BATTERY

CONTENTS

page

GENERAL INFORMATION
INTRODUCTION 1
SAFETY PRECAUTIONS AND WARNINGS 1
DESCRIPTION AND OPERATION
BATTERY IGNITION OFF DRAW (IOD) 1
CHARGING TIME REQUIRED 2
DIAGNOSIS AND TESTING
BATTERY BUILT-IN TEST INDICATOR 2
BATTERY IGNITION OFF DRAW (IOD) 3
BATTERY LOAD TEST 4
BATTERY OPEN CIRCUIT VOLTAGE TEST 6

page

SERVICE PROCEDURES
BATTERY CHARGING 6
CHARGING COMPLETELY DISCHARGED BATTERY 7
VISUAL INSPECTION 7
REMOVAL AND INSTALLATION
BATTERY TRAY 9
BATTERY 8
SPECIFICATIONS
BATTERY SPECIFICATIONS 10
TORQUE 10

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, 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.

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 RUBBER 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

DESCRIPTION AND OPERATION (Continued)

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 the Battery Charging Timetable for charging times.

BATTERY CHARGING TIMETABLE

Charging Amperage	5 Amperes	10 Amperes	20 Amperes
Open Circuit Voltage	Hours Charging at 21°C (70°F)		
12.25 to 12.39	6 hours	3 hours	1.5 hours
12.00 to 12.24	8 hours	4 hours	2 hours
11.95 to 11.99	12 hours	6 hours	3 hours
10.00 to 11.94	14 hours	7 hours	3.5 hours
less than 10.00	See Charging Completely Discharged Battery		

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. 1) into view at approximately 75 percent state-of-charge.

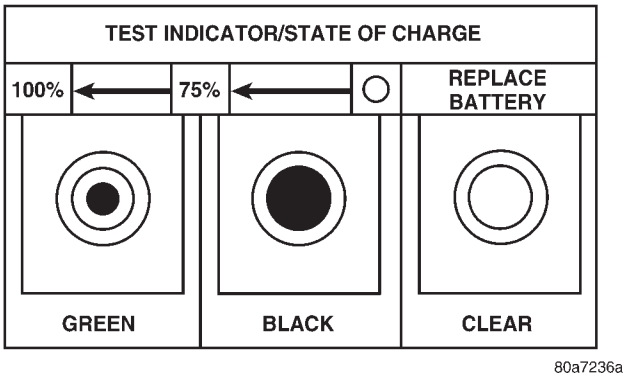

Fig. 1 Reading Test Indicator

DIAGNOSIS AND TESTING

BATTERY BUILT-IN TEST INDICATOR

USING TEST INDICATOR

The Test Indicator (Fig. 1), (Fig. 2) and (Fig. 3) 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. 1), (Fig. 3) and note the color of the indicator. Refer to the following description of colors:

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

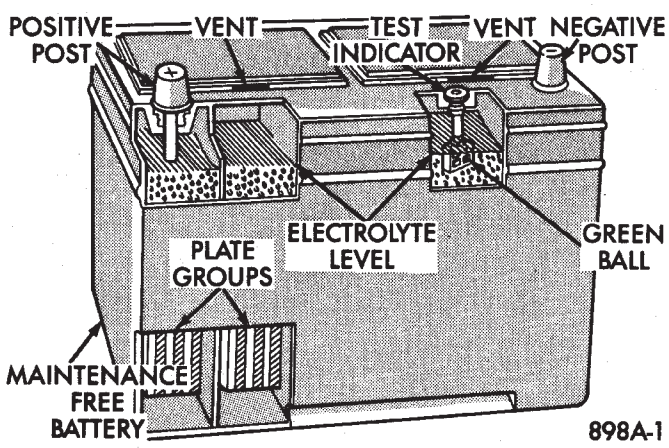

Fig. 2 Battery Construction and Test Indicator

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)

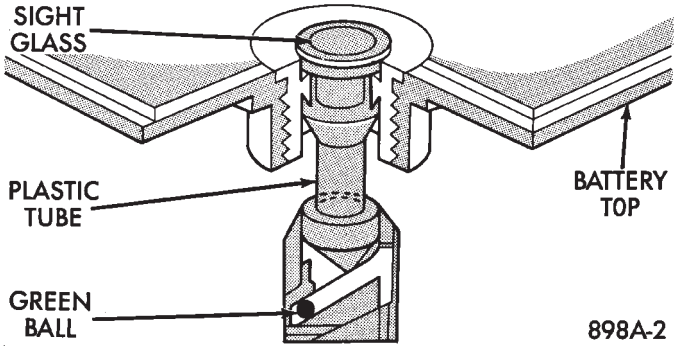

Fig. 3 Test Indicator

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. 1). 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 table 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 (IOD)

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.
- During Transmission Control Module (TCM) power down there will be 500 milliamperes present for 20 minutes. Afterwards less than 1.0 milliampere.

