

STARTING SYSTEMS

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DESCRIPTION AND OPERATION

STARTING SYSTEM

DESCRIPTION

An electrically operated engine starting system is standard factory-installed equipment on this model. The starting system is designed to provide the vehicle operator with a convenient, efficient and reliable means of cranking and starting the internal combustion engine used to power the vehicle and all of its accessory systems. The starting system includes the following major components:

- Battery
- Battery cables
- Clutch pedal position switch (manual transmission)
- Ignition switch
- Park/neutral position switch (automatic transmission)
- Starter motor (including the integral starter solenoid)
- Starter relay.

The starting system consists of two separate circuits. A high-amperage feed circuit that feeds the starter motor between 150 and 350 amperes of battery current, and a low-amperage control circuit that operates on less than 20 amperes of battery current. The starting system high-amperage feed circuit includes the battery, the battery cables, the contact disc portion of the starter solenoid, and the starter motor. The following starting system feed circuit components are covered in more detail in other areas of this service manual:

- The battery is located in the passenger side front corner of the engine compartment, near the upper radiator crossmember and provides the electrical current needed to operate the starting system.

Refer to **Battery** in the index of this service manual for the location of more information on the battery.

- The battery cables connect the battery to the electrical system of the vehicle and to the starting system. Refer to **Battery Cables** in the index of this service manual for the location of more information on the battery cables.

The starting system low-amperage control circuit includes the ignition switch, the clutch pedal position switch (manual transmission), the park/neutral position switch (automatic transmission), the starter relay, the electromagnetic windings of the starter solenoid, and the wire harnesses that connect these components. The following starting system control circuit components are covered in more detail in other areas of this service manual:

- The ignition switch is mounted on the bottom of the steering column and actuates the starting system when a properly coded ignition key is inserted in the ignition lock cylinder on the right side of the steering column and turned to the spring-loaded momentary Start position. Refer to **Ignition Switch and Key Lock Cylinder** in the index of this service manual for the location of more information on the ignition switch.

- The clutch pedal position switch is integral to the master cylinder of the clutch hydraulic linkage assembly on models equipped with a manual transmission. Refer to **Clutch Hydraulic Linkage** in the index of this service manual for the location of more information on the clutch pedal position switch.

- On models with the 2.5L engine, the park/neutral position switch is threaded into the left side of the automatic transmission case and has a spring-loaded plunger that is actuated by a cam integral to the gearshift mechanism within the transmission. The back up lamp switch is also integral to the park/neutral position switch. On models with the 4.0L

DESCRIPTION AND OPERATION (Continued)

engine, the park/neutral position switch is mounted on the right side of the automatic transmission case. The switch is indexed to and driven by the transmission manual valve shaft. Refer to **Park/Neutral Position Switch** in the index of this service manual for the location of more information on either version of the park/neutral position switch.

Following are general descriptions of the starter relay and the starter motor. See the owner's manual in the vehicle glove box for more information on the features, use and operation of the starting system. Refer to **Starting System** in the index of this service manual for the location of complete wiring diagrams for the 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 or RHD, if a special illustration or procedure is required.

OPERATION

If the vehicle is equipped with a manual transmission, the clutch pedal position switch is installed in series between the ignition switch and the coil battery terminal of the starter relay. This normally open switch prevents the starter relay from being energized when the ignition switch is turned to the momentary Start position, unless the clutch pedal is fully depressed. This feature prevents starter motor operation while the clutch disc and the flywheel are engaged. The starter relay coil ground terminal is always grounded on vehicles with a manual transmission.

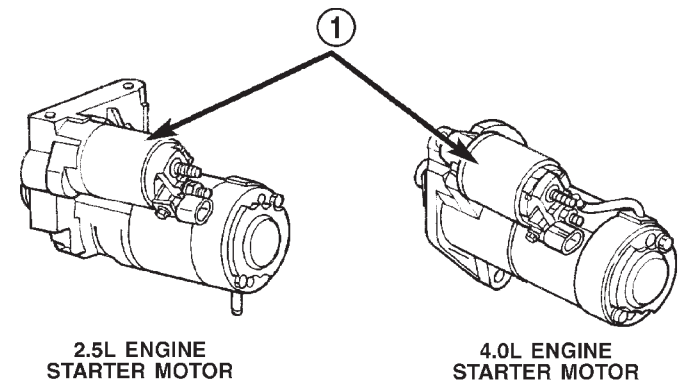
If the vehicle is equipped with an automatic transmission, battery voltage is supplied through the low-amperage control circuit to the coil battery terminal of the starter relay when the ignition switch is turned to the momentary Start position. The park/neutral position switch is installed in series between the starter relay coil ground terminal and ground. This normally open switch prevents the starter relay from being energized and the starter motor from operating unless the automatic transmission gear selector is in the Neutral or Park positions.

When the starter relay coil windings are energized, the relay directs battery current to the starter solenoid coil windings. When the starter solenoid coil windings are energized, the solenoid directs battery current to the starter motor, which cranks the engine

by engaging the starter pinion gear with the starter ring gear. Once the engine starts, the ignition switch key is released by the vehicle operator. When the ignition switch key is released, the switch automatically returns to the On position, which de-energizes the starting system.

STARTER MOTOR

DESCRIPTION



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Fig. 1 Starter Motors

1 - STARTER SOLENOID

The starter motors used for both the 2.5L and the 4.0L engines available in this model are not interchangeable (Fig. 1). However, each of these starter motors incorporates several of the same features to create a reliable, efficient, compact, lightweight and powerful unit. Both starters feature high torque direct current electric motors. Inside both starter motors the commutator of the rotating motor armature is contacted by four brushes. The starter motor for the 2.5L engine is driven by four permanent magnet field poles, while the starter motor for the 4.0L engine is driven by four electromagnetic field coils wound around four pole shoes. The 2.5L starter motor is rated at 1.2 kilowatts (about 1.6 horsepower) output at 12 volts, while the 4.0L starter motor is rated at 1.4 kilowatts (about 1.9 horsepower) output at 12 volts.

These starter motors are equipped with a planetary gear reduction (intermediate transmission) system. The planetary gear reduction system consists of a gear that is integral to the output end of the electric motor armature shaft that is in continual engagement with a larger gear that fits on a spline on the input end of the starter pinion gear shaft. This feature makes it possible to reduce the dimensions of the starter. At the same time, it allows higher armature rotational speed and delivers increased torque through the starter pinion gear.

DESCRIPTION AND OPERATION (Continued)

Both starter motors use an overrunning clutch and starter pinion gear unit to engage and drive the starter ring gear, which is integral to the flywheel (manual transmission) or torque converter drive plate (automatic transmission) mounted on the rear crankshaft flange. Shims are available and can be used to adjust the 2.5L starter motor mounting position to correct for improper starter pinion gear to starter ring gear engagement.

