

SECTION 1E

ENGINE ELECTRICAL

CAUTION: Do not throw electrical cables or components under a moving vehicle. Do not use any electrical components, such as a battery, while the vehicle is running. Do not use any electrical components, such as a battery, while the vehicle is running. Do not use any electrical components, such as a battery, while the vehicle is running.

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SPECIFICATIONS

STARTER SPECIFICATIONS

Application	Description
Starter 0.8 Kilowatts No Load Test @ 10 volts Drive Pinion Speed at:	Minimum 60 - Maximum 98 amps 6,000-12,000 rpm
Solenoid Hold-in Windings @ 10 volts Pull-in Windings @ 10 volts	13-19 amps 59-79 amps
Starter 1.4 Kilowatts No Load Test @ 12.2 volts Drive Pinion Speed at:	Minimum 40 - Maximum 90 amps 3,200-4,800 rpm
Solenoid Hold-in Windings @ 10 volts Pull-in Windings @ 10 volts	13-19 amps 59-79 amps

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GENERATOR SPECIFICATIONS

Application	Description
Types	CS-121D CS-128D

BATTERY SPECIFICATIONS

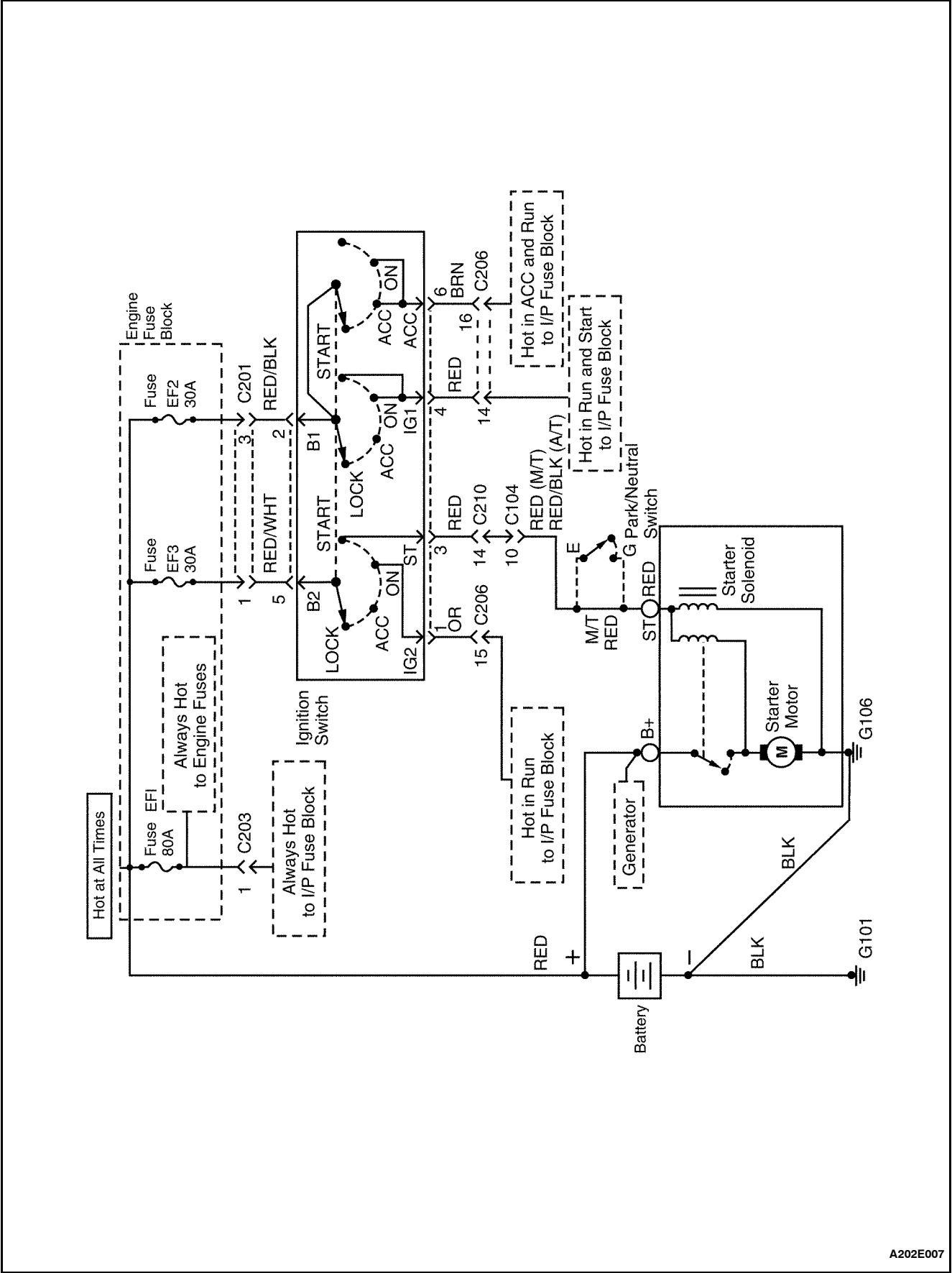
Application	Description
L4 Engine	
Cold Cranking Amps	550 amps
RC (Minimum)	90 minutes
Load Test	270 amps
Replacement	85B-60
Minimum Voltage: 9.6 9.4 9.1 8.8 8.5 8.0	Estimated Temperature: 21_C (70_F) 20_C (68_F) 0_C (32_F) * 10_C (14_F) * 18_C (0.4_F) Below * 18_C (Below 0_F)

FASTENER TIGHTENING SPECIFICATIONS

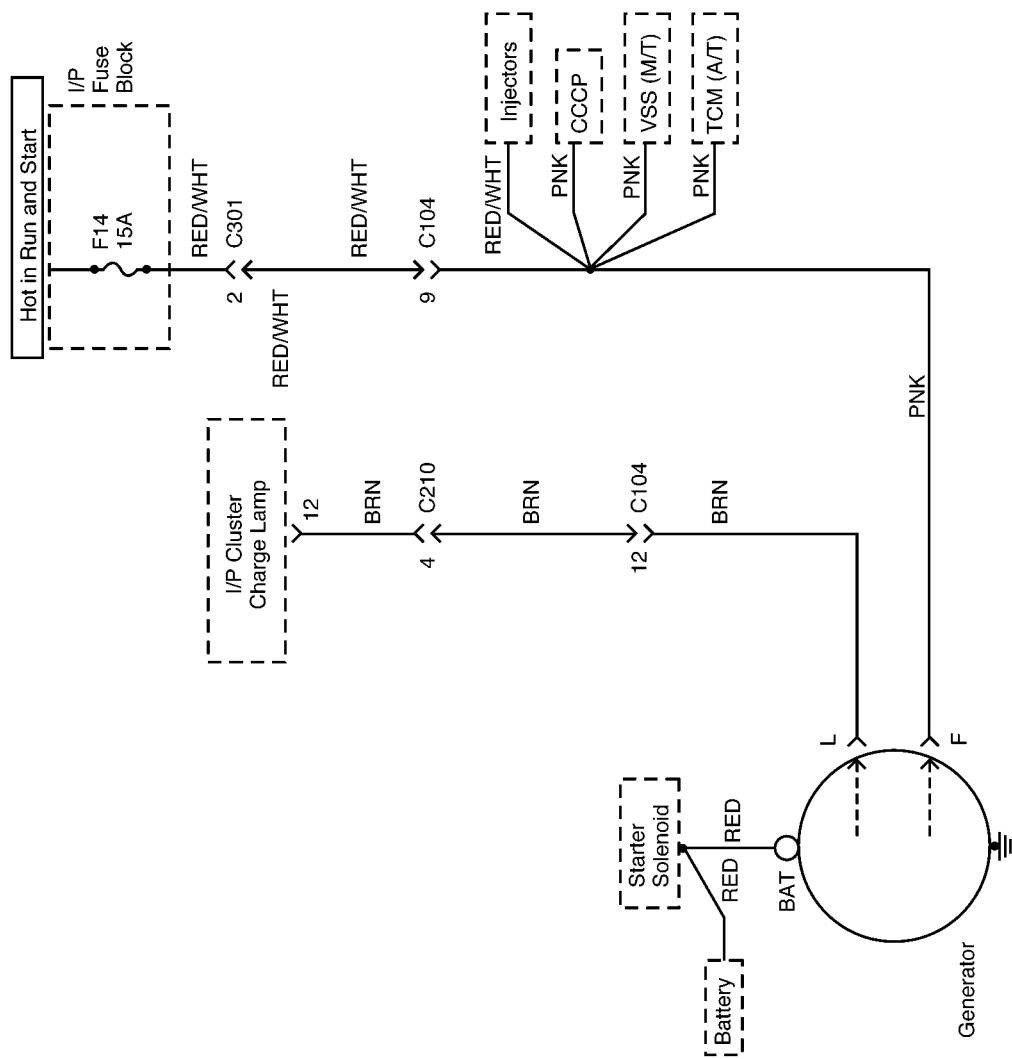
Application	NSm	Lb-Ft	Lb-In
Battery Cable Nuts	15	11	-
Battery Carrier Tray Lower Bolts	20	15	-
Battery Carrier Tray Upper Bolts	20	15	-
Battery Retainer Clamp-to-Battery Rod Nuts	5	-	44
Fuel Rail Retaining Bolts	20	15	-
Generator Battery Lead Connector Nut	15	11	-
Generator Drive End Bearing Nut (CS-121D)	81	60	-
Generator Drive End Nut (CS-128D)	100	74	-
Generator Lower Bracket-to-Generator	20	15	-
Generator Shackle Bracket Bolt	20	15	-
Generator Through-Bolts (CS-121D)	10	-	89
Generator Through-Bolts (C5-128D)	25	18	-
Starter End Frame-to-Brush Holder Assembly Bolts (0.8 Kilowatts)	3	-	27
Starter Field Connector Nut	8	-	71
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SCHEMATIC AND ROUTING DIAGRAMS

STARTING SYSTEM



CHARGING SYSTEM



DIAGNOSIS

NO CRANK

Step	Action	Value(s)	Yes	No
1	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 Step 2	Go to Step 8
2	Check the battery state of charge. Is the green eye showing from the built-in hydrometer?	-	Go to Step 3	Go to "Charging Procedure"
3	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 Step 4
4	1. Connect the voltmeter negative lead to the negative battery terminal. 2. Connect the voltmeter positive lead to the engine block. 3. Place the ignition in the START position. Does the voltmeter indicate the value specified?	> 0.5 v	Go to Step 5	Go to Step 6
5	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	-
6	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 value specified?	< 9 v	Go to Step 7	Go to Step 13
7	Clean, tighten, or replace the positive battery cable. Is the repair complete?	-	System OK	-
8	Check system fuse EF3 in the engine fuse block. Is fuse EF3 blown?	-	Go to Step 9	Go to Step 10
9	Replace system fuse EF3. Is the repair complete?	-	System OK	-
10	Check the connection at the starter "S" terminal. Is the connection in good condition?	-	Go to Step 12	Go to Step 11
11	Repair the starter "S" terminal. Is the repair complete?	-	System OK	-
12	1. Connect the voltmeter positive lead to the starter "S" terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. 3. Place the ignition in the START position. 4. Read the voltage present at the "S" terminal. Does the voltmeter indicate the specified value?	> 7 v	Go to Step 13	Go to Step 14

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NO CRANK (Cont'd)

Step	Action	Value(s)	Yes	No
13	Repair or replace the starter. Is the repair complete?	-	System OK	-
14	Turn on the heater blower. Does the blower operate?	-	Go to Step 24	Go to Step 15
15	1. Disconnect connector C201. 2. Connect the voltmeter positive lead to terminal 1 of connector C201. 3. Connect the voltmeter negative terminal to ground. Does the voltmeter indicate the specified value?	12 v	Go to Step 17	Go to Step 16
16	Repair the open in the RED/WHT wire from fuse EF3 to Connector C201. Is the repair complete?	-	System OK	-
17	Check the contacts of terminal 1 on connector C201. Are the contacts OK?	-	Go to Step 19	Go to Step 18
18	Repair the faulty contact of connector C201. Is the repair complete?	-	System OK	-
19	1. Reconnect connector C201. 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 Step 21	Go to Step 20
20	Repair the open in the RED/WHT wire from terminal 1 of connector C201 to terminal 5 of the ignition switch connector. Is the repair complete?	-	System OK	-
21	Check the contacts of terminal 5 of the ignition switch connector. Are the contacts OK?	-	Go to Step 23	Go to Step 22
22	Repair the faulty contact of the ignition switch connector. Is the repair complete?	-	System OK	-
23	Replace the ignition switch. Is the repair complete?	-	System OK	-
24	Does the vehicle have an automatic transmission?	-	Go to Step 25	Go to Step 35
25	1. Disconnect the Park/Neutral switch connector. 2. Connect the voltmeter positive lead to the Park/Neutral switch connector terminal E, connected to the RED/BLK wire. 3. Connect the voltmeter negative lead to the negative battery terminal. 4. Place the ignition in the START position. Does the voltmeter indicate the value specified?	< 7 v	Go to Step 26	Go to Step 31
26	Check continuity between the Park/Neutral switch connector terminal G, connected to the RED wire, and the Park/Neutral switch connector terminal E, connected to the RED/BLK wire. Does the ohmmeter indicate the specified value?	0 W	Go to Step 27	Go to Step 30

NO CRANK (Cont'd)

Step	Action	Value(s)	Yes	No
27	Check the condition of terminals E and G on both the Park/Neutral switch connector and on the Park/Neutral switch. Are any of these terminals faulty?	-	Go to Step 28	Go to Step 29
28	Repair the faulty terminal. Is the repair complete?	-	System OK	-
29	Repair the open in the RED wire between terminal G of the Park/Neutral switch connector and the starter "S" terminal. Is the repair complete?	-	System OK	-
30	Replace the Park/Neutral switch. Is the repair complete?	-	System OK	-
31	1. Reconnect the Park/Neutral switch. 2. Disconnect connector C104. 3. Connect the voltmeter positive lead to terminal 10 of connector C104 on the ECM/ABS harness. 4. Connect the voltmeter negative lead to ground. 5. Turn the ignition switch to START. Does the voltmeter indicate the specified value?	12 v	Go to Step 32	Go to Step 39
32	Check terminal 10 on both sides of connector C104. Is one of them faulty?	-	Go to Step 33	Go to Step 34
33	Repair the faulty terminal. Is the repair complete?	-	System OK	-
34	Repair the open in the RED/BLK wire from terminal 10 of connector C104 to terminal E of the Park/Neutral switch. Is the repair complete?	-	System OK	-
35	1. Disconnect connector C104. 2. Connect the voltmeter positive lead to terminal 10 of connector C104 on the ECM/ABS harness. 3. Connect the voltmeter negative lead to ground. 4. Turn the ignition switch to START. Does the voltmeter indicate the specified value?	12 v	Go to Step 36	Go to Step 39
36	Check terminal 10 on both sides of connector C104. Is one of them faulty?	-	Go to Step 37	Go to Step 38
37	Repair the faulty terminal. Is the repair complete?	-	System OK	-
38	Repair the open in the RED wire from terminal 10 of connector C104 to the starter "S" terminal. Is the repair complete?	-	System OK	-
39	1. Disconnect connector C210. 2. Connect the voltmeter positive lead to terminal 14 of connector C210 on the I/P harness. 3. Connect the voltmeter negative lead to ground. 4. Turn the ignition switch to START. Does the voltmeter indicate the specified value?	12 v	Go to Step 40	Go to Step 43
40	Check terminal 14 on both sides of connector C210. Is one of them faulty?	-	Go to Step 41	Go to Step 42
41	Repair the faulty terminal. Is the repair complete?	-	System OK	-

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NO CRANK (Cont'd)

Step	Action	Value(s)	Yes	No
42	Repair the open in the RED wire from terminal 14 of connector C210 to terminal 10 of connector C104. Is the repair complete?	-	System OK	-
43	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 switch to START. Does the voltmeter indicate the specified value?	12 v	Go to Step 45	Go to Step 44
44	Replace the ignition switch. Is the repair complete?	-	System OK	-
45	Check terminal ST on the ignition switch and terminal 3 of the ignition switch connector. Are the terminals in good condition?	-	Go to Step 46	Go to Step 47
46	Repair the open in RED wire between terminal 3 of the ignition switch connector and terminal 14 of connector C210. Is the repair complete?	-	System OK	-
47	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 an 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 runout. 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 a broken 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 0.30 mm (0.012 inch). If normal starter shims are not available, plain washers 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 damage is obvious, 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 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 (Off the Vehicle)" 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 any 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.

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GENERATOR OUTPUT TEST

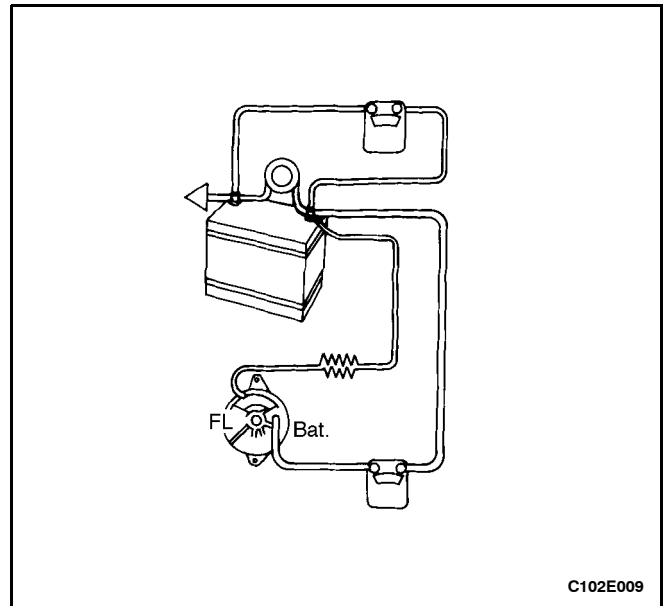
1. Perform the generator system test. Refer to "Generator System Check" in this section.
2. Replace the generator if it fails that test. Refer to "Generator" in the On-Vehicle Service section. If it passes the test, perform the on-vehicle output check which follows.

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 switch in the OFF position, check and record the battery voltage.
5. Remove the harness connector from the generator.
6. Turn the ignition switch to the RUN position 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 that 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 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.



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GENERATOR SYSTEM CHECK

When operating normally, the generator indicator lamp will come on when the ignition switch is in the RUN position 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 or glove box lamp, to stay on.

Diagnose the generator with the following procedure:

1. Visually check the belt and wiring.
2. With the ignition switch in the ON position 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.
 - D If the lamp lights, replace the generator. Refer to "Generator" in the On-Vehicle Service section.
 - D If the lamp does not light, locate the open circuit between the ignition switch and the harness connector. The indicator lamp bulb may be burned out.
3. With the ignition switch in the ON position and the engine running at moderate speed, the charge indicator lamp should be off. If not, detach the wiring harness at the generator.
 - D If the lamp goes off, replace the generator. Refer to "Generator" in the On-Vehicle Service section.
 - D If the lamp stays on, check for a short to ground in the harness between the connector and the indicator lamp.

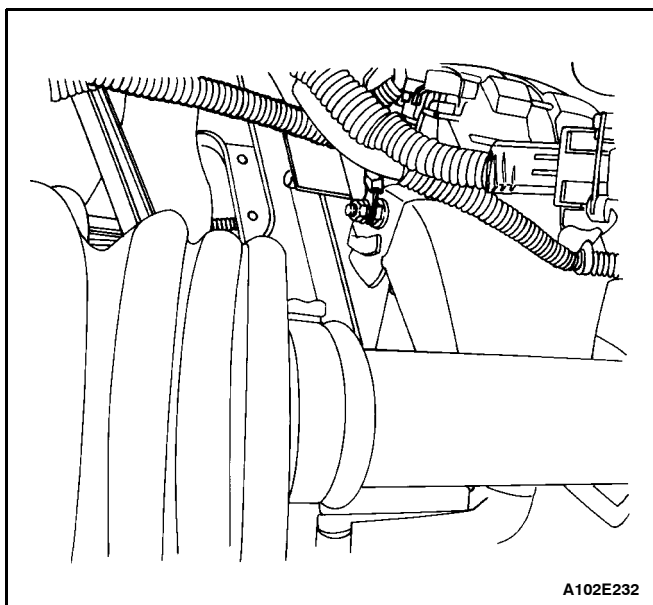
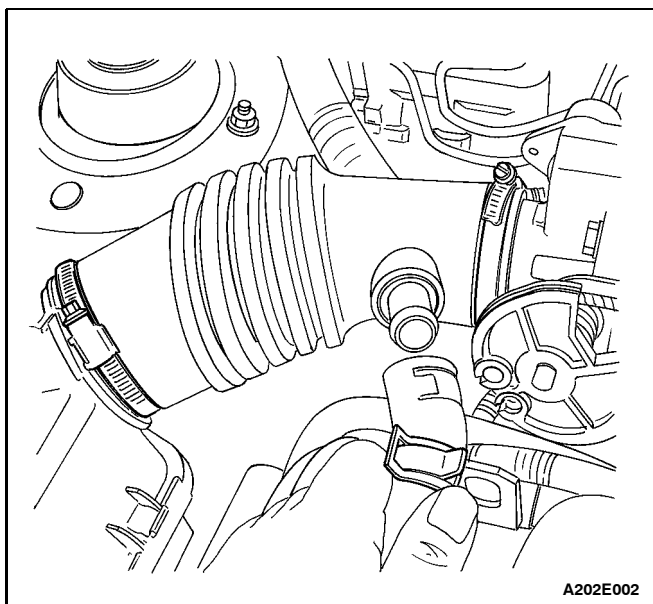
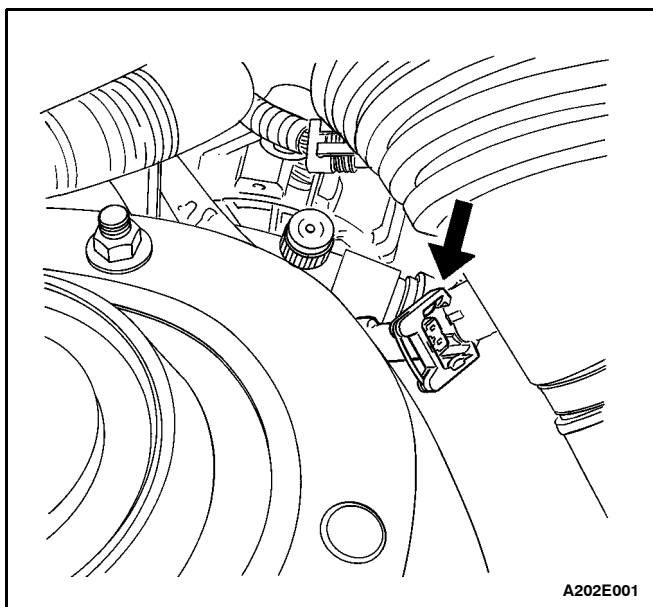
Important: Always check the generator for output before assuming that a grounded "L" terminal circuit has damaged the regulator. Refer to "Generator" in the Unit Repair section.

MAINTENANCE AND REPAIR ON-VEHICLE SERVICE

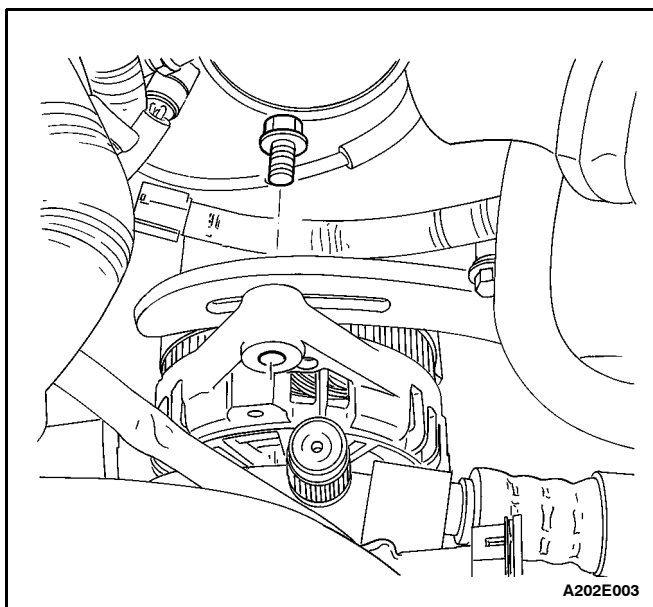
GENERATOR

Removal Procedure

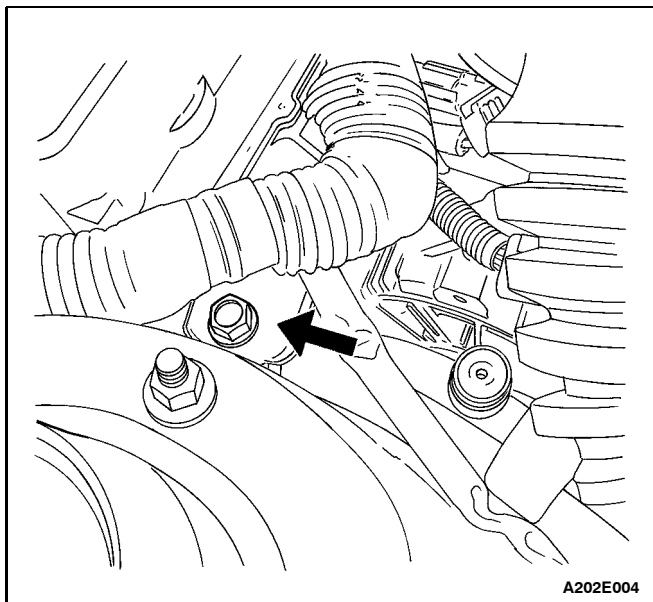
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature (MAT) sensor electrical connector from the air intake tube.
3. Remove the breather tube clamp and all other clamps to remove the air intake tube.
4. Remove the battery harness connector nut from the generator.