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

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
- Body Control Module
- Remote Keyless Entry Module

DIAGNOSIS AND TESTING (Continued)

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.

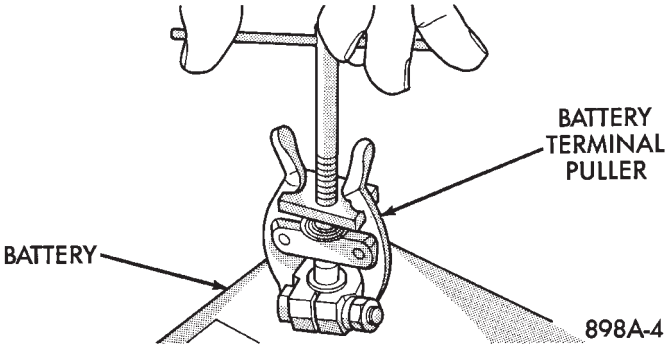

Fig. 4 Disconnect Battery Negative Cable

(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, disconnect the TCM.

(d) If reading is OK, replace TCM.

(e) If reading stays, there is a short circuit to one of the modules. 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

DIAGNOSIS AND TESTING (Continued)

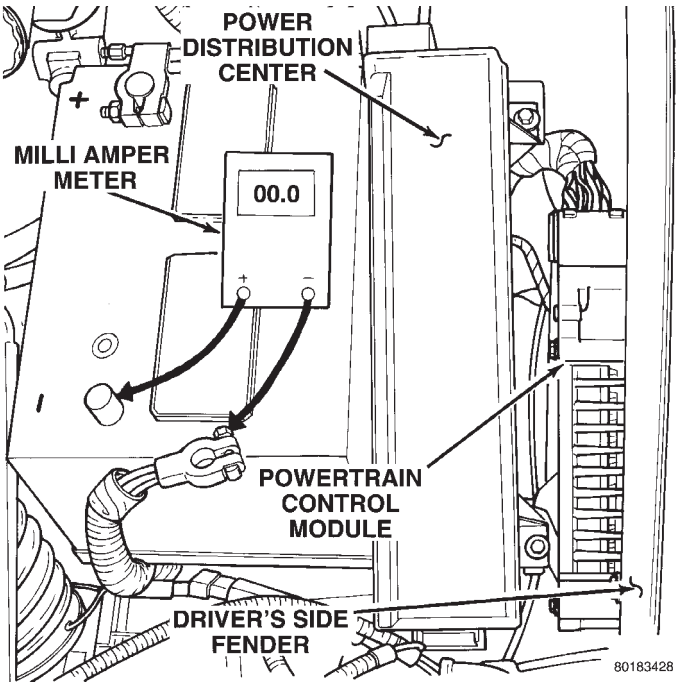

Fig. 5 Milliampere Meter Connection

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).

