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 lamp 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.

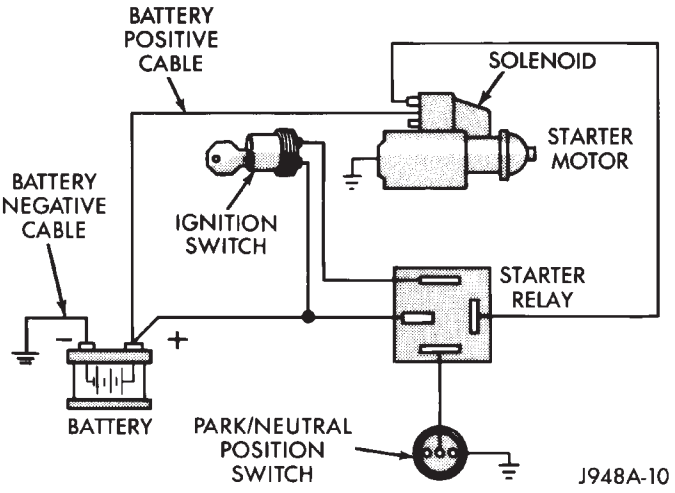

Fig. 1 Starting System Components (Typical)

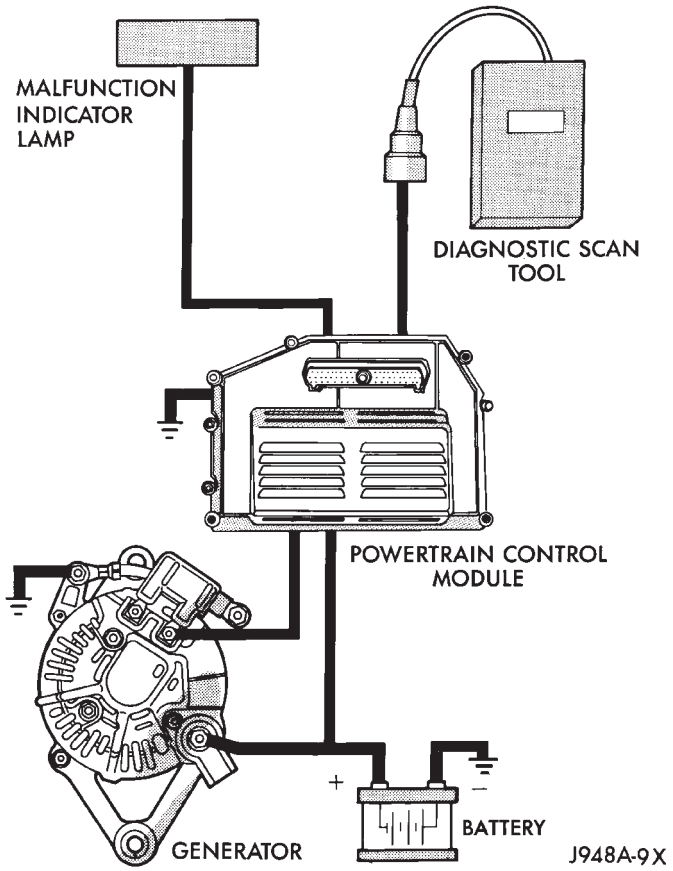

Fig. 2 Charging System Components

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 output over an extended period. A chemical reaction occurs between the sulfuric acid solution (electrolyte) and the lead +/− plates in each cell of the battery. As the battery discharges, the plates collect the 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. 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.

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

When the electrolyte level is below the top of the plates distilled water should be added. The battery must be completely charged. The top, posts, and terminals should be properly cleaned before diagnostic procedures are performed. See Group 8B - Battery/Starter/Generator Service, for additional information.

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% of the electrolyte by weight, or 24% by volume.

The condition of a battery may be determined from the results of 2 tests:

- hydrometer test
- ability to supply current (battery load test)

Perform the hydrometer test first. If the specific gravity is less than 1.235, (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 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.

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 Diagnosis in this group.

(6) Defective charging system.

(7) Defective battery.

HYDROMETER TEST

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

Before testing, visually inspect battery for any 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, and cell variation is more than 50 points (0.050), it is an indication that the battery is unserviceable.

If the specific gravity of one or more cells is less than 1.235, charge the battery at a rate of approximately 5 amperes. Continue charging until 3 consecutive specific gravity tests, taken at 1 hour intervals, are constant.

If the cell specific gravity variation is more than 50 points (0.050) after 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.

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/Generator 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 headlamps on for 15 seconds then allow up to 5 minutes for voltage to stabilize.

(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. 3).

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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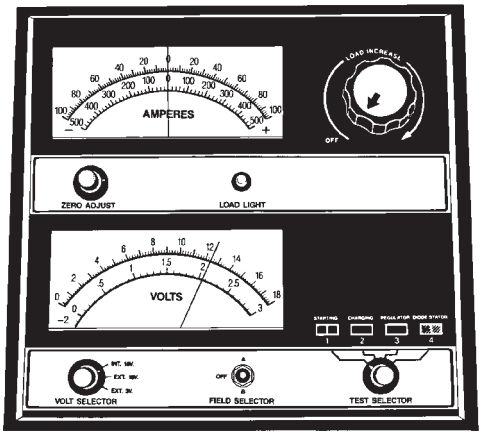

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Fig. 3 Testing Open Circuit Voltage

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 amperage 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.

(2) Connect a suitable volt-ammeter-load tester (Fig. 4) to the battery posts (Fig. 5). 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. 5).