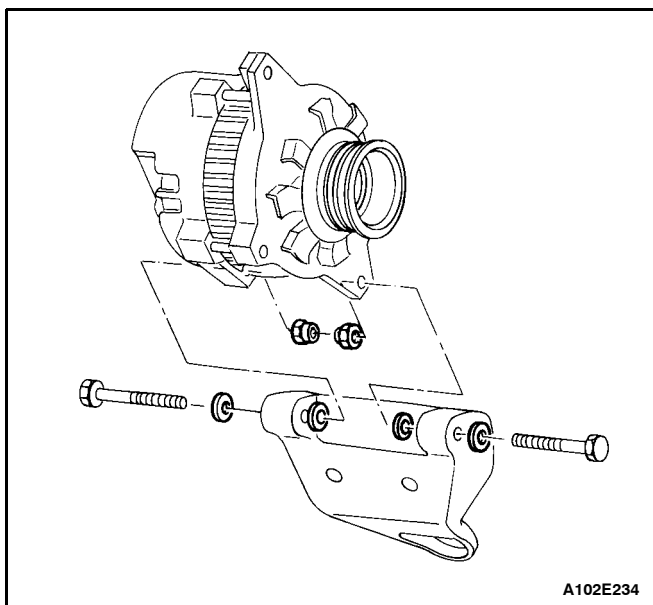
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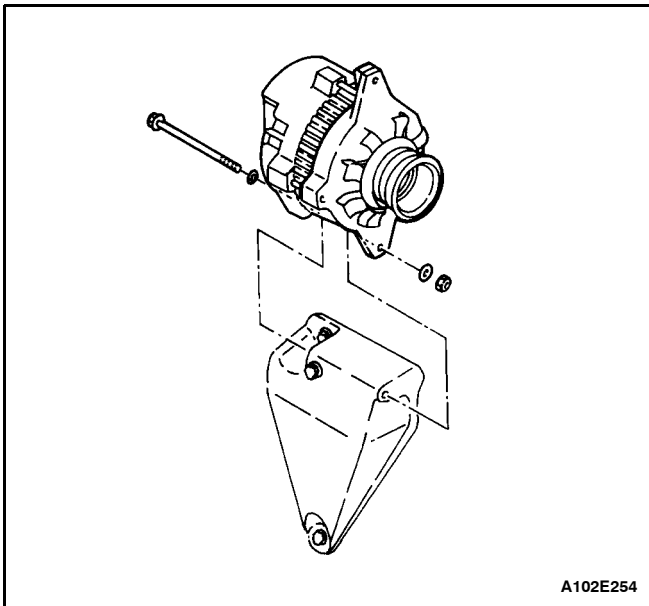
5. Remove the generator shackle bracket bolt and the washer.
6. Remove the serpentine accessory drive belt. For vehicles equipped with power steering and air conditioning, refer to Section 6B, Power Steering Pump for belt removal.



7. Remove the bolt and the retaining clamp of the harness.



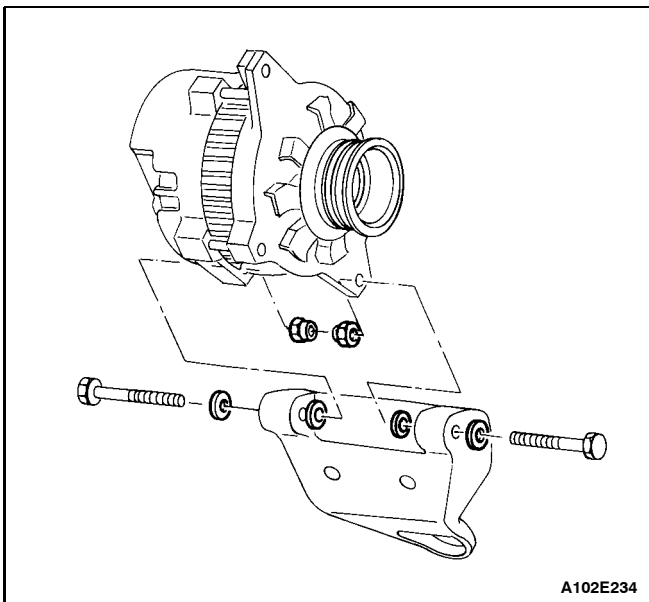
8. For vehicles with the SOHC engine, remove the nuts and the washers which hold the generator lower bracket-to-generator bolts.



9. For vehicles with the DOHC engine, remove the throttle body. Refer to Section 1F, Engine Controls.
10. Remove the fuel rail mounting bolts.

Notice: Take extreme care not to damage the fuel injector O-rings to prevent fuel leaks when the fuel rail is re-seated.

11. Unseat the fuel rails from the cylinder head, and slightly push the fuel rail assembly clear of the cylinder head in the direction of the master cylinder.
12. Remove the nut and the washers which hold the generator lower bracket-to-generator bolt.
13. Carefully remove the generator.

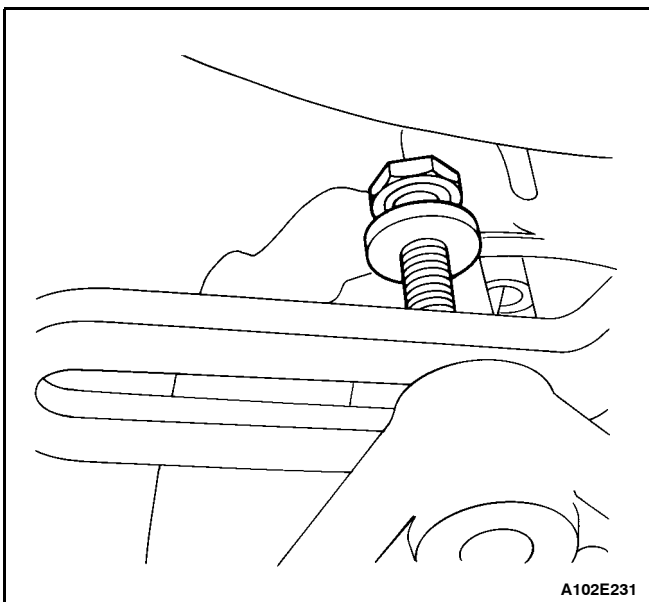


Installation Procedure

1. Install the generator at the generator lower bracket and insert the generator bolts.
2. Install the nuts and the washers on the generator lower bracket-to-generator bolts (SOHC engine is shown).

Tighten

Tighten the generator lower bracket-to-generator nuts to 20 Nsm (15 lb-ft).

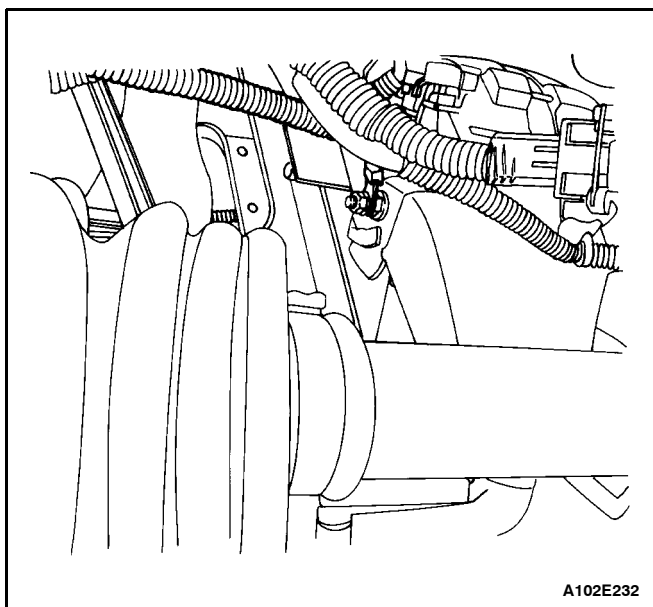


3. Install the serpentine accessory drive belt on vehicles not equipped with power steering and air conditioning.
4. Secure the generator to the shackle bracket with the bolt (SOHC engine is shown). For vehicles equipped with power steering and air conditioning, refer to Section 6B, Power Steering Pump.

Tighten

Tighten the generator shackle bracket bolt to 20 Nsm (15 lb-ft).

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5. Connect the harness connector to the back of the generator.

6. Install the generator lead to the battery and fasten the lead with the nut.

Tighten

Tighten the generator battery lead connector nut to 15 NSm (11 lb-ft).

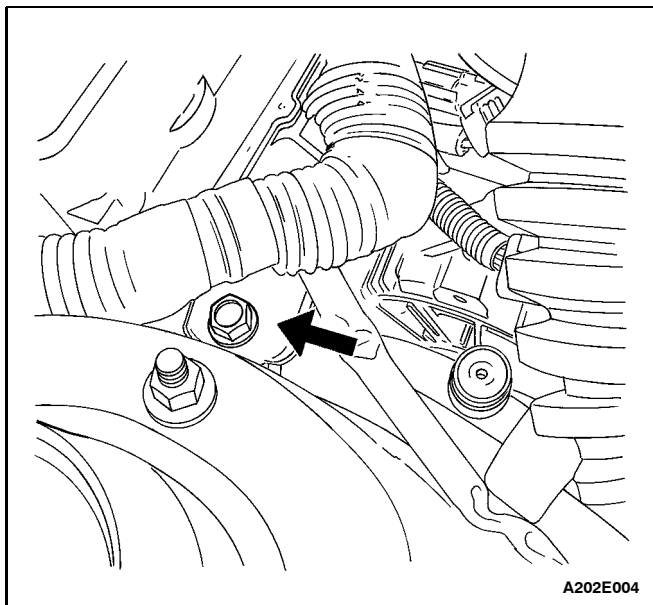
7. Lubricate the injector O-rings on the DOHC engine with engine oil.

8. Install the fuel rail assembly.

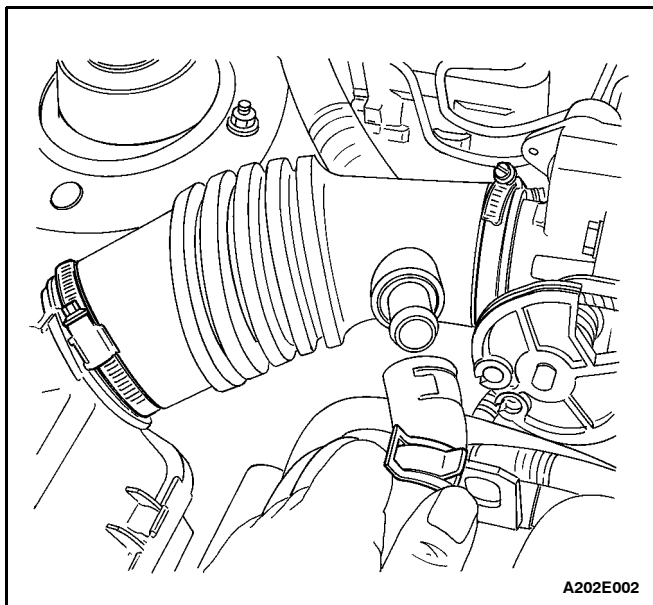
Tighten

Tighten the fuel rail retaining bolts to 20 NSm (15 lb-ft).

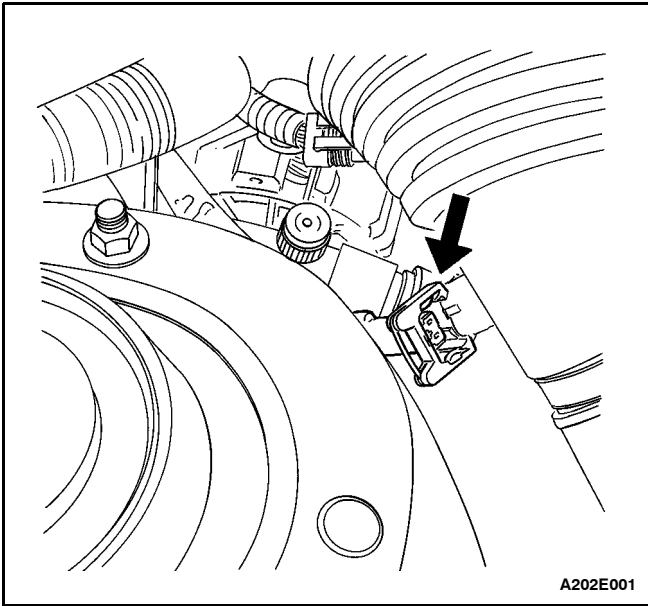
9. Install the throttle body. Refer to Section 1F, Engine Controls.



10. Install the harness retaining clamp bolt.

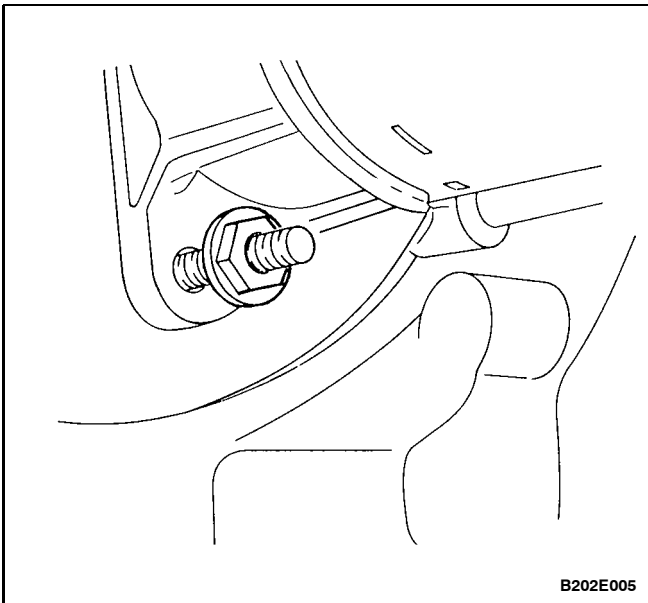


11. Install the air intake tube and the connector.



12. Install the MAT electrical connector to the air intake tube.

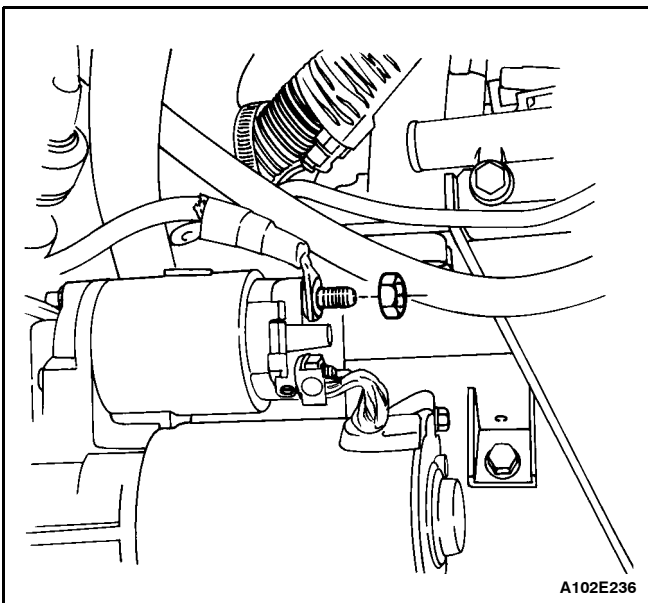
13. Connect the negative battery cable.



STARTER

Removal Procedure

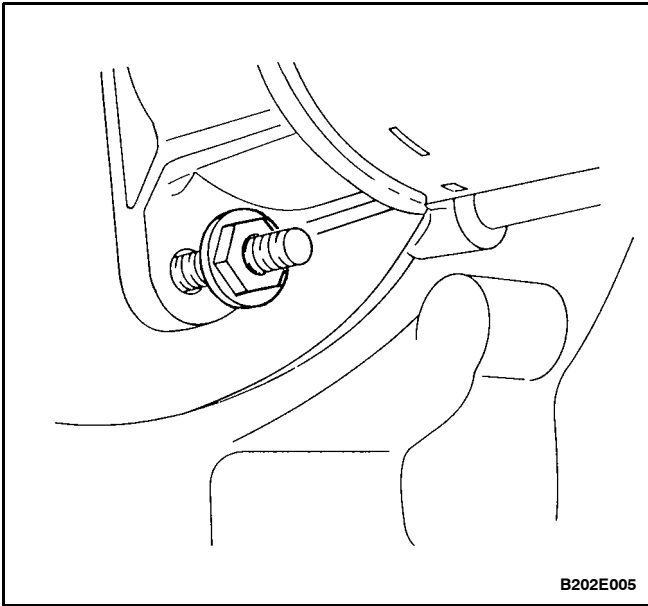
1. Remove the nut that secures the starter ground wire to the mounting stud.
2. Remove the ground wire.
3. Remove the lower and then the upper starter stud/weld nut assemblies. (The lower stud/weld nut assembly is shown.)



4. Remove the starter solenoid nuts to disconnect the electrical cables.

5. Remove the starter assembly.

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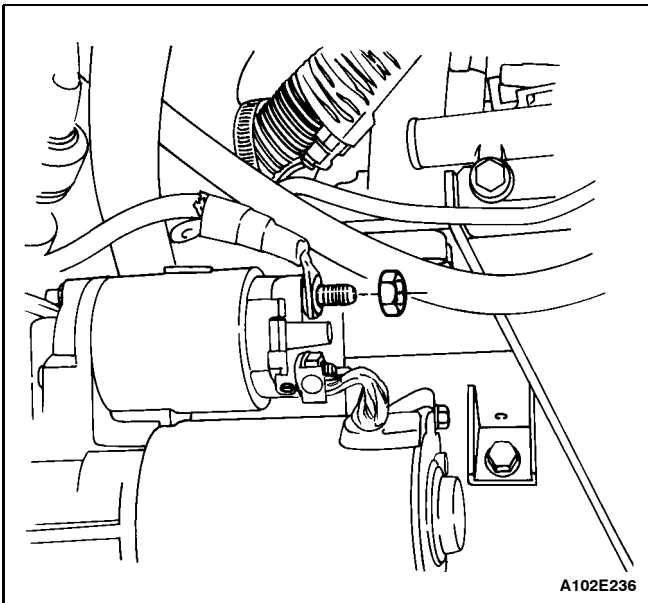


Installation Procedure

1. Place the starter assembly in position using an assistant to prop up the starter to aid in fastening the upper mounting stud with the weld nut.
2. Install the upper and the lower starter mounting studs with the weld nuts.

Tighten

Tighten the starter mounting studs to 43 N \cdot m (32 lb-ft).



3. Position the starter electrical wires on the solenoid terminals.
4. Position the ground wire on the lower stud.
5. Install the starter solenoid nuts.

Tighten

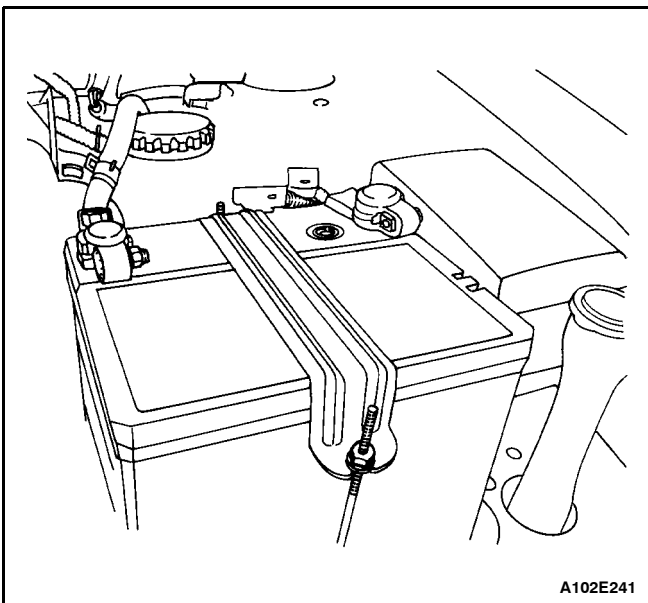
Tighten the starter solenoid terminal-to-battery cable terminal nut to 7 N \cdot m (62 lb-in).

Tighten the starter solenoid terminal-to-ignition terminal nut to 6 N \cdot m (53 lb-in).

6. Install the ground wire nut.

Tighten

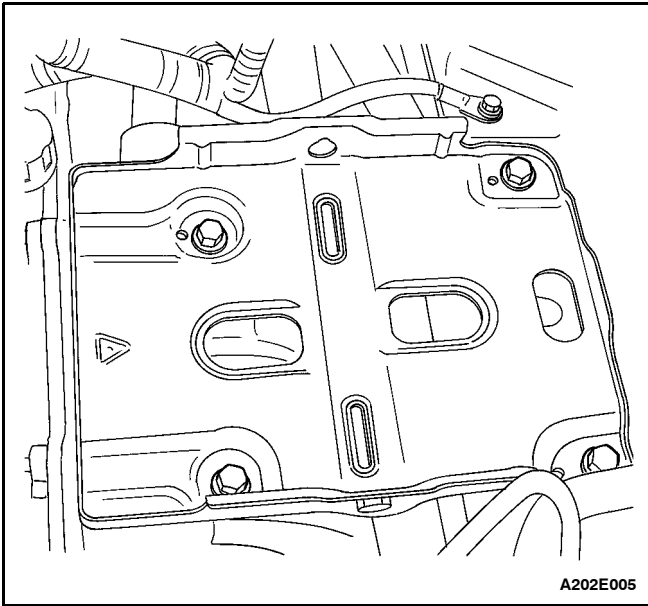
Tighten the ground wire terminal to the point at which it meets the nut. Then tighten the ground wire terminal an additional quarter turn.



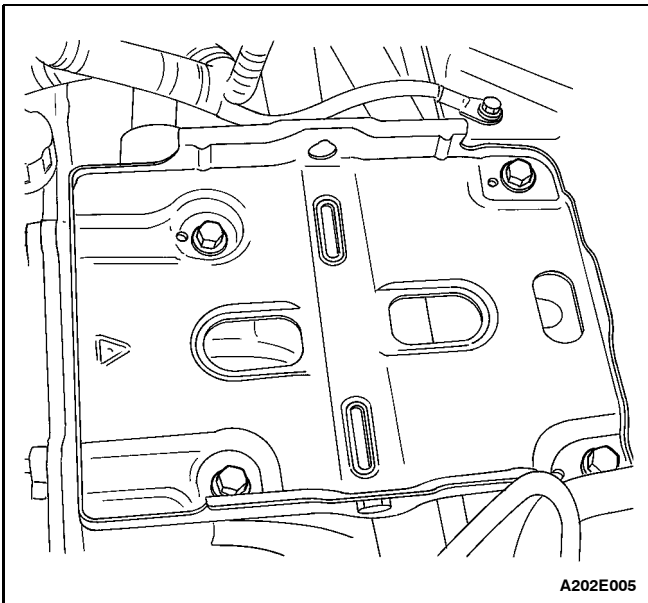
BATTERY/BATTERY TRAY

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. Detach the carrier tray if necessary by removing the upper and the lower bolts.

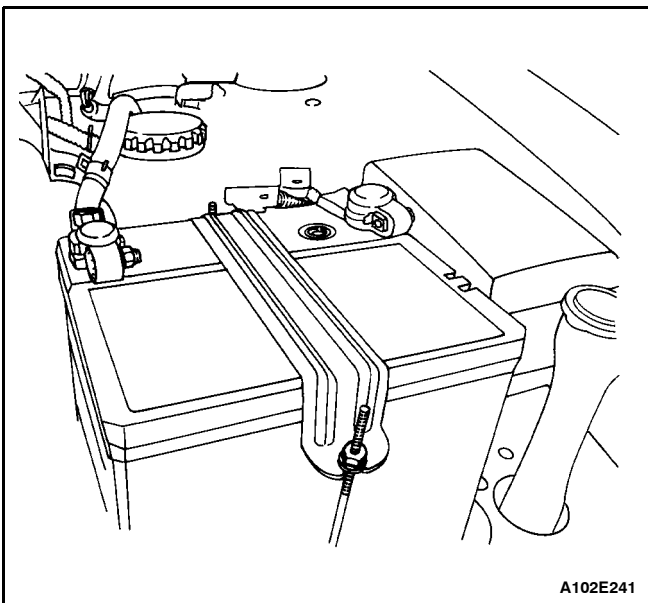


Installation Procedure

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

Tighten

Tighten the battery carrier tray upper and lower bolts to 20 N \cdot m (15 lb-ft).

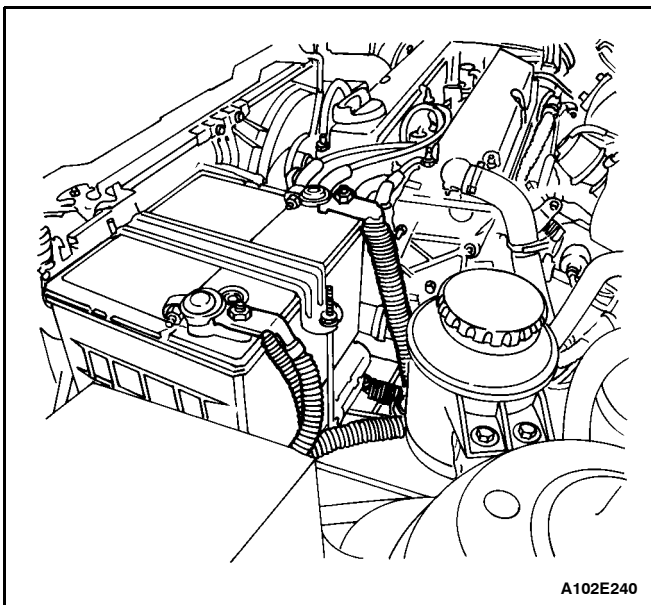


2. Install the battery into the tray.
3. Fasten the bar clamp to the battery by loosely attaching the battery rods from the battery tray cutouts through the bar clamp holes, and loosely tightening the nuts.

Tighten

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

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4. Connect the negative and the positive battery cables.

