn head lights on for 15 seconds then allow up to 5 minutes for voltage to stablize.

(2) Remove both battery cables, negative first.

(3) Using a voltmeter connected to the battery posts, see instructions provided with voltmeter, measure open circuit voltage (Fig. 6).

This voltage reading will indicate state of charge, but will not reveal cranking capacity. Refer to Battery Open Circuit Voltage chart.

BATTERY OPEN CIRCUIT VOLTAGE

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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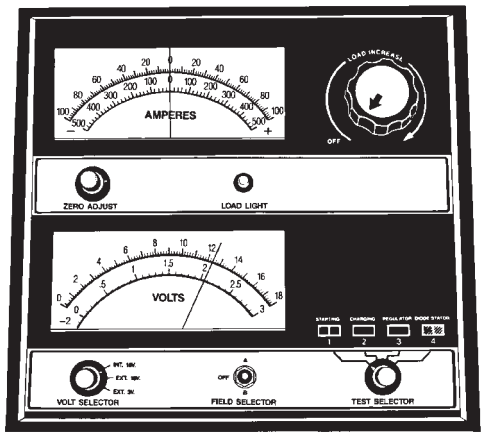

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Fig. 6 Testing Open Circuit Voltage

BATTERY LOAD TEST

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

A battery load test will verify the cranking ability based on the cold crank rating of the battery.

Before performing battery load test, the battery must be FULLY CHARGED.

(1) Remove both battery cables, negative first. Battery top and posts should be clean. If indicator is not green, charge the battery. See Battery Charging Procedures in this section.

(2) Connect a suitable Volt-Ammeter-Load tester (Fig. 7) to the battery posts (Fig. 8). Refer to operating instructions provided with the tester being used. Check the open circuit voltage (no load) of the battery. Voltage should be equal to or greater than 12.4 volts (Fig. 7) with a green test indicator.

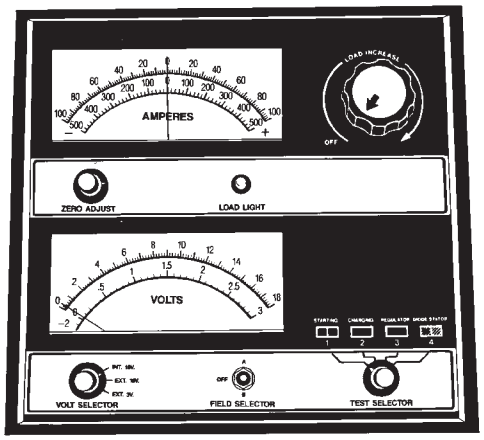

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Fig. 7 Volt-Amps-Load Tester (Typical)

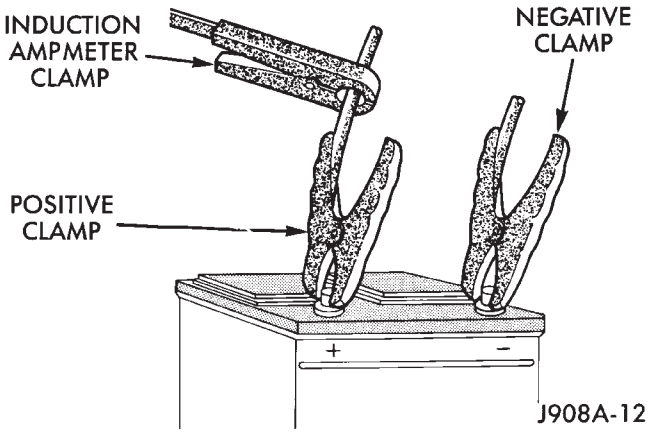

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Fig. 8 Volt-Ammeter-Load Tester Connections

(3) Rotate the load control knob (carbon pile rheostat) to apply a 300 amp load for 15 seconds then return the control knob to off (Fig. 9). This will remove the surface charge from the battery.

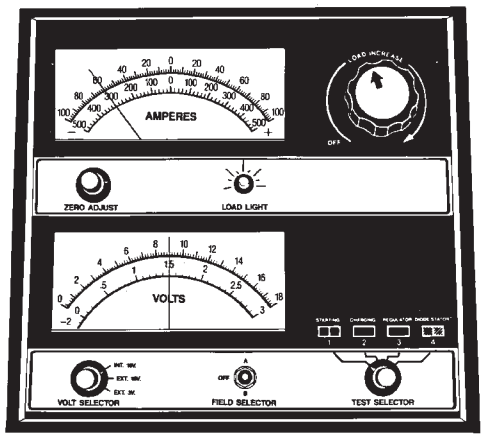

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Fig. 9 Remove Surface Charge from Battery

(4) Allow the battery to stabilize to open circuit voltage (may take up to 5 minutes).

(5) Rotate the load control knob to maintain a load (50% of cold crank rating—see Specifications) for a

minimum of 15 seconds (Fig. 10). After 15 seconds, record the (loaded) voltage reading and return the load control to off.

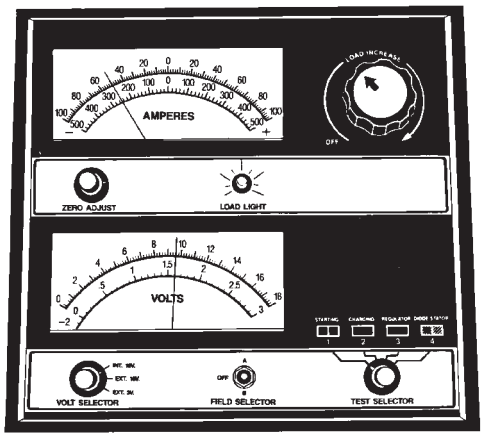

Fig. 10 Load 50% Cold Crank Rating Note Voltage

(6) Voltage drop will vary according to battery temperature at the time of the load test. Battery temperature can be estimated by the ambient temperature over the past several hours. If the battery has been charged, boosted, or loaded a few minutes prior to test, the battery would be somewhat warmer. Refer to Load Test Temperature chart for proper loaded voltage reading.

(7) If the voltmeter reading fell below 9.6 volts, with the battery temperature at a minimum of 70°F (21°C), replace the battery.

LOAD TEST TEMPERATURE		
Minimum Voltage	Temperature	
	F°	C°
9.6	70 and above	21 and above
9.5	60	16
9.4	50	10
9.3	40	4
9.1	30	-1
8.9	20	-7
8.7	10	-12
8.5	0	-18

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BATTERY CHARGING

A battery is completely charged when it has:

- an open circuit voltage of 12.4 volts or more.
- has enough cranking capacity (minimum 9.6 volts when loaded for 15 seconds to 50% of cold cranking amperage rating at 21°C/70°F).

A green test indicator on the top of the battery, indicates the battery is charged enough for further testing. A black indicator means the battery state of charge is below 75%. A yellow or bright indicator means the battery has low electrolyte level. Add distilled water as required.

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

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

WARNING: DO NOT ASSIST BOOST OR CHARGE A FROZEN BATTERY, CASING MAY FRACTURE.

WARNING: POISON, CAUSES SEVERE BURNS. BATTERY CONTAINS SULFURIC ACID, AVOID CONTACT WITH SKIN, EYES, OR CLOTHING. IN EVENT OF CONTACT, FLUSH WITH WATER AND CALL PHYSICIAN IMMEDIATELY. KEEP OUT OF REACH OF CHILDREN.

CAUTION: Disconnect the vehicle's battery negative cable before charging battery to avoid damage to electrical systems. Do not exceed 16.0 volts while charging battery.

Battery electrolyte will bubble inside case while being charged properly. If the electrolyte boils or is discharged from the vent holes while charging, immediately reduce charging rate or turn off charger. Determine battery condition.

