STARTING

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GENERAL INFORMATION

INTRODUCTION

The starting system (Fig. 1) has:

- Ignition switch
- Starter relay
- Neutral starting and back up switch
- Clutch pedal position switch
- Wiring harness
- Battery
- Starter motor with an integral solenoid

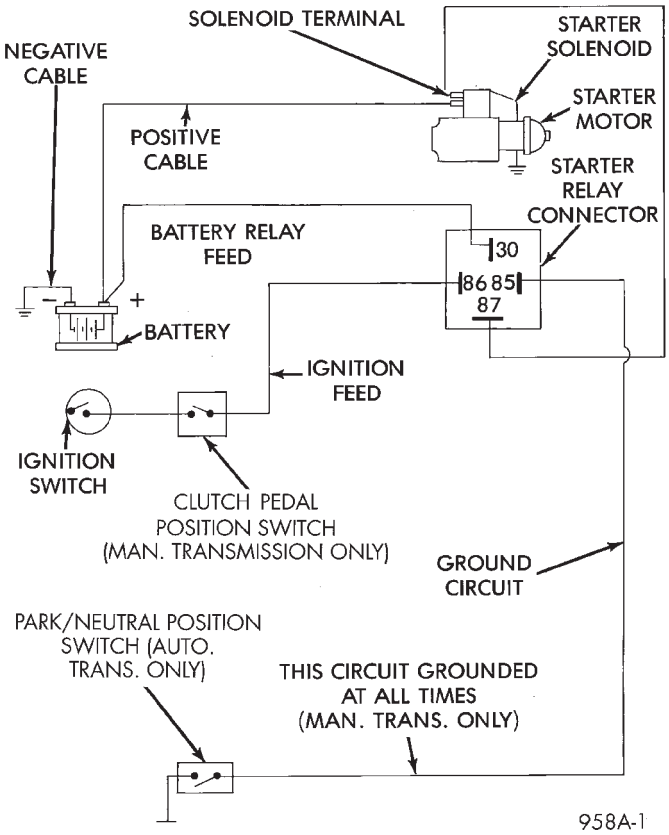


Fig. 1 Starting System

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.

BOSCH STARTER

The Bosch is a permanent magnet starter motor. A planetary gear train transmits power between starter motor and pinion shaft. The fields have six permanent magnets. The starter system consists of two separate circuits:

- A high amperage supply to feed the starter motor.
- A low amperage circuit to control the starter solenoid.

SUPPLY CIRCUIT AND CONTROL CIRCUIT

The starter system consists of two separate circuits:

- A high amperage supply to feed the starter motor.
- A low amperage circuit to control the starter solenoid.

DIAGNOSIS AND TESTING

CONTROL CIRCUIT TEST

The starter control circuit has:

- Starter solenoid
- Starter relay
- Transmission range sensor, or Park/Neutral Position switch with automatic transmissions
- Clutch Pedal Position Switch with manual transmissions
- Ignition switch
- Battery
- All related wiring and connections

CAUTION: Before performing any starter tests, the ignition and fuel systems must be disabled.

- To disable ignition and fuel systems, disconnect the Automatic Shutdown Relay (ASD). The ASD relay is located in the in the Power Distribution Center (PDC). Refer to the PDC cover for the proper relay location.

STARTER SOLENOID

WARNING: CHECK TO ENSURE THAT THE TRANSMISSION IS IN THE PARK POSITION WITH THE PARKING BRAKE APPLIED

(1) Verify battery condition. Battery must be in good condition with a full charge before performing any starter tests. Refer to Battery Tests.

(2) Perform Starter Solenoid test BEFORE performing the starter relay test.

(3) Raise the vehicle.

(4) Perform a visual inspection of the starter/starter solenoid for corrosion, loose connections or faulty wiring.

(5) Lower the vehicle.

(6) Locate and remove the starter relay from the Power Distribution Center (PDC). Refer to the PDC label for relay identification and location.