Tighten

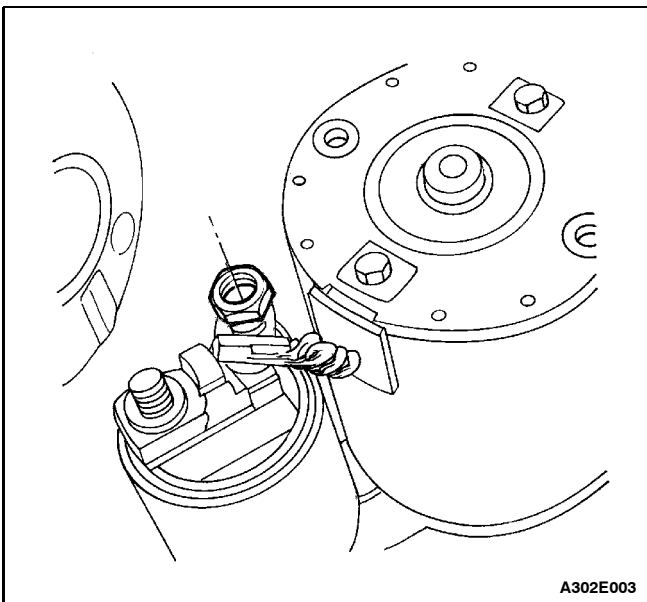
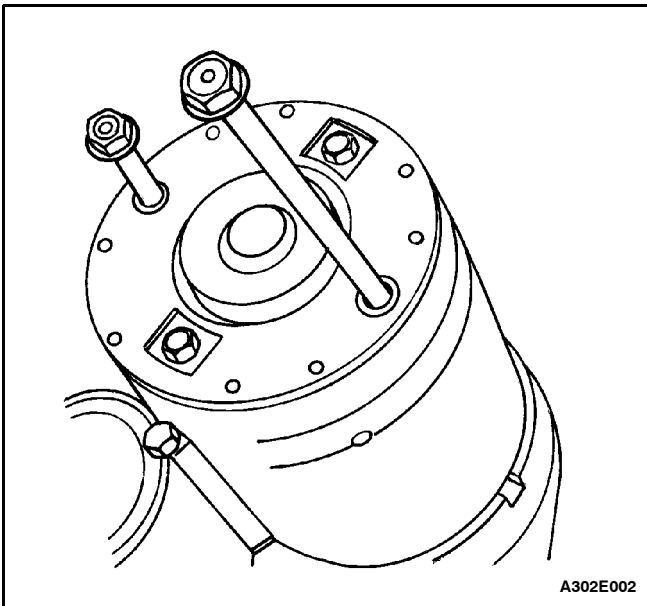
Tighten the battery cable nuts to 15 N·m (11 lb-ft).

UNIT REPAIR

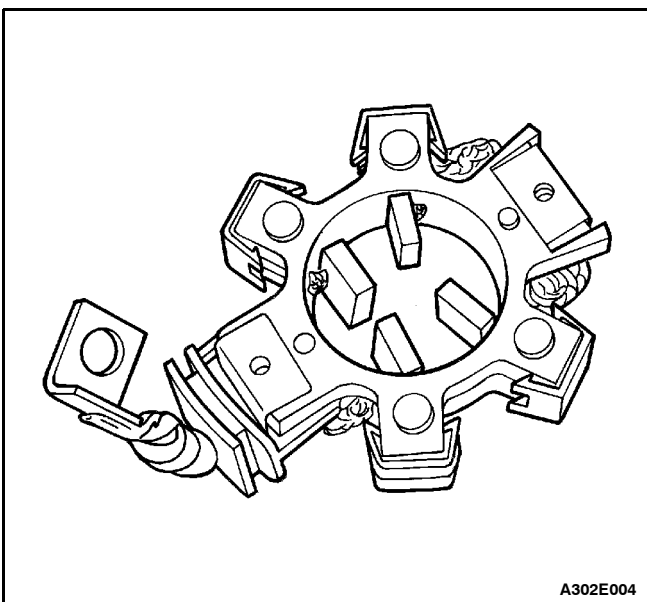
STARTER MOTOR (0.8 KILOWATTS)

Disassembly Procedure

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

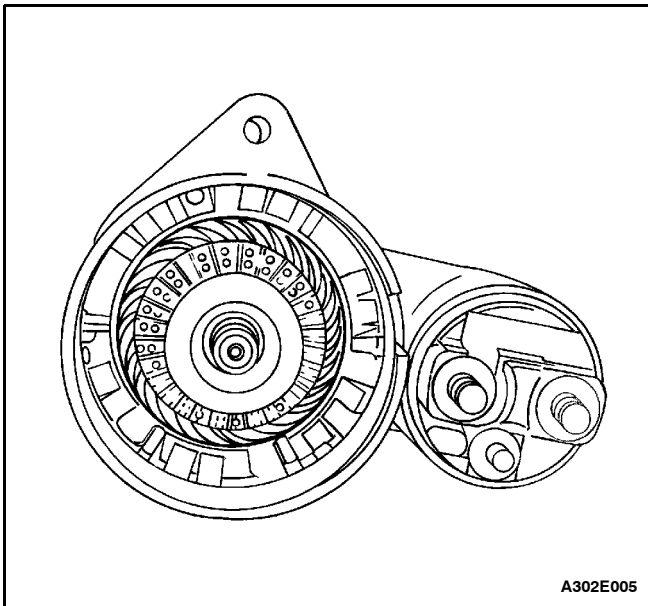


3. Remove the field connector nut. Disconnect the field connector.

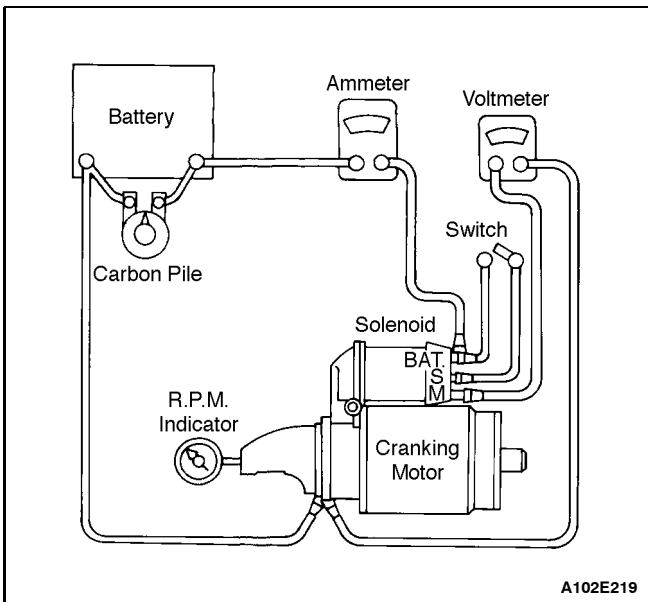


4. Pry off the commutator end frame/brush/brush holder assembly from the field frame.
5. Remove the bolts that secure the end frame to the brush/brush holder assembly.
6. Inspect the brushes, the pop-out springs, and the plastic spring retainers for wear and damage. Replace the parts, if necessary.

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7. Check the armature to see if it turns freely. If the armature does not turn freely, break down the assembly beginning with Step 9. Otherwise, give the armature a no-load test.

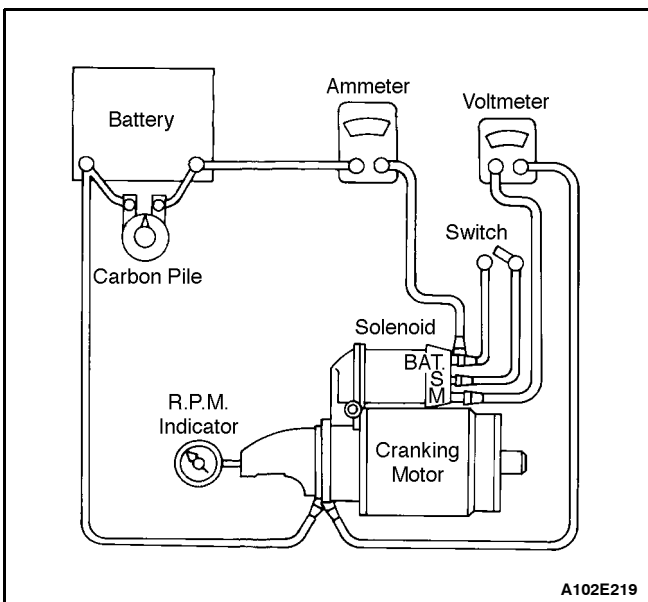


Important: If the specified current draw does not include the solenoid, deduct from the armature reading the specified current draw of the solenoid hold-in winding.

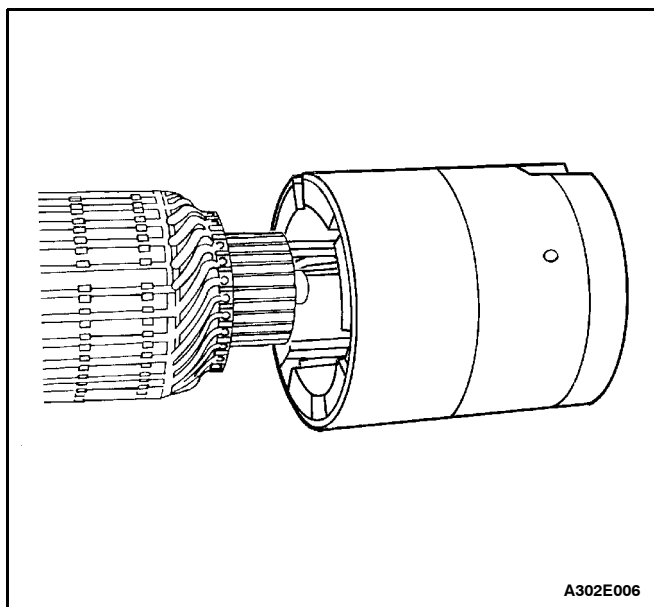
Notice: Complete the testing in a minimum amount of time to prevent overheating and damaging the solenoid.

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:

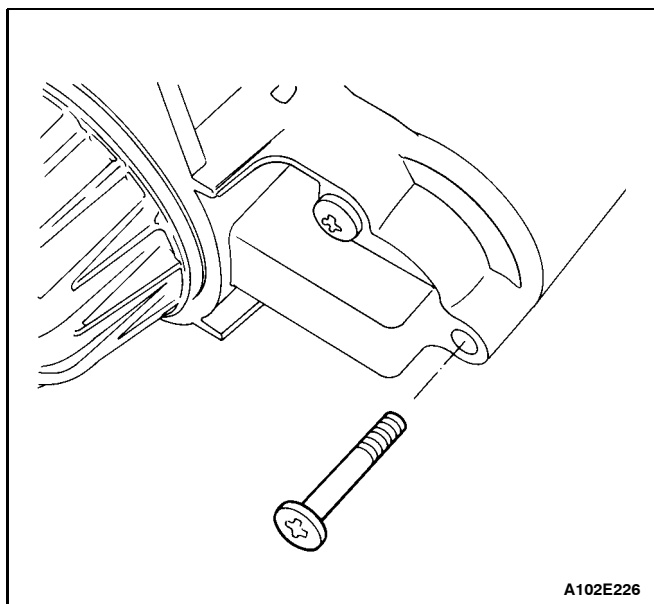
- 8.1. Rated current draw and no-load speed indicate a normal condition for the starter motor.
- 8.2. Low free speed and high current draw indicate too much friction (tight, dirty, or worn bearings, or a bent armature shaft), a shorted armature, or a shorted armature and fields.



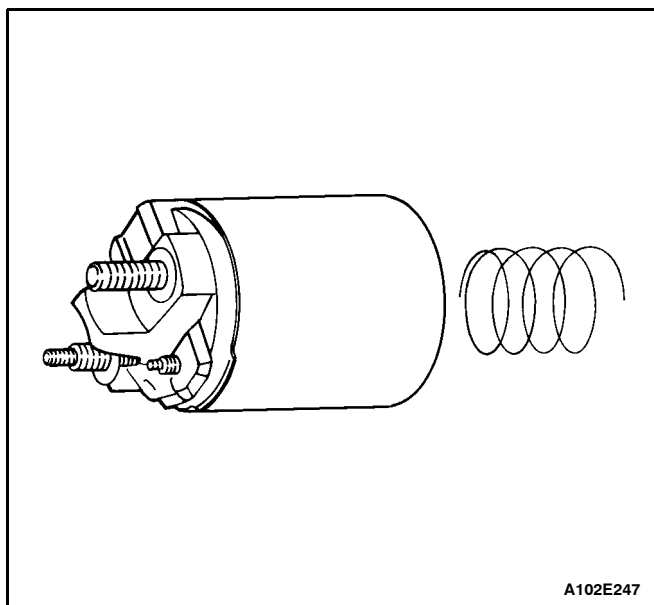
- 8.3. Failure to operate with high current draw indicates a direct ground in the terminal or fields, or "frozen" bearings.
- 8.4. Failure to operate with no current draw indicates an open field circuit, open armature coils, broken brush springs, worn brushes, high insulation between the commutator bars,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



9. Separate the field frame from the armature assembly.

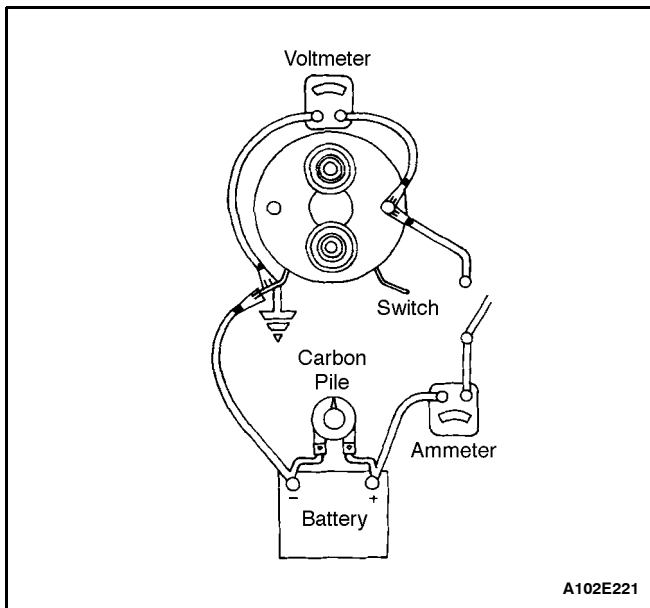


10. Remove the solenoid assembly screws.



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

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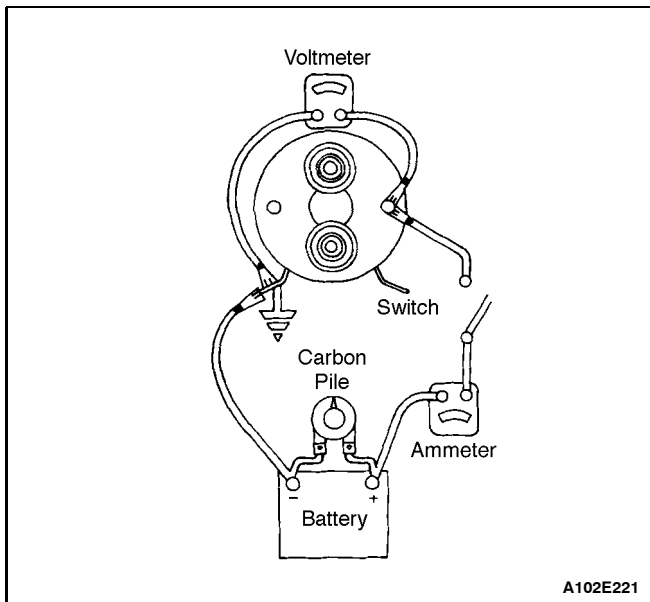
Important: If the solenoid is not removed from the starting motor, the connector strap terminals must be removed from the terminal on the solenoid before making these tests.

12. Test the solenoid windings by checking the current draw.

12.1. Check the hold-in windings by connecting an ammeter in series with a 12-volt battery, the switch terminal, and to ground.

12.2. Connect the carbon pile across the battery.

12.3. Adjust the voltage to 10 volts. The ammeter reading should be 13 to 19 amperes.



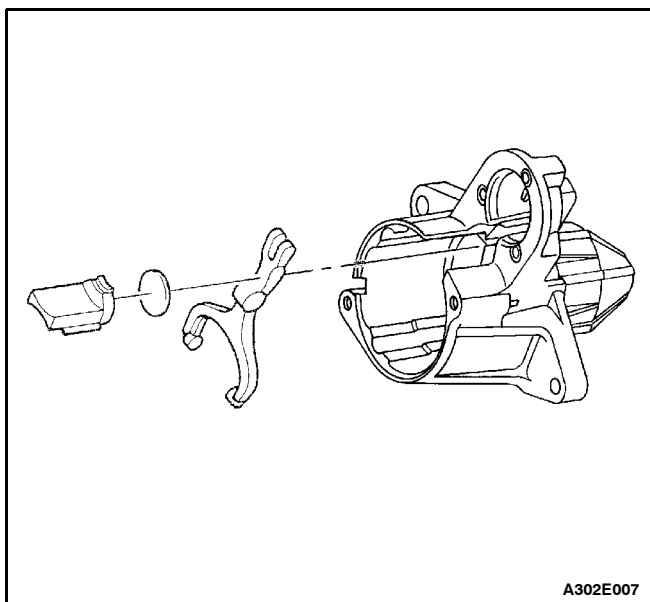
Important: Current will decrease as the windings heat up. Current draw readings that are over specifications indicate shorted turns or a ground in the windings of the solenoid. Both conditions require replacement of the solenoid. Current draw readings that are under specifications indicate excessive resistance. No reading indicates an open circuit.

13. Check both windings, connecting them as in the preceding test.

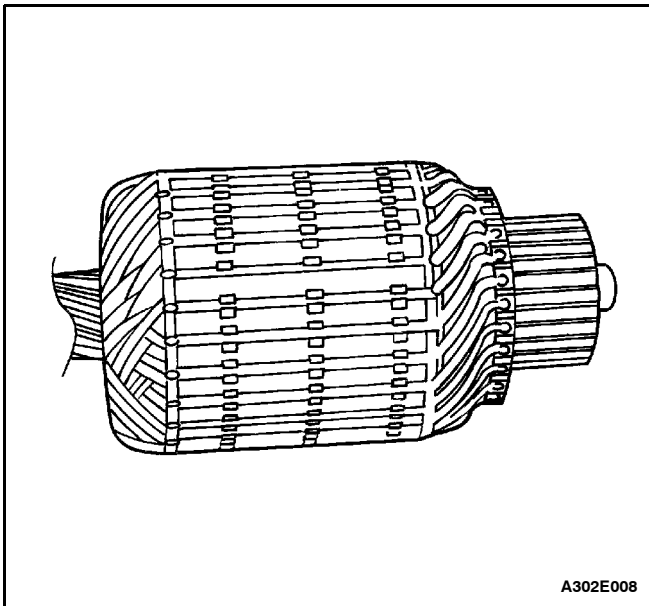
13.1. Ground the solenoid motor terminal.

13.2. Adjust the voltage to 10 volts. The ammeter reading should be 59 to 79 amperes.

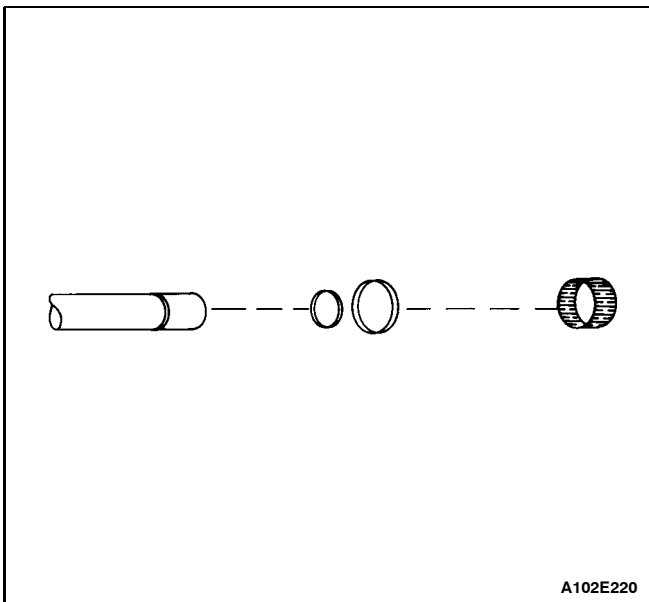
13.3. Check the connections and replace the solenoid, if needed.



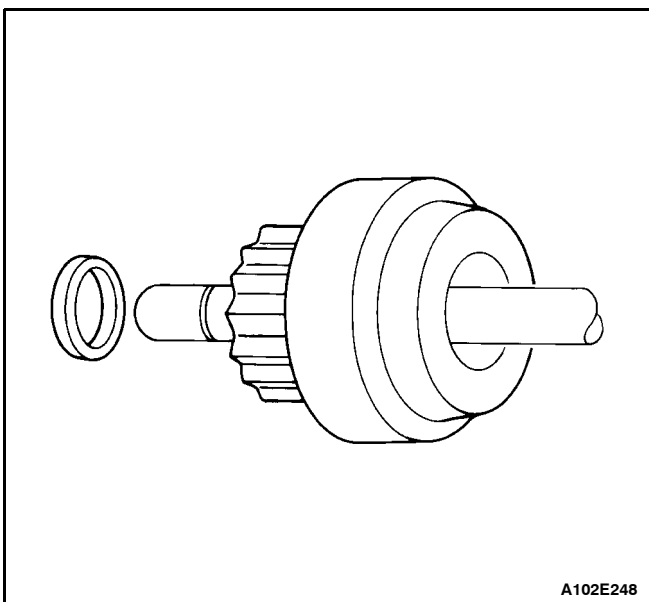
14. Remove the plunger with the boot and the shift lever assembly.



15. Remove the armature assembly from the starter housing.

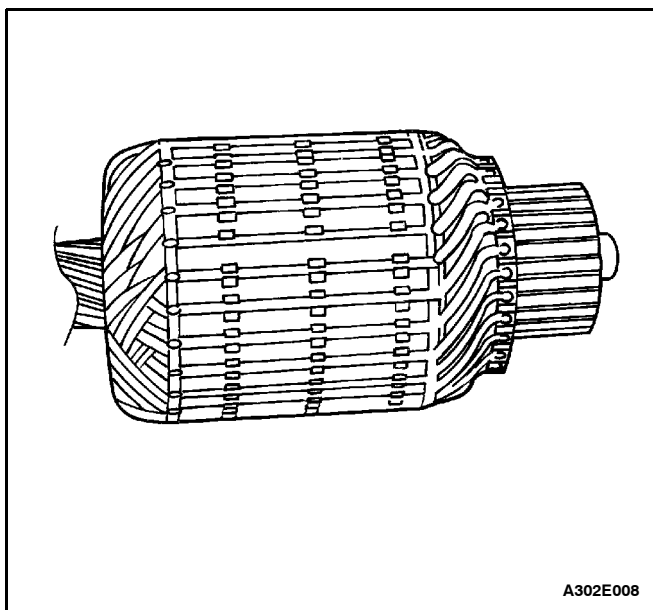


16. Disassemble the shaft assembly by separating the bushing from the shaft.
17. Remove the collar and the locking ring from the groove on the shaft.

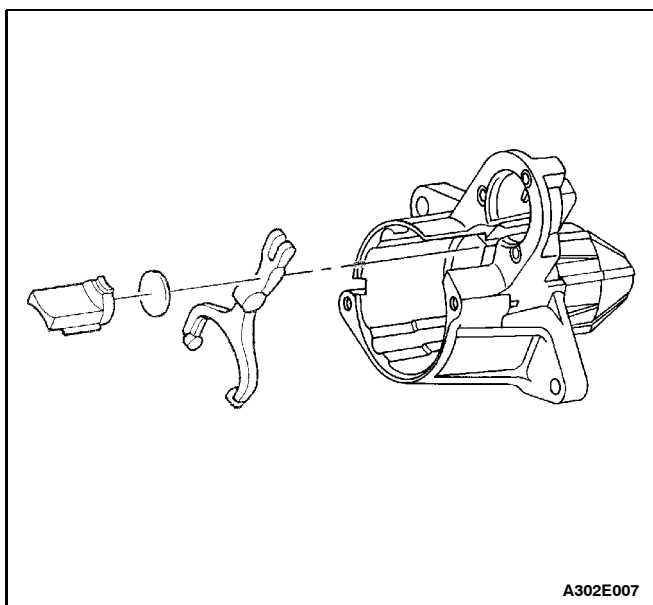


18. Remove the pinion stop and the drive from the shaft.

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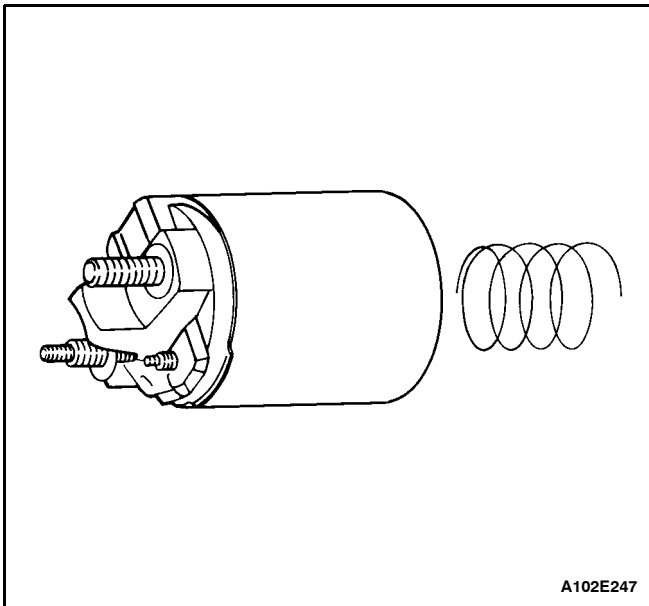


19. Inspect the armature shaft, the collar, and the pinion for discoloration, damage, or wear. Replace the parts, as needed.
20. Inspect the armature commutator. If the commutator is rough, it should be turned down. The outside diameter of the commutator must measure at least 41.91 mm (1.650 inches) after it is undercut or turned. Do not turn out-of-round commutators.
21. Inspect the points where the armature conductors join the commutator bars. Make sure the armature conductors and the commutator bars have a good connection. A burned commutator bar is usually evidence of a poor connection.
22. If test equipment is available, check the armature for short circuits by placing it on a growler and holding a saw blade over the armature core while the armature is rotated. If the saw blade vibrates, replace the armature.
23. Recheck the armature after cleaning between the commutator bars. If the saw blade vibrates, replace the armature.