Battery should not be hot to touch.

If the battery feels hot to the touch, turn off charger and let cool before restarting.

Some battery chargers are equipped with polarity (+ to +/- to -) 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 jostle the battery or vehicle to bring green ball into view in the test indicator when state-of-charge has reached 75%.

After the battery has been charged, green indicator, perform a load test to determine cranking capacity. 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. Clean and inspect battery hold

BATTERY CHARGING TIME TABLE

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		

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downs, tray, terminals, posts, and top before completing service, see Group 8B - Battery/Starter/Generator Service.

CHARGING TIME REQUIRED

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

(1) **Size of Battery—** A completely discharged large, heavy-duty battery requires more than twice the recharging time as a completely discharged small capacity battery.

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

(2) **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. Then, in time, the battery will accept a higher rate as battery warms.

(3) **Charger Capacity—** A charger, that supplies only 5 amperes, will require a much longer charging time than a charger that supplies 20 amperes or more.

(4) **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 the battery charges the specific gravity of the electrolyte will rise slowly.

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.

(1) Measure voltage at battery posts with a voltmeter, accurate to 1/10 volt (Fig. 11). If below 10 volts, then charge current will be low and it could take some time before it accepts a current greater than a few milliamperes. Such low current may not be detectable on ammeters built into many chargers.

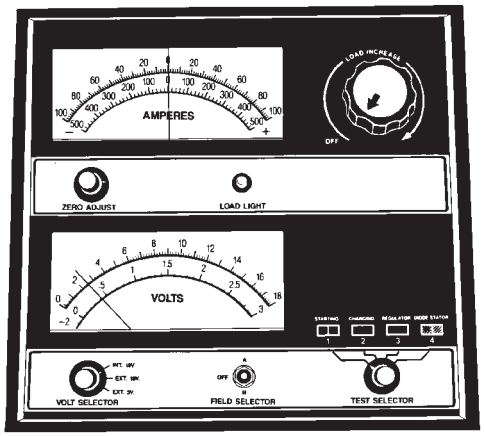

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Fig. 11 Voltmeter Accurate to 1/10 Volt Connected

(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, even though leads are connected properly. This makes it appear that battery will not accept charging current. Refer to instructions provided with battery charger being used.

(3) Battery chargers vary in the amount of voltage and current they provide. For time required for battery to accept measurable charger current at various voltages, refer to Charge Rate chart. If charge current is still not measurable at end of 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.

CHARGE RATE

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

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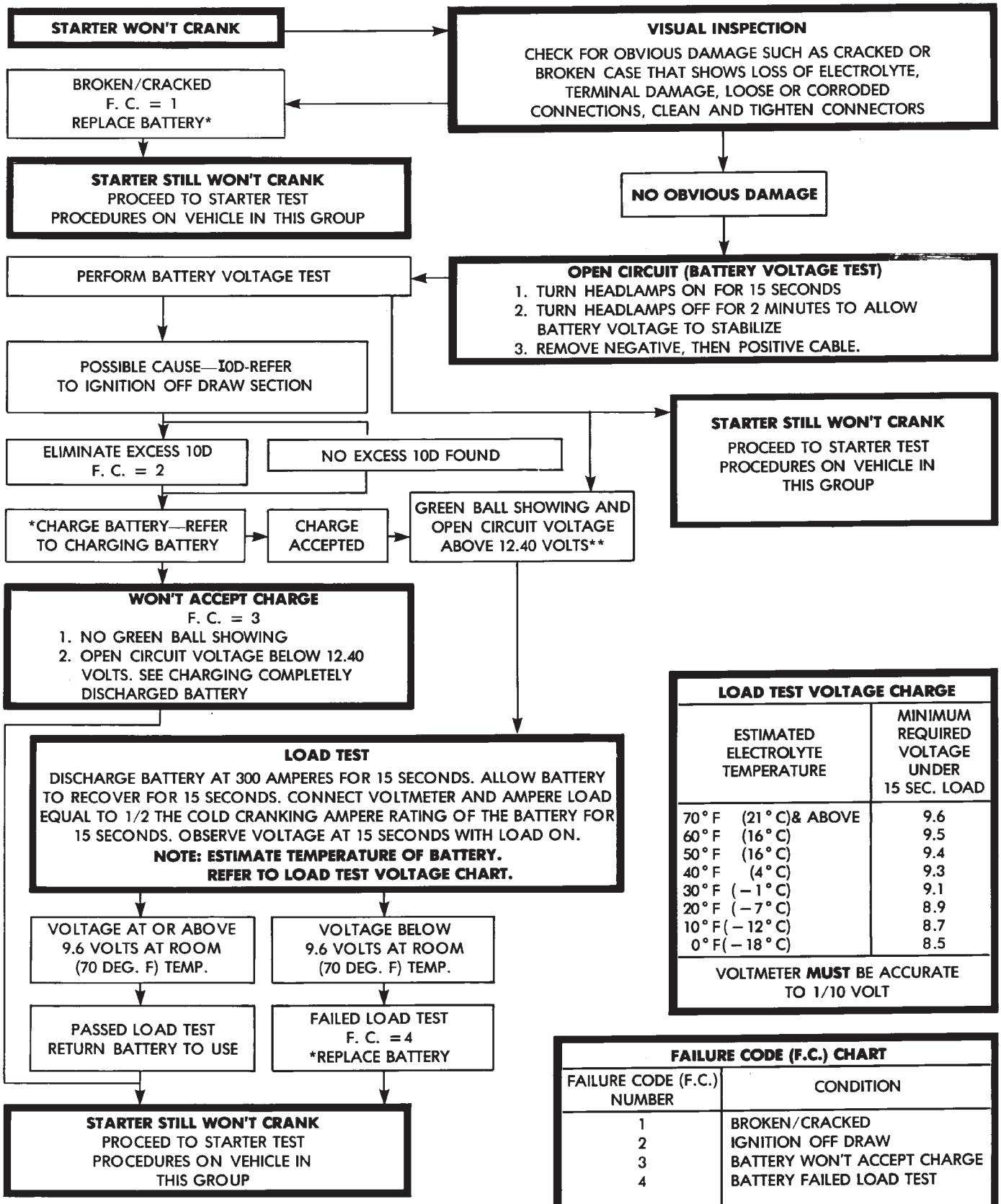
BATTERY DIAGNOSTICS CHART



LOAD TEST VOLTAGE CHARGE	
ESTIMATED ELECTROLYTE TEMPERATURE	MINIMUM REQUIRED VOLTAGE UNDER 15 SEC. LOAD
70° F (21° C)& ABOVE	9.6
60° F (16° C)	9.5
50° F (16° C)	9.4
40° F (4° C)	9.3
30° F (−1° C)	9.1
20° F (−7° C)	8.9
10° F (−12° C)	8.7
0° F (−18° C)	8.5
VOLTMETER **MUST** BE ACCURATE TO 1/10 VOLT	

FAILURE CODE (F.C.) CHART	
FAILURE CODE (F.C.) NUMBER	CONDITION
1	BROKEN/CRACKED
2	IGNITION OFF DRAW
3	BATTERY WON'T ACCEPT CHARGE
4	BATTERY FAILED LOAD TEST

NOTES: *AFTER CHARGING OR REPLACING A BATTERY, CHECK THE VEHICLE'S CHARGING SYSTEM, AND CLEAN AND TIGHTEN BATTERY CONNECTORS (REFER TO APPLICABLE SECTIONS OF THIS SERVICE MANUAL).

