

SECTION 6D

ENGINE ELECTRICAL

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Charging System

Servicing Cautions

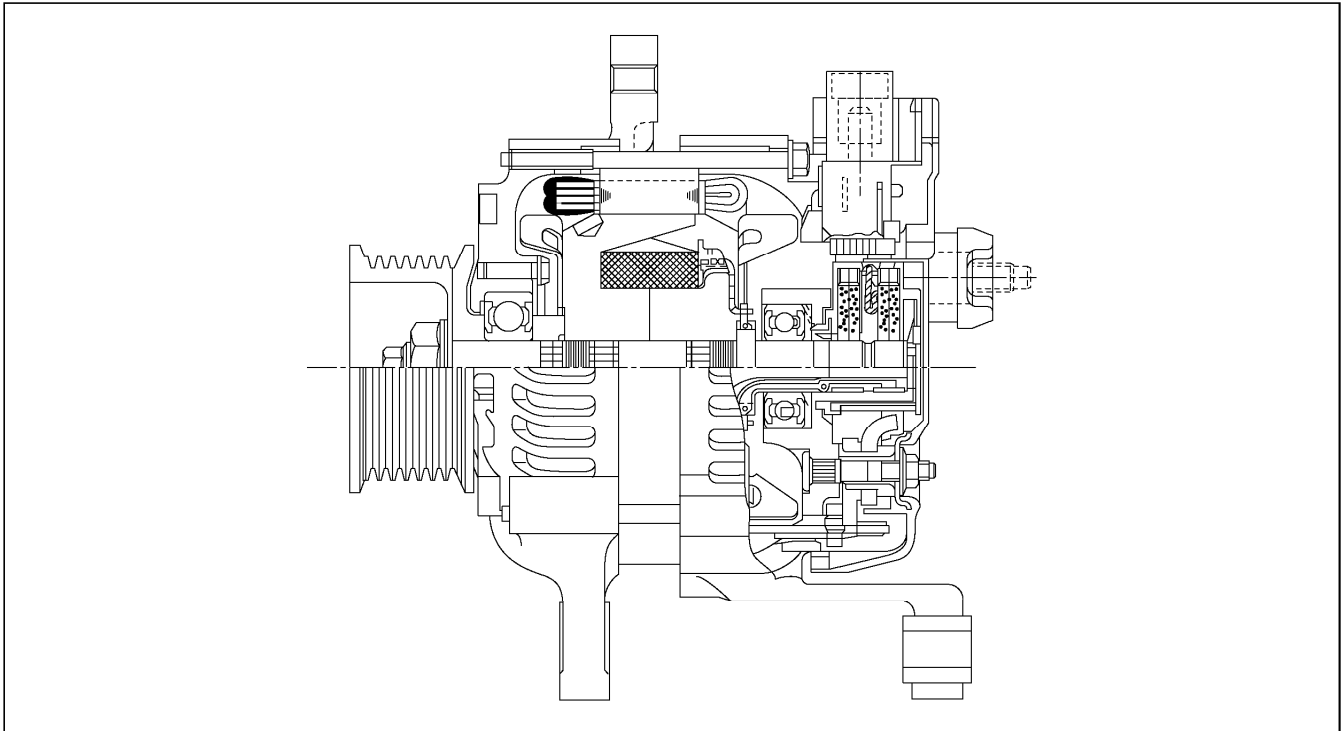
- Battery polarity is important. If the battery cables are reversed, the generator diodes will be destroyed.
- Do not remove the battery cables or the charging circuit wiring when the engine is running.
- Confirm that the terminal wires are connected to the proper terminals by checking the terminal numbers (the number on the terminal wire and the terminal must be the same).
- Disconnect the battery negative cable (-) before inspecting the generator.
- Do not open or close the battery relay switch when the engine is running.
- Disconnect the battery negative cable (-) when using external equipment (Quick-Charge) to charge the battery.
- When steam cleaning or washing the engine, do not allow steam or water to come in direct contact with the battery and other electrical system components.
- Be sure to read the item on belt tension adjustment before beginning the procedure.

Important Generator Components and Function

- The generator used on 4JK1 engine cannot be disassembled.
- The generator uses a built-in solid-state IC voltage regulator. The regulator and other important components together with their connections are shown in the illustration.
- The voltage regulator is installed to the rear cover assembly of the generator together with the brush holder and the rectifier. The generator requires no additional voltage regulation.
- 9 diodes are connected to the stator coil to convert AC to DC. The DC voltage is delivered to the generator output terminal.

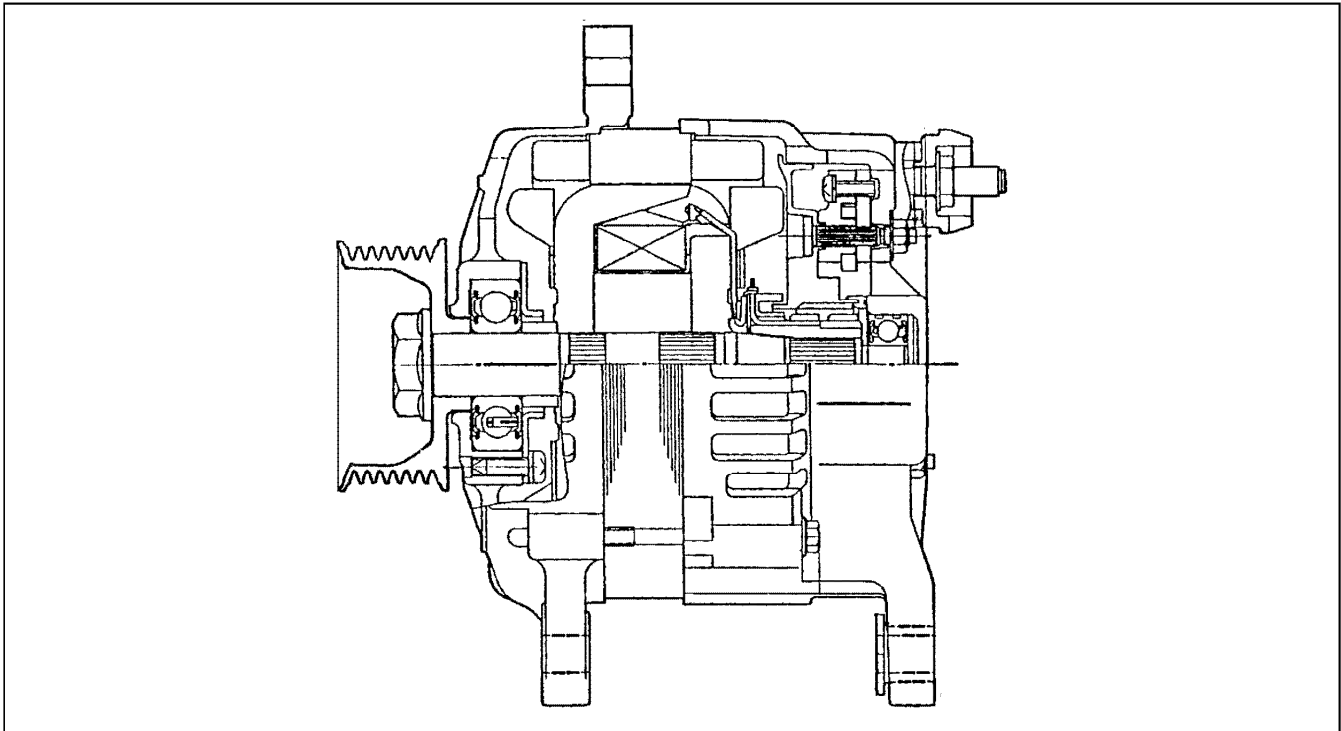


AC Generator (4JK1)



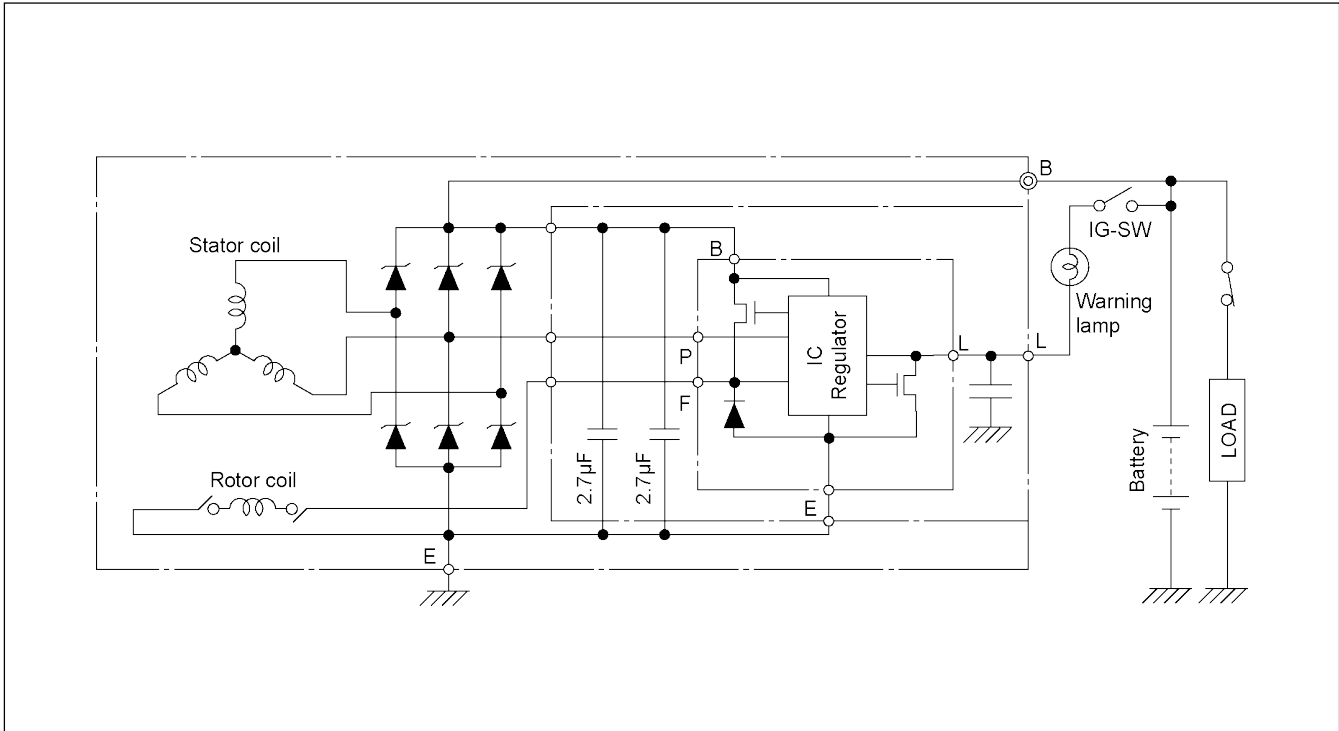
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AC Generator (4JJ1)



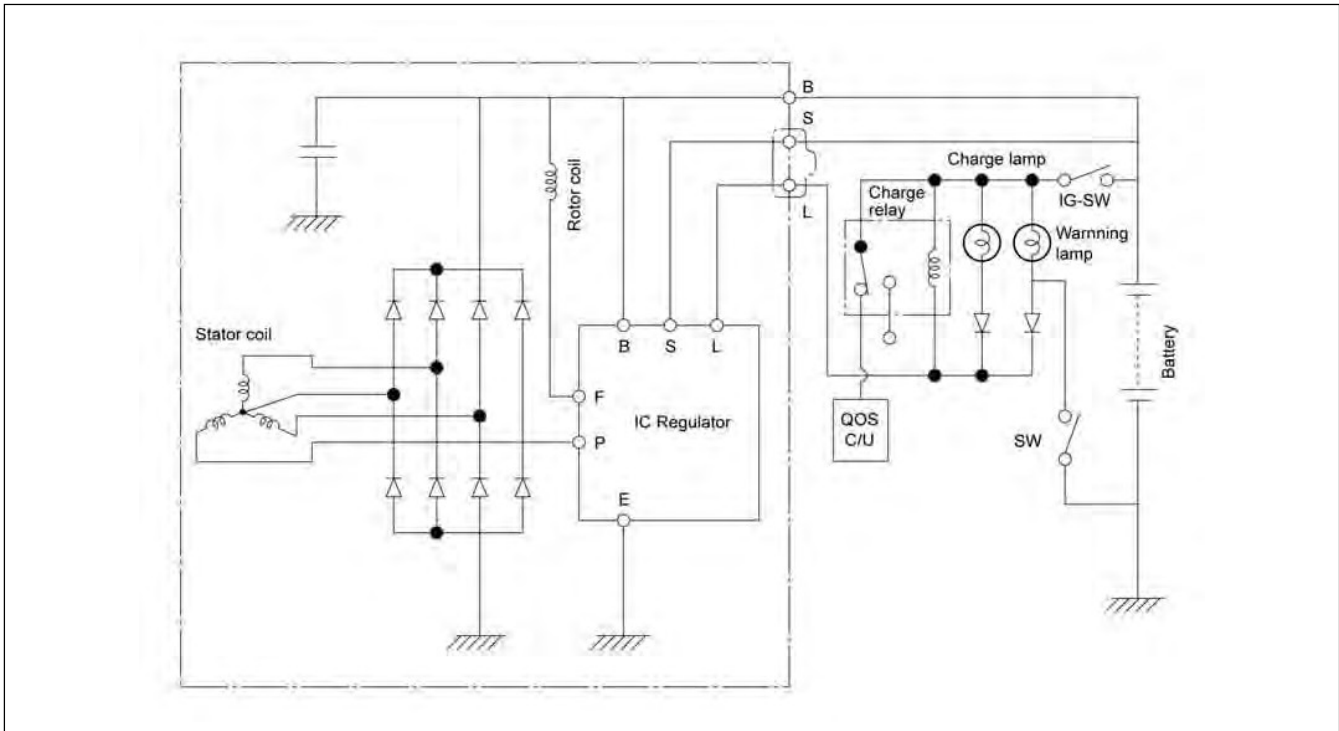
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Charging System (4JK1)



