BATTERY

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GENERAL INFORMATION

INTRODUCTION

The battery stores, stabilizes, and delivers electrical current to operate various electrical systems in the vehicle. The determination of whether a battery is good or bad is made by its ability to accept a charge. It also must 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 original equipment (OE) battery is equipped with a hydrometer (test indicator) built into the battery cover. The specific gravity indicates the battery's state-of-charge. The OE battery is sealed and water cannot be added.

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.

When the electrolyte level is below the top of the plates, Yellow/Clear in the test Indicator, the battery must be replaced. The battery must be completely charged, and the battery top, posts, and cable clamps must be cleaned before diagnostic procedures are performed.

NOTE: This group covers both Left-Hand Drive (LHD) and Right-Hand Drive (RHD) versions of this model. Whenever required and feasible, the RHD versions of affected vehicle components have been constructed as mirror-image of the LHD versions. While most of the illustrations used in this group represent only the LHD version, the diagnostic and service procedures outlined can generally be applied to either version. Exceptions to this rule have been clearly identified as LHD, RHD, or Export if a special illustration or procedure is required.

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 4 to 10 milliamperes after all the modules time out. If a vehicle will not be operated for approximately a 20 days, the IOD fuse should be disconnected to minimize the vehicle electrical drain on the battery. The IOD fuse is located in the Power Distribution Center (PDC). Refer to the PDC to locate the cover proper fuse.

DESCRIPTION AND OPERATION (Continued)

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. 1) 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. 1 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, bringing the green ball (Fig. 2) into view at approximately 75 percent state-of-charge.

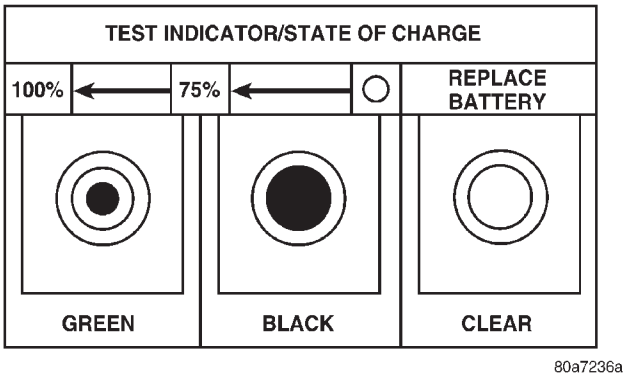

Fig. 2 Reading Test Indicator

DIAGNOSIS AND TESTING

BATTERY BUILT-IN TEST INDICATOR

USING TEST INDICATOR

The Test Indicator (Fig. 2), (Fig. 3) and (Fig. 4) measures the specific gravity of the electrolyte. Specific Gravity (SG) of the electrolyte will show state-of-charge (voltage). The test indicator WILL NOT show cranking capacity of the battery. Refer to Battery Load Test for more information. Look into the sight glass (Fig. 2), (Fig. 4) and note the color of the indicator. Refer to the following description of colors:

NOTE: GREEN = 75 to 100% state-of-charge

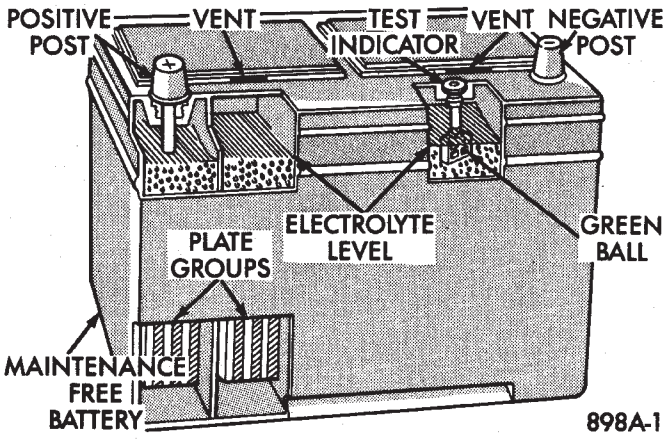

Fig. 3 Battery Construction and Test Indicator

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

NOTE: BLACK OR DARK = 0 to 75% state-of-charge

The battery is INADEQUATELY charged and must be charged until green dot is visible, (12.4 volts or greater) before the battery is tested or returned to

