

# STARTING SYSTEMS

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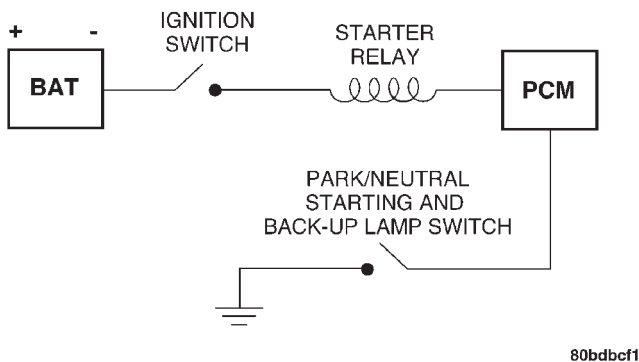
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## GENERAL INFORMATION

### INTRODUCTION

The starting system (Fig. 1) and (Fig. 2) has:

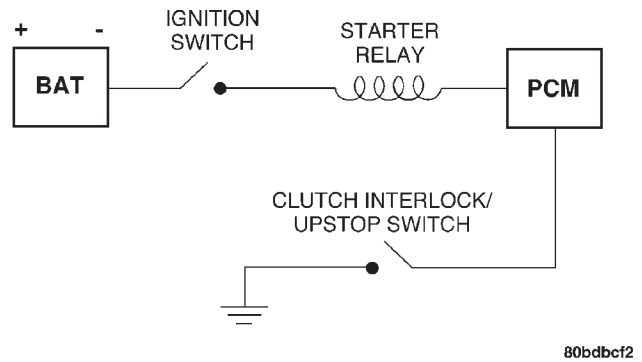
- Ignition switch
- Starter relay
- Park/Neutral Starting Back-Up Lamp Switch with automatic transmissions
- Clutch Interlock/Upstop Switch with manual transmissions
- Powertrain Control Module (PCM) for double start over ride
- Wiring harness
- Battery
- Starter motor with an integral solenoid



**Fig. 1 Starting System Components - Automatic**

These components form two separate circuits. A high amperage circuit that feeds the starter motor up to 300+ amps, and a control circuit that operates on less than 20 amps.

The Powertrain Control Module (PCM) controls a double start over ride safety that does not allow the



**Fig. 2 Starting System Components - Manual**

starter to be engaged if the engine is already running.

### 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.

## DESCRIPTION AND OPERATION

### STARTER MOTOR

The starter is a permanent magnet starter motor. The fields have six permanent magnets. A planetary gear train transmits power between starter motor and pinion shaft. The starter provides mechanical torque to rotate the crankshaft at an RPM (crank speed) necessary for self-sustained spark/ignition.

## DIAGNOSIS AND TESTING

### CONTROL CIRCUIT

The starter control circuit has:

- Starter solenoid
- Starter relay
- Park/Neutral Starting and Back-Up Lamp Switch with automatic transmissions
- Clutch Interlock/Upstop Switch with manual transmissions
- Ignition switch
- Battery
- All related wiring and connections
- Double Start Override algorithm located in the PCM

**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 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 motor and starter solenoid is good. Go to the Starter Relay Test.

- (b) If engine does not crank or solenoid chatters, check wiring and connectors from starter relay to starter solenoid for loose or corroded connections. Check for corroded connections 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 WITH THE PARKING BRAKE APPLIED.

### RELAY TEST

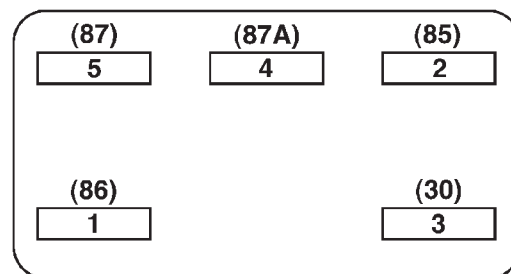
The starter relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for relay identification and location. Use the Starter Relay Pin Call-Out table and (Fig. 3) for relay testing.

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  $75 \pm 5$  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. 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.