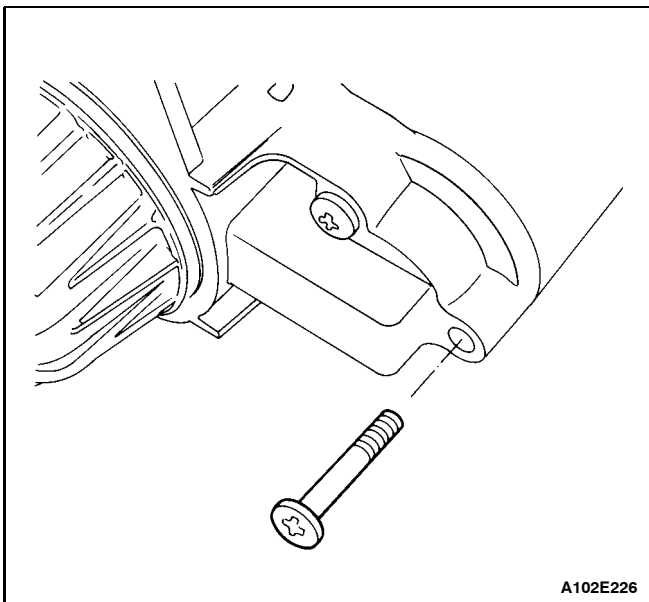


Assembly Procedure

1. Clean all of the starter motor parts, but do not use grease-dissolving solvents for cleaning the armature and the field coils.
2. Lubricate the drive and the bushings.
3. If proceeding with just the reassembly of the solenoid, perform Steps 4 and 5.
4. If the starter and the solenoid were fully disassembled, begin reassembly by installing the shift lever assembly with the plunger and the boot.



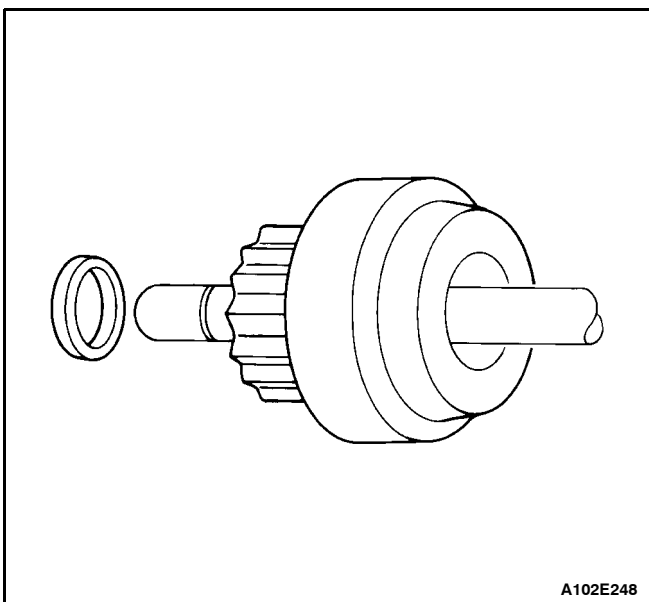
5. Position the solenoid assembly and the return spring against the plunger, applying the sealer to the solenoid flange.



6. Fasten the solenoid assembly with the screws.

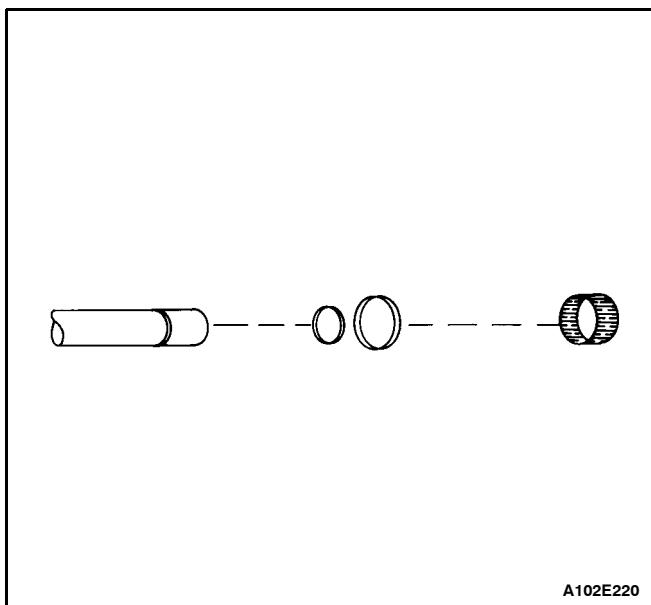
Tighten

Tighten the starter solenoid assembly screws to 8 NSm (71 lb-in).

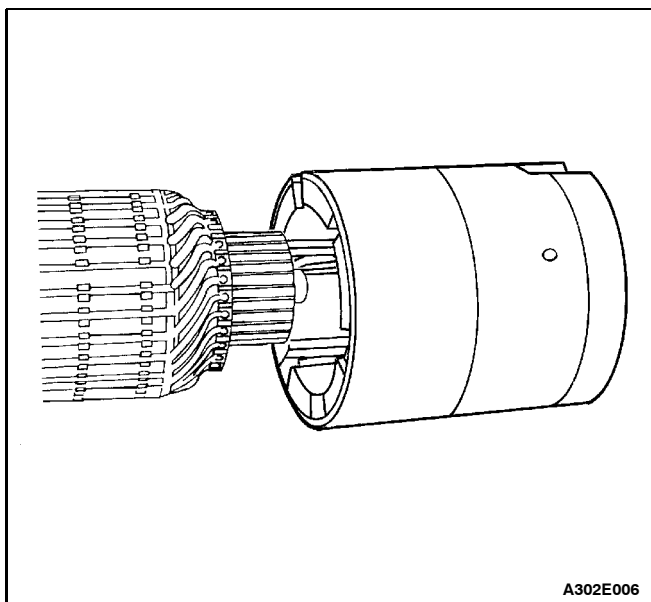


7. Install the drive and the pinion stop on the armature shaft.

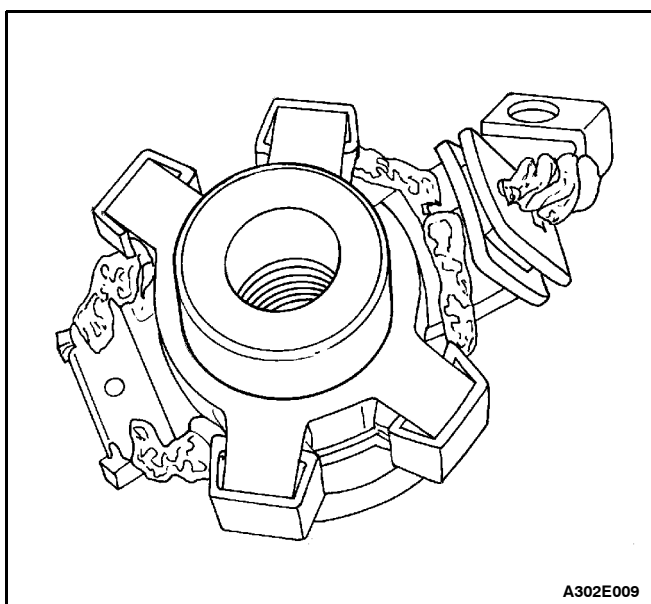
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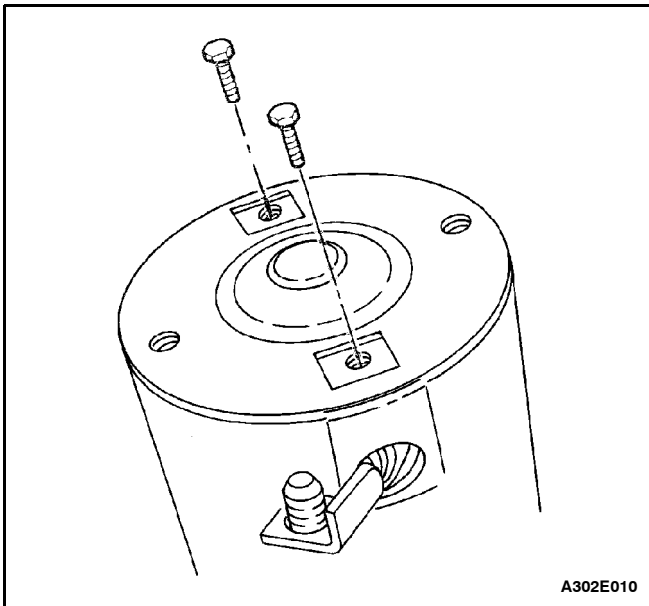
8. Install the lock ring into the groove on the armature shaft.
9. Insert the collar.



10. Install the field frame.



11. With new brushes positioned in the brush holder assembly, measure the inside diameter of the brush holder assembly.
12. Insert the brush holder assembly on a plastic, steel, or wooden dowel about the same diameter as the inside diameter of the brush holder assembly.

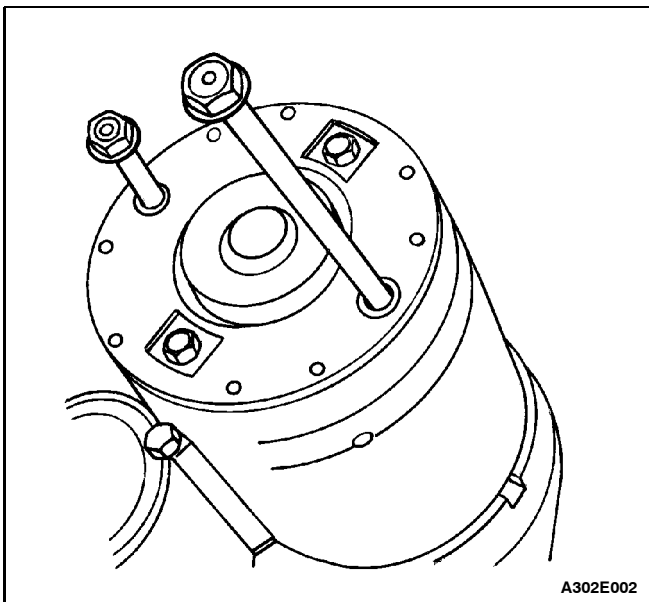


13. Position the end of the dowel with the armature commutator end. Slide the brush holder assembly onto the armature.

14. Install the end frame on the brush holder assembly with the bolts.

Tighten

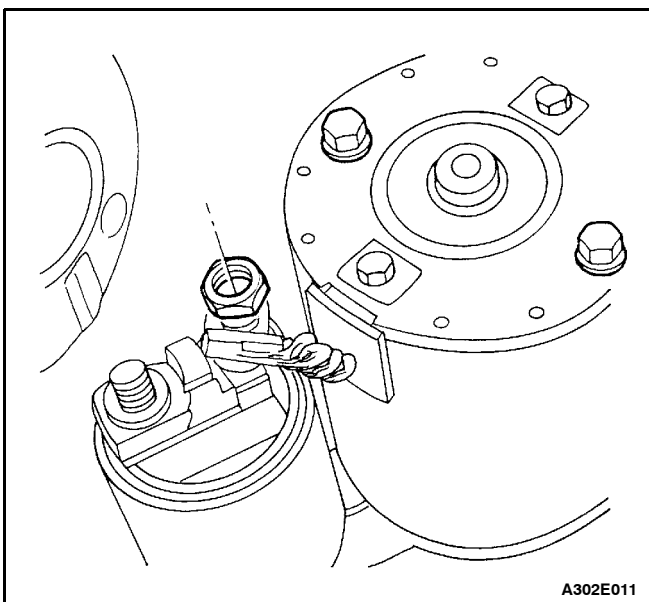
Tighten the starter end frame-to-brush holder assembly bolts to 3 NSm (27 lb-in).



15. Install the starter through-bolts.

Tighten

Tighten the starter through-bolts to 6 NSm (53 lb-in).

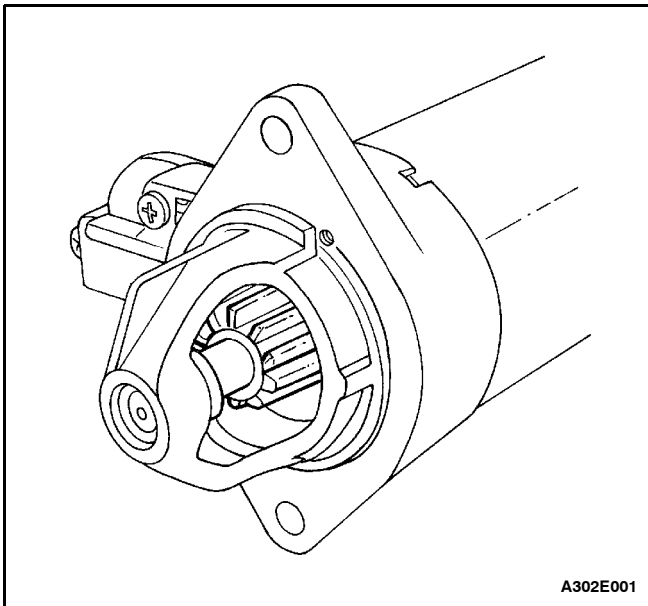


16. Install the starter field coil connection to the starter terminal and fasten it with the nut.

Tighten

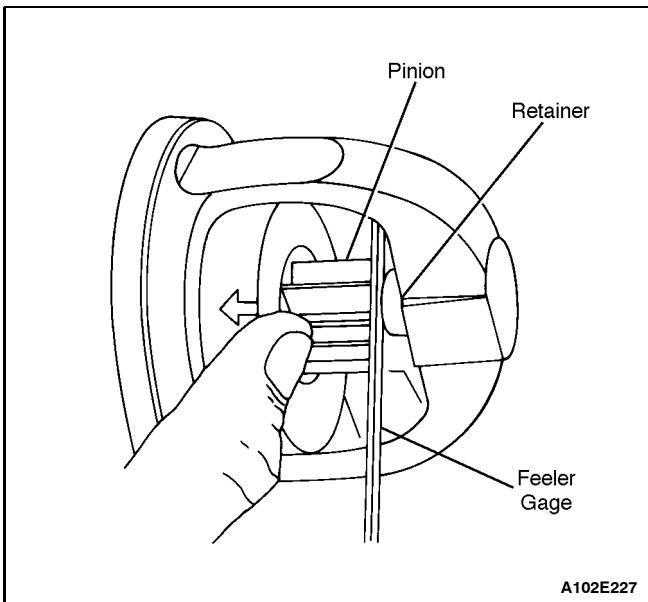
Tighten the starter field connector nut to 8 NSm (71 lb-in).

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

17. When the solenoid is replaced, it is necessary to check the pinion clearance.



18. Disconnect the motor field coil connector from the solenoid motor terminal and carefully insulate the connector.

19. Connect one 12-volt battery lead to the solenoid switch terminal and the other to the starter frame.

20. Flash a jumper lead momentarily from the solenoid motor terminal to the starter frame, allowing the pinion to shift in the cranking position, where it will remain until the battery is disconnected.

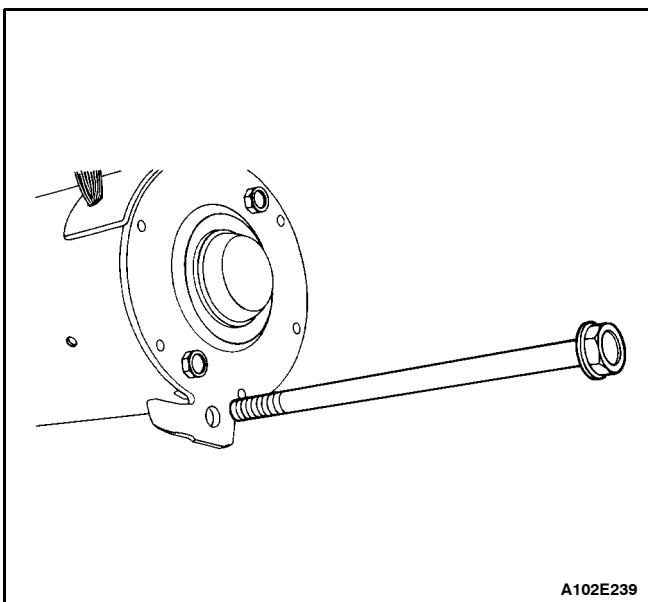
Important: A means for adjusting the pinion clearance is not provided on the starter motor. If the clearance does not fall within the limits, check for improper installation and replace all worn parts.

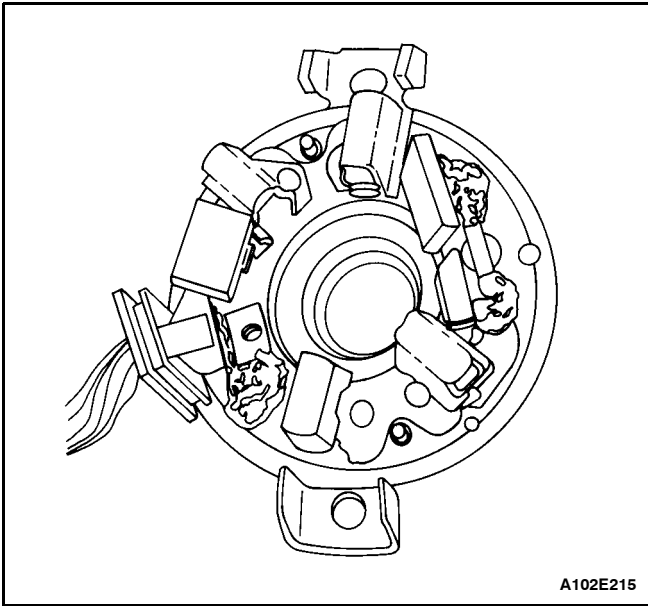
21. Push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge. The clearance should be 0.25 to 3.56 mm (0.01 to 0.14 inch).

STARTER MOTOR (1.4 KILOWATTS)

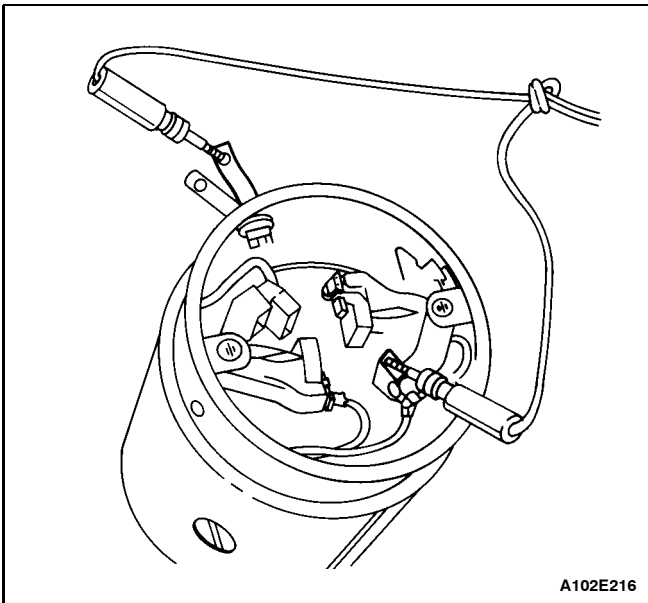
Disassembly Procedure

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



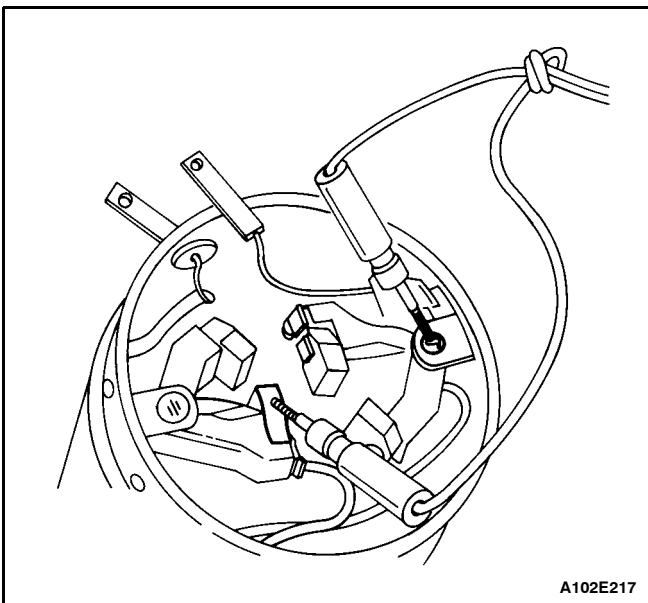


3. Remove the commutator end frame/brush holder assembly.
4. Inspect the brushes, the pop-out springs, and the brush holders for wear and damage. Replace the assembly, if necessary.



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.

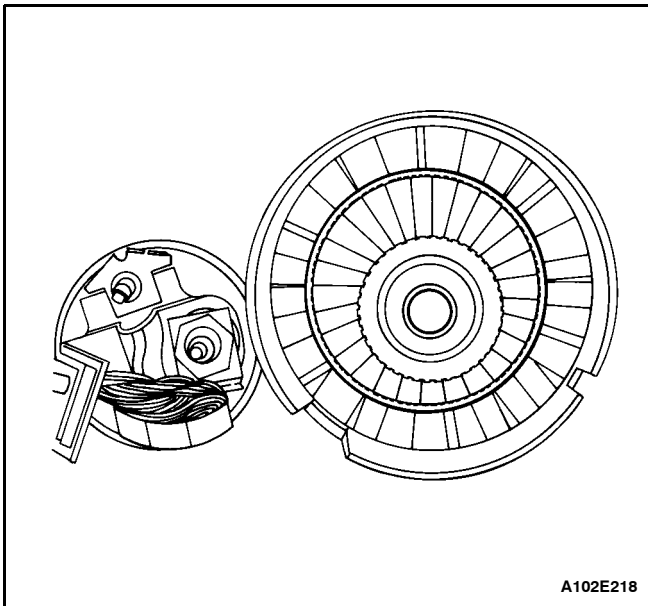
5. For only those starters having a shunt coil connection, use a test lamp, placing one lead on the shunt coil terminal while connecting the other lead to a ground brush or an insulated brush.



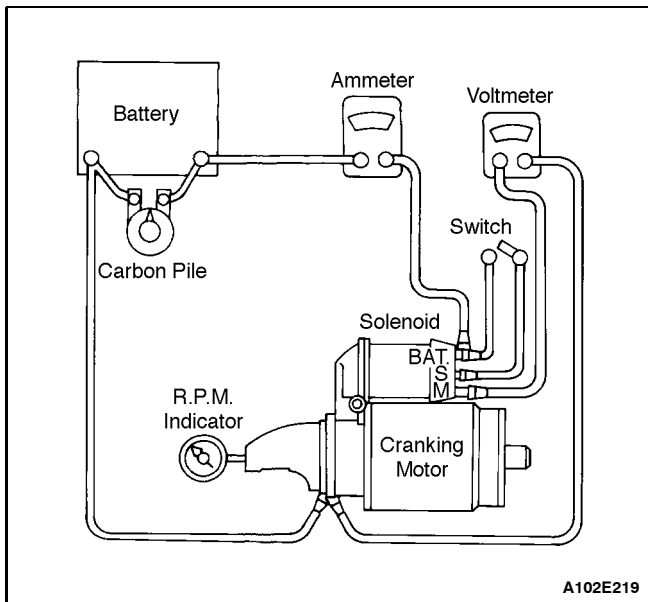
6. When testing a series coil for ground, separate the series and the shunt coil strap terminals during the test.

- 6.1 With the strap terminals not touching the case or the other ground, using a test lamp, placing one lead on the grounded brush holder and the other lead on either insulated brush.
- 6.2 If the lamp is lit, a grounded series coil is indicated and must be repaired or replaced.
- 6.3 Test for an open circuit on each insulated brush by placing one lead on the series coil terminal and the other lead on the insulated brush.
- 6.4 If the test lamp is not lit, the series coil is open and will require repair or replacement.

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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 14. Otherwise, give the armature a no-load test.

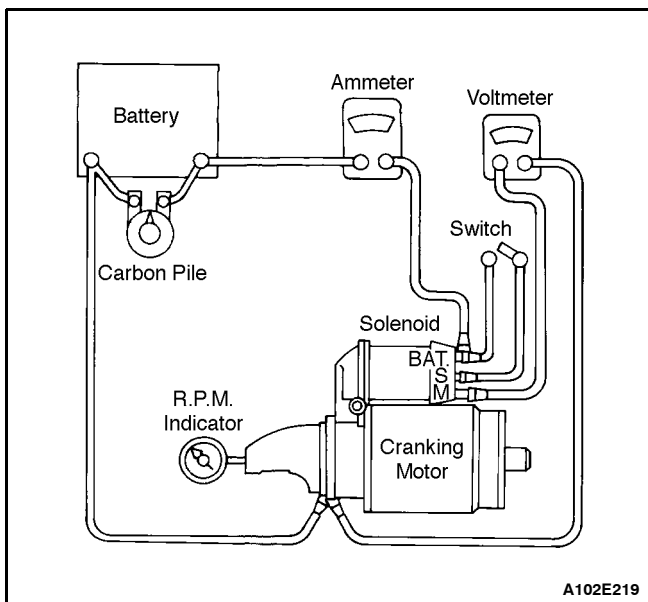


Notice: Complete the testing in a minimum amount of time to prevent overheating and damaging the solenoid.