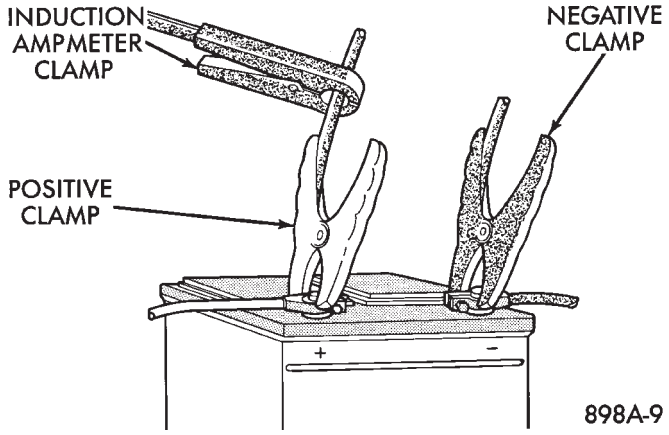

Fig. 6 Volt-Ammeter Load Tester Connections

(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

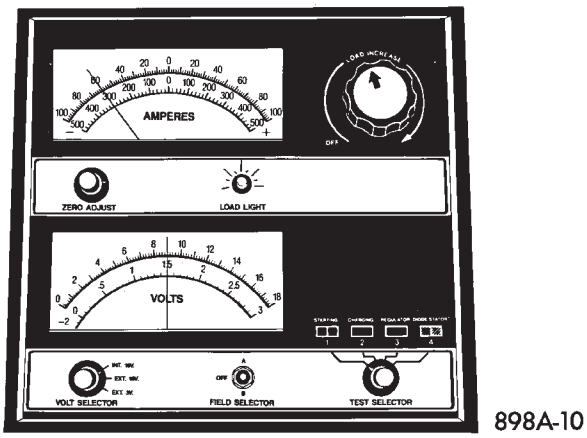

Fig. 7 Remove Surface Charge From Battery

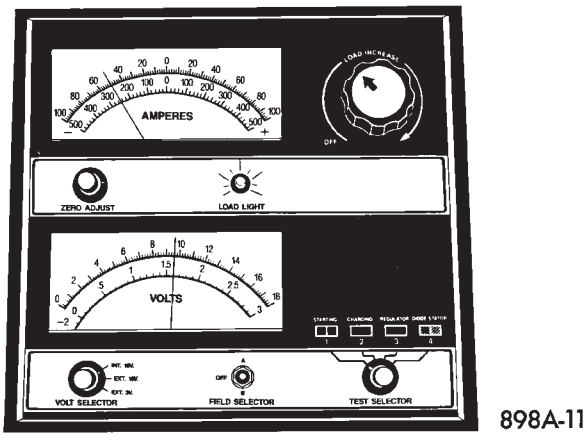

Fig. 8 Load 50% Cold Crank Rating

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 Battery Load Test Temperature Table:

BATTERY 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.

DIAGNOSIS AND TESTING (Continued)

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. Refer to Battery Open Circuit Voltage table.

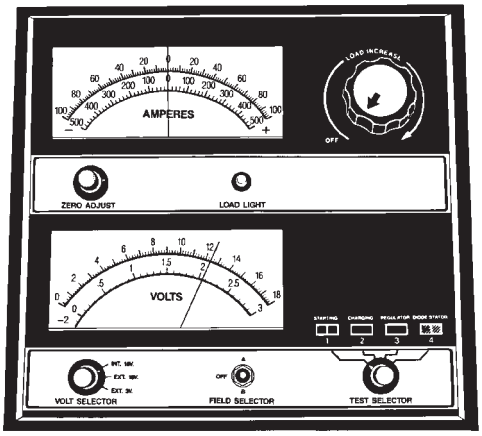

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Fig. 9 Testing Open Circuit Voltage

BATTERY OPEN CIRCUIT VOLTAGE

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

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.

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

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

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.
- It passes the 15 second load test, refer to the Load Test Temperature chart.
- The built in test indicator dot is GREEN (Fig. 1).

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

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

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

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

SERVICE PROCEDURES (Continued)

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. Refer to Battery Charging Rate table.

BATTERY CHARGING RATE

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

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

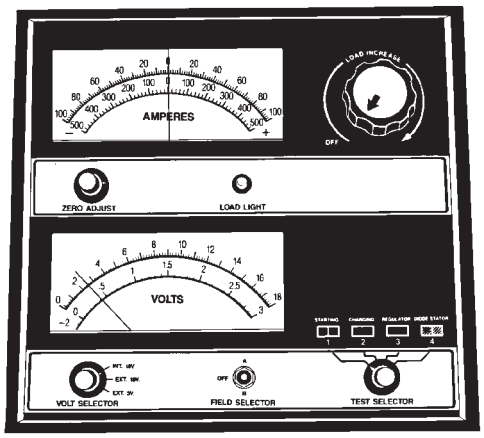

Fig. 10 Voltmeter Accurate to 1/10 Volt (Connected)

(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 Battery Charging Rate table. 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. 11).