(7) Connect a remote starter switch or a jumper wire between the remote battery positive post and terminal 87 of the starter relay connector.

(a) If engine cranks, starter/starter solenoid is good. Go to the Starter Relay Test.

(b) If engine does not or solenoid chatters, check wiring and connectors from starter relay to starter solenoid for loose or corroded connections. Particularly at starter terminals.

(c) Repeat test. If engine still fails to crank properly, trouble is within starter or starter mounted solenoid, and replace starter.

STARTER RELAY

WARNING: CHECK TO ENSURE THAT THE TRANSMISSION IS IN THE PARK POSITION/NEUTRAL WITH THE PARKING BRAKE APPLIED

RELAY TEST

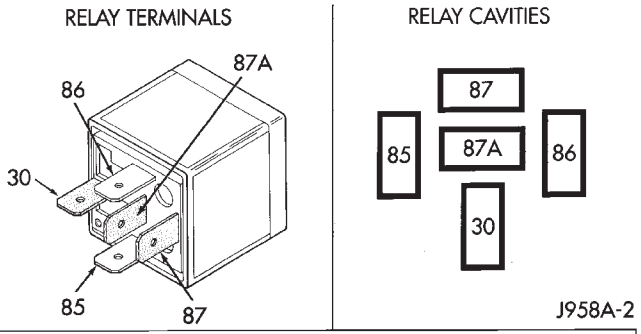
The starter relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for relay identification and location.

Remove the starter relay from the PDC as described in this group to perform the following tests:

(1) A relay in the de-energized position should have continuity between terminals 87A and 30, and no continuity between terminals 87 and 30. If OK, go to Step 2. If not OK, replace the faulty relay.

(2) Resistance between terminals 85 and 86 (electromagnet) should be 75 ±5 ohms. If OK, go to Step 3. If not OK, replace the faulty relay.

(3) Connect a battery B+ lead to terminals 86 and a ground lead to terminal 85 to energize the relay. The relay should click. Also test for continuity between terminals 30 and 87, and no continuity between terminals 87A and 30. If OK, refer to Relay Circuit Test procedure. If not OK, replace the faulty relay.



TERMINAL LEGEND	
NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

Starter Relay

RELAY CIRCUIT TEST

(1) The relay common feed terminal cavity (30) is connected to battery voltage and should be hot at all times. If OK, go to Step 2. If not OK, repair the open circuit to the PDC fuse as required.

(2) The relay normally closed terminal (87A) is connected to terminal 30 in the de-energized position, but is not used for this application. Go to Step 3.

(3) The relay normally open terminal (87) is connected to the common feed terminal (30) in the energized position. This terminal supplies battery voltage to the starter solenoid field coils. There should be

DIAGNOSIS AND TESTING (Continued)

continuity between the cavity for relay terminal 87 and the starter solenoid terminal at all times. If OK, go to Step 4. If not OK, repair the open circuit to the starter solenoid as required.

(4) The coil battery terminal (86) is connected to the electromagnet in the relay. It is energized when the ignition switch is held in the Start position. On vehicles with a manual transmission, the clutch pedal must be fully depressed for this test. Check for battery voltage at the cavity for relay terminal 86 with the ignition switch in the Start position, and no voltage when the ignition switch is released to the On position. If OK, go to Step 5. If not OK with an automatic transmission, check for an open or short circuit to the ignition switch and repair, if required. If the circuit to the ignition switch is OK, see the Ignition Switch Test procedure in this group. If not OK with a manual transmission, check the circuit between the relay and the clutch pedal position switch for an open or a short. If the circuit is OK, see the Clutch Pedal Position Switch Test procedure in this group.