****CHECKING OPEN CIRCUIT VOLTAGE WILL MONITOR "GREEN BALL" INDICATION FOR ALL 6 CELLS.**

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IGNITION OFF DRAW (IOD)

Ignition off draw refers to power being drained from the battery with the ignition turned off. A normal vehicle electrical system will draw from 5 to 20 milliamps. This is with the ignition in the OFF position, and all non-ignition controlled circuits in proper working order. A vehicle that has not been operated for approximately 20 days, may discharge the battery to an inadequate level. Battery drain should not exceed approximately 20 MA (20 milliamps = 0.020 amps).

The 20 MA are needed to supply PCM memory, digital clock memory, ETR (electronically tuned radio) and Security Alarm memory.

Excessive battery drain is caused by items left turned on, internally shorted generator, or intermittent short in wiring.

If IOD is over 20 milliamperes, the defect must be found and corrected before replacing a battery. In most cases the battery can be charged and returned to service. See BATTERY CHARGING in this section.

TEST PROCEDURE

Testing for higher amperage IOD must be performed first to prevent damage to most milliamp meters.

(1) If the vehicle is equipped with a Security Alarm disconnect the Security Alarm relay that is located in the relay center under the glove box.

(2) Verify that all electrical accessories are OFF. Turn off all lights, remove ignition key, and close all doors. If the vehicle is equipped with electronic accessories (illuminated entry, high line radio), allow the systems to automatically shut off (time out), up to 3 minutes.

(3) After determining that the underhood lamp is operating properly then disconnect bulb.

(4) Disconnect negative cable from battery.

(5) Connect a typical 12 volt test light (low wattage bulb) between the negative cable clamp and the battery negative terminal. If equipped with security alarm, cycle the key in the door to turn off the flashing lights. Make sure that the doors remain closed so that illuminated entry is not activated.

The test light may light brightly for up to 3 minutes or may not light at all (depending on the electrical equipment). The term brightly being used throughout the following tests, implies the brightness of the test light will be the same as if it were connected across the battery.

The test light must be securely clamped to the negative cable and battery terminal. If the test light becomes disconnected during any of the IOD test, the electronic timer function will be activated and all tests must be repeated.

If the ammeter circuit is broken the Security alarm module will turn on parking lamps.

(6) After 3 minutes, the test light should turn OFF or be DIMLY lit (depending on the electrical equipment). If the test light remains brightly lit do not disconnect it. Remove each fuse or circuit breaker (refer to Group 8 - Wiring Diagrams) until test light is either OFF or DIMLY lit. This will eliminate the higher amperage draw.

If test light is still bright after disconnecting each fuse and circuit breaker, disconnect the wiring harness from the generator. Refer to Generator Testing in this group. Do not disconnect the test light.

After higher amperage IOD has been corrected, low amperage IOD may be checked.

It is now safe to install milliamp meter to check for low amperage IOD.

(7) With test light still connected securely clamp an ammeter between battery negative terminal and negative battery cable.

If the test light or the milliamp meter circuit is broken the Security alarm module will turn on parking lamps. Do not open any doors or turn on any electrical accessories with the test light disconnected or the meter may be damaged.

(8) Disconnect test light. The current draw should not exceed 0.020 amp. If it exceeds 0.020 milliamps isolate each circuit by removing circuit breakers and fuses. The meter reading drops once the high current problem is found. Repair this section of the circuit, whether it is a wiring short or component failure.

ENGINE STARTER MOTOR TEST PROCEDURES

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GENERAL INFORMATION

The starting system consists of an:

- ignition switch
- starter relay
- park/neutral position switch (automatic transmission)
- wiring harness
- battery
- starter motor with an integral solenoid.

These components form 2 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).

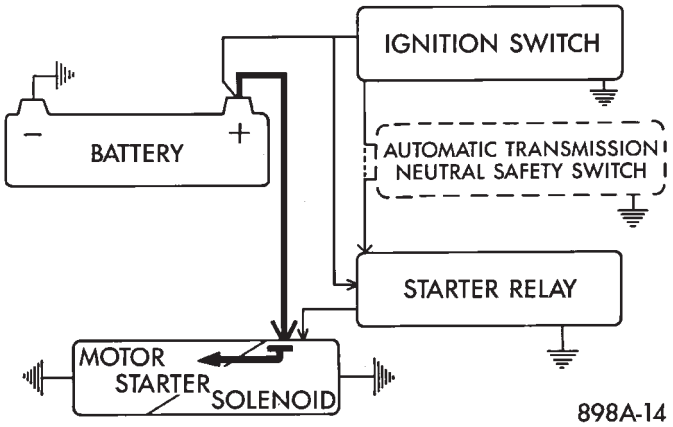

Fig. 1 Starting System Components

STARTER SYSTEM DIAGNOSTIC INSPECTIONS

Before removing any unit from the starter motor system for repair, perform the following inspections:

BATTERY INSPECTION

To determine condition of the battery, perform the testing procedure outlined in the Battery Section.

WIRING INSPECTION

Inspect wiring for damage. Inspect all connections at the starter motor solenoid, park/neutral position switch (if equipped), back-up lamp switch connector, ignition/start switch, and battery (including all ground connections). Clean and tighten all connections as required.

SOLENOID, RELAY AND IGNITION/START SWITCH INSPECTION

Inspect the solenoid, relay and switch to determine their condition. Also, if equipped with automatic transmission, inspect condition of the park/neutral position switch. Testing information can be found in the following pages.

If the following components are working properly remove the starter motor and follow procedures in the Testing Section.

- battery
- wiring
- switch
- solenoid
- relay
- park/neutral position switch

COLD CRANKING TEST

(1) Battery must first pass load and voltage drop tests and be fully charged before proceeding. Refer to Battery Test Procedures.

(2) Connect a suitable volt-ampere tester to the battery terminals (Fig. 2). Refer to the operating instructions provided with the tester being used.

(3) Fully engage parking brake, place manual transmission in NEUTRAL, automatic transmission in PARK.

(4) Verify that all lights and accessories are OFF.

(5) Remove coil secondary cable from distributor and connect to ground.

(6) Rotate and hold the ignition switch (key) in the START position. Note cranking voltage and amperage.

(a) If voltage reads above 9.6 volts and amperage draw reads above specifications, go to Starter Feed Circuit Tests.

(b) If voltage reads 12.5 volts or greater and amperate reads 0 to 10 amps, go to Starter Control Circuit Tests.

A cold engine will increase starter motor current.

STARTER FEED CIRCUIT TESTS - (VOLTAGE DROP METHOD)

The voltage drop tests will determine if there is excessive resistance in the high current circuit. When performing these tests, it is important that the volt-

STARTING SYSTEM DIAGNOSIS

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 ALTERNATOR DRIVE BELT TENSION.
- DISCONNECT AND GROUND COIL CABLE.

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

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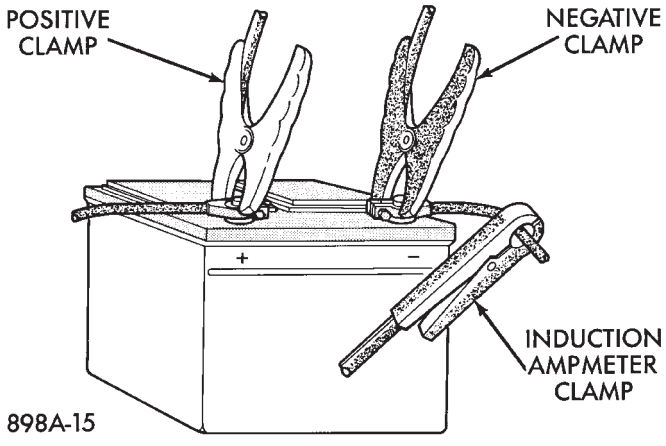


Fig. 2 Volt-Amps Tester Connections (Typical)

meter be connected to the terminals that the cables are connected to instead of to the cables themselves. For example, when testing between the battery and solenoid, touch the voltmeter test probes to the battery post and the solenoid threaded stud. The following operation will require a voltmeter, accurate to 1/10 of a volt.