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Charging System (4JJ1)



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Troubleshooting

Symptoms

- No charging
- Inadequate charging
- Excessive charging
- Unstable charging current
- Abnormal generator noise



No charging

Possible problem	Countermeasure
Dead battery	Replace
Open or shorted wiring	Repair
Open or shorted ammeter	
Loose wiring connections	
One or more generator coils open or shorted	Replace
Bad diode	
Bad regulator	
Loose regulator connections	Repair

Inadequate charging

Possible problem	Countermeasure
Dead battery	Replace
Open or shorted wiring	Repair
Loose wiring connections	
Loose generator drive belt	Adjust belt tension
Stator coil intermittent short	Replace
Bad diode	
Loose battery connections	Repair
Bad regulator	Replace
Loose regulator connections	Repair

Excessive charging

Possible problem	Countermeasure
Bad regulator	Replace

Unstable charging current

Possible problem	Countermeasure
Open wiring connection or broken wire	Repair
Loose generator drive belt	Adjust belt tension
Open or shorted stator coil	Replace
Loose terminal connections	Repair
Bad regulator	Replace
Loose regulator terminal connections	Repair

Abnormal operating noise

Possible problem	Countermeasure
Loose generator drive belt	Adjust belt tension
Bad bearing	Replace
Loose rotor core or stator core	Repair
Bad diode	Replace
Open or shorted stator coil	Replace

Diagnosis

On-vehicle Inspection

The charging system warning light tells the vehicle operator of possible problems with the system.

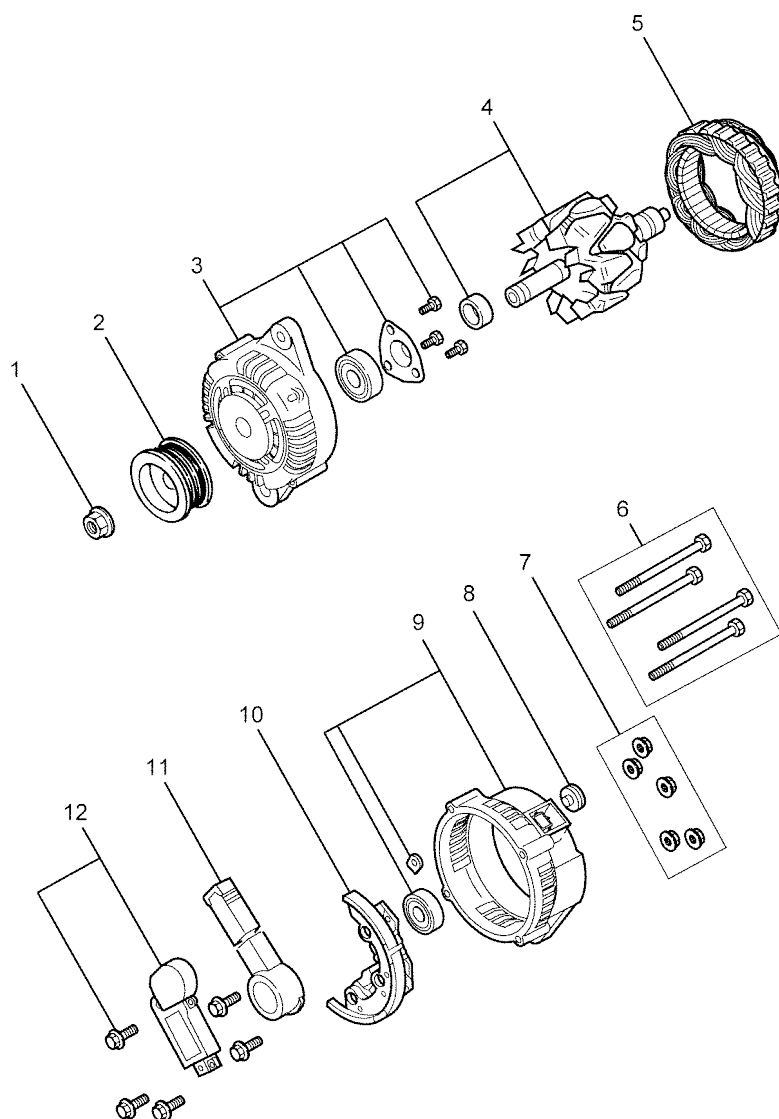
When the ignition switch is moved to the ON position, the light turns on. The light turns off immediately after the engine is started. If the light turns on during engine operation, there is a problem with the charging system. Perform the checks described below.

1. Check the belt (broken or loose).
2. Check the harness connectors (loose or disconnected).
3. With the engine off, turn the ignition switch to the ON position. If the warning lamp does not light, remove the harness connector from the generator. Ground the connector IG terminal. The lamp should light. If it does not, the bulb is burned out. Replace the bulb.
4. Start the engine. If the warning lamp remains on, the generator must be repaired or replaced.

Specifications

Battery power	Volts	12
Generator output	Amperes	90
Rotational direction (Viewed from pulley)	—	Clockwise
Rated speed	rpm	5,000
Maximum speed		18,000

Unit Servicing (4JJ1)



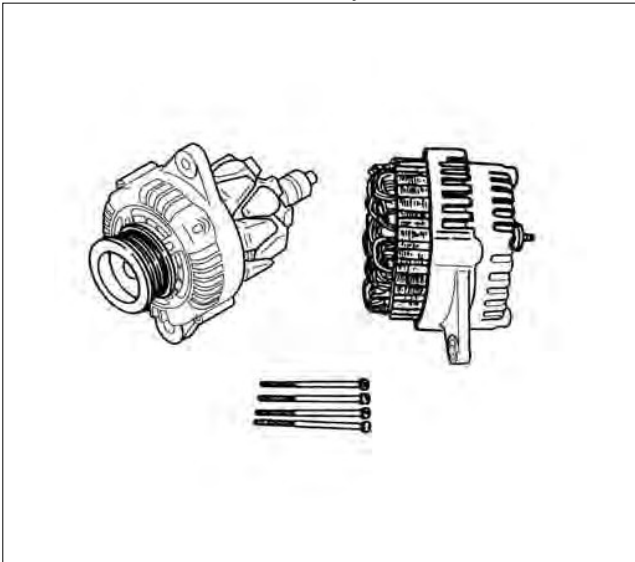
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Legend

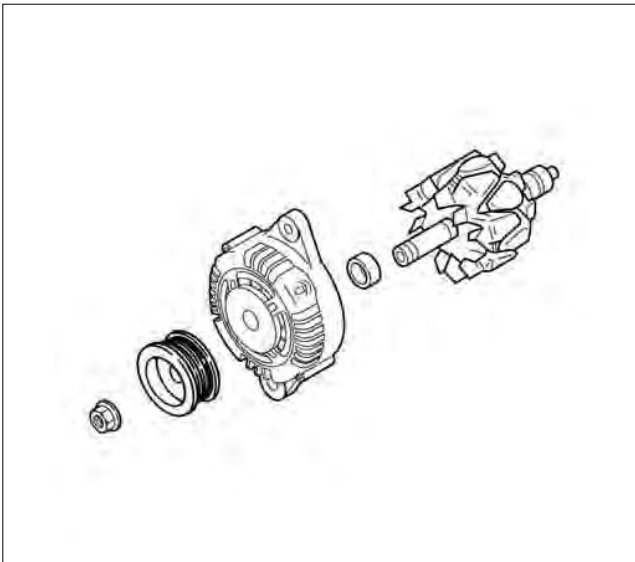
- | | |
|-------------------------|------------------------------|
| 1. Pulley Nut | 7. Nuts |
| 2. Pulley | 8. Terminal Insulation Plate |
| 3. Front Cover Assembly | 9. Rear Cover Assembly |
| 4. Rotor Assembly | 10. Rectifier |
| 5. Stator | 11. Brush Holder |
| 6. Through Bolts | 12. Regulator Assembly |

Disassembly

1. Remove the through bolts.
2. Insert a flat-blade screwdriver between the front cover and the stator. Pry the parts apart.
3. Separate the front cover/rotor assembly from the rear cover/stator assembly.

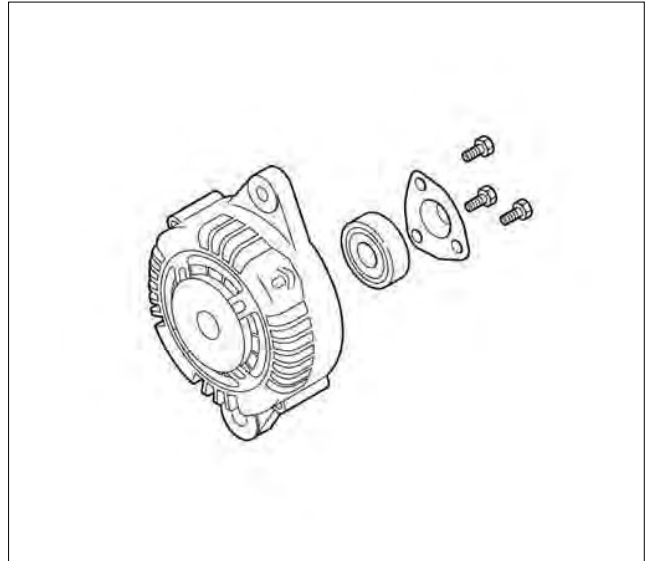


4. Place the front cover and rotor in a vise.
5. Remove the pulley nut and the pulley.
6. Remove the rotor from the front cover.

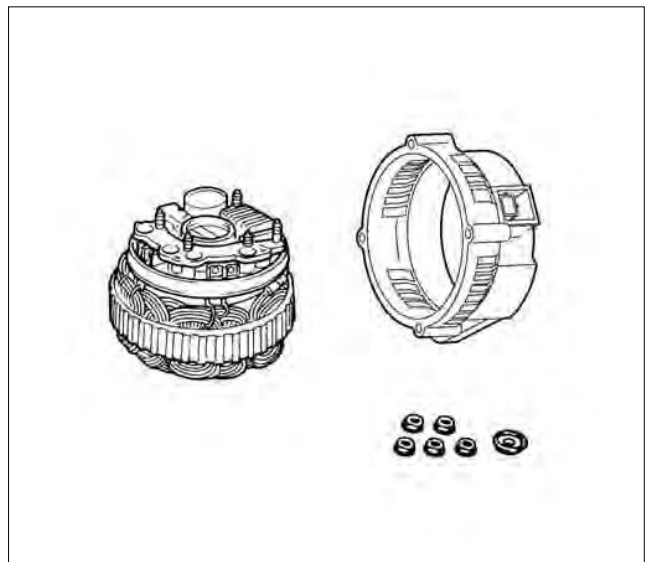


7. Remove the screw from the front cover.

8. Remove the bearing retainer and the bearing.

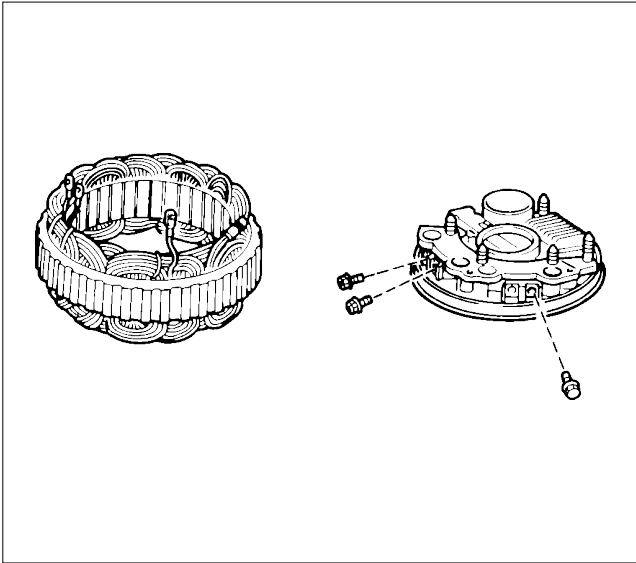


9. Remove the B-terminal nut.
10. Remove the rectifier and the brush holder.
11. Remove the rear cover from the stator.



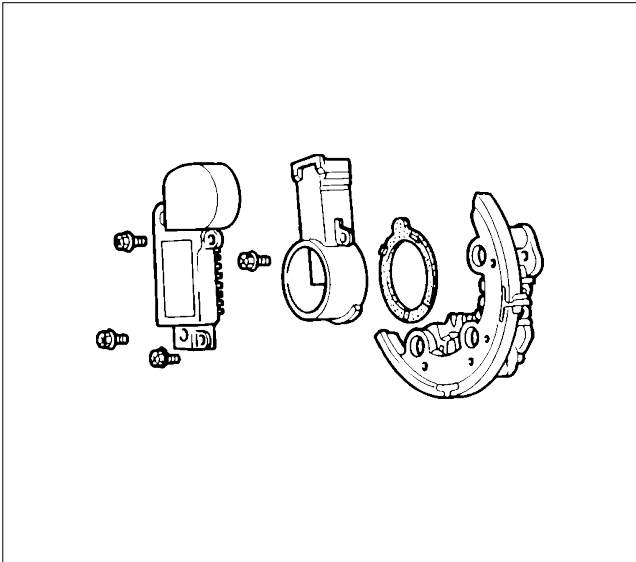
12. Remove the bolts securing the stator terminal to the rectifier.