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**Fig. 3 Starter Relay**

DIAGNOSIS AND TESTING (Continued)

STARTER RELAY PIN CALL-OUT

PIN	CIRCUIT	COLOR	DESCRIPTION
1 (86)	A041	YL	IGNITION SWITCH OUTPUT (START)
2 (85)	K090	TN	PCM
3 (30)	A001	RD	FUSED B+
4 (87A)			NOT USED
5 (87)	T040	BR	STARTER SOLENOID

**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 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 interlock/upstop switch for an open or a short circuit. If the circuit is OK, refer to the Clutch Interlock/Upstop Switch Diagnosis and Testing in Group 6-Clutch.

(5) The coil ground terminal (85) is connected to the electromagnet in the relay. It is grounded through the PCM only when the gearshift selector lever is in the Park or Neutral positions. On vehicles with a manual transmission, it is grounded through the PCM when the clutch pedal is depressed. Check for continuity to ground at the cavity for relay terminal 85. If not OK, check for an open or short circuit to the park/neutral starting and back-up lamp switch, or the clutch interlock/upstop switch. Repair, as necessary. If the circuit is OK, refer to the Park/

Neutral Starting and Back-Up Lamp Switch Removal and Installation in Group 21-Transaxle. Testing is located within the Removal and Installation procedures.

**SAFETY SWITCHES**

For diagnosis of:

- Clutch Interlock/Upstop Switch, refer to Diagnosis and Testing in Group 6-Clutch.
- Park/Neutral Starting and Back-Up Lamp Switch, refer to Removal and Installation in Group 21-Transaxle. Testing is located within the Removal and Installation procedures.

**IGNITION SWITCH**

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

**BATTERY**

Refer to Group 8A-Battery for Diagnosis and Testing of the battery.

**ALL RELATED WIRING AND CONNECTORS**

Refer to Group 8W-Wiring Diagrams.

**FEED CIRCUIT RESISTANCE**

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.**

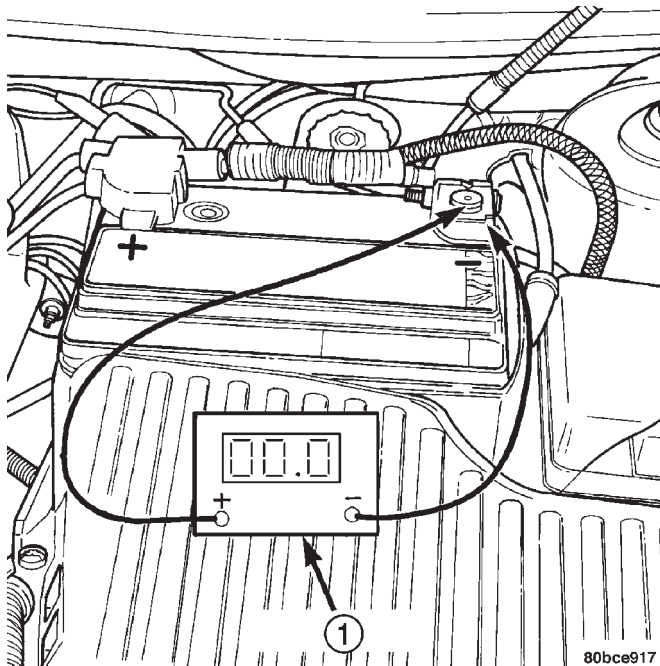
(1) To disable the ignition and fuel systems, disconnect the Automatic Shutdown (ASD) Relay. The ASD relay is located in the Power Distribution Center (PDC). Refer to the PDC cover for proper relay location.

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

## DIAGNOSIS AND TESTING (Continued)

(a) Connect the negative lead of the voltmeter to the battery negative post, and positive lead to the battery negative cable clamp (Fig. 4). 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. 4). 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.

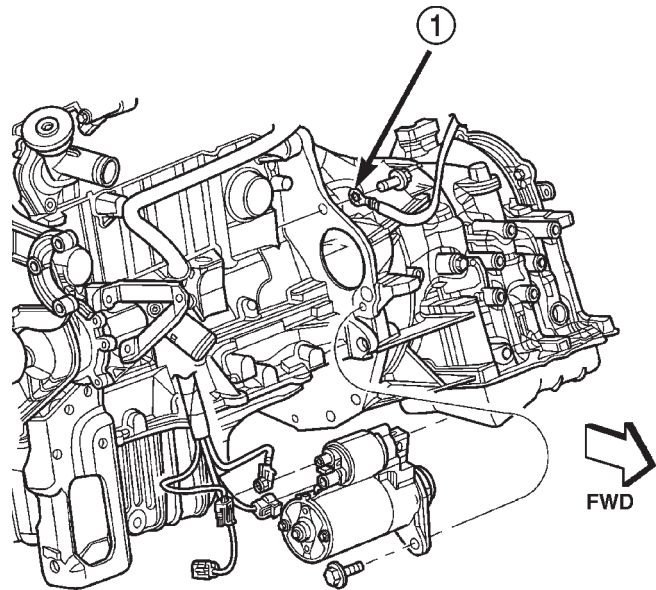


**Fig. 4 Battery Connection Resistance**

1 - VOLTMETER

(c) Connect negative lead of voltmeter to battery negative terminal, and positive lead to engine block near the battery cable attaching point (Fig. 5). 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.

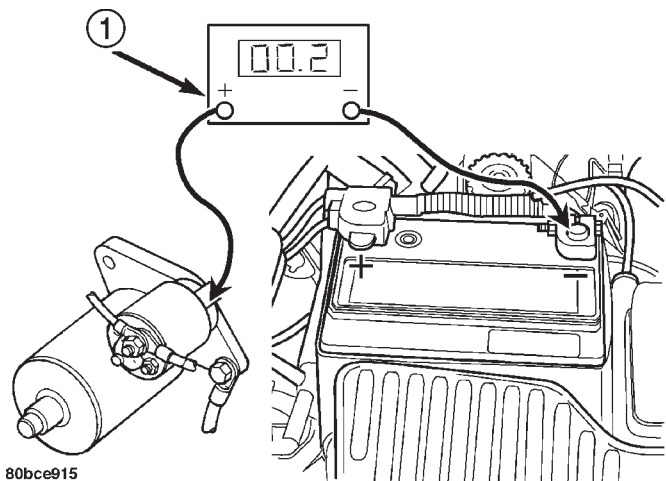
(3) Connect positive voltmeter lead to the starter motor housing and the negative lead to the battery negative terminal (Fig. 6). Hold the ignition switch key in the START position. If voltage reads above 0.2 volt, correct poor starter to engine ground.



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**Fig. 5 Ground Circuit Resistance**

1 - NEGATIVE BATTERY CABLE



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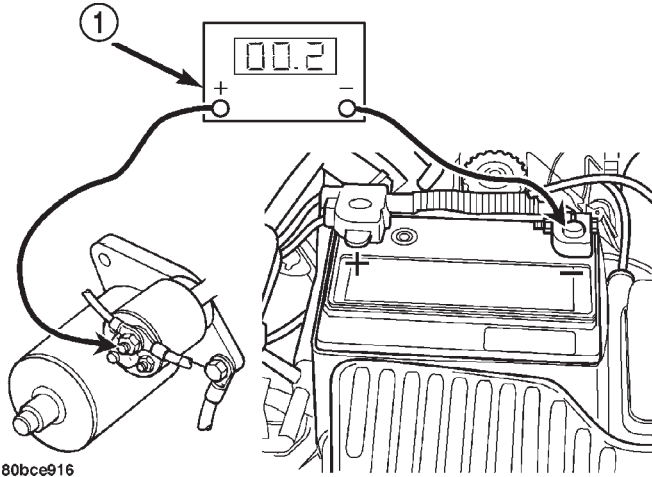
**Fig. 6 Starter Motor Ground Resistance**

1 - VOLTMETER

(a) Connect the positive voltmeter lead to the battery positive terminal, and negative lead to battery cable terminal on starter solenoid (Fig. 7). 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.

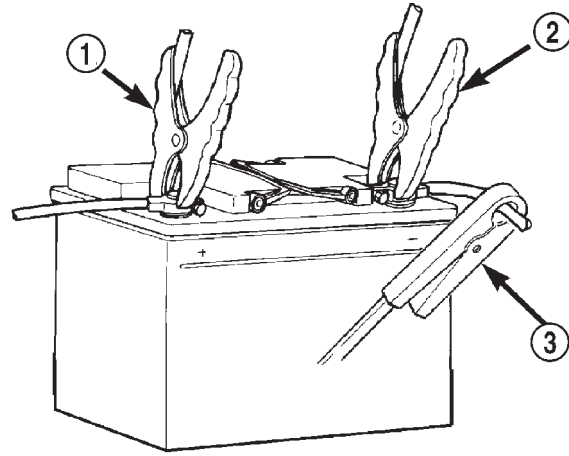
DIAGNOSIS AND TESTING (Continued)



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**Fig. 7 Battery Positive Cable Resistance**

1 - VOLTMETER



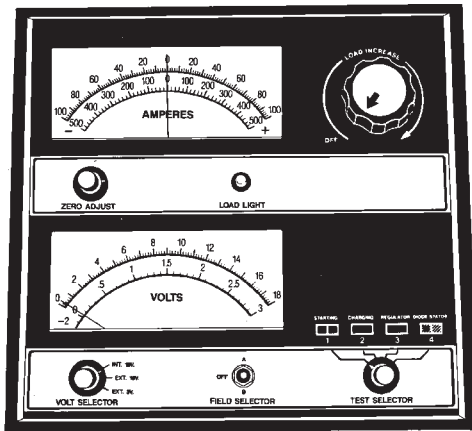
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**Fig. 9 Volt-Ampere Tester Connections - Typical**

- 1 - POSITIVE CLAMP
- 2 - NEGATIVE CLAMP
- 3 - INDUCTION AMMETER CLAMP

**FEED CIRCUIT**

The following procedure will require a suitable volt-ampere tester (Fig. 8).



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**Fig. 8 Volt Ampere Tester - Typical**

**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. 9). Refer to the operating instructions provided with the tester being used.

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

(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. 8).

- If voltage reads above 9.6 volts, and amperage draw reads above 280 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.
- If voltage is below 9.6 volts and amperage draw is above 300 amps, the problem is the starter. Replace the starter. Refer to Starter Removal and Installation in this section.

(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 the ASD relay. Start the vehicle several times to assure the problem has been corrected.

## DIAGNOSIS AND TESTING (Continued)

## STARTING SYSTEM

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 Interlock/Upstop Switch** - Visually inspect the clutch interlock/upstop switch for indications of physical damage and loose or corroded wire harness connections.

- **Park/Neutral Starting and Back-Up Lamp Switch** - Visually inspect the park/neutral starting and back-up lamp 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 Motor** - Visually inspect the starter motor 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.	<ol style="list-style-type: none"> <li>1. BATTERY DISCHARGED OR FAULTY.</li> <li>2. STARTING CIRCUIT WIRING FAULTY.</li> <li>3. STARTER RELAY FAULTY.</li> <li>4. IGNITION SWITCH FAULTY.</li> <li>5. PARK/NEUTRAL STARTING AND BACK-UP LAMP SWITCH (AUTO TRANS) FAULTY OR MIS-ADJUSTED.</li> <li>6. CLUTCH INTERLOCK/UPSTOP SWITCH (MAN TRANS) FAULTY.</li> <li>7. STARTER SOLENOID FAULTY.</li> <li>8. STARTER ASSEMBLY FAULTY.</li> </ol>	<ol style="list-style-type: none"> <li>1. REFER TO GROUP 8A, BATTERY. CHARGE OR REPLACE BATTERY, IF REQUIRED.</li> <li>2. REFER TO FEED CIRCUIT RESISTANCE TEST AND FEED CIRCUIT TEST IN THIS SECTION.</li> <li>3. REFER TO RELAY TEST, IN THIS SECTION. REPLACE RELAY, IF NECESSARY.</li> <li>4. REFER TO IGNITION SWITCH TEST, IN GROUP 8D-IGNITION SYSTEM OR GROUP 8W-WIRING DIAGRAMS. REPLACE SWITCH, IF NECESSARY.</li> <li>5. REFER PARK/NEUTRAL STARTING AND BACK-UP LAMP SWITCH TEST IN GROUP 21-TRANSAXLE. REPLACE SWITCH, IF NECESSARY.</li> <li>6. REFER TO CLUTCH INTERLOCK/UPSTOP SWITCH TEST, IN GROUP 6-CLUTCH (LOCATED WITHIN THE SWITCH REMOVAL AND INSTALLATION). REPLACE SWITCH, IF NECESSARY.</li> <li>7. REFER TO SOLENOID TEST, IN THIS SECTION. REPLACE STARTER ASSEMBLY, IF NECESSARY.</li> <li>8. IF ALL OTHER STARTING SYSTEM COMPONENTS AND CIRCUITS CHECK OK, REPLACE STARTER ASSEMBLY.</li> </ol>
STARTER ENGAGES, FAILS TO TURN ENGINE.	<ol style="list-style-type: none"> <li>1. BATTERY DISCHARGED OR FAULTY.</li> <li>2. STARTING CIRCUIT WIRING FAULTY.</li> <li>3. STARTER ASSEMBLY FAULTY.</li> <li>4. ENGINE SEIZED.</li> </ol>	<ol style="list-style-type: none"> <li>1. REFER TO GROUP 8A, BATTERY. CHARGE OR REPLACE BATTERY AS NECESSARY.</li> <li>2. REFER TO THE FEED CIRCUIT RESISTANCE TEST AND THE FEED CIRCUIT TEST IN THIS SECTION. REPAIR AS NECESSARY.</li> <li>3. IF ALL OTHER STARTING SYSTEM COMPONENTS AND CIRCUITS CHECK OK, REPLACE STARTER ASSEMBLY.</li> <li>4. REFER TO GROUP 9-ENGINE, FOR DIAGNOSTIC AND SERVICE PROCEDURES.</li> </ol>
STARTER ENGAGES, SPINS OUT BEFORE ENGINE STARTS.	<ol style="list-style-type: none"> <li>1. BROKEN TEETH ON STARTER RING GEAR.</li> <li>2. STARTER ASSEMBLY FAULTY.</li> </ol>	<ol style="list-style-type: none"> <li>1. REMOVE STARTER. INSPECT RING GEAR AND REPLACE IF NECESSARY.</li> <li>2. IF ALL OTHER STARTING SYSTEM COMPONENTS AND CIRCUITS CHECK OK, REPLACE STARTER ASSEMBLY.</li> </ol>
STARTER DOES NOT DISENGAGE.	<ol style="list-style-type: none"> <li>1. STARTER IMPROPERLY INSTALLED.</li> <li>2. STARTER RELAY FAULTY.</li> <li>3. IGNITION SWITCH FAULTY.</li> <li>4. STARTER ASSEMBLY FAULTY.</li> </ol>	<ol style="list-style-type: none"> <li>1. INSTALL STARTER. TIGHTEN STARTER MOUNTING HARDWARE TO CORRECT TORQUE SPECIFICATIONS.</li> <li>2. REFER TO RELAY TEST, IN THIS SECTION. REPLACE RELAY, IF NECESSARY.</li> <li>3. REFER TO IGNITION SWITCH TEST, IN GROUP 8D-IGNITION SYSTEM. REPLACE SWITCH, IF NECESSARY.</li> <li>4. IF ALL OTHER STARTING SYSTEM COMPONENTS AND CIRCUITS CHECK OK, REPLACE STARTER ASSEMBLY.</li> </ol>

