

# SECTION : 1E

## ENGINE ELECTRICAL

**CAUTION :** *Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.*

## TABLE OF CONTENTS

<b>SPECIFICATIONS</b> .....	1E-1	<b>UNIT REPAIR</b> .....	1E-18
STARTER SPECIFICATIONS .....	1E-1	STARTER MOTOR .....	1E-18
GENERATOR SPECIFICATIONS .....	1E-1	GENERATOR – CS 121 DIF .....	1E-29
BATTERY SPECIFICATIONS .....	1E-2		
FASTENER TIGHTENING SPECIFICATIONS .	1E-2	<b>GENERAL DESCRIPTION AND SYSTEM</b>	
<b>SCHEMATIC AND ROUTING DIAGRAMS</b> .....	1E-3	<b>OPERATION</b> .....	1E-37
STARTING SYSTEM .....	1E-3	BATTERY .....	1E-37
CHARGING SYSTEM .....	1E-4	RATINGS .....	1E-37
<b>DIAGNOSIS</b> .....	1E-5	RESERVE CAPACITY .....	1E-37
NO CRANK .....	1E-5	COLD CRANKING AMPERAGE .....	1E-37
STARTER MOTOR NOISE .....	1E-8	BUILT-IN HYDROMETER .....	1E-37
BATTERY LOAD TEST .....	1E-8	CHARGING PROCEDURE .....	1E-37
GENERATOR OUTPUT TEST .....	1E-9	CHARGING TIME REQUIRED .....	1E-38
GENERATOR SYSTEM CHECK .....	1E-9	CHARGING A COMPLETELY DISCHARGED	
<b>MAINTENANCE AND REPAIR</b> .....	1E-11	BATTERY (OFF THE VEHICLE) .....	1E-38
ON-VEHICLE SERVICE .....	1E-11	JUMP STARTING PROCEDURE .....	1E-38
GENERATOR – CS 121 DIF .....	1E-11	GENERATOR .....	1E-39
STARTER – PG 150S .....	1E-14	CHARGING SYSTEM .....	1E-39
BATTERY AND BATTERY TRAY .....	1E-16	STARTER .....	1E-39
		STARTING SYSTEM .....	1E-39

## SPECIFICATIONS

### STARTER SPECIFICATIONS

Application	Description
<b>Starter–PG 150S</b> No Load Test @ 12.2 volts Drive Pinion Speed at:	Minimum 40 – Maximum 90 amps 3,200–4,800 rpm
<b>Solenoid</b> Hold-in Windings @ 12.2 volts Pull-in Windings @ 12.2 volts	12 – 20 amps 60 – 90 amps

### GENERATOR SPECIFICATIONS

Application	Description
Type	CS-121 DIF

## BATTERY SPECIFICATIONS

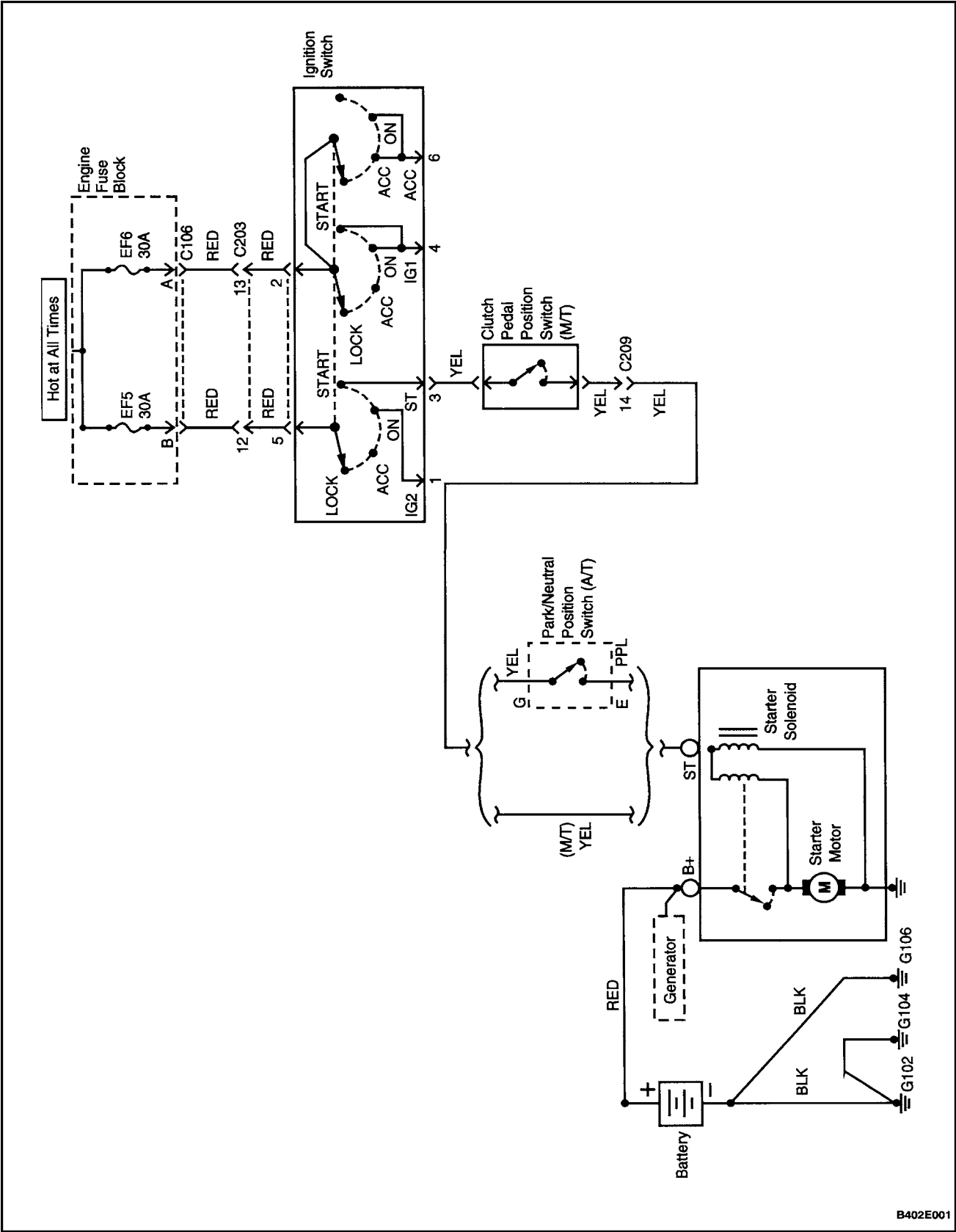
Application	Description
Cold Cranking Amps	550 amps/630 amps
Reserve Capacity Minimum	90 minutes
Load Test	270 amps
Replacement	85B–60
Minimum Voltage:	Estimated Temperature:
9.6	21° C (69.8° F)
9.4	20° C (68° F)
9.1	0° C (32° F)
8.8	–10° C (14° F)
8.5	–18° C (0° F)
8.0	Below –18° C (Below 0.4° F)

## FASTENER TIGHTENING SPECIFICATIONS

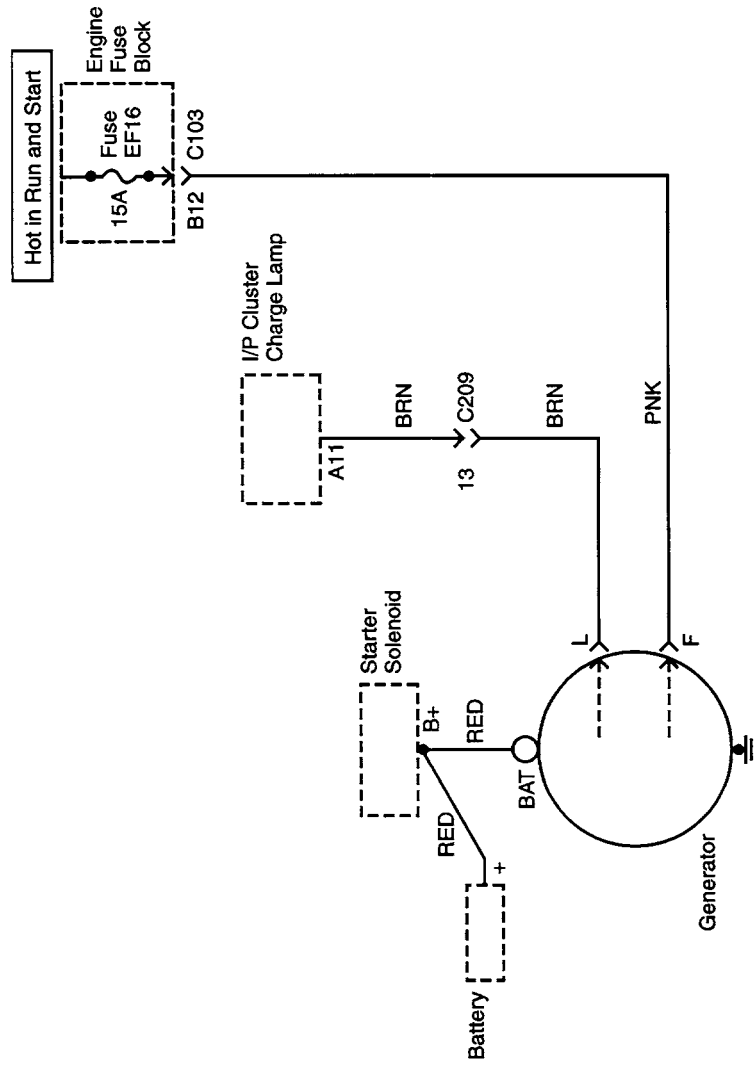
Application	N•m	Lb•Ft	Lb•In
Battery Cable Nuts	5	–	44
Battery Carrier Tray Upper, Lower, and Side Bolts	20	15	–
Battery Retainer Clamp–to–Battery Rod Nuts	5	–	44
Generator Drive End Bearing Nut	81	60	–
Generator Lower Bracket–to–Engine Block Bolts	50	37	–
Generator Through–Bolts	10	–	89
Generator–to–Intake Manifold and Cylinder Head Support Bracket Bolts	37	27	–
Generator–to–Intake Manifold Strap Bracket Bolt	22	16	–
Intake Manifold–to–Cylinder Body Strap Bracket Bolts	22	16	–
Starter Field Connector Nut	12	–	106
Starter Lower Mounting Stud Ground Wire Nut	–	–	–
Starter Solenoid Assembly Screws	8	–	71
Starter Solenoid Terminal–to–Battery Cable Terminal Nut	12	–	106
Starter Solenoid Terminal–to–Ignition Solenoid Terminal Nut	6	–	53
Starter Through–Bolts	6	–	53
Starter–to–Engine Block Mounting Bolt	45	33	–
Starter–to–Engine Transaxle Mounting Bolt	50	37	–
Upper Starter Bolt and Lower Start Stud/Weld Nut Assembly	43	32	–

# SCHEMATIC AND ROUTING DIAGRAMS

## STARTING SYSTEM



## CHARGING SYSTEM



# DIAGNOSIS

## NO CRANK

Step	Action	Value(s)	Yes	No
1	1. Press the clutch pedal completely down. 2. Turn the key to START. Does the vehicle start?		System OK	Go to <i>Step 2</i>
2	1. Disconnect the clutch pedal position switch wires. 2. Check for continuity between the switch terminals when the clutch pedal switch is pushed to ON. Does the ohmmeter indicate the specified value?	0 $\Omega$	Go to <i>Step 4</i>	Go to <i>Step 3</i>
3	Replace the clutch pedal position switch. Does the vehicle start?		System OK	Go to <i>Step 4</i>
4	1. Turn the headlamps ON. 2. Turn the dome lamps ON. 3. Turn the key to START. Do the lights dim or go out?		Go to <i>Step 5</i>	Go to <i>Step 11</i>
5	Check the battery state of charge. Is the green eye showing from the built-in hydrometer?		Go to <i>Step 6</i>	Go to "Charging Procedure"
6	1. Connect the voltmeter positive lead to the positive battery terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	< 9.6 v	Go to "Charging Procedure"	Go to <i>Step 7</i>
7	1. Connect the voltmeter negative lead to the negative battery terminal. 2. Connect the voltmeter positive lead to the engine block. 3. Turn the ignition to START. Does the voltmeter indicate the specified value?	> 0.5 v	Go to <i>Step 8</i>	Go to <i>Step 9</i>
8	1. Clean and tighten the negative battery cable connections both at the battery end and at the ground end. 2. Replace the cable if needed. Is the repair complete?		System OK	
9	1. Connect the voltmeter positive lead to the starter "B" terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. 3. Check the cranking voltage. Does the voltmeter indicate the specified value?	< 9 v	Go to <i>Step 10</i>	Go to <i>Step 16</i>
10	Clean, tighten, or replace the positive battery cable. Is the repair complete?		System OK	
11	Check system fuse EF3 in the engine fuse block. Is fuse EF3 blown?		Go to <i>Step 12</i>	Go to <i>Step 13</i>

## 1E – 6 ENGINE ELECTRICAL

Step	Action	Value(s)	Yes	No
12	Replace system fuse EF3. Is the repair complete?		System OK	
13	Check the connection at the starter "S" terminal. Is the connection in good condition?		Go to <i>Step 15</i>	Go to <i>Step 14</i>
14	Repair the starter "S" terminal. Is the repair complete?		System OK	
15	1. Connect the voltmeter positive lead to the starter "S" terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. 3. Turn the ignition to START. 4. Read the voltage present at the "S" terminal. Does the voltmeter indicate the specified value?	> 7 v	Go to <i>Step 16</i>	Go to <i>Step 17</i>
16	Repair or replace the starter. Is the repair complete?		System OK	
17	Turn on the heater blower. Does the blower operate?		Go to <i>Step 27</i>	Go to <i>Step 18</i>
18	1. Disconnect connector C203. 2. Connect the voltmeter positive lead to terminal 12 of connector C203. 3. Connect the voltmeter negative terminal to ground. Does the voltmeter indicate the specified value?	12 v	<i>Step 20</i>	<i>Step 19</i>
19	Repair the open in the RED wire from fuse EF5 to Connector C203. Is the repair complete?		System OK	
20	Check the contacts of terminal 12 on connector C203. Are the contacts OK?		Go to <i>Step 22</i>	Go to <i>Step 21</i>
21	Repair the faulty contact of connector C203. Is the repair complete?		System OK	
22	1. Reconnect connector C203. 2. Disconnect the ignition switch connector. 3. Connect the voltmeter positive lead to terminal 5 of the ignition switch connector. 4. Connect the voltmeter negative terminal to ground. Does the voltmeter indicate the specified value?	11–14 v	Go to <i>Step 24</i>	Go to <i>Step 23</i>
23	Repair the open in the RED wire from terminal 12 of connector C203 to terminal 5 of the ignition switch connector. Is the repair complete?		System OK	
24	Check the contacts of terminal 5 of the ignition switch connector. Are the contacts OK?		Go to <i>Step 26</i>	Go to <i>Step 25</i>
25	Repair the faulty contact of the ignition switch connector. Is the repair complete?		System OK	
26	Replace the ignition switch. Is the repair complete?		System OK	
27	Does the vehicle have an automatic transmission?		Go to <i>Step 28</i>	Go to <i>Step 38</i>

Step	Action	Value(s)	Yes	No
28	1. Disconnect the Park/Neutral Position Switch connector. 2. Connect the voltmeter positive lead to the Park/Neutral Position Switch connector terminal G, connected to the YEL wire. 3. Connect the voltmeter negative lead to the negative battery terminal. 4. Turn the ignition to START. Does the voltmeter indicate the specified value?	< 7 v	Go to Step 29	Go to Step 34
29	Check continuity between the Park/Neutral Position Switch connector terminal E, connected to the PPL wire, and the Park/Neutral Position Switch connector terminal G, connected to the YEL wire. Does the ohmmeter indicate the specified value?	0 $\Omega$	Go to Step 30	Go to Step 33
30	Check the condition of terminals E and G on both the Park/Neutral Position Switch connector and on the Park/Neutral Position Switch. Are any of these terminals faulty?		Go to Step 31	Go to Step 32
31	Repair the faulty terminal. Is the repair complete?		System OK	
32	Repair the open in the PPL wire between terminal E of the Park/Neutral Position Switch connector and the starter "S" terminal. Is the repair complete?		System OK	
33	Replace the Park/Neutral Position Switch. Is the repair complete?		System OK	
34	1. Reconnect the Park/Neutral Position Switch. 2. Disconnect connector C209. 3. Connect the voltmeter positive lead to terminal 14 of connector C209 on the I/P harness. 4. Connect the voltmeter negative lead to ground. 5. Turn the ignition to START. Does the voltmeter indicate the specified value?	12 v	Go to Step 35	Go to Step 38
35	Check terminal 14 on both sides of connector C209. Is one of them faulty?		Go to Step 36	Go to Step 37
36	Repair the faulty terminal. Is the repair complete?		System OK	
37	Repair the open in the YEL wire from terminal 14 of connector C209 to terminal G of the Park/Neutral Position Switch. Is the repair complete?		System OK	
38	1. Disconnect the ignition switch connector. 2. Connect the voltmeter positive lead to terminal ST of the ignition switch. 3. Connect the voltmeter negative lead to ground. 4. Turn the ignition to START. Does the voltmeter indicate the specified value?	12 v	Go to Step 40	Go to Step 39
39	Replace the ignition switch. Is the repair complete?		System OK	
40	Check terminal ST on the ignition switch and terminal 3 of the ignition switch connector. Are the terminals in good condition?		Go to Step 41	Go to Step 42

Step	Action	Value(s)	Yes	No
41	Repair the open in YEL wire between terminal 3 of the ignition switch connector and terminal 14 of connector C209. Is the repair complete?		System OK	
42	Repair the faulty terminal. Is the repair complete?		System OK	

## STARTER MOTOR NOISE

To correct starter motor noise during starting, use the following procedure:

Checks	Action
Check for a high-pitched whine during cranking (before the engine fires). The engine cranks and fires properly.	The distance is too great between the starter pinion and the flywheel. Shimming the starter toward the flywheel is required.
Check for a high-pitched whine after the engine fires, as the key is being released. The engine cranks and fires properly. This intermittent complaint is often diagnosed as "starter hang-in" or "solenoid weak."	The distance is too small between the starter pinion and the flywheel. Shimming the starter away from the flywheel is required.
Check for a loud "whoop" after the engine fires but while the starter is still held engaged. The sound is like a siren if the engine is revved while the starter is engaged.	The most probable cause is a defective clutch. A new clutch will often correct this problem.
Check for a "rumble," a "growl," or, in severe cases, a "knock" as the starter is coasting down to a stop after starting the engine.	The most probable cause is a bent or unbalanced starter armature. A new armature will often correct this problem.