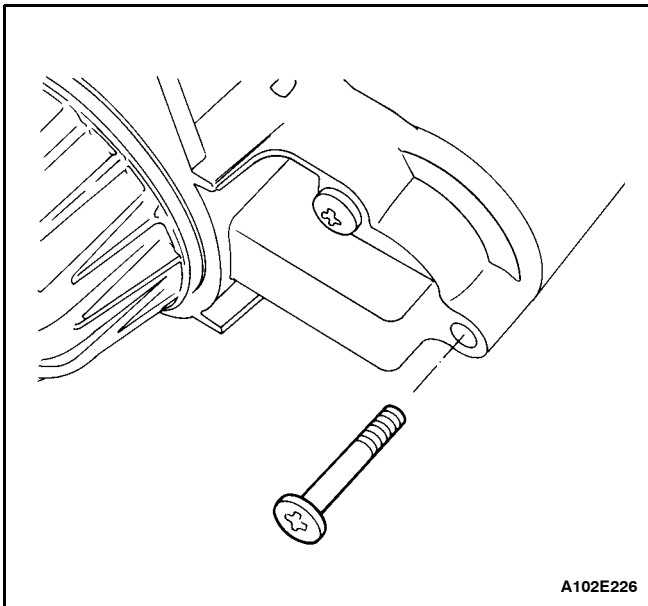
Important: If the specified current draw does not include the solenoid, deduct from the armature reading the specified current draw of the solenoid hold-in winding.

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:

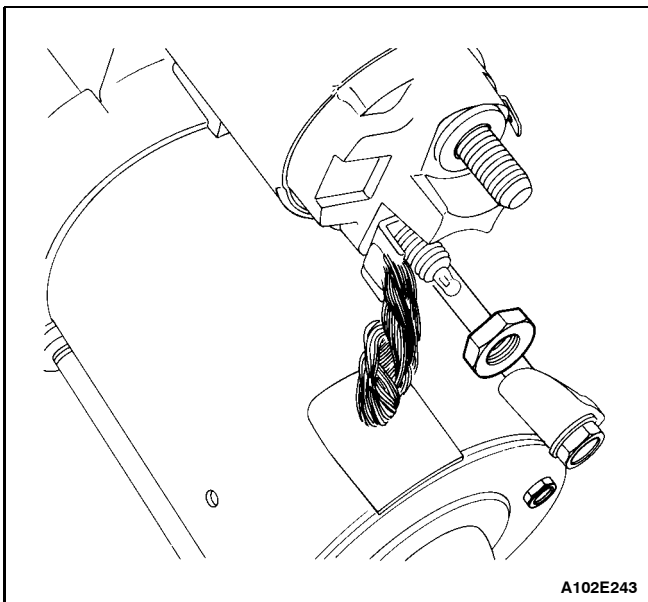
- 8.1 Rated current draw and no-load speed indicate a normal condition for the starter motor.
- 8.2 Low free speed and high current draw indicate too much friction from tight, dirty, or worn bearings, or a bent armature shaft, a shorted armature, or a shorted armature or fields.
- 8.3 Failure to operate with high current draw indicates a direct ground in the terminal or fields, or "frozen" bearings.
- 8.4 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.
- 8.5 Low no-load speed and low current indicate high internal resistance and high current draw, which usually mean shorted fields.



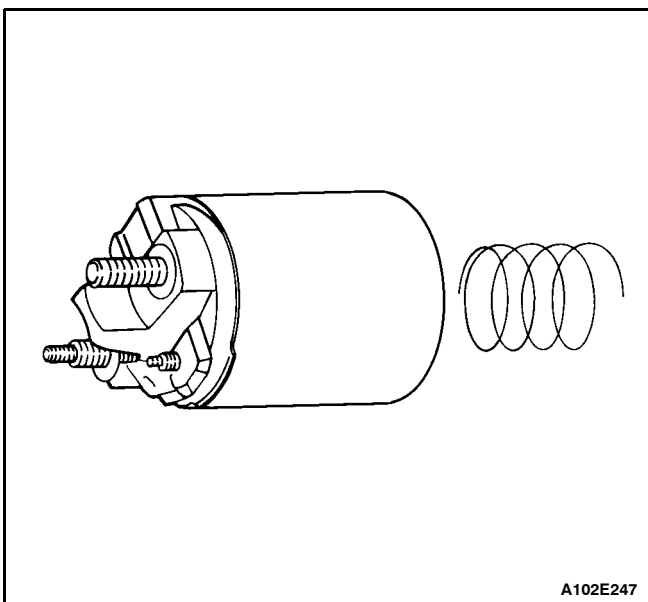
9. Remove the solenoid assembly screws.



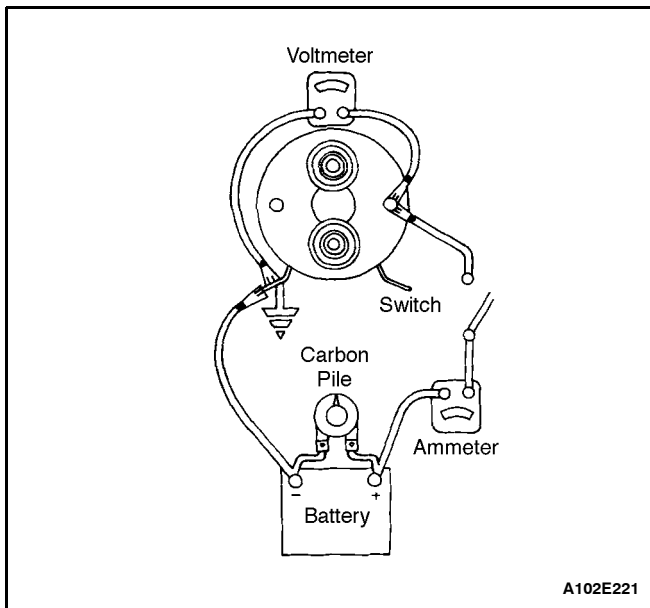
10. Remove the field connector nut. Disconnect the field connector.



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



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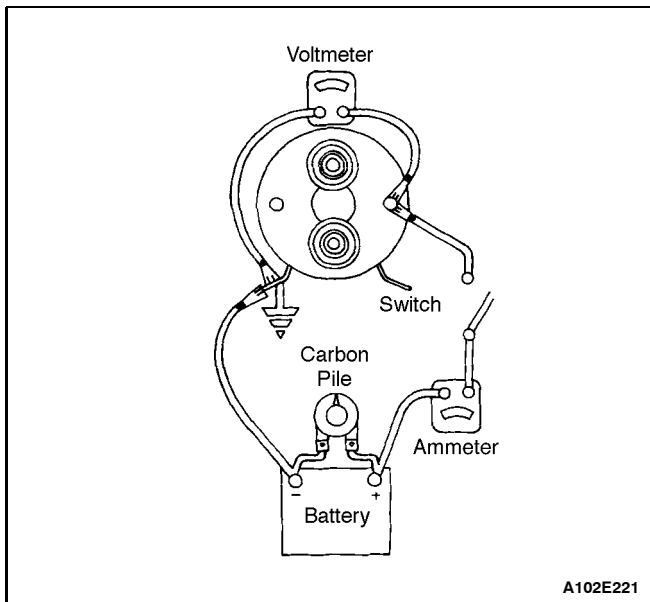
Important: If the solenoid is not removed from the starting motor, the connector strap terminals must be removed from the terminal on the solenoid before making these tests.

12. Test the solenoid windings by checking the current draw.

12.1 Check the hold-in windings by connecting an ammeter in series with a 12-volt battery, the switch terminal, and to ground.

12.2 Connect the carbon pile across the battery.

12.3 Adjust the voltage to 12.2 volts. The ammeter reading should be 12 to 21 amperes.



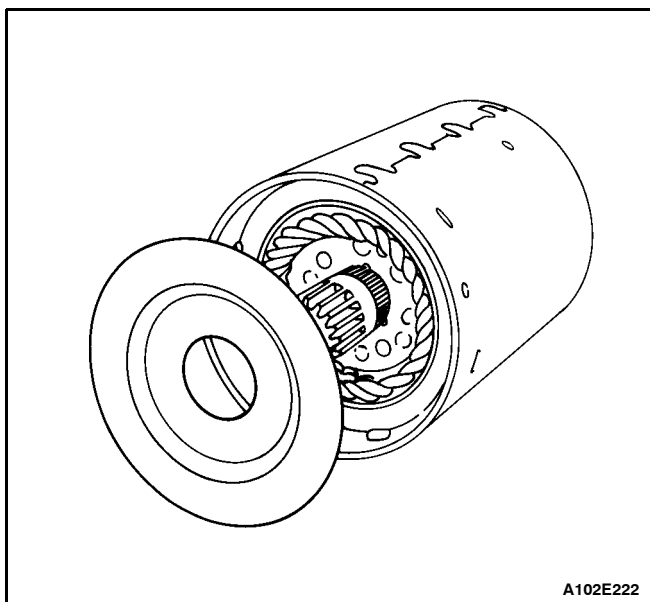
Important: Current will decrease as the windings heat up. Current draw readings that are over specifications indicate shorted turns or a ground in the windings of the solenoid. Both conditions require replacement of the solenoid. Current draw readings that are under specifications indicate excessive resistance. No reading indicates an open circuit.

13. Check both windings, connecting them according to the preceding test.

13.1 Ground the solenoid motor terminal.

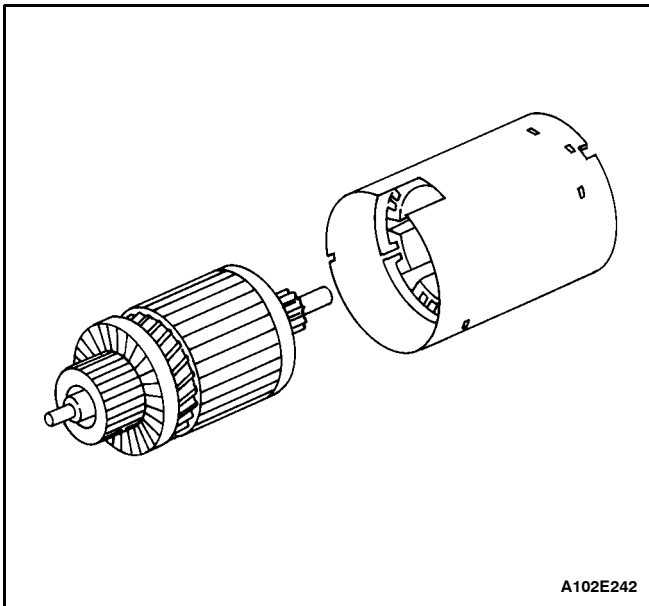
13.2 Adjust the voltage to 12.2 volts. The ammeter reading should be 60 to 90 amperes.

13.3 Check the connections and replace the solenoid, if necessary.

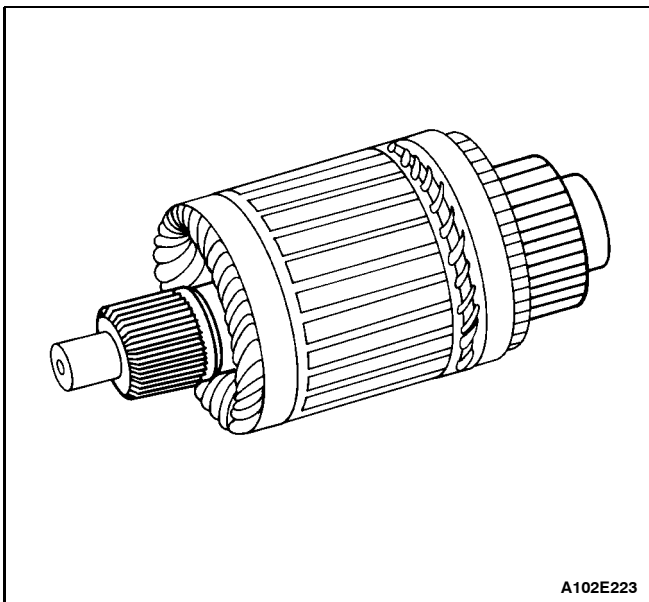


14. Slide the field frame with the enclosed armature assembly away from the starter assembly.

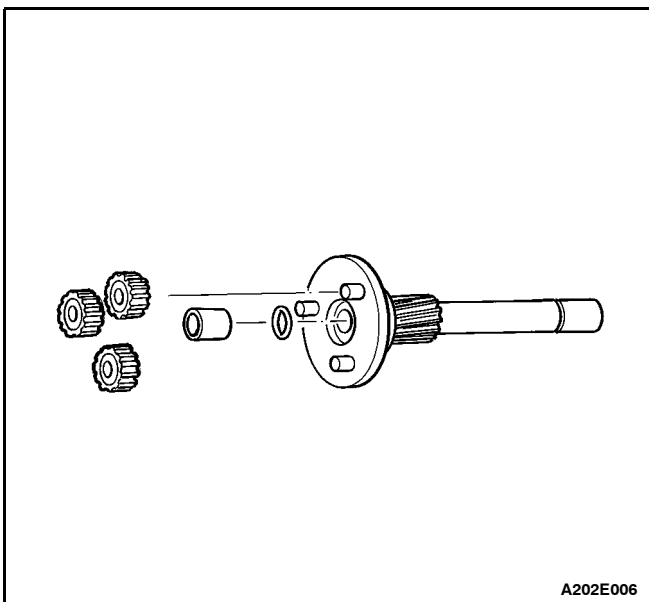
15. Remove the shield.



16. Separate the field frame from the armature.

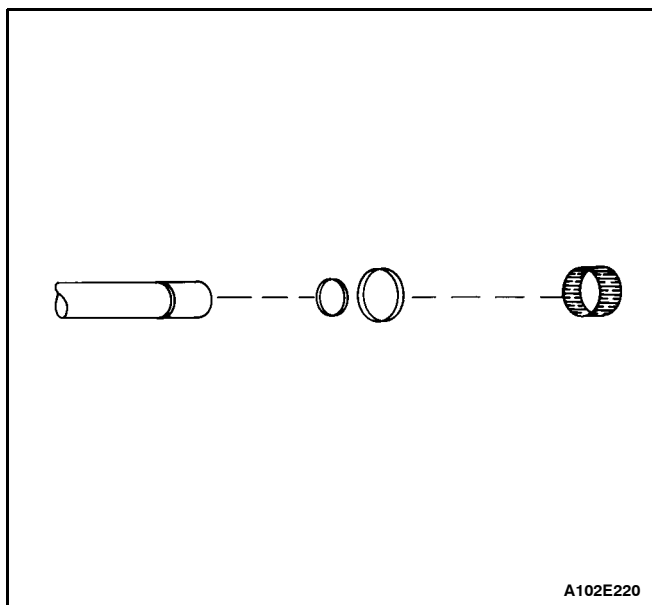


17. Inspect the shaft, the bearing, and the pinion for discoloration, damage, or wear. Replace, if necessary.
18. Inspect the armature commutator. If the commutator is rough, it should be turned down. The outside diameter of the commutator must measure at least 41.91 mm (1.650 inches) after it is undercut or turned. Do not turn out-of-round commutators.
19. 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.
20. If test equipment is available, check the armature for short circuits by placing it on a growler, and holding back a saw blade over the armature core while the armature is rotated. If the saw blade vibrates, replace the armature.
21. Recheck the armature after cleaning between the commutator bars. If the saw blade vibrates, replace the armature.



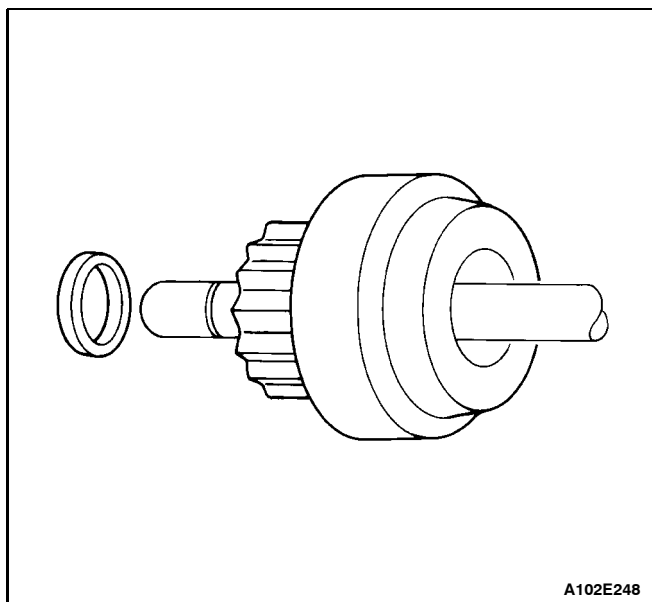
22. Remove the gears, the bushings, and the washer.
23. Remove the cushion and the driveshaft assembly from the starter housing.

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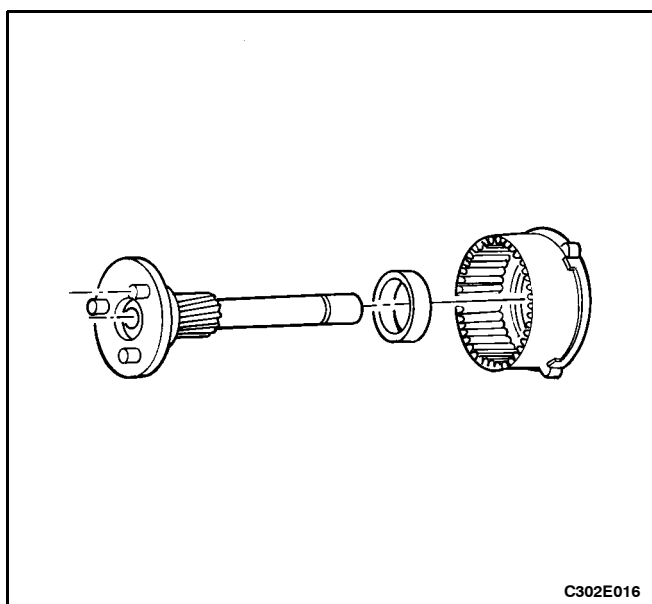


24. Disassemble the driveshaft assembly by first separating the needle bearing from the driveshaft.

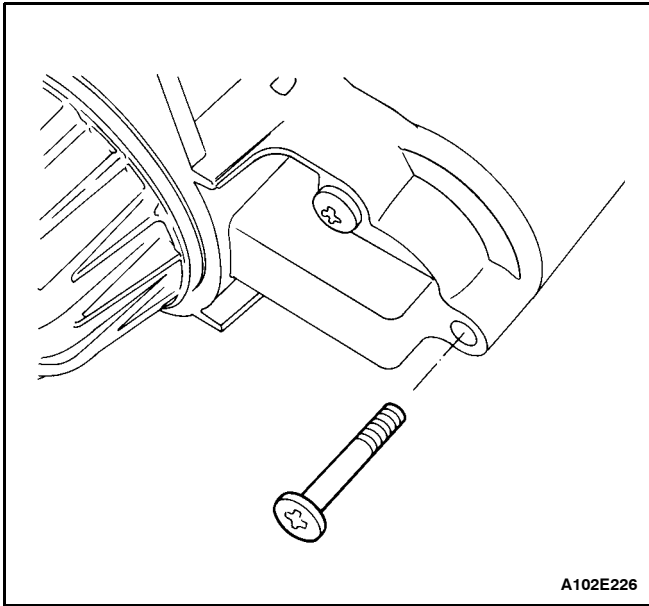
25. Remove the collar and the locking ring from the groove in the driveshaft.



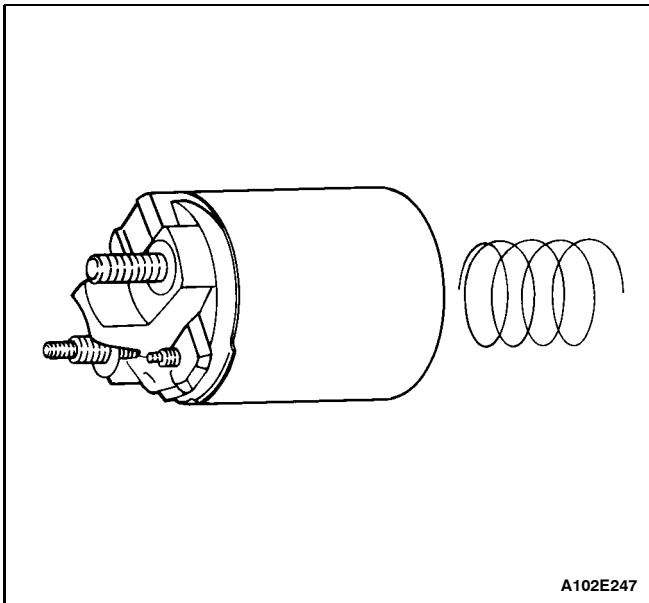
26. Remove the pinion stop and the drive from the driveshaft.



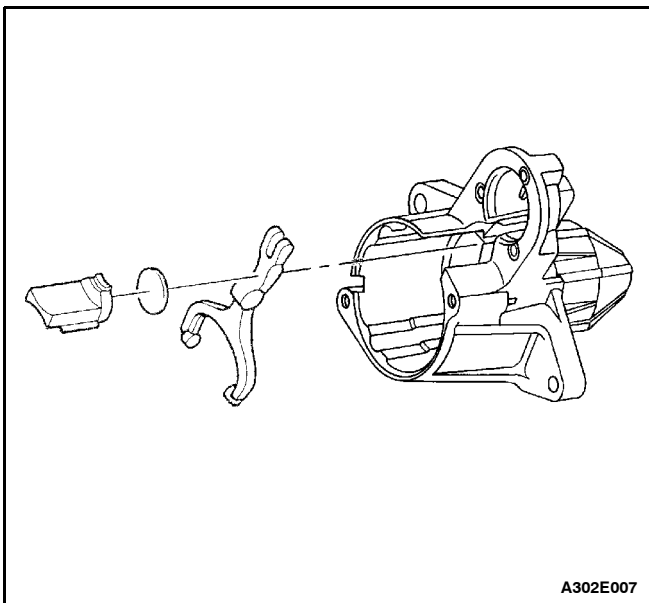
27. Remove the gear support and the collar from the driveshaft.



28. 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.

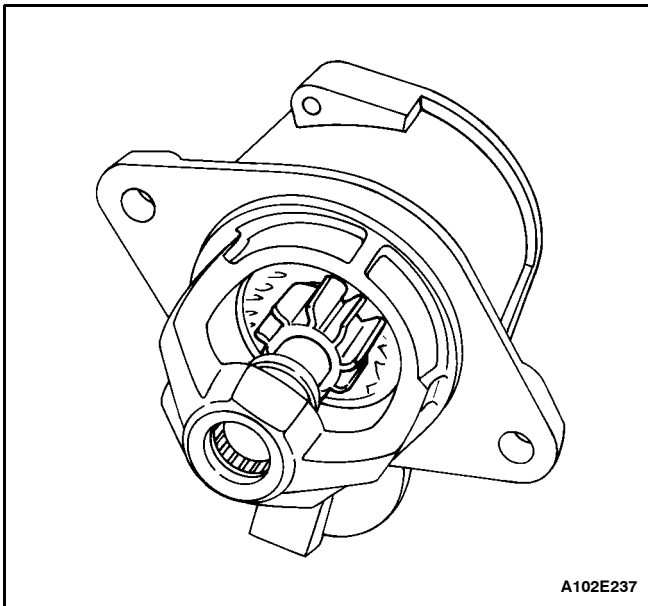


29. Rotate the solenoid 90 degrees and remove it along with the return spring.



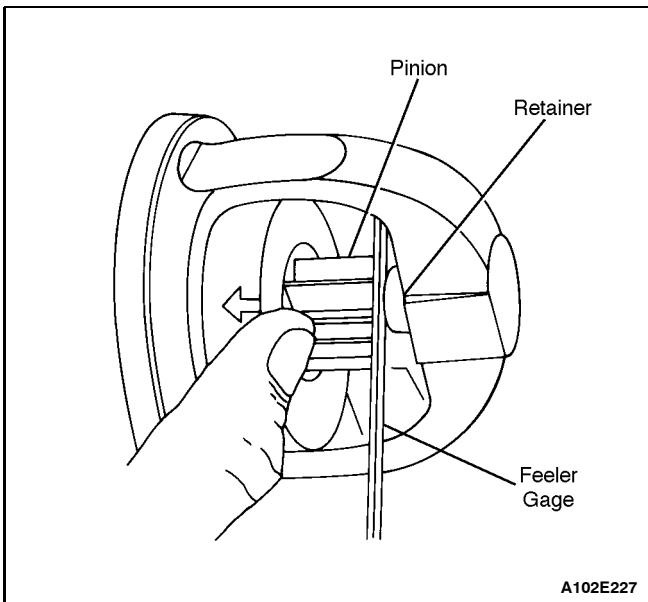
30. Remove the plunger with the boot and the shift lever assembly. Test the solenoid windings, if not done in Step 12.

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

31. When the starter motor is disassembled and the solenoid is replaced, it is necessary to check the pinion clearance when the starter is reassembled.



32. Disconnect the motor field coil connector from the solenoid motor terminal and carefully insulate the connector.

33. Connect one 12-volt battery lead to the solenoid switch terminal and the other to the starter frame.

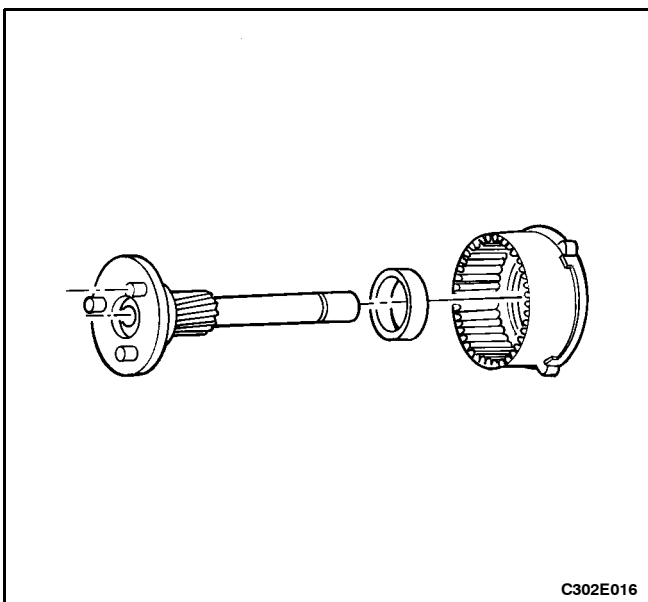
34. Flash a jumper lead momentarily from the solenoid motor terminal to the starter frame, allowing shifting of the pinion in the cranking position, where it will remain until the battery is disconnected.