DIAGNOSIS AND TESTING (Continued)

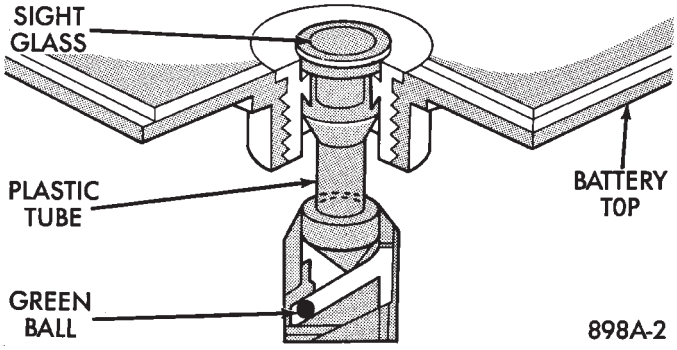

Fig. 4 Test Indicator

use. Refer to Causes of Battery Discharging in this Group for more information.

NOTE: CLEAR COLOR = Replace Battery

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

A clear color dot shows electrolyte level in battery is below the test indicator (Fig. 2). Water cannot be added to a maintenance free battery. The battery must be replaced. A low electrolyte level may be caused by an over charging condition. Refer to Generator Test Procedures on Vehicle.

CAUSES OF BATTERY DISCHARGING

It is normal to have a small 5 to 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 pulled. 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.

BATTERY DIAGNOSIS AND TESTING		
STEPS	**POSSIBLE CAUSE**	**CORRECTION**
VISUAL INSPECTION Check for possible damage to battery and clean battery.	(1) Loose battery post, Cracked battery cover or case, Leaks or Any other physical (2) Battery OK.	(1) Replace Battery (2) Check state of charge. Refer to Test Indicator.
TEST INDICATOR Check Charge Eye Color	(1) GREEN (2) BLACK (3) CLEAR	(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) Ensure that the indicator eye is GREEN 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) Ensure that the indicator eye is GREEN 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.

DIAGNOSIS AND TESTING (Continued)

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 (IOD)

High current draw on the battery with the ignition OFF will discharge a battery. After a dead battery is recharged, the vehicle ignition off draw (IOD) should be checked. To 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
- Trunk lid is closed
- Engine compartment hood lamp is disconnected or lamp removed
- Glove box door is closed
- Sun visor vanity lights are OFF
- All doors are closed
- Allow the ignition key lamp system to time out in approximately 30 seconds, if equipped.

(2) Disconnect battery negative cable (Fig. 5).

(3) Connect a 12 Volt test lamp, with a cold resistance of 5-7 ohms, between the battery negative cable clamp and the negative post (Fig. 6). If test lamp goes out system is OK. If test lamp lights and stays ON, go to Test Lamp Stays ON procedure.

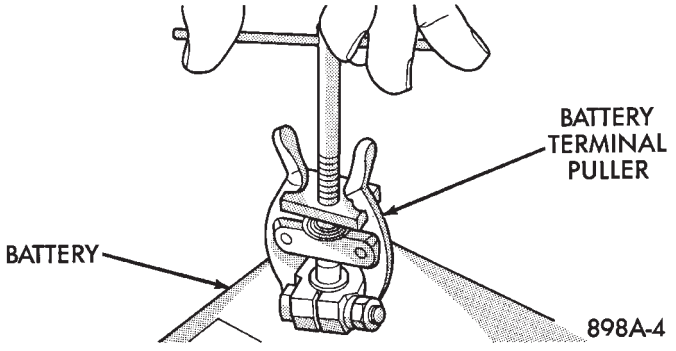

Fig. 5 Disconnect Battery Negative Cable

TEST LAMP STAYS ON

There is either a short circuit or a fault in an electronic module. Two fuses in the Power Distribution Center (PDC) feed the modules with ignition off draw.