(5) The coil ground terminal (85) is connected to the electromagnet in the relay. On vehicles with an automatic transmission, it is grounded through the park/neutral position switch only when the gearshift selector lever is in the Park or Neutral positions. On vehicles with a manual transmission, it is grounded at all times. Check for continuity to ground at the cavity for relay terminal 85. If not OK with an automatic transmission, check for an open or short circuit to the park/neutral position switch and repair, if required. If the circuit is OK, see the Park/Neutral Position Switch Test procedure in this group. If not OK with a manual transmission, repair the circuit to ground as required.

SAFETY SWITCHES

For diagnostics,

- Clutch Pedal Position Switch, refer to Group 6, Clutch.
- Park/Neutral Position Switch, refer to Group 21, Transaxle

IGNITION SWITCH

After testing starter solenoid and relay, test ignition switch and wiring. Refer to Group 8D, Ignition Systems or Group 8W, Wiring Diagrams. Check all wiring for opens or shorts, and all connectors for being loose or corroded.

BATTERY

Refer to Group 8A, Battery for proper procedures.

ALL RELATED WIRING AND CONNECTORS

Refer to Group 8W, Wiring Diagrams,

FEED CIRCUIT RESISTANCE TEST

Before proceeding with this operation, review Diagnostic Preparation and Starter Feed Circuit Tests. The following operation will require a voltmeter, accurate to 1/10 of a volt.

CAUTION: Ignition system also must be disabled to prevent engine start while performing the following tests.

(1) To disable the ignition and fuel systems, disconnect the Automatic Shutdown Relay (ASD). The ASD relay is located in the Power Distribution Center (PDC). Refer to the PDC cover for proper relay location.

(2) With all wiring harnesses and components properly connected, perform the following:

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

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

(c) Connect negative lead of voltmeter to battery negative terminal, and positive lead to engine block near the battery cable attaching point (Fig. 3). Rotate and hold the ignition switch in the START position. If voltage reads above 0.2 volt, correct poor contact at ground cable attaching point. If voltage reading is still above 0.2 volt after correcting poor contacts, replace ground cable.

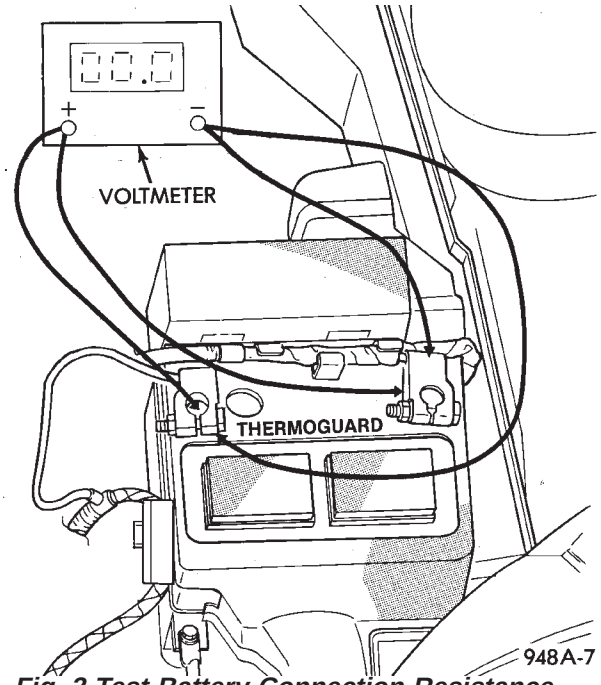


Fig. 2 Test Battery Connection Resistance

DIAGNOSIS AND TESTING (Continued)