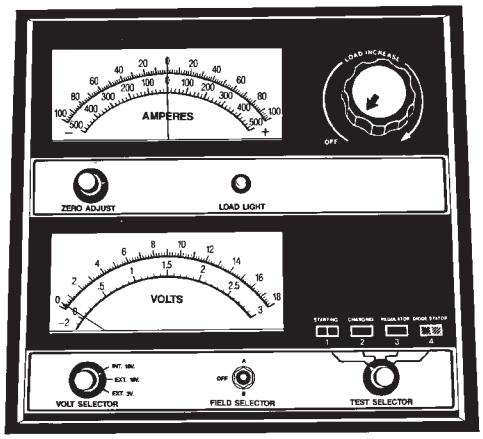

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Fig. 4 Volt-Amps-Load Tester (Typical)

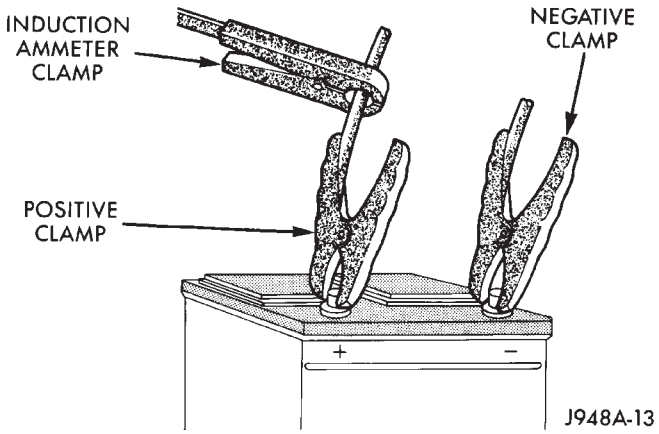

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Fig. 5 Volt-Ammeter-Load Tester Connections

(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. 6). This will remove the surface charge from the 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 amperage rating—see Specifications) for a minimum of 15 seconds (Fig. 7). After 15 seconds, record the (loaded) voltage reading and return the load control knob 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 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.

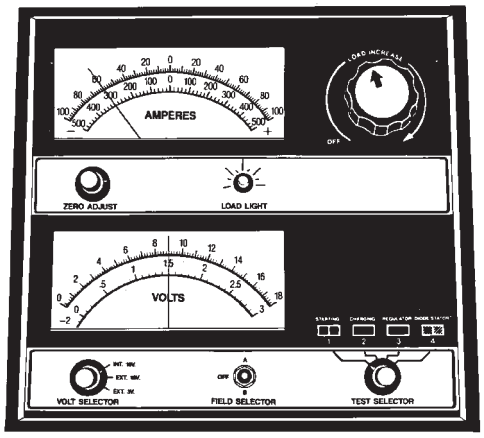

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Fig. 6 Remove Surface Charge from Battery

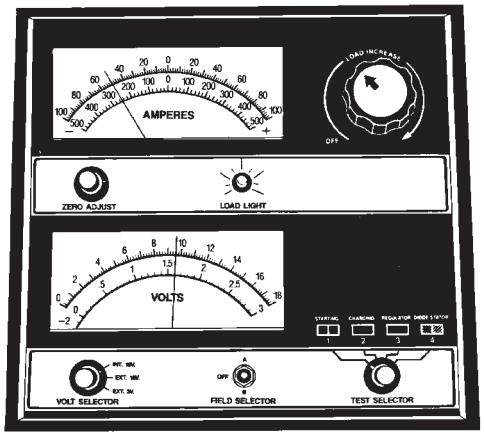

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Fig. 7 Load 50% Cold Crank Rating Note Voltage

(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 crank amperage rating at 21°C (70°F).

An open circuit voltage of 12.4 volts or greater, indicates battery is charged enough for further testing and possible return to use.

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: Always disconnect the 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 and evaluate 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.

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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After the battery has been charged to 12.4 volts or greater, 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 holddowns, 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 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. 8). 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.

(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.

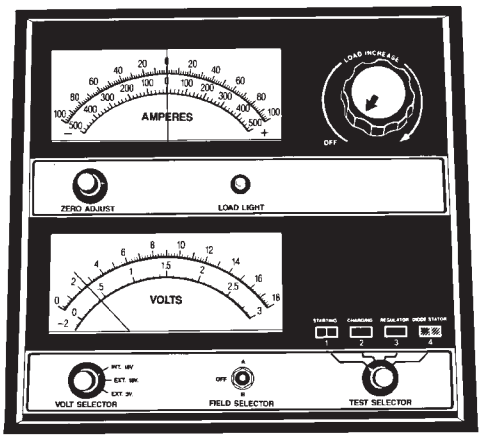

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Fig. 8 Voltmeter Accurate to 1/10 Volt Connected

(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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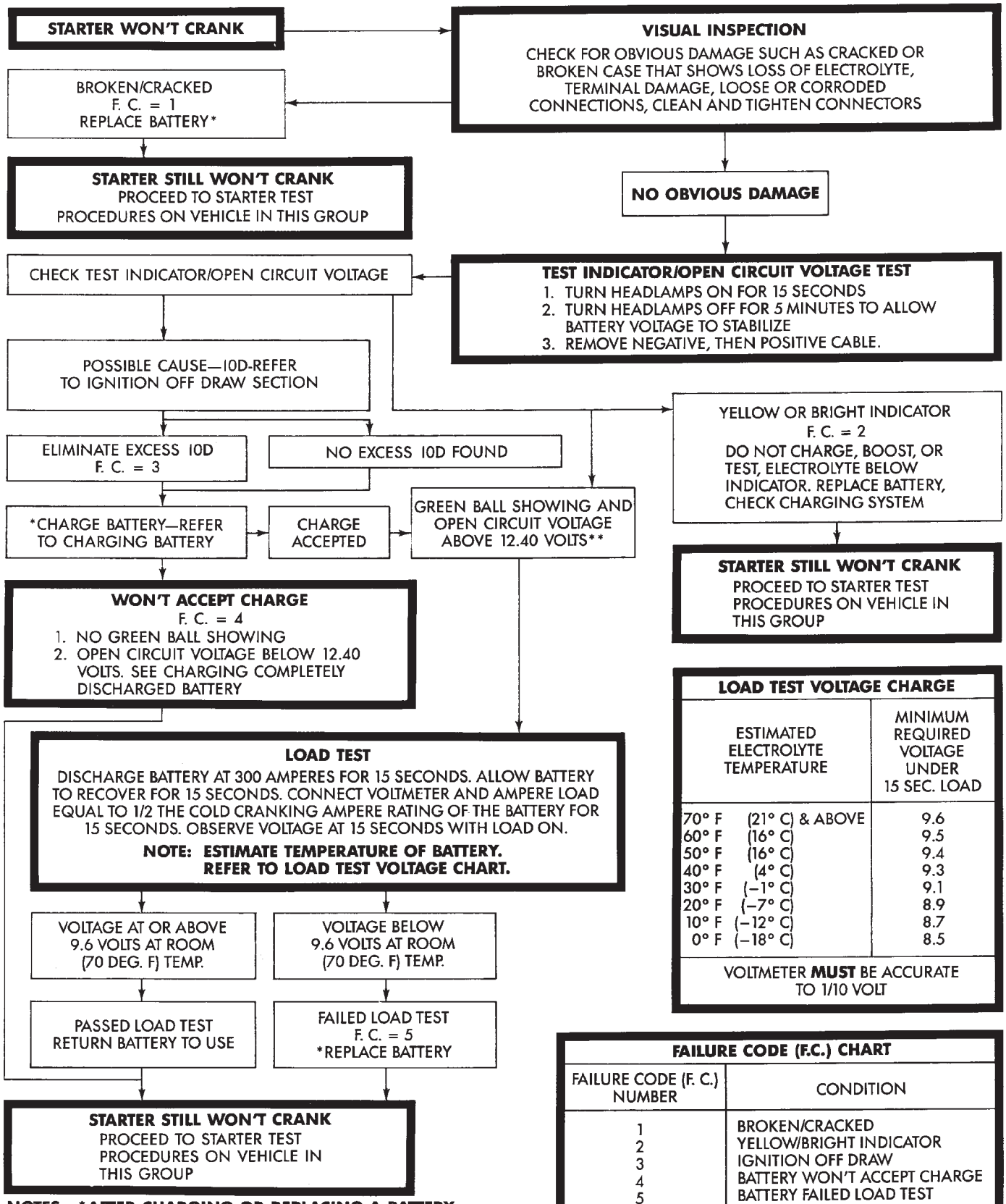
BATTERY DIAGNOSTICS CHART

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	YELLOW/BRIGHT INDICATOR
3	IGNITION OFF DRAW
4	BATTERY WON'T ACCEPT CHARGE
5	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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SPECIFICATIONS

BATTERY CLASSIFICATIONS AND RATINGS

Group Size	Cold Crank AMPS	Reserve Capacity (Min.)	Engine	Vehicle Series
58	430	80	2.5L & 4.0L	All
58	500	85	2.5L, 4.0L	All

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TORQUE SPECIFICATIONS

Description	Torque
Battery Strap Screw	2 N•m (20 in. lbs.)
Battery Tray Nut	2 N•m (20 in. lbs.)
Battery Clamp Nut	2 N•m (20 in. lbs.)

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IGNITION OFF DRAW (IOD) DIAGNOSIS

GENERAL INFORMATION

Ignition off draw refers to power being drained from the battery with the ignition switch turned off. A normal vehicle electrical system will draw from 5 to 20 milliamps. This is with the ignition switch 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, and ETR (electronically tuned radio) memory.

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

If the 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.

When a vehicle will not be used for 20 days or more (stored), remove IOD fuse in the Power Distribution Center to reduce battery discharging.

TEST PROCEDURE

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

(1) Verify that all electrical accessories are OFF. Turn off all lamps, 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.

(2) Determine that the underhood lamp is operating properly, then disconnect or remove bulb.

(3) Disconnect negative cable from battery.

(4) Connect a typical 12-volt test lamp (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 lamp 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 lamp will be the same as if it were connected across the battery.

The test lamp must be securely clamped to the negative cable and battery terminal. If the test lamp becomes disconnected during any part 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.

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

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

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.

(6) With test lamp still connected securely, clamp an ammeter between battery negative terminal and negative battery cable.

Do not open any doors or turn on any electrical accessories with the test lamp disconnected or the meter may be damaged.

(7) Disconnect test lamp. 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 ON VEHICLE

INDEX

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.

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 Battery Test Procedures.

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 switch, starter relay, and battery (including all ground connections). Clean and tighten all connections as required.

SOLENOID, RELAY AND IGNITION 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.

STARTING SYSTEM 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. 1). 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 lamps and accessories are OFF.

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

(6) Rotate and hold the ignition switch 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 amperage reads below specifications, go to Starter Control Circuit Tests.

A cold engine will increase starter motor current and reduce battery voltage.

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 voltmeter 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).

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 GENERATOR 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			STARTER IMPROPERLY MOUNTED
STARTER ASSEMBLY FAULTY		REFER TO APPROPRIATE GROUP AND SECTION OF THIS MANUAL FOR PROPER SERVICE AND TEST PROCEDURES FOR THE COMPONENTS INVOLVED		

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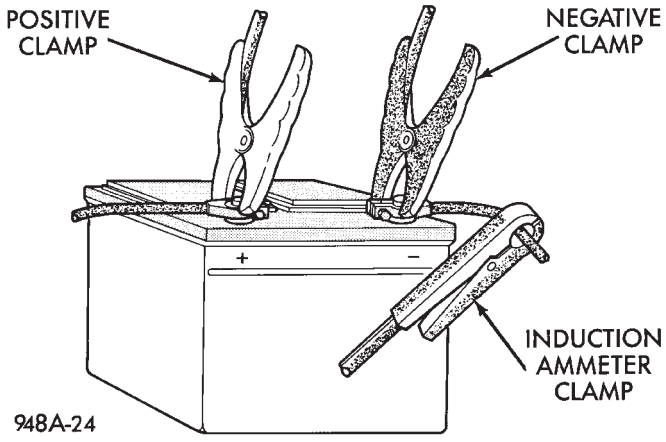


Fig. 1 Volt-Amps Tester Connections (Typical)

(1) Connect positive lead of voltmeter to battery negative post. Connect negative voltmeter lead to battery negative cable clamp (Fig. 2). Rotate and hold ignition switch in the START position. Observe voltmeter. If voltage is detected, correct poor contact between cable clamp and post.

(2) Connect positive lead of voltmeter to battery positive post. Connect negative lead to battery cable positive clamp (Fig. 2). Rotate and hold ignition switch in the START position. Observe voltmeter. If voltage is detected, correct poor contact between cable clamp and post.

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

(4) Rotate and hold ignition switch in the START position. If voltage reads above 0.2 volt, correct poor

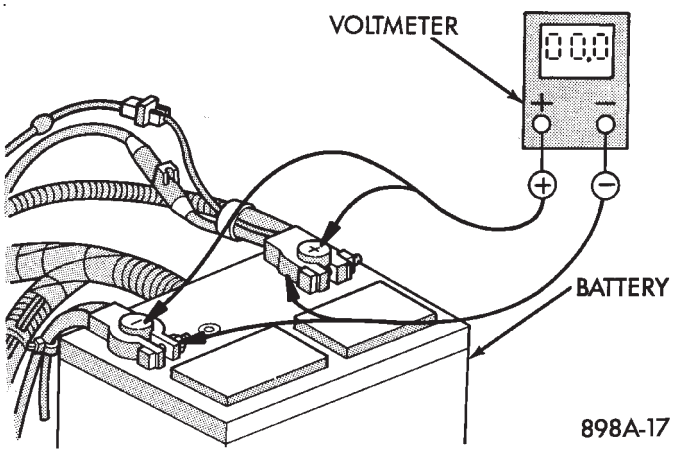


Fig. 2 Test Battery Connection Resistance

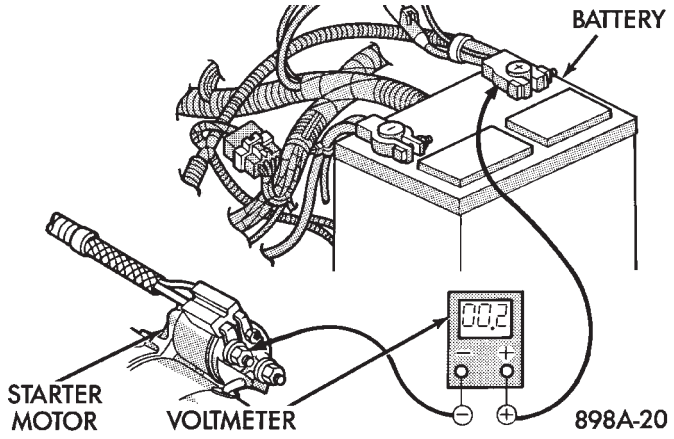


Fig. 3 Test Positive Battery Cable Resistance (Typical)

contact at battery cable to solenoid connection. If reading is still above 0.2 volt, replace positive battery cable.

(5) Connect voltmeter to measure between the battery negative post and the engine block (Fig. 4).

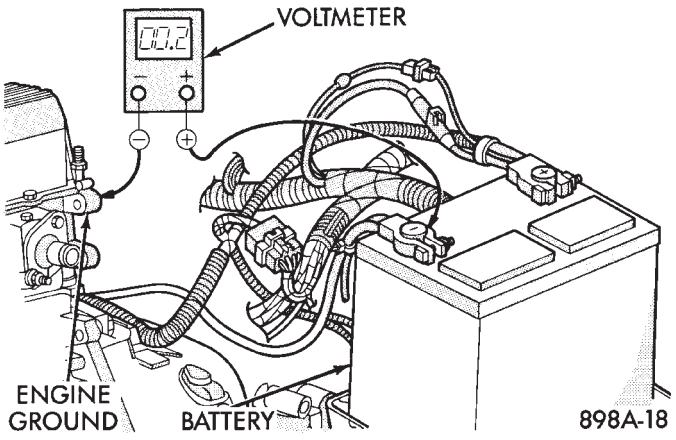


Fig. 4 Test Ground Circuit Resistance

(6) Rotate and hold ignition switch 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 starter motor housing. Connect negative lead to battery negative terminal (Fig. 5).

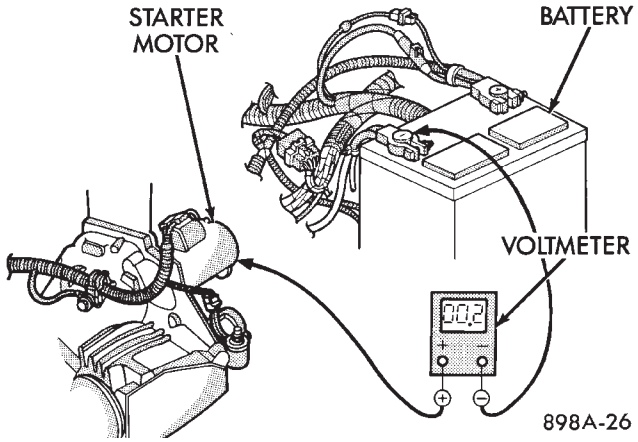


Fig. 5 Test Starter Motor Ground (Typical)

(8) Rotate and hold ignition switch 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 Solenoid Testing.

STARTER CONTROL CIRCUIT TESTS

The starter control circuit consists of a starter solenoid, starter relay, ignition switch, park/neutral position switch (automatic transmission), and 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/Generator 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. 6).

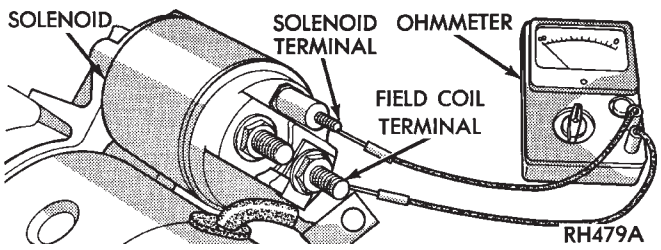


Fig. 6 Continuity Test Between Solenoid Terminal and Field Coil Terminal

(3) Check for continuity between solenoid terminal and solenoid housing. There should be continuity (Fig. 7).

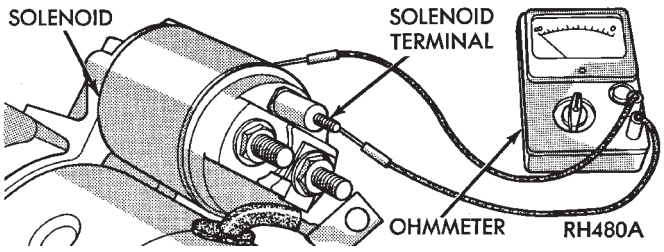


Fig. 7 Continuity Test Between Solenoid Terminal and Solenoid Case

(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.

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

STARTER RELAY OPERATION/TESTING

The starter relay is in the Power Distribution Center (Figs. 8 and 9). Refer to the underside of the Power Distribution Center cover for relay location.