The starter motors for both engines are activated by an integral heavy duty starter solenoid switch mounted to the overrunning clutch housing. This electromechanical switch connects and disconnects the feed of battery current to the starter motor through a movable contact on one end of the solenoid core or plunger. At the same time, the solenoid plunger actuates a shift fork that engages and disengages the starter pinion gear with a starter ring gear. The starter solenoid has two electromagnetic windings or coils, a pull-in coil and a hold-in coil. The pull-in coil requires more battery current and produces a stronger electromagnetic field than the hold-in coil.

Both starter motors are serviced only as a unit with their starter solenoids, and cannot be repaired. If either component is faulty or damaged, the entire starter motor and starter solenoid unit must be replaced.

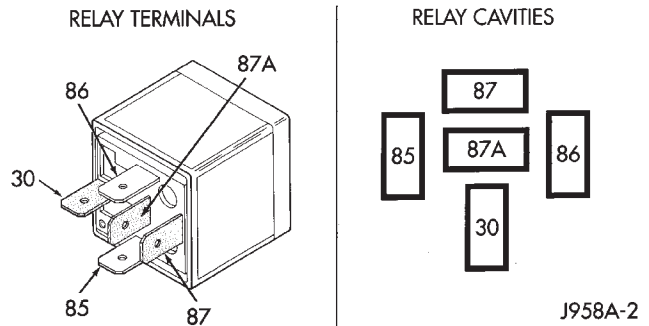
OPERATION

When the starter solenoid pull-in coil windings are energized the solenoid plunger is drawn into the electromagnetic coil. The solenoid plunger pulls the shift lever in the starter motor. This engages the starter overrunning clutch and pinion gear with the starter ring gear on the manual transmission flywheel or on the automatic transmission torque converter drive plate. As the solenoid plunger reaches the end of its travel, it moves the solenoid contact disc to complete the high-amperage starter feed circuit and energizes the solenoid hold-in coil windings. Battery current now flows between the solenoid battery terminal and the starter field terminal, energizing the starter and cranking the engine.

Once the engine starts, the overrunning clutch protects the starter motor from damage by allowing the starter pinion gear to spin faster than the pinion shaft. When the solenoid plunger hold-in coil is de-energized, the solenoid plunger return spring returns the plunger to its relaxed position. This causes the solenoid contact disc to open the starter feed circuit, and the shift lever to disengage the overrunning clutch and pinion gear unit from the starter ring gear.

STARTER RELAY

DESCRIPTION



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

Fig. 2 Starter Relay

The starter relay (Fig. 2) is an electromechanical device that switches battery current to the pull-in coil of the starter solenoid when the ignition switch is turned to the Start position. The starter relay is located in the Power Distribution Center (PDC), in the engine compartment. See the fuse and relay layout label affixed to the inside surface of the PDC cover for starter relay identification and location.

The starter relay is a International Standards Organization (ISO) relay. Relays conforming to the ISO specifications have common physical dimensions, current capacities, terminal patterns, and terminal functions.

The starter relay cannot be repaired or adjusted and, if faulty or damaged, it must be replaced.

OPERATION

The ISO relay consists of an electromagnetic coil, a resistor or diode, and three (two fixed and one movable) electrical contacts. The movable (common feed) relay contact is held against one of the fixed contacts (normally closed) by spring pressure. When the electromagnetic coil is energized, it draws the movable contact away from the normally closed fixed contact, and holds it against the other (normally open) fixed contact.

When the electromagnetic coil is de-energized, spring pressure returns the movable contact to the normally closed position. The resistor or diode is connected in parallel with the electromagnetic coil in the relay, and helps to dissipate voltage spikes that are produced when the coil is de-energized.

DIAGNOSIS AND TESTING

STARTING SYSTEM

DIAGNOSIS

The battery, starting system and charging system in the vehicle operate with one another, and must be tested as a complete system. In order for the engine to start and the battery to charge properly, all of the components that are used in these systems must perform within specifications. The service information for these systems has been separated within this service manual to make it easier to locate the specific information you are seeking. However, when attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used for the battery, starting system and charging system include the most basic conventional diagnostic methods, to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of an induction-type milliampere ammeter, a volt/ohmmeter, a battery charger, a carbon pile rheostat (load tester) and a 12-volt test lamp may be required. All OBD-sensed systems are monitored by the PCM. Each monitored circuit is assigned a Diagnostic Trouble Code (DTC). The PCM will store a DTC in electronic memory for any failure it detects. Refer to **Charging System, On-Board Diagnostic Test** in the index of this service manual for the location of the proper on-board diagnostic test procedures.

Starting System Diagnosis		
Condition	Possible Cause	Correction
Starter fails to operate.	<ol style="list-style-type: none"> 1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter relay faulty. 4. Ignition switch faulty. 5. Clutch pedal position switch faulty. 6. Park/Neutral position switch faulty or misadjusted. 7. Starter solenoid faulty. 8. Starter motor faulty. 	<ol style="list-style-type: none"> 1. Refer to Battery in the index of this service manual for the location of the proper battery diagnosis and testing procedures. Replace the faulty battery, as required. 2. Refer to Starting System in the index of this service manual for the location of complete starting system wiring diagrams. Test and repair the faulty starter feed and/or control circuits, as required. 3. Refer to Starter Relay in the index of this service manual for the location of the proper starter relay diagnosis and testing procedures. Replace the faulty starter relay, as required. 4. Refer to Ignition Switch and Key Lock Cylinder in the index of this service manual for the location of the proper ignition switch diagnosis and testing procedures. Replace the faulty ignition switch, as required. 5. Refer to Clutch Pedal Position Switch in the index of this service manual for the location of the proper clutch pedal position switch diagnosis and testing procedures. Replace the faulty clutch hydraulic linkage unit, as required. 6. Refer to Park/Neutral Position Switch in the index of this service manual for the location of the proper park/neutral position switch diagnosis and testing procedures. Replace the faulty park/neutral position switch, as required. 7. Refer to Starter Motor in the index of this service manual for the location of the proper starter solenoid diagnosis and testing procedures. Replace the faulty starter motor, as required. 8. Refer to Starter Motor in the index of this service manual for the location of the proper starter motor diagnosis and testing procedures. Replace the faulty starter motor, as required.