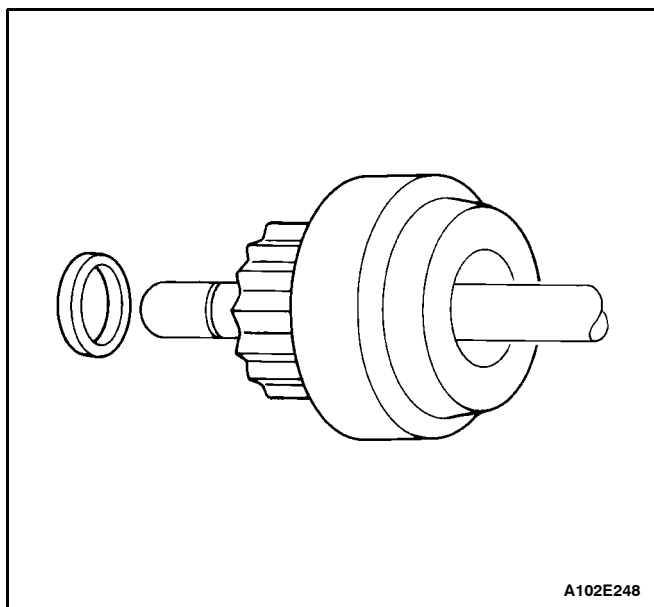
Important: A means for adjusting the pinion clearance is not provided on the starter motor. If the clearance does not fall within the limits, check for improper installation and replace all worn parts.

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

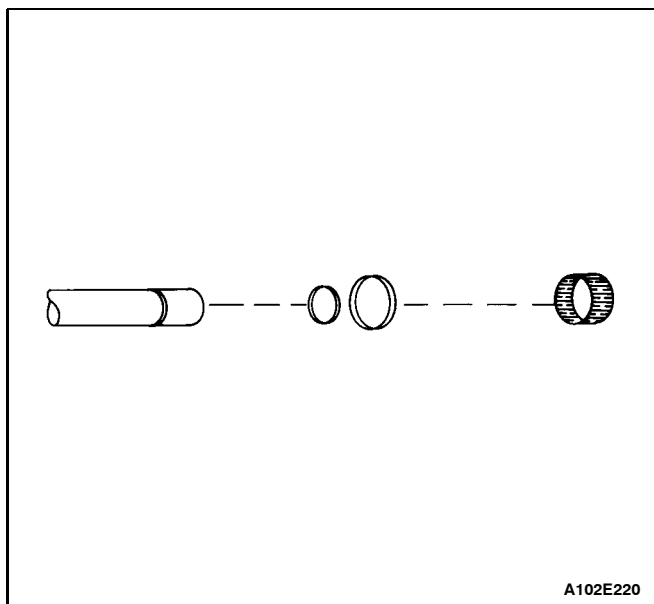
Assembly Procedure

1. Clean all of the starter motor parts, but 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 and the collar on the driveshaft assembly.



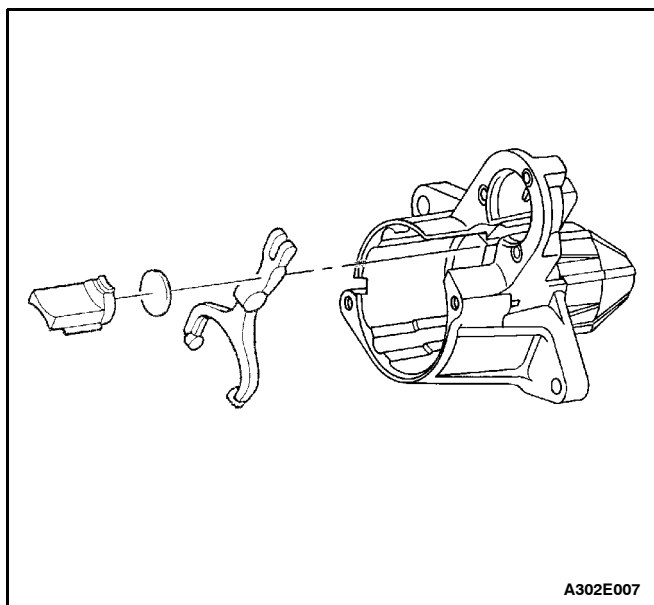


4. Install the drive and the pinion stop on the driveshaft.



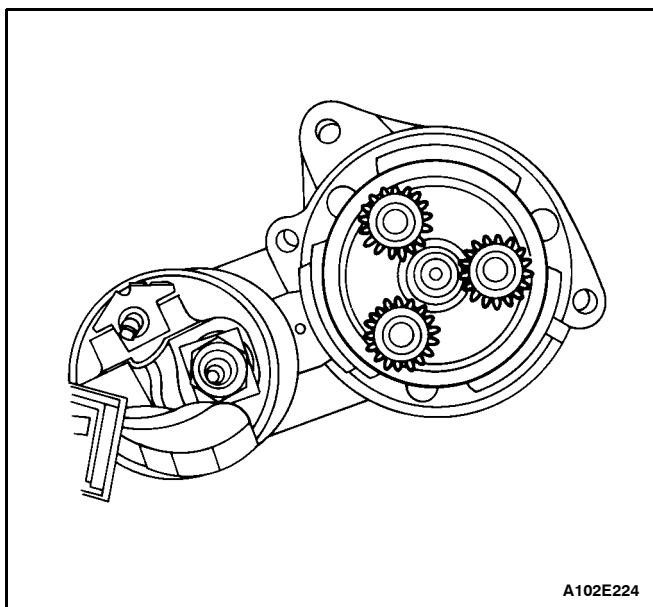
5. Install the lock ring into the groove on the driveshaft and insert the collar.

6. Install the needle bearing.



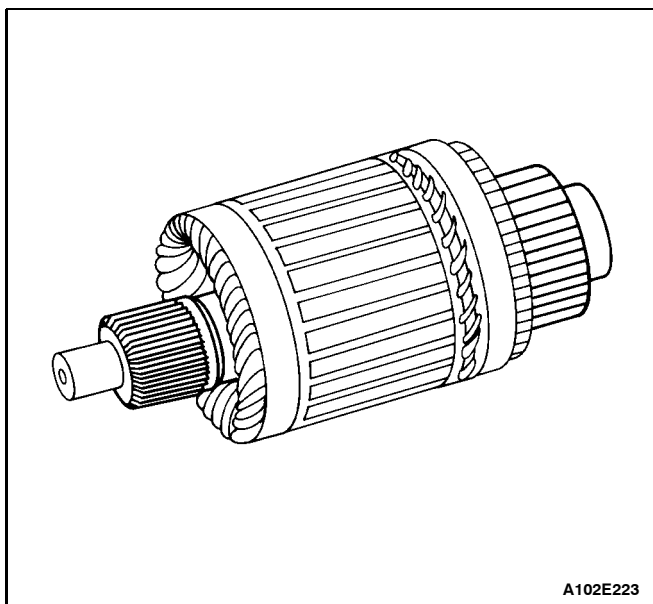
7. Install the shift lever assembly with the plunger and the boot.

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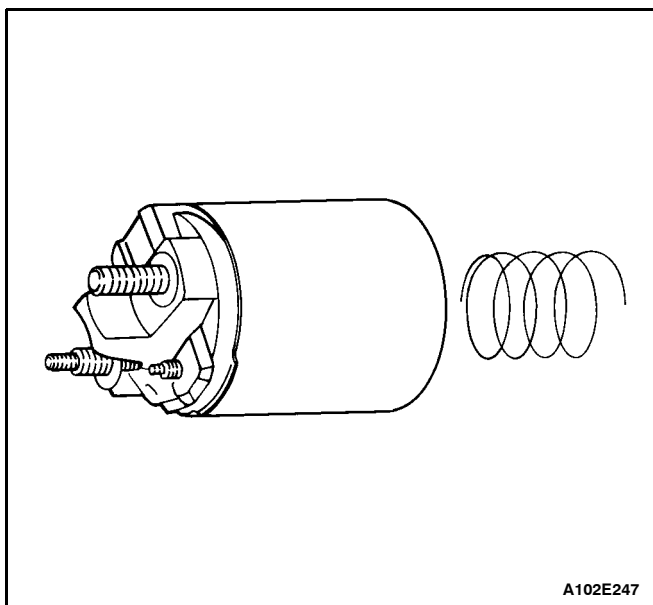


8. Lubricate the gears with lubricant and install the driveshaft assembly with the bushing and the washer on the gear end.

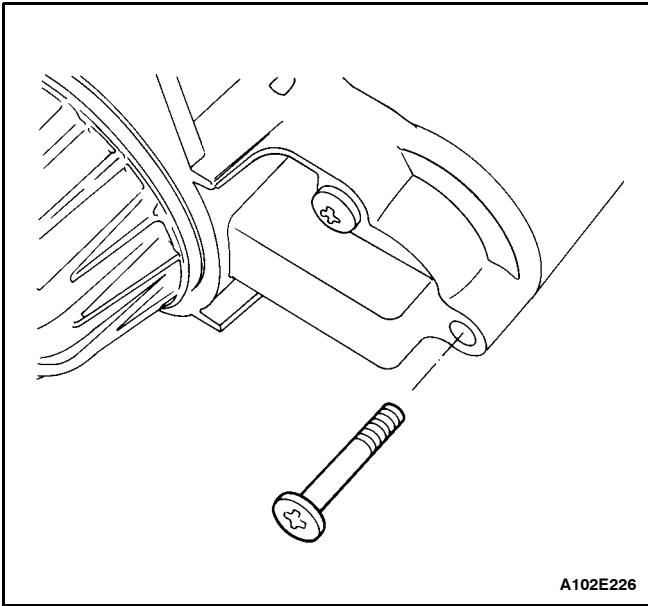
9. Install the cushion and the gears.



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, applying sealer to the solenoid flange.



12. Fasten the solenoid assembly with the screws.

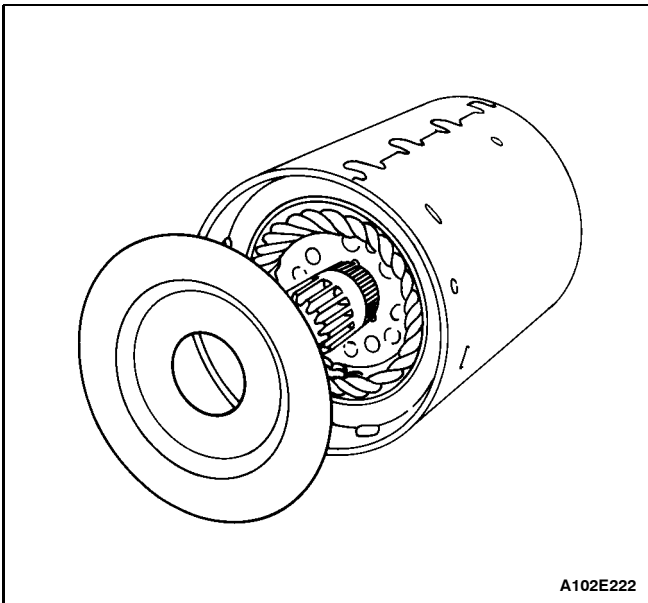
Tighten

Tighten the starter solenoid assembly screws to 8 NSm (71 lb-in).

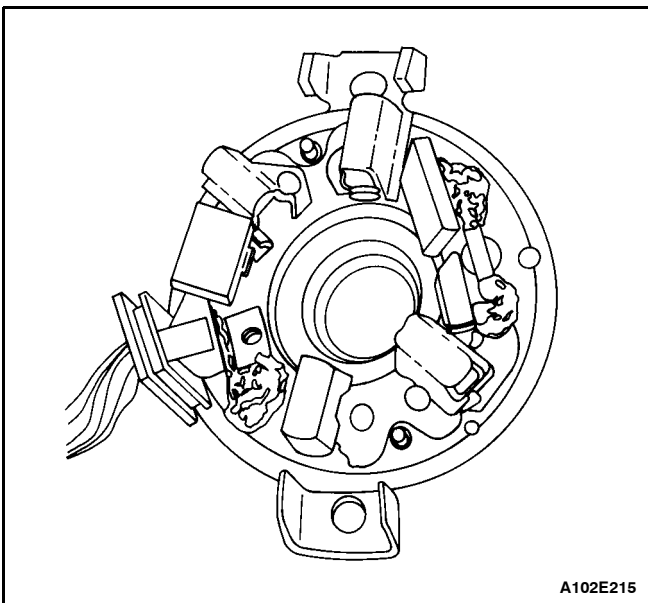
13. Install the field coil connection to the starter terminal. Install the nut.

Tighten

Tighten the starter field connector nut to 8 NSm (71 lb-in).

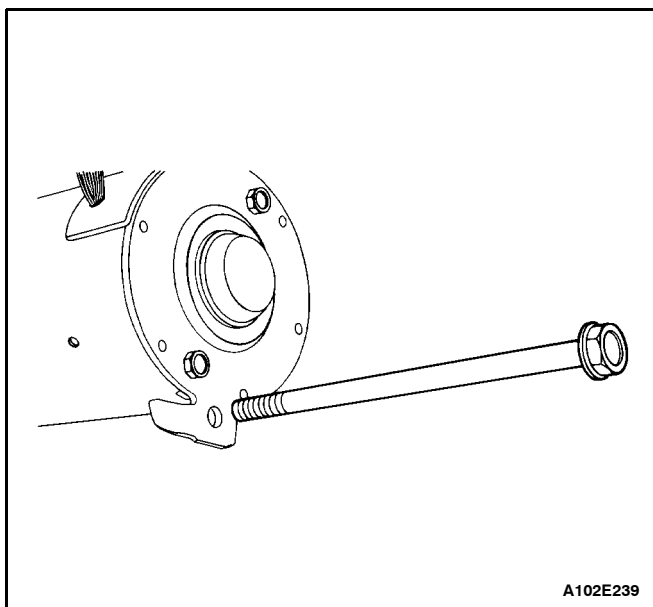


14. Position the armature assembly into the field frame.
15. Place the shield on the armature and the field frame assembly.
16. Install the armature and the field frame assembly with the shield into the starter housing.



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

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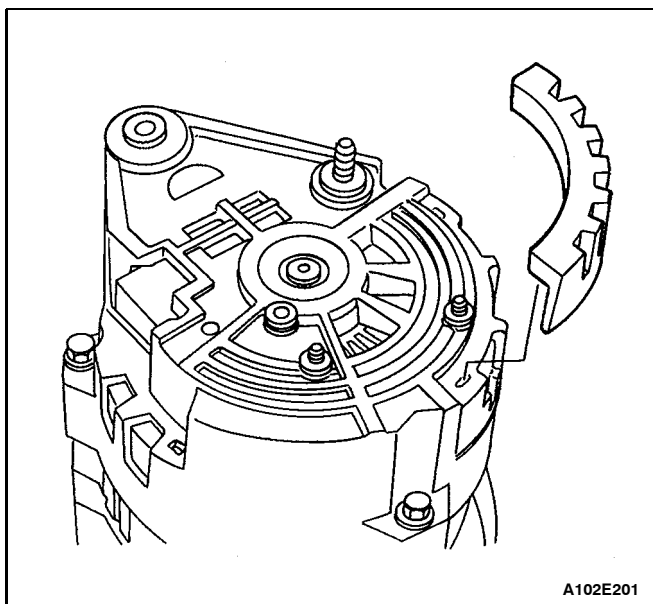
18. Install the starter through-bolts.

19. Install the starter. Refer to "Starter" in this section.

Tighten

Tighten the starter through-bolts to 6 Nsm (53 lb-in).

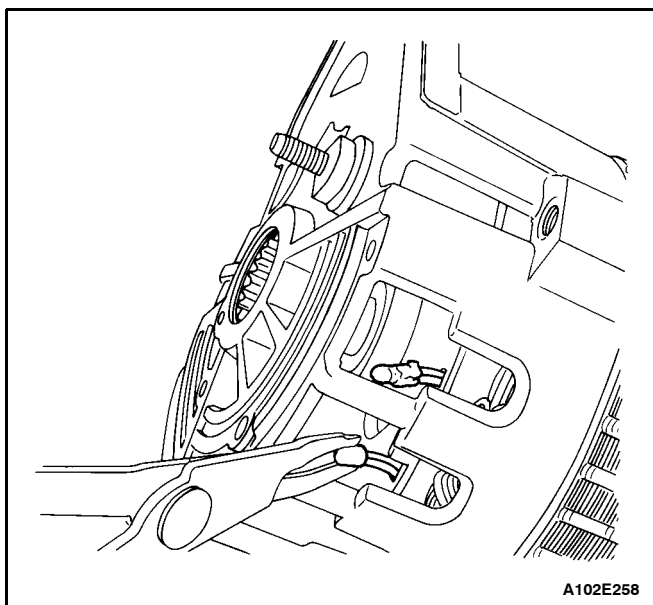
20. Refer to "Starter" in this section.



GENERATOR (C5-121D)

Disassembly Procedure

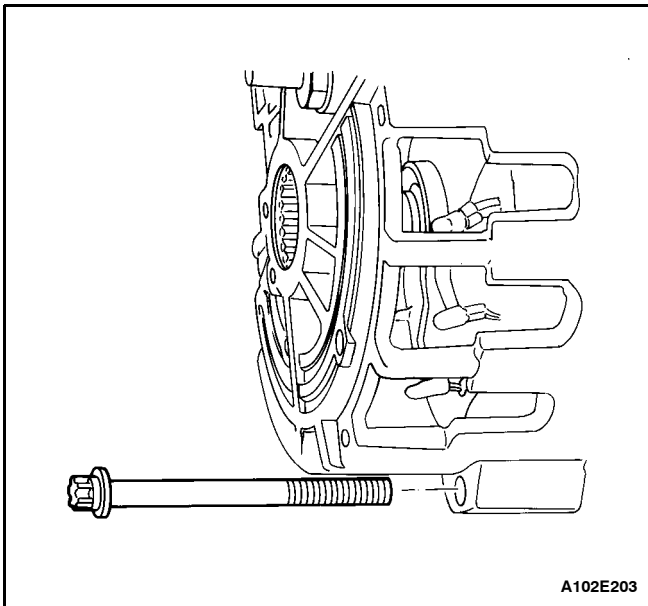
1. Remove the generator. Refer to "Generator" in the On-Vehicle Service section.
2. Mark a match line that cannot easily be removed on the end frame to make assembly easier.
3. Pry off the plastic cover to expose the stator connections.



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

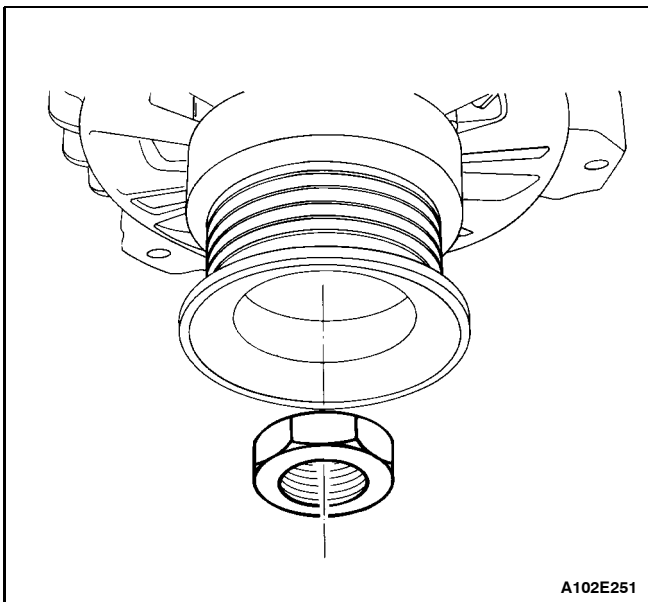
4. Remove the stator connections from the rectifier bridge terminals by unsoldering or cutting the wires.

- 5. Remove the generator through-bolts.**

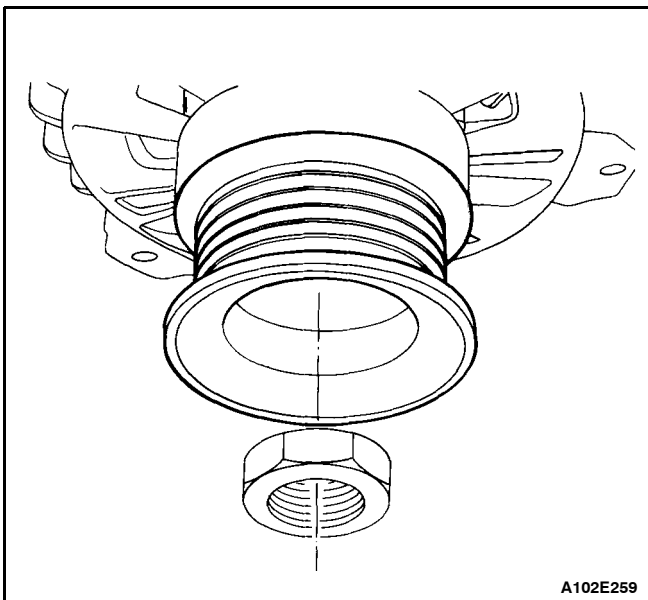


Important: The fastening torque of this nut is 81 NSm (60 lb-ft) and may not normally be unfastened using hand strength.

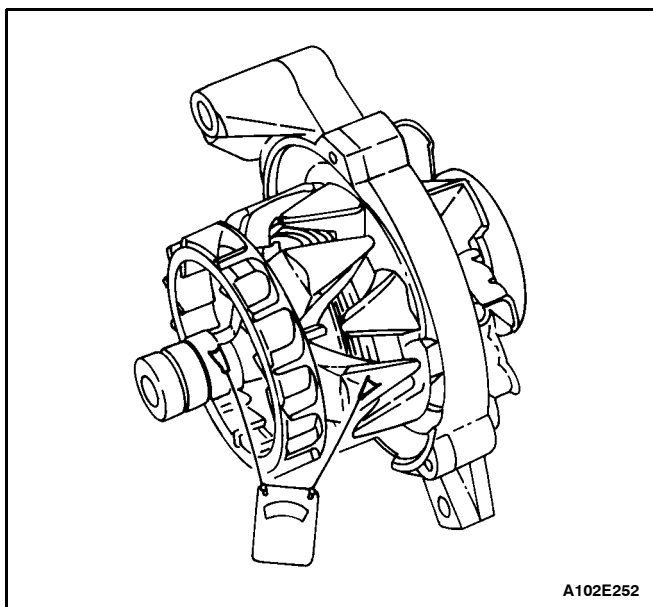
- 6. Move to the drive end of the generator and remove the drive end bearing nut.**



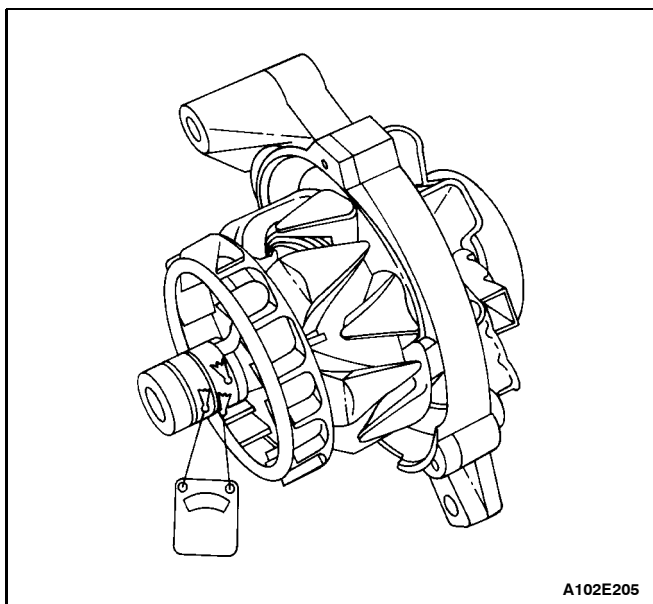
- 7. Remove the pulley and the collars.**



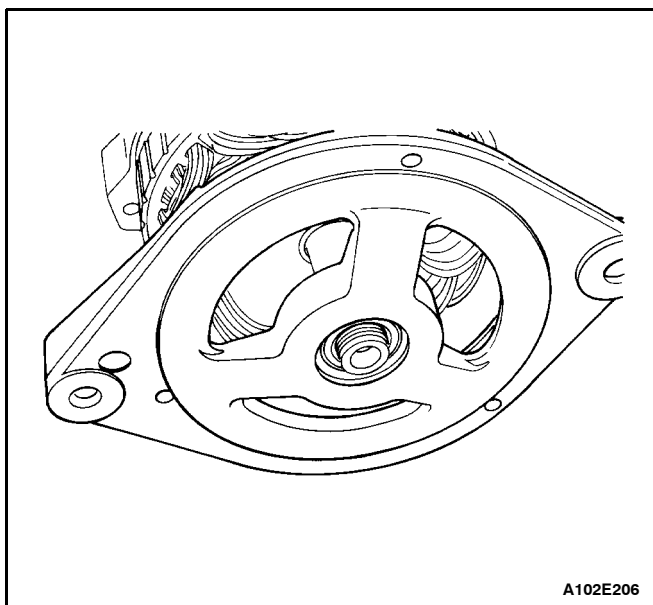
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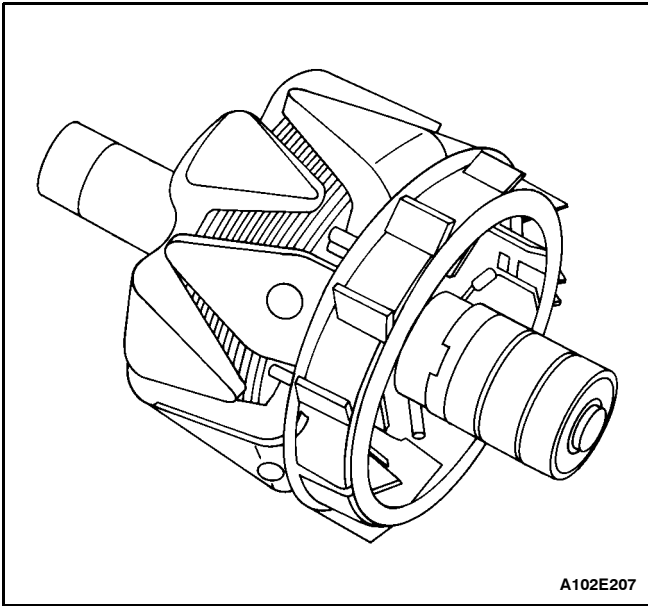
8. Test the rotor for an open circuit by using the ohmmeter with the drive end frame assembled. The reading should be sufficiently high, or the rotor must be replaced.