If the complaint is noise, correction can be achieved by proper shimming as follows:

1. Check for a bent or a worn flywheel.
2. Start the engine and carefully touch the outside diameter of the rotating flywheel ring gear with chalk or a crayon to show the high point of the tooth run-out. Turn the engine OFF and rotate the flywheel so that the marked teeth are in the area of the starter pinion gear.
3. Disconnect the negative battery cable to prevent the cranking of the engine.
4. Check the pinion-to-flywheel clearance by using a wire gauge of 0.5 mm (0.02 inch) minimum thickness (or diameter). Center a pinion tooth between two flywheel teeth and the gauge. Do not gauge in the corners, where a misleading larger dimension may be observed. If the clearance is under this minimum, shimming the starter away from the flywheel is required.
5. If the clearance approaches 1.5 mm (0.06 inch) or more, shimming the starter toward the flywheel is required. This condition is generally the cause of broken flywheel teeth or the starter housing. Shim the starter toward the flywheel by shimming only the outboard starter mounting pad. A shim of 0.40 mm (0.016 inch) thickness at this location will decrease the clearance by approximately 0.30mm

(0.012 inch). If normal starter shims are not available, plainwashers or other suitable material may be used as shims.

## BATTERY LOAD TEST

1. Check the battery for obvious damage, such as a cracked or broken case or cover, which could permit the loss of electrolyte. If obvious damage is noted, replace the battery.

**CAUTION : Do not charge the battery if the hydrometer is clear or light yellow. Instead, replace the battery. If the battery feels hot or if violent gassing or spewing of electrolyte through the vent hole occurs, discontinue charging or reduce the charging rate to avoid personal injury.**

2. Check the hydrometer. If the green dot is visible, go to the load test procedure. If the indicator is dark but green is not visible, charge the battery. For charging a battery removed from the vehicle, refer to "Charging a Completely Discharged Battery" in this section.
3. Connect a voltmeter and a battery load tester across the battery terminals.
4. Apply a 300-ampere load for 15 seconds to remove all surface charge from the battery.
5. Remove the load.



6. Wait 15 seconds to let the battery recover, and apply a 270–ampere load.

**Important :** The battery temperature must be estimated by touch and by the temperature condition the battery has been exposed to for the preceding few hours.

7. If the voltage does not drop below the minimum listed, the battery is good and should be reinstalled. If the voltage is less than the minimum listed, replace the battery. Refer to "Battery Specifications" in this section.

## GENERATOR OUTPUT TEST

1. Perform the generator system test. Refer to "Generator System Check" in this section.
2. Replace the generator if it fails that test. Refer to "Generator" in the On–Vehicle Service section. If it passes the test, perform the on–vehicle output check which follows.

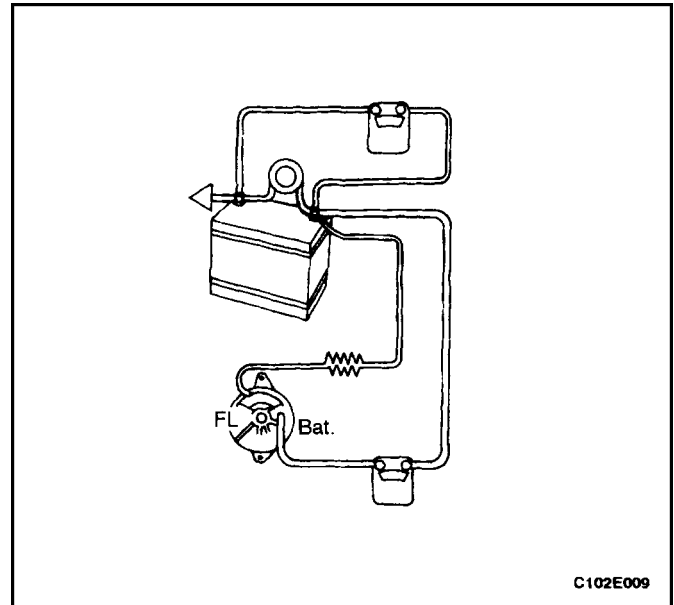
**Important :** Always check the generator for output before assuming that a grounded "L" terminal circuit has damaged the regulator.

3. Attach a digital multimeter, an ammeter, and a carbon pile load to the vehicle.

**Important :** Be sure the vehicle battery is fully charged, and the carbon pile load is turned off.

4. With the ignition in OFF, check and record the battery voltage.
5. Remove the harness connector from the generator.
6. Turn the ignition to RUN with the engine not running. Use a digital multimeter to check for voltage in the harness connector "L" terminal.
7. The reading should be near the specified battery voltage of 12 volts. If the voltage is too low, check the indicator "L" terminal circuits for open and grounded circuits causing voltage loss. Correct any open wires, terminal connections, etc., as necessary. Refer to "Charging System" in this section.
8. Attach the generator harness connector.
9. Run the engine at a moderate idle, and measure the voltage across the battery terminals. The reading should be above the recorded in Step 14 but less than 16 volts. If the reading is over 16 volts or below the previous reading, replace the generator. Refer to "Generator" in the On–Vehicle Service portion of this section.
10. Run the engine at a moderate idle, and measure the generator amperage output.
11. Turn on the carbon pile, and adjust it to obtain the maximum amps while maintaining the battery voltage above 13 volts.
12. If the reading is within 15 amps of the generator's rating noted on the generator, the generator is good. If not, replace the generator. Refer to "Generator" in the On–Vehicle Service section.

13. With the generator operating at the maximum output, measure the voltage between the generator housing and the battery negative terminal. The voltage drop should be 0.5 volt or less. If the voltage drop is more than 0.5 volt, check the ground path from the generator housing to the negative battery cable.
14. Check, clean, tighten, and recheck all of the ground connections.



## GENERATOR SYSTEM CHECK

When operating normally, the generator indicator lamp will come on when the ignition is in RUN, and go out when the engine starts. If the lamp operates abnormally or if an undercharged or overcharged battery condition occurs, the following procedure may be used to diagnose the charging system. Remember that an undercharged battery is often caused by accessories being left on overnight, or by a defective switch that allows a lamp, such as a trunk lamp or a glove box lamp, to stay on.

Diagnose the generator with the following procedure:

1. Visually check the belt and the wiring.
2. With the ignition in RUN and the engine stopped, the charge indicator lamp should be on. If not, detach the harness at the generator and ground the "L" terminal in the harness with a fused 5–ampere jumper lead.
  - If the lamp lights, replace the generator. Refer to "Generator" in the On–Vehicle Service section.
  - If the lamp stays on, check for a short to ground in the harness between the connector and the indicator lamp.
3. With the ignition switch in the RUN position and the engine running at moderate speed, the charge indicator lamp should be off. If not, detach the wiring harness at the generator.

- If the lamp goes off, replace the generator. Refer to "Generator" in the On–Vehicle Service section.
- If the lamp stays on, check for a short to ground in the harness between the connector and the indicator lamp.

**Important :** Important: Always check the generator for output before assuming that a grounded "L" terminal circuit has damaged the regulator. Refer to "Generator" in the Unit Repair section.

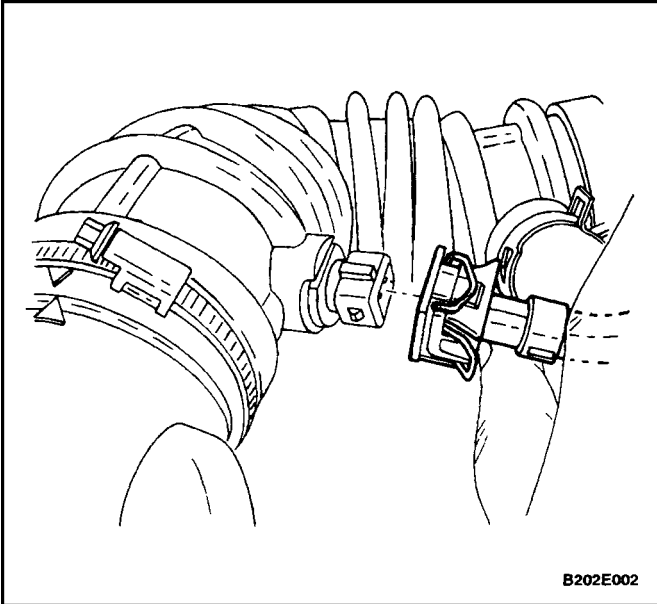
## MAINTENANCE AND REPAIR

### ON-VEHICLE SERVICE

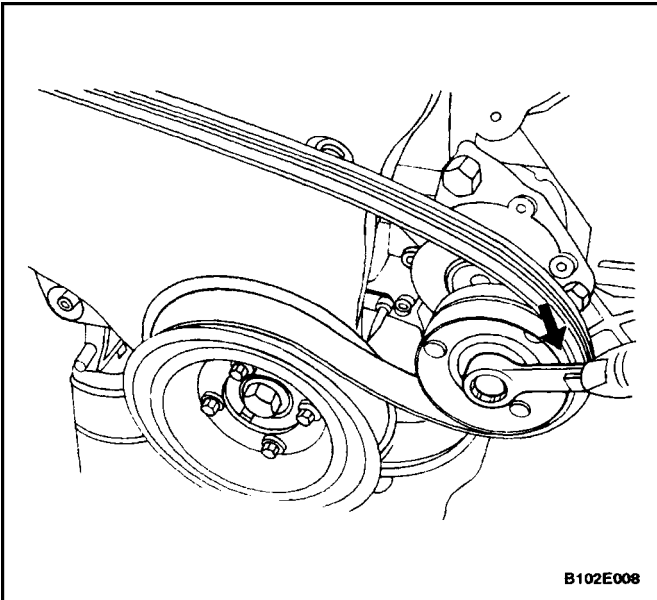
#### GENERATOR – CS 121 DIF

##### Removal Procedure

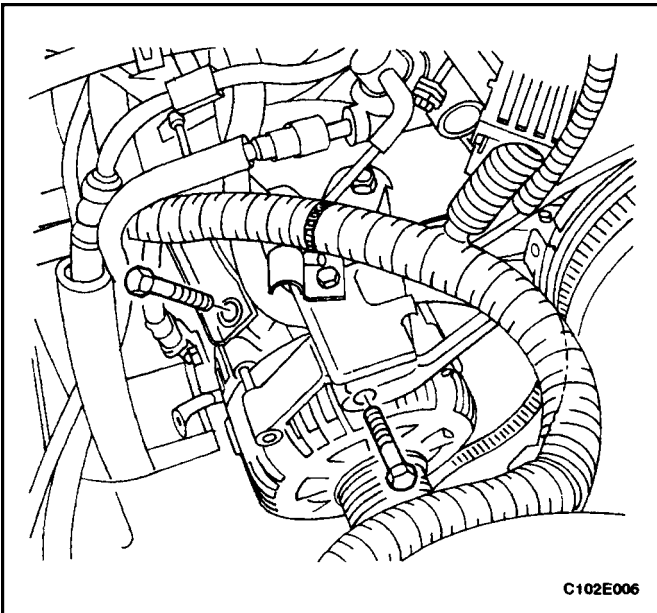
1. Disconnect the negative battery cable.
2. Disconnect the intake air temperature (IAT) sensor electrical connector from the air intake tube.
3. Remove all the clamps from the air intake tube hose, and set aside the tube.
4. Raise and suitably support the vehicle.
5. Disconnect the harness connector from the back of the generator.
6. Remove the accessory drive belt by lowering the vehicle and turning the automatic tensioner roller bolt clockwise to relieve tension on the belt. Refer to *Section 6B, Power Steering Pump*.
7. Push up the power steering reservoir and set it aside.
8. Remove the generator upper mounting bolts to the intake manifold/cylinder head support bracket, the intake manifold strap bracket, and the intake manifold-to-cylinder body strap bracket.



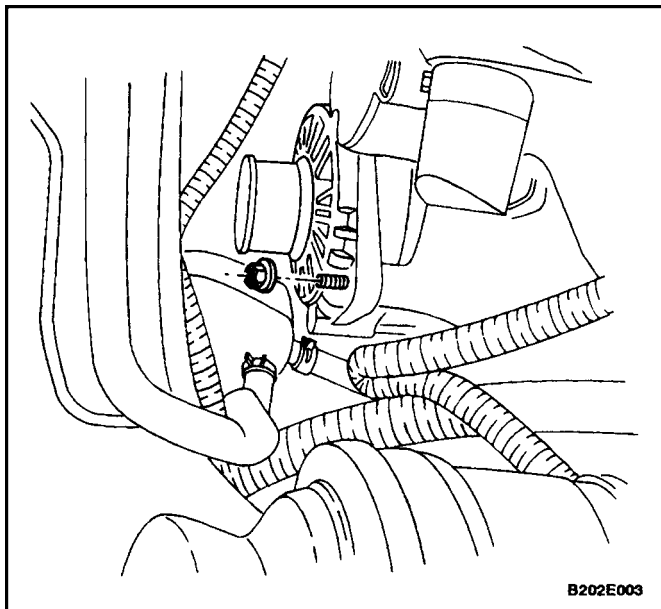
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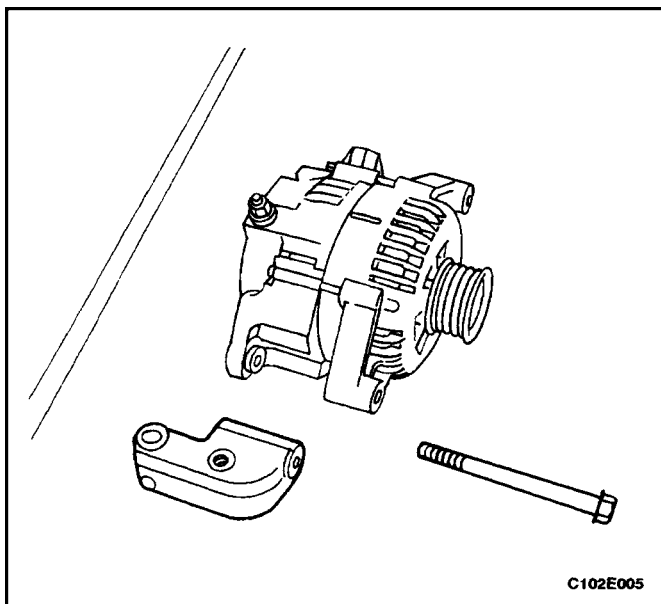
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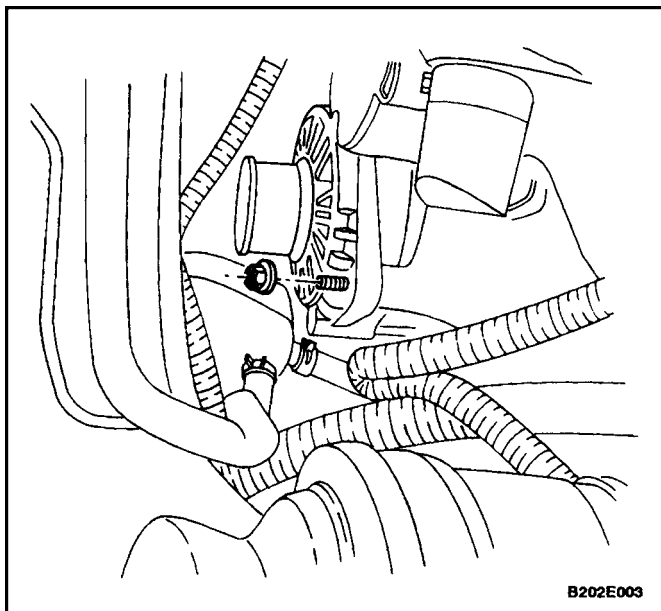
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9. Raise and suitably support the vehicle. Remove the nut and the washers which hold the generator lower bracket-to-generator bolt. Work the bolt loose and remove the generator.

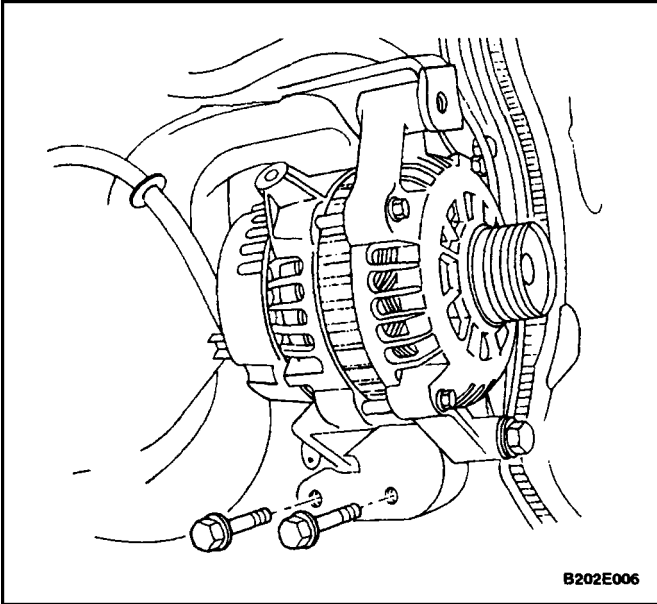


10. Remove the generator lower support bracket bolts.
11. Carefully remove the generator with the lower bracket attached.
12. Remove the generator lower support bracket nut, the bolt, and the washer.