DIAGNOSIS AND TESTING (Continued)

Starting System Diagnosis		
Condition	Possible Cause	Correction
Starter engages, fails to turn engine.	<ol style="list-style-type: none"> 1. Battery discharged or faulty. 2. Starting circuit wiring faulty. 3. Starter motor faulty. 4. Engine seized. 	<ol style="list-style-type: none"> 1. Refer to Battery in the index of this service manual for the location of the proper battery diagnosis and testing procedures. Replace the faulty battery, as required. 2. Refer to Starting System in the index of this service manual for the location of complete starting system wiring diagrams. Test and repair the faulty starter feed and/or control circuits, as required. 3. Refer to Starter Motor in the index of this service manual for the location of the proper starter motor diagnosis and testing procedures. Replace the faulty starter motor, as required. 4. Refer to Engine Diagnosis in the index of this service manual for the location of the proper engine diagnosis and testing procedures. Repair or replace the faulty engine, as required.
Starter engages, spins out before engine starts.	<ol style="list-style-type: none"> 1. Starter ring gear faulty. 2. Starter motor faulty. 	<ol style="list-style-type: none"> 1. Refer to Starter Motor in the index of this service manual for the location of the proper starter motor removal and installation procedures. Remove the starter motor to inspect the starter ring gear. Replace the faulty starter ring gear, as required. 2. Refer to Starter Motor in the index of this service manual for the location of the proper starter motor diagnosis and testing procedures. Replace the faulty starter motor, as required.
Starter does not disengage.	<ol style="list-style-type: none"> 1. Starter motor improperly installed. 2. Starter relay faulty. 3. Ignition switch faulty. 4. Starter motor faulty. 	<ol style="list-style-type: none"> 1. Refer to Starter Motor in the index of this service manual for the location of the proper starter motor installation procedures. Tighten the starter motor mounting hardware to the correct tightness specifications, as required. 2. Refer to Starter Relay in the index of this service manual for the location of the proper starter relay diagnosis and testing procedures. Replace the faulty starter relay, as required. 3. Refer to Ignition Switch and Key Lock Cylinder in the index of this service manual for the location of the proper ignition switch diagnosis and testing procedures. Replace the faulty ignition switch, as required. 4. Refer to Starter Motor in the index of this service manual for the location of the proper starter motor diagnosis and testing procedures. Replace the faulty starter motor, as required.

TESTING

Before testing the starting system perform a visual inspection of the starting system components and connections. Refer to **Starting System** in the index of this service manual for the location of the proper starting system cleaning and inspection procedures.

COLD CRANKING TEST

Refer to **Starting System** in the index of this service manual for the location of complete starting sys-

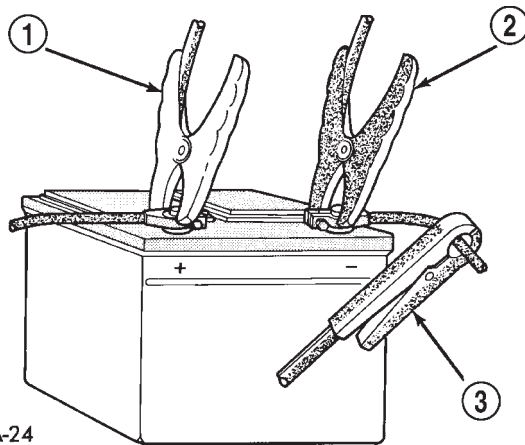
tem wiring diagrams. Before performing this test, be certain that the following procedures are accomplished:

- The battery is fully-charged and load tested. Refer to **Battery Charging** in the index of this service manual for the location of the proper battery charging procedures. Refer to **Battery** in the index of this service manual for the location of the battery diagnosis and testing procedures, including the proper battery load test procedures.

DIAGNOSIS AND TESTING (Continued)

- Fully engage the parking brake.
- If the vehicle is equipped with an automatic transmission, place the gearshift selector lever in the Park position. If the vehicle is equipped with a manual transmission, place the gearshift selector lever in the Neutral position and block the clutch pedal in the fully depressed position.
- Verify that all lamps and accessories are turned off.
- To prevent the engine from starting, remove the Automatic ShutDown (ASD) relay. The ASD relay is located in the Power Distribution Center (PDC), in the engine compartment. See the fuse and relay layout label affixed to the underside of the PDC cover for ASD relay identification and location.

(1) Connect a suitable volt-ampere tester to the battery terminals (Fig. 3). See the instructions provided by the manufacturer of the volt-ampere tester being used.



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Fig. 3 Volts-Amps Tester Connections - Typical

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

(2) Rotate and hold the ignition switch in the Start position. Note the cranking voltage and current (amperage) draw readings shown on the volt-ampere tester.

(a) If the voltage reads below 9.6 volts, refer to **Starter Motor** in the index of this service manual for the location of the proper starter motor diagnosis and testing procedures. If the starter motor tests OK, refer to **Engine Diagnosis** in the index of this service manual for the location of the proper engine diagnosis and testing procedures. If the starter motor is not OK, replace the faulty starter motor.

(b) If the voltage reads above 9.6 volts and the current (amperage) draw reads below specifications, refer to the **Feed Circuit Test** in this section.

(c) If the voltage reads 12.5 volts or greater and the starter motor does not turn, refer to the **Control Circuit Test** in this section.

(d) If the voltage reads 12.5 volts or greater and the starter motor turns very slowly, refer to the **Feed Circuit Test** in this section.

NOTE: A cold engine will increase the starter current (amperage) draw reading, and reduce the battery voltage reading.

FEED CIRCUIT TEST

The starter feed circuit test (voltage drop method) will determine if there is excessive resistance in the high-amperage starter feed circuit. Refer to **Starting System** in the index of this service manual for the location of complete starting system wiring diagrams.

When performing the voltage drop test, it is important to remember that the voltage drop is giving an indication of the resistance between the two points at which the voltmeter probes are attached. **EXAMPLE:** When testing the resistance of the battery positive cable, touch the voltmeter leads to the battery positive cable terminal clamp and to the battery positive cable eyelet terminal at the starter solenoid B(+) terminal stud. If you probe the battery positive terminal post and the battery positive cable eyelet terminal at the starter solenoid B(+) terminal stud, you are reading the combined voltage drop in the battery positive cable terminal clamp-to-terminal post connection and the battery positive cable.

The following operation will require a voltmeter accurate to 1/10 (0.10) volt. Before performing this test, be certain that the following procedures are accomplished:

- The battery is fully-charged and load tested. Refer to **Battery Charging** in the index of this service manual for the location of the proper battery charging procedures. Refer to **Battery** in the index of this service manual for the location of the battery diagnosis and testing procedures, including the proper battery load test procedures.

- Fully engage the parking brake.
- If the vehicle is equipped with an automatic transmission, place the gearshift selector lever in the Park position. If the vehicle is equipped with a manual transmission, place the gearshift selector lever in the Neutral position and block the clutch pedal in the fully depressed position.

- Verify that all lamps and accessories are turned off.

DIAGNOSIS AND TESTING (Continued)

- To prevent the engine from starting, remove the Automatic ShutDown (ASD) relay. The ASD relay is located in the Power Distribution Center (PDC), in the engine compartment. See the fuse and relay layout label affixed to the underside of the PDC cover for ASD relay identification and location.

(1) Connect the positive lead of the voltmeter to the battery negative terminal post. Connect the negative lead of the voltmeter to the battery negative cable terminal clamp (Fig. 4). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If voltage is detected, correct the poor contact between the battery negative cable terminal clamp and the battery negative terminal post.