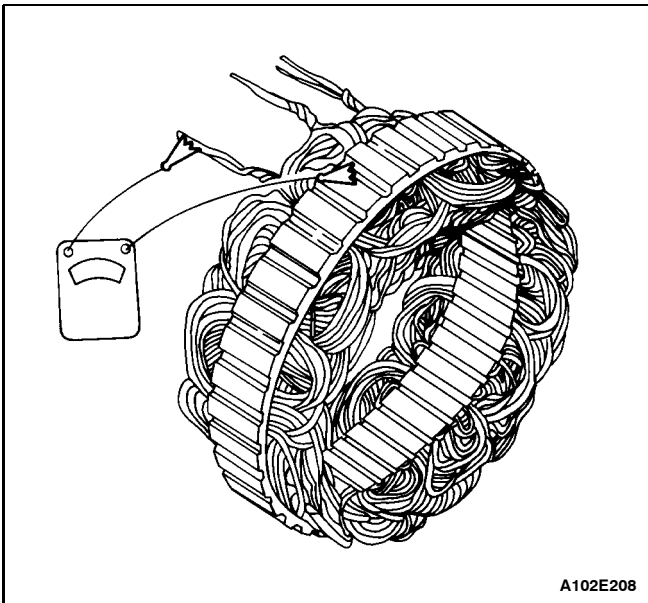
9. Test the rotor for open and short circuits. The reading should be 1.7 to 2.3 ohms, or the rotor should be replaced.



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.

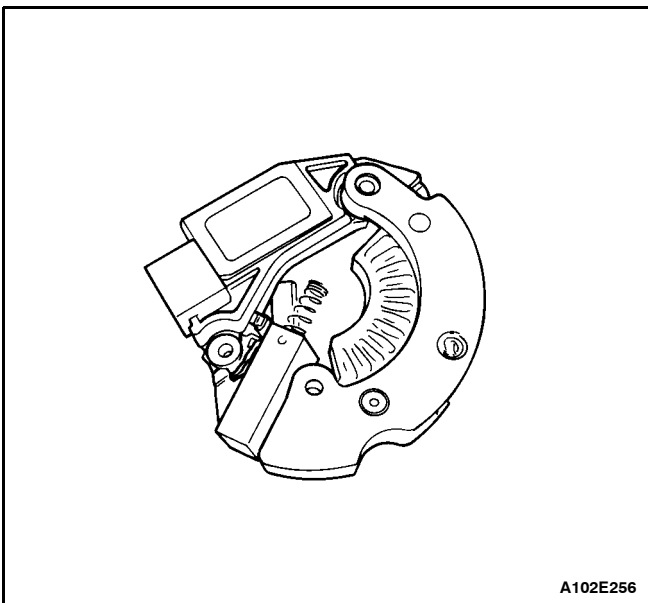


12. Remove the rotor assembly.



13. Remove the stator.

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



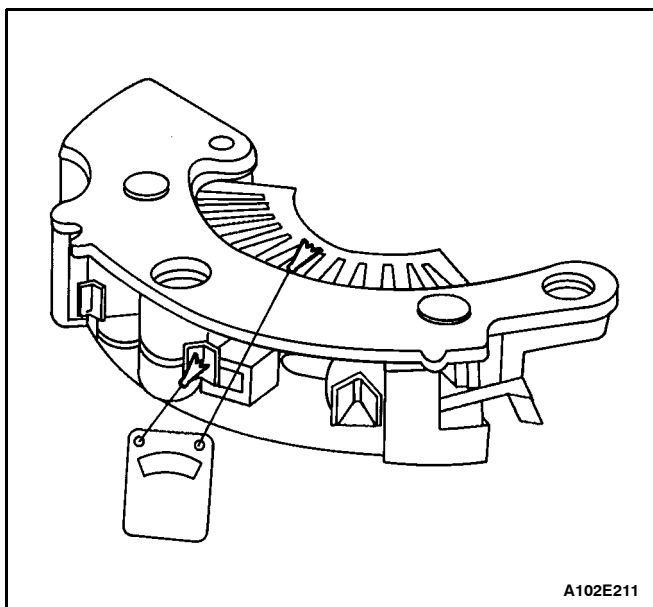
15. Pry off the baffle.

16. Remove the rectifier/regulator/brush holder assembly screws.

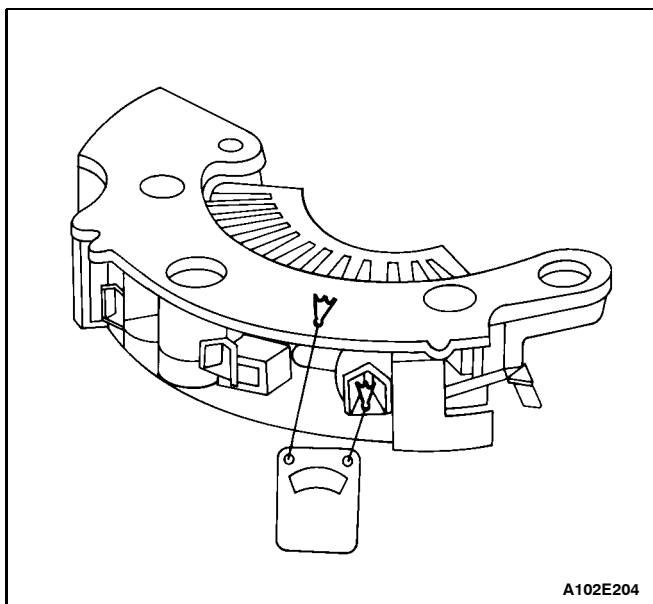
17. Remove the brush holder assembly and the regulator, cutting the terminal between the regulator and the rectifier bridge.

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.

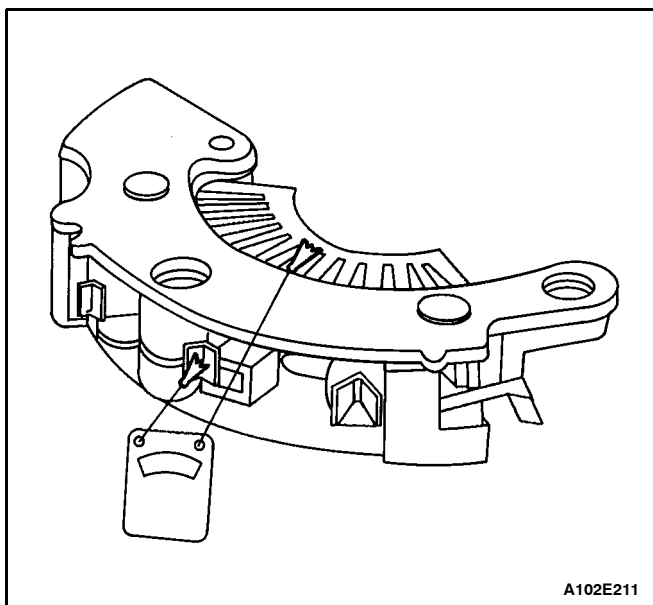
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18. Test the rectifier bridge by connecting the ohmmeter terminals to the bridge and the heat sink.



19. Retest by connecting the ohmmeter terminals in reverse.



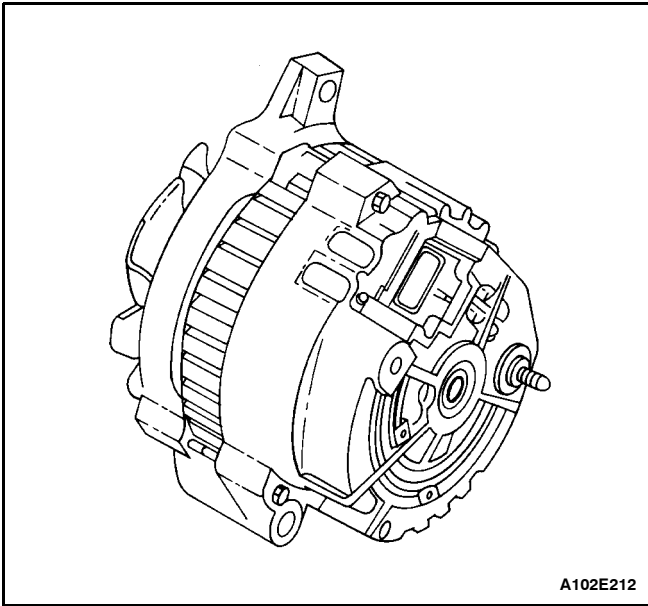
20. Replace the rectifier bridge, if each reading is the same.

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

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

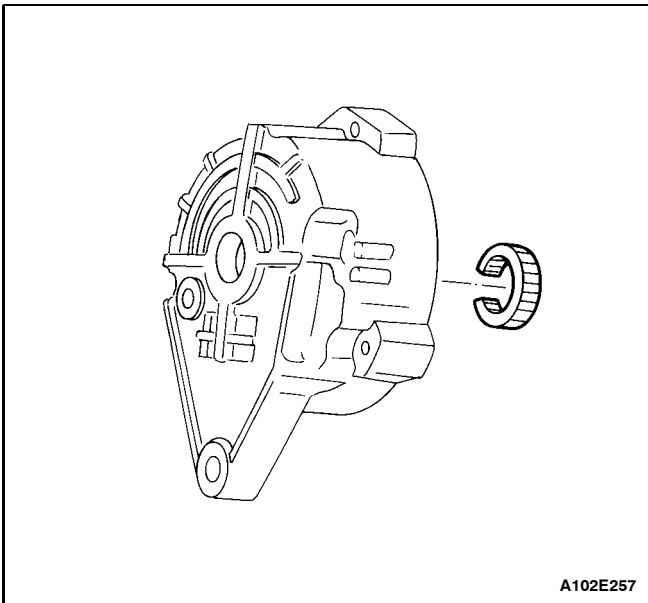
22. Test the diodes by connecting the ohmmeter terminals to the bridge terminal and the base plate. If the reading is the same, the rectifier bridge should be replaced.

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

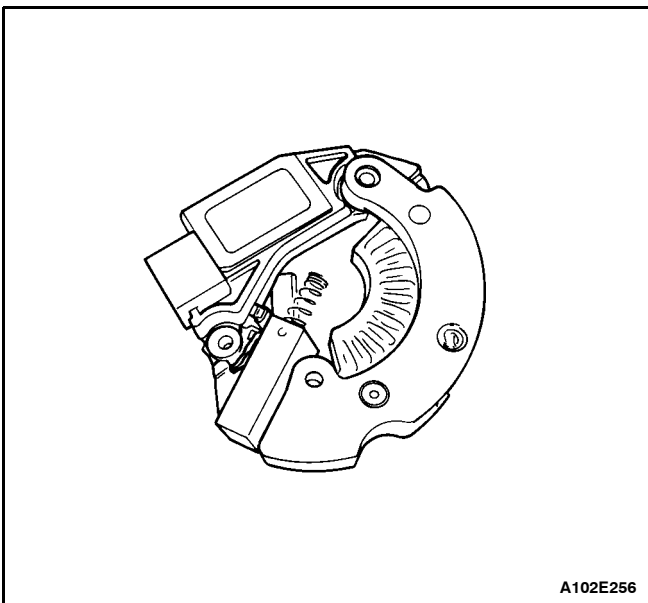


Assembly Procedure

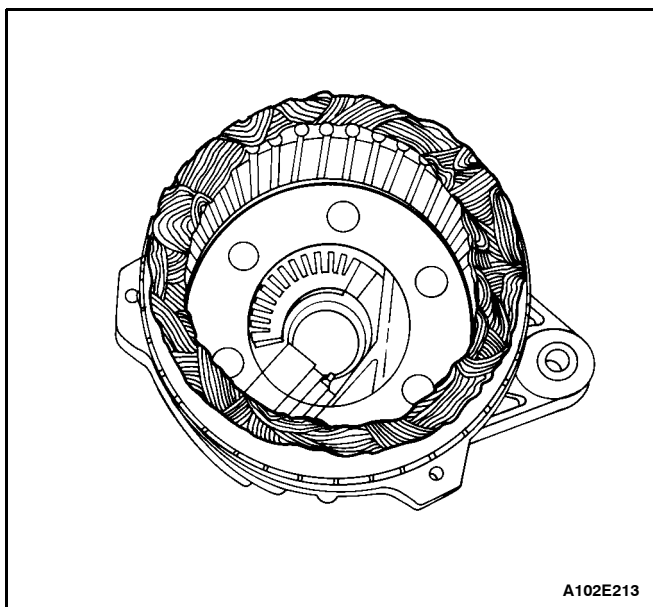
1. Install the new ring in the slip ring end frame.
2. Push the new bearing outer race into the bottom of the end frame casting.



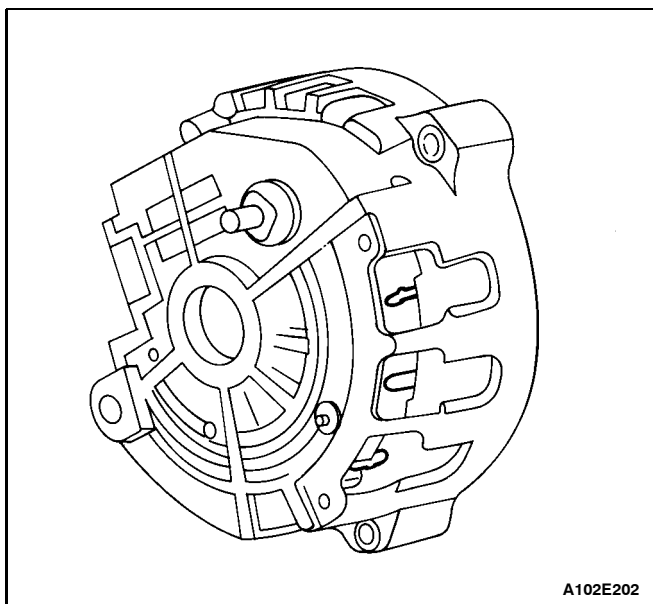
3. Solder the brush holder terminal to the regulator terminal, if removed.
4. Fix the brush holder with the retainer pin, and solder the regulator/brush holder assembled terminal to the rectifier terminal.
5. Apply silicone grease between the bridge and the end frame for radiation purposes.
6. Fasten the screws holding the rectifier regulator/brush holder assembly to the end frame.
7. Punch the new baffle with the pin into the brush.



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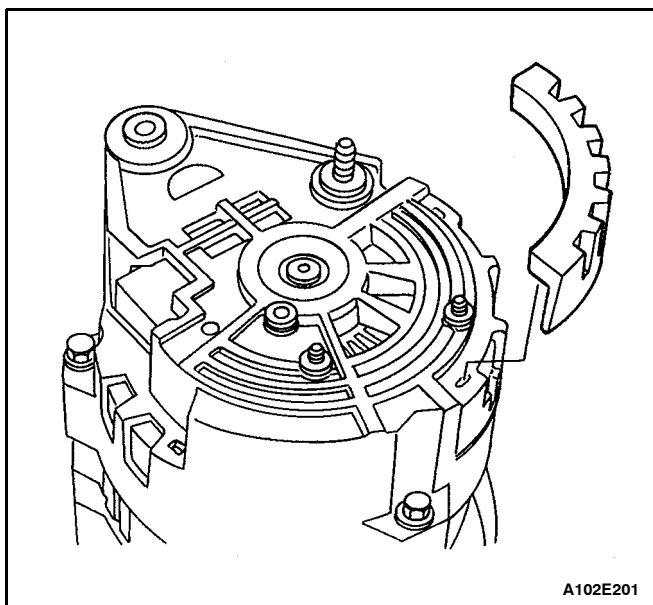


8. Install the stator.

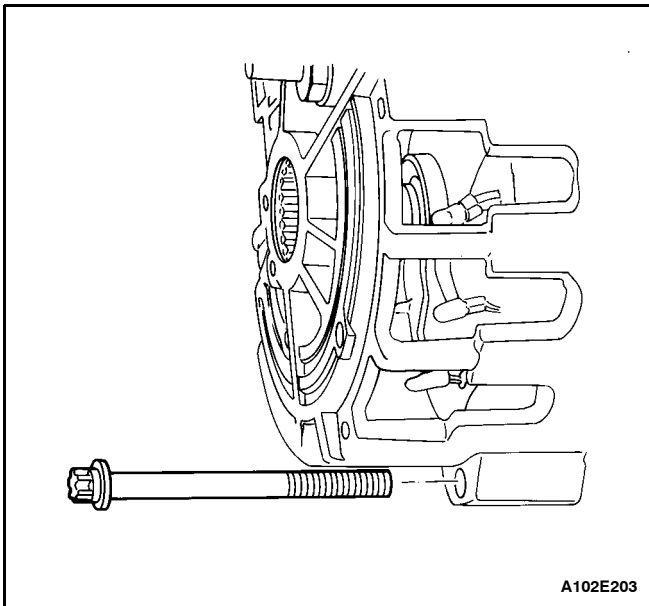


Notice: Take care to prevent damage to the vehicle by protecting the diode in the rectifier bridge from excessive heat while soldering or welding.

9. Solder or weld the connectors of the rectifier bridge.



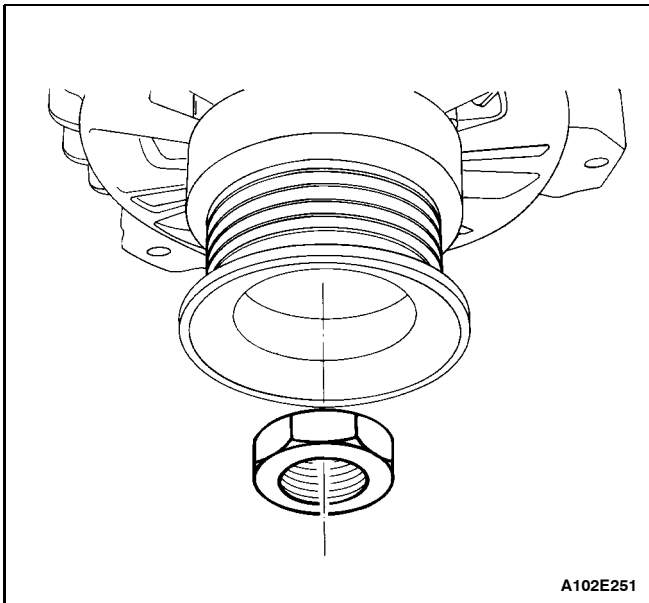
10. Install the outside cover.



11. Position the rotor assembly shaft with the drive end frame in the slip ring end assembly until the gap between the outer lace 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 NSm (89 lb-in).

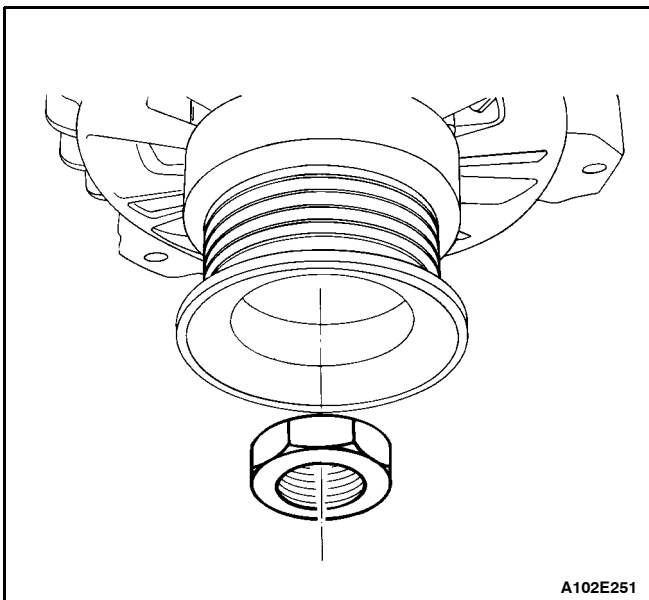


13. Position the fan, the collars, and the pulley on the rotor shaft and secure with the nut.

Tighten

Tighten the generator drive end bearing nut to 81 NSm (60 lb-ft).

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

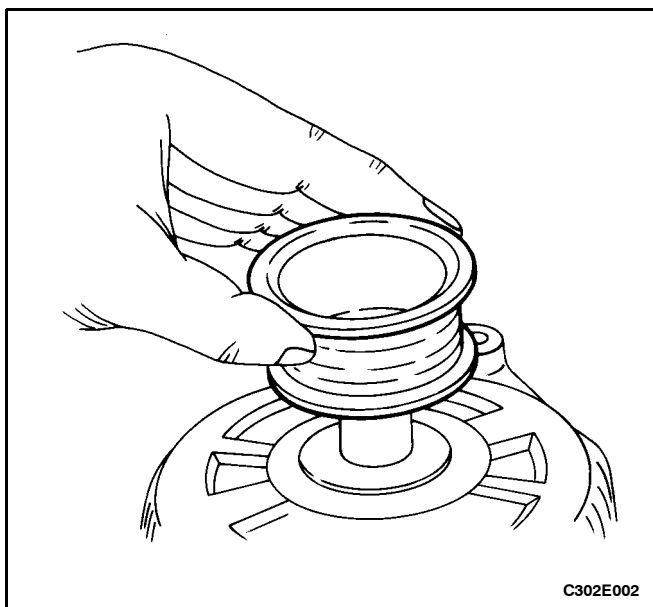


GENERATOR (CS-128D)

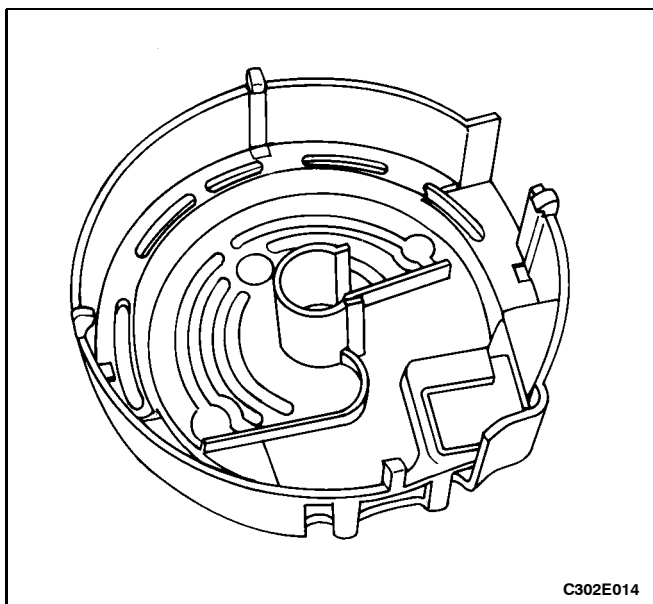
Disassembly Procedure

1. Remove the generator. Refer to "Generator" in this section.
2. Remove the driveshaft nut.

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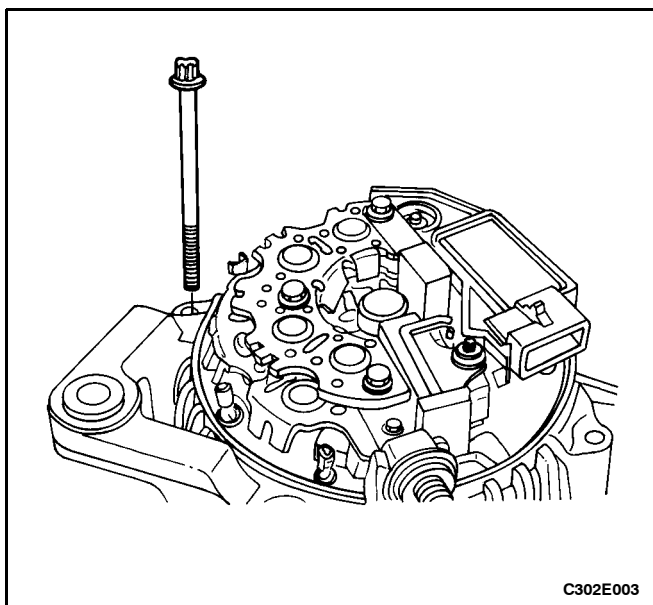


3. Remove the pulley and the collar from the driveshaft.

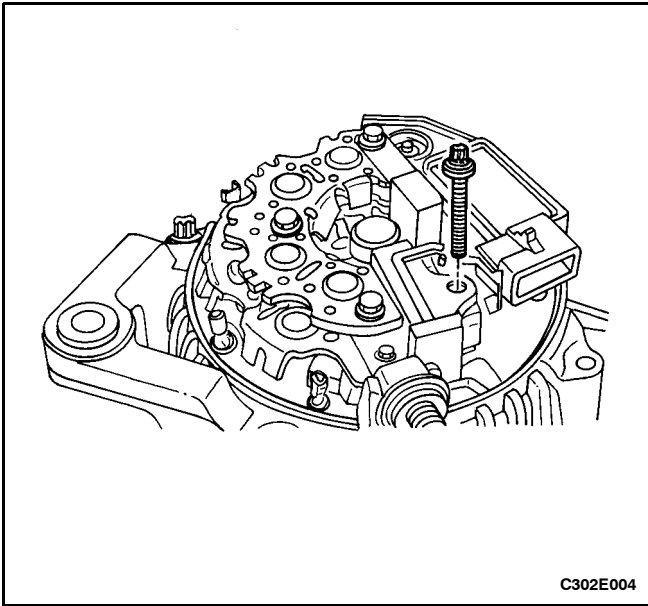


4. Pry off the plastic cover that encloses the rectifier and the regulator/brush holder assemblies.

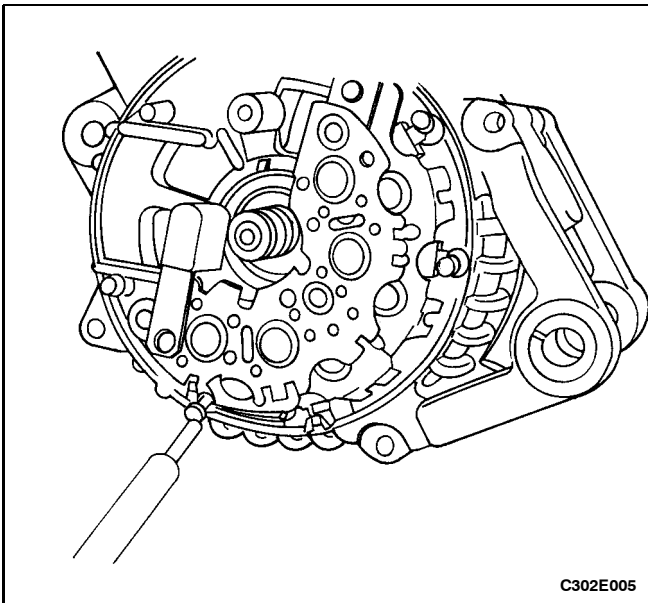
5. Inspect the cover for damage.