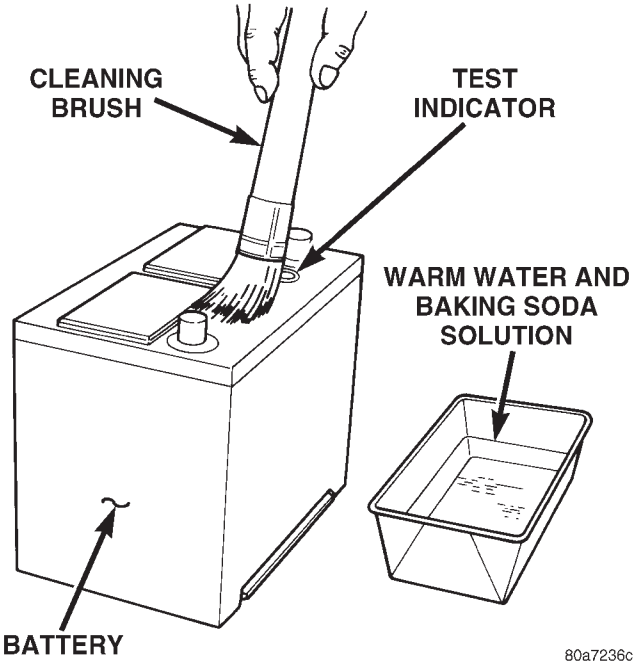

Fig. 11 Cleaning Battery

(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. 12).

(7) Clean battery cable clamps with a battery terminal cleaning tool (Fig. 13). Replace cables that are frayed or have broken clamps.

SERVICE PROCEDURES (Continued)

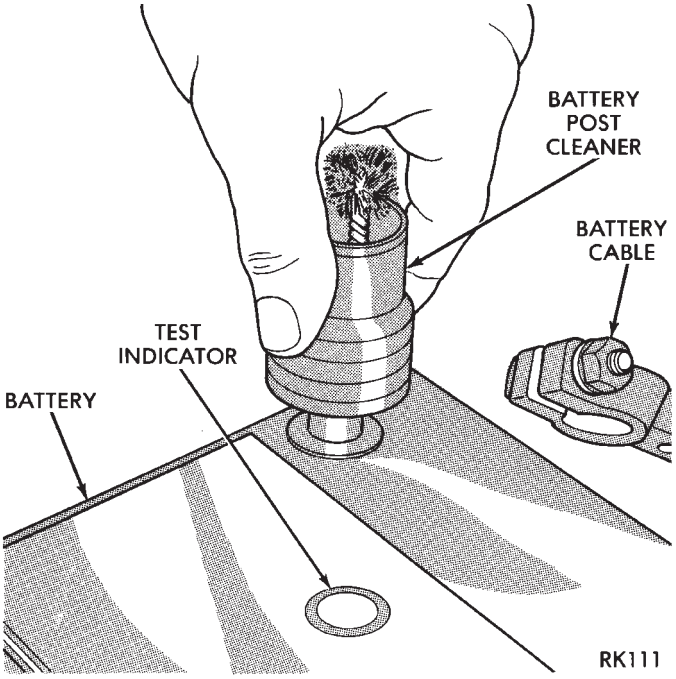

Fig. 12 Cleaning Battery Post

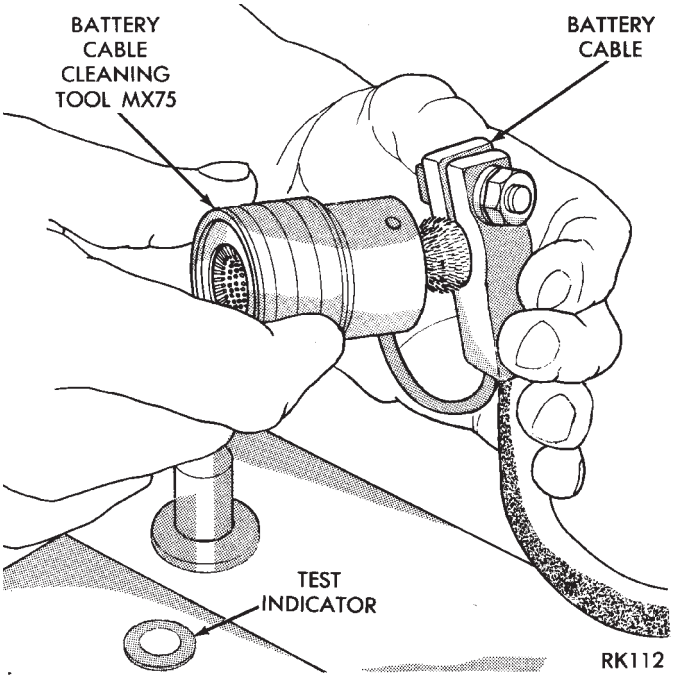

Fig. 13 Cleaning Battery Cable Terminal

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. 14).