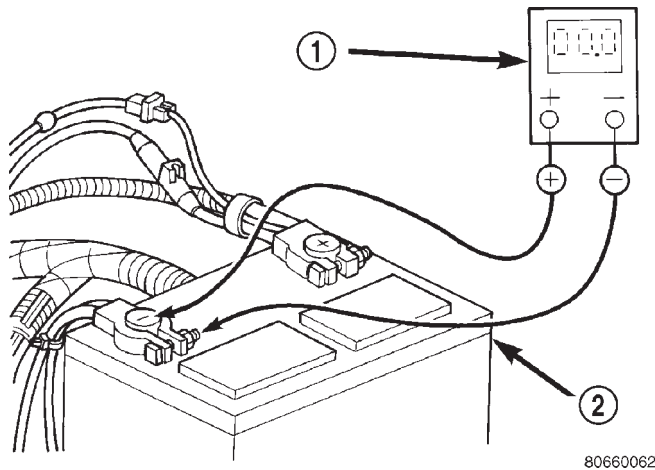


Fig. 4 Test Battery Negative Connection Resistance - Typical

- 1 - VOLTMETER
- 2 - BATTERY

(2) Connect the positive lead of the voltmeter to the battery positive terminal post. Connect the negative lead of the voltmeter to the battery positive cable terminal clamp (Fig. 5). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If voltage is detected, correct the poor connection between the battery positive cable terminal clamp and the battery positive terminal post.

(3) Connect the voltmeter to measure between the battery positive cable terminal clamp and the starter solenoid B(+) terminal stud (Fig. 6). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, clean and tighten the battery positive cable eyelet terminal connection at the starter solenoid B(+) terminal stud. Repeat the test. If the reading is still above 0.2 volt, replace the faulty battery positive cable.

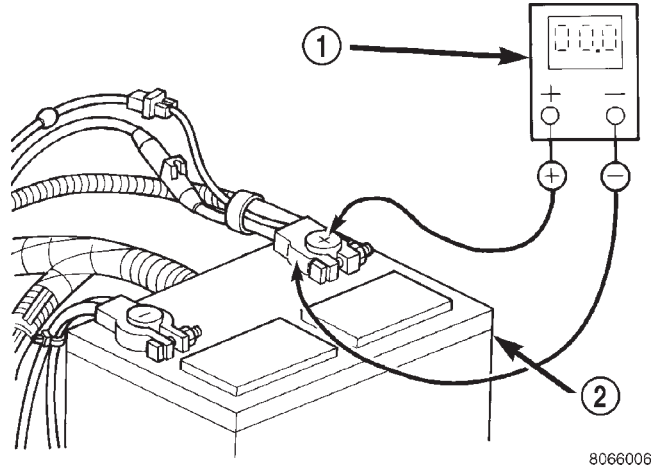


Fig. 5 Test Battery Positive Connection Resistance - Typical

- 1 - VOLTMETER
- 2 - BATTERY

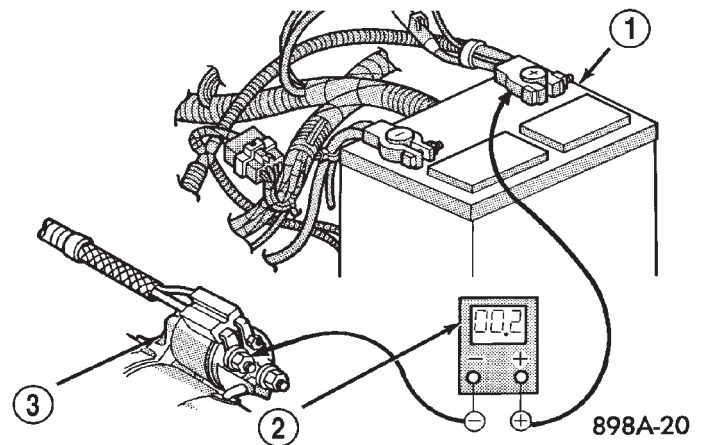


Fig. 6 Test Battery Positive Cable Resistance - Typical

- 1 - BATTERY
- 2 - VOLTMETER
- 3 - STARTER MOTOR

(4) Connect the voltmeter to measure between the battery negative cable terminal clamp and a good clean ground on the engine block (Fig. 7). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, clean and tighten the battery negative cable eyelet terminal connection to the engine block. Repeat the test. If the reading is still above 0.2 volt, replace the faulty battery negative cable.

DIAGNOSIS AND TESTING (Continued)

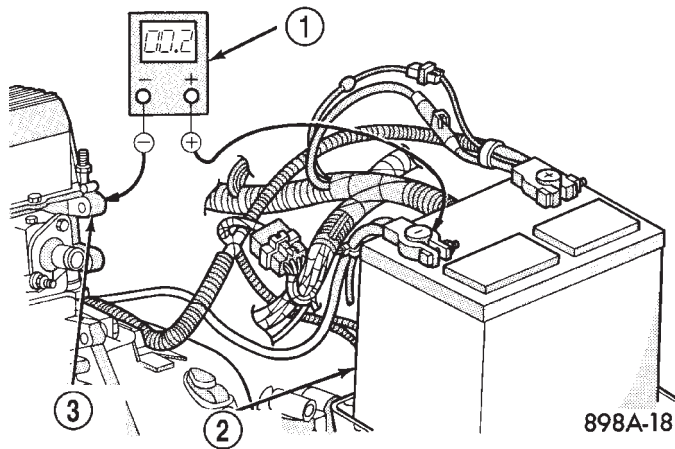


Fig. 7 Test Ground Circuit Resistance - Typical

- 1 - VOLTMETER
- 2 - BATTERY
- 3 - ENGINE GROUND

(5) Connect the positive lead of the voltmeter to the starter housing. Connect the negative lead of the voltmeter to the battery negative terminal post (Fig. 8). Rotate and hold the ignition switch in the Start position. Observe the voltmeter. If the reading is above 0.2 volt, correct the poor starter to engine block ground contact.

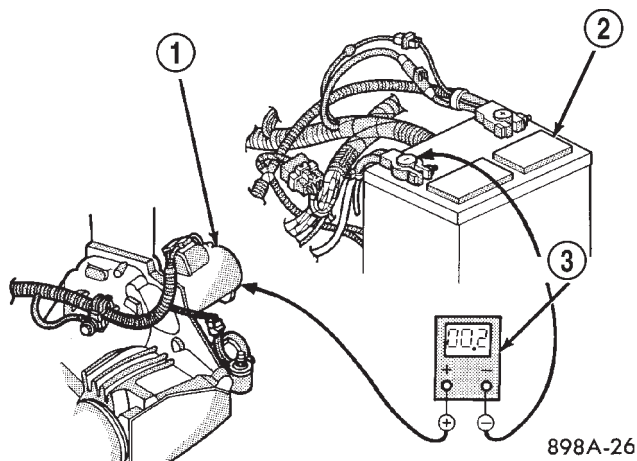


Fig. 8 Test Starter Ground - Typical

- 1 - STARTER MOTOR
- 2 - BATTERY
- 3 - VOLTMETER

If the resistance tests detect no feed circuit problems, refer to **Starter Motor** in the index of this service manual for the location of the proper starter motor diagnosis and testing procedures.