13.Remove the stator.



066RS030

14.Remove the bolts securing the regulator, the rectifier, and the brush holder. Separate the parts.



066RW025

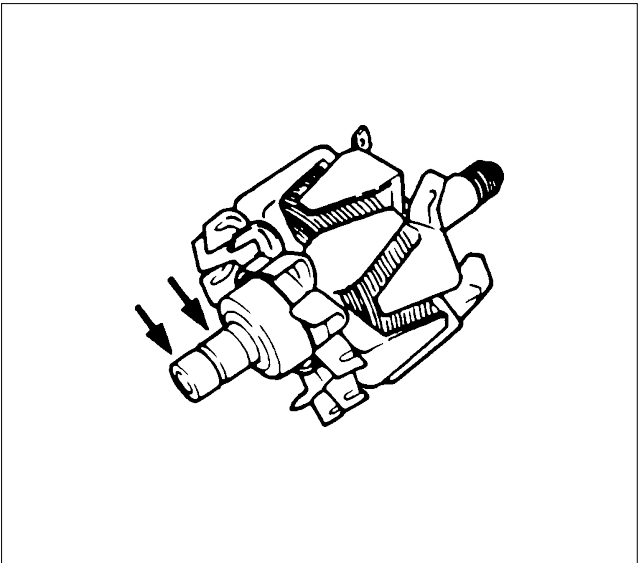
Inspection and Repair

Repair or replace any parts found to be excessively worn or damaged during the inspection procedure.

Rotor Assembly

1. Check for dirty or rough slip ring surfaces. Remove dirt from the surfaces with a clean rag. Use No. 500 or No. 600 sandpaper to smooth the surfaces.
2. Measure the slip ring diameters. Replace the slip ring if the diameter is less than the specified limit.

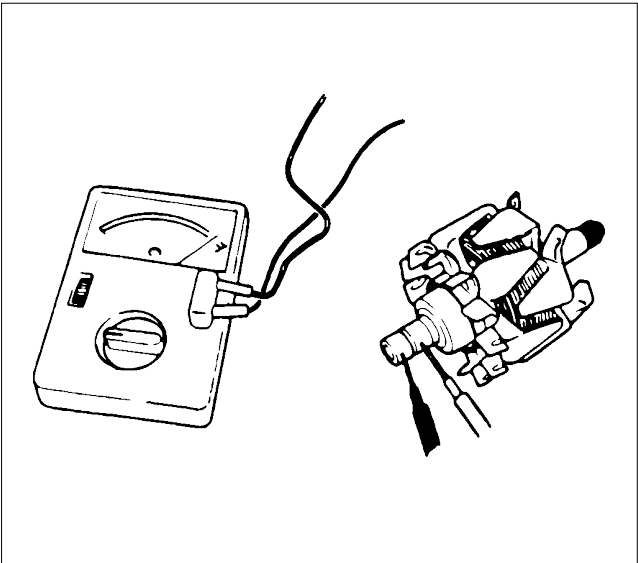
Slip ring diameter	mm (in)
Standard	27 (1.063)
Limit	26 (1.024)



066RS032

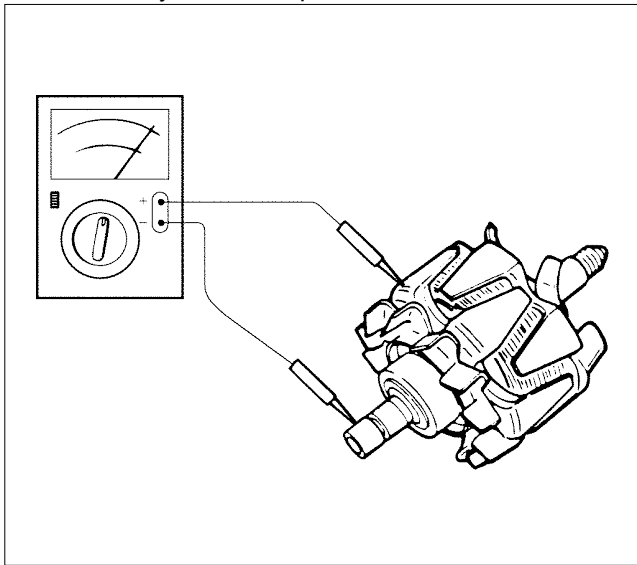
3. Measure the electrical resistance between the slip rings. If the resistance is greater than the specified limit (open circuit), repair is required.

Slip ring resistance	Ω
Less than 3.75	



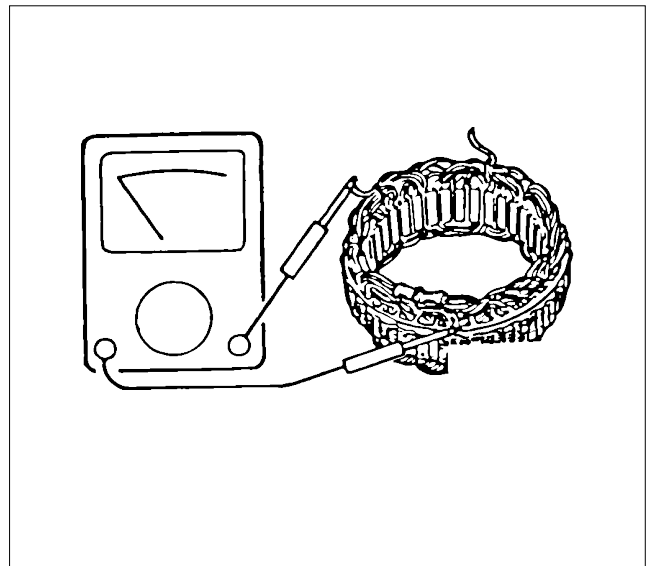
066RS033

4. Check for conductivity between the slip rings and the rotor core. If there is continuity, the rotor assembly must be replaced.



066RS017

Stator coil/core resistance	MΩ
1	



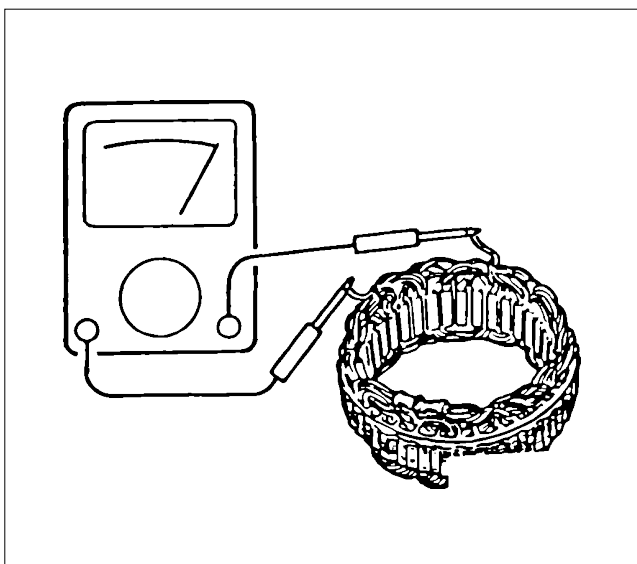
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Stator Coil

1. Measure the stator coil resistance. If the resistance is less than the specified value, the stator coil must be replaced.

Stator coil resistance

0.07Ω at 20°C (68°F)



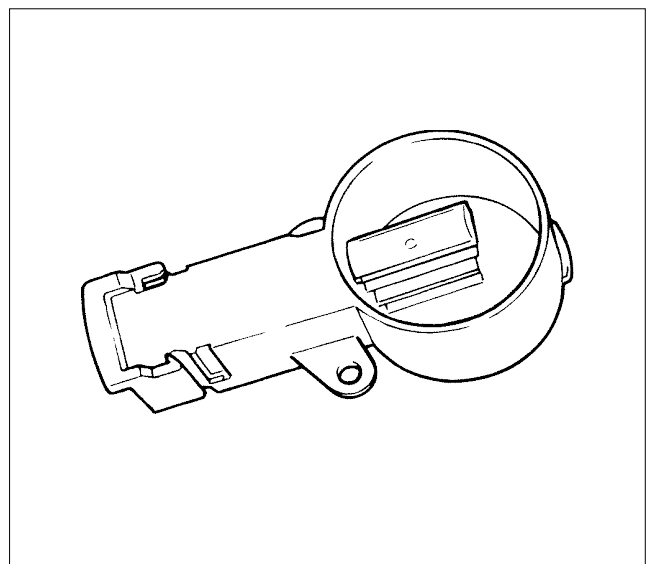
066RS034

2. Measure the resistance between the stator coil and the stator core. If the resistance is less than the specified value, the stator coil must be replaced.

Brushes

Measure the brush height. If the height is less than the specified limit, the brushes must be replaced.

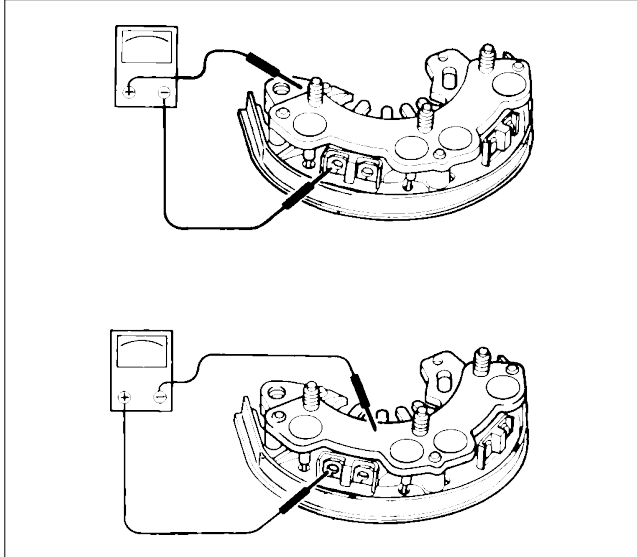
Brush height	mm (in)
Standard	18 (0.709)
Limit	5.5 (0.217)



066RW024

Rectifier

Measure each of the diode resistances in both directions (anode/cathode and cathode/anode). If any of the diodes have the same resistance in both directions, the rectifier must be replaced.