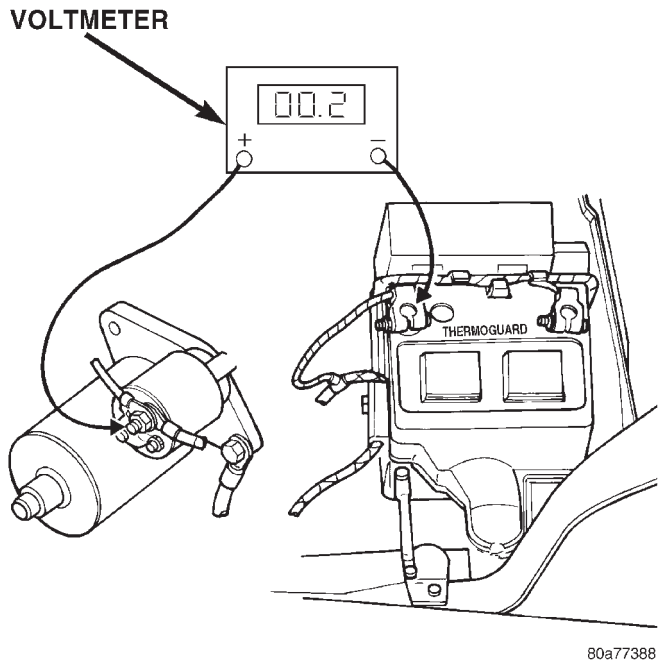


Fig. 3 Test Ground Circuit Resistance

(3) Connect positive voltmeter lead to the starter motor housing and the negative lead to the battery negative terminal (Fig. 4). Hold the ignition switch key in the START position. If voltage reads above 0.2 volt, correct poor starter to engine ground.

(a) Connect the positive voltmeter lead to the battery positive terminal, and negative lead to battery cable terminal on starter solenoid (Fig. 5). Rotate and hold the ignition switch in the START position. If voltage reads above 0.2 volt, correct poor contact at battery cable to solenoid connection. If reading is still above 0.2 volt after correcting poor contacts, replace battery positive cable.

(b) If resistance tests do not detect feed circuit failures, replace the starter motor.

FEED CIRCUIT TEST

The following procedure will require a suitable volt-ampere tester (Fig. 6).

CAUTION: Before performing any starter tests, the ignition and fuel systems must be disabled.

(1) Connect a volt-ampere tester to the battery terminals (Fig. 7). Refer to the operating instructions provided with the tester being used.

(2) To disable the ignition and fuel systems, disconnect the Automatic Shutdown Relay (ASD). The ASD relay is located in the Power Distribution Center (PDC). Refer to the PDC cover for proper relay location. The 2.5L Diesel Engine, to disable the engine from starting, disconnect wire connector from the Fuel Solenoid.