Before performing the tests, assure the following procedures are accomplished:
- remove coil secondary cable from distributor and connect to ground
- transmission in NEUTRAL (manual transmission) or PARK (automatic transmission)
- parking brake applied
- battery is fully charged (refer to Battery Test Procedures).

(1) Connect positive lead of the voltmeter to the battery negative post. Connect negative lead to the battery negative cable clamp (Fig. 3). 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.

(2) Connect positive lead of voltmeter to the battery positive post. Connect negative lead to the battery cable positive clamp (Fig. 3). 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.

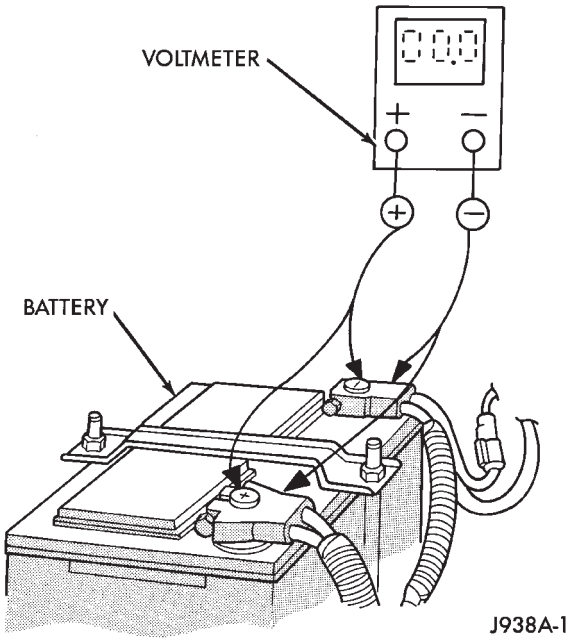


Fig. 3 Test Battery Connection Resistance

(3) Connect a voltmeter to measure between the battery positive post and the center of the B+ starter solenoid stud (Fig. 4).

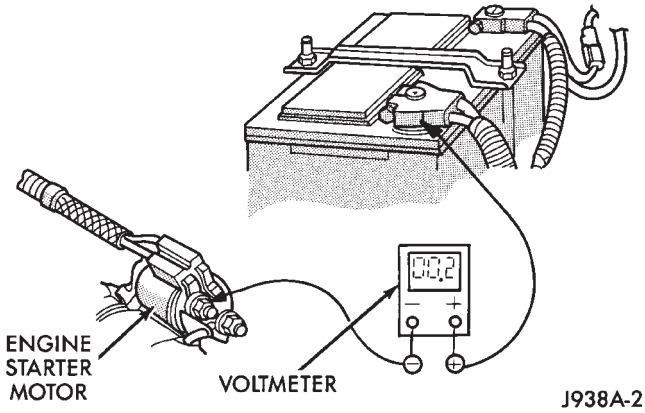


Fig. 4 Test Positive Battery Cable Resistance (Typical)

(4) Rotate and hold the ignition with (key) 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, replace positive battery cable.

(5) Connect the voltmeter to measure between the battery negative post and the engine block (Fig. 5).

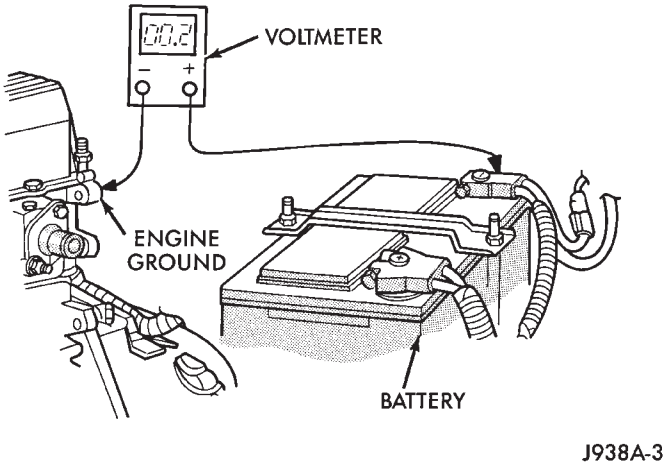


Fig. 5 Test Ground Circuit Resistance

(6) Rotate and hold the ignition with (key) in the START position. If voltage reads above 0.2 volt, correct poor contact at ground cable attaching point. Voltage reading still above 0.2 volt, replace ground cable.

(7) Connect positive voltmeter lead to the starter motor housing and the negative lead to the battery negative terminal (Fig. 6).

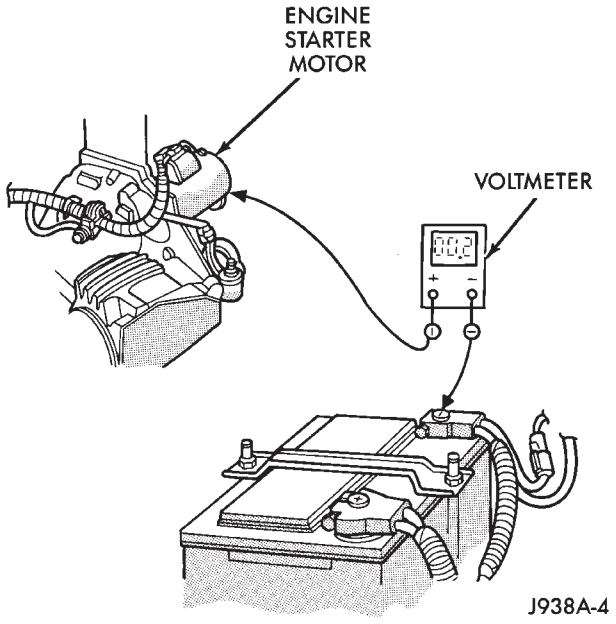


Fig. 6 Test Starter Motor Ground (Typical)

(8) Rotate and hold the ignition switch (key) in the START position. If voltage reads above 0.2 volt, correct poor starter to engine ground.

If resistance tests detect no feed circuit failures, remove the starter motor and go to Bench Testing Starter Solenoid.

STARTER CONTROL CIRCUIT TESTS

The starter control circuit consists of a:

- starter solenoid
- starter relay
- ignition switch
- park/neutral position switch (automatic transmission)
- all their wiring and connections.

Testing procedures for these components are as follows and should be followed in order as described.

CAUTION: Before performing any test disconnect distributor connector to prevent engine from starting.

SOLENOID TESTING

Refer to Group 8B - Battery Starter Service for starter removal procedures.

(1) Disconnect field coil wire from field coil terminal.

(2) Check for continuity between solenoid terminal and field coil terminal with a continuity tester. There should be continuity (Fig. 7).

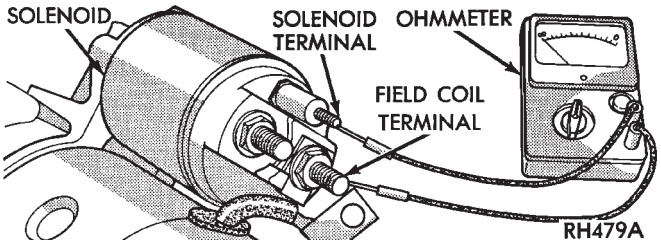


Fig. 7 Continuity Test Between Solenoid Terminal and Field Coil Terminal

(3) Check for continuity between solenoid terminal and solenoid housing. There should be continuity (Fig. 8).