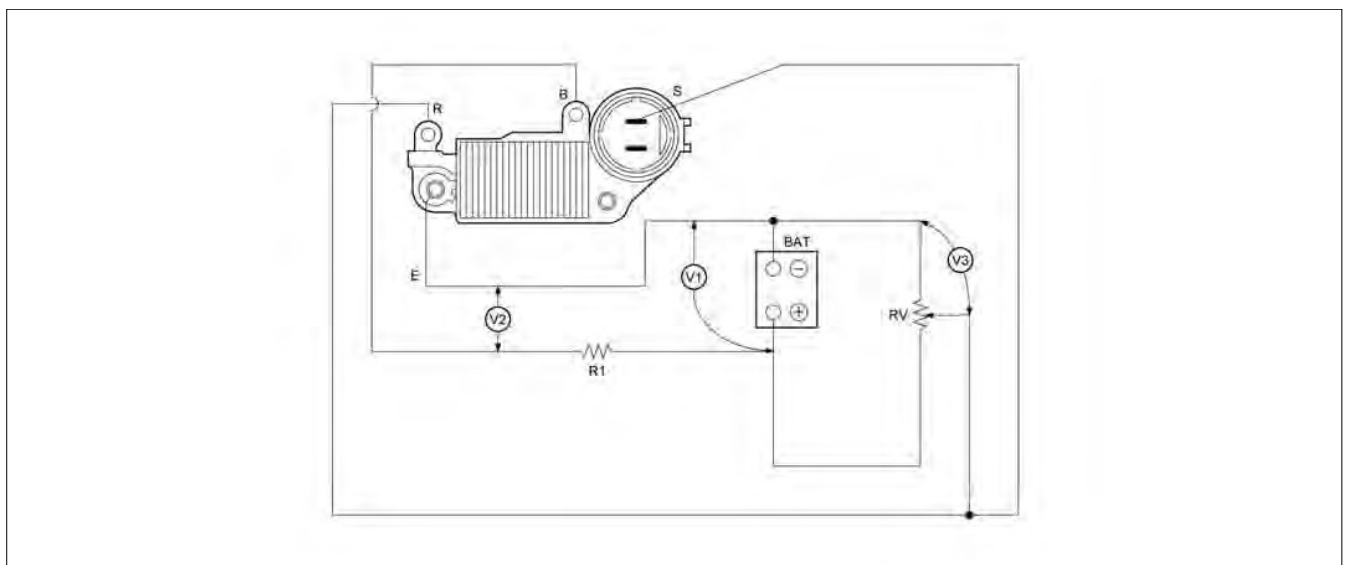
066RS036

Regulator Assembly

There are 3 checkpoints (12V batteries, 10 ohms 3W resistor, 0-50V/0.5V steps, and 300 ohms 12W variable resistor). Refer to the schematic below.

Measuring Procedure

1. Measure the voltage (BAT) at the V1 checkpoint. A 10-13 volt reading indicates that the BAT battery is good.
2. Measure the voltage at checkpoints V1 and V2 as you gradually increase the resistance of the variable resistor from 0. The voltage at V1 should change with the voltage at V2. If it does not, the regulator is damaged and must be replaced.
3. Measure the voltage at checkpoint V3 with the variable resistor setting fixed. If the measured voltage is 14.4 ± 0.3 , the regulator is good. If the measured voltage is outside this range, the regulator is damaged and must be replaced.



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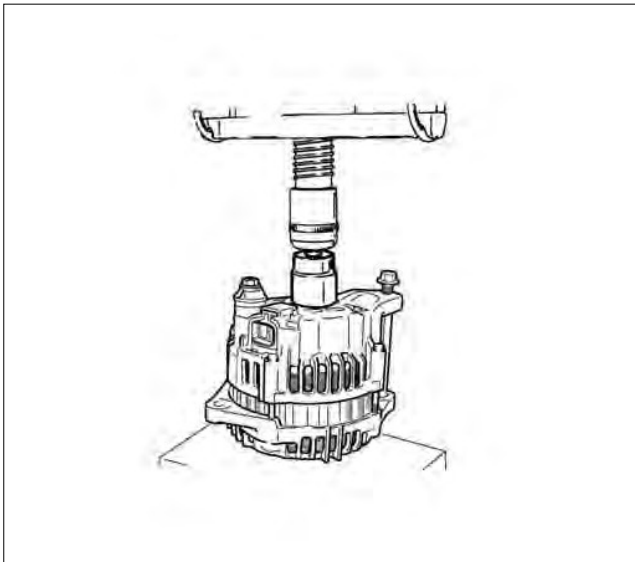
Reassembly

Follow the disassembly steps in reverse order to reassemble the generator. Pay close attention to the items below.

- Be very careful not to reverse battery polarity. Reversed battery polarity will destroy the rectifier diodes.
- Do not ground the generator B-terminal. Heat and fire damage to the harness will result.
- If using a fast charge procedure, be sure to disconnect the battery positive cable. If you do not, the rectifier diodes will be exposed to high positive voltage that will destroy them.
- Be very careful to reassemble the parts to their original positions. Particular care must be taken with insulated parts.
- Carefully clean all insulated parts so that they are completely free of oil and/or grease.
- Be sure that B-terminal twist-type stoppers (round terminal) are securely inserted before tightening the nuts.

Final Assembly

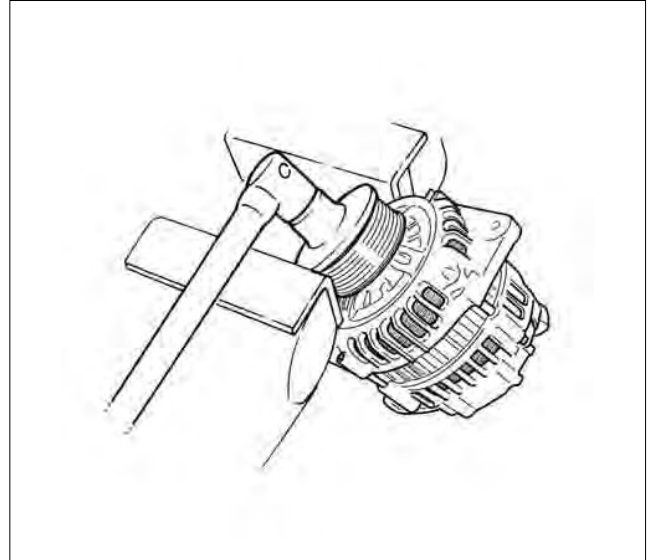
1. Use a bench press to install the rotor and rear cover to the front cover.



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2. Install the pulley to the rotor shaft and tighten the bolt to the specified torque.

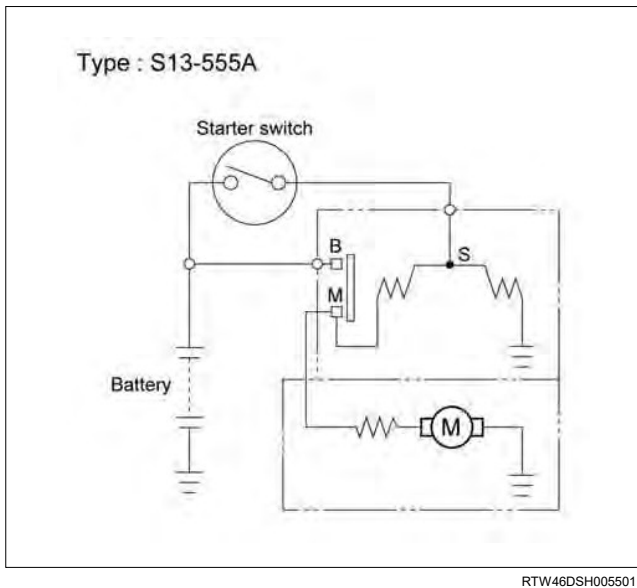
Pulley bolt torque	N·m (kg·m / lb ft)
111 (11.3 / 81.7)	



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Starter Motor

Starting Circuit Diagram



Important Operations – Installation

Follow the removal procedure in the reverse order to perform the installation procedure. Pay careful attention to the important points during the installation procedure.

Starter Motor

1. Install the starter motor to the rear plate.
2. Tighten the starter motor bolts to the specified torque.

Starter Motor Bolt Torque	N·m (kg·m/lb ft)
85 (8.7 / 63)	

3. Install the Engine oil level gage.
4. Install the A/T oil level gage.
5. Reconnect the battery cable at the starter motor and the ground cable at the cylinder body.
6. Reconnect the battery cable and the ground cable at the battery terminals.

Removal and Installation

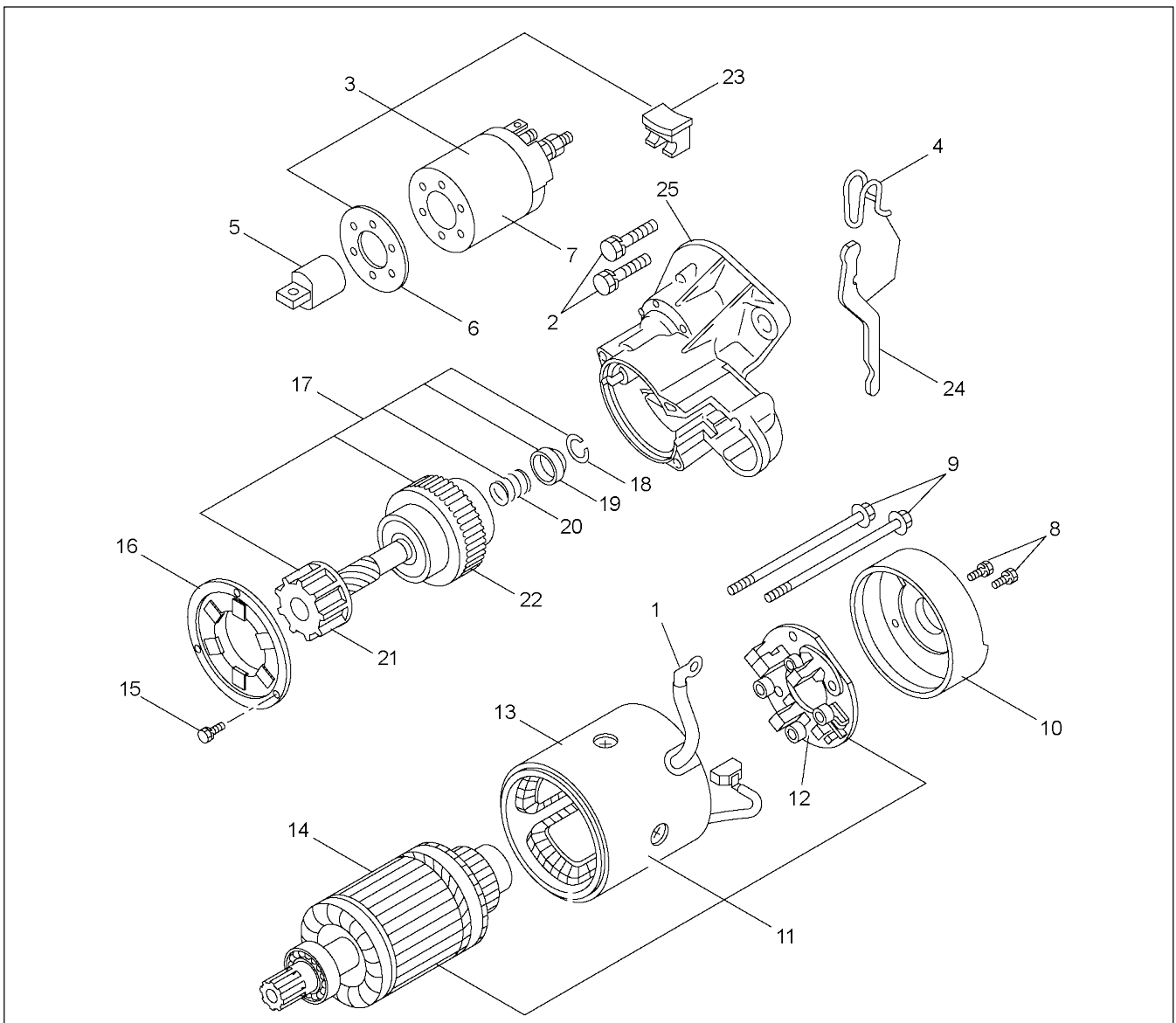
Read this Section carefully before performing any removal and installation procedure. This Section gives you important points as well as the order of operation. Be sure that you understand everything in this Section before you begin.

Important Operations - Removal

Starter Motor

1. Disconnect the battery cable and the ground cable at the battery terminals.
2. Remove the A/T oil level gage.
3. Remove the Engine oil level gage.
4. Disconnect the magnetic switch cable at the terminal bolts.
5. Disconnect the battery cable at the starter motor and the ground cable at the cylinder body.
6. Remove the starter motor from the engine.

