

ENGINE 4H SERIES

SECTION 6D3
CHARGING SYSTEM

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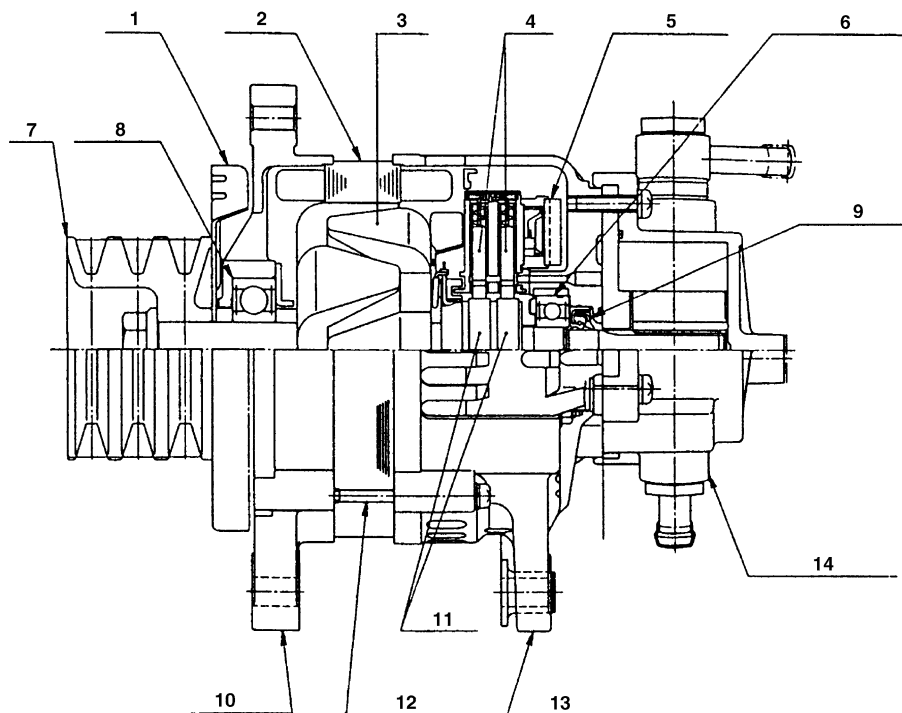
GENERAL DESCRIPTION

The charging system is the IC integral regulator charging system and its main components are connected as shown in figure.

The regulator is a solid state type and it is mounted along with the brush holder assembly inside the generator installed on the rear end cover.

The generator does not require particular maintenance such as voltage adjustment. The rectifier connected to the stator coil has nine diodes to transform A.C. voltage into D.C. voltage. This D.C. voltage is connected to the output terminal of generator.