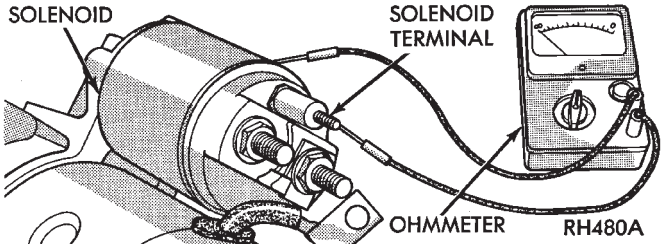


Fig. 8 Continuity Test Between Solenoid Terminal and Solenoid Case

(4) If there is continuity, solenoid is good. If there is no continuity in either test, solenoid has an open circuit and is defective. Replace starter motor.

(5) Install starter as described in Group 8B - Battery/Starter/Generator Service.

(6) Connect field coil wire to field coil terminal.

STARTER RELAY OPERATION/TESTING

The starter relay is in the Power Distribution Center (Fig. 9). Refer to the underside of the Power Distribution Cover for relay location.

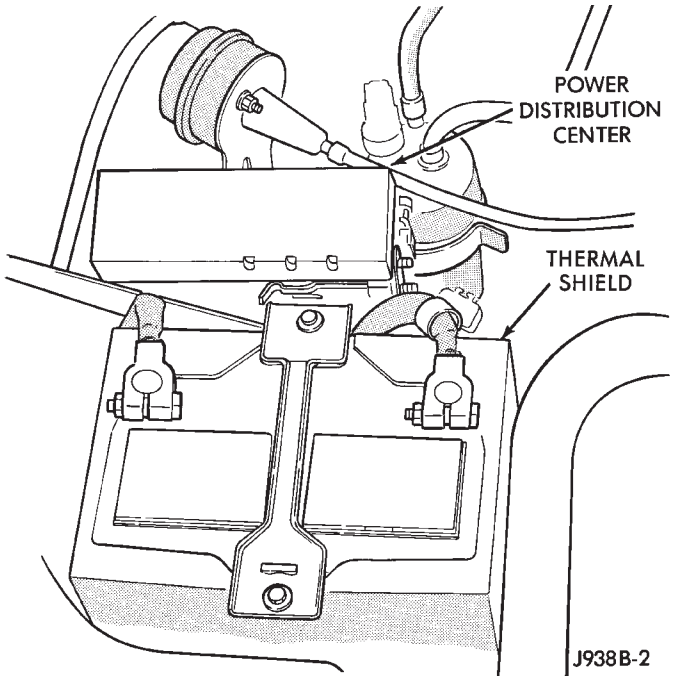
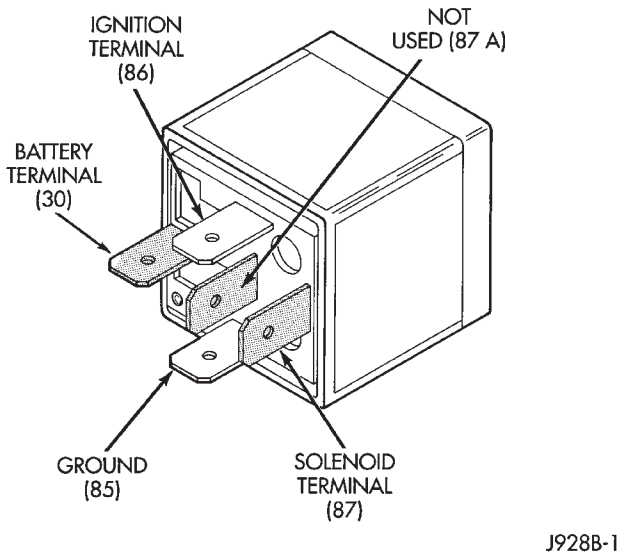


Fig. 9 Power Distribution Center

ENGINE STARTER RELAY CONNECTIONS



OPERATION

- The battery terminal (30) is usually connected to battery voltage and can be switched or B+ at all times.

• Terminal No. 87A is connected to terminal 30 in the de-energized position.
• The solenoid terminal (87) is connected to the battery terminal (30) in the energized position which supplies battery voltage to the operated device.
• The ignition terminal (86) is connected to the electromagnet and usually connected to a switched power source.
• The ground terminal (85) is connected to the electromagnet and is usually grounded by a switch or the PCM.

TESTING

Remove relay from the Power Distribution Center to perform the following tests.
• A relay in the de-energized position should have continuity between terminal 87A and terminal 30.
• Resistance value between terminals 85 and 86 (electromagnet) is 75 ±5 ohms.
• Connect a battery to terminals 85 and 86. There should be continuity between terminal 30 and 87.

IGNITION SWITCH TEST

After testing starter solenoid and relay and they check out okay, trouble is probably with ignition switch or its wiring.

Check all wiring for opens and shorts and connections for being loose or corroded.

PARK/NEUTRAL POSITION SWITCH

Refer to Group 21 - Transmissions for diagnostic information.

GENERATOR TEST PROCEDURES ON VEHICLE

INDEX

GENERAL INFORMATION

The generator is belt-driven by the engine. All engines use serpentine drive.

The amount of DC current produced by the generator is controlled by the Powertrain Control Module (PCM) (Fig. 1).

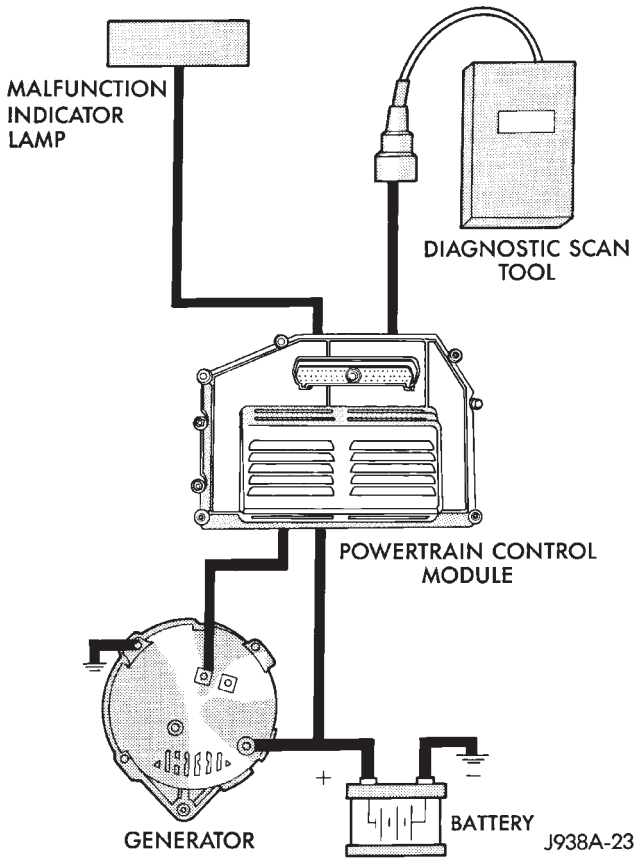


Fig. 1 Charging System Components (Typical)

All vehicles are equipped with On Board Diagnostics (OBD). All OBD sensing systems are monitored by the PCM. The PCM will store in electronic memory any detectable failure within the monitored circuits. Refer to USING ON-BOARD DIAGNOSTIC SYSTEM in this group for more information.

OPERATIONAL CHECK WITH BATTERY INDICATOR (BASE CLUSTER ONLY)

When operating normally, the indicator bulb will come on when the ignition switch is turned to the RUN or START position. After the engine starts, the indicator bulb goes off. With the engine running, the charge indicator should come on only when there is a problem in the charging system (base cluster only).

OPERATIONAL CHECK WITH VOLTMETER

When the ignition switch is turned to the RUN 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 RUN) should register.