Disassembly



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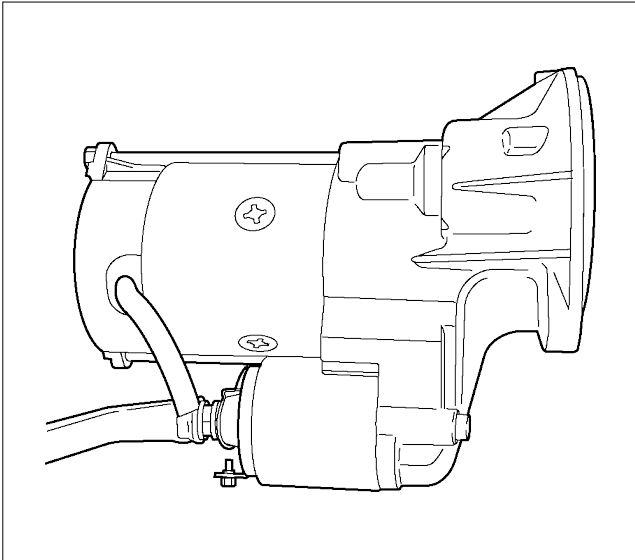
Disassembly Steps

1. Lead Wire
2. Bolt
3. Magnetic Switch Assembly
4. Torsion Spring
5. Plunger
6. Dust Cover
7. Magnetic Switch
8. Screw
9. Through Bolt
10. Rear Cover
11. Motor Assembly
12. Brush Holder
13. Yoke
14. Armature
15. Bolt
16. Bearing Retainer
17. Pinion Assembly
18. Pinion Stopper Clip
19. Pinion Stopper
20. Return Spring
21. Pinion Shaft
22. Clutch
23. Dust Cover
24. Shift Lever
25. Gear Case

Important Operations

1. Lead Wire

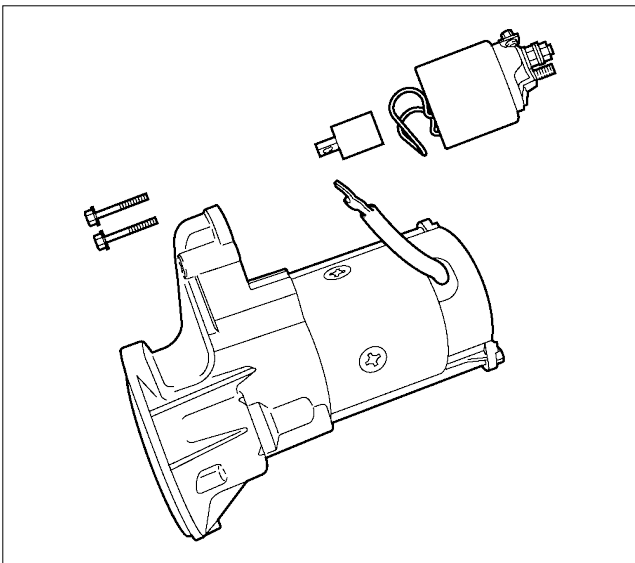
Disconnect the lead wire at the magnetic switch.



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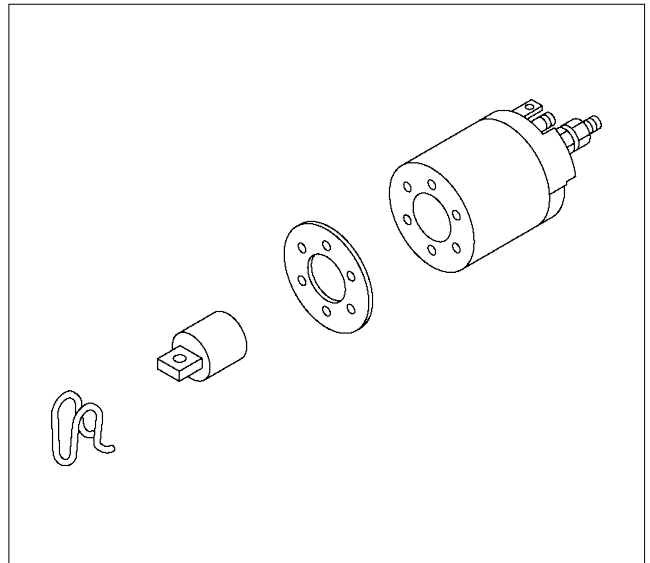
2. Magnetic Switch Assembly

Remove the magnetic switch bolts, then remove the switch from the shift lever.



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Remove the torsion spring from the magnetic switch.



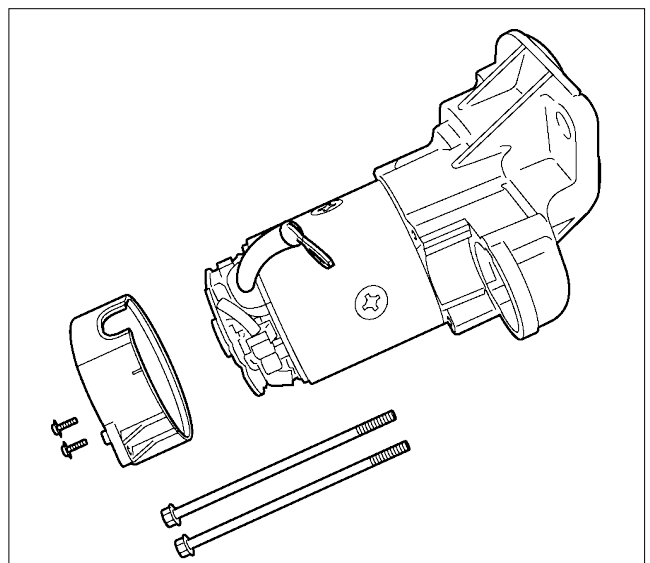
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3. Through Bolt

4. Screw

5. Rear Cover

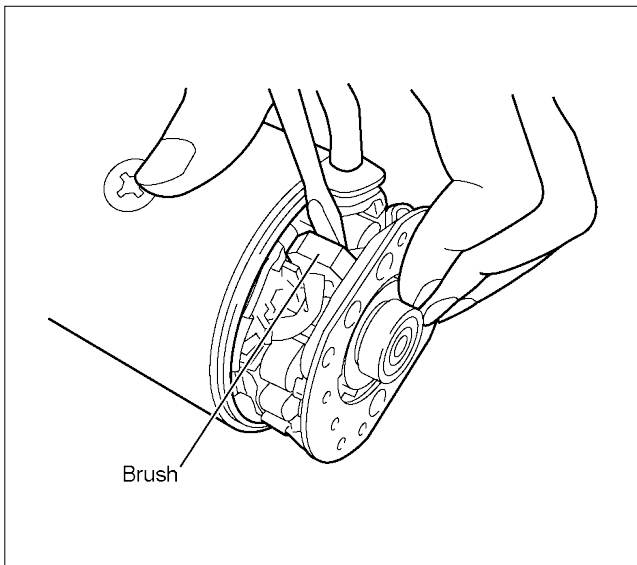
Remove the through bolts, then remove the rear cover.



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6. Motor Assembly

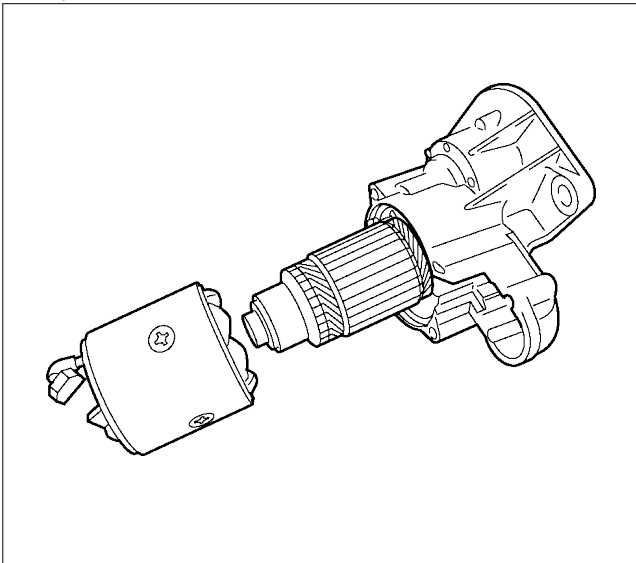
Remove the four brushes from the brush holders.



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Remove the yoke along with the armature and the brush holder from the gear case.

Remove the brushes and commutator carefully so as not to allow them in contact with the adjacent parts.



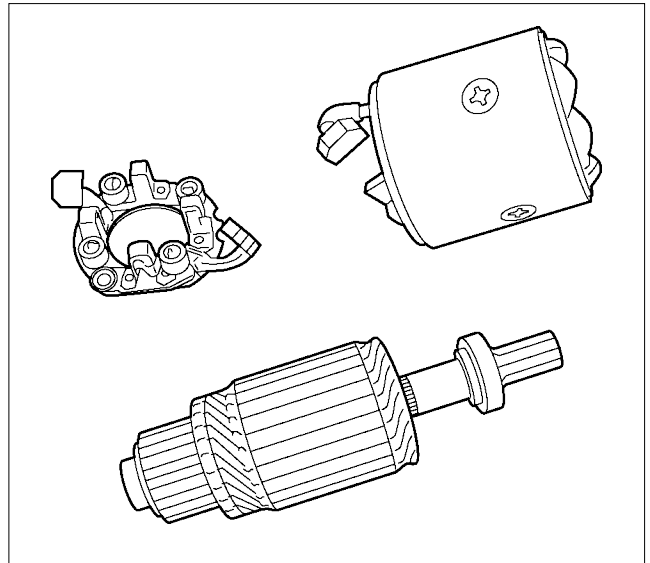
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7. Brush Holder

8. Yoke

9. Armature

Remove the brush holder and pull out the armature assembly free from the yoke.



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10. Bearing Retainer

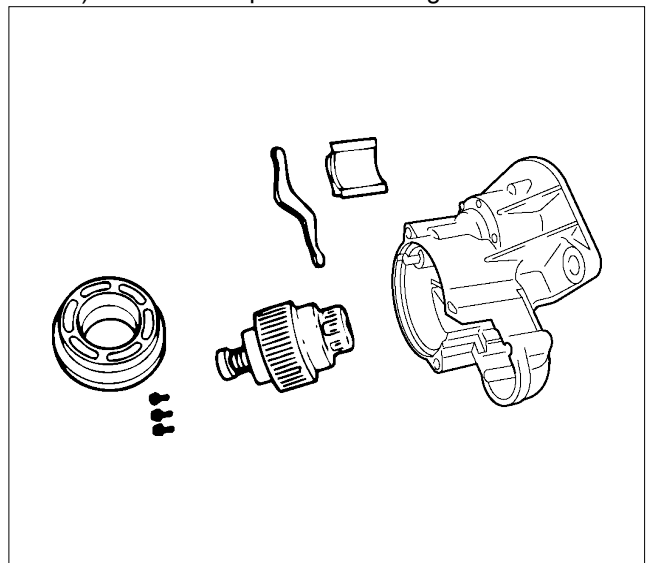
11. Pinion Assembly

12. Dust Cover

13. Shift Lever

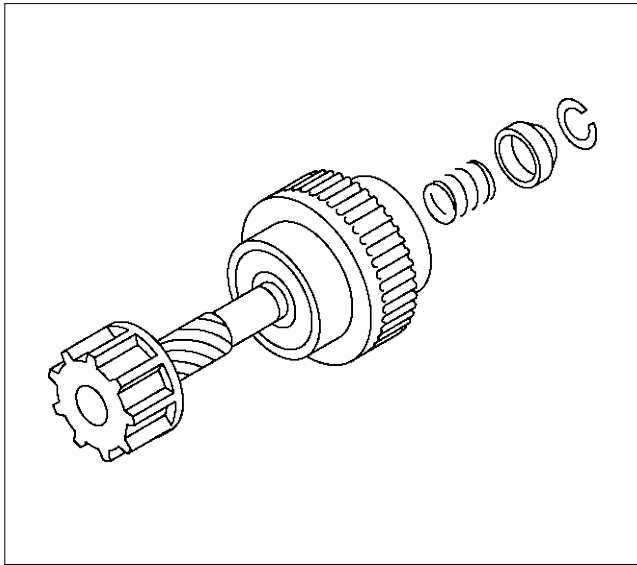
14. Gear Case

- 1) Remove the bearing retainer.
- 2) Remove the pinion from the gear case.



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- 3) Use a screwdriver to remove the stopper clip. Then disassemble the pinion assembly.



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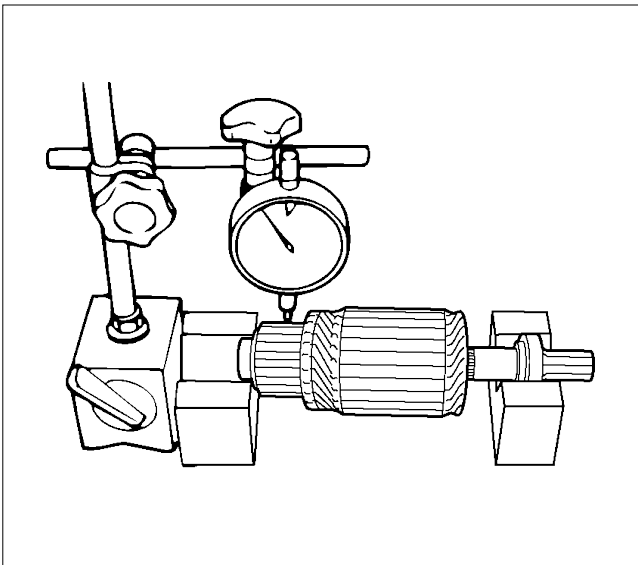
Inspection and Repair

Make the necessary adjustments, repairs, and part replacement if excessive wear or damage is discovered during inspection.

Armature

- 1. Measure the commutator run-out. Replace the commutator if the measured run-out exceeds the specified limit.

