

# STARTING SYSTEMS

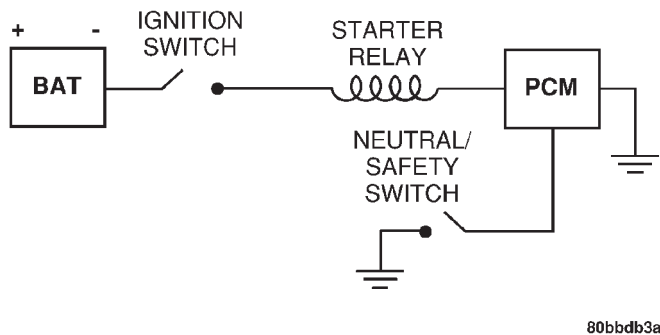
## CONTENTS

	page	page
<b>GENERAL INFORMATION</b>		
GENERAL INFORMATION .....	1	
<b>DESCRIPTION AND OPERATION</b>		
BOSCH AND MELCO STARTERS .....	1	
NIPPONDENSO STARTER .....	1	
SUPPLY CIRCUIT AND CONTROL CIRCUIT .....	1	
<b>DIAGNOSIS AND TESTING</b>		
CONTROL CIRCUIT TEST .....	2	
FEED CIRCUIT RESISTANCE TEST .....	3	
		3
		4
<b>REMOVAL AND INSTALLATION</b>		
SAFETY SWITCHES .....	6	
STARTER .....	6	
STARTER RELAY .....	8	
<b>SPECIFICATIONS</b>		
STARTER .....	8	
TORQUE .....	8	

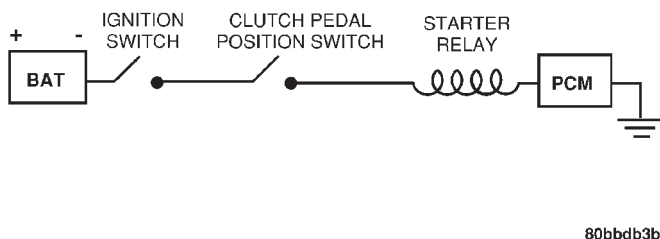
## GENERAL INFORMATION

### GENERAL INFORMATION

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



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



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

- Ignition switch
- Starter relay
- Transmission range sensor, or Park/Neutral Position switch with automatic transmissions

- Clutch Pedal Position Switch with manual transmissions

- Powertrain Control Module (PCM)
- Wiring harness
- Battery
- Starter motor with an integral solenoid

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 starter to be engaged if the engine is already running.

## DESCRIPTION AND OPERATION

### BOSCH AND MELCO STARTERS

The Bosch and Melco are permanent magnet starter motors. A planetary gear train transmits power between starter motor and pinion shaft. The fields have six permanent magnets. The Bosch is used on 2.0L engines and Melco is used on 2.5L engines.

### NIPPONDENSO STARTER

The Nippondenso is a reduction gear-field coil starter motor and is available on 2.4L engine.

### 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 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 crank 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

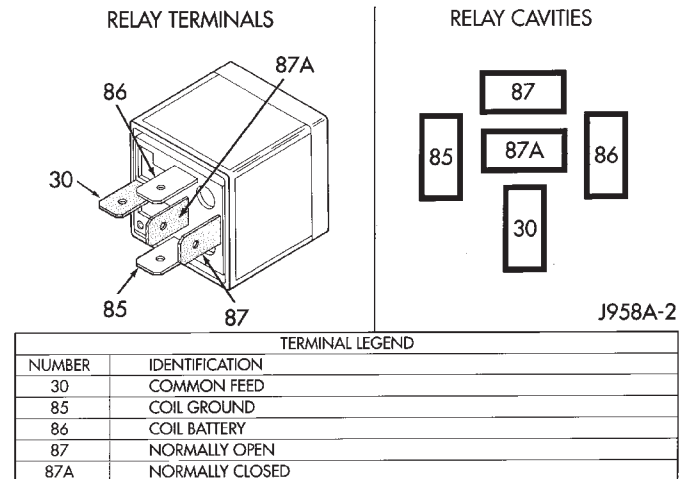
The starter relay is located in the Power Distribution Center (PDC) in the engine compartment. Refer to the PDC label for relay identification and location.