CONTROL CIRCUIT TEST

The starter control circuit components should be tested in the order in which they are listed, as follows:

- Starter Relay Refer to **Starter Relay** in the index of this service manual for the location of the proper starter relay diagnosis and testing procedures.
- Starter Solenoid Refer to **Starter Motor** in the index of this service manual for the location of the proper starter solenoid diagnosis and testing procedures.

- Ignition Switch Refer to **Ignition Switch and Key Lock Cylinder** in the index of this service manual for the location of the proper ignition switch diagnosis and testing procedures.

- Clutch Pedal Position Switch If the vehicle is equipped with a manual transmission, refer to **Clutch Pedal Position Switch** in the index of this service manual for the location of the proper clutch pedal position switch diagnosis and testing procedures.

- Park/Neutral Position Switch If the vehicle is equipped with an automatic transmission, refer to **Park/Neutral Position Switch** in the index of this service manual for the location of the proper park/neutral position switch diagnosis and testing procedures.

STARTER MOTOR NOISE - 2.5L ENGINE

See the Starter Motor Noise Diagnosis chart (Fig. 9). If the complaint is similar to Conditions 1 and 2 in the chart, correction can be made by placing shims between the starter motor and the engine block using the following procedures:

DIAGNOSIS AND TESTING (Continued)

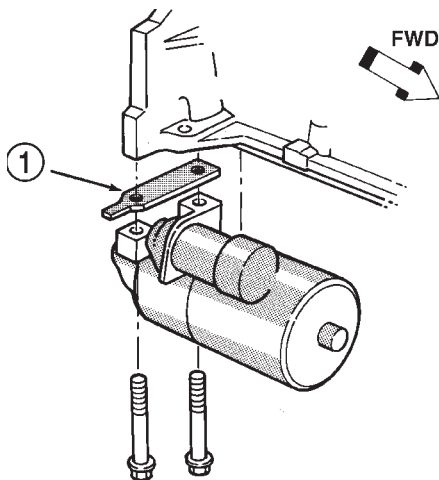
CONDITION	POSSIBLE CAUSE	CORRECTION
1. VERY HIGH FREQUENCY WHINE BEFORE ENGINE STARTS; ENGINE STARTS OK.	1. Excessive distance between pinion gear and flywheel/drive plate gear.	1. Move starter motor toward flywheel/drive plate by removing shim(s), if possible.
2. VERY HIGH FREQUENCY WHINE AFTER ENGINE STARTS WITH IGNITION KEY RELEASED. ENGINE STARTS OK.	2. Insufficient distance between starter motor pinion gear and flywheel/drive plate runout can cause noise to be intermittent.	2. Shim starter motor away from flywheel/drive plate. Inspect flywheel/drive plate for damage; bent, unusual wear, and excessive runout. Replace flywheel/drive plate as necessary.
3. A LOUD "WHOOOP" AFTER ENGINE STARTS WHILE STARTER MOTOR IS ENGAGED.	3. Most probable cause is defective overrunning clutch.	3. Replace starter motor.
4. A "RUMBLE," "GROWL," OR "KNOCK" AS STARTER MOTOR COASTS TO STOP AFTER ENGINE STARTS.	4. Most probable cause is bent or unbalanced starter motor armature.	4. Replace starter motor.

NOTE: A high frequency whine during cranking is normal for this starter motor.

FIG. 9 STARTER MOTOR NOISE DIAGNOSIS

(1) If the complaint is similar to Condition 1, the starter motor must be moved toward the starter ring gear by removing shims from both starter mounting pads on the engine block (Fig. 10). Refer to **Starter Motor** in the index of this service manual for the location of the proper starter motor removal and installation procedures.

NOTE: The shim thickness is 0.381 mm (0.015 in.). These shims may be stacked if additional thickness is required.



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Fig. 10 Starter Motor Shim

1 - STARTER MOTOR SHIM

(2) If the complaint is similar to Condition 2, the starter motor must be moved away from the starter ring gear. This is done by installing shim(s) across both starter mounting pads on the engine block. More than one shim may be required. Refer to **Starter Motor** in the index of this service manual for the location of the proper removal and installation procedures.

NOTE: This is a condition that will generally cause broken starter (flywheel/torque converter drive plate) ring gear teeth or broken starter motor housings.

STARTER MOTOR

Correct starter motor operation can be confirmed by performing the following free running bench test. This test can only be performed with the starter motor removed from the vehicle. Refer to **Starting System** in the index of this service manual for the location of the proper starter motor specifications.

CAUTION: The 2.5L engine uses a permanent magnet starter. Permanent magnet starters are highly sensitive to hammering, shocks, external pressure and reverse polarity. This starter motor must never be clamped in a vise by the starter field frame. The starter should only be clamped by the mounting flange. Do not reverse the battery cable connections to this starter motor when testing. The permanent magnets may be damaged and the starter rendered unserviceable if it is subjected to any of these conditions.

DIAGNOSIS AND TESTING (Continued)

STARTER MOTOR

(1) Remove the starter motor from the vehicle. Refer to **Starter Motor** in the index of this service manual for the location of the proper starter motor removal and installation procedures.

(2) Mount the starter motor securely in a soft-jawed bench vise. The vise jaws should be clamped on the mounting flange of the starter motor. Never clamp on the starter motor by the field frame.

(3) Connect a suitable volt-ampere tester and a 12-volt battery to the starter motor in series, and set the ammeter to the 100 ampere scale. See the instructions provided by the manufacturer of the volt-ampere tester being used.

(4) Install a jumper wire from the solenoid terminal to the solenoid B(+) terminal stud. The starter motor should operate. If the starter motor fails to operate, replace the faulty starter motor.

(5) Adjust the carbon pile load of the tester to obtain the free running test voltage. Refer to **Starting System** in the index of this service manual for the location of the proper starter motor free running test voltage specifications.

(6) Note the reading on the ammeter and compare this reading to the free running test maximum amperage draw. Refer to **Starting System** in the index of this service manual for the location of the proper starter motor free running test maximum amperage draw specifications.

(7) If the ammeter reading exceeds the maximum amperage draw specification, replace the faulty starter motor.

STARTER SOLENOID

This test can only be performed with the starter motor removed from the vehicle.

(1) Remove the starter motor from the vehicle. Refer to **Starter Motor** in the index of this service manual for the location of the proper starter motor removal and installation procedures.

(2) Disconnect the wire from the solenoid field coil terminal.

(3) Check for continuity between the solenoid terminal and the solenoid field coil terminal with a continuity tester (Fig. 11). There should be continuity. If OK, go to Step 4. If not OK, replace the faulty starter motor.

(4) Check for continuity between the solenoid terminal and the solenoid case (Fig. 12). There should be continuity. If not OK, replace the faulty starter motor.