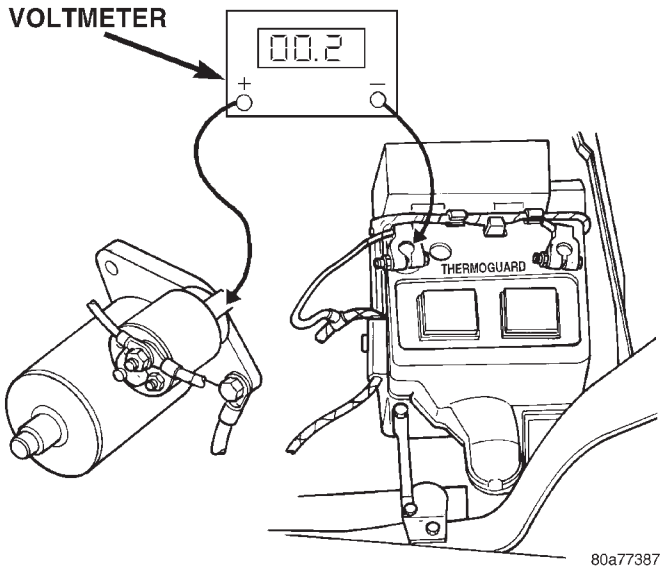


Fig. 4 Test Starter Motor Ground

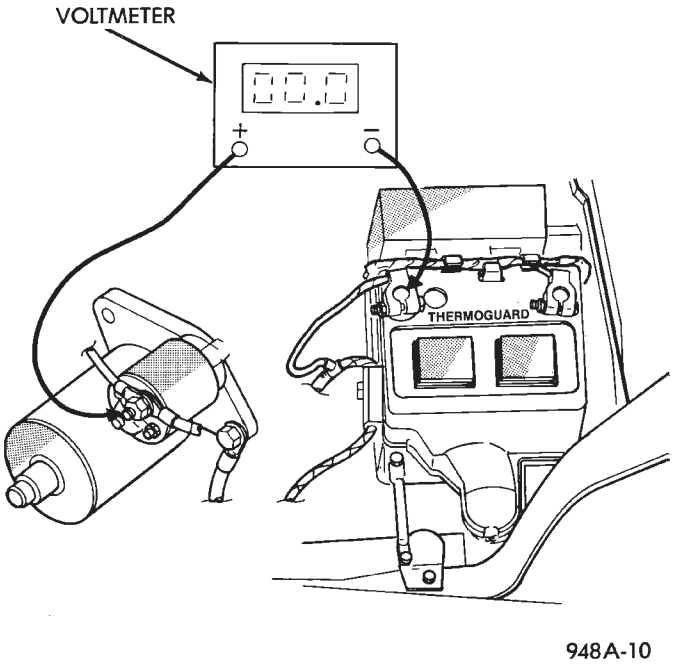


Fig. 5 Test Battery Positive Cable Resistance

(3) Verify that all lights and accessories are OFF, and the transmission shift selector is in the PARK position or with the clutch pedal depressed and SET parking brake.

CAUTION: Do not overheat the starter motor or draw the battery voltage below 9.6 volts during cranking operations.

(4) Rotate and hold the ignition switch in the START position. Observe the volt-ampere tester (Fig. 6).

DIAGNOSIS AND TESTING (Continued)

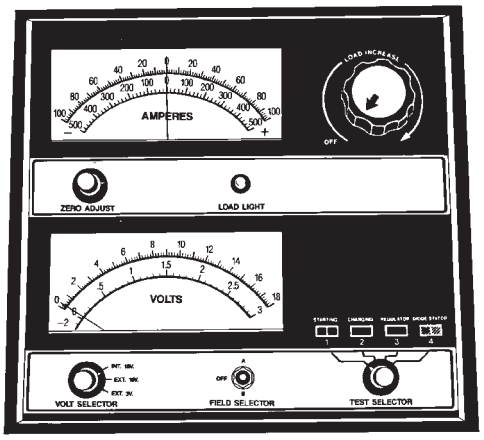


Fig. 6 Volt Ampere Tester

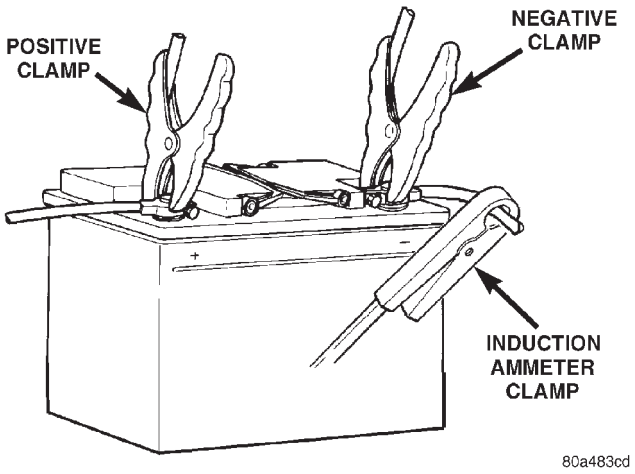


Fig. 7 Volt-Ampere Tester Connections

- If voltage reads above 9.6 volts, and amperage draw reads above 280 amps or the Diesel engine above 450 amps, check for engine seizing or faulty starter.
- If voltage reads 12.4 volts or greater and amperage reads 0 to 10 amps, check for corroded cables and/or bad connections.
- Voltage below 9.6 volts and amperage draw above 300 amps or Diesel engine above 500 amps, the problem is the starter. Replace the starter refer to starter removal.