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  $75 \pm 5$  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. 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.



### 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 Starting System Test. The following operation will require a voltmeter, accurate to one tenth of a volt.

**CAUTION: Before Performing any starter test, the Ignition and fuel systems must be disabled.**

(1) To disable ignition and fuel systems disconnect the Automatic Shutdown Relay (ASD) in the Power Distribution Center (PDC).

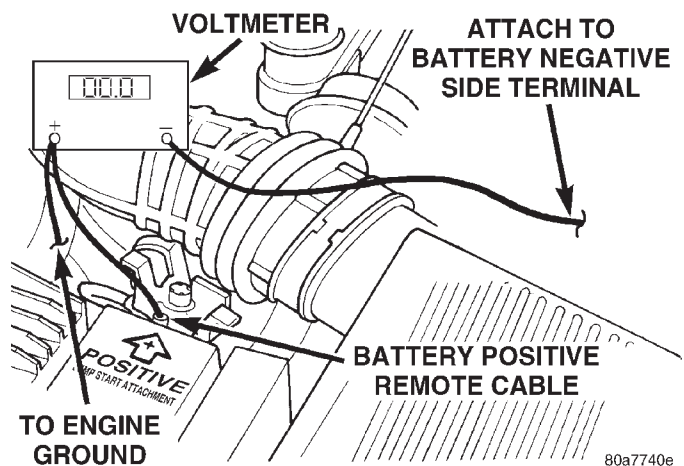
(2) Check that all wiring harnesses and components properly connected. Connect negative lead of voltmeter to battery negative terminal, and positive lead to engine block near the battery cable attaching point (Fig. 2). Rotate and hold the ignition switch in the START position. If voltage reads above 0.2 volt, clean or repair the poor contact at ground cable attaching points. If voltage reading is still above 0.2 volt after correcting poor contacts, replace ground cable.

(3) Connect the positive voltmeter lead to the battery positive terminal, and negative lead to battery positive cable terminal on starter solenoid (Fig. 3). Rotate and hold the ignition switch in the START position. If voltage reads above 0.2 volt, clean or repair the poor contact at:

- Battery cable to solenoid connection
- Battery cable to remote terminal
- Battery cable to battery

If reading is still above 0.2 volt after correcting poor contacts, replace battery positive cable as necessary.

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

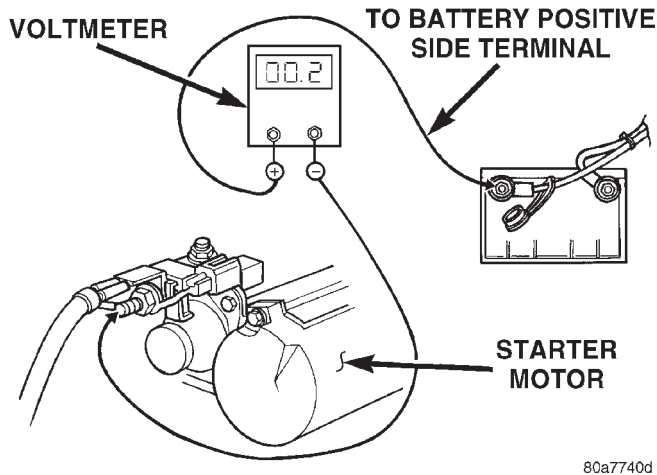


**Fig. 2 Test Ground Circuit Resistance**

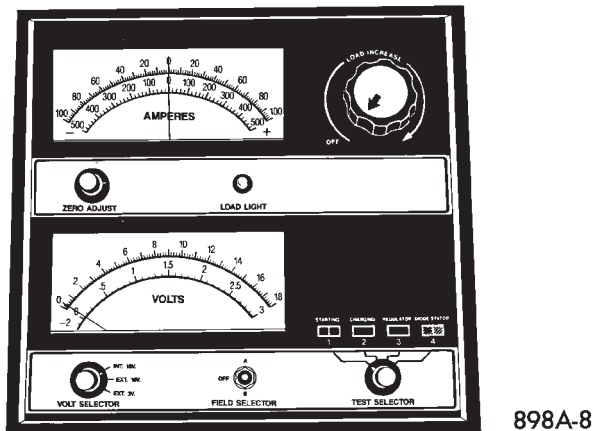
**FEED CIRCUIT TEST**

The following procedure will require a suitable volt-ampere tester (Fig. 4).

## DIAGNOSIS AND TESTING (Continued)



**Fig. 3 Test Battery Positive Cable Resistance**



**Fig. 4 Volt Ampere Tester**

**CAUTION:** Before Performing any starter test, the ignition and fuel systems must be disabled.

(1) Connect a volt-ampere tester (Fig. 4) to the remote battery terminals (Fig. 5). Refer to the operating instructions provided with the tester being used.

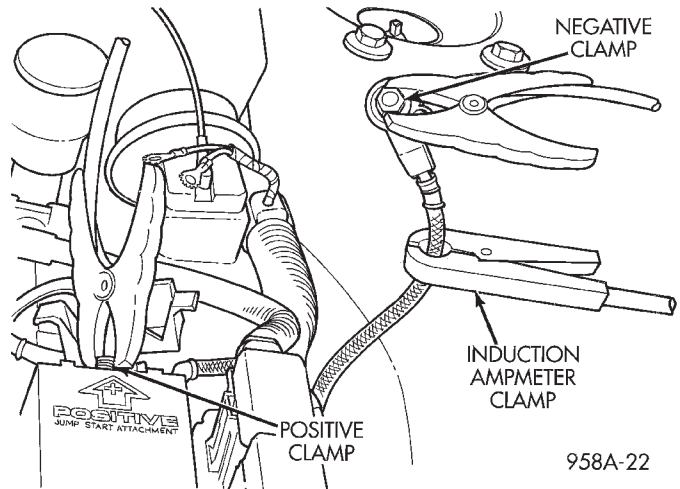
(2) To disable the ignition and fuel systems, disconnect the Automatic Shutdown Relay (ASD) in the Power Distribution Center (PDC). Refer to the PDC cover for the proper relay location.

(3) Verify that:

- All lamps and accessories are OFF
- Automatic transmission shift selector is in PARK
- Manual transmission clutch pedal depressed
- Set parking brake

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

• Voltage above 9.6 volts, and amperage draw above 280 amps, check for engine seizing or faulty starter.



**Fig. 5 Volt-Ampere Tester Connections**

- Voltage above 12.4 volts 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, the problem is the starter. Replace the starter refer to starter removal.

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

(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. 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 AIR-BAGS, 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 AIR-BAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.**

## INSPECTION

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

DIAGNOSIS AND TESTING (Continued)

- **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 indica-

tions 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.

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.

## DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE CAUSE	CORRECTION
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

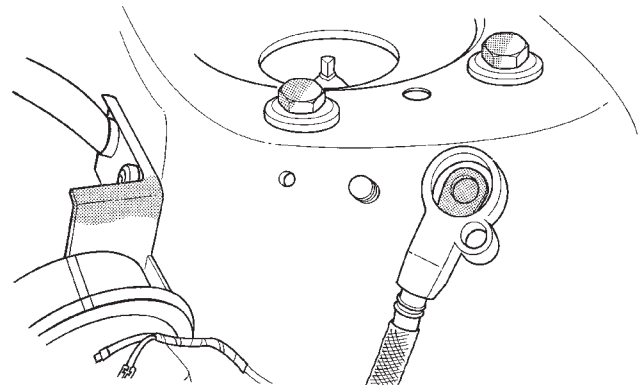
## SAFETY SWITCHES

For Removal and Installation of the:

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

## STARTER

**CAUTION:** The generator output terminal must be connected to the battery positive terminal of the starter solenoid. For the charging and cranking systems to operate properly.



958A-18

**Fig. 6 Remove Remote Battery Cable at Shock Tower**

## 2.0L ENGINE – WITH MANUAL TRANSAXLE

## REMOVAL

- (1) Disconnect the remote battery negative cable from the terminal on shock tower (Fig. 6).
- (2) Remove air cleaner resonator, refer to Group 14, Fuel.
- (3) Remove the battery positive cable nut from starter. Remove battery positive cable and generator output wire from starter (Fig. 7).
- (4) Disconnect push on solenoid connector. Unlock the red locking tab and compress lock to release the connector.
- (5) Remove two bolts attaching starter to transmission housing and remove starter from vehicle.

## INSTALLATION

For installation, reverse the above procedures. Clean corrosion/dirt from wire terminals before installing wiring to the solenoid.