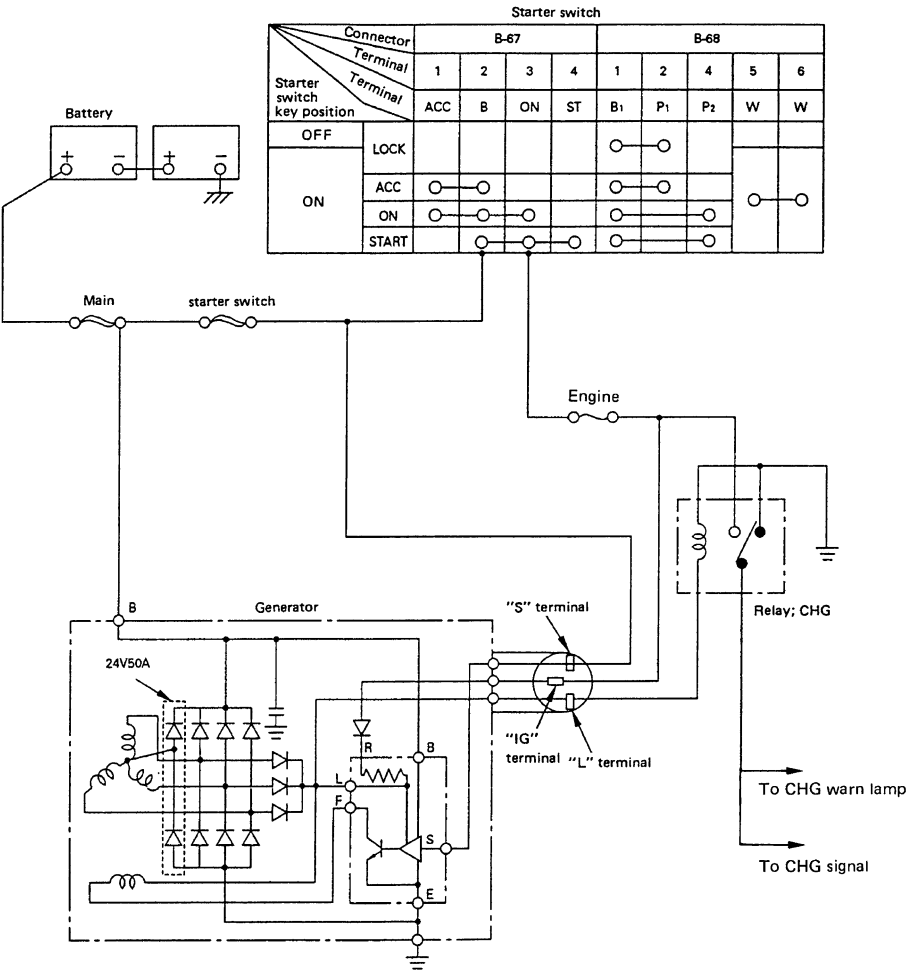
Component



N6A1032E

Legend

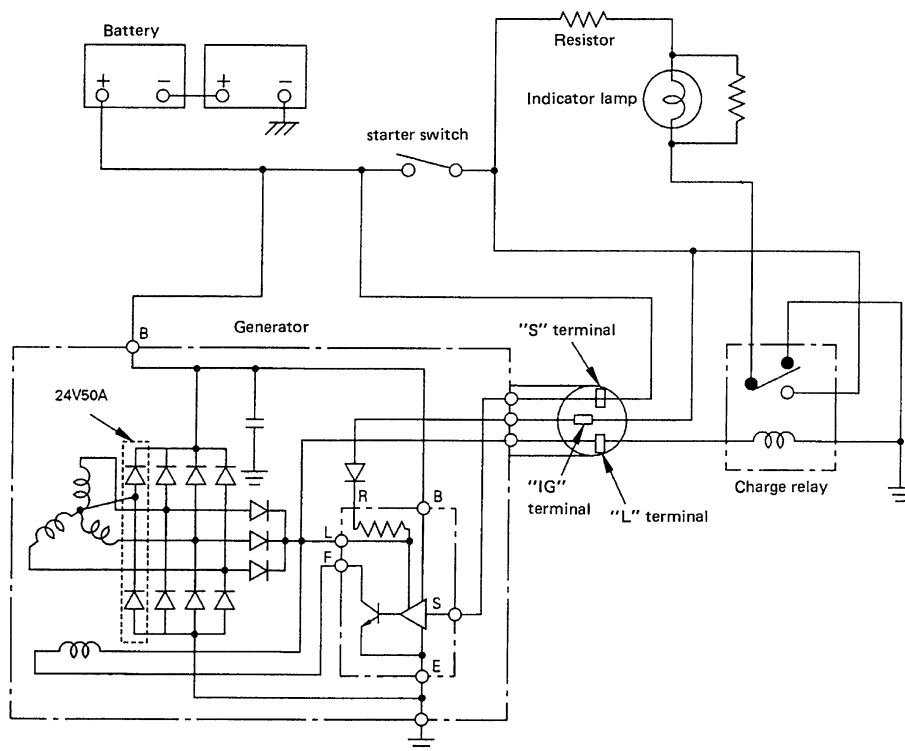
- | | |
|-----------------|------------------|
| 1. Fan | 8. Ball bearing |
| 2. Stator | 9. Oil seal |
| 3. Rotor | 10. Front cover |
| 4. Brush | 11. Slip ring |
| 5. IC regulator | 12. Through bolt |
| 6. Ball bearing | 13. Rear cover |
| 7. Pulley | 14. Vacuum pump |



DIAGNOSIS

General On-Vehicle Inspection

The operating condition of charging system is indicated by the charge warning lamp. The warning lamp comes on when the starter switch is turned to "ON" position. The charging system operates normally if the lamp goes off when the engine starts. If the warning lamp shows abnormality or if undercharged or overcharged battery condition is suspected, perform diagnosis by checking the charging system as follows:



