BATTERY

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GENERAL INFORMATION

INTRODUCTION

The battery stores, stabilizes, and delivers electrical current to operate various electrical systems in the vehicle (Fig. 1). The determination of whether a battery is good or bad is made by its ability to accept a charge. It also must supply high-amperage current for a long enough period to be able to start the vehicle. The capability of the battery to store electrical current comes from a chemical reaction. This reaction takes place between the sulfuric acid solution (electrolyte) and the lead +/- plates in each cell of the battery. As the battery discharges, the plates react with the acid from the electrolyte. When the charging system charges the battery, the water is converted to sulfuric acid in the battery. The concentration of acid in the electrolyte is measured as specific gravity using a hydrometer. The specific gravity indicates the battery's state-of-charge.

The battery is vented to release gases that are created when the battery is being charged and discharged.

The battery top, posts, and terminals should be cleaned when other under hood maintenance is performed.

The battery top, posts, cable clamps must be cleaned and battery must be completely charged before diagnostic procedures are performed.

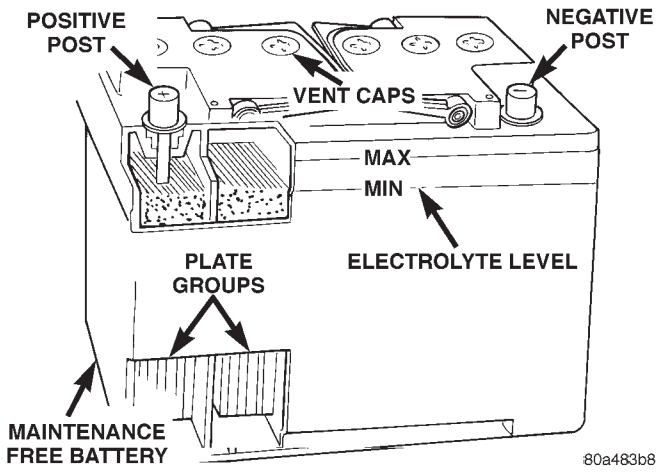

Fig. 1 Battery Construction

SAFETY PRECAUTIONS AND WARNINGS

WARNING:

DO NOT ALLOW JUMPER CABLE CLAMPS TO TOUCH EACH OTHER WHEN CONNECTED TO A BOOSTER SOURCE.

DO NOT USE OPEN FLAME NEAR BATTERY.

REMOVE METALLIC JEWELRY WORN ON HANDS OR WRISTS TO AVOID INJURY BY ACCIDENTAL ARCING OF BATTERY CURRENT.

WHEN USING A HIGH OUTPUT BOOSTING DEVICE, DO NOT ALLOW THE DISABLED VEHICLE'S BATTERY TO EXCEED 16 VOLTS. PERSONAL INJURY OR DAMAGE TO ELECTRICAL SYSTEM CAN RESULT.

TO PROTECT THE HANDS FROM BATTERY ACID, A SUITABLE PAIR OF HEAVY DUTY RUB-

GENERAL INFORMATION (Continued)

BER GLOVES, NOT THE HOUSEHOLD TYPE, SHOULD BE WORN WHEN REMOVING OR SERVICING A BATTERY. SAFETY GLASSES ALSO SHOULD BE WORN.

DESCRIPTION AND OPERATION

BATTERY IGNITION OFF DRAW (IOD)

A completely normal vehicle will have a small amount of current drain on the battery with the key out of the ignition. It can range from 5 to 25 milliamperes after all the modules time out. If a vehicle will not be operated for approximately a 20 days, the IOD fuse should be pulled to eliminate the vehicle electrical drain on the battery. The IOD fuse is located in the Power Distribution Center (PDC). Refer to the PDC cover for proper fuse.

CHARGING TIME REQUIRED

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

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

SIZE OF BATTERY

A completely discharged large heavy-duty battery may require more recharging time than a completely discharged small capacity battery, refer to (Fig. 2) for charging times.

CHARGING AMPERAGE	5 AMPS	10 AMPS	15 AMPS	20 AMPS
OPEN CIRCUIT VOLTAGE	HOUR CHARGING AT 21°C (77°F)			
12.34 TO 12.52	4.6 HRS.	2.3 HRS.	1.5 HRS.	1.1 HRS.
12.16 TO 12.33	6.9 HRS.	3.4 HRS.	2.3 HRS.	1.8 HRS.
11.97 TO 12.15	9.2 HRS.	4.6 HRS.	3.0 HRS.	2.3 HRS.
10.00 TO 11.96	11.5 HRS.	5.8 HRS.	3.8 HRS.	2.9 HRS.
10.00 TO 0	SEE CHARGING COMPLETELY DISCHARGE BATTERY			

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Fig. 2 Battery Charging Time

TEMPERATURE

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

CHARGER CAPACITY

A charger which can supply only five amperes will require a much longer period of charging than a charger that can supply 20 amperes or more.

STATE OF CHARGE

A completely discharged battery requires more charging time than a partially charged battery. Electrolyte is nearly pure water in a completely discharged battery. At first, the charging current amperage will be low. As water is converted back to sulfuric acid inside the battery, the current amp rate will rise. Also, the specific gravity of the electrolyte will rise. The electrolyte should be tested with a Hydrometer to check the specific gravity.

USING HYDROMETER

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

NOTE: Periodically disassemble the hydrometer and wash components with soap and water. Inspect the float for possible leaks. If the paper inside has turned brown, the float is defective.

Before testing, visually inspect the battery for any damage:

- Cracked container or cover
- Loose post
- Corrosion

and any other thing that would cause the battery to be unserviceable. To interpret the hydrometer correctly, hold it with the top surface of the electrolyte in the hydrometer at eye level.

Disregard the curvature of the liquid where the surface rises against the float because of surface cohesion (Fig. 3). Remove only enough electrolyte from the battery to keep the float off the bottom of the hydrometer barrel with pressure on the bulb released. Keep the hydrometer in a vertical position while drawing the electrolyte into the hydrometer and observing the specific gravity. 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, 20°C (68°F). When testing the specific gravity at any other temperature, a correction factor is required, otherwise specific gravity readings will not indicate the true state of charge.

The correction factor is approximately a specific gravity value of 0.004, referred to as 4 points of specific gravity for every 5.5°C (10°F). If electrolyte temperature is below 20°C (68°F) you subtract. If the temperature is above 20°C (68°F) you add to the

DESCRIPTION AND OPERATION (Continued)

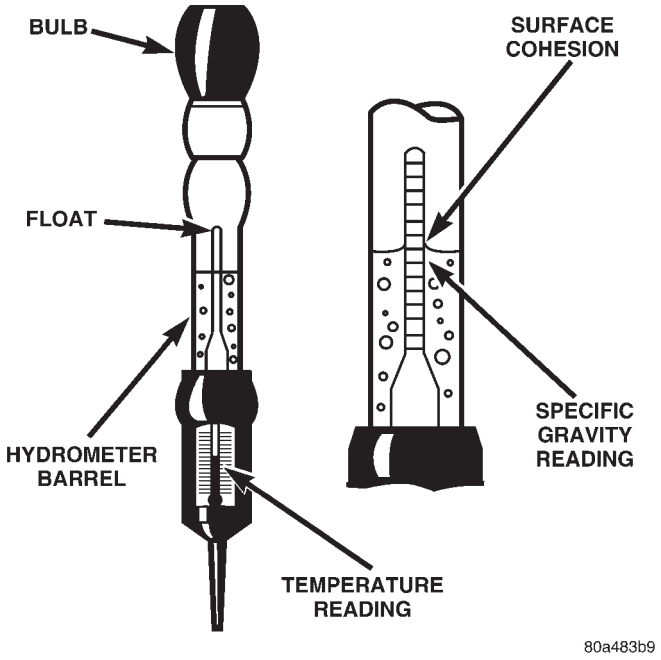

Fig. 3 Battery Hydrometer

hydrometer reading. Always correct the specific gravity for temperature variation. Test the specific gravity of the electrolyte in each battery cell. Refer to the information with the Hydrometer.

Example 1:

- Hydrometer reading: 1.260
- Electrolyte temperature: -7°C (20°F)
- Subtract specific gravity: -0.019
- Correction specific gravity: 1.241

Example 2:

- Hydrometer reading: 1.225
- Electrolyte temperature: -38°C (100°F)
- Add specific gravity: +0.013
- Correction specific gravity: 1.238

A fully charged relatively new battery has a specific gravity reading of 1.285 plus 0.015 or minus 0.010.

If the specific gravity of all cells is above 1.235, but variation between cells 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, recharge the battery at a rate of approximately 5 amperes. Continue charging until three 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.

DIAGNOSIS AND TESTING

BATTERY DISCHARGING

CAUSE OF BATTERY DISCHARGING

It is normal to have a small 5 to 25 milliamperes continuous electrical draw from the battery. This draw will take place with the ignition in the OFF position, and the courtesy, dome, storage compartments, and engine compartment lights OFF. The continuous draw is due to various electronic features or accessories that require electrical current with the ignition OFF to function properly. When a vehicle is not used over an extended period of approximately 20 days the IOD fuse should be disconnected. The fuse is located in the power distribution center. Disconnection of this fuse will reduce the level of battery discharge. Refer to Battery Diagnosis and Testing Chart and to the proper procedures.

ABNORMAL BATTERY DISCHARGING

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

BATTERY IGNITION OFF DRAW

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

(1) Verify that all electrical accessories are OFF.

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

(2) Disconnect battery negative cable (Fig. 4).

DIAGNOSIS AND TESTING (Continued)

BATTERY DIAGNOSIS AND TESTING		
STEPS	**POSSIBLE CAUSE**	**CORRECTION**
VISUAL INSPECTION Check for possible damage to battery and clean battery.	(1) Corroded post(s) or terminal(s) (2) Loose terminal(s) (3) Loose battery post, Cracked battery cover or case, Leaks or Any other physical (4) Battery OK.	(1) Clean post(s) or terminal(s) (2) Clean and tighten (3) Replace Battery (4) Check state of charge. Refer to Hydrometer Test
PERFORM BATTERY HYDROMETER TEST	(1) 1.285 (2) 1.235 (3) 1.175 or a variation between cells of 0.050 or greater	(1) Battery is charged. Perform Battery 0pen Circuit Voltage Test (2) Perform Battery Charging procedure. (3) Replace Battery.
BATTERY OPEN CIRCUIT VOLTAGE TEST	(1) Battery is above 12.40 Volts (2) Battery is below 12.40 Volts.	(1) Perform the Battery Load Test. (2) Perform Battery Charging procedure.
BATTERY CHARGING	(1) Battery accepted Charge. (2) Battery will not accept charge	(1) Pass Hydrometer Test and perform Battery 0pen Circuit Voltage Test (2) Perform Charging a Completely Discharged Battery.
BATTERY LOAD TEST	(1) Acceptable minimum voltage. (2) Unacceptable minimum voltage	(1) Battery is OK to put in use, perform Battery Ignition Off Draw Test. (2) Replace Battery and perform Battery Ignition Off Draw Test.
CHARGING A COMPLETELY DISCHARGED BATTERY	(1) Battery accepted charge. (2) Battery will not accept charge.	(1) Pass Hyrometer Test and perform Battery 0pen Circuit Voltage Test. (2) Replace Battery.
IGNITION OFF DRAW TEST	(1) IOD is 5-25 Milliamperes. (2) IOD Exceeds 25 Milliamperes.	(1) Vehicle is normal. (2) Eliminate excess IOD draw.

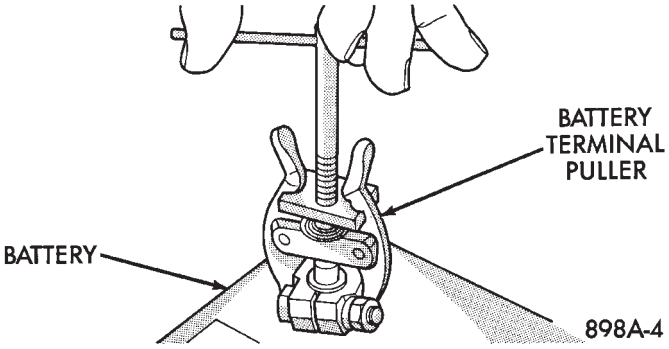

Fig. 4 Disconnect Battery Negative Cable

CAUTION: Always disconnect the meter before opening a door.

(3) Using an multimeter, that has least a milliampere range of 200 mA. Set meter to the highest mA range. Install meter between the battery negative cable and battery negative post (Fig. 5). Carefully remove the test lamp without disconnecting the meter. After all modules time-out the total vehicle IOD should be less than 25 milliamperes. If ignition off draw is more than 25 milliamperes go to Step 4.

(4) Each time the test lamp or milliampere meter is disconnected and connected, all electronic timer functions will be activated for approximately one minute. The Body Control Module (BCM) ignition off draw can reach 90 milliamperes.

(5) Remove the PDC fuses:

- Interior lamps
- Brake lamp
- IOD

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

(7) Install all fuses. After installing fuse, the current can reach 90 mA. After time-out the reading should not exceed 25 mA. If OK go to. If not, disconnect:

- Radio

DIAGNOSIS AND TESTING (Continued)

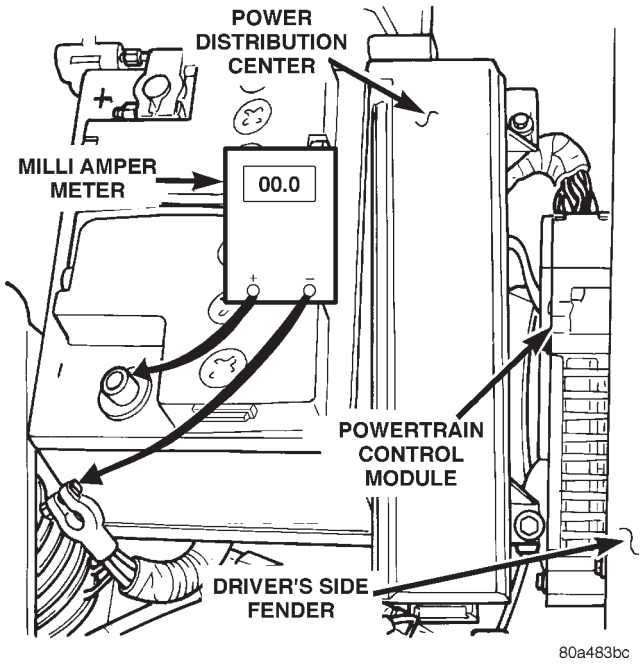

Fig. 5 Milliampere Meter Connection

- Body Control Module
- Remote Keyless Entry Module

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

(9) Remove interior and brake lamp fuses. Install the fuses. The milliampere reading should be 2-4 mA. If reading is higher than 4 mA:

(a) Disconnect PCM.

(b) If reading is OK, replace PCM.

(c) If reading does not change there is a short circuit to the PCM. Refer to Group 8W, Wiring Diagrams.

BATTERY LOAD TEST

A fully charged battery must have cranking capacity, to provide the starter motor and ignition system enough power to start the engine over a broad range of ambient temperatures. A battery load test will verify the actual cranking capability of the battery.

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

(1) Remove both battery cables, negative cable first. The battery top, cables and posts should be clean. Test battery with a hydrometer. If battery charge is low the charge battery. Refer to Battery Charging Procedures.

(2) Connect a Volt/Ammeter/Load tester to the battery posts (Fig. 6). Rotate the load control knob of the Carbon pile rheostat to apply a 300 amp load. Apply this load for 15 seconds to remove the surface charge from the battery, and return the control knob to off (Fig. 7).

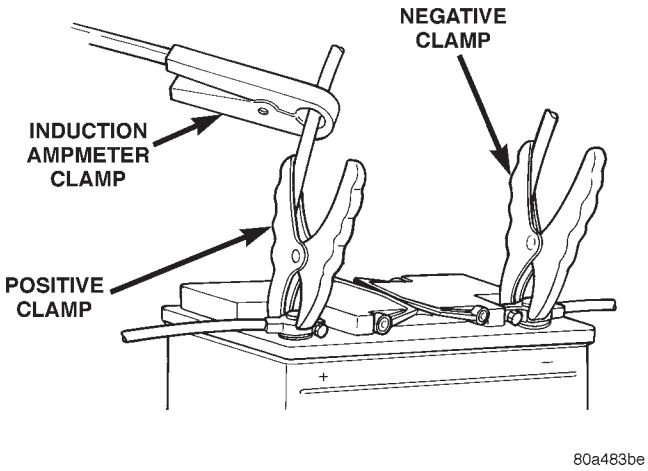

Fig. 6 Volt-Ammeter Load Tester Connections

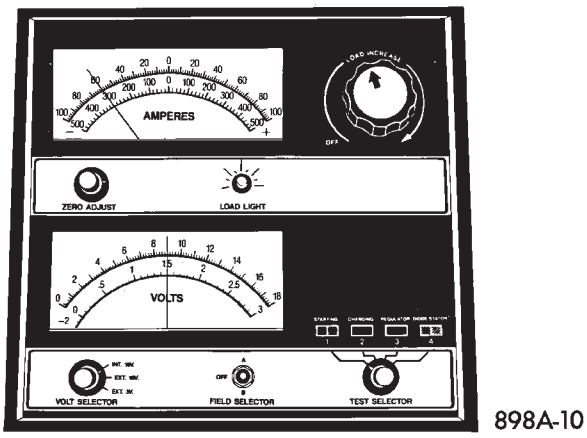

Fig. 7 Remove Surface Charge From Battery

(3) Allow the battery to stabilize for 2 minutes, and then verify open circuit voltage.

(4) Rotate the load control knob on the tester to maintain 50% of the battery cold crank rating for 15 seconds (Fig. 8). Record the loaded voltage reading and return the load control to off. Refer to the Battery Specifications at the rear of this Group.

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

DIAGNOSIS AND TESTING (Continued)

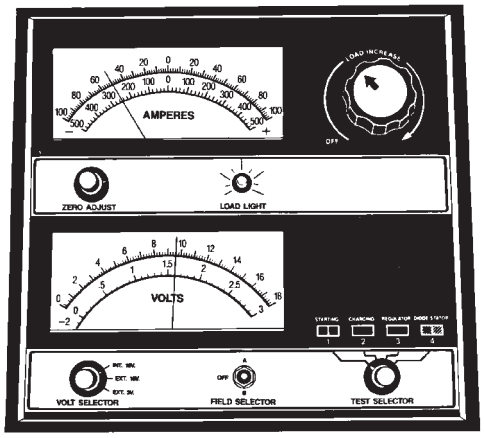

Fig. 8 Load 50% Cold Crank Rating

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

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

BATTERY OPEN CIRCUIT VOLTAGE TEST

An open circuit voltage no load test shows the state of charge of a battery and whether it is ready for a load test at 50 percent of the battery's cold crank rating. Refer to Battery Load Test. If a battery has open circuit voltage reading of 12.4 volts or greater, and will not pass the load test, replace the battery because it is defective. To test open circuit voltage, perform the following operation.

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

(2) Connect a Volt/Ammeter/Load tester to the battery posts (Fig. 6). Rotate the load control knob of the Carbon pile rheostat to apply a 300 amp load. Apply this load for 15 seconds to remove the surface charge from the battery, and return the control knob to off (Fig. 7).

(3) Allow the battery to stabilize for 2 minutes, and then verify the open circuit voltage (Fig. 9).

(4) This voltage reading will approximate the state of charge of the battery. It will not reveal battery cranking capacity (Fig. 10).

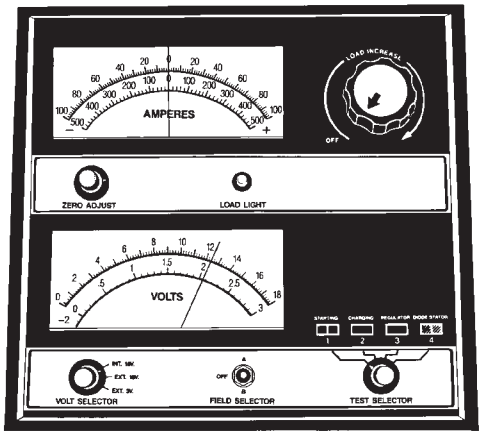

Fig. 9 Testing Open Circuit Voltage

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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Fig. 10 Battery Open Circuit Voltage

SERVICE PROCEDURES

BATTERY CHARGING

WARNING: DO NOT CHARGE A BATTERY THAT HAS EXCESSIVELY LOW ELECTROLYTE LEVEL. BATTERY MAY SPARK INTERNALLY AND EXPLODE. EXPLOSIVE GASES FORM OVER THE BATTERY. DO NOT SMOKE, USE FLAME, OR CREATE SPARKS NEAR BATTERY. DO NOT ASSIST BOOST OR CHARGE A FROZEN BATTERY. BATTERY CASING MAY FRACTURE. BATTERY ACID IS POISON, AND MAY CAUSE SEVERE BURNS. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES, OR CLOTHING. IN THE EVENT OF CONTACT, FLUSH WITH WATER AND CALL PHYSICIAN IMMEDIATELY. KEEP OUT OF REACH OF CHILDREN.

SERVICE PROCEDURES (Continued)

CAUTION: Disconnect the battery NEGATIVE cable first (Fig. 4) before charging battery to avoid damage to electrical systems. Do not exceed 16.0 volts while charging battery. Refer to the instructions supplied with charging equipment

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

- It has an open circuit voltage charge of at least 12.4 volts (Fig. 10).
- It passes the 15 second load test, refer to the Load Test Temperature chart.
- The specific gravity reading is 1.285 plus 0.015 or minus 0.010.

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

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

CAUTION: Do not overcharge Battery.

Test the battery until the specific gravity reading is 1.285 plus 0.015 or minus 0.010.

After the battery has been charged to 12.4 volts or greater, perform a load test to determine cranking capacity. Refer to Battery Load Test in this Group. If the battery passes the load test, return the battery to use. If battery will not endure a load test, it must be replaced. Properly clean and inspect battery hold downs, tray, terminals, cables, posts, and top before completing service.

CHARGING COMPLETELY DISCHARGED BATTERY

The following procedure should be used to recharge a completely discharged battery. Unless procedure is properly followed, a good battery may be needlessly replaced (Fig. 11).

(1) Measure the voltage at battery posts with a voltmeter accurate to 1/10 volt (Fig. 12). If below 10 volts, charge current will be low, and it could take some time before it accepts a current in excess of a few milliamperes. Such low current may not be detectable on amp meters built into many chargers.

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

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

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Fig. 11 Charging Rate

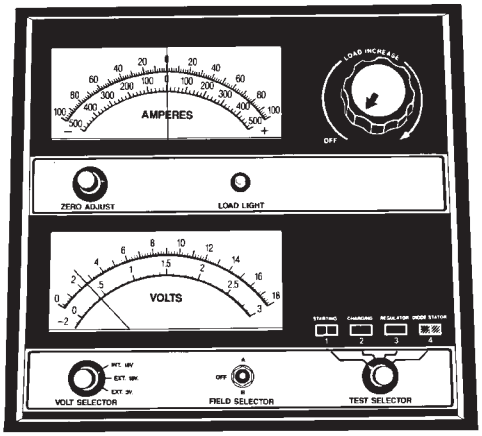

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Fig. 12 Voltmeter Accurate to 1/10 Volt (Connected)

(3) Battery chargers vary in the amount of voltage and current they provide. For the time required for the battery to accept measurable charger current at various voltages, refer to (Fig. 11). If charge current is still not measurable after charging times, the battery should be replaced. If charge current is measurable during charging time, the battery may be good, and charging should be completed in the normal manner.