## 2.0L ENGINE WITH AUTOMATIC TRANSAXLE – 2.4L ENGINE

## REMOVAL

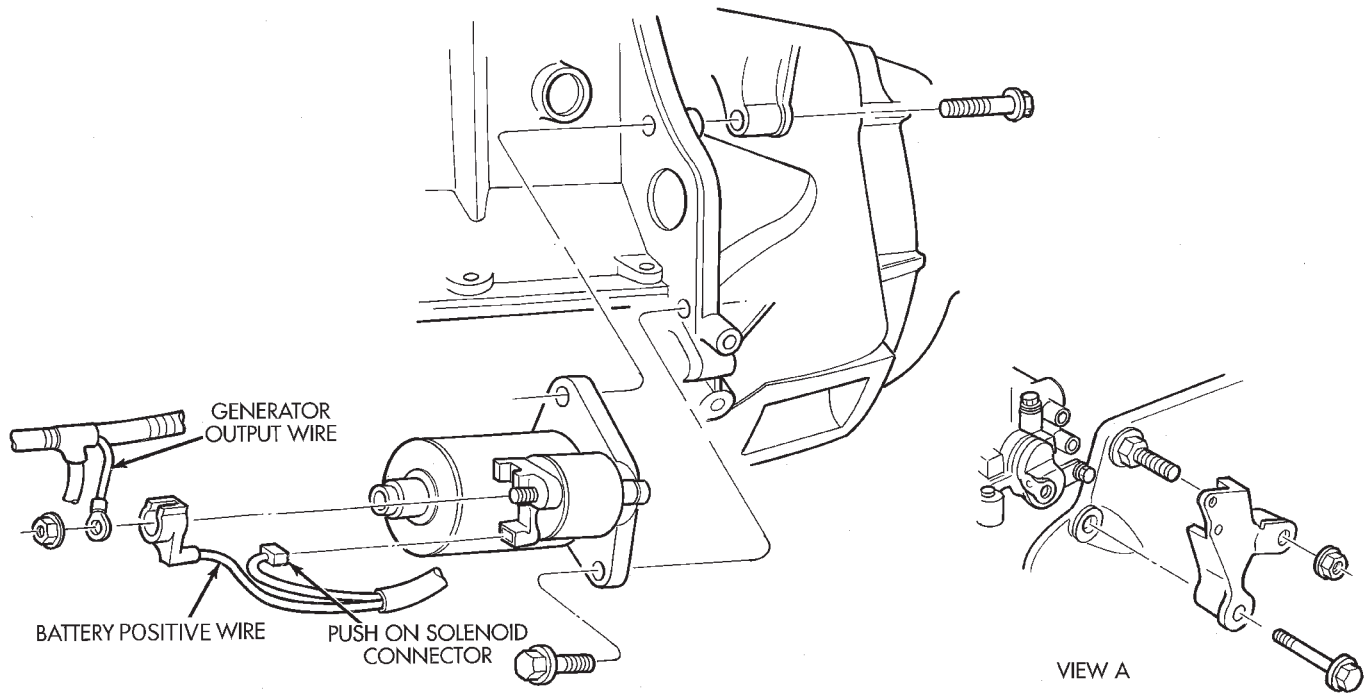
- (1) Disconnect battery negative cable from remote negative terminal on shock tower (Fig. 6).

- (2) Remove air cleaner resonator, refer to Group 14, Fuel.
- (3) Remove three Transmission Control Module (TCM) mounting screws. Move TCM to provide access to top starter mounting bolt. DO NOT disconnect TCM wiring.
- (4) Remove top bolt attaching starter to transmission housing (Fig. 8).
- (5) Raise vehicle.
- (6) Remove battery positive cable nut from starter and remove cable.
- (7) Disconnect push on solenoid connector. Unlock the red locking tab and compress lock to release the connector (2.0L only).
- (8) Remove the bottom bolt attaching starter to transmission housing (Fig. 8).
- (9) Remove starter from vehicle.