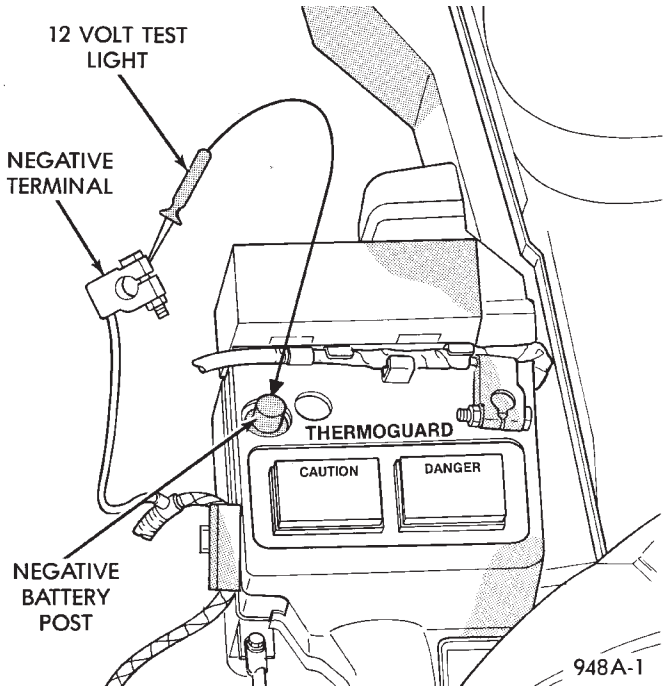

Fig. 6 Ignition OFF (IOD) Test

- Interior lamps fuse (10 Amp) (IOD) PDC.
- Fuel pump fuse (20 Amp) in PDC

(1) Remove interior lamp and fuel pump fuses. By removing these fuses all ignition off draw from the vehicle electronics will be disconnected. The test lamp should go out. If test lamp goes out go to Step 2. If test lamp does not go out there is a current draw or short circuit. Refer to Group 8W, Wiring Diagrams.

(2) Install the fuel pump fuse. If test lamp lights, there is a current draw or short circuit in the A14 wiring circuit feed.

(a) Disconnect Powertrain Control Module.

(b) If test lamp goes out, replace Powertrain Control Module.

(c) If test lamp does not go out, there is a current draw or short circuit in the A14 circuit feed. Refer to Group 8W, Wiring Diagrams.

(3) Install the interior lamp fuse. If test lamp lights, there is a current draw or short circuit in the M01 circuit. Refer to Group 8W, Wiring Diagrams. If test lamp stays out, go to Step 4

(4) Use a multi-meter that has at least a range of 200 milliamperes. Install meter between the battery negative cable and battery negative post (Fig. 7). Carefully remove the test lamp without disconnecting the meter. After all modules time-out the total vehicle IOD should be less than 10 milliamperes. If ignition off draw is more than 10 milliamperes go to Step 5.

(5) Remove both fuses from the Power Distribution Center:

- Fuel pump fuse (20 Amp)

DIAGNOSIS AND TESTING (Continued)

- Interior lamps fuse (10 Amp)

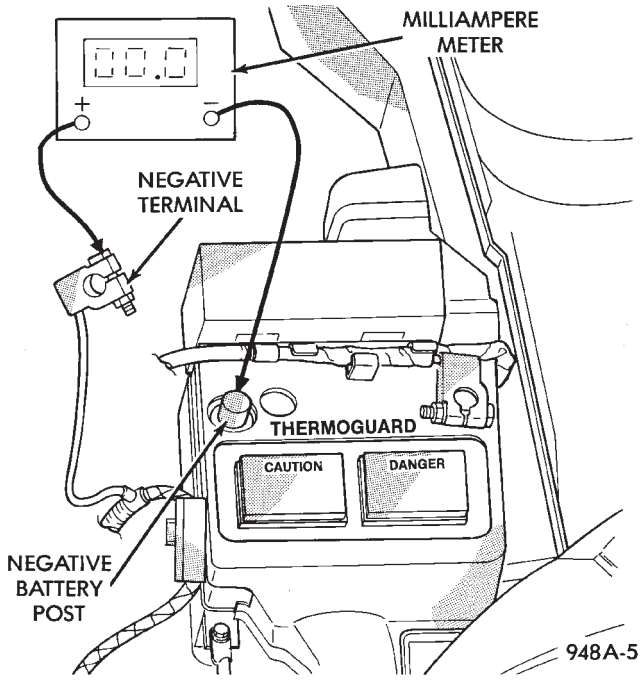

Fig. 7 Milliampere Meter Connection

(6) If there is any reading with fuses removed there is a current draw or short circuit in the wiring. Refer to Group 8W, Wiring Diagrams. If OK go to Step 7.