DIAGNOSTIC PROCEDURES

If the indicator does not operate properly, or if an undercharged or overcharged battery condition occurs, the following procedures may be used to diagnose the charging system.

Remember that an undercharged battery is often caused by:

- accessories being left on overnight
- or by a defective switch

which allows a bulb, such as a trunk or glove box light, to stay on (refer to Ignition Off Draw).

VISUAL INSPECTION

- Inspect condition of battery cable terminals, battery posts, connections at engine block, starter motor solenoid and relay. They should be clean and tight. Repair as required.
- Inspect all fuses in the fuse block for tightness in receptacles. They should be properly installed and tight. Repair or replace as required.
- Inspect the electrolyte level in the battery and add water if necessary.
- Inspect generator mounting bolts for tightness. Replace or torque bolt as required (refer to Torque Specifications).
- Inspect generator drive belt condition and tension. Tension or replace belt as required. Refer to Belt Tension Specifications.

• Inspect connection at generator B+ output. It should be clean and tight. Repair as required.

OUTPUT WIRE RESISTANCE TEST

Generator output wire resistance test will show amount of Voltage Drop across generator output wire between generator BAT terminal and battery positive post.

PREPARATION

(1) Before starting test make sure vehicle has a fully charged battery. Test and procedures on how to check for a fully charged battery are shown in Battery section of this Group.

(2) Turn OFF ignition switch.

(3) Disconnect negative cable from the battery.

(4) Disconnect generator output wire from generator output Battery terminal.

(5) Connect a 0-150 ampere scale D.C. ammeter in series between generator BAT terminal and disconnected generator output wire (Fig. 2). Connect Positive lead to generator BAT terminal and Negative lead to disconnected generator output wire.

(6) Connect Positive lead of a test voltmeter (Range 0-18 volts minimum) to disconnected generator output wire. Connect negative lead of test voltmeter to battery positive cable at positive post.

(7) Connect one end of a Jumper Wire to ground and with other end probe green K20 lead wire at back of generator (Fig. 2). (This will generate a DTC).

CAUTION: Do not connect dark green/black A61 lead of wiring to ground. Refer to Group 8W - Wiring Diagrams for more information.

(8) Connect an engine tachometer and connect negative cable to battery.

(9) Connect a variable carbon pile rheostat between battery terminals. Be sure carbon pile is in "Open" or "Off" position before connecting leads. See Battery Section, Load Testing for instructions.

TEST

(1) Start engine. Immediately after starting, reduce engine speed to idle.

(2) Adjust engine speed and carbon pile to maintain 20 amperes flowing in circuit. Observe voltmeter reading. Voltmeter reading should not exceed 0.5 volts.

RESULTS

If a higher voltage drop is indicated, inspect, clean and tighten all connections between generator BAT terminal and battery Positive post. A voltage drop test may be performed at each connection to locate connection with excessive resistance. If resistance tested satisfactorily, reduce engine speed, turn off carbon pile and turn off ignition switch.

(1) Disconnect negative cable from battery.

(2) Remove test ammeter, voltmeter, carbon pile, and tachometer.

(3) Remove "Jumper Wire".

(4) Connect generator output wire to generator BAT terminal post. Tighten to 5 to 6 N•m (45 to 75 in. lbs.).

(5) Connect negative cable to battery.

(6) Use DRB II scan tool to erase DTC.

CURRENT OUTPUT TEST

Generator output test determines whether generator can deliver its rated current output.

PREPARATION

(1) Before starting any tests make sure vehicle has a fully charged battery. Test and procedures on how to check for a fully charged battery are shown in Battery section of this Group.

(2) Disconnect negative cable from battery.

(3) Disconnect generator output wire at the generator battery terminal.

(4) Connect a 0-150 ampere scale D.C. ammeter in series between generator BAT terminal and disconnected generator output wire (Fig. 3). Connect Positive lead to generator BAT terminal and negative lead to disconnected generator output wire.

(5) Connect positive lead of a test voltmeter (range 0-18 volts minimum) to generator BAT terminal.

(6) Connect negative lead of test voltmeter to a good ground.

(7) Connect an engine tachometer and connect battery negative cable.

(8) Connect a variable carbon pile rheostat between battery terminals. Be sure carbon pile is in OPEN or OFF position before connecting leads. See Battery section, Load Testing for instructions.

(9) Connect one end of a Jumper Wire to ground and with other end probe green K20 lead wire at back of generator (Fig. 3). (This will generate a DTC).

CAUTION: Do not connect dark green/black A61 lead of wiring to ground. Refer to Group 8W - Wiring Diagrams for more information.

TEST

(1) Start engine. Immediately after starting reduce engine speed to idle.

(2) Adjust carbon pile and engine speed in increments until a speed of 1250 rpm and voltmeter reading of 15 volts is obtained.

CAUTION: Do not allow voltage meter to read above 16 volts.

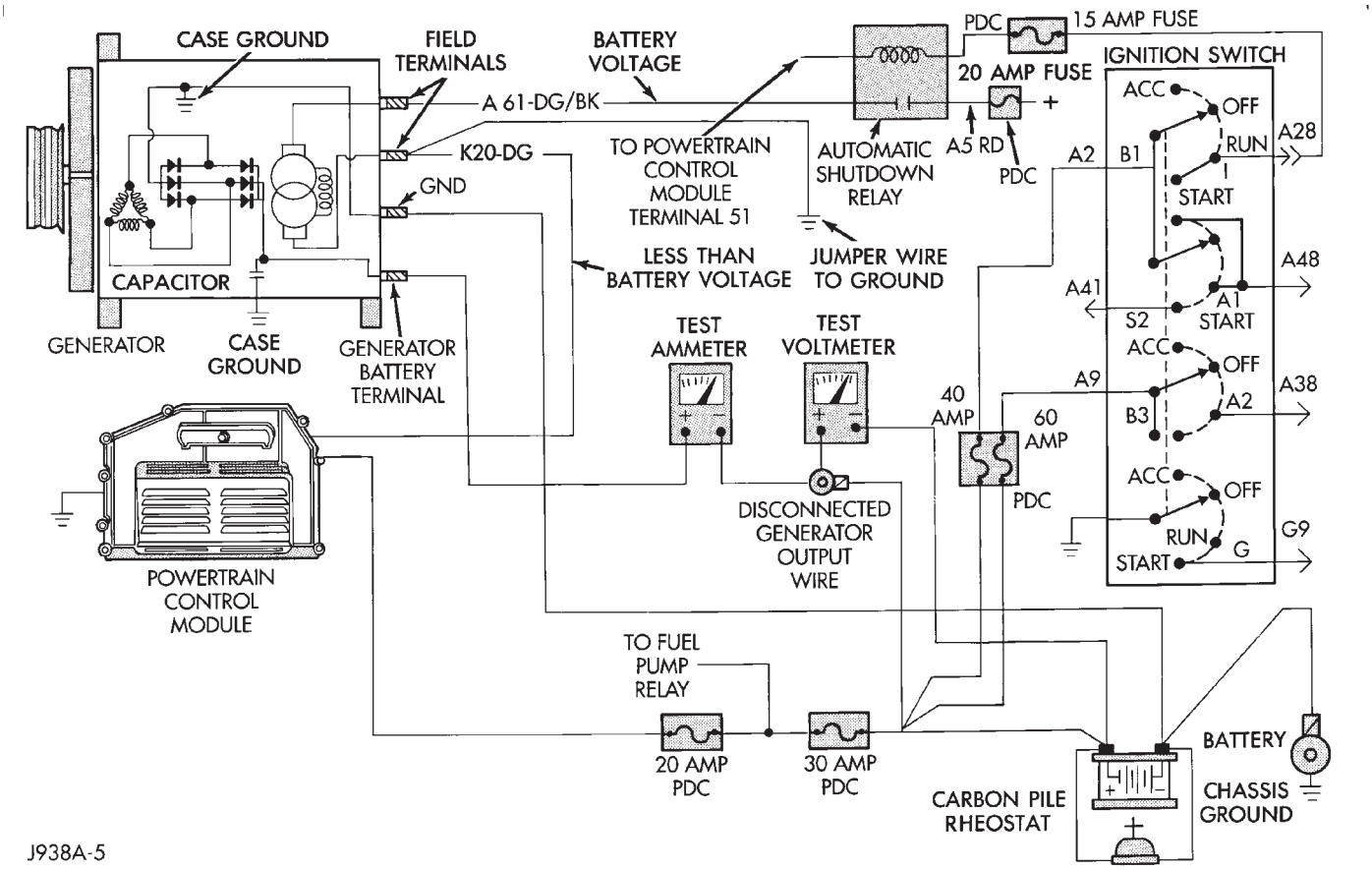


Fig. 2 Generator Output Wire Resistance Test (Typical)