### Installation Procedure

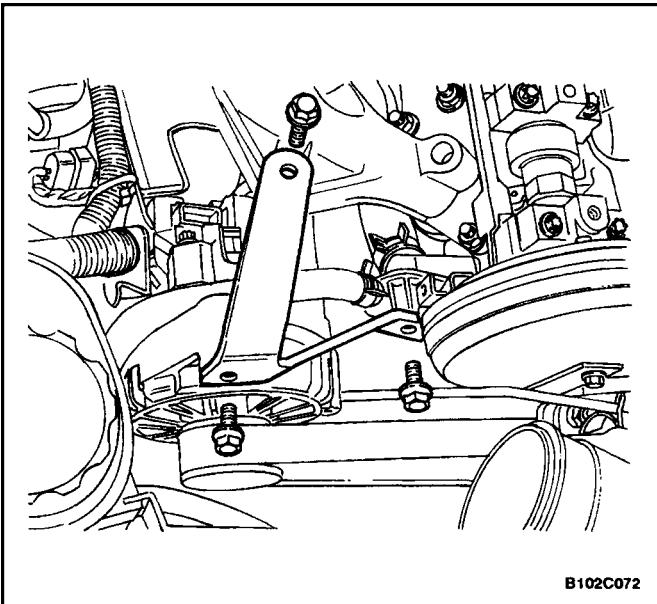
1. Install the generator to the generator lower bracket and insert the generator bolt.



2. Install the generator and the lower support bracket assembly to the engine block.

**Tighten**

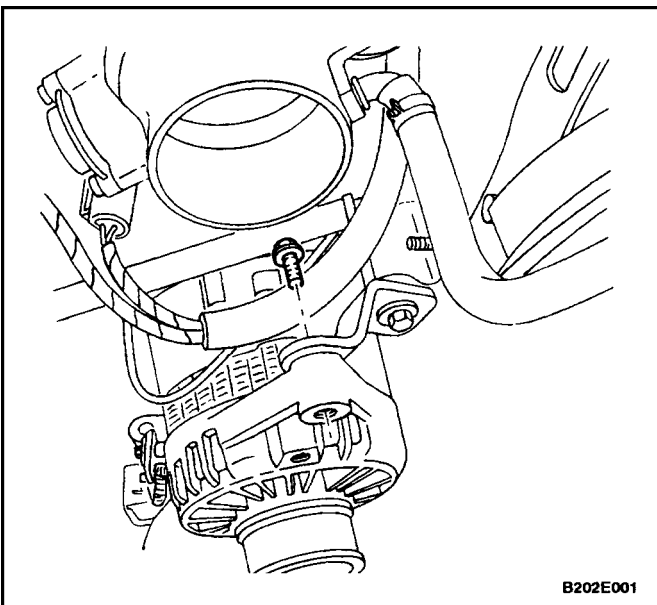
Tighten the generator lower bracket-to-engine block bolts to 50 N•m (37 lb-ft).



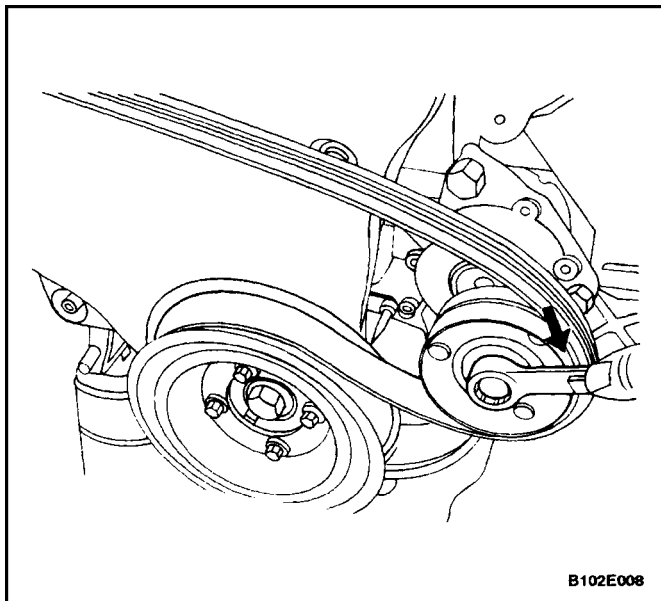
3. Install the generator-to-intake manifold and cylinder head support bracket bolts, the generator-to-intake manifold strap bracket bolt, and the intake manifold-to-cylinder body strap bracket bolts over the starter.

**Tighten**

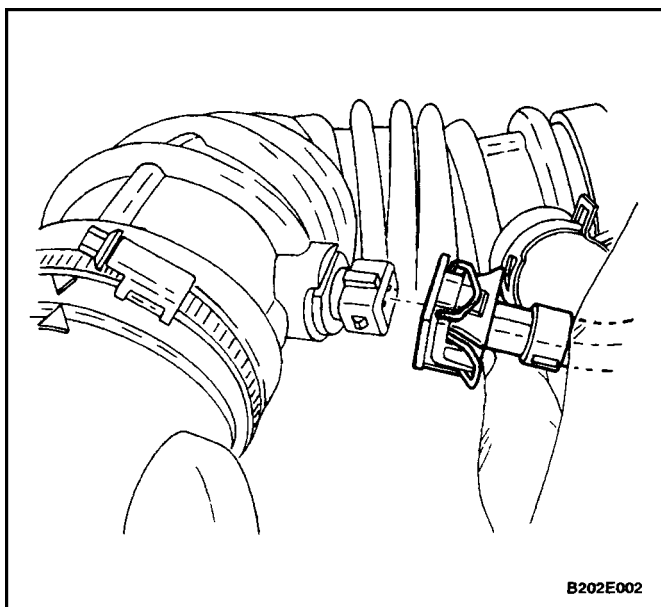
Tighten the generator-to-intake manifold and cylinder head support bracket bolts to 37 N•m (27 lb-ft). Tighten the generator-to-intake manifold strap bracket bolt and the intake manifold-to-cylinder body strap bracket bolts to 22 N•m (16 lb-ft).



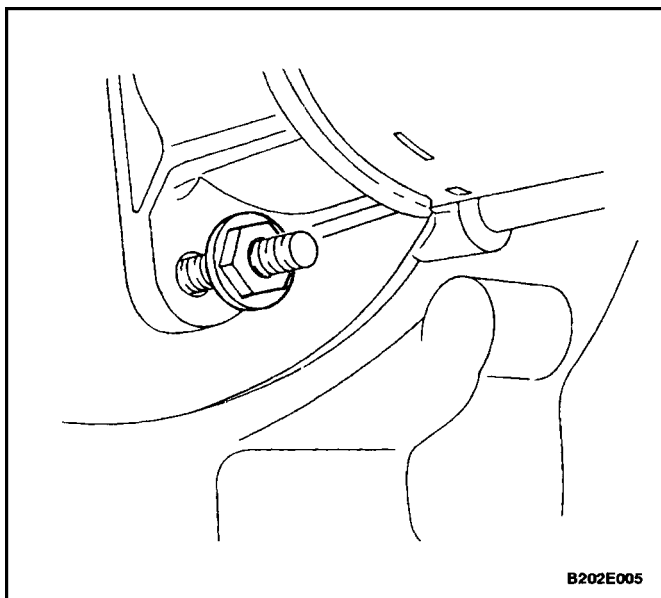
4. Connect the harness connector to the back of the generator, if applicable.



5. Route the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.
6. Relieve tension on the belt by first applying downward pressure on the automatic tension roller bolt and then releasing pressure once the belt is in place.
7. Install the power steering reservoir.



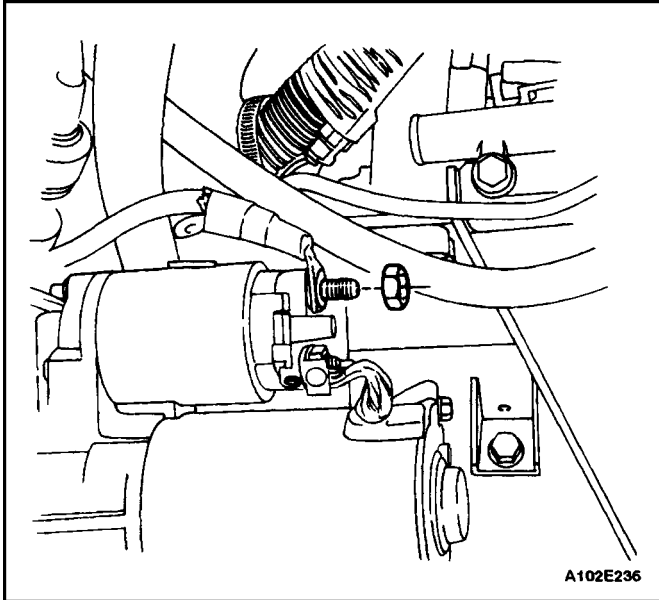
8. Install the air intake tube and connect the IAT sensor electrical connector.
9. Connect the negative battery cable.



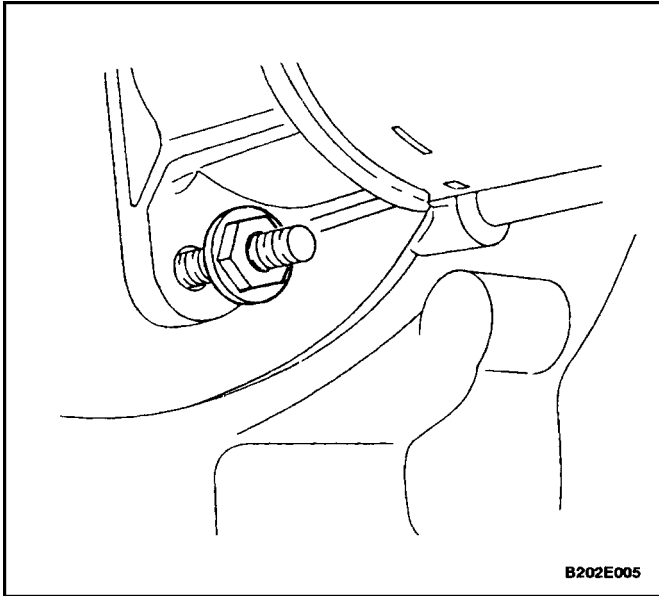
## STARTER – PG 150S

### Removal Procedure

1. Remove the nut which secures the starter ground wire to the lower mounting stud and remove the ground wire.
2. Remove the starter-to-engine block mounting bolt and the starter-to-transmission mounting bolt.



3. Remove the starter solenoid nuts to disconnect the electrical cable.
4. Remove the starter assembly.

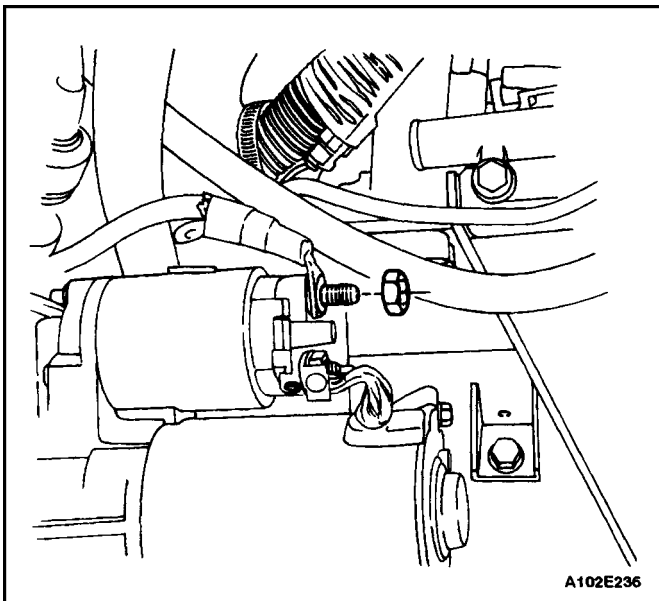


### Installation Procedure

1. Place the starter assembly in position using an assistant to prop up the starter. This will aid in screwing in the upper stud with the weld nut.
2. Install the starter mounting bolts.

#### Tighten

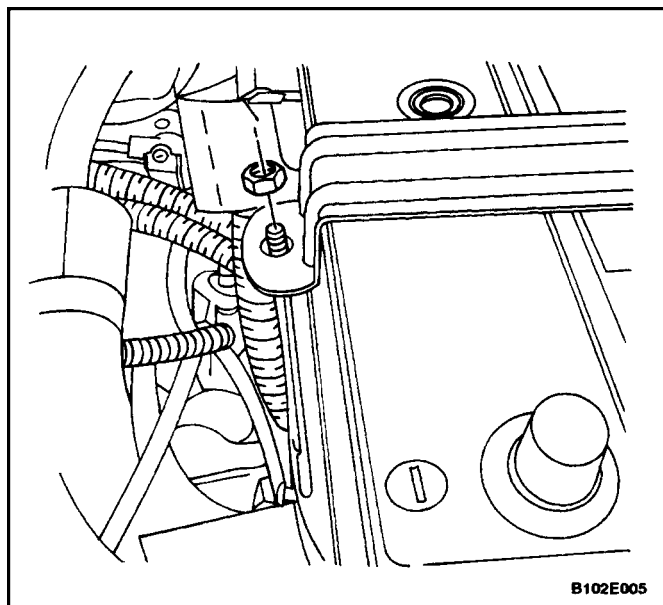
Tighten the starter-to-engine block mounting bolt to 45 N•m (33 lb-ft) and the starter-to-transaxle mounting bolt to 50 N•m (37 lb-ft).



3. Position the starter electrical wire on the solenoid terminal and the ground wire on the lower stud.
4. Install the starter solenoid nuts and the ground wire nut.

#### Tighten

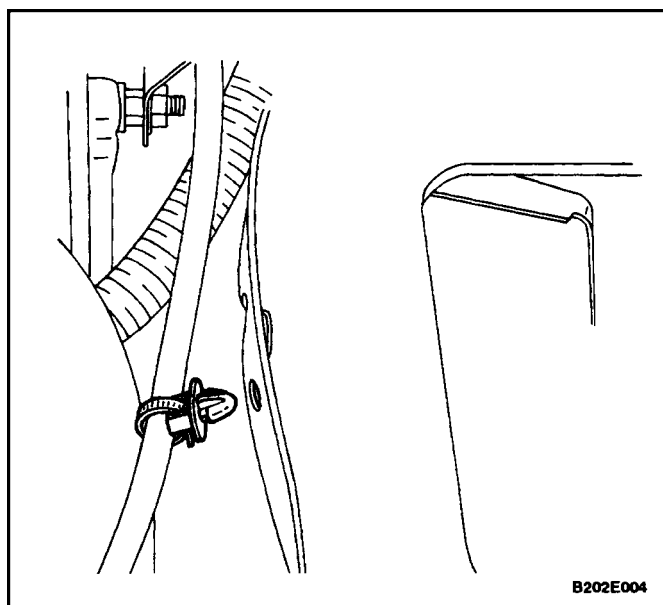
Tighten the starter solenoid terminal-to-battery cable terminal nut to 12 N•m (106 lb-in), and the starter solenoid terminal-to-ignition solenoid terminal nut to 6 N•m (53 lb-in). Tighten the starter lower mounting stud ground wire nut to N•m (lb-in).



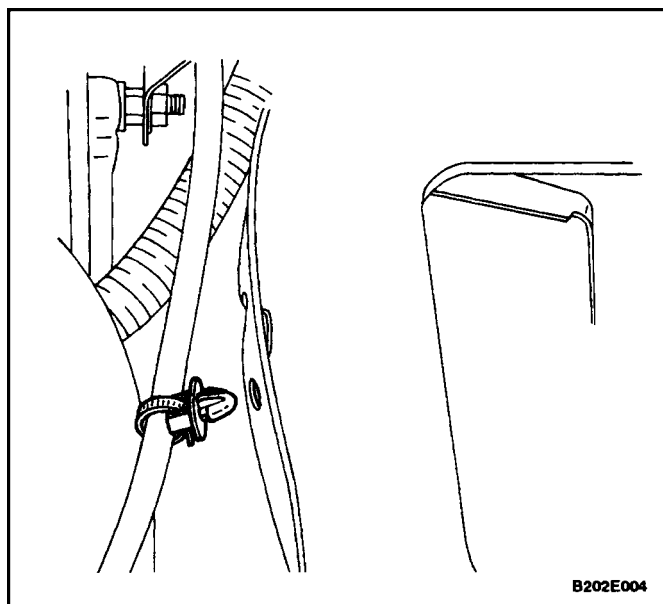
## BATTERY AND BATTERY TRAY

### Removal Procedure

1. Disconnect the negative battery cable and then disconnect the positive battery cable.
2. Remove the nuts from the battery rods that fasten the battery hold-down bar clamp.



3. Check the battery carrier tray for obvious cracks or damage. Unclip the lead to the negative battery cable from the side of the battery tray, (if applicable). Detach the carrier tray, if necessary, by removing the upper battery carrier tray bolts, and the side bolt that connects the hydraulic clutch hose bracket to the battery carrier tray, (if applicable, as shown).
4. Remove the lower battery tray bolts.



### Installation Procedure

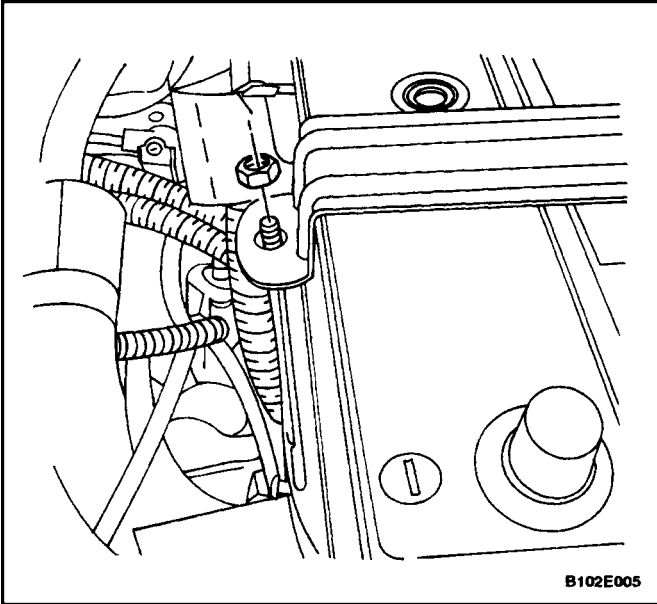
1. Install the battery carrier by fastening the carrier tray upper, lower, and side bolts.