(7) Install interior lamp fuse. After installing fuse, the current can reach 250 milliamperes. After timeout the reading should not exceed 8 milliamperes. If NOT OK go to Step 8. If OK go to Step 9.

- Ignition key lamp system
- Radio
- Remote keyless entry module, if equipped

(8) Disconnect radio and ignition switch key lamp one component at time, to see if any component is at fault. If the high reading is not eliminated there is a short circuit in the wiring. Refer to Group 8W, Wiring Diagrams.

CAUTION: Always disconnect the meter before opening a door.

(9) Remove interior lamps fuse and install the fuel pump fuse. The reading should be between 1-3 milliamperes. If reading is higher than 3 milliamperes:

(a) Disconnect Powertrain Control Module.

(b) If reading drops to zero, replace Powertrain Control Module.

(c) If reading remains the same there is a current draw or short circuit in the A14 circuit. 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. 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. 8). 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. 9).

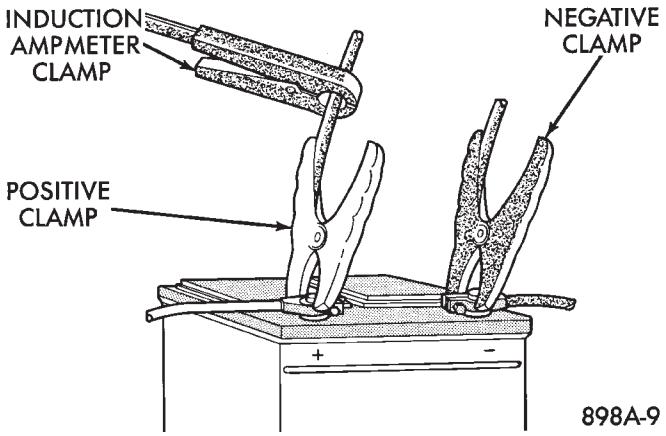

Fig. 8 Volt-Ammeter Load Tester Connections

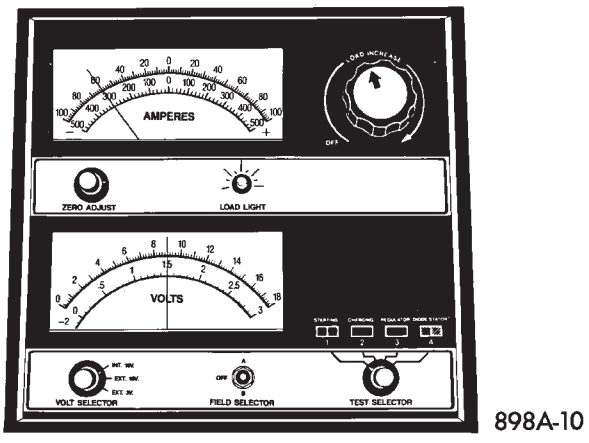

Fig. 9 Remove Surface Charge From Battery

DIAGNOSIS AND TESTING (Continued)

(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. 10). Record the loaded voltage reading and return the load control to off. Refer to the Battery Specifications at the rear of this Group.

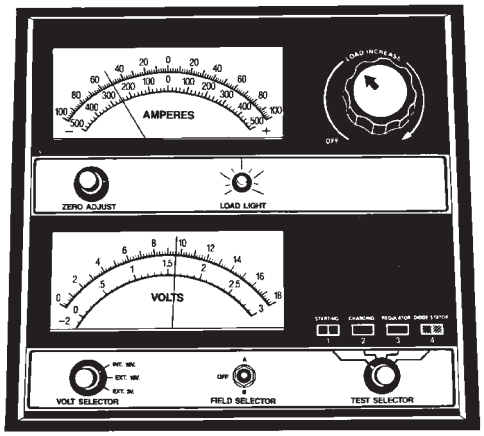

Fig. 10 Load 50% Cold Crank Rating

(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:

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. 8). 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. 9).