Commutator Run-Out mm (in)	
Standard	Limit
0.05 (0.002)	0.25 (0.010)



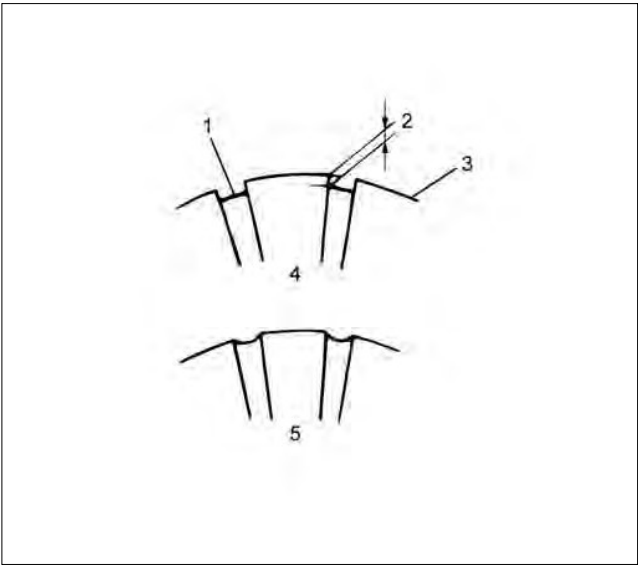
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- 2. Check the commutator mica segments for excessive wear.
- 3. Measure the mica segment depth.

Mica Segment Depth mm (in)	
Standard	Limit
0.5 - 0.8 (0.020 - 0.030)	0.2 (0.008)

If the mica segment depth is less than the standard but more than the limit, the commutator may be reground.

If the mica segment depth is less than the limit, the commutator must be replaced.



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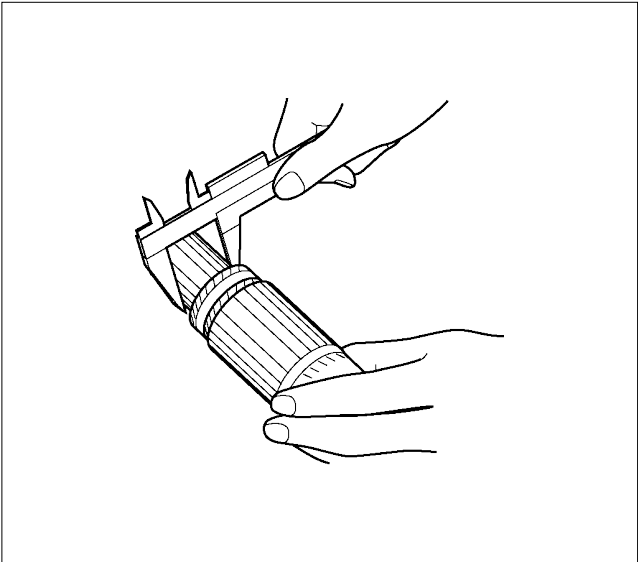
Legend

- 1. Insulator
- 2. 0.5 - 0.8 mm (0.020 - 0.030 in)
- 3. Commutator Segments
- 4. Correct
- 5. Incorrect

- 4. Measure the commutator outside diameter.

Commutator Outside Diameter mm (in)	
Standard	Limit
36.5 (1.44)	35.5 (1.40)

If the measured outside diameter is less than the specified limit, the commutator must be replaced.



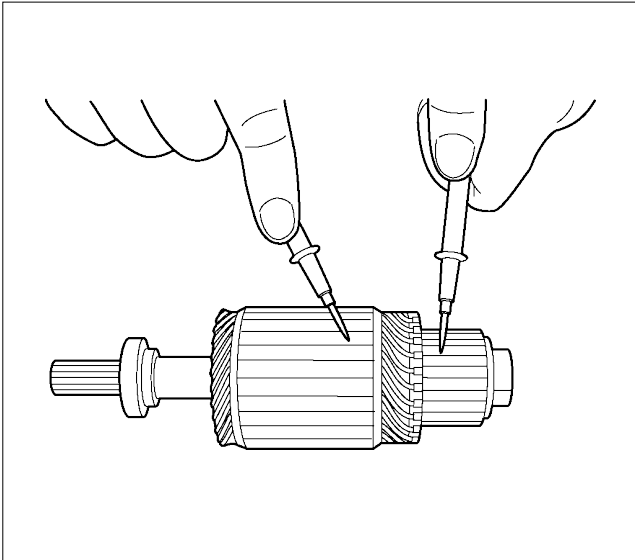
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5. Use a circuit tester to check the armature for grounding.

- 1) Hold one probe of the circuit tester against the commutator segment.
- 2) Hold the other circuit tester probe against the armature core.

If the circuit tester indicates continuity, the armature is grounded.

The armature must be replaced.



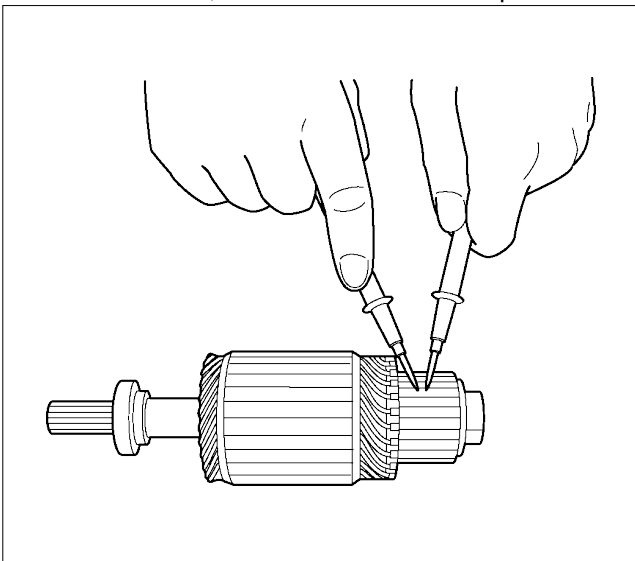
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6. Use the circuit tester to check the armature for continuity.

- 1) Hold the circuit tester probes against two commutator segments.
- 2) Repeat Step 1 at different segments of the armature core.

There should be continuity between all segments of the commutator.

If there is not, the armature must be replaced.



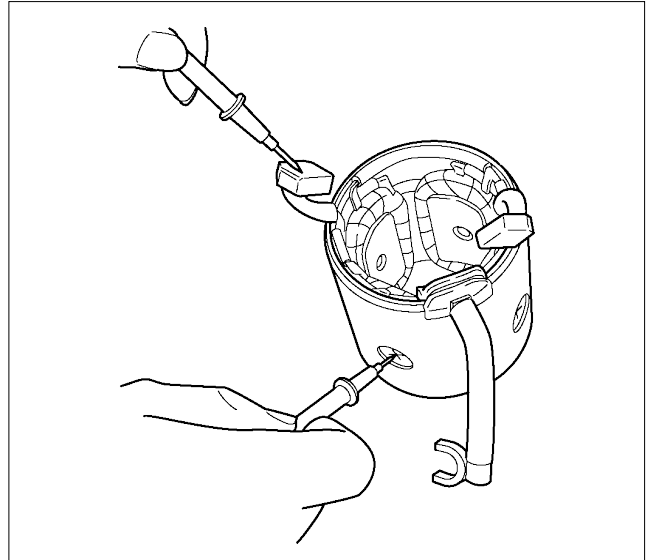
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Yoke

1. Use a circuit tester to check the field winding ground.

- 1) Hold one circuit tester probe against the field winding end or brush.
- 2) Hold the other circuit tester probe against the bare surface of the yoke body.

There should be no continuity. If there is continuity, the field coil is grounded. The yoke must be replaced.

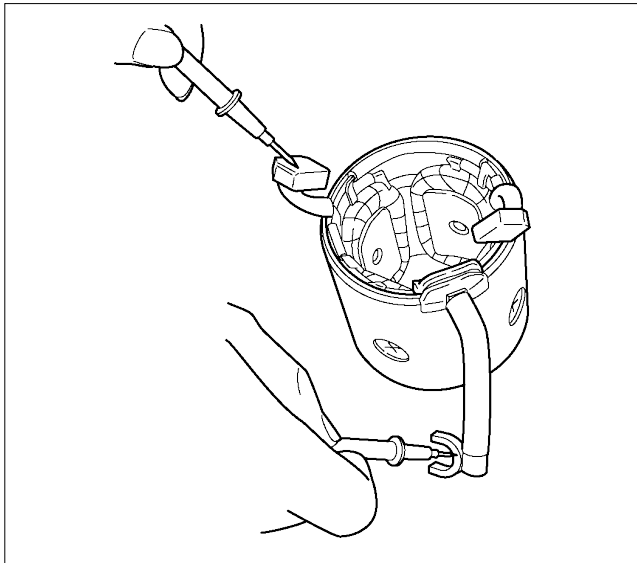


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2. Use the circuit tester to check the field winding continuity.

- 1) Hold one circuit tester probe against the "M" terminal lead wire.
- 2) Hold the other circuit tester probe against the field winding brush.

There should be continuity. If there is no continuity, the yoke must be replaced.



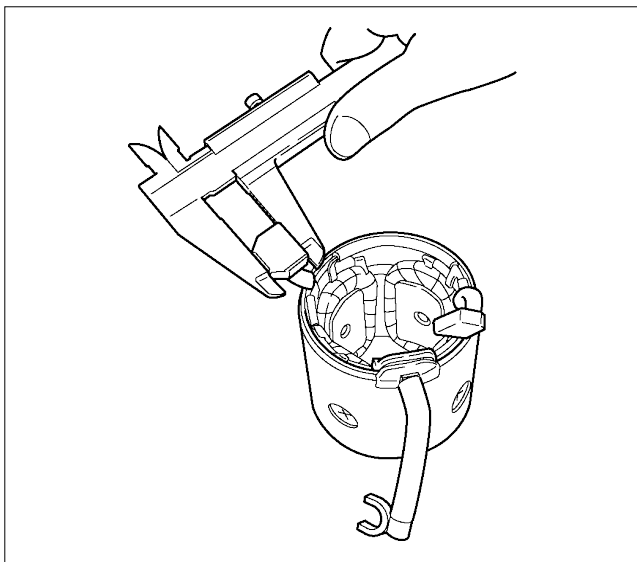
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Brush and Brush Holder

1. Use a vernier caliper to measure the brush length (four brushes).
Replace the brushes as a set if one or more of the brush lengths is less than the specified limit.

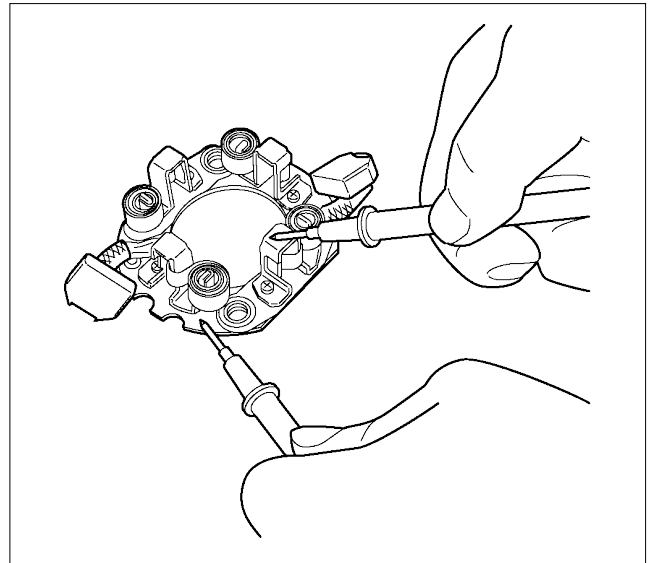
Brush Length mm (in)

Standard	Limit
15 (0.59)	12 (0.47)



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2. Use a circuit tester to check the brush holder insulation.
Touch one probe to the holder plate and the other probe to the positive brush holder.
There should be no continuity.

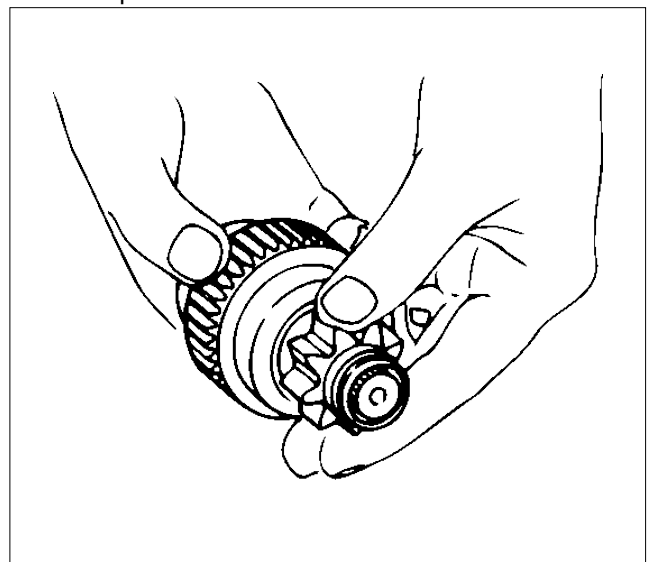


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3. Inspect the brushes for excessive wear.
If the negative brushes have excessive wear, the entire brush holder assembly must be replaced.
If the positive brushes have excessive wear, the entire yoke must be replaced.