(3) The ammeter reading must be within limits shown in generator specifications in back of this group.

RESULTS

(1) If reading is less than specified and generator output wire resistance is not excessive, generator should be replaced; refer to Group 8C - Generator Service for information.

(2) After current output test is completed reduce engine speed, turn off carbon pile and turn off ignition switch.

(3) Disconnect negative cable from battery.

(4) Remove test ammeter, voltmeter, tachometer and carbon pile.

(5) Remove Jumper Wire (Fig. 3).

(6) Connect generator output wire to generator BAT terminal post. Tighten nut to 8.5±1.5 N•m (75±15 in. lbs.).

(7) Connect negative cable to battery.

(8) Use DRB II scan tool to erase DTC.

USING ON-BOARD DIAGNOSTIC SYSTEM

OPERATION OF ON-BOARD DIAGNOSTIC (OBD) SYSTEM

The Powertrain Control Module monitors critical input and output circuits of the charging system making sure they are okay. Some are checked continuously and some are checked only under certain conditions.

If the OBD system senses that one critical circuit is bad, it will consider this a real problem and put a DTC into memory. Each input and output circuit monitored by the OBD system has its own DTC. The DTC will stay in memory as long as the circuit continues to be bad. If the problem does not happen again after the DTC is put into memory, the Powertrain Control Module will clear the memory after 50 to 100 engine starts.

DIAGNOSTIC TROUBLE CODES

Diagnostic trouble codes are two-digit numbers flashed on Malfunction Indicator lamp that identify which circuit is bad. In most cases they do not identify which component in a circuit is bad. A DTC description can be read using the DRB II scan tool. Refer to Group 14 - Fuel Systems for more information. Therefore, a DTC is only a result, not necessarily the reason for the problem. In some cases, because of the design of the driveability test procedure, a DTC can be the reason for the problem. It is important that the test procedure be followed to understand what the DTC of the on-board diagnostic system are trying to tell.

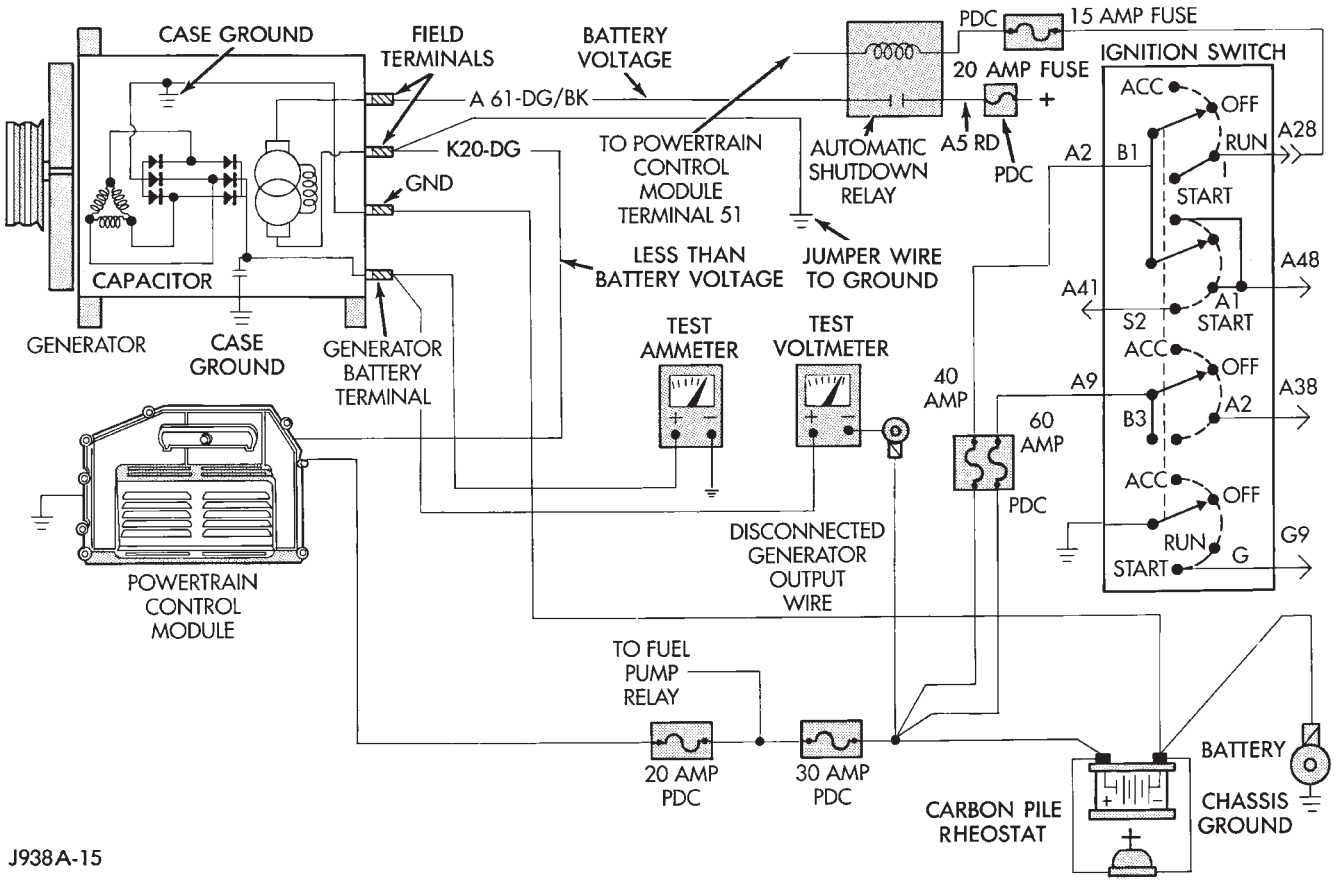


Fig. 3 Generator Current Output Test (Typical)

HOW TO USE MALFUNCTION INDICATOR LAMP FOR DIAGNOSTIC TROUBLE CODES

To start this function, cycle the ignition switch on-off-on-off-on within 5 seconds. This will allow any fault stored in the Powertrain Control Module to be displayed. The Malfunction Indicator lamp will display a DTC by flashing on and off. There is a short pause between flashes and a longer pause between digits. All codes displayed are two digit numbers with a four second pause between codes.