## INSTALLATION

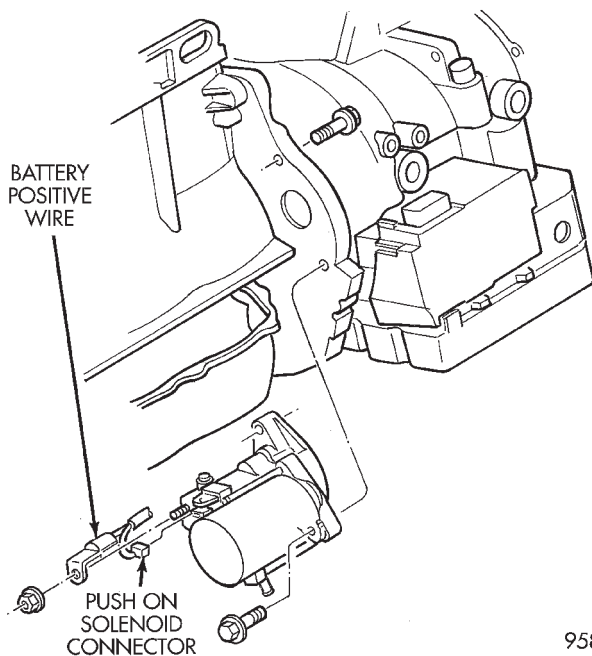
- (1) With vehicle is raised, set starter face into transmission housing.
- (2) Lower vehicle.
- (3) Install top starter mounting bolt but do not tighten.
- (4) Raise vehicle.

REMOVAL AND INSTALLATION (Continued)



958B-4

**Fig. 7 Wire Terminal Connection – 2.0L Engine**



958B-6

**Fig. 8 Wire Terminal Connection**

(5) Install bottom starter mounting bolt and tighten to 54 N·m (40 ft. lbs.) torque.

- (6) Clean corrosion/dirt from wire terminals before installing wiring to the solenoid.
- (7) Connect battery positive cable to solenoid post (Fig. 8).
- (8) Connect the push-on solenoid connector.
- (9) Lower vehicle.
- (10) Tighten top starter bolt to 54 N·m (40 ft. lbs.) torque.
- (11) Install TCM and the mounting screws.
- (12) Install air cleaner resonator, refer to Group 14, Fuel.
- (13) Connect battery remote cable to the remote terminal.

**2.5L ENGINE**

**REMOVAL**

- (1) Disconnect battery negative cable from remote negative terminal on shock tower (Fig. 6).
- (2) Raise vehicle.
- (3) Remove oil filter.
- (4) Remove battery positive cable nut from starter and remove cable (Fig. 9).
- (5) Disconnect push on solenoid connector.

REMOVAL AND INSTALLATION (Continued)

(6) Remove three bolts attaching starter to transmission housing and remove starter from vehicle.

INSTALLATION

For installation, reverse the above procedures. Clean corrosion/dirt from wire terminals before installing wiring to the solenoid.

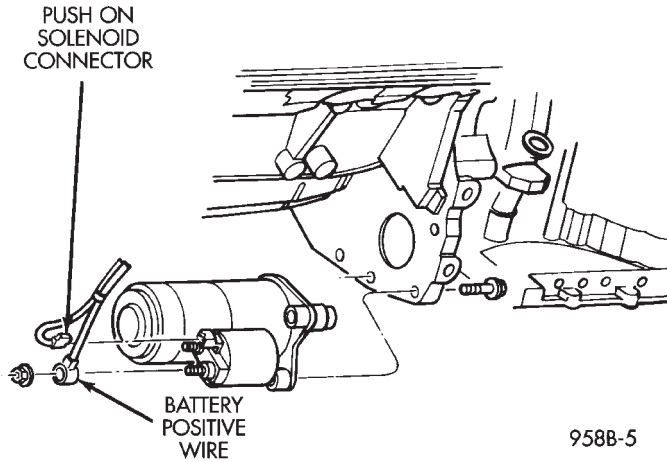


Fig. 9 Wire Terminal Connection – 2.5L Engine

STARTER RELAY

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

SPECIFICATIONS

STARTER

Manufacturer	BOSCH	MELCO	NIPPONDENSO
Engine Application	2.0L	2.5L	2.4L
Power rating	0 .95 Kw	1.2 Kw	1.4 Kw
Voltage	12 VOLTS	12 VOLTS	12 VOLTS
Brushes	4	4	4
Drive	Planetary Gear Train	Planetary Gear Train	Offset Gear Reduced

Engine 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.)