Overrunning Clutch

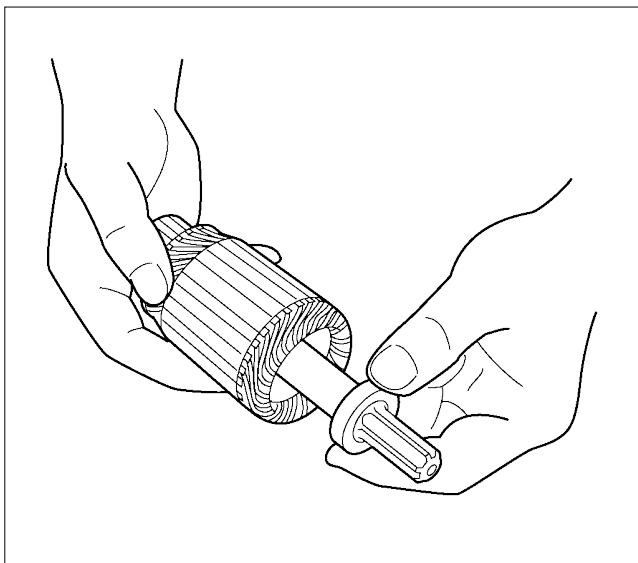
1. Inspect the overrunning clutch gear teeth for excessive wear and damage.
Replace the overrunning clutch if necessary.
2. Rotate the pinion clockwise.
It should turn smoothly.
3. Try to rotate the pinion in the opposite direction.
The pinion should lock.



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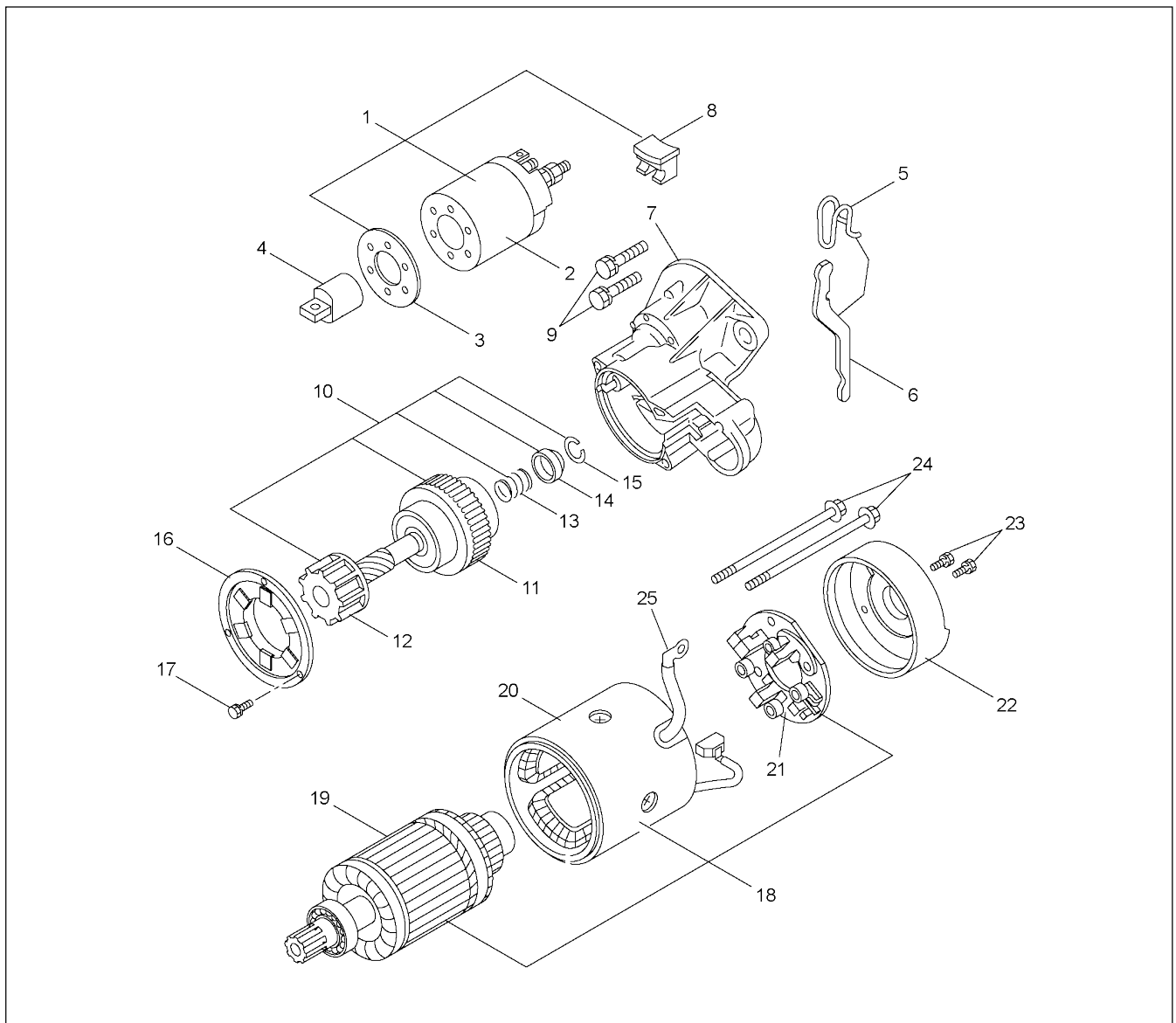
Bearing

Inspect the bearings for excessive wear and damage.
Replace the bearings if necessary.



RTW46DSH004401

Reassembly



RTW46DLF000601

Reassembly Steps

1. Magnetic Switch Assembly
2. Magnetic Switch
3. Dust Cover
4. Plunger
5. Torsion Spring
6. Shift Lever
7. Gear Case
8. Dust Cover
9. Bolt
10. Pinion Assembly
11. Clutch
12. Pinion Shaft
13. Return Spring
14. Pinion Stopper
15. Pinion Stopper Clip
16. Bearing Retainer
17. Bolt
18. Motor Assembly
19. Armature
20. Yoke
21. Brush Holder
22. Rear Cover
23. Screw
24. Through Bolt
25. Lead Wire

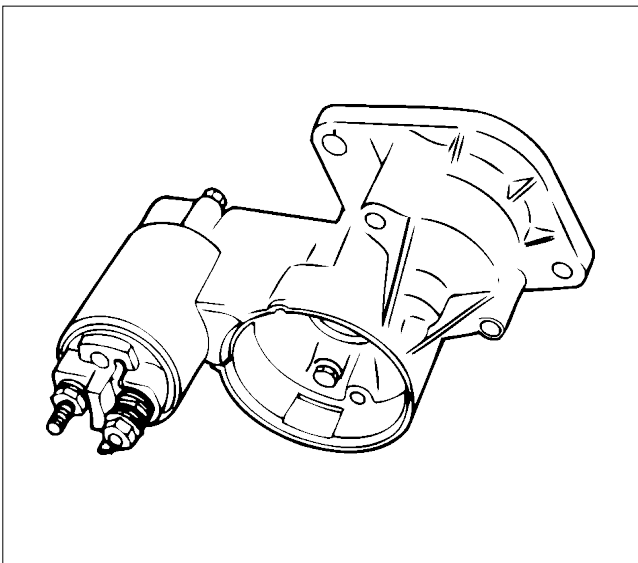
Important Operations

- 1. Magnetic Switch Assembly
 - 1) Attach the torsion spring to the hole in the magnetic switch as illustrated.
 - 2) Insert the shift lever into the plunger hole of the magnetic switch.



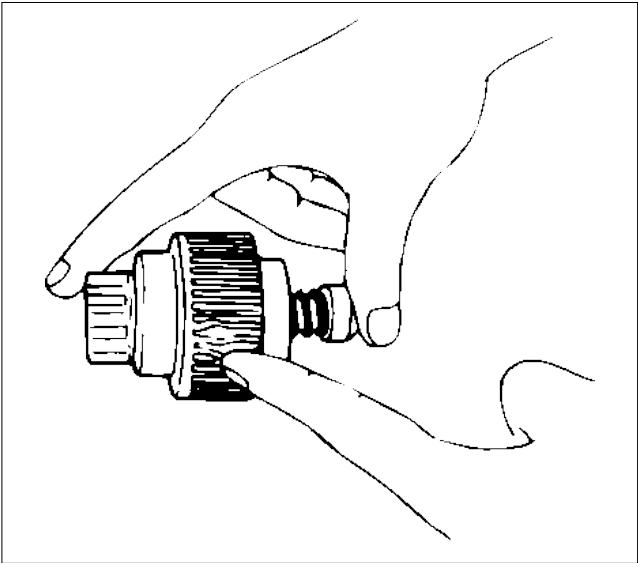
- 2. Gear Case
- 3. Dust Cover
 - 1) Install the magnetic switch assembly in the gear case.
 - 2) Install the dust cover.

Dust Cover Bolt Torque	N·m (kg·m/lb in)
8 (0.8 / 69)	

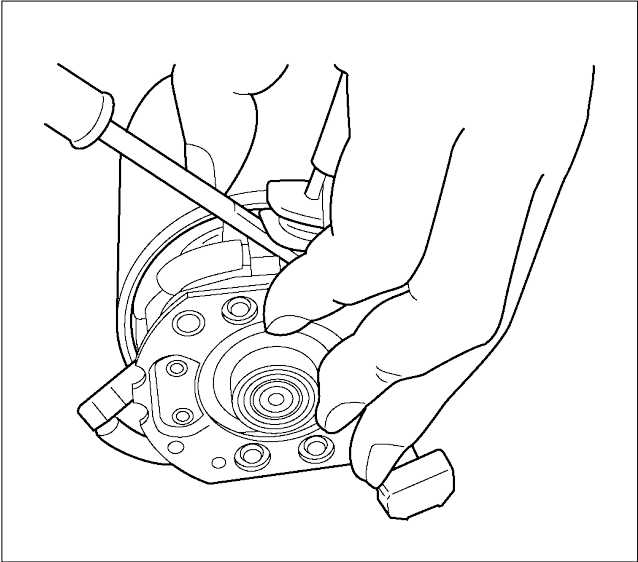


- 4. Pinion Assembly

Apply a coat of grease to the reduction gear and install the pinion assembly to the armature shaft.



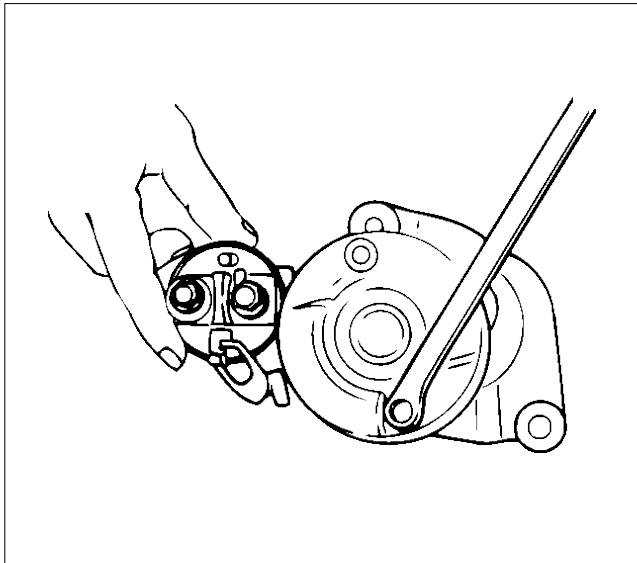
- 5. Brush Holders
 - 1) Install the brushes into the brush holder with raising the spring end of the brush spring. Take care not to damage the commutator face.
 - 2) Install the brush holder with aligning the peripheries of the yoke and the brush holder.



- 6. Through Bolt

Install the through bolts in the rear cover and tighten them to the specified torque.