#### Tighten

Tighten the battery carrier tray upper, lower, and side bolts, (if applicable), to 20 N•m (15 lb-ft).

2. Push in the clip of the negative battery lead to the hole in the side of the battery tray, (if applicable).

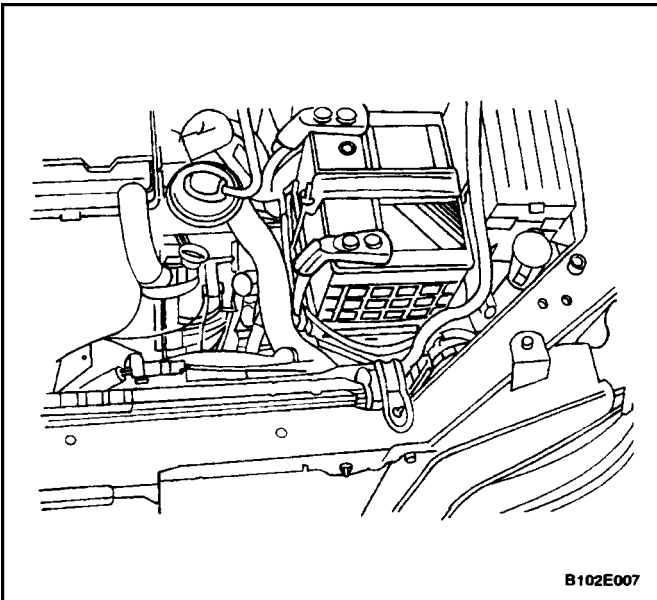




3. Install the battery into the tray.
4. Fasten the bar clamp to the battery by loosely attaching the battery rods from the battery tray cut-outs through the bar clamp holes, and loosely tightening the nuts.

**Tighten**

Tighten the battery retainer clamp-to-battery rod nuts to 5 N•m (44 lb-in).



5. Connect the negative and the positive battery cables.

**Tighten**

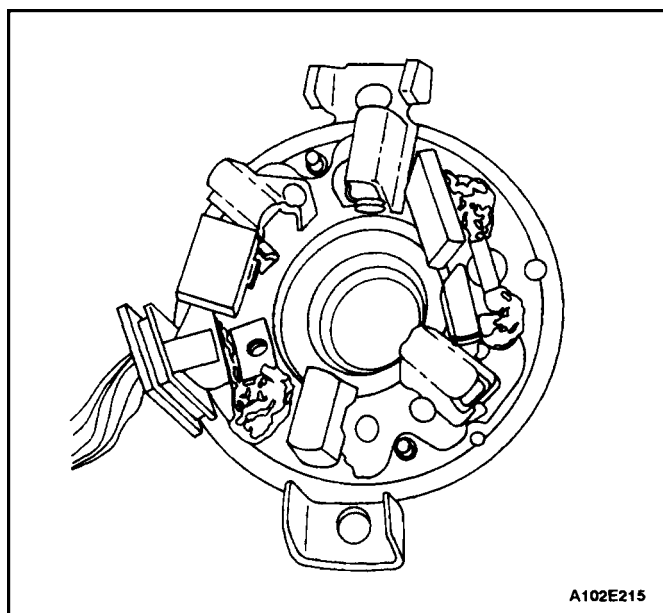
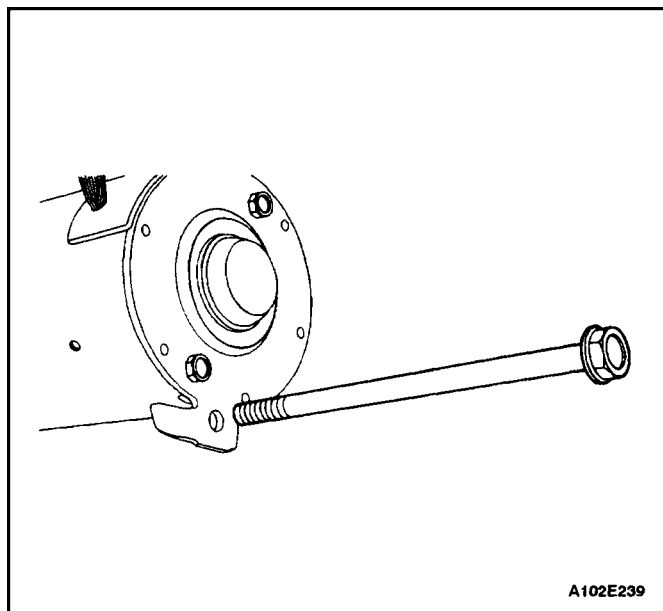
Tighten the battery cable nuts to 5 N•m (44 lb-in).

## UNIT REPAIR

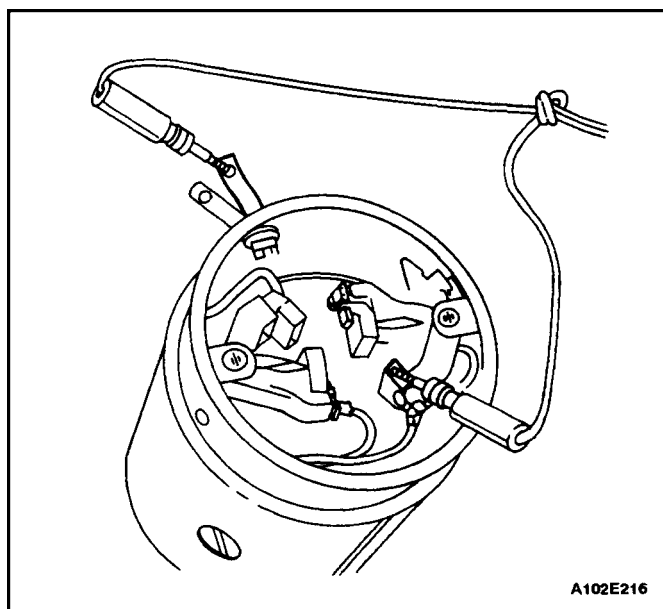
### STARTER MOTOR

#### Disassembly Procedure

1. Remove the starter. Refer to "Starter" in this section.
2. Remove the starter through-bolts.

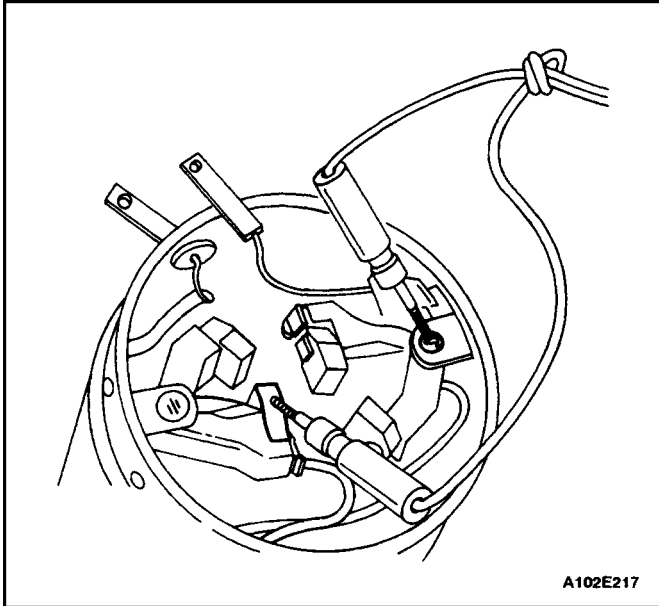


3. Remove the commutator end frame/brush holder assembly.
4. Inspect the brushes, the pop-out springs, and the brush holders for wear and damage. Replace the assembly, if necessary.

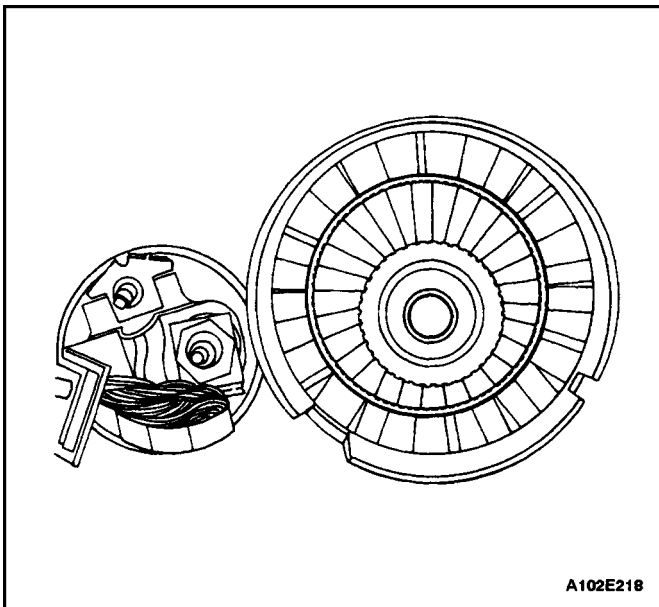


**Important :** This test should be made for each ground or insulated brush to ensure continuity through both brushes and leads. If the lamp fails to light, the field coil is open and will require replacement.

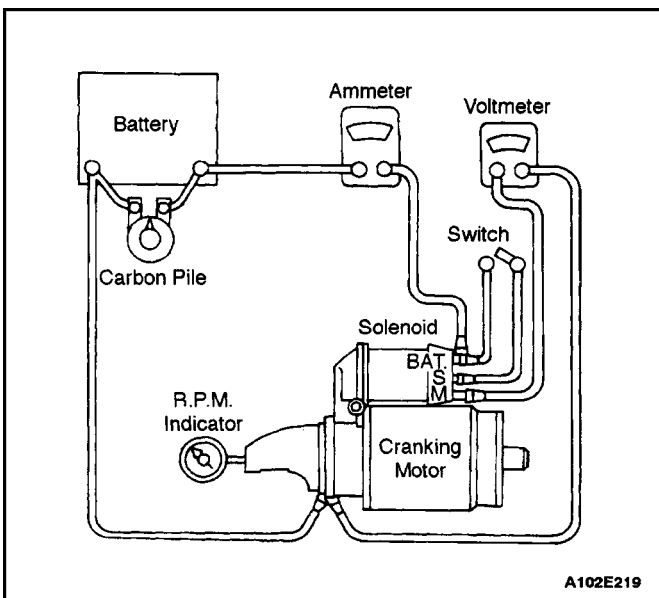
5. Use the following procedure for only those starters having a shunt coil connection: using a test lamp, place one lead on the shunt coil terminal and connect the other lead to a ground brush or insulated brush.



6. When testing series coils for ground, separate the series and the shunt coil strap terminals during the test. in this section. Make disconnections only with the switch open. Use the test results as follows:
  - 1) Make sure the strap terminals are not touching the case or the other ground.
  - 2) Using a test lamp, place one lead on the grounded brush holder and the other lead on either insulated brush.
  - 3) If the lamp is lit, a grounded series coil is indicated and must be repaired or replaced.
  - 4) To test for an open circuit, on each insulated brush, place one lead on the series coil terminal and the other lead on the insulated brush.
  - 5) If the test lamp is not lit, the series coil is open and will require repair or replacement.



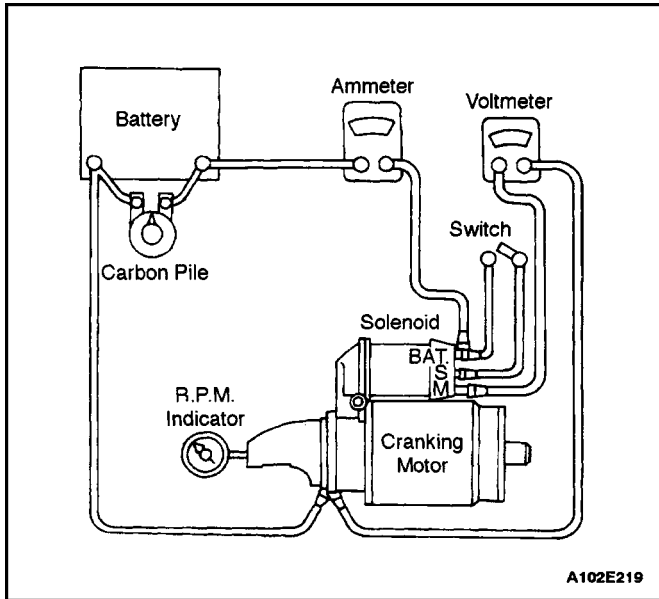
7. Check the armature to see if it turns freely. If the armature does not turn freely, break down the assembly immediately, starting with Step 12. Otherwise, give the armature a no-load test.



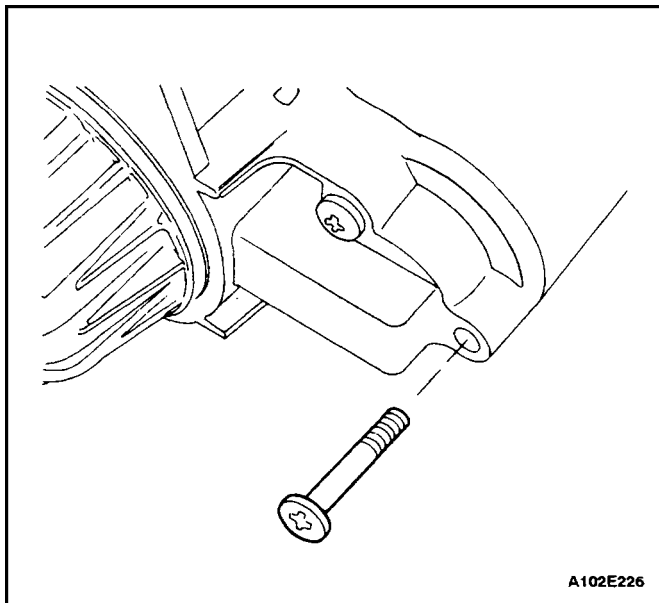
**Notice :** Complete the testing in a minimum amount of time to prevent overheating of the solenoid.

**Important :** If the specified current draw does not include the solenoid, deduct from the armature reading the specified current draw of the solenoid hold-in winding.

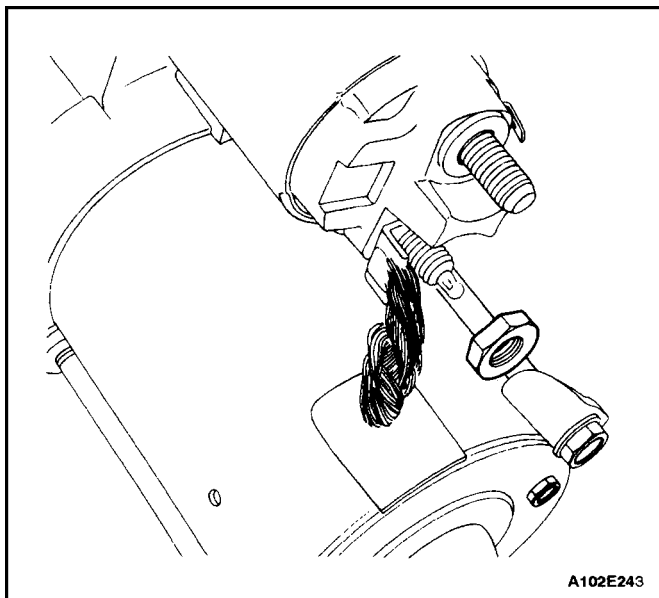
8. To begin the no-load test, close the switch and compare the rpm, the current, and the voltage readings with the specifications. Refer to "Starter Specifications" in this section. Make disconnections only with the switch open. Use the test results as follows:
  - 1) Rated current draw and no-load speed indicate a normal condition for the starter motor.
  - 2) Low free speed and high current draw indicate too much friction (tight, dirty or worn bearings or a bent armature shaft), a shorted armature, or a shorted armature or fields.



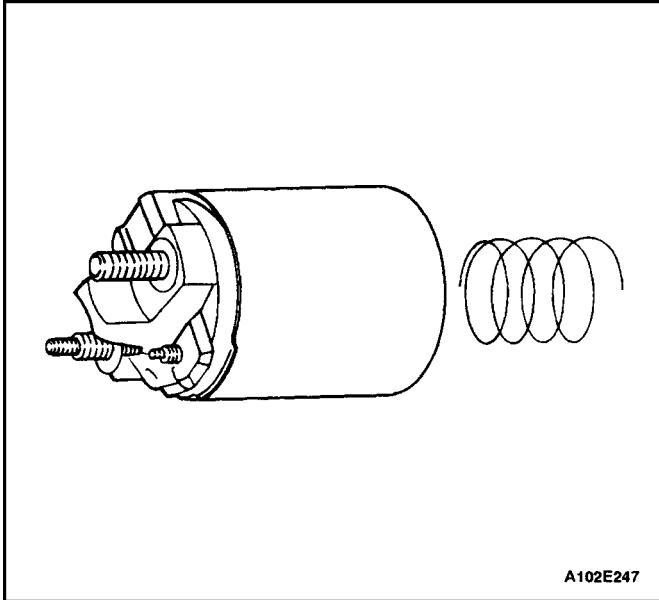
- 1) Failure to operate with high current draw indicates a direct ground in the terminal or fields, or "frozen" bearings.
- 2) Failure to operate with no current draw indicates an open field circuit, open armature coils, broken brush springs, worn brushes, high insulation between the commutator bars, or other causes which would prevent good contact between the brushes and the commutator.
- 3) Low, no-load speed and a low current indicate high internal resistance and high current draw, which usually mean shorted fields.