STARTER RELAY

The starter relay (Fig. 13) is located in the Power Distribution Center (PDC), in the engine compartment. Refer to the fuse and relay layout label affixed

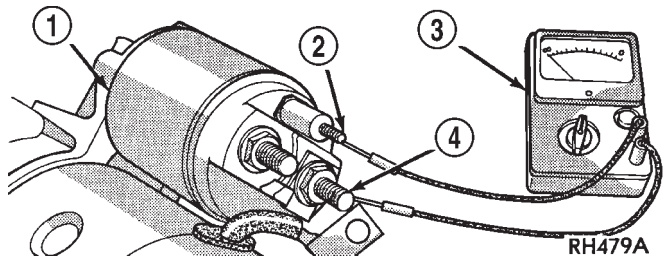


Fig. 11 Continuity Test Between Solenoid Terminal and Field Coil Terminal - Typical

- 1 - SOLENOID
- 2 - SOLENOID TERMINAL
- 3 - OHMMETER
- 4 - FIELD COIL TERMINAL

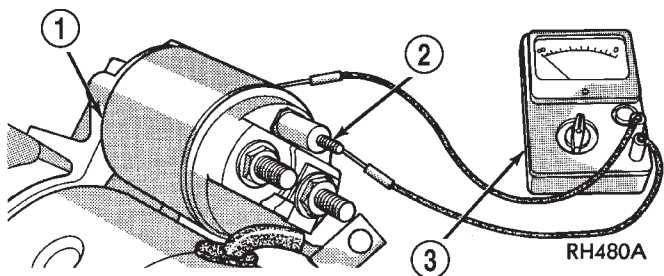


Fig. 12 Continuity Test Between Solenoid Terminal and Solenoid Case - Typical

- 1 - SOLENOID
- 2 - SOLENOID TERMINAL
- 3 - OHMMETER

to the underside of the PDC cover for starter relay identification and location. Refer to **Starting System** in the index of this service manual for the location of complete starting system wiring diagrams.

RELAY TEST

(1) Remove the starter relay from the PDC. Refer to **Starter Relay** in the index of this service manual for the location of the proper starter relay removal and installation procedures.

(2) 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 3. If not OK, replace the faulty relay.

(3) Resistance between terminals 85 and 86 (electromagnet) should be 75 ± 5 ohms. If OK, go to Step 4. If not OK, replace the faulty relay.

(4) Connect a battery to terminals 85 and 86. There should now be continuity between terminals 30 and 87, and no continuity between terminals 87A and 30. If OK, perform the Relay Circuit Test that follows. If not OK, replace the faulty relay.

DIAGNOSIS AND TESTING (Continued)

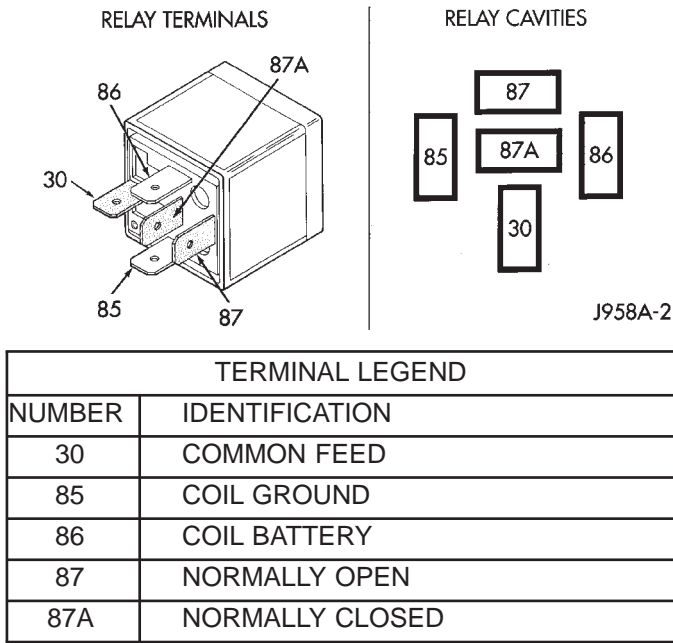


Fig. 13 Starter Relay

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 fused B(+) fuse in the PDC 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 coil. 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 engine starter motor relay output 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 blocked in the fully depressed position 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 a manual transmission, disconnect the clutch pedal position switch wire harness connector and install a jumper wire between the two cavities in the body half of the connector and check for battery voltage again at the cavity for relay terminal 86. If now OK, replace the faulty clutch pedal position switch. If still not OK with a manual trans-

mission or if not OK with an automatic transmission, check for an open or shorted fused ignition switch output (start) circuit to the ignition switch and repair, as required. If the fused ignition switch output (start) circuit is OK, refer to **Ignition Switch and Key Lock Cylinder** in the index of this service manual for the location of the proper ignition switch diagnosis and testing procedures.

(5) The coil ground terminal (85) is connected to the electromagnet in the relay. On vehicles with a manual transmission, it is grounded at all times. 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. Check for continuity to ground at the cavity for relay terminal 85. If not OK with a manual transmission, repair the open park/neutral position switch sense circuit to ground as required. If not OK with an automatic transmission, check for an open or shorted park/neutral position switch sense circuit to the park/neutral position switch and repair, as required. If the park/neutral position switch sense circuit checks OK, refer to **Park/Neutral Position Switch** in the index of this service manual for the location of the proper park/neutral position switch diagnosis and testing procedures.

REMOVAL AND INSTALLATION

STARTER MOTOR

REMOVAL

2.5L ENGINE

(1) Disconnect and isolate the battery negative cable.

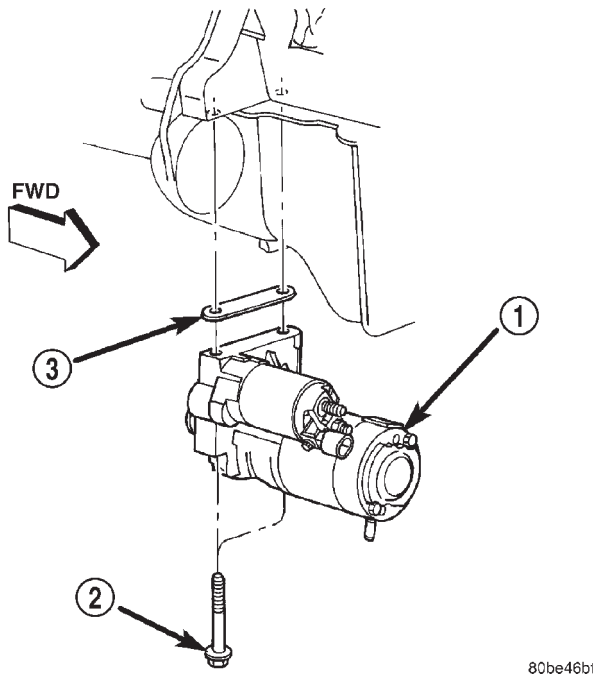
(2) Raise and support the vehicle.