VISUAL INSPECTION

CAUTION: Do not allow baking soda solution to enter vent holes, as damage to battery can result.

(1) Clean top of battery with a solution of warm water and baking soda.

(2) Apply soda solution with a bristle brush and allow to soak until acid deposits loosen (Fig. 13).

(3) Rinse soda solution from battery with clear water and blot battery dry with paper toweling. Dispose of toweling in a safe manner. Refer to the WARNINGS on top of battery.

(4) Inspect battery case and cover for cracks, leakage or damaged hold down ledge. If battery is damaged replace it.

SERVICE PROCEDURES (Continued)

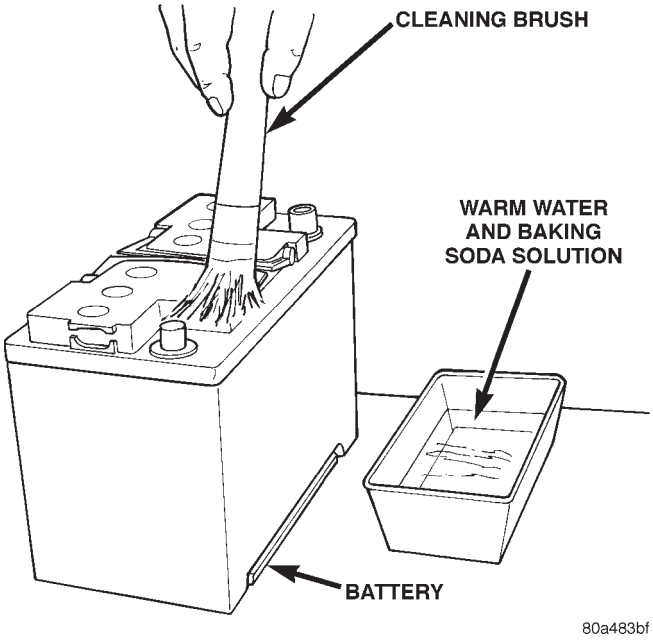

Fig. 13 Cleaning Battery

(5) Inspect battery tray for damage caused by acid from battery. If acid is present, clean area with baking soda solution.

(6) Clean battery posts with a battery post cleaning tool (Fig. 14).

(7) Clean battery cable clamps with a battery terminal cleaning tool (Fig. 15). Replace cables that are frayed or have broken clamps.

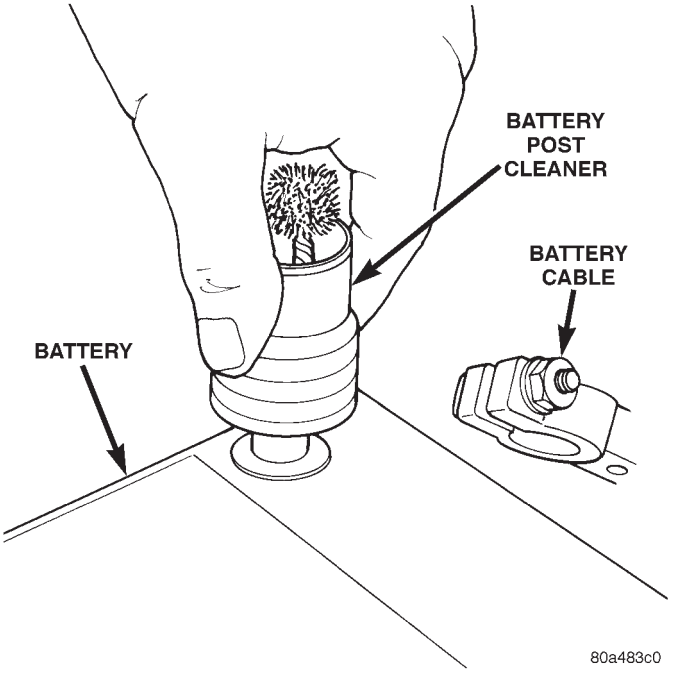

Fig. 14 Cleaning Battery Post

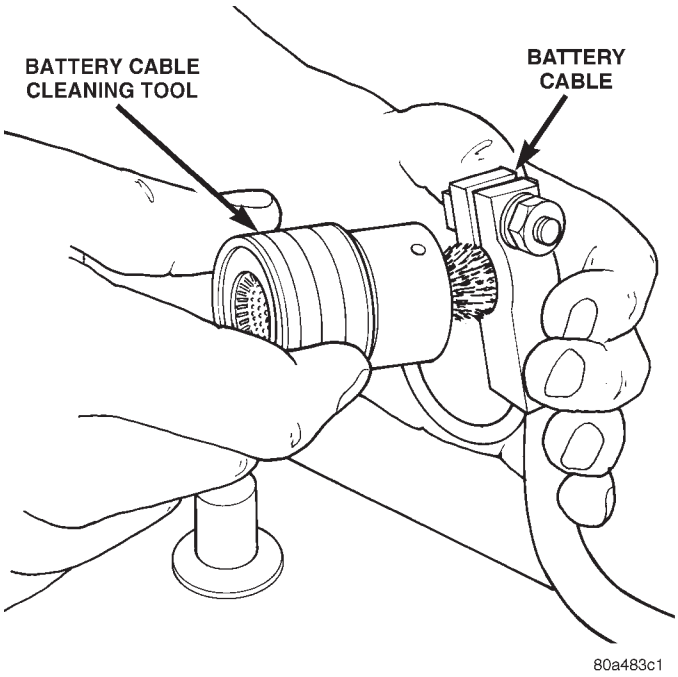

Fig. 15 Cleaning Battery Cable Terminal

REMOVAL AND INSTALLATION

BATTERY

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

REMOVAL

(1) Verify that the ignition switch and all accessories are OFF.

(2) Disconnect battery cable terminals from the battery posts, negative first (Fig. 16).

3

(3) Remove battery hold down (Fig. 17).

(4) Remove battery from vehicle (Fig. 18).

INSTALLATION

Inspect and clean battery and attaching components before installation.

(1) Install battery in vehicle making sure that battery is properly positioned on battery tray.

(2) Install battery hold down.

(3) Connect battery cable terminals, positive cable first. Make sure the top of battery terminals are flush with top of posts.

WARNING: DO NOT OVER TIGHTEN BATTERY CABLE CLAMPS, DAMAGE TO CLAMPS CAN RESULT.

REMOVAL AND INSTALLATION (Continued)

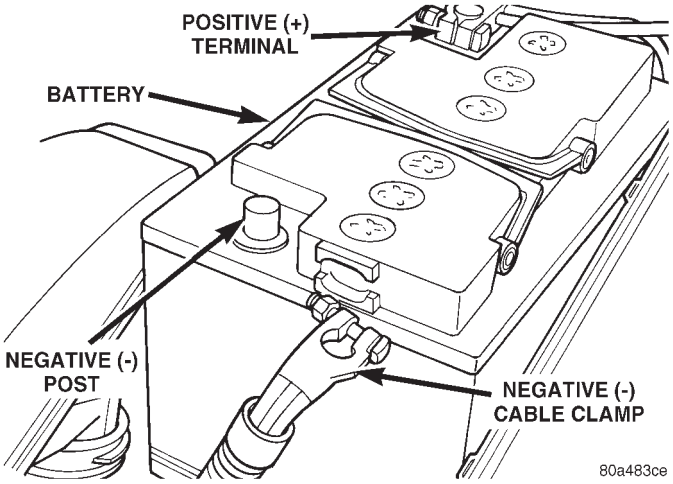

Fig. 16 Battery Cable Disconnected

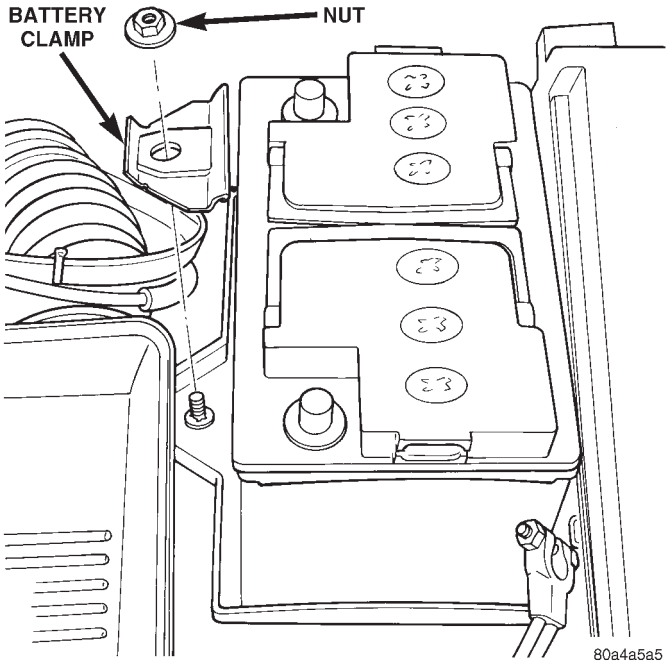

Fig. 17 Battery Hold Down

(4) Tighten terminal nuts to 8.5 N·m (75 in. lbs.).

BATTERY TRAY

REMOVAL

(1) Remove battery, refer to the above procedures.

(2) Remove nut and two bolts from battery tray (Fig. 19).

(3) Remove battery tray from vehicle.

(4) Remove speed control servo attaching bolt from battery tray (if equipped). Use care when disconnecting vacuum lines from reservoir (Fig. 20).

INSTALLATION

For installation, reverse the above procedures.

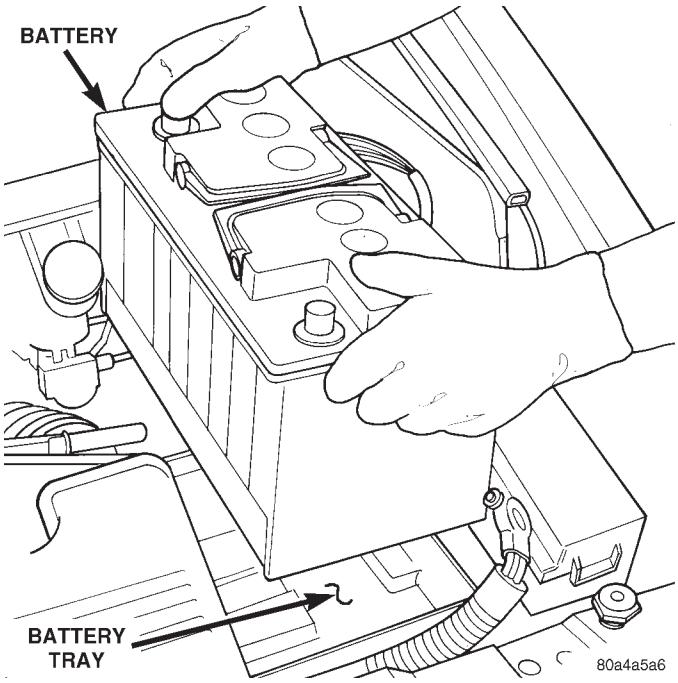

Fig. 18 Remove Battery

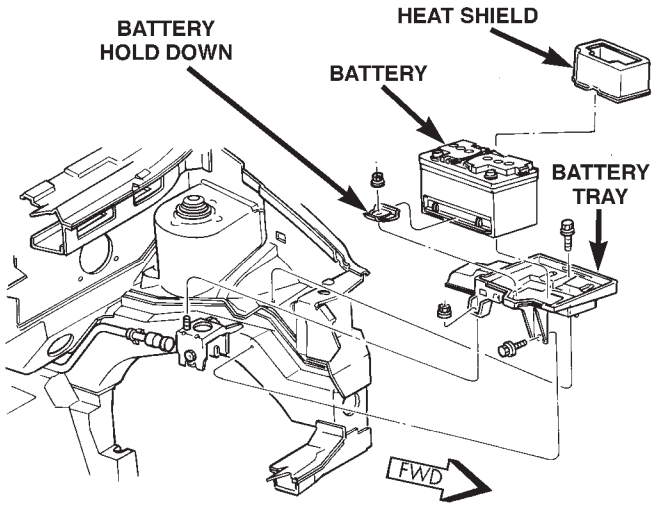

Fig. 19 Battery Tray Removal

SPECIFICATIONS

BATTERY SPECIFICATIONS

CRANKING RATING

The current battery can deliver for 30 seconds and maintain a terminal voltage of 7.2 volts or greater at specified temperature.

SPECIFICATIONS (Continued)

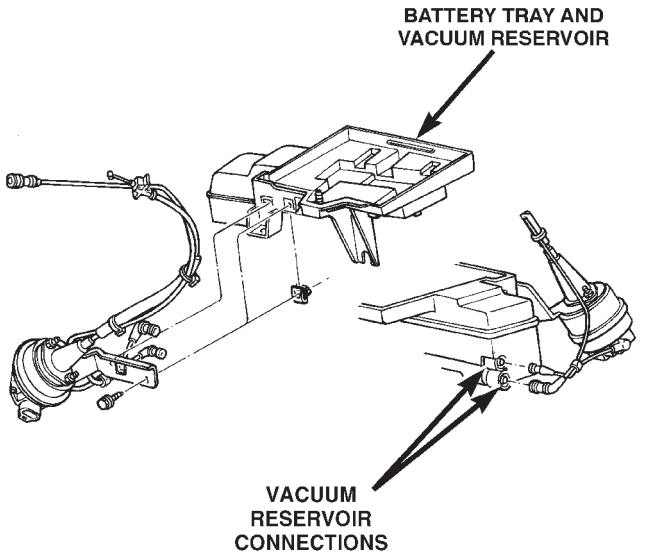

Fig. 20 Speed Control Servo Removal

Reserve (Amps)	Cold Cranking Rating @ -17.8C (0.0F) DIN/BCI	Reserve Capacity
200 Amp	500 Amp	110 Minutes
250 Amp	600 Amp	120 Minutes
315 Amp	685 Amp	125 Minutes

TORQUE

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