(5) After the starting system problems have been corrected, verify the battery state-of-charge and charge battery if necessary. Disconnect all testing equipment and connect ASD relay or the Fuel Solenoid. Start the vehicle several times to assure the problem has been corrected.

STARTING SYSTEM TEST

For circuit descriptions and diagrams, refer to 8W-21, Starting System in Group 8W, Wiring Diagrams.

WARNING: ON VEHICLES EQUIPPED WITH AIRBAGS, REFER TO GROUP 8M - PASSIVE RESTRAINT SYSTEMS BEFORE ATTEMPTING STEERING WHEEL, STEERING COLUMN, OR INSTRUMENT PANEL COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

INSPECTION

Before removing any unit from the starting system for repair or diagnosis, perform the following inspections:

- **Battery** - Visually inspect the battery for indications of physical damage and loose or corroded cable connections. Determine the state-of-charge and cranking capacity of the battery. Charge or replace the battery, if required. Refer to Group 8A, Battery for more information.
- **Ignition Switch** - Visually inspect the ignition switch for indications of physical damage and loose or corroded wire harness connections.
- **Clutch Pedal Position Switch** - Visually inspect the clutch pedal position switch for indications of physical damage and loose or corroded wire harness connections.
- **Park/Neutral Position Switch** - Visually inspect the park/neutral position switch for indications of physical damage and loose or corroded wire harness connections.
- **Starter Relay** - Visually inspect the starter relay for indications of physical damage and loose or corroded wire harness connections.
- **Starter** - Visually inspect the starter for indications of physical damage and loose or corroded wire harness connections.
- **Starter Solenoid** - Visually inspect the starter solenoid for indications of physical damage and loose or corroded wire harness connections.
- **Wiring** - Visually inspect the wire harness for damage. Repair or replace any faulty wiring, as required.

DIAGNOSIS AND TESTING (Continued)

STARTING SYSTEM DIAGNOSIS		
CONDITION	**POSSIBLE CAUSE**	**CORRECTION**
STARTER FAILS TO ENGAGE.	1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter relay faulty. 4. Ignition switch faulty. 5. Park/Neutral position switch (auto trans) faulty or mis-adjusted. 6. Clutch pedal position switch (man trans) faulty. 7. Starter solenoid faulty. 8. Starter assembly faulty.	1. Refer to Group 8A, Battery. Charge or replace battery, if required. 2. Refer to Feed Circuit Resistance Test and Feed Circuit Test in this section. 3. Refer to Relay Test, in this section. Replace relay, if necessary. 4. Refer to Ignition Switch Test, in Group 8D Ignition System or Group 8W, Wiring Diagrams. Replace switch, if necessary. 5. Refer Park/Neutral Position Switch Test, in Group 21, Transaxle. Replace switch, if necessary. 6. Refer to Clutch Pedal Position Switch Test, in Group 6, Clutch. Replace switch, if necessary. 7. Refer to Solenoid Test, in this section. Replace starter assembly, if necessary. 8. If all other starting system components and circuits check OK, replace starter assembly.
STARTER ENGAGES, FAILS TO TURN ENGINE.	1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter assembly faulty. 4. Engine seized.	1. Refer to Group 8A, Battery. Charge or replace battery as necessary. 2. Refer to the Feed Circuit Resistance Test and the Feed Circuit Test in this section. Repair as necessary. 3. If all other starting system components and circuits check OK, replace starter assembly. 4. Refer to Group 9 Engine, for diagnostic and service procedures.
STARTER ENGAGES, SPINS OUT BEFORE ENGINE STARTS.	1. Broken teeth on starter ring gear. 2. Starter assembly faulty.	1. Remove starter. Inspect ring gear and replace if necessary. 2. If all other starting system components and circuits check OK, replace starter assembly.
STARTER DOES NOT DISENGAGE.	1. Starter improperly installed. 2. Starter relay faulty. 3. Ignition switch faulty. 4. Starter assembly faulty.	1. Install starter. Tighten starter mounting hardware to correct torque specifications. 2. Refer to Relay Test, in this section. Replace relay, if necessary. 3. Refer to Ignition Switch Test, in Group 8D, Ignition System. Replace switch, if necessary. 4. If all other starting system components and circuits check OK, replace starter assembly.