(3) Allow the battery to stabilize for 2 minutes, and then verify the open circuit voltage (Fig. 11).

(4) This voltage reading will approximate the state of charge of the battery. It will not reveal battery cranking capacity (Fig. 12).

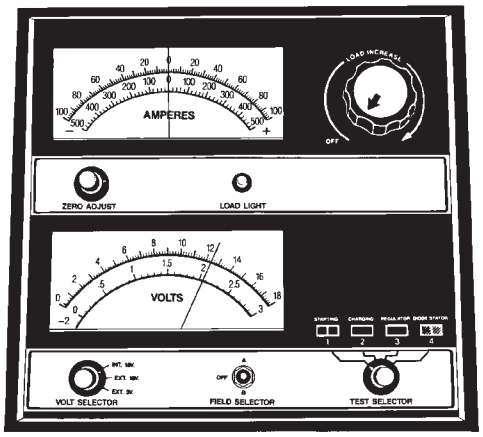

Fig. 11 Testing Open Circuit Voltage

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. 12 Battery Open Circuit Voltage

BATTERY TEMPERATURE SENSOR

For Battery Temperature Sensor refer to Group 8C Generator.

SERVICE PROCEDURES

BATTERY CHARGING

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

- It has an open circuit voltage charge of at least 12.4 volts (Fig. 12).
- It passes the 15 second load test. Refer to Battery Load Test.
- The built in test indicator dot is GREEN (Fig. 2).

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

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

CAUTION: Disconnect the battery NEGATIVE cable first, before charging battery to avoid damage to electrical systems. Lift the red battery boot cover from the positive cable clamp. Do not exceed 16.0 volts while charging battery. Refer to the instructions supplied with charging equipment

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

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

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

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

After the battery has been charged to 12.4 volts or greater, perform a load test to determine cranking capacity. Refer to Battery Load Test in this Group. If the battery passes the load test, the battery is OK to use. If battery will not pass the 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. 13).

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.

Fig. 13 Charging Rate

(1) Measure the voltage at battery posts with a voltmeter accurate to 1/10 volt (Fig. 14). 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.

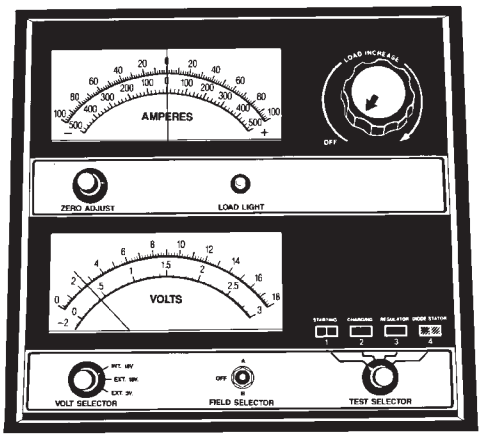

Fig. 14 Voltmeter Accurate to 1/10 Volt (Connected)

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

(3) Battery chargers vary in the amount of voltage and current they provide. For the time required for the battery to accept measurable charger current at various voltages, refer to (Fig. 13). If charge current is still not measurable after charging times, the battery should be replaced. If charge current is measur-

SERVICE PROCEDURES (Continued)

able 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. 15).

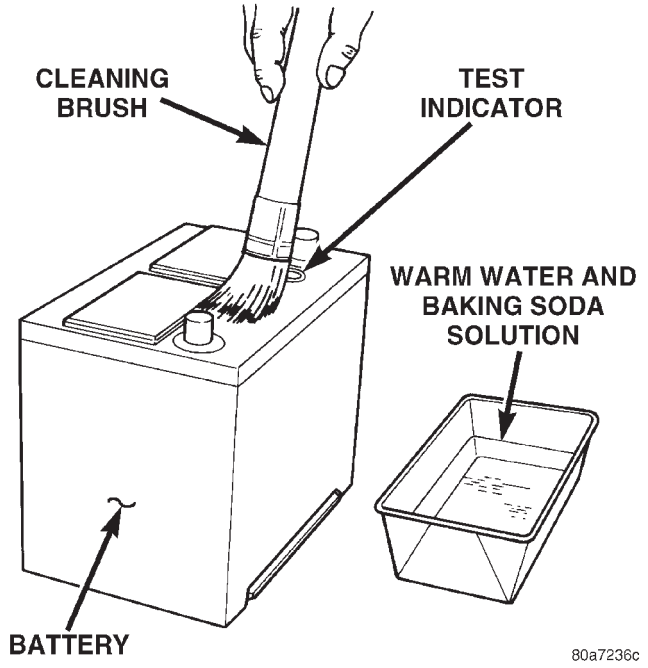

Fig. 15 Cleaning Battery

(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.