(3) While supporting the starter motor with one hand, use the other hand to remove the two screws that secure the starter motor to the engine block (Fig. 14).

(4) Lower the starter motor from the engine block far enough to access and remove the nut that secures the battery positive cable eyelet terminal to the starter solenoid B(+) terminal stud (Fig. 15). Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(5) Remove the battery positive cable eyelet terminal from the starter solenoid B(+) terminal stud. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

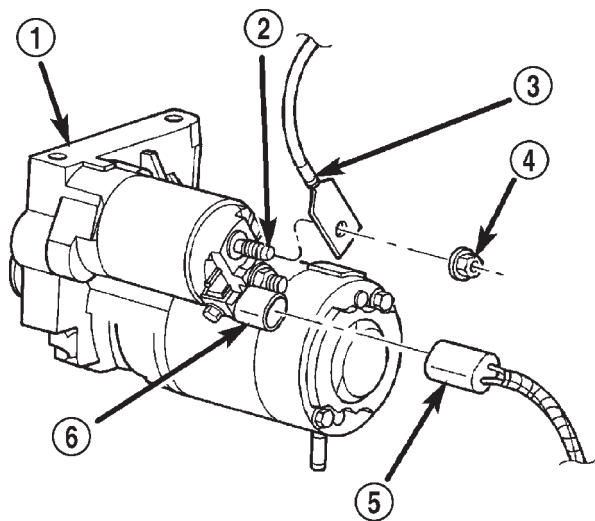
REMOVAL AND INSTALLATION (Continued)



80be46bi

Fig. 14 Starter Motor Remove/Install - 2.5L Engine

- 1 - STARTER MOTOR
- 2 - SCREW (2)
- 3 - SHIM



80be46cb

Fig. 15 Starter Connections Remove/Install - Typical

- 1 - STARTER MOTOR
- 2 - SOLENOID B(+) TERMINAL STUD
- 3 - BATTERY POSITIVE CABLE EYELET TERMINAL
- 4 - NUT
- 5 - SOLENOID TERMINAL WIRE HARNESS CONNECTOR
- 6 - SOLENOID TERMINAL CONNECTOR RECEPTACLE

(6) Disconnect the solenoid terminal wire harness connector from the connector receptacle on the starter solenoid. Always support the starter motor

during this process. Do not let the starter motor hang from the wire harness.

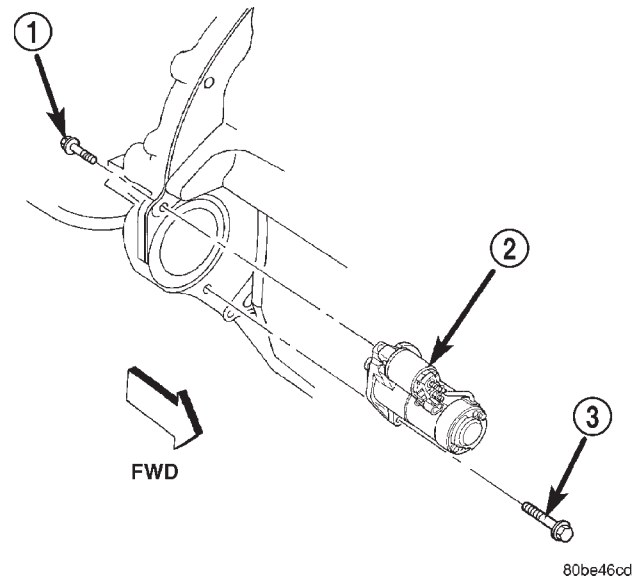
(7) Remove the starter motor and any starter motor shims (if used) from the engine block.

4.0L ENGINE

(1) Disconnect and isolate the battery negative cable.

(2) Raise and support the vehicle.

(3) Remove the lower screw (forward facing) that secures the starter motor to the manual transmission clutch housing or the automatic transmission torque converter housing (Fig. 16).



80be46cd

Fig. 16 Starter Motor Remove/Install - 4.0L Engine

- 1 - SCREW
- 2 - STARTER MOTOR
- 3 - SCREW

(4) While supporting the starter motor with one hand, use the other hand to remove the upper screw (rearward facing) that secures the starter motor to the manual transmission clutch housing or the automatic transmission torque converter housing.

(5) Lower the starter motor from the front of the manual transmission clutch housing or automatic transmission torque converter housing far enough to access and remove the nut that secures the battery positive cable eyelet terminal to the starter solenoid B(+) terminal stud (Fig. 15). Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(6) Remove the battery positive cable eyelet terminal from the solenoid B(+) terminal stud. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(7) Disconnect the solenoid terminal wire harness connector from the connector receptacle on the

REMOVAL AND INSTALLATION (Continued)

starter solenoid. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(8) Remove the starter motor from the manual transmission clutch housing or automatic transmission torque converter housing.

INSTALLATION

2.5L ENGINE

(1) Position the starter motor to the engine block.

(2) Reconnect the solenoid terminal wire harness connector to the connector receptacle on the starter solenoid. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(3) Install the battery positive cable eyelet terminal onto the starter solenoid B(+) terminal stud. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(4) Install and tighten the nut that secures the battery positive cable eyelet terminal to the starter solenoid B(+) terminal stud. Tighten the nut to 11.3 N·m (100 in. lbs.). Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(5) Position the starter motor and any starter motor shims that were removed during the starter motor removal procedure to the engine block. Loosely install the two starter motor mounting screws to secure the starter motor and shims to the engine block.

NOTE: Shim thickness available is 0.381 mm (0.015 in.). Refer to Starter Motor Noise - 2.5L Engine in the index of this service manual for the location of the proper starter motor noise diagnosis and testing procedures.

(6) Tighten the two screws that secure the starter motor and shims to the engine block. Tighten the screws to 44.7 N·m (33 ft. lbs.).

(7) Lower the vehicle.

(8) Reconnect the battery negative cable.

4.0L ENGINE

(1) Position the starter motor to the manual transmission clutch housing or automatic transmission torque converter housing.

(2) Reconnect the solenoid terminal wire harness connector to the connector receptacle on the starter solenoid. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(3) Install the battery positive cable eyelet terminal onto the starter solenoid B(+) terminal stud.

Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(4) Install and tighten the nut that secures the battery positive cable eyelet terminal to the starter solenoid B(+) terminal stud. Tighten the nut to 11.3 N·m (100 in. lbs.). Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(5) Position the starter motor to the manual transmission clutch housing or automatic transmission torque converter housing. Loosely install the two starter motor mounting screws to secure the starter motor to the manual transmission clutch housing or automatic transmission torque converter housing.

(6) Tighten the lower (forward facing) screw that secures the starter motor to the manual transmission clutch housing or automatic transmission torque converter housing. Tighten the screw to 40.7 N·m (30 ft. lbs.).