REMOVAL AND INSTALLATION

SAFETY SWITCHES

For Removal and Installation of the:

- Clutch Position Switch, refer to Group 6, Clutch.
- Park/Neutral Switch, refer to Group 21, Transaxle.

STARTER

REMOVAL

(1) Disconnect battery negative cable (Fig. 8).

(2) Raise vehicle.

(3) Vehicles equipped with A/C:

(a) Using a floor jack or jack stand, support the engine and transmission assembly so they will not rotate.

(b) Remove the front engine mount bolt from the insulator and front crossmember mounting bracket (Fig. 9).

(c) Lower the front of the engine, rotate the engine forward, allowing easier removal of starter motor.

(4) For easier servicing, do not remove the wiring from starter at this time.

(5) Remove two bolts attaching starter to transmission housing (Fig. 10).

(6) Remove starter/starter solenoid assembly from transmission housing. Position the starter to gain access to the wiring connectors.

(7) Remove the battery positive cable nut and remove the battery positive and generator output wire from the starter (Fig. 11).

(8) Disconnect push-on solenoid connector.

(9) Position the starter vertically such that the pinion end faces downward.

(10) Remove the starter through the bottom of the vehicle. Move aside A/C plumbing as necessary.

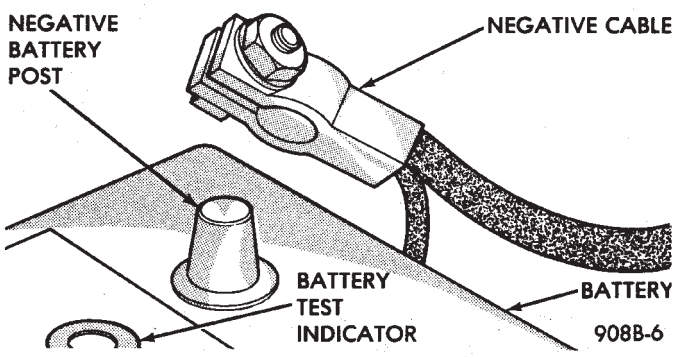


Fig. 8 Battery Cable Removal and Installation

INSTALLATION

(1) Clean corrosion/dirt from the cable and wire terminals before installing wiring to the solenoid.

(2) Connect the battery positive and generator output wire to the starter solenoid post (Fig. 11).