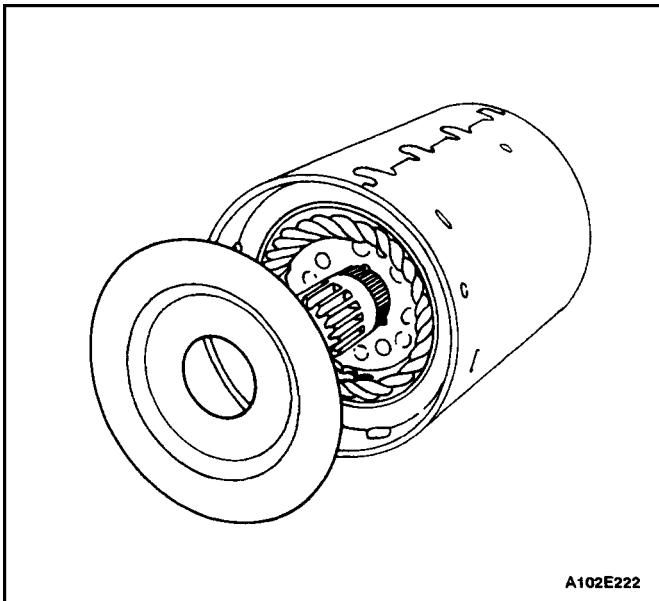
9. Remove the solenoid assembly screws.



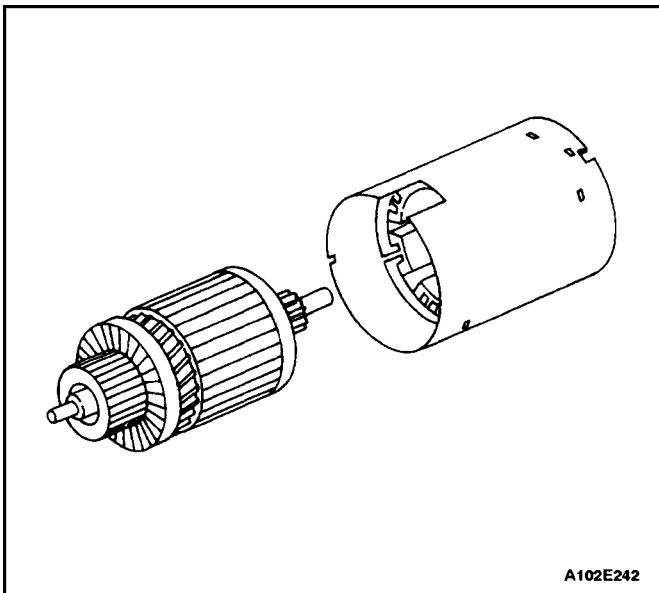
10. Remove the field connector nut. Disconnect the field connector.



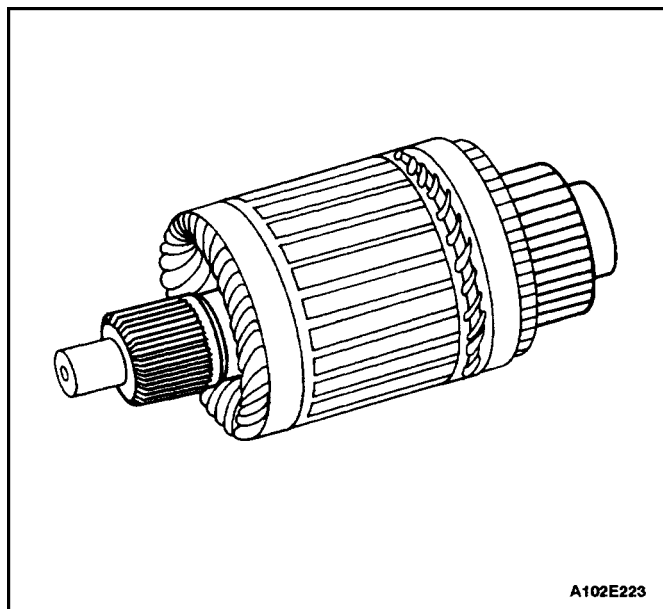
11. Rotate the solenoid 90 degrees and remove it along with the plunger return spring.



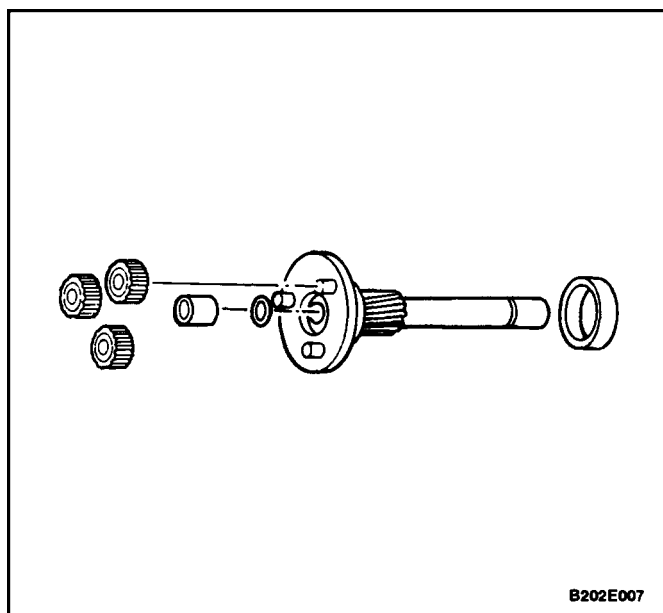
12. Slide the field frame with the enclosed armature assembly away from the starter assembly.
13. Remove the shield.



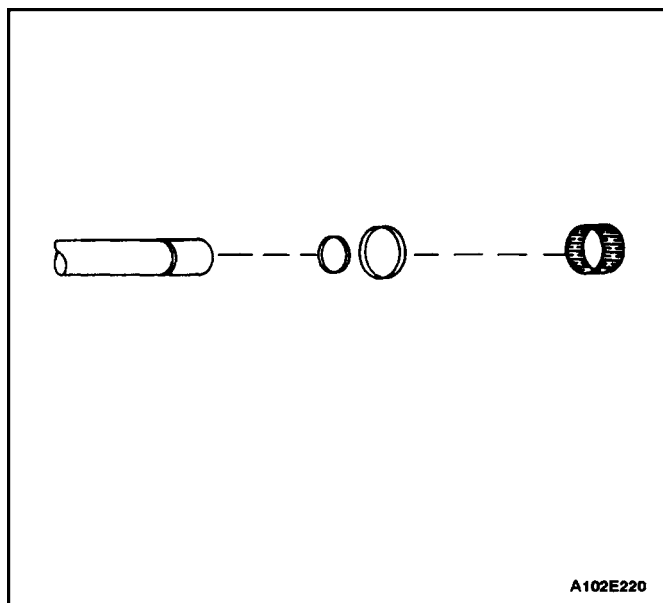
14. Separate the field frame from the armature.



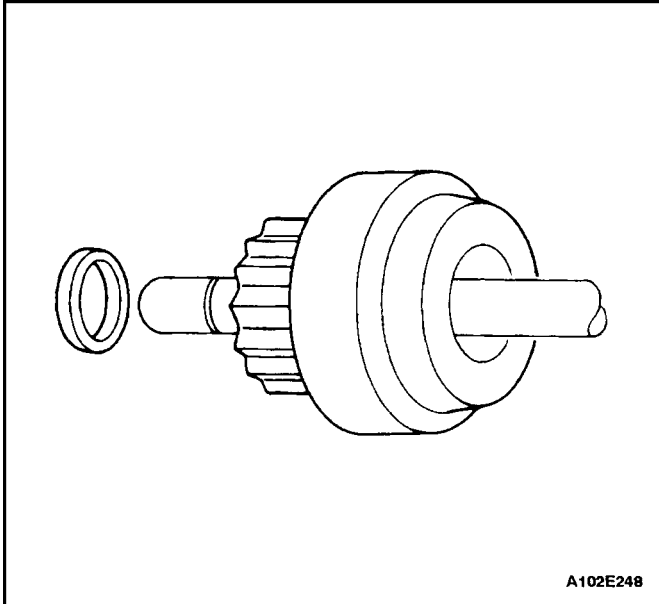
15. Inspect the shaft, the bearing, and the pinion for discoloration, damage, or wear. Replace if necessary.
16. Inspect the points where the armature conductors join the commutator bars. Make sure they have a good connection. A burned commutator bar is usually evidence of a poor connection.
17. If test equipment is available, check the armature for short circuits by placing it on a growler, and holding a hacksaw blade over the armature core while the armature is rotated. If the hacksaw blade vibrates, replace the armature.
18. Recheck after cleaning between the commutator bars. If the hacksaw blade vibrates, replace the armature.



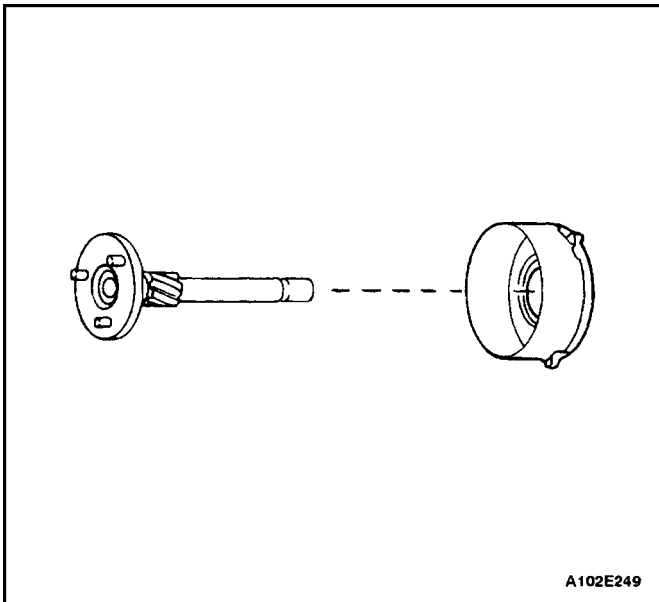
19. Remove the gears, the bushing, and the washer.
20. Remove the cushion and the driveshaft assembly from the starter housing.



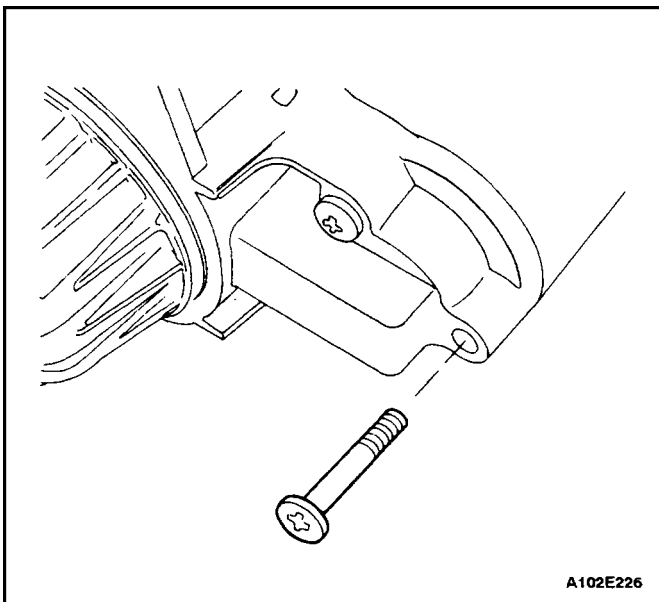
21. Disassemble the driveshaft assembly by first separating the needle bearing from the driveshaft.
22. Remove the collar and the locking ring from the groove in the driveshaft.



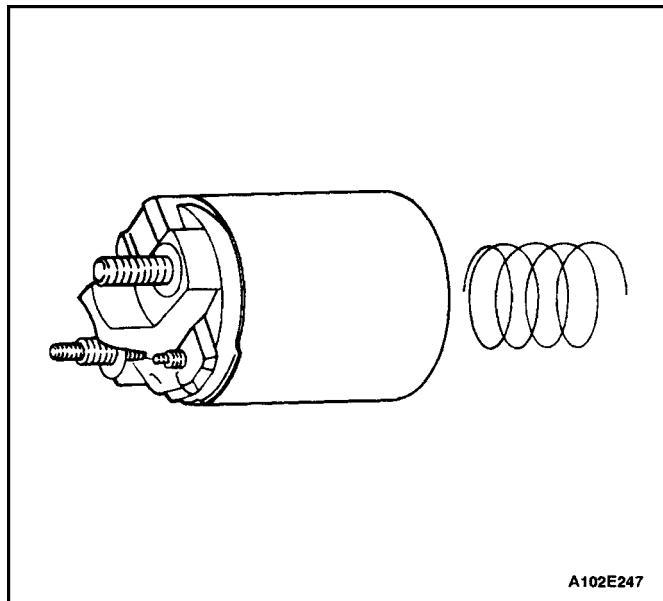
23. Remove the pinion stop and the drive from the driveshaft.



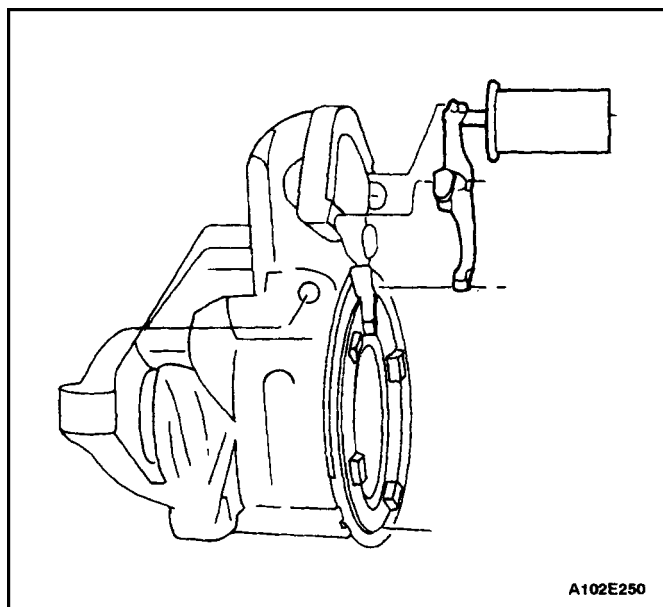
24. Remove the gear support from the driveshaft.



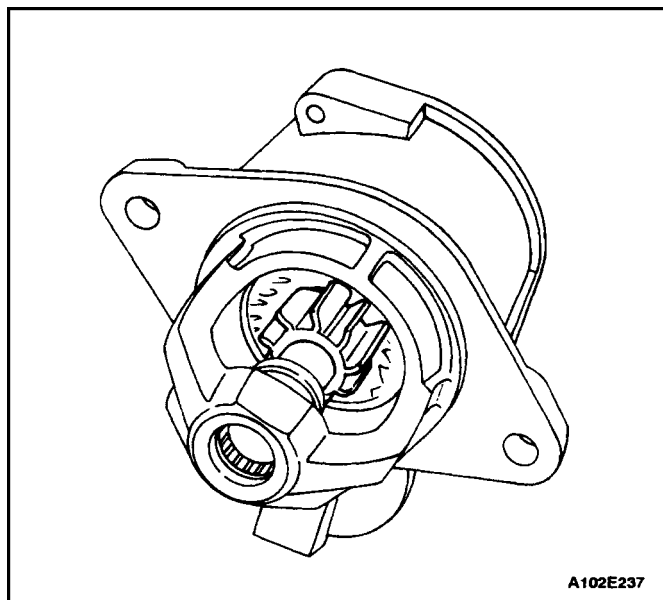
25. If not done in the previous steps, remove the screws that hold the solenoid assembly into the housing, and remove the nut from the field coil connector.



26. Rotate the solenoid 90 degrees and remove it along with the return spring.



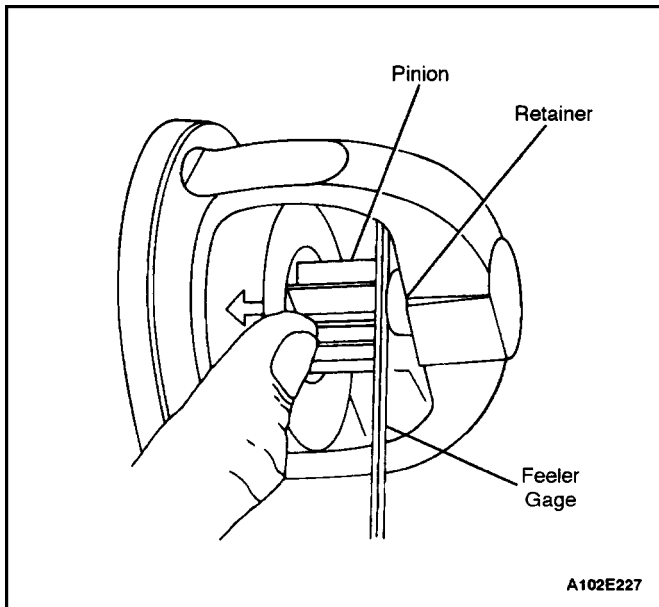
27. Remove the plunger with the boot and the shift lever assembly.



**Notice :** The pinion clearance must be correct to prevent the buttons on the shift lever yoke from rubbing on the clutch collar during engine cranking.

28. When the starter motor is disassembled and the solenoid is replaced, check the pinion clearance.





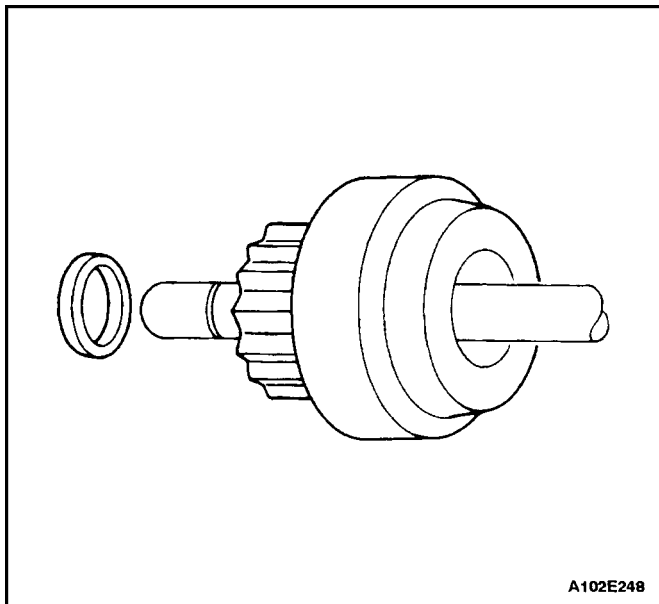
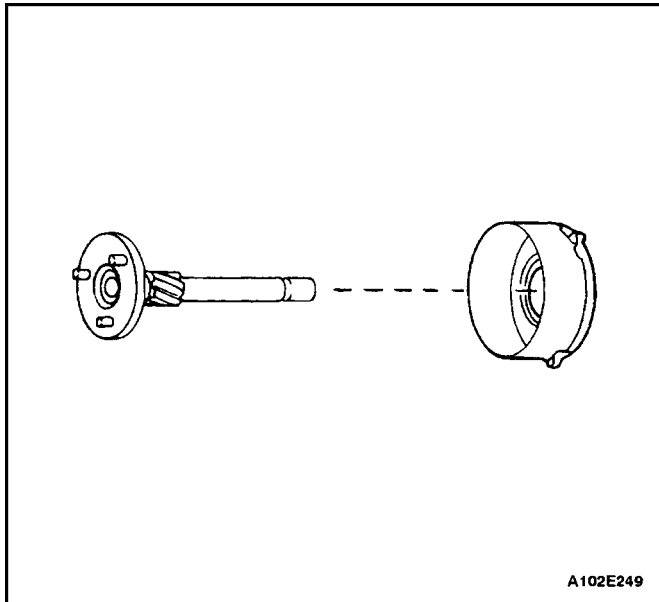
29. Disconnect the motor field coil connector from the solenoid motor terminal and carefully insulate the connector.
30. Connect one 12-volt battery lead to the solenoid switch terminal and the other 12-volt battery lead to the starter frame.
31. Flash a jumper lead momentarily from the solenoid motor terminal to the starter frame, allowing shifting of the pinion in the cranking position, where it will remain until the battery is disconnected.

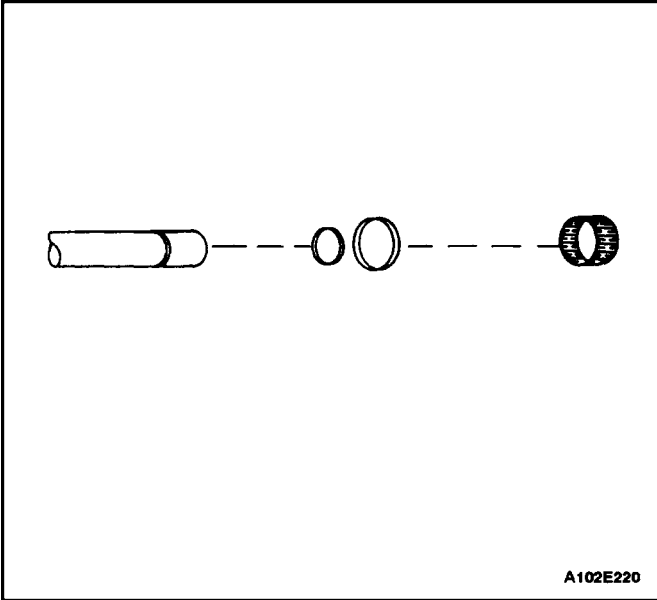
**Important :** A means for adjusting the pinion clearance is not provided on the starter motor. If the clearance does not fall within the limits, check for improper installation and replace all of the worn parts.

32. Push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge. The clearance should be 0.25 to 3.56 mm (0.01 to 0.14 inch).

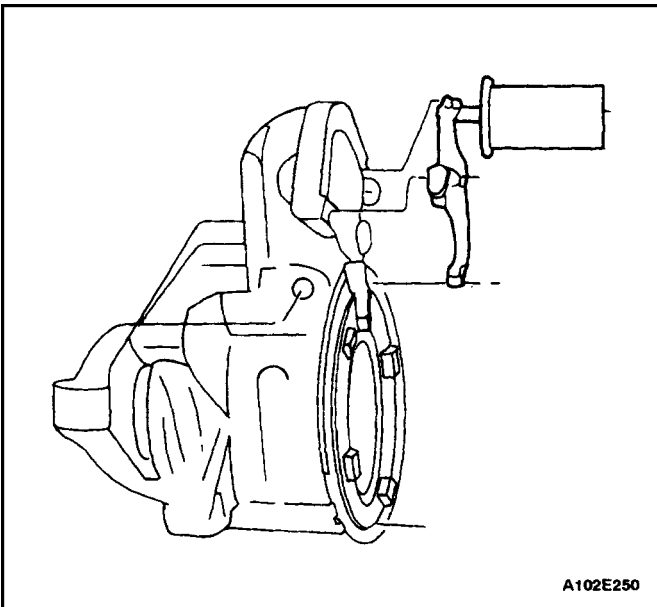
### Assembly Procedure

1. Clean all of the starter motor parts. Do not use grease-dissolving solvents for cleaning the armature and the field coils.
2. Lubricate the gears with lubricant. (Begin at Step 7 if proceeding with just the reassembly of the solenoid.)
3. If full disassembly of the starter and the solenoid was performed, begin reassembly by placing the gear support on the driveshaft assembly.
4. Install the drive and the pinion stop on the drive-shaft.

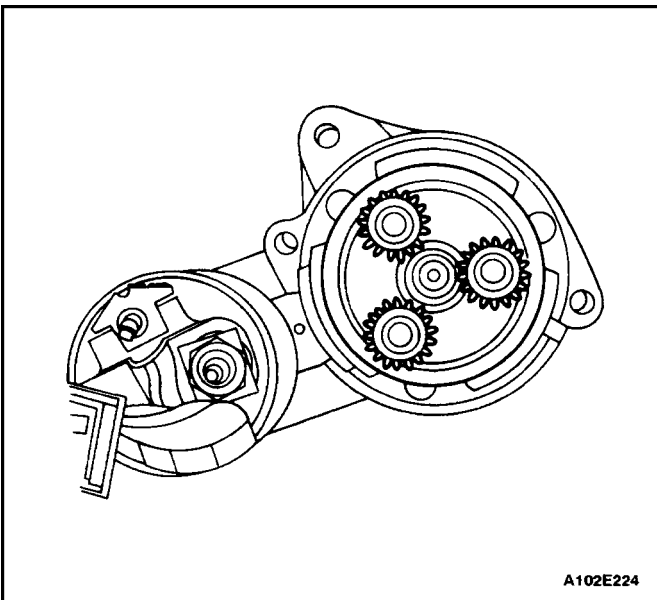




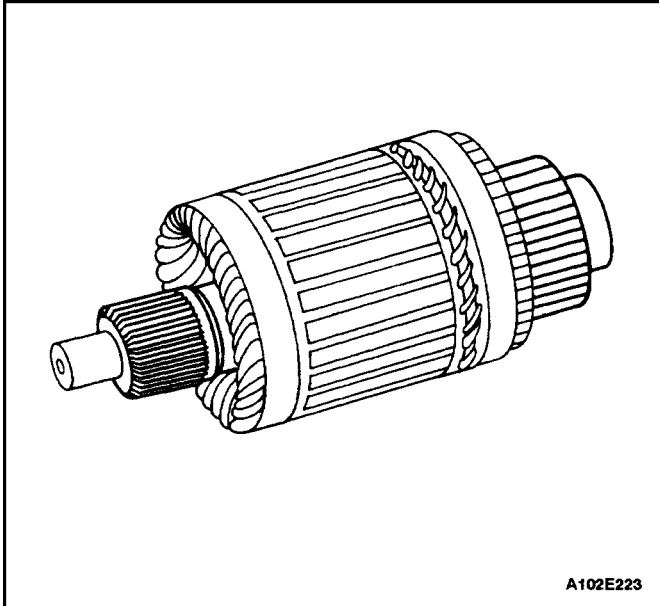
5. Install the lock ring into the groove on the driveshaft and insert the collar.
6. Install the needle bearing.



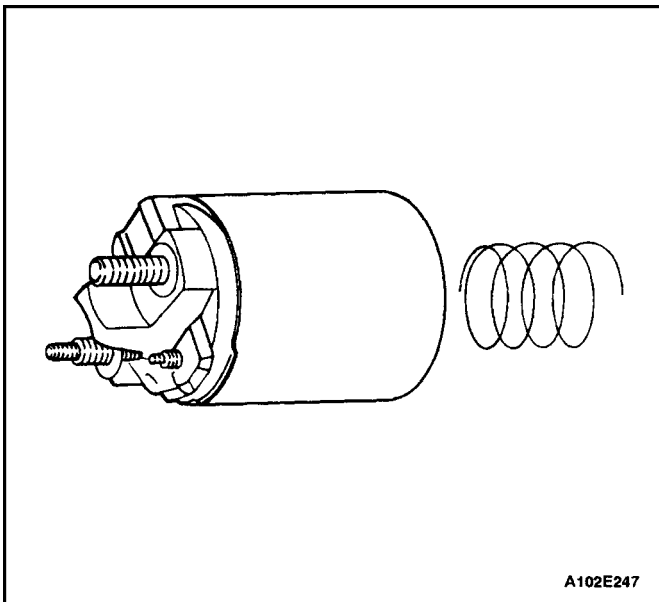
7. Install the shift lever assembly with the plunger and the boot.



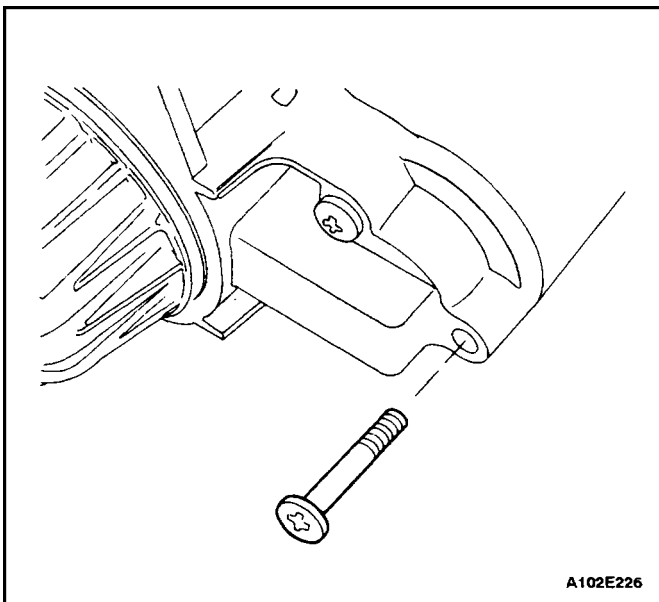
8. Lubricate the gears with lubricant and install the driveshaft assembly with the bushing and the washer on the gear end.
9. Install the cushion and the gears.



10. Lubricate the drive end of the armature shaft with lubricant and install the new gear and the bearing, if necessary.



11. Position the solenoid assembly and the return spring against the plunger. Apply sealer to the solenoid flange.



12. Fasten the solenoid assembly with the screws.

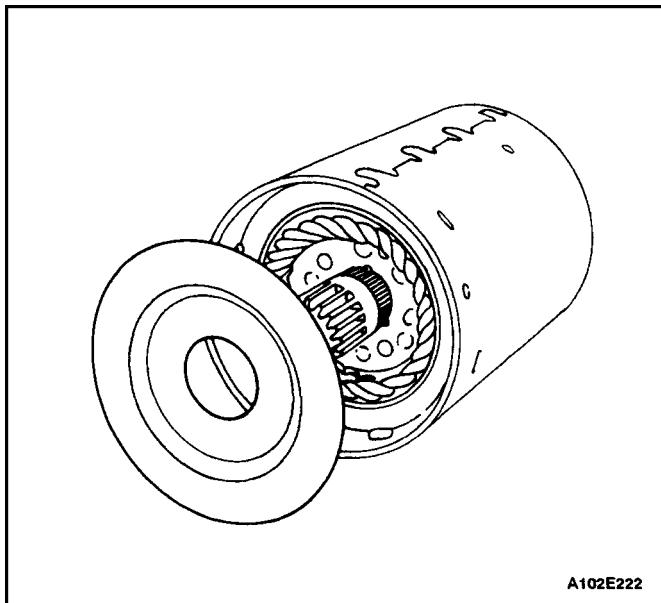
**Tighten**

Tighten the starter solenoid assembly screws to 8 N•m (71 lb-in).

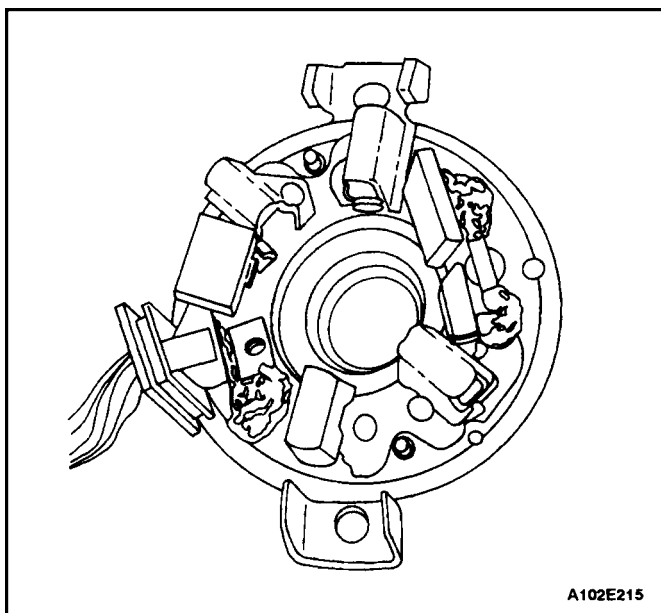
13. Install the field coil connection to the starter terminal. Install the nut.

**Tighten**

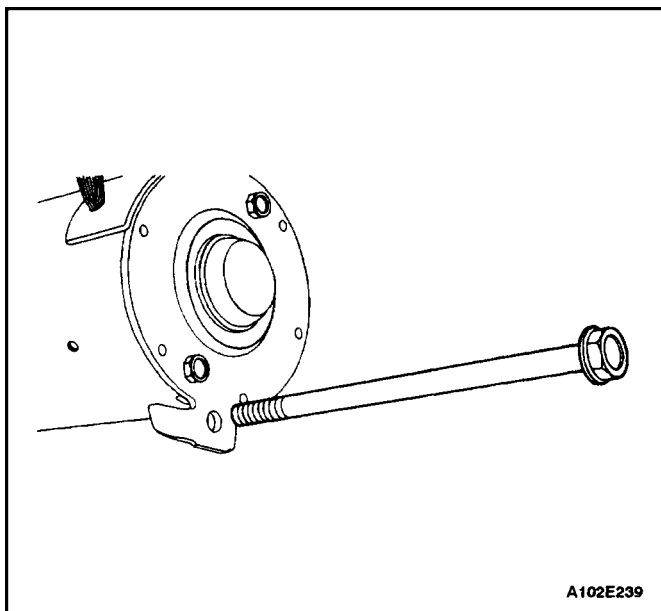
Tighten the starter field connector nut to 12 N•m (106 lb-in).



14. Position the armature assembly into the field frame.
15. Place the shield on the armature and the field frame assembly.
16. Install the armature and the field frame assembly with the shield into the starter housing.



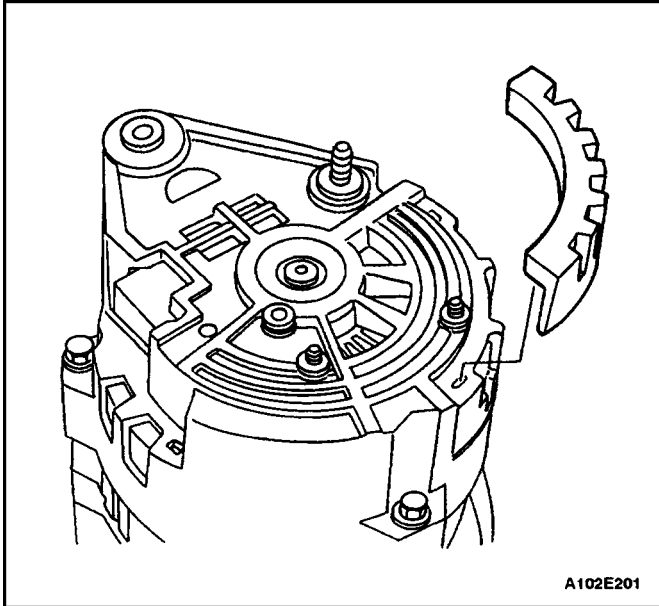
17. Position the commutator end frame/brush holder assembly, lining up the end frame holes with the through-bolt holes in the housing.



18. Install the starter through-bolts.
19. Install the starter. Refer to "Starter" in this section.

### **Tighten**

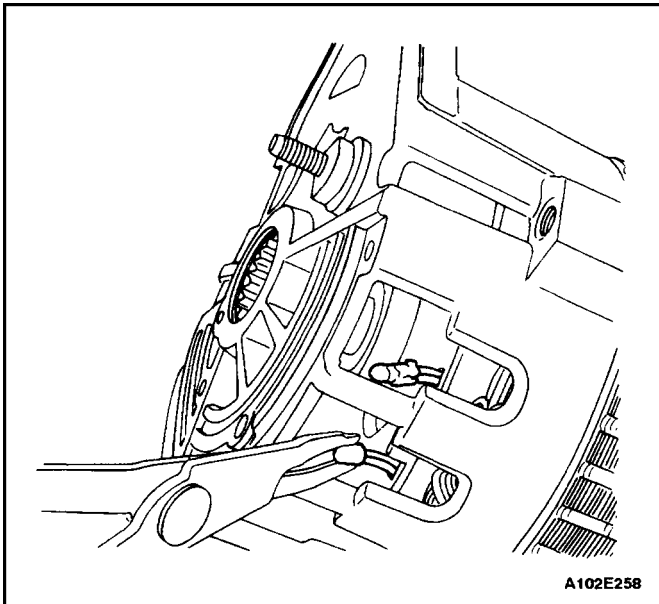
Tighten the starter through-bolts to 6 N•m (53 lb-in).



## GENERATOR – CS 121 DIF

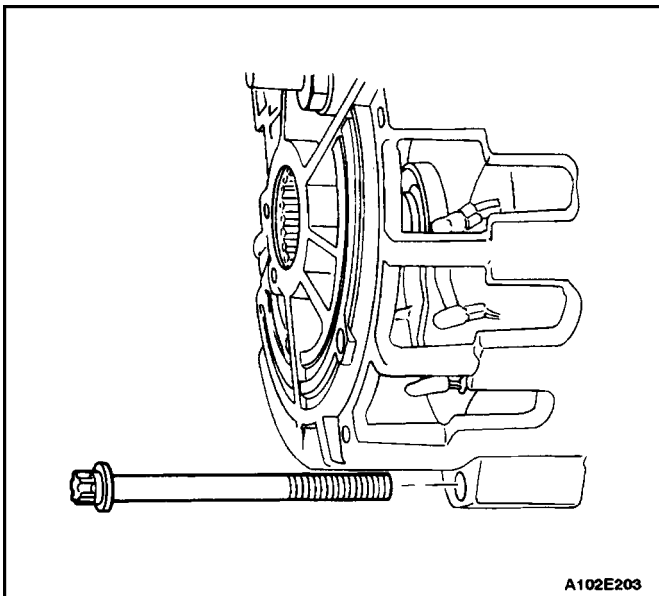
### Disassembly Procedure

1. Remove the generator. Refer to "Generator" in the On-Vehicle Service section.
2. Mark a match line that cannot easily be removed on the end frame to make assembly easier.
3. Pry off the plastic cover to expose the stator connections.

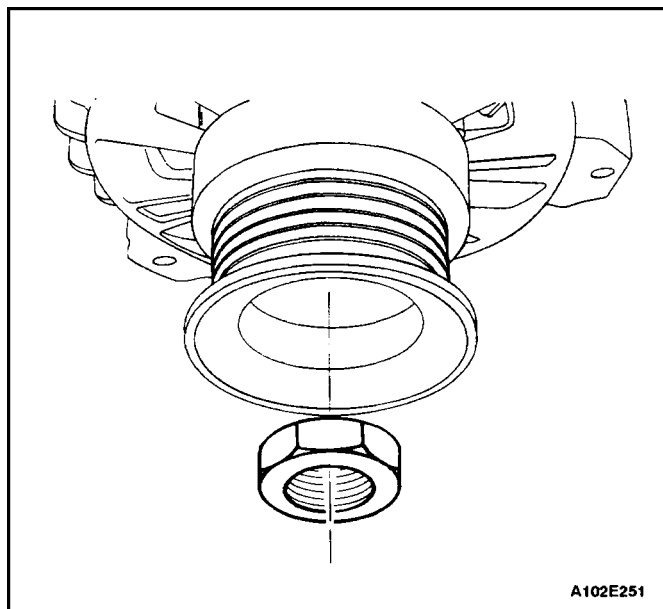


**Notice :** If the stator connections are not welded, melt the lead. Avoid excessive heating, as it can damage the diodes in the rectifier bridge.

4. Remove the stator connections from the rectifier bridge terminals by cutting the wires.

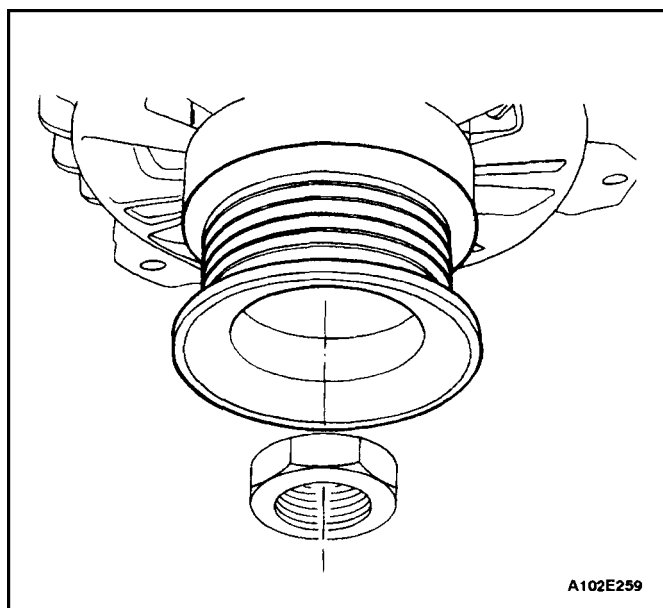


5. Remove the generator through-bolts.

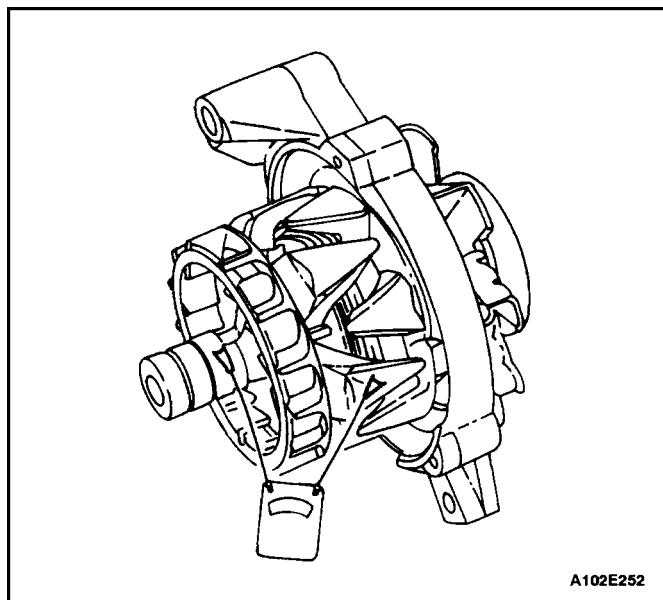


**Important :** The fastening torque of the drive end bearing nut is 81 N•m (60 lb–ft) and may not normally be unfastened using hand strength.

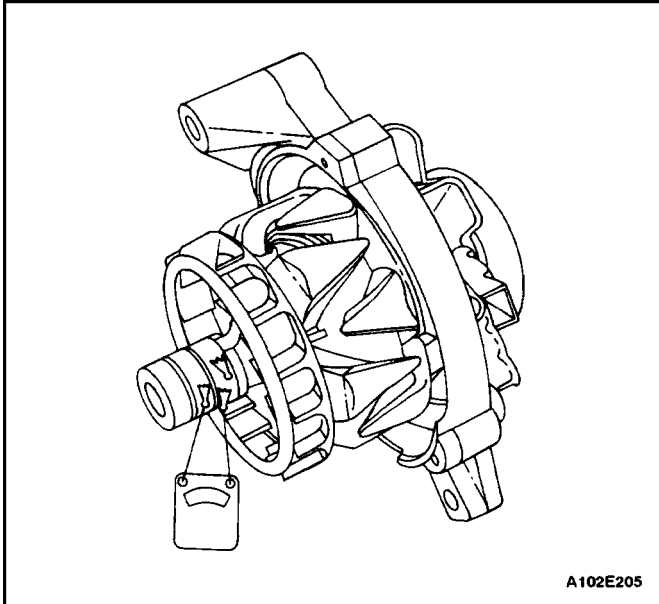
6. Remove the drive end bearing nut.



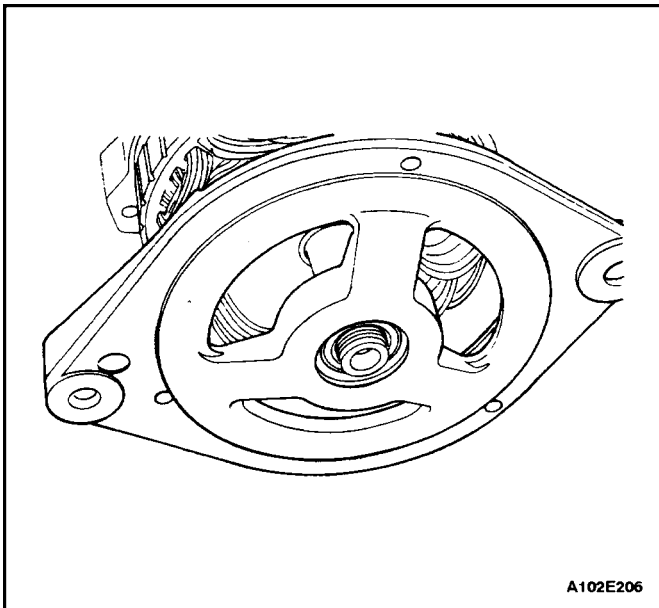
7. For vehicles with an internal fan, remove the pulley and the collars.



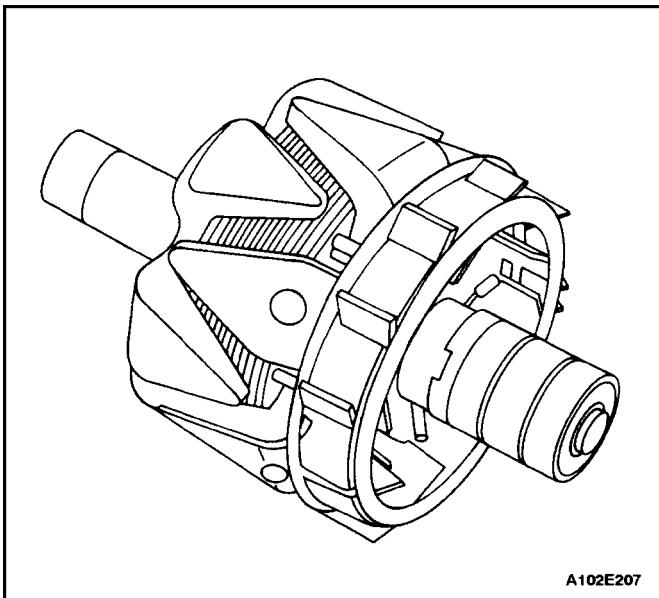
8. Test the rotor for an open circuit by using the ohm-meter with the drive end frame assembled. The reading should be sufficiently high, or the rotor must be replaced.



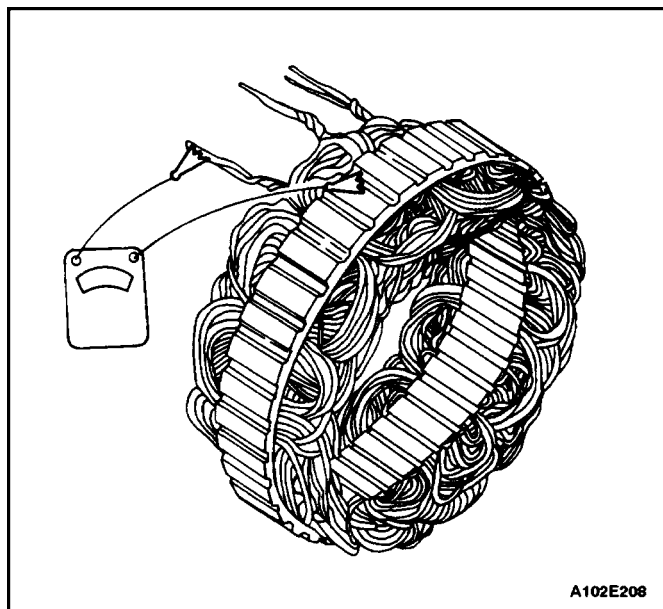
9. Test the rotor for open and short circuits. The reading should be 1.7 to 2.3 ohms, or the rotor should be replaced.



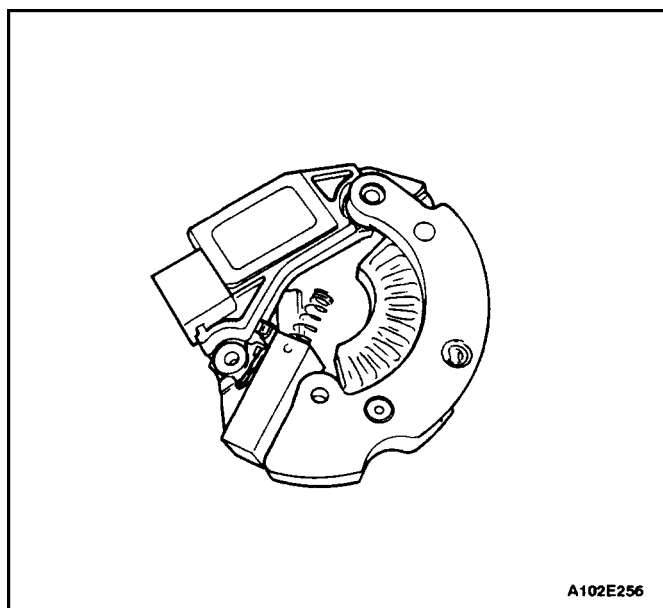
10. Remove the drive end frame from the shaft.
11. For vehicles with an internal generator fan, remove the drive end frame and the fan.



12. Remove the rotor assembly.

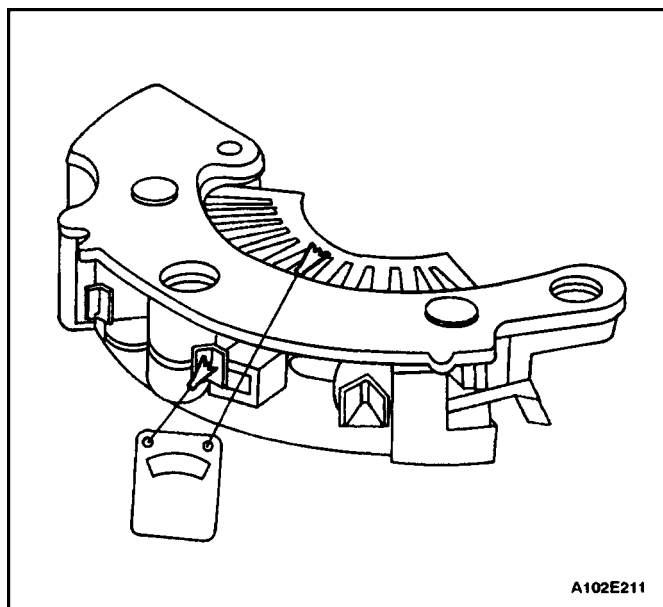


13. Remove the stator.
14. Test the stator for an open circuit using the ohmmeter.



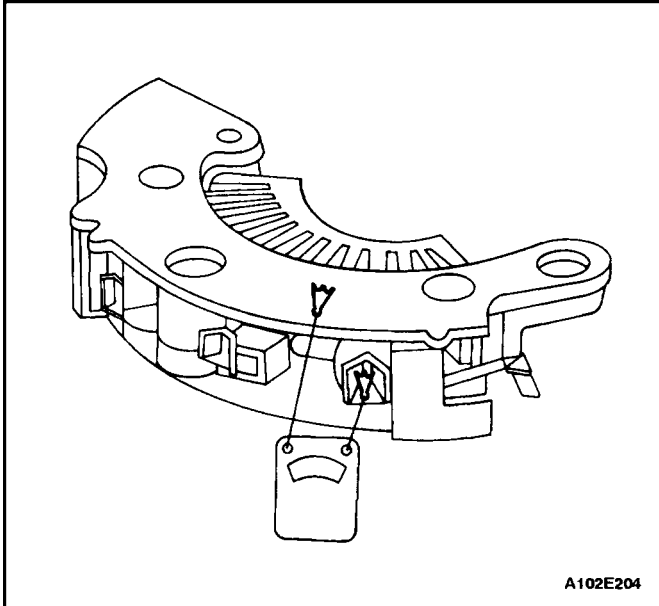
15. Pry off the baffle.
16. Remove the rectifier/regulator/brush holder assembly screws.
17. Remove the brush holder assembly and the regulator, cutting the terminal between the regulator and the rectifier bridge.

**Important :** If the brush can be reused, reassemble the brush to the holder with the retaining pin, after cleaning the brush with a soft, clean cloth.

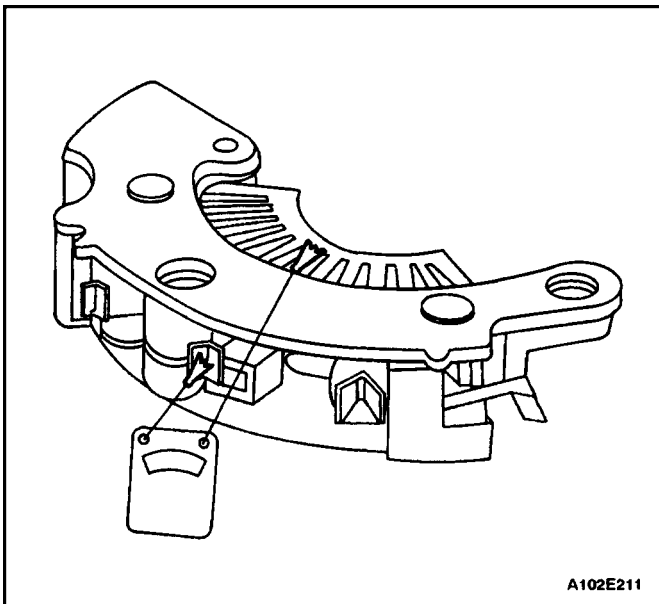


18. Test the rectifier bridge by connecting the ohmmeter terminals to the bridge and the heat sink.





19. Retest by connecting the ohmmeter terminals in the reverse order.

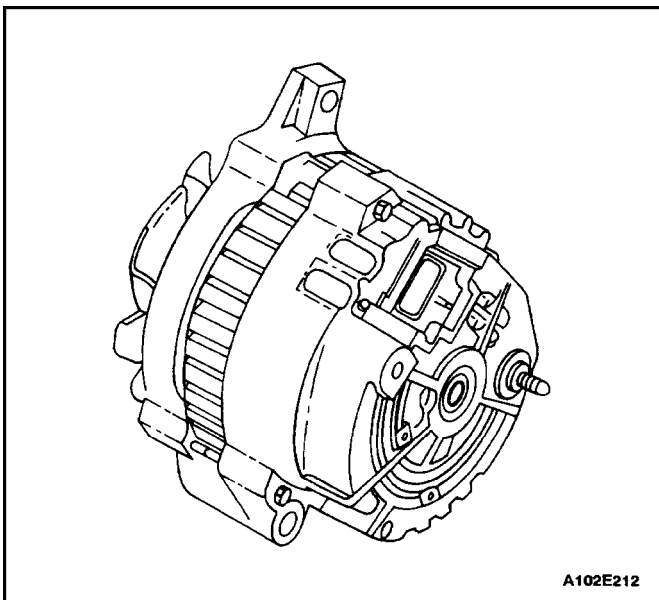


20. Replace the rectifier bridge if each reading is the same.

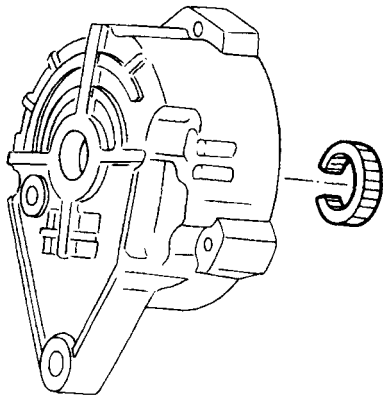
21. Test the remaining two diodes after the above procedure.