(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. 16).

(7) Clean battery cable clamps with a battery terminal cleaning tool (Fig. 17). Replace cables that are frayed or have broken clamps.

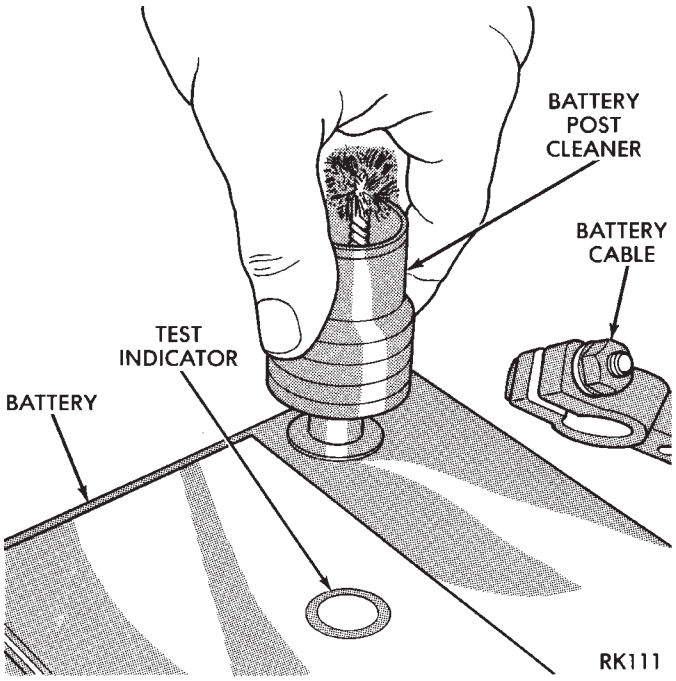

Fig. 16 Cleaning Battery Post

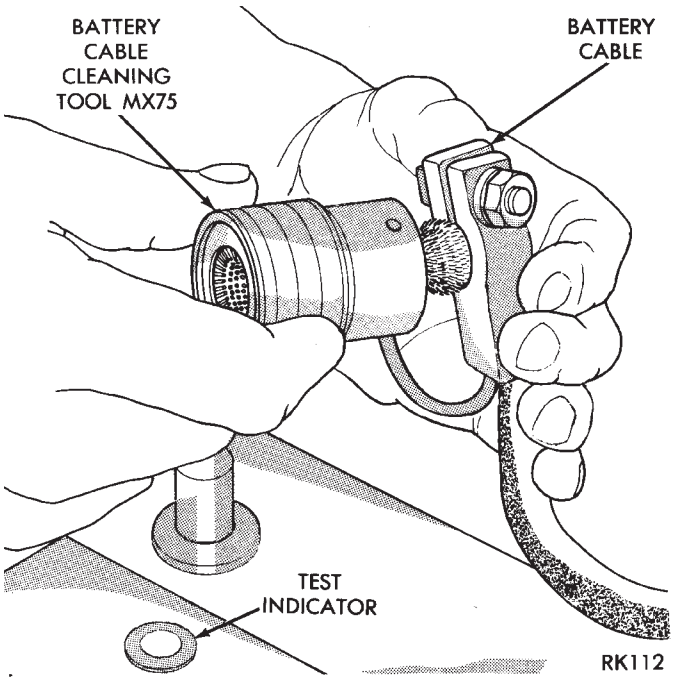

Fig. 17 Cleaning Battery Cable Terminal

REMOVAL AND INSTALLATION

BATTERY

REMOVAL

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

(2) Remove battery negative cable then the positive cable (Fig. 5).

(3) Remove battery thermoguard cover (Fig. 18).

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.

(4) Remove battery hold down clamp (Fig. 19) and battery from vehicle.