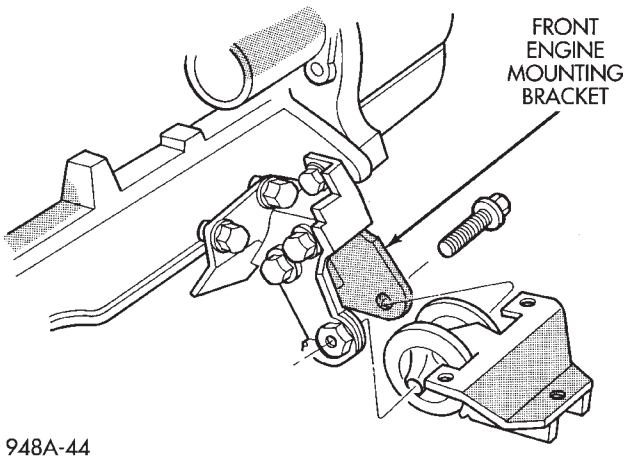


Fig. 9 Front Engine Mount Bolt Removal

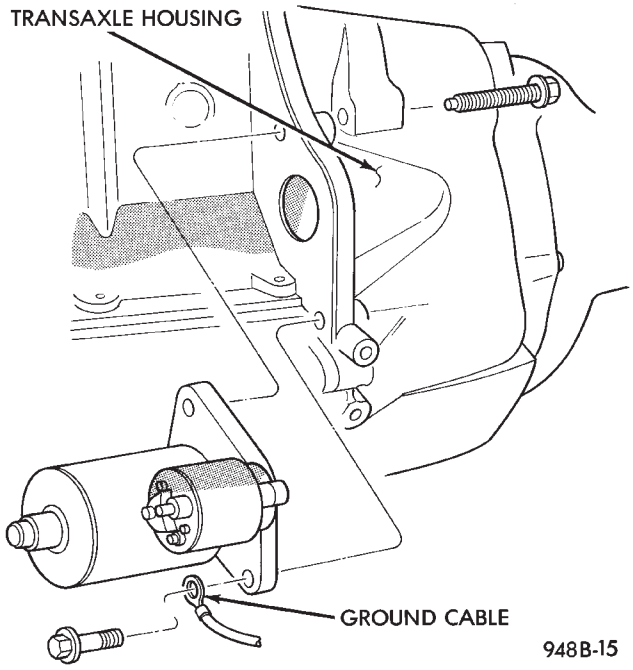


Fig. 10 Starter Removal

CAUTION: It is critical that the generator output terminal be connected to the battery positive terminal of the starter solenoid, for proper operation of the charging and cranking systems.

(3) Connect the push-on solenoid connector.

(4) Position the starter face into transmission housing. Support starter in pilot and start the top bolt (Fig. 10).

(5) Attach ground cable to lower mounting bolt and start bolt.

(6) Ensure the proper starter alignment before tightening the starter mounting bolts to 54 N·m (40 ft. lbs.) torque.

(7) Vehicles equipped with A/C:

REMOVAL AND INSTALLATION (Continued)

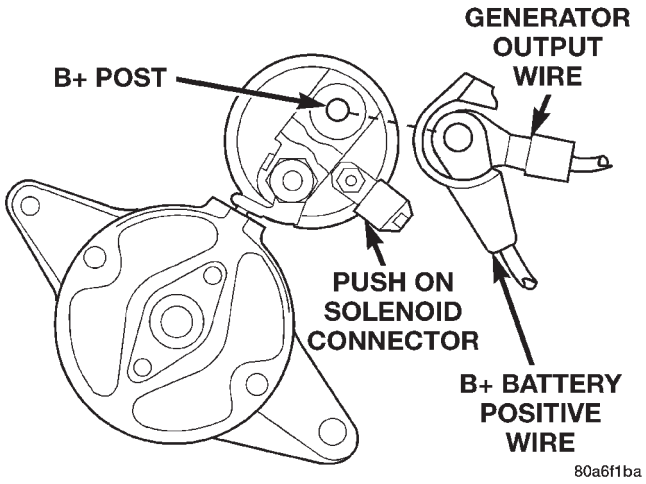


Fig. 11 Wire Connection

(a) Using a floor jack or jack stand, raise the engine and transmission assembly to the original position.

(b) Install the front engine mount bolt through the insulator and front crossmember mounting bracket (Fig. 9).

(c) Tighten bolt to 54 N·m (40 ft. lbs.) torque.

(8) Lower vehicle and connect battery cables.

STARTER RELAY

The relay is located in the Power Distribution Center (PDC). Refer to the PDC cover for relay location.

SPECIFICATIONS

STARTER

Manufacturer	BOSCH
Engine Application	2.0L OHC - DOHC
Power rating	0 .95 Kw
Voltage	12 VOLTS
No. of Fields	6
No. of Poles	6
Brushes	4
Drive	Planetary Gear Train
Cranking Amperage Draw test	150 - 280 Amps.

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

TORQUE

DESCRIPTION	TORQUE
Starter Mounting Bolts	54 N·m (40 ft. lbs.)
Starter Solenoid Battery Nut	10 N·m (90 in. lbs.)