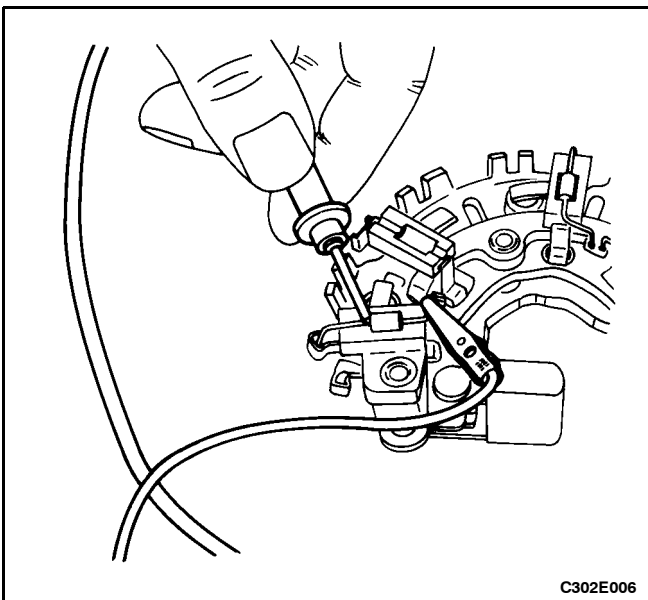
6. Remove the generator through-bolts.



7. Remove the bolts that fasten the rectifier assembly and the regulator assembly to the slip ring end frame.

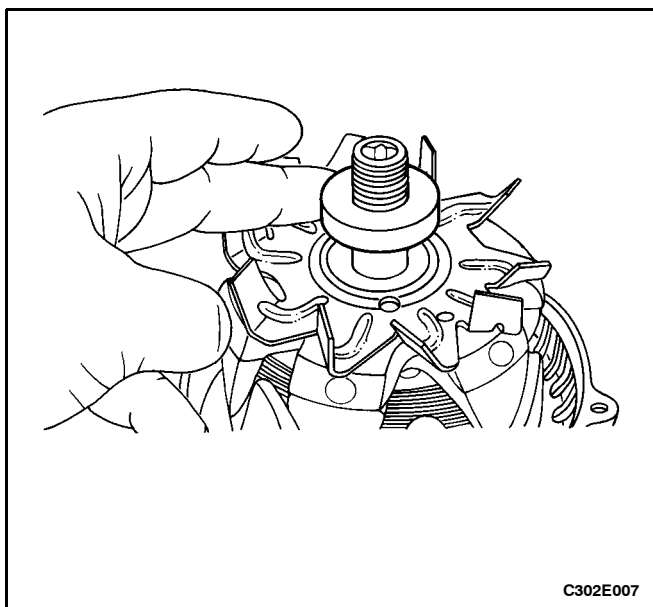


8. To remove the regulator/brush holder and the rectifier assemblies, first melt the solder of the lead that connects the regulator/brush holder assembly to the rectifier assembly. Then melt the lead to the stator, followed by the other rectifier assembly leads to the stator (as shown).

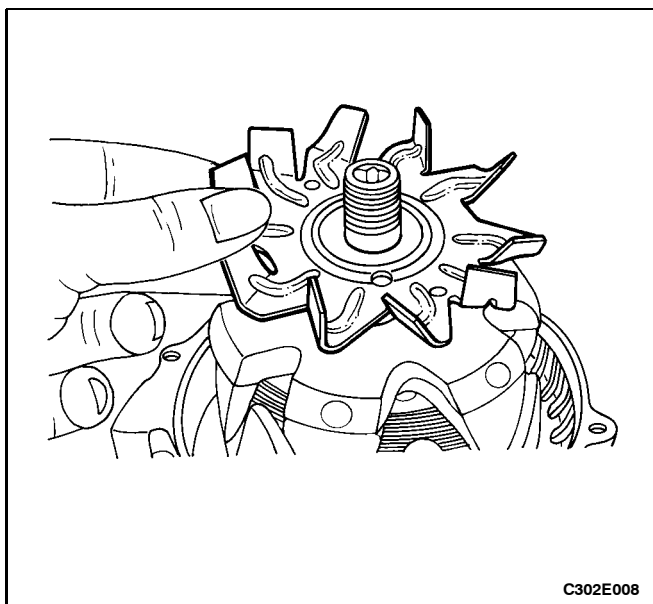


9. Test each of the three diodes of the rectifier assembly for continuity. Connect the ohmmeter probes on each side of the diode. Retest by connecting the ohmmeter probes in reverse. If the readings are the same, replace the rectifier.

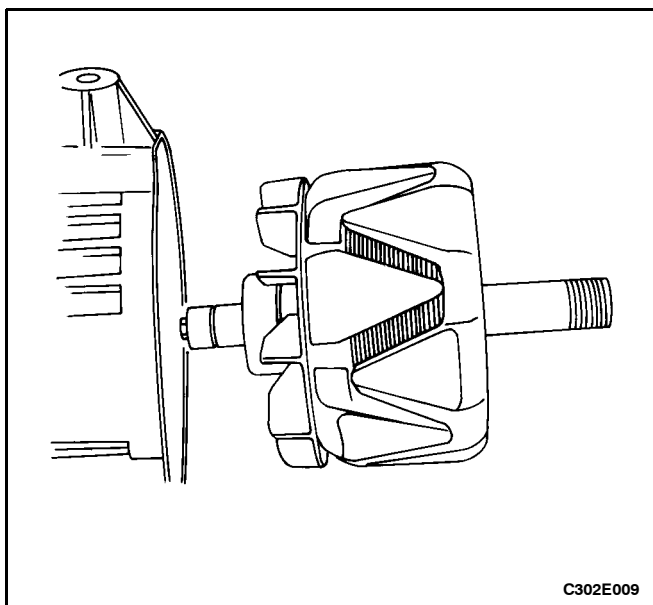
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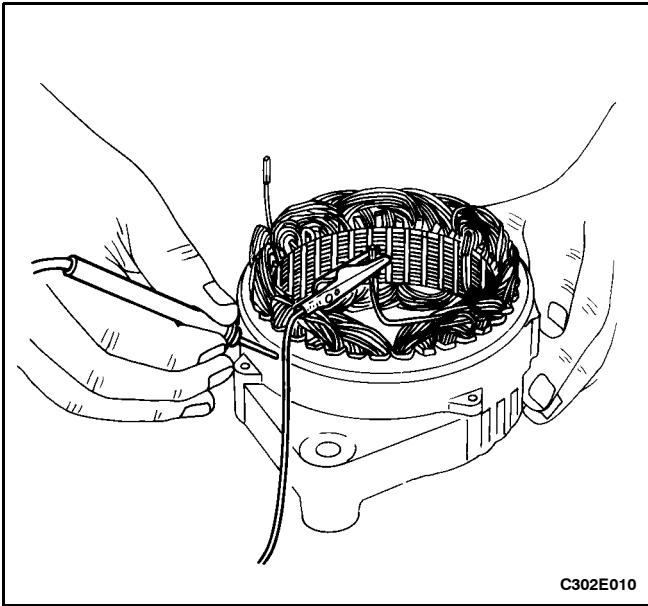
10. Mark a line perpendicular to the crack between the case of the drive end frame and that of the slip ring end frame.
11. Pry open the drive end frame from the slip ring end frame.
12. Remove the collar.



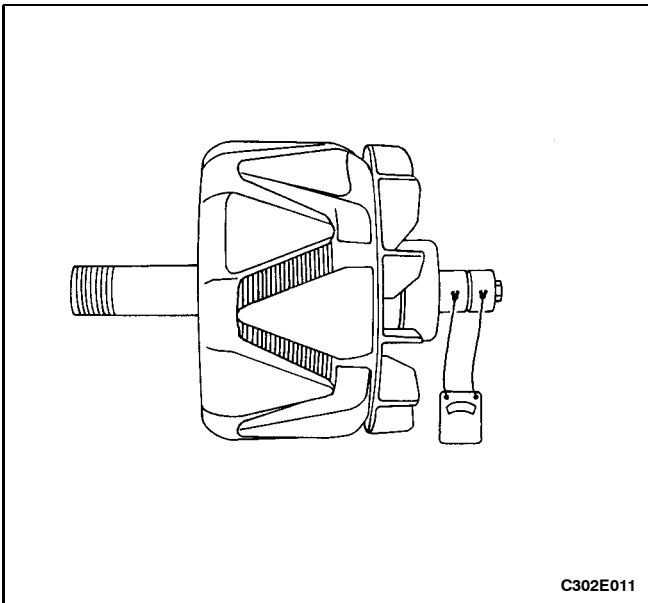
13. Remove the fan.



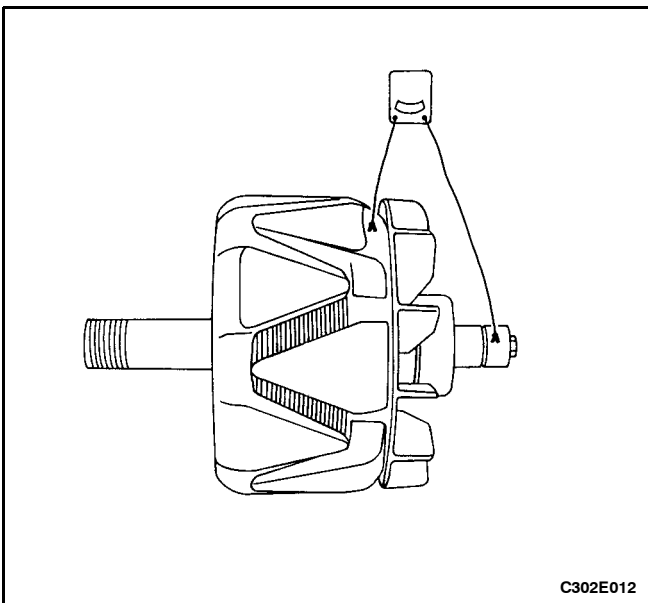
14. Separate the rotor from the slip ring end frame.



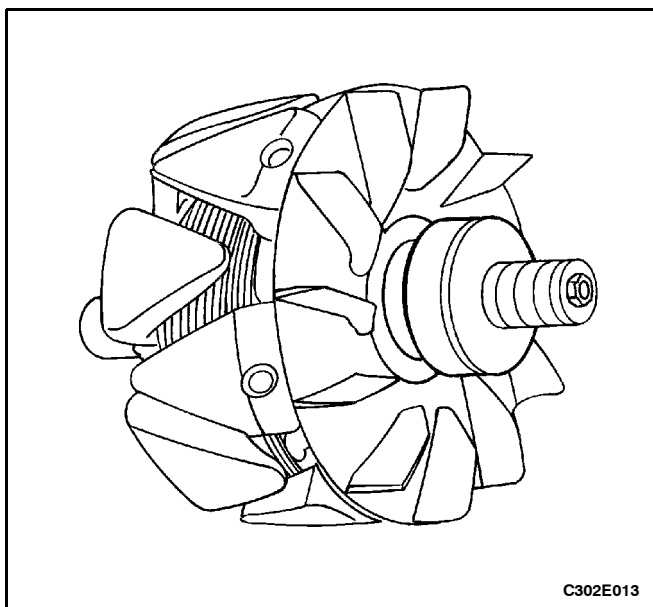
15. Using an ohmmeter, test the stator for ground. If the reading is low, replace the stator.
16. Check the stator for an open circuit by placing the probes on two terminals. If the reading is high (infinite), replace the stator.



17. Using an ohmmeter, test the rotor for an open circuit. Check for continuity between the slip rings. Standard resistance (cold) is 2.8 to 3.0 ohms. If there is no continuity, replace the rotor.

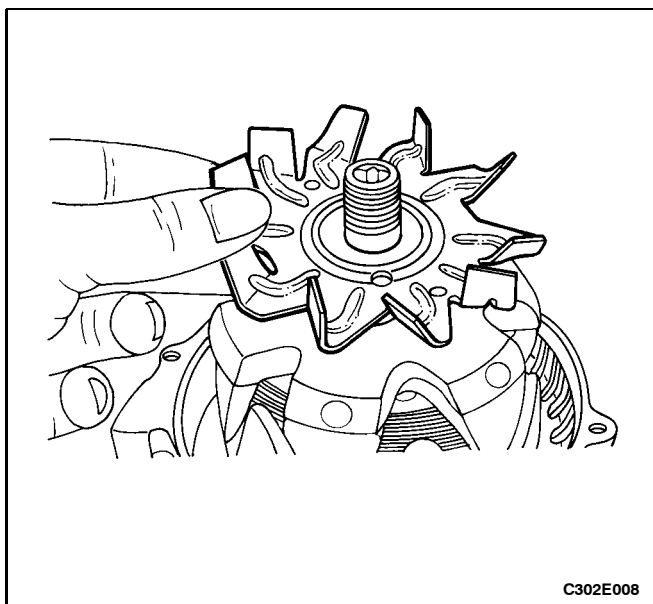


18. Using an ohmmeter, inspect the rotor for ground. Check for continuity between the rotor and the slip ring. If there is no continuity between the rotor and the slip ring, replace the rotor.

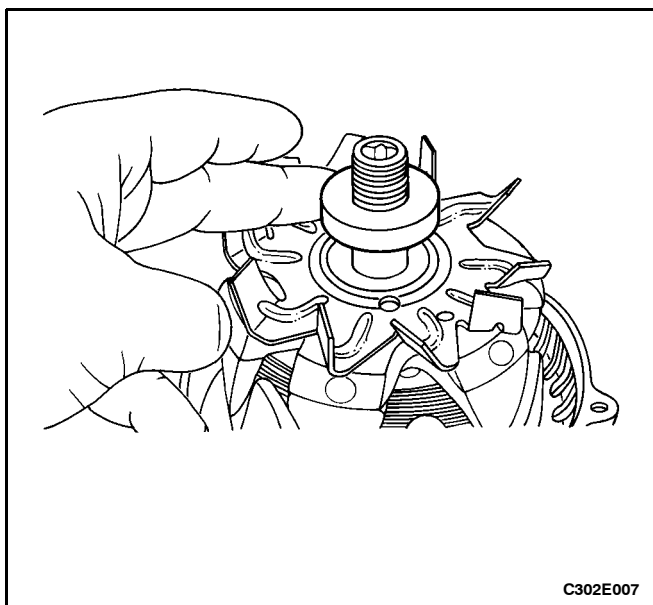


Assembly Procedure

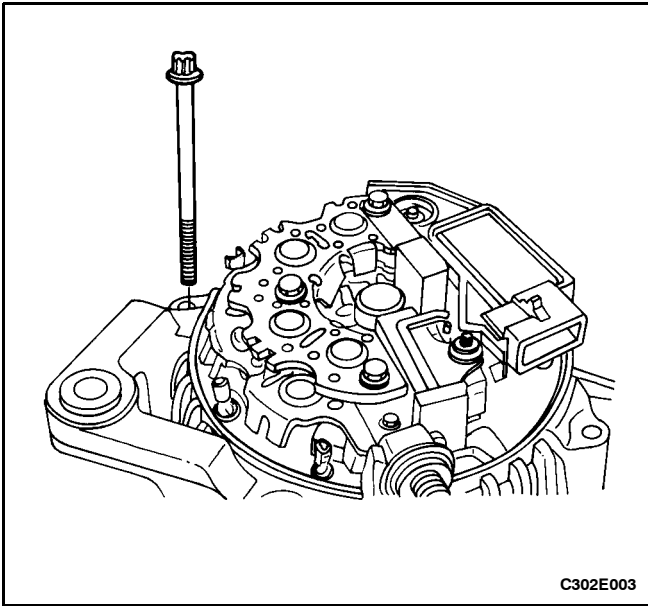
1. Check the bearing on the fan side of the rotor assembly. Replace the bearing if it is rough or worn, especially if the generator is diagnosed as having a noisy bearing with the vehicle running.
2. If required, install a new bearing and insert the bearing retainer on the rotor assembly shaft.



3. Press the rotor assembly onto the end frame.
4. Install the fan on the rotor shaft.



5. Install the collar.

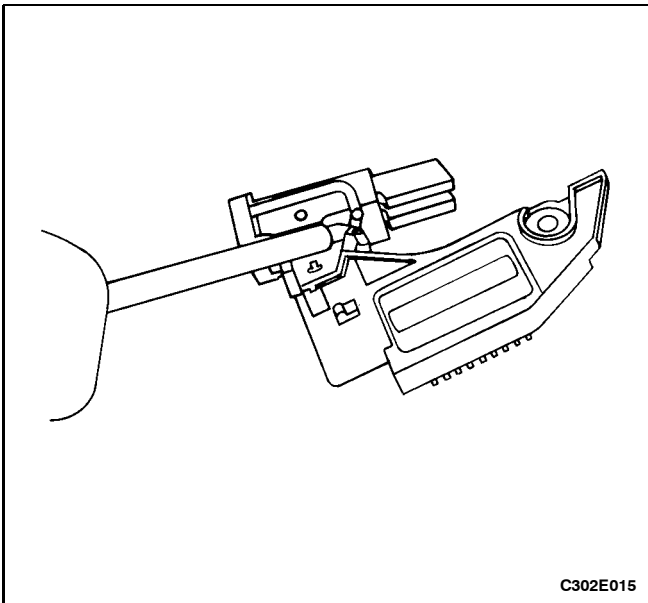


6. Install the slip ring end frame assembly by lining up the terminal ends of the stator with the end frame cover holes, and then lining up the marks that were made on the drive end frame case and the slip ring end frame case before the two cases were separated.

7. Install the generator through-bolts.

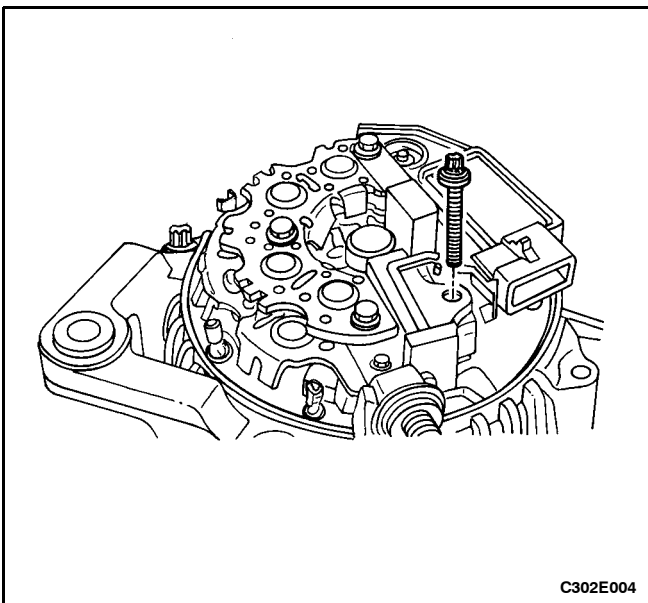
Tighten

Tighten the generator through-bolts to 25 N \cdot m (18 lb-ft).



8. Install the rectifier assembly by first soldering its terminals to the stator terminal ends.

9. If the brushes are worn, solder the terminal of the new brush holder assembly to the regulator assembly.



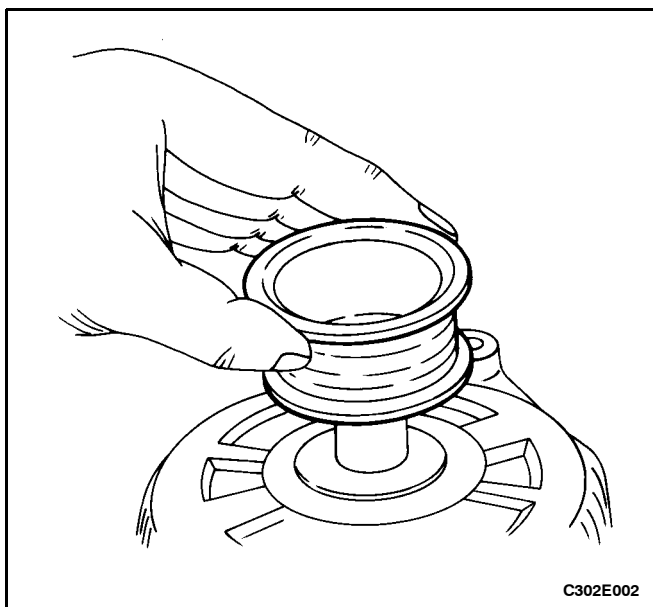
10. Solder the terminal of the regulator/brush holder assembly to the rectifier assembly.

11. Fasten the rectifier and the regulator/brush holder assemblies to the slip ring end frame with the bolts.

Tighten

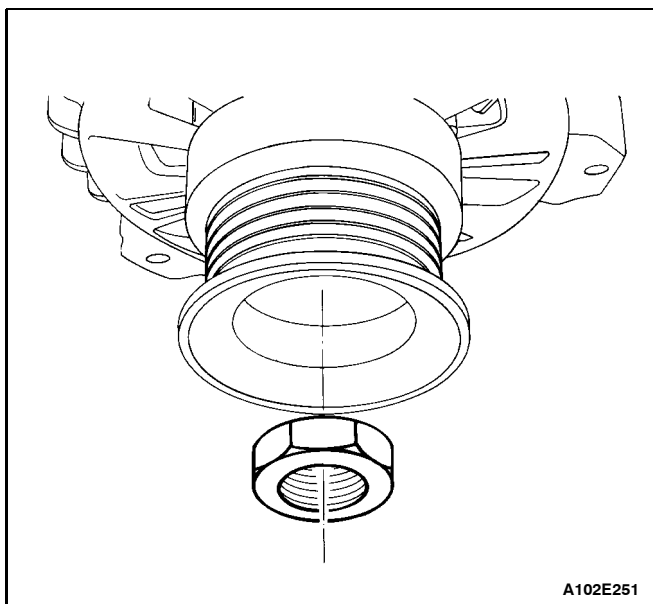
Tighten the rectifier and the regulator/brush holder assembly bolts to the point at which they are touching their respective mounting plates. Then tighten the bolts with an additional quarter turn.

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12. Snap in the cover.

13. Install the collar and the pulley on the drive end shaft.



14. Install the drive end nut.

Tighten

Tighten the generator drive end nut to 100 NSm (74 lb-ft).

15. Install the generator in the vehicle. Refer to "Generator" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

BATTERY

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.

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 sealed battery has the following advantages over conventional batteries:

- D No water need be added for the life of the battery.
- D It is protected against overcharge. If too much voltage is applied to the battery, it will not accept as much current as a conventional battery. In a conventional battery, the excess voltage will still try to charge the battery, leading to gassing, which causes liquid loss.
- D It is not as liable to self-discharge as a conventional battery. This is particularly important when a battery is left standing for long periods of time.
- D It has more power available in a lighter and a smaller case.

RATINGS

A battery has two ratings: (1) A reserve capacity rating designated at 27_C (81_F), which is the time a fully charged battery will provide 25 amperes current flow at or above 10.5 volts; (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 (81_F) and 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, which 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:

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

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:
 - D GREEN DOT VISIBLE - Any green appearance is interpreted as a "green dot," meaning the battery is ready for testing.
 - D 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.
3. Occasionally, a third condition may appear:
 - D 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 char-

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ger 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" in this section.

CHARGING TIME REQUIRED

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

- D **Size of Battery** - A completely discharged large heavy-duty battery requires more than twice the recharging as a completely discharged small passenger car battery.
- D **Temperature** - A longer time will be needed to charge any battery at -18_C (0_F) than at 27_C (81_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.
- D **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.
- D **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 be needlessly 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.

3. 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

- D If the charge current is not measurable at the end of the above charging times, the battery should be replaced.
- D 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.

- D If the charge current is still not measurable after using the charging time calculated by the above method, the battery should be replaced.
- D If the charge current is measurable during the charging time, the battery is good, and charging should be completed in the normal manner.

JUMP STARTING PROCEDURE

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

Notice: Make sure the cables are not on or near pulleys, fans, or other parts that will move when the engine starts, damaging the parts.

4. Shift an automatic transaxle to Park (P), or a manual transaxle to Neutral (N).

Caution: Do not use cables that have loose or missing insulation, or injury could result.

5. 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: Do not attach the cable directly to the negative terminal of the discharged battery. Doing so could cause sparks and a possible battery explosion, possibly resulting in personal injury.

6. 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.
7. 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.
8. 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-121D and the CS-128D. 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 a fan are used. There is no test hole.

Unlike three-wire generators, the CS-121D and the CS-128D 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 lights when the ignition switch is turned to ON, 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 at full brilliance for several kinds of defects, as well as when the system voltage is too high or too low.

The regulator voltage setting varies with the temperature and limits the system voltage by controlling the rotor

field current. The regulator switches rotor field current on and off at a fixed frequency of about 400 hertz. By varying the on-/off-time time, correct average field current for proper system voltage control is obtained. 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

The Delco-Remy CS charging system has several models available, including the CS-121D and the CS-128D. The number denotes the outer diameter in millimeters of the stator laminations.

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 a 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.