An example of a code is as follows:

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

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

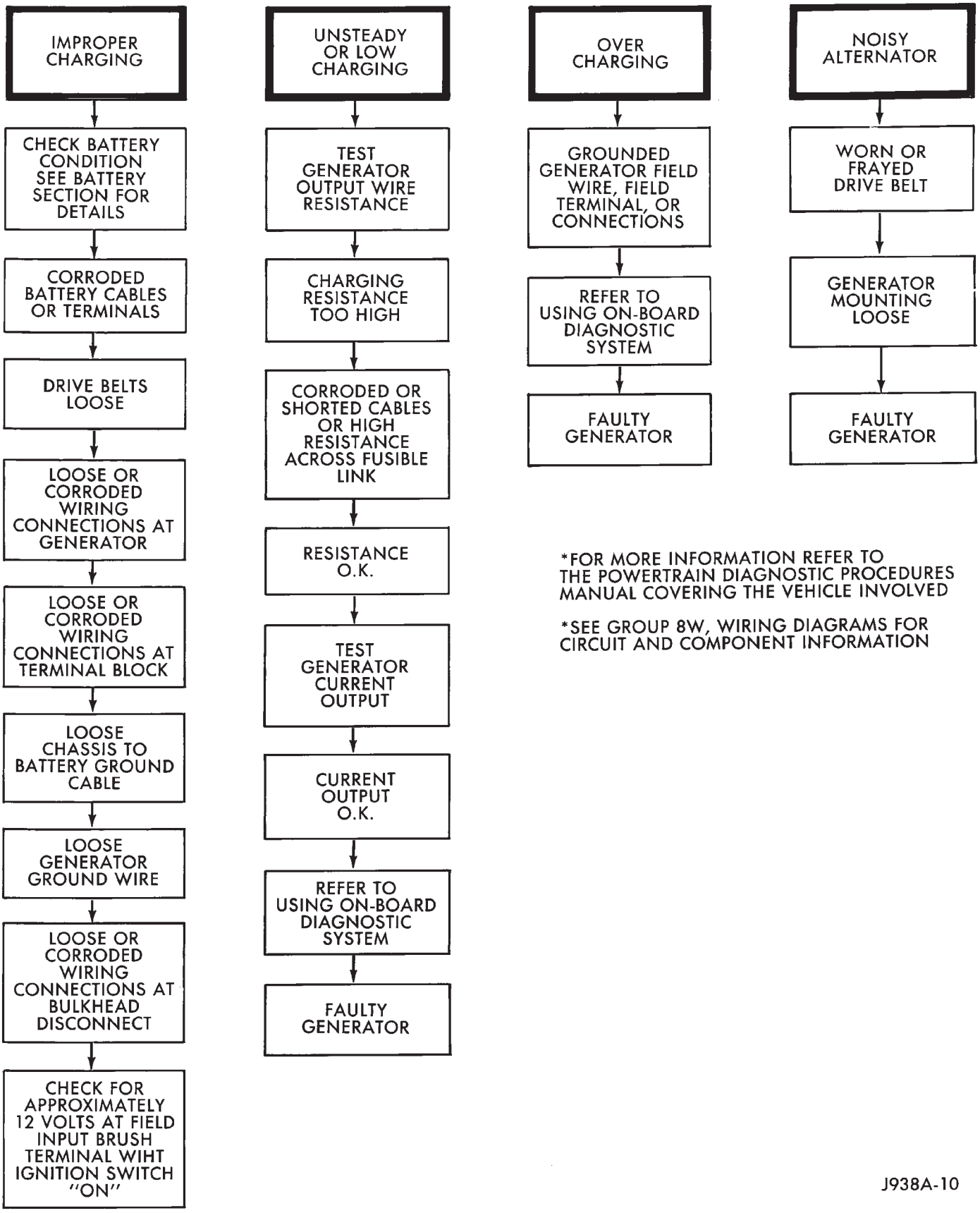
(3) Lamp pauses for 4 seconds, flashes 4 times, pauses and then flashes 7 times.

The two codes are 41 and 47. Any number of codes can be displayed as long as they are in memory. The lamp will flash until all are displayed (55 = End of test).

CHARGING SYSTEM DIAGNOSTIC TROUBLE CODES

See Generator Diagnostic Trouble Code Chart for DTC which apply to the charging system. Refer to the Powertrain Diagnostic Procedures Manual to diagnose an On-Board Diagnostic System, Diagnostic Trouble Code.

CHARGING SYSTEM DIAGNOSTICS



*FOR MORE INFORMATION REFER TO THE POWERTRAIN DIAGNOSTIC PROCEDURES MANUAL COVERING THE VEHICLE INVOLVED

*SEE GROUP 8W, WIRING DIAGRAMS FOR CIRCUIT AND COMPONENT INFORMATION

J938A-10

GENERATOR DIAGNOSTIC TROUBLE CODE (DTC)

DTC	Type	Malfunction Indicator Lamp	Circuit	When Monitored By the Logic Module	When Put Into Memory	Actuator Test	Sensor Read Test
41	Fault	Yes	Generator Field Control (Charging System)	All the time when the ignition switch is on.	An open or shorted condition in the generator field control circuit.	Yes	None
46	Fault	Yes	Charging System Voltage	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.	None	Yes
47	Fault	Yes	Charging System Voltage	Engine rpm above 1,500 rpm	Battery voltage 1 volt less than set point during engine operation and no change in voltage during internal PCM test performed on generator field.	None	Yes

J938A-20

SPECIFICATIONS

BATTERY CLASSIFICATIONS AND RATINGS

Group Size	Cold Crank AMPS	Reserve Capacity (Min.)	Engine
34	600	120	ALL

J938A-11

GENERATOR OUTPUT VOLTAGE SPECIFICATIONS

Ambient Temperature °C (°F)	Acceptable Voltage Range
−40 to −6.7 (−40 to 20)	14.5 to 15.0
−6.7 to 26.7 (20 to 80)	13.87 to 15.0
26.7 to 60 (80 to 140)	13.25 to 14.37
60 to 71.1 (140 to 160)	13.25 to 13.75

J918C-13

Type	Part Number	Engine	Rating
Nippondenso	56005685	4.0L,5.2L	90 Amps

J938B-17

4.0L ENGINE

TORQUE SPECIFICATIONS

COMPONENT	TORQUE	
Generator Mounting Bolts	38 N•m (28 ft. lbs.)	
Power Steering Pump (or Idler Pulley) Mounting Bolts	27 N•m (30 ft. lbs.)	
Belt Tension	New Belt 800-900	N (lbs-f) (180-200)
	Used Belt 623-712	N (lbs-f) (140-160)

J938B-11

TORQUE SPECIFICATIONS

Description	Torque
Battery Strap Screw	10 N•m (90 in. lbs.)
Battery Tray Screw	10 N•m (90 in. lbs.)

J938A-14

ENGINE STARTER MOTOR AND SOLENOID TESTING SPECIFICATIONS

Description	Specifications @ 20 °C (68 °F)
No Load Test With 11.2 volts Max. Amps Min. RPM	 90 2500
Solenoid Hold-in Winding Voltage	3.5 Min.
Pull-in Winding Voltage	7.8 Max.

J928B-25

ENGINE STARTER MOTOR COLD CRANKING SPECIFICATIONS

Battery Test Voltage	12.5 Volts
Cold Cranking Voltage (Minimum)	9.6 Volts
Cold Cranking Amps	130 Amps

J918B-17

5.2L ENGINE

REDUCTION GEAR STARTER

Manufacturer	Nippondenso
Engine Application	5.2L
Part Number and Power Rating	56004934 1.4 Kw
Voltage	12
No. of Fields	4
No. of Poles	4
Brushes	4
Drive	Reduction Gear Train
Free Running Test Voltage Amperage Draw Minimum Speed RPM	 11 73 Amps 3601 RPM
Solenoid Closing Voltage	7.5 Volts
Cranking Amperage Draw Test	125-200 Amps*

*Engine should be up to operating temperature. Extremely heavy oil or tight engine will increase starter amperage draw.

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