**Notice :** Some kinds of digital ohmmeters are not suited for testing the bridge diode. In this case, consult the manufacturer regarding the test capacity.

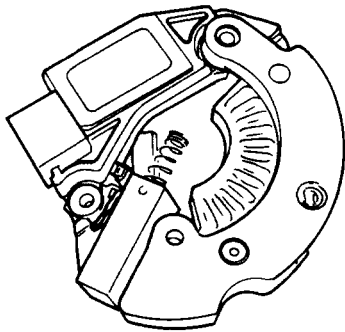
22. Test the diodes by connecting the ohmmeter terminals to the bridge terminal and the base plate. If the reading is the same, the rectifier bridge should be replaced.



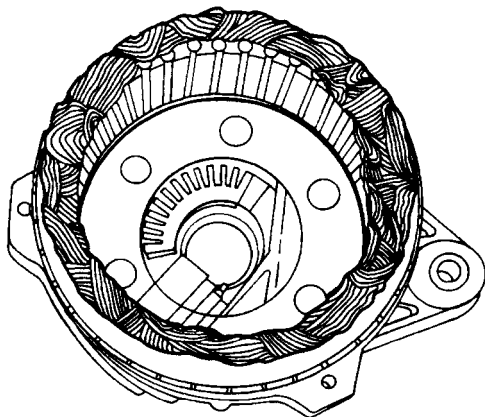
23. Remove the ring in the slip ring end frame.



A102E257



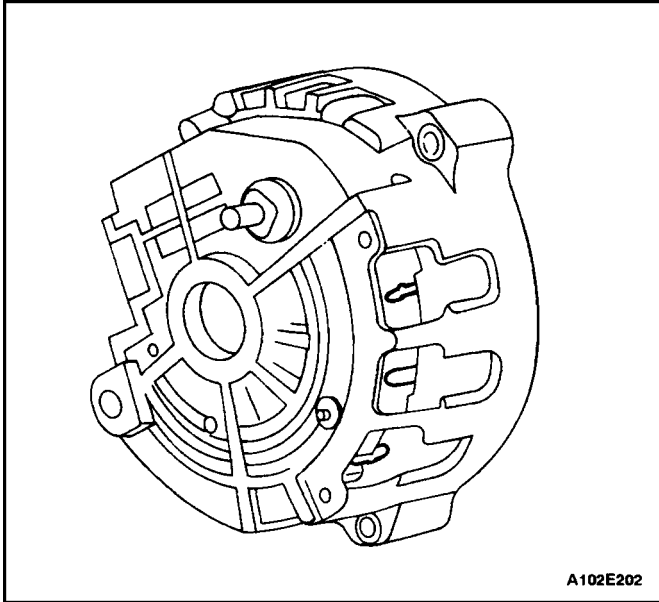
A102E256



A102E213

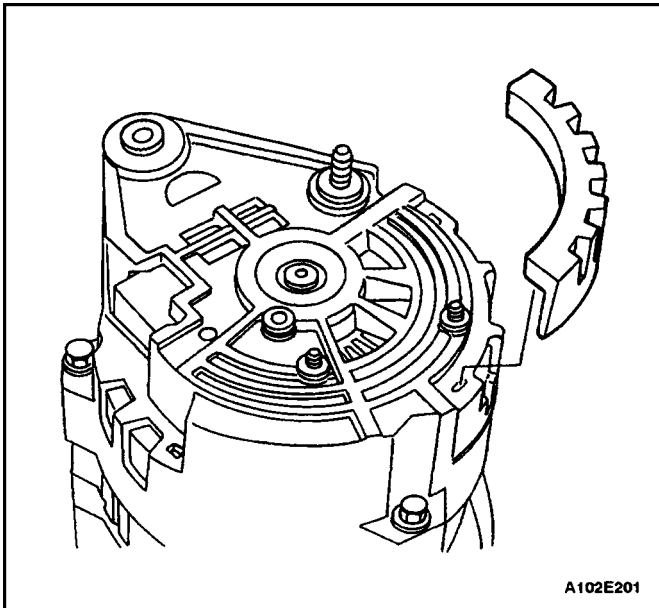
## Assembly Procedure

1. Install the new ring in the slip ring end frame.
2. Push the new bearing outer race into the bottom of the end frame casting.
3. Weld the brush holder terminal to the regulator terminal, if removed.
4. Fix the brush holder with the retainer pin, and weld the regulator/brush holder assembly terminal to the rectifier terminal.
5. Apply silicone grease between the bridge and the end frame for radiation purposes.
6. Fasten the screws holding the rectifier regulator/brush holder assembly to the end frame.
7. Punch the new baffle with the pin into the brush.
8. Install the stator.

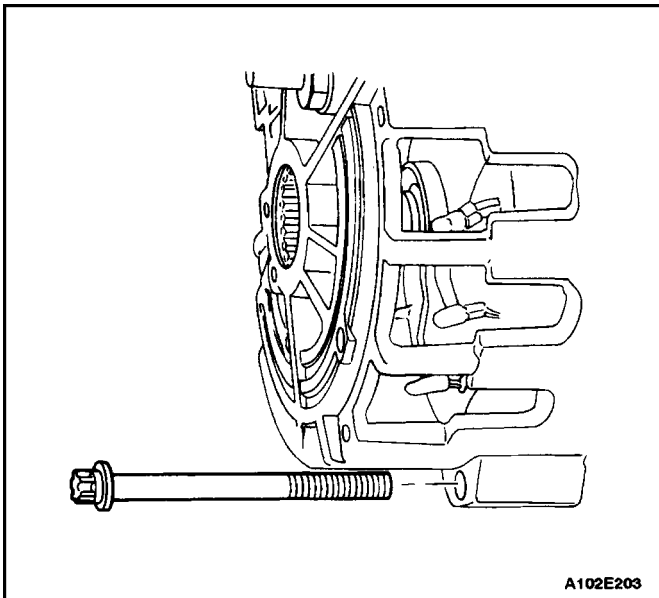


**Notice :** Take care to protect the diode in the rectifier bridge from excessive heat while welding.

9. Weld the connectors of the rectifier bridge.



10. Install the outside cover.

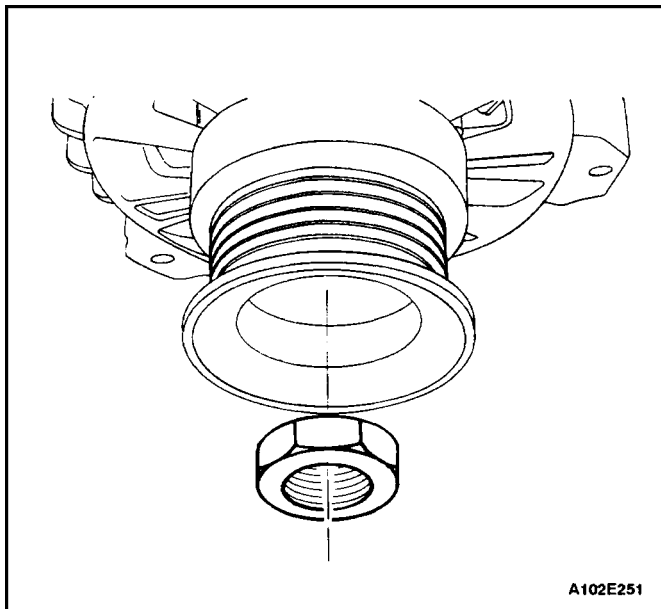


11. Position the rotor assembly shaft with the drive end frame in the slip ring end assembly until the gap between the outer race and the end frame casting is 1.9 mm (0.075 inch).

12. Install the generator through-bolts.

**Tighten**

Tighten the generator through-bolts to 10 N•m (89 lb-in).



13. Position the fan, the collars, and the pulley on the rotor shaft and secure with the nut.

**Tighten**

Tighten the generator drive end bearing nut to 81 N•m (60 lb–ft).

14. Install the generator. Refer to "Generator" in the On–Vehicle Service section.

# GENERAL DESCRIPTION AND SYSTEM OPERATION

## BATTERY

The sealed battery is standard on all cars. There are no vent plugs in the cover. The battery is completely sealed, except for two small vent holes in the sides. These vent holes allow the small amount of gas produced in the battery to escape. The battery has the following advantages over conventional batteries:

- No water addition for the life of the battery.
- Overcharge protection. If too much voltage is applied to the battery, it will not accept it. In a conventional battery, the excess voltage will still try to charge the battery, leading to gassing, which causes liquid loss.
- Not as liable to self-discharge as compared to a conventional battery. This is particularly important when a battery is left standing for long periods of time.
- More power available in a lighter and smaller case.

The battery has three major functions in the electrical system. First, the battery provides a source of energy for cranking the engine. Second, the battery acts as a voltage stabilizer for the electrical system. Finally, the battery can, for a limited time, provide energy when the electrical demand exceeds the output of the generator.

## RATINGS

A battery has two ratings: (1) a reserve capacity rating designated at 27°C (80°F), which is the time a fully charged battery will provide 25 amperes current flow at or above 10.5 volts; and (2) a cold cranking amp rating determined under testing at -18°C (0°F), which indicates the cranking load capacity.

## RESERVE CAPACITY

The reserve capacity is the maximum length of time it is possible to travel at night with the minimum electrical load and no generator output. Expressed in minutes, Reserve Capacity (or RC rating) is the time required for a fully charged battery, at a temperature of 27°C (80°F), being discharged at a current of 25 amperes, to reach a terminal voltage of 10.5 volts.

## COLD CRANKING AMPERAGE

The cold cranking amperage test is expressed at a battery temperature of -18°C (0°F). The current rating is the minimum amperage. This must be maintained by the battery for 30 seconds at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts. This rating is a measure of cold cranking capacity.

The battery is not designed to last indefinitely. However, with proper care, the battery will provide many years of service.

If the battery tests well, but fails to perform satisfactorily in service for no apparent reason, the following factors may point to the cause of the trouble:

- Vehicle accessories are left on overnight.
- Slow average driving speeds are used for short periods.
- The vehicle's electrical load is more than the generator output, particularly with the addition of after-market equipment.
- Defects in the charging system, such as electrical shorts, a slipping generator belt, a faulty generator, or a faulty voltage regulator.
- Battery abuse, including failure to keep the battery cable terminals clean and tight, or a loose battery holddown clamp.
- Mechanical problems in the electrical system, such as shorted or pinched wires.

## BUILT-IN HYDROMETER

The sealed battery has a built-in, temperature-compensated hydrometer in the top of the battery. This hydrometer is to be used with the following diagnostic procedure:

1. When observing the hydrometer, make sure that the battery has a clean top.
2. Under normal operation, two indications can be observed:
  - GREEN DOT VISIBLE – Any green appearance is interpreted as a "green dot," meaning the battery is ready for testing.
  - DARK GREEN DOT IS NOT VISIBLE – If there is a cranking complaint, the battery should be tested. The charging and electrical systems should also be checked at this time.
1. Occasionally, a third condition may appear:
  - CLEAR OR BRIGHT YELLOW – This means the fluid level is below the bottom of the hydrometer. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping, or normal battery wear. Finding a battery in this condition may indicate high charging by a faulty charging system. Therefore, the charging and the electrical systems may need to be checked if a cranking complaint exists. If the cranking complaint is caused by the battery, replace the battery.

## CHARGING PROCEDURE

1. Batteries with the green dot showing do not require charging unless they have just been discharged (such as in cranking a vehicle).
2. When charging sealed-terminal batteries out of the vehicle, install the adapter kit. Make sure all the charger connections are clean and tight. For best

results, batteries should be charged while the electrolyte and the plates are at room temperature. A battery that is extremely cold may not accept current for several hours after starting the charger.

3. Charge the battery until the green dot appears. The battery should be checked every half-hour while charging. Tipping or shaking the battery may be necessary to make the green dot appear.
4. After charging, the battery should be load tested. Refer to "Starter Motor – PG 150S" in this section.

## CHARGING TIME REQUIRED

The time required to charge a battery will vary depending upon the following factors:

- **Size of Battery** – A completely discharged large heavy-duty battery requires more than twice the recharging time as a completely discharged small passenger car battery.
- **Temperature** – A longer time will be needed to charge any battery at  $-18^{\circ}\text{C}$  ( $0^{\circ}\text{F}$ ) than at  $27^{\circ}\text{C}$  ( $80^{\circ}\text{F}$ ). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. The battery will accept a higher current rate as the battery warms.
- **Charger Capacity** – A charger which can supply only 5 amperes will require a much longer charging period than a charger that can supply 30 amperes or more.
- **State-of-Charge** – A completely discharged battery requires more than twice as much charge as a one-half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

## CHARGING A COMPLETELY DISCHARGED BATTERY (OFF THE VEHICLE)

Unless this procedure is properly followed, a perfectly good battery may need to be replaced.

The following procedure should be used to recharge a completely discharged battery:

1. Measure the voltage at the battery terminals with an accurate voltmeter. If the reading is below 10 volts, the charge current will be very low, and it could take some time before the battery accepts the current in excess of a few milliamperes. Refer to "Charging Time Required" in this section, which focuses on the factors affecting both the charging time required and the rough estimates in the table below. Such low current may not be detectable on ammeters available in the field.
2. Set the battery charger on the high setting.

**Important :** Some chargers feature polarity protection circuitry, which prevents charging unless the charger leads are correctly connected to the battery terminals. A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer's instruction for bypassing or overriding the circuitry so that the charger will turn on and charge a low-voltage battery.

1. Continue to charge the battery until the charge current is measurable. Battery chargers vary in the amount of voltage and current provided. The time required for the battery to accept a measurable charge current at various voltages may be as follows:

Voltage	Hours
16.0 or more	Up to 4 hours
14.0–15.9	Up to 8 hours
13.9 or less	Up to 16 hours

- If the charge current is not measurable at the end of the above charging times, the battery should be replaced.
- If the charge current is measurable during the charging time, the battery is good, and charging should be completed in the normal manner.

**Important :** It is important to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore the battery to a usable state. As a general rule, using the reserve capacity rating (RC) as the number of ampere hours of charge usually brings the green dot into view.

- If the charge current is still not measurable after using the charging time calculated by the above method, the battery should be replaced.

## JUMP STARTING PROCEDURE

1. Position the vehicle with the good (charged) battery so that the jumper cables will reach.
2. Turn off the ignition, all the lights, and all the electrical loads in both vehicles. Leave the hazard flasher on if jump starting where there may be other traffic. In addition, leave on any other lights needed for the work area.
3. In both vehicles, apply the parking brake firmly.

**Notice :** To avoid vehicle damage, make sure the cables are not on or near pulleys, fans, or other parts that will move when the engine starts.

1. Shift an automatic transaxle to PARK, or a manual transaxle to NEUTRAL.

**CAUTION :** In order to avoid injury, do not use cables that have loose or missing insulation.

1. Clamp one end of the first jumper cable to the positive terminal on the battery. Make sure it does not touch any other metal parts. Clamp the other end of the same cable to the positive terminal on the other battery. Never connect the other end to the negative terminal of the discharged battery.

**CAUTION :** *To avoid injury do not attach the cable directly to the negative terminal of the discharged battery. Doing so could cause sparks and a possible battery explosion.*

1. Clamp one end of the second cable to the negative terminal of the booster battery. Make the final connection to a solid engine ground (such as the engine lift bracket) at least 450 millimeters (18 inches) from the discharged battery.
2. Start the engine of the vehicle with the good battery. Run the engine at a moderate speed for several minutes. Then start the engine of the vehicle which has the discharged battery.
3. Remove the jumper cables by reversing the above sequence exactly. Remove the negative cable from the vehicle with the discharged battery first. While removing each clamp, take care that it does not touch any other metal while the other end remains attached.

## GENERATOR

The Delco–Remy CS charging system has several models available, including the CS–121 DIF. The number denotes the outer diameter in millimeters of the stator lamination.

CS generators are equipped with internal regulators. A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier generators. A conventional pulley and fan are used. There is no test hole.

Unlike three–wire generators, the CS–121 DIF may be used with only two connections: battery positive and an "L" terminal to the charge indicator lamp.

As with other charging systems, the charge indicator lamp illuminates when the ignition is turned to RUN, and goes out when the engine is running. If the charge indicator is on with the engine running, a charging system defect is indicated. This indicator light will glow for several kinds of defects as well as when the system voltage is too high or too low.

The regulator voltage setting varies with temperature and limits the system voltage by controlling rotor field current. At high speeds, the on–time may be 10 percent and the off–time 90 percent. At low speeds, with high electrical loads, the on–time may be 90 percent and the off–time 10 percent.

## CHARGING SYSTEM

CS generators use a new type of regulator that incorporates a diode trio. A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier generators. A conventional pulley and fan are used. There is no test hole.

## STARTER

Wound field starter motors have pole pieces, arranged around the armature, which are energized by wound field coils.

Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icy conditions, and splashes.

In the basic circuit, solenoid windings are energized when the switch is closed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear. The solenoid main contacts close. Cranking then takes place.

When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun, the switch should be released immediately after the engine starts.

## STARTING SYSTEM

The engine electrical system includes the battery, the ignition, the starter, the generator, and all the related wiring. Diagnostic tables will aid in troubleshooting system faults. When a fault is traced to a particular component, refer to that component section of the service manual.

The starting system circuit consists of the battery, the starter motor, the ignition switch, and all the related electrical wiring. All of these components are connected electrically.