## REMOVAL AND INSTALLATION

### SAFETY SWITCHES

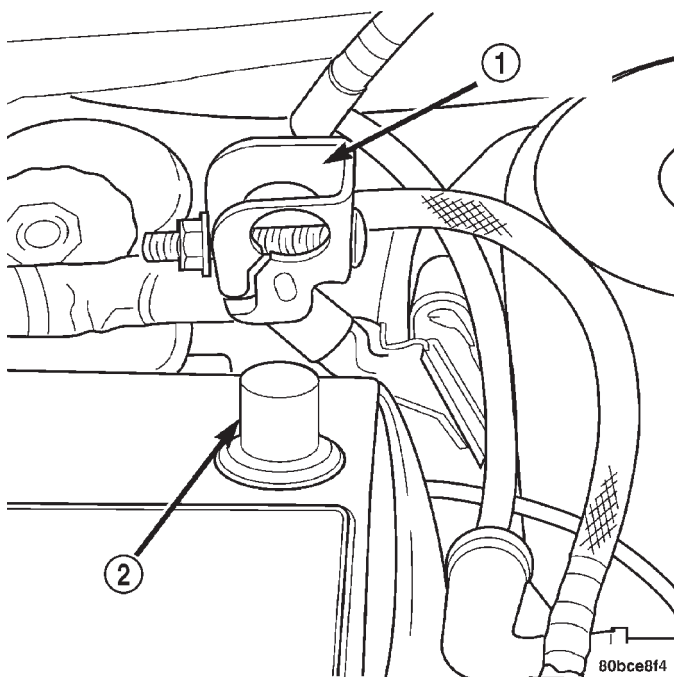
For Removal and Installation of:

- Clutch Interlock/Upstop Switch, refer to Removal and Installation in Group 6-Clutch.
- Park/Neutral Starting and Back-Up Lamp Switch, refer to Removal and Installation in Group 21-Transaxle.

### STARTER MOTOR

#### REMOVAL

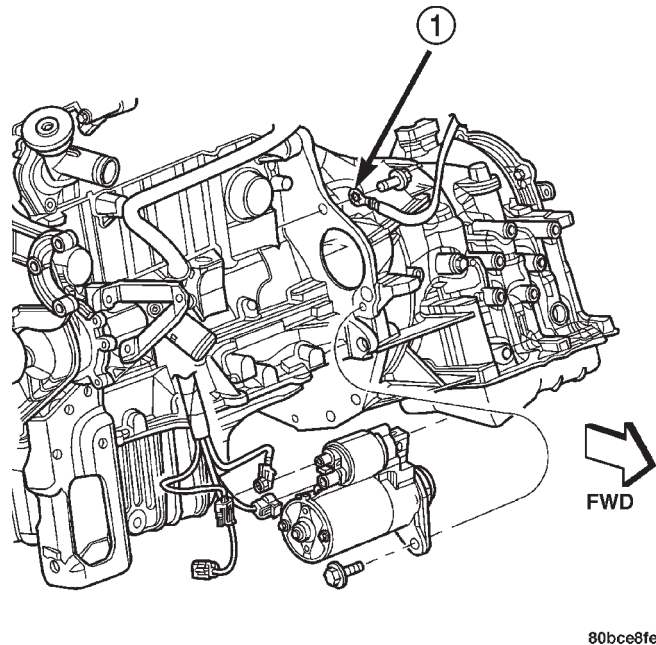
(1) Disconnect and isolate the battery negative cable (Fig. 10).



**Fig. 10 Battery Negative Cable Remove/Install**

- 1 - NEGATIVE CABLE  
2 - NEGATIVE BATTERY POST

- (2) Raise vehicle on hoist.
- (3) Remove starter bolts (Fig. 11).
- (4) Remove starter assembly.
- (5) Disengage latch and remove solenoid connector from starter assembly.
- (6) Remove battery positive connector from starter assembly. It is not necessary to remove the alternator output lead from the connector.



**Fig. 11 Starter Mounting/Location**

- 1 - NEGATIVE BATTERY CABLE

#### INSTALLATION

- (1) Clean corrosion/dirt from the cable and wire terminals before installing wiring to the solenoid.
- (2) Attach battery positive connector to starter. Ensure alternator positive connector is snapped into the battery positive connector. Tighten the captive nut to 10 N·m (90 in. lbs.).

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

- (3) Install solenoid connector to starter. Ensure that latch is fully engaged.
- (4) Position the starter face into transmission housing. Start bottom mounting bolt and thread in until bolt is snug.
- (5) Attach ground cable to upper starter mounting bolt.
- (6) Ensure the proper starter alignment before tightening the starter mounting bolts to 54 N·m (40 ft. lbs.) torque.
- (7) Lower vehicle and connect negative battery cable.

#### STARTER RELAY

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



**SPECIFICATIONS**

**STARTER MOTOR**

Engine Application	2.0L OHC - DOHC
Power rating	1.1 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.

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

**TORQUE**

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