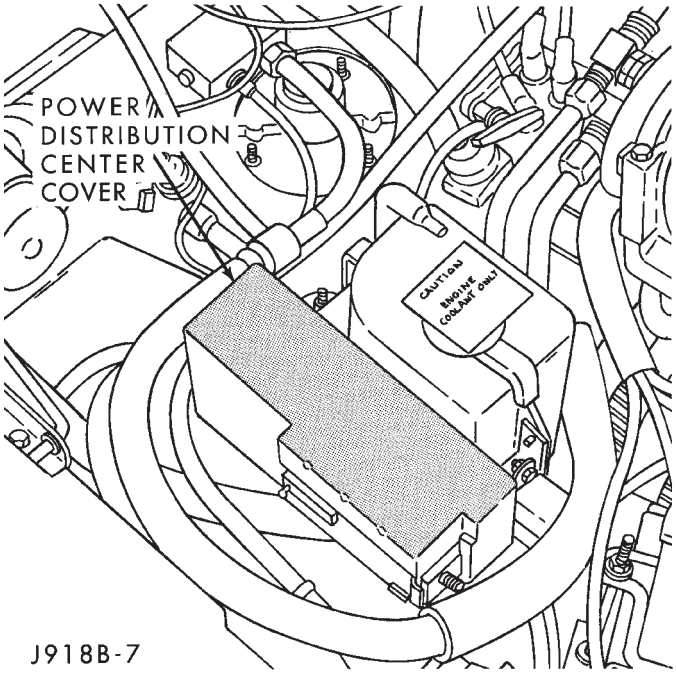


Fig. 8 Power Distribution Center—XJ

OPERATION

- Terminal No. 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.
- Terminal No. 87 is connected to terminal 30 in the energized position which supplies battery voltage to the operated device.
- Terminal No. 86 is connected to the electromagnet and usually connected to a switched power source.

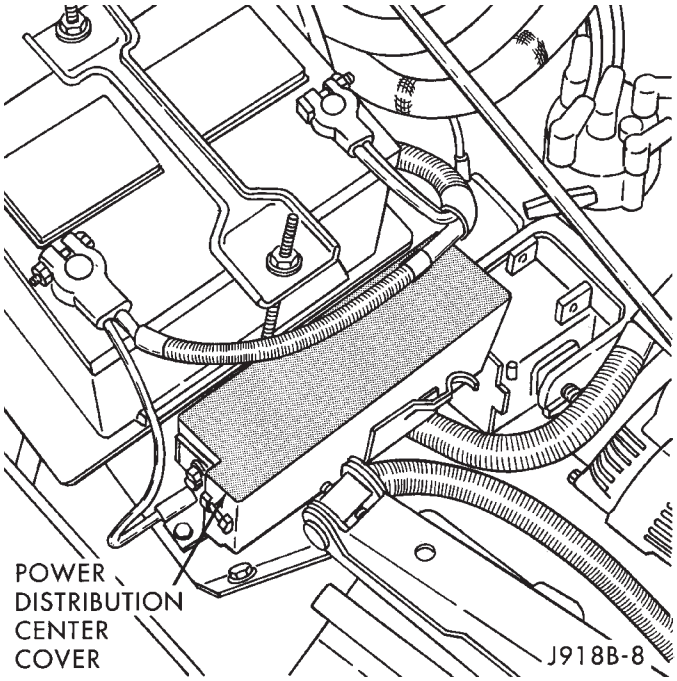
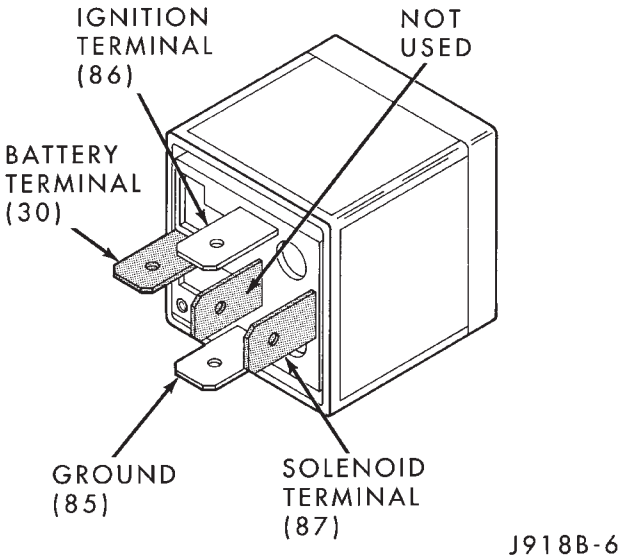


Fig. 9 Power Distribution Center—YJ

STARTER RELAY CONNECTIONS



- Terminal No. 85 is connected to the electromagnet and is usually grounded by a switch or Powertrain Control Module.

TESTING

Remove relay from 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 OK, 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.

2.5L STARTER MOTOR NOISE DIAGNOSIS

If the complaint is similar to Conditions No. 1 and No. 2 of chart below, correction can be achieved by proper "shimming" according to the following procedures:

- Disconnect the battery negative cable (to prevent inadvertent starting of engine).

Two shim thicknesses are available. One is 0.381 mm (0.015 in.) and the other is 1.143 mm (0.045 in.).

If the complaint is similar to Condition No. 1, the starter motor must be moved toward the flywheel/driveplate using thinner shims (Fig. 10).

This is generally a condition that causes broken flywheel/driveplate ring gear teeth or broken starter motor housings.

If the complaint is similar to Condition No. 2, the starter motor must be moved away from the flywheel/driveplate. This is done by installing shim(s) across both mounting pads. More than one shim may be required.

CONDITION	POSSIBLE CAUSE	CORRECTION
1. VERY HIGH FREQUENCY WHINE BEFORE ENGINE STARTS; ENGINE STARTS OK.	1. Excessive distance between pinion gear and flywheel/drive plate gear.	1. Shim starter motor toward flywheel/drive plate.
2. VERY HIGH FREQUENCY WHINE AFTER ENGINE STARTS WITH IGNITION KEY RELEASED. ENGINE STARTS OK.	2. Insufficient distance between starter motor pinion gear and flywheel/drive plate runout can cause noise to be intermittent.	2. Shim starter motor away from flywheel/drive plate. Inspect flywheel/drive plate for damage; bent, unusual wear, and excessive runout. Replace flywheel/drive plate as necessary.
3. A LOUD "WHOOP" AFTER ENGINE STARTS WHILE STARTER MOTOR IS ENGAGED.	3. Most probably cause is defective overrunning clutch.	3. Replace starter motor.
4. A "RUMBLE," "GROWL," OR "KNOCK" AS STARTER MOTOR COASTS TO STOP AFTER ENGINE STARTS.	4. Most probable cause is bent or unbalanced starter motor armature.	4. Replace starter motor.