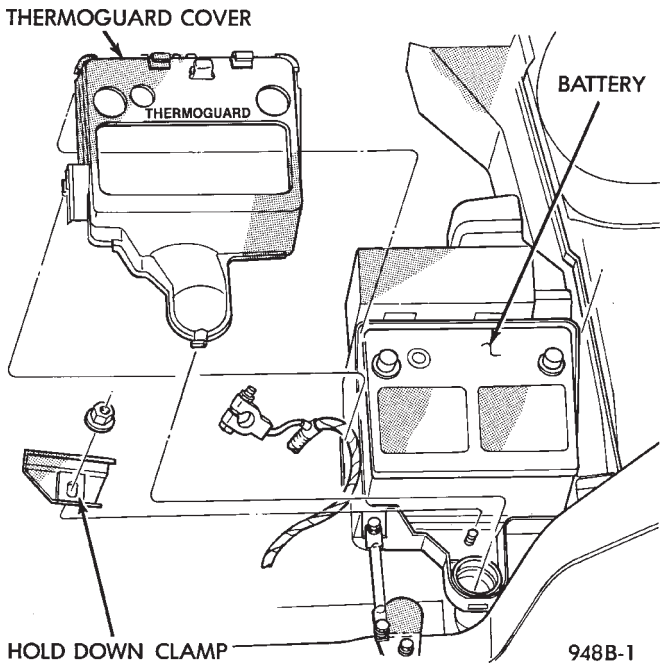

Fig. 18 Battery Thermoguard

INSTALLATION

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

(2) Install battery hold down clamp, making sure that it is properly positioned on battery.

(3) Place thermoguard cover over the battery and snap it together with battery tray (Fig. 20). The battery tray pencil strut may have to be loosened on one end to install the thermoguard cover. After the thermoguard cover is in place, tighten pencil strut as necessary.

(4) Connect battery cable clamps to battery posts and making sure top of clamp is flush or below with

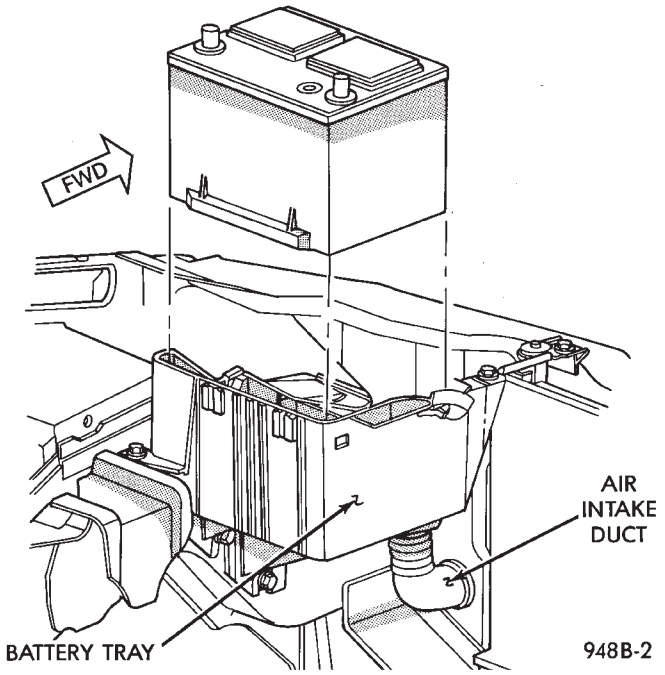

Fig. 19 Battery Hold-Down

top of post (Fig. 21). Install battery positive cable first.

(5) Tighten clamp nuts securely.

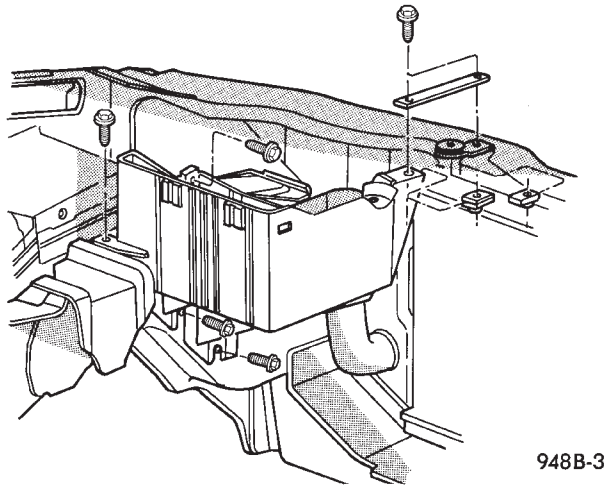

Fig. 20 Battery Tray Removal

BATTERY TRAY

REMOVAL

(1) Remove battery, refer to Battery Removal.