(7) Tighten the upper (rearward facing) screw that secures the starter motor to the manual transmission clutch housing or automatic transmission torque converter housing. Tighten the screw to 47.5 N·m (35 ft. lbs.).

(8) Lower the vehicle.

(9) Reconnect the battery negative cable.

STARTER RELAY

REMOVAL

(1) Disconnect and isolate the battery negative cable.

(2) Remove the cover from the Power Distribution Center (PDC) (Fig. 17).

(3) See the fuse and relay layout label affixed to the underside of the PDC cover for starter relay identification and location.

(4) Remove the starter relay from the PDC.

INSTALLATION

(1) See the fuse and relay layout label affixed to the underside of the PDC cover for the proper starter relay location.

(2) Position the starter relay in the proper receptacle in the PDC.

(3) Align the starter relay terminals with the terminal cavities in the PDC receptacle.

(4) Push down firmly on the starter relay until the terminals are fully seated in the terminal cavities in the PDC receptacle.

(5) Install the cover onto the PDC.

(6) Reconnect the battery negative cable.

REMOVAL AND INSTALLATION (Continued)

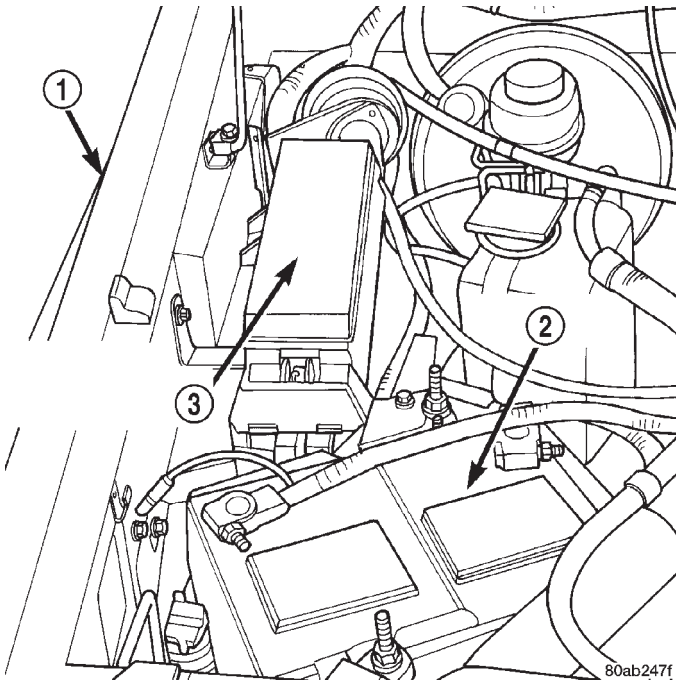


Fig. 17 Power Distribution Center

- 1 - RIGHT FENDER
- 2 - BATTERY
- 3 - POWER DISTRIBUTION CENTER

CLEANING AND INSPECTION

STARTING SYSTEM

The following components of the starting system should be carefully inspected whenever any starting system problem is encountered.

WARNING: ON VEHICLES EQUIPPED WITH AIRBAGS, DISABLE THE AIRBAG SYSTEM BEFORE ATTEMPTING ANY STEERING WHEEL, STEERING COLUMN, OR INSTRUMENT PANEL COMPONENT DIAGNOSIS OR SERVICE. DISCONNECT AND ISOLATE THE BATTERY NEGATIVE (GROUND) CABLE, THEN WAIT TWO MINUTES FOR THE AIRBAG SYSTEM CAPACITOR TO DISCHARGE BEFORE PERFORMING FURTHER DIAGNOSIS OR SERVICE. THIS IS THE ONLY SURE WAY TO DISABLE THE AIRBAG SYSTEM. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

- **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 **Battery** in the index of this service manual for the location of the proper battery cleaning and inspection procedures.

- **Ignition Switch** Visually inspect the ignition switch for indications of physical damage and loose or corroded wire harness connections. Clean corroded connections as required. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures. Refer to **Ignition Switch and Key Lock Cylinder** in the index of this service manual for the location of the proper ignition switch service procedures.

- **Clutch Pedal Position Switch** If the vehicle is equipped with a manual transmission, visually inspect the clutch pedal position switch for indications of physical damage and loose or corroded wire harness connections. Clean corroded connections as required. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures. Refer to **Clutch Hydraulic Linkage** in the index of this service manual for the location of the proper clutch pedal position switch service procedures.

- **Park/Neutral Position Switch** If the vehicle is equipped with an automatic transmission, visually inspect the park/neutral position switch for indications of physical damage and loose or corroded wire harness connections. Clean corroded connections as required. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures. Refer to **Park/Neutral Position Switch** in the index of this service manual for the location of the proper park/neutral position switch service procedures.

- **Starter Relay** Visually inspect the starter relay for indications of physical damage and loose or corroded wire harness connections. Clean corroded connections as required. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures. Refer to **Starter Relay** in the index of this service manual for the location of the proper starter relay service procedures.

- **Starter Motor** Visually inspect the starter motor for indications of physical damage and loose or corroded wire harness connections. Clean corroded connections as required. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures. If the problem being diagnosed involves improper starter engagement, disengagement or noise complaints the starter motor should be removed. With the starter motor removed, inspect the starter pinion and ring gears for damaged or missing teeth. Replace faulty components as required. Refer to **Starter Motor** in the index of this

CLEANING AND INSPECTION (Continued)

service manual for the location of the proper starter motor removal and installation procedures.

- **Starter Solenoid** Visually inspect the starter solenoid for indications of physical damage and loose or corroded wire harness connections. Clean corroded connections as required. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures. Refer to **Starter Motor** in the index of this service manual for the location of the proper starter solenoid service procedures.

- **Wiring** Visually inspect the starting system wire harnesses for indications of physical damage. Repair or replace any faulty wiring, as required. Refer to **Starting System** in the index of this service manual for the location of complete starting system wiring diagrams. Refer to **Wiring Diagrams** in the index of this service manual for the location of the proper wiring repair or connector and terminal service procedures.

SPECIFICATIONS

STARTING SYSTEM

Starter Motor and Solenoid	
Manufacturer	Mitsubishi
Engine Application	2.5L, 4.0L
Power Rating	2.5L - 1.2 Kilowatt (1.6 Horsepower) 4.0L - 1.4 Kilowatt (1.9 Horsepower)
Voltage	12 Volts
Number of Fields	4
Number of Poles	4
Number of Brushes	4
Drive Type	Planetary Gear Reduction
Free Running Test Voltage	11.2 Volts
Free Running Test Maximum Amperage Draw	90 Amperes
Free Running Test Minimum Speed	2.5L - 2600 rpm 4.0L - 2500 rpm
Solenoid Closing Maximum Voltage Required	7.8 Volts
*Cranking Amperage Draw Test	2.5L - 130 Amperes 4.0L - 160 Amperes
*Test at operating temperature. Cold engine, tight (new) engine, or heavy oil will increase starter amperage draw.	