Through Bolt Torque	N·m (kg·m/lb in)
8.1 (0.83 / 69.7)	



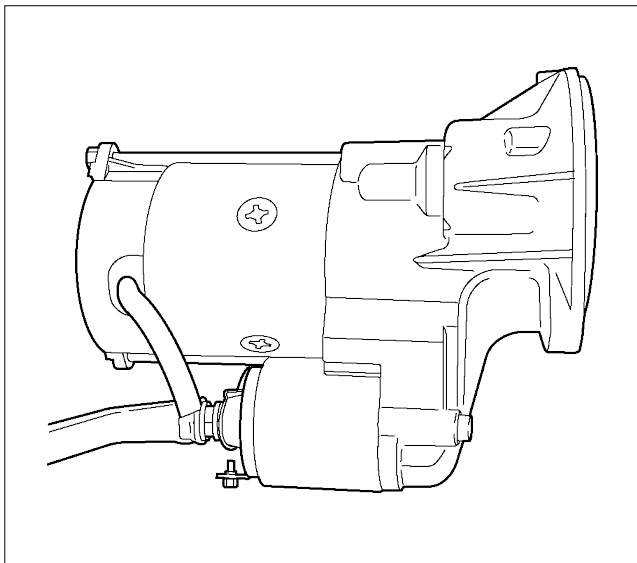
065RY00044

7. Lead Wire

Connect the lead wire in the magnetic switch and tighten the terminal nut to the specified torque.

Lead Wire Terminal Nut Torque N·m (kg·m/lb in)

8.6 (0.88 / 74.9)



RTW46DSH002601

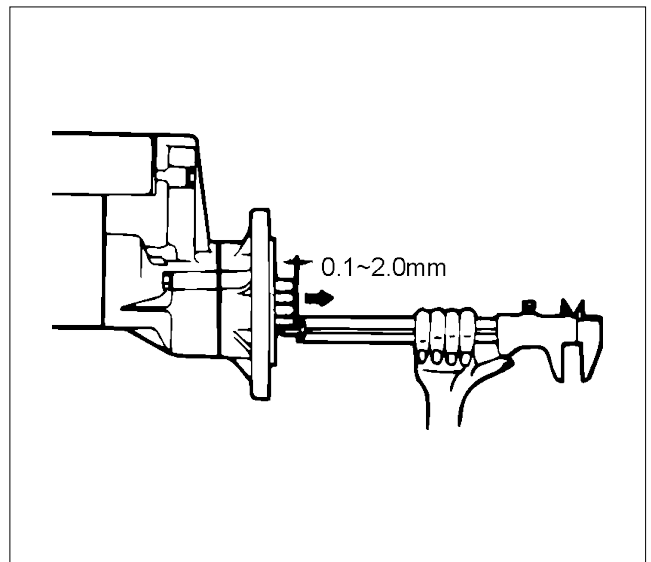
Inspection After Assembly

Use a vernier caliper to measure the pinion shaft thrust play.

The pinion shaft thrust play is equal to the pinion shaft end and pinion stopper clearance.

Pinion Shaft Thrust Play mm (in)

0.1 – 2.0 (0.004 – 0.078)



RTW46DSH005801

Magnetic Switch

The following tests must be performed with the starter motor fully assembled.

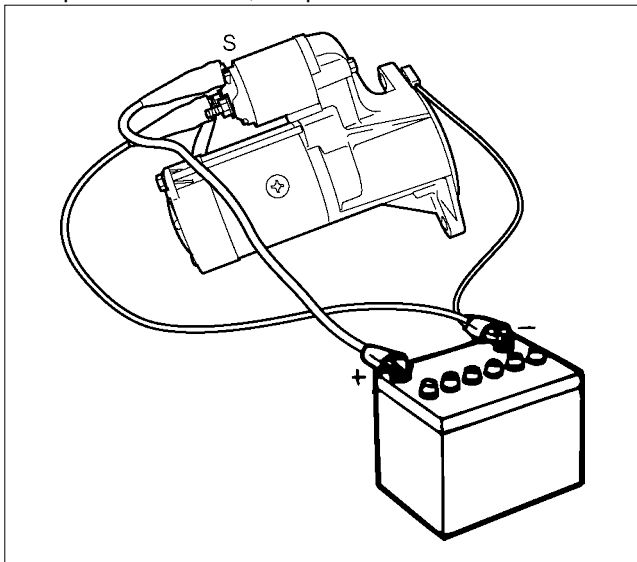
The yoke lead wire must be disconnected from the "M" terminal.

To prevent coil burning, complete each test as quickly as possible (within three to five seconds).

Temporarily connect the solenoid switch between the clutch and the housing and run the following test. Complete each test within three to five seconds.

1. Pull-in Test

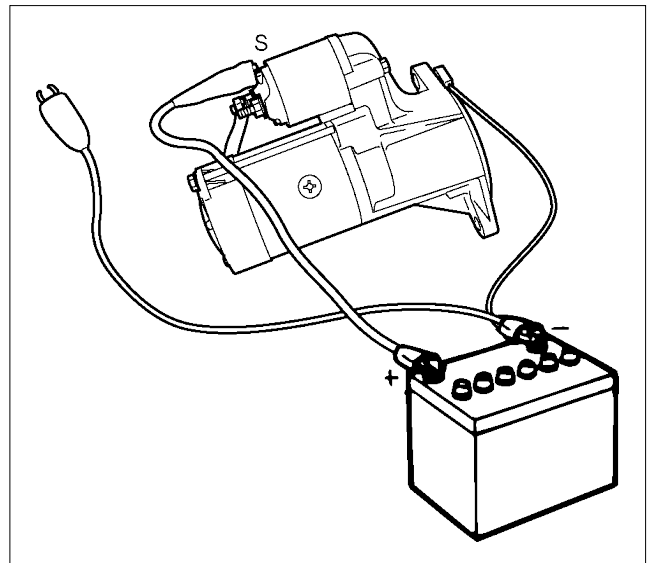
Connect the battery negative terminal with the solenoid switch body and the M terminal. When current is applied to the S terminal from the battery positive terminal, the pinion should flutter.



RTW46DSH004601

2. Hold-in Maintenance Test

Disconnect the lead at the M terminal. The pinion should continue to flutter.

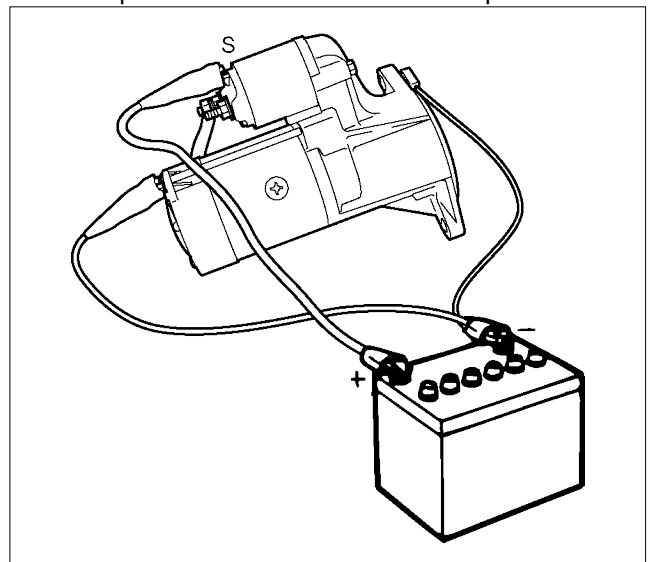


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3. Return Test

Disconnect the battery positive lead at the S terminal.

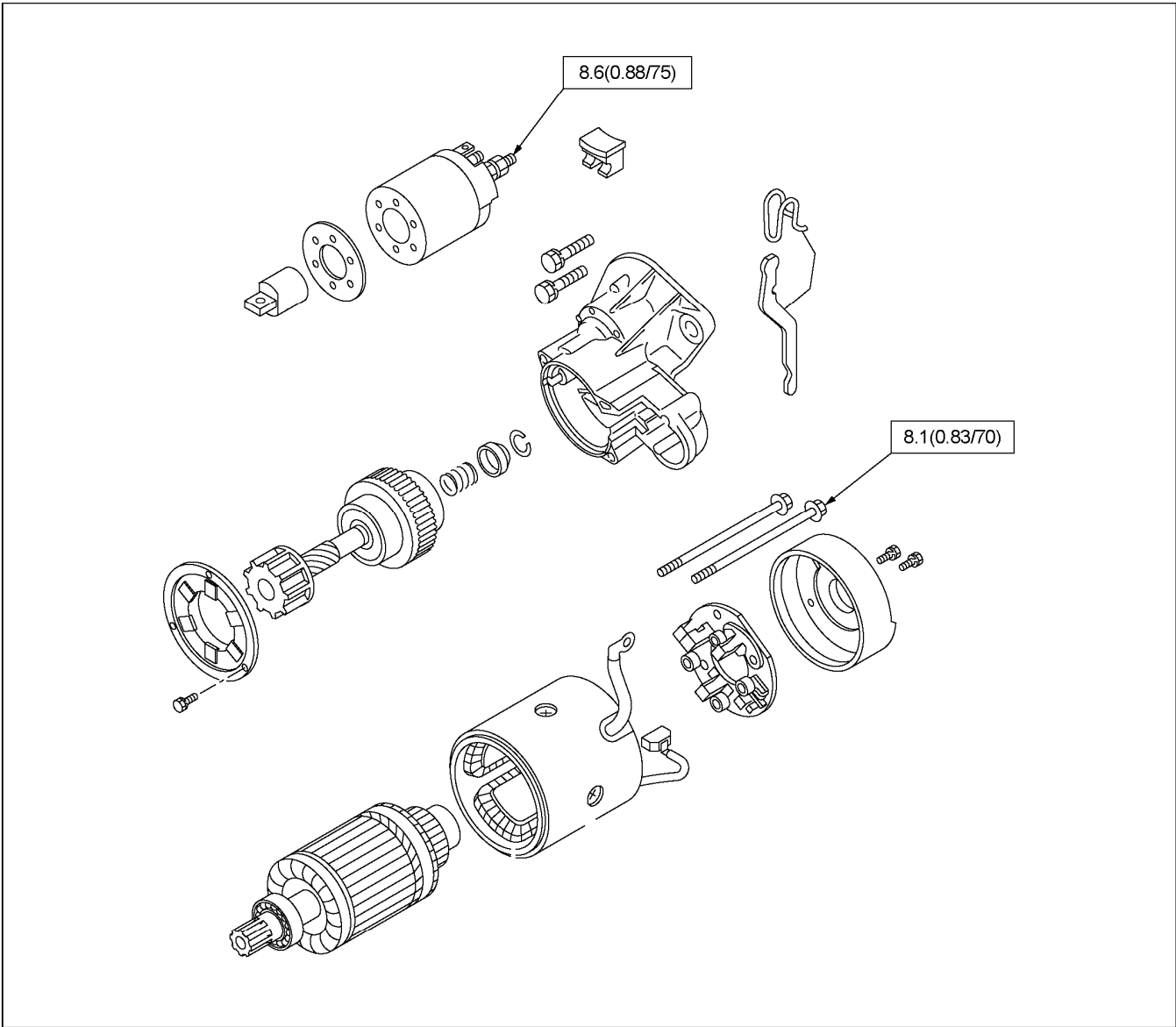
The pinion should return to its home position.



RTW46DSH004701

Torque Specifications

N·m (kg·m/lb in)



RTW76DLF000101

Pre-Heating System

Inspection and Repair

Make the necessary adjustments, repairs, and part replacement if excessive wear or damage is discovered during inspection.

Visual Check

Check the main fuses and glow indicator for damage.
Replace the part(s) if required.

Glow Relay

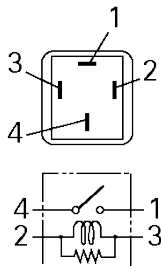
The glow relay is located in the relay box the engine compartment.

Use an ohmmeter to measure the resistance between terminals No.2 and No.3.

If the measured value is outside the specified range, the glow relay must be replaced.

Glow Relay Resistance Ohms

94 - 114



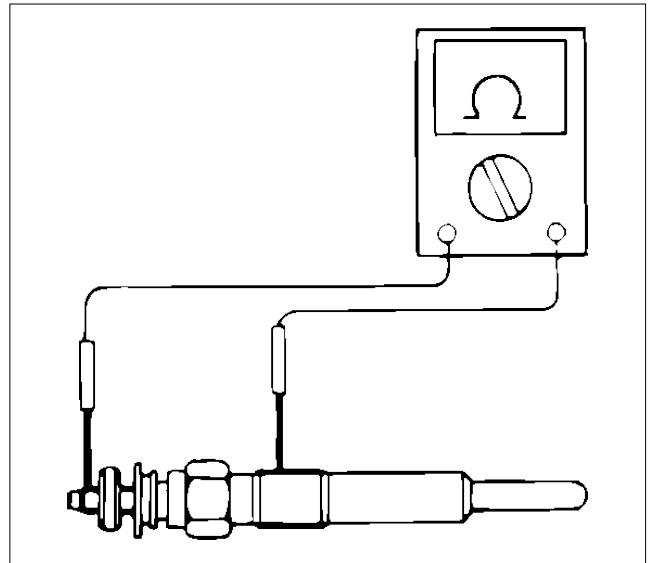
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Glow Plug

Use a circuit tester to test the glow plugs for continuity.

Glow Plug Resistance (Reference) Ohms

Approximately 0.9



LNW21KSH001401