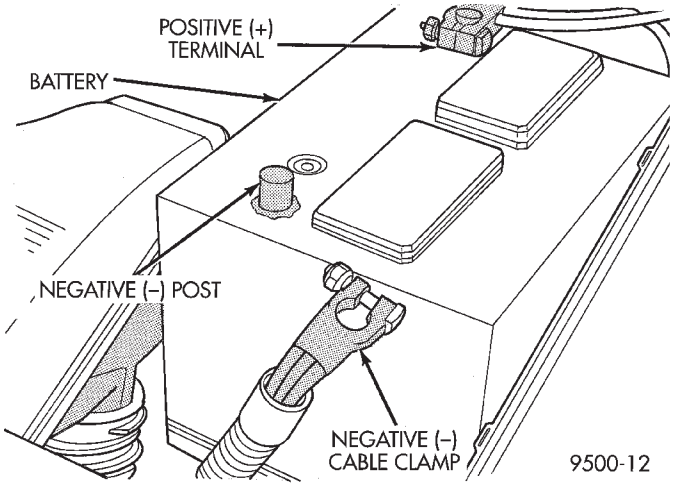

Fig. 14 Battery Cable Disconnected

(3) Remove battery heat shield (Fig. 15).

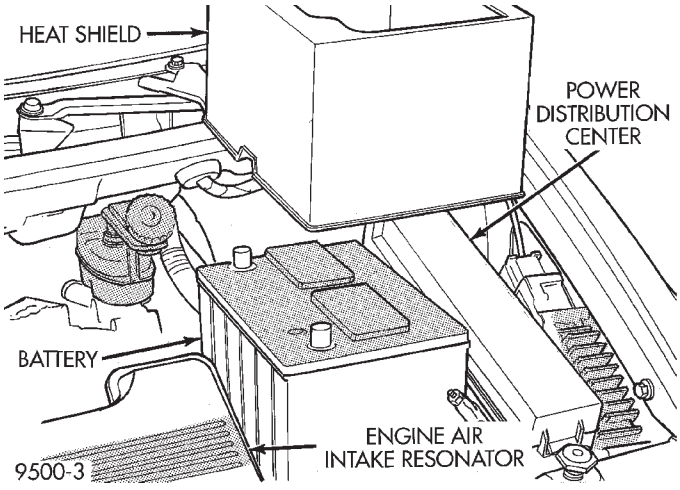

Fig. 15 Battery Heat Shield

(4) Remove battery hold down (Fig. 16).

(5) Remove battery from vehicle (Fig. 17).

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.

REMOVAL AND INSTALLATION (Continued)