(2) Remove battery tray pencil strut. Remove battery tray, refer to (Fig. 20).

INSTALLATION

For installation reverse above procedures.

REMOVAL AND INSTALLATION (Continued)

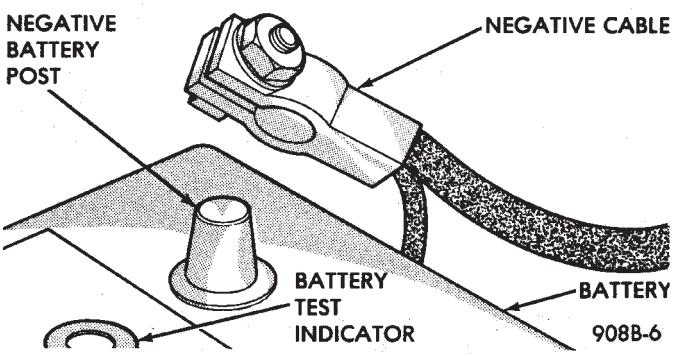

Fig. 21 Remove and Install Battery Cables

FRESH AIR INLET TUBE REMOVAL

REMOVAL

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

(2) Remove battery negative cable first then the positive cable (Fig. 5).

(3) Remove battery thermoguard cover (Fig. 18).

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.

(4) Squeeze the sides of the tube at the pull strap lock tabs and push down through the hole in the battery tray (Fig. 22). DO NOT push directly down on the pull strap itself.

(5) Remove the tube from the radiator closure panel by squeezing the lock tabs and pushing from the front side (Fig. 19).

INSTALLATION

For installation reverse above procedures. Ensure that the lock tabs are properly seated in the radiator panel and to the bottom of battery tray (Fig. 22). Ensure that the tube opening is properly aligned with hole before pulling on strap.

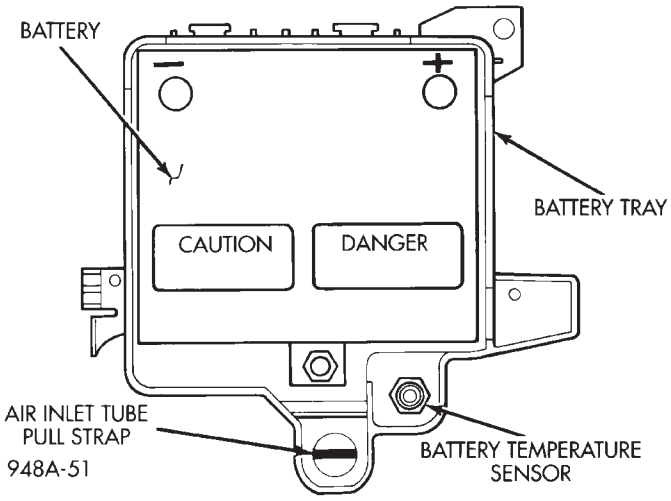

Fig. 22 Air Inlet Tube Pull Strap

SPECIFICATIONS

BATTERY SPECIFICATIONS

Load Test (Amps)	Cold Cranking Rating @ -18°C (0°F)	Reserve Capacity
225 Amp	450 Amp	85 Minutes

COLD CRANK RATING

The current battery can deliver for 30 seconds and maintain a terminal voltage of 7.2 volts or greater at –18° C (0° F).

RESERVE CAPACITY RATING

The length of time a battery can deliver 25 amps and maintain a minimum terminal voltage of 10.5 volts at 27°C (80°F).

TORQUE

DESCRIPTION	TORQUE
Battery Hold Down Bolt	
Clamp Bolt	9 N·m (75 in. lbs.)