NOTE: A high frequency whine during cranking is normal for this starter motor.

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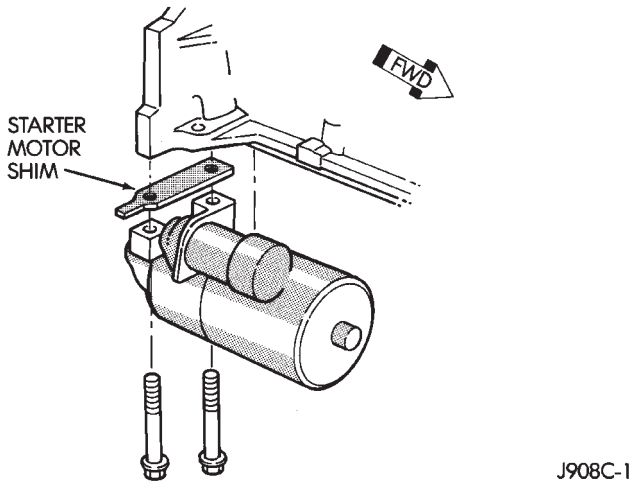


Fig. 10 Starter Motor Shimming

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).

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 ON 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).

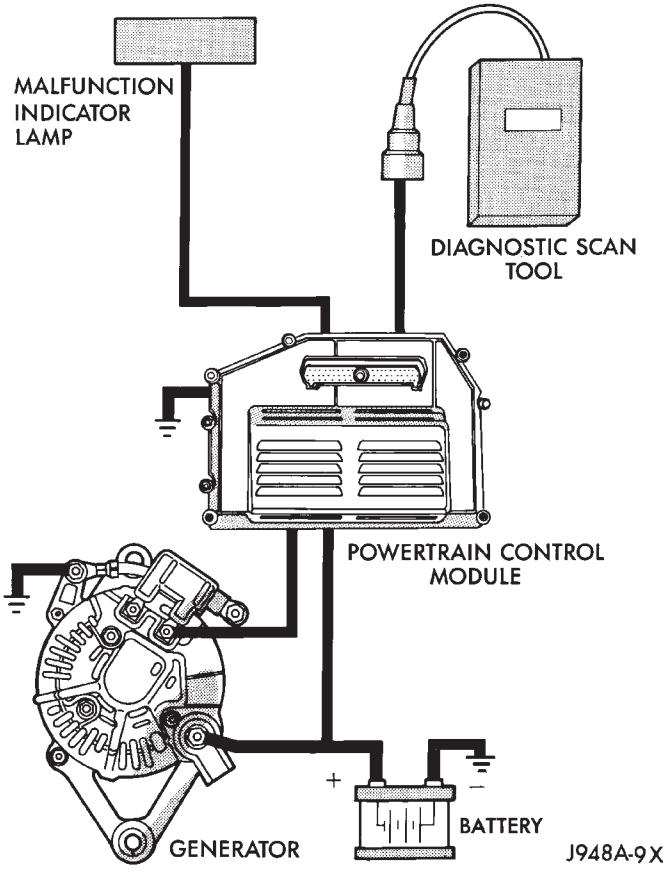


Fig. 1 Charging System Components (Typical)

OPERATIONAL CHECK WITH VOLTMETER

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

DIAGNOSTIC PROCEDURES

If the indicator operates abnormally, 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 liftgate or glove box light, to stay on (refer to Ignition Off Draw Diagnosis).

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 in Battery/Starter/Generator Service.
- Inspect generator drive belt condition and tension. Tension or replace belt as required. Refer to Belt Tension Specifications in Battery/Starter/Generator Service.
- Inspect connection at generator B+ output. It should be clean and tight. Repair as required.

GENERATOR OUTPUT WIRE RESISTANCE TEST

Generator output wire resistance test will show amount of voltage drop across generator output wire between generator battery 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 Test Procedures.

(2) Turn OFF ignition switch.

(3) Disconnect negative cable from battery.

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

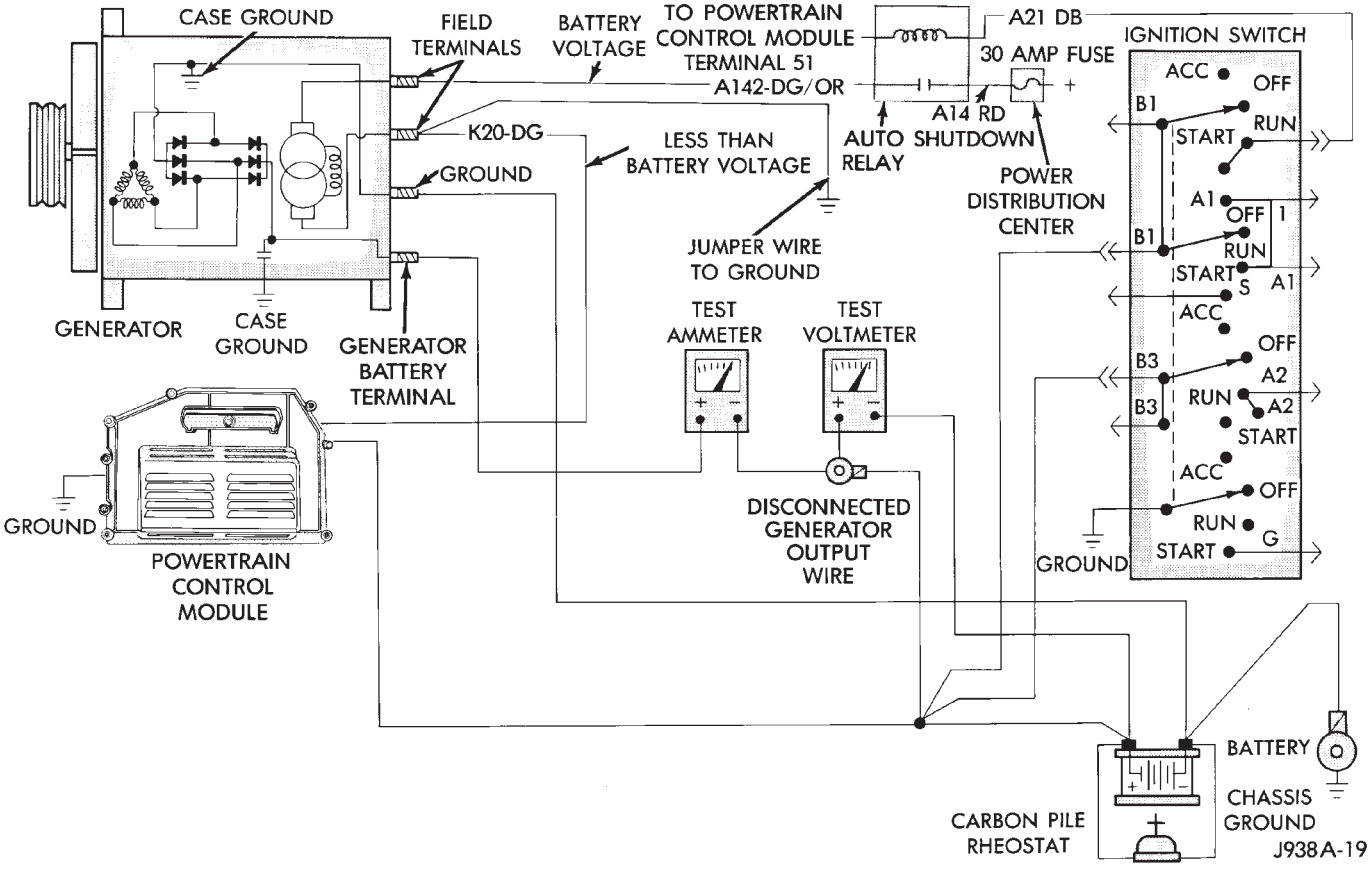


Fig. 2 Generator Output Wire Resistance Test (Typical)

(5) Connect a 0-150 ampere scale D.C. ammeter in series between generator battery terminal and disconnected generator output wire (Fig. 2). Connect positive lead to generator battery 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 green/orange A142 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 Load Testing in Battery Test Procedures 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 battery 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 battery terminal. Tighten to 5 to 6 N•m (45 to 75 in. lbs.).

(5) Connect negative cable to battery.

(6) Use DRB scan tool to erase DTC.

GENERATOR 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 Test Procedures.

(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 battery terminal and disconnected generator output wire (Fig. 3). Connect positive lead to generator battery terminal and negative lead to disconnected generator output wire.

(5) Connect positive lead of a test voltmeter (range 0-18 volts minimum) to generator battery 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 Load Testing in Battery Test Procedures.

(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 green/orange A142 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.

(3) The ammeter reading must be within limits shown for that size of generator being tested. See Generator Specifications in Battery/Starter/Generator Service.

RESULTS

(1) If reading is less than specified and generator output wire resistance is not excessive, generator should be replaced. Refer to Group 8B - Battery/Starter/Generator Service.

(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.

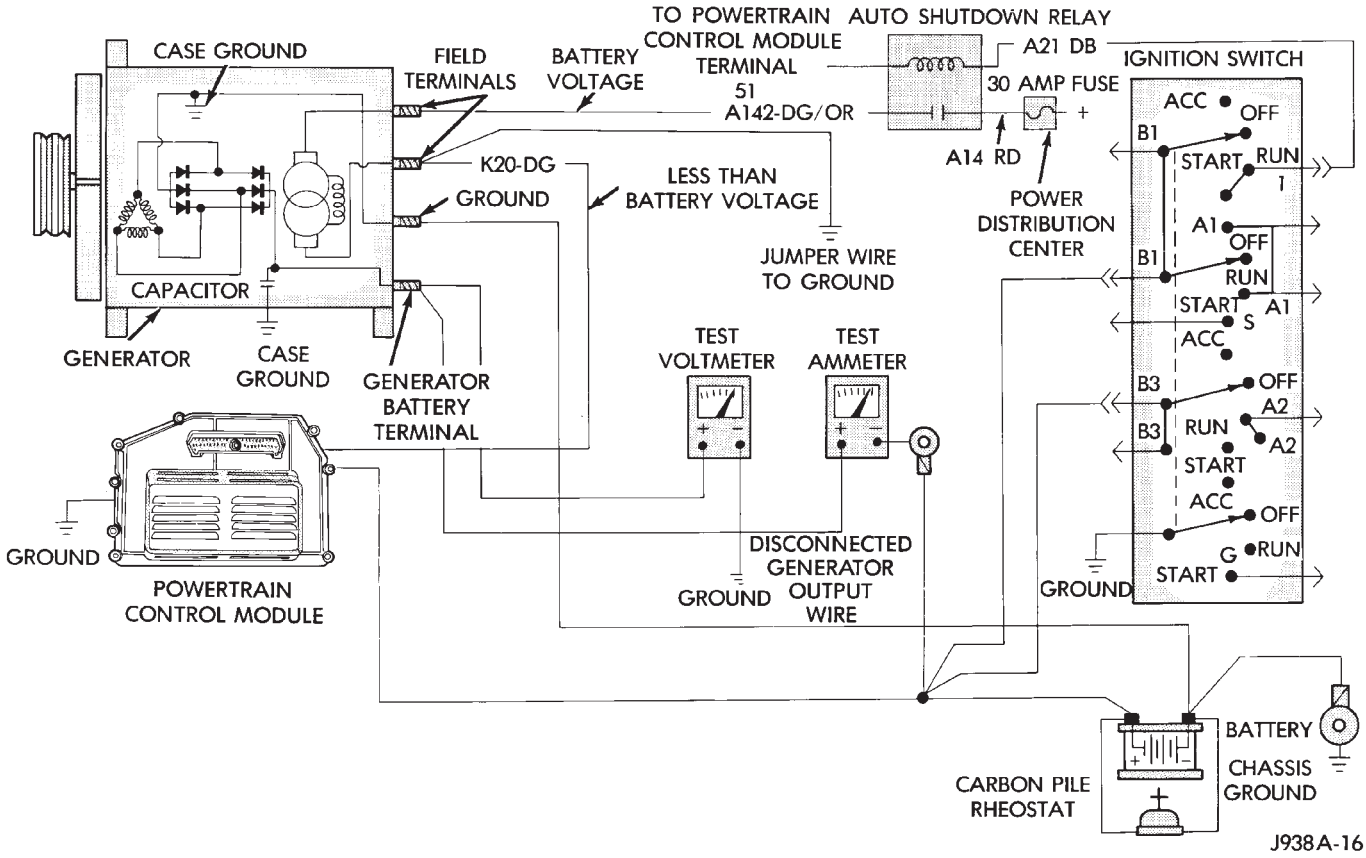


Fig. 3 Generator Current Output Test (Typical)

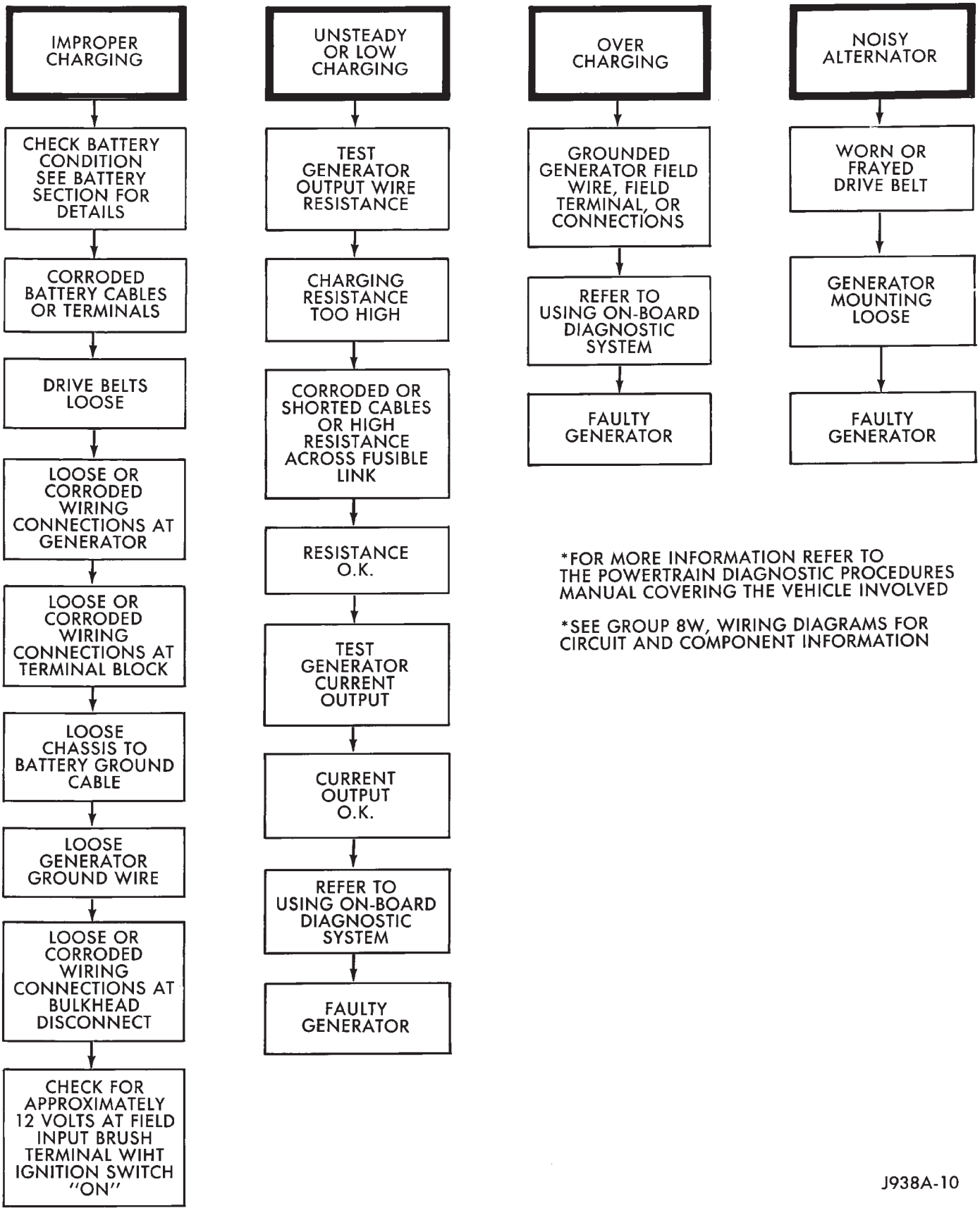
(5) Remove jumper wire (Fig. 3).

(6) Connect generator output wire to generator battery terminal. Tighten nut to 5-6 N•m (45-75 in. lbs.).

(7) Connect negative cable to battery.

(8) Use DRB scan tool to erase DTC.

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

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USING ON-BOARD DIAGNOSTIC SYSTEM

OPERATION OF ON-BOARD DIAGNOSTIC (OBD) SYSTEM

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

If OBD system senses that one critical circuit is bad during the monitoring cycle, it will put a diagnostic trouble code into memory. Each input and output circuit monitored by the OBD system has its own diagnostic trouble code. The diagnostic trouble code (DTC) will stay in memory as long as the circuit continues to be bad. If the problem does not happen again after the fault code is put into memory, the PCM is programmed to clear the memory after 50 engine starts.

DIAGNOSTIC TROUBLE CODES (DTC)

Diagnostic trouble codes are two-digit numbers flashed on Malfunction Indicator (Check Engine) Lamp that identify which circuit is bad. In most cases they do not identify which component in a circuit is bad. A trouble code description can be read using the DRB scan tool. Refer to Group 14 - Fuel Systems for more information. Therefore, a DTC is only a symptom, not necessarily the cause 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 caused the DTC of the on-board diagnostic system to be set.

HOW TO USE MALFUNCTION INDICATOR (CHECK ENGINE) LAMP FOR DIAGNOSTIC TROUBLE CODES

To start this function, cycle the ignition switch ON-OFF-ON-OFF-ON within 5 seconds and any trouble code stored in the PCM will be displayed. The Malfunction Indicator (Check Engine) Lamp will display a DTC by flashing on and off. There is a short pause between flashes and a longer pause between digits. All codes displayed are two digit numbers with a 4 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 2 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 diagnostic trouble codes which apply to the charging system. Refer to the Powertrain Diagnostic Procedures manal to diagnose an On-Board Diagnostic System, Trouble Code.

GENERATOR DIAGNOSTIC TROUBLE CODE (DTC)

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

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

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