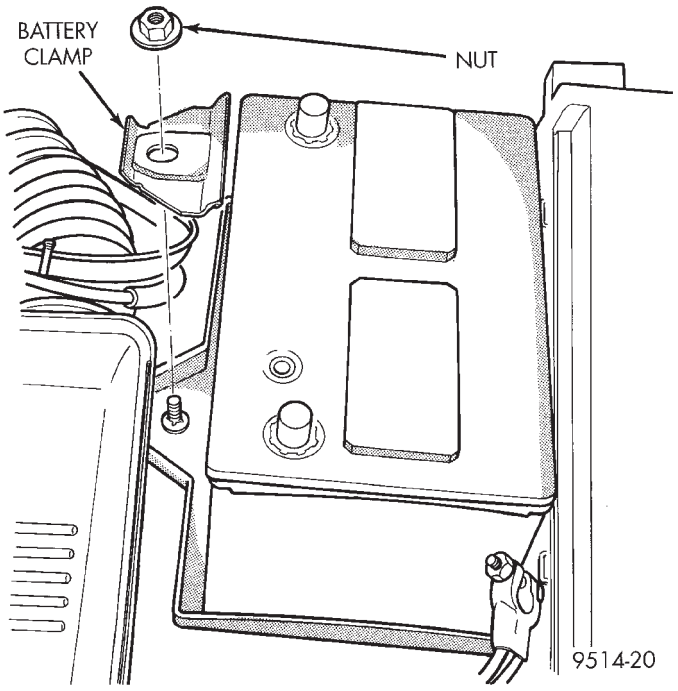

Fig. 16 Battery Hold Down

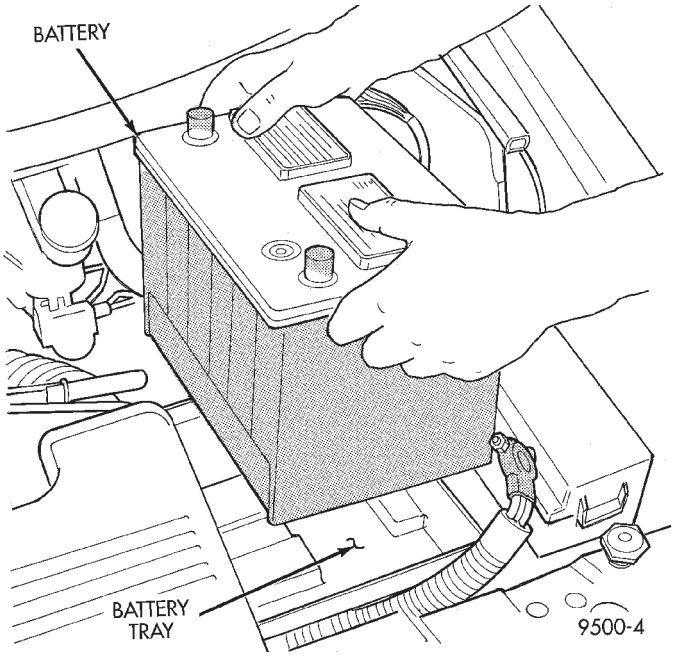

Fig. 17 Remove Battery

(3) Place battery heat shield over battery. The top inside surface of heat shield must be flush with top of battery.

(4) 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.

(5) 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. 18).

(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. 19).

INSTALLATION

For installation, reverse the above procedures.

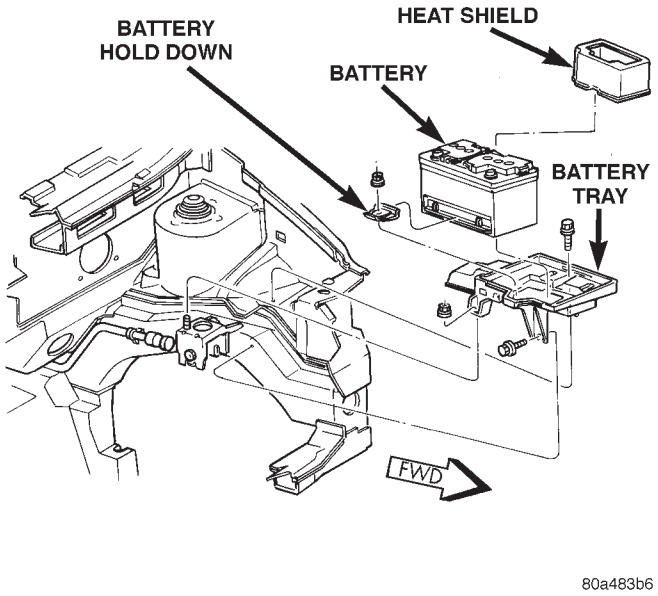

Fig. 18 Battery Tray Removal

REMOVAL AND INSTALLATION (Continued)

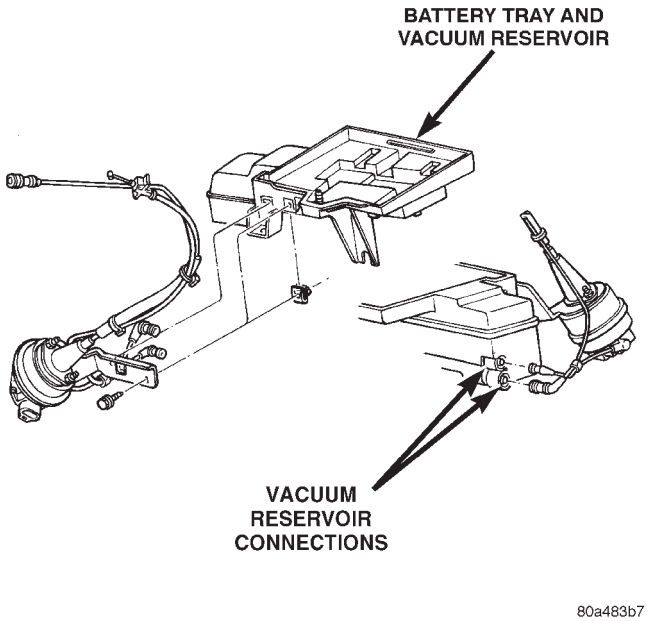

Fig. 19 Speed Control Servo Removal

SPECIFICATIONS

BATTERY SPECIFICATIONS

Load Test (Amps)	Cold Cranking Rating @ 0°F	Reserve Capacity
250 Amp	500 Amp	110 Minutes
300 Amp	600 Amp	120 Minutes
340 Amp	685 Amp	125 Minutes

CRANKING RATING

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

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	14 N·m (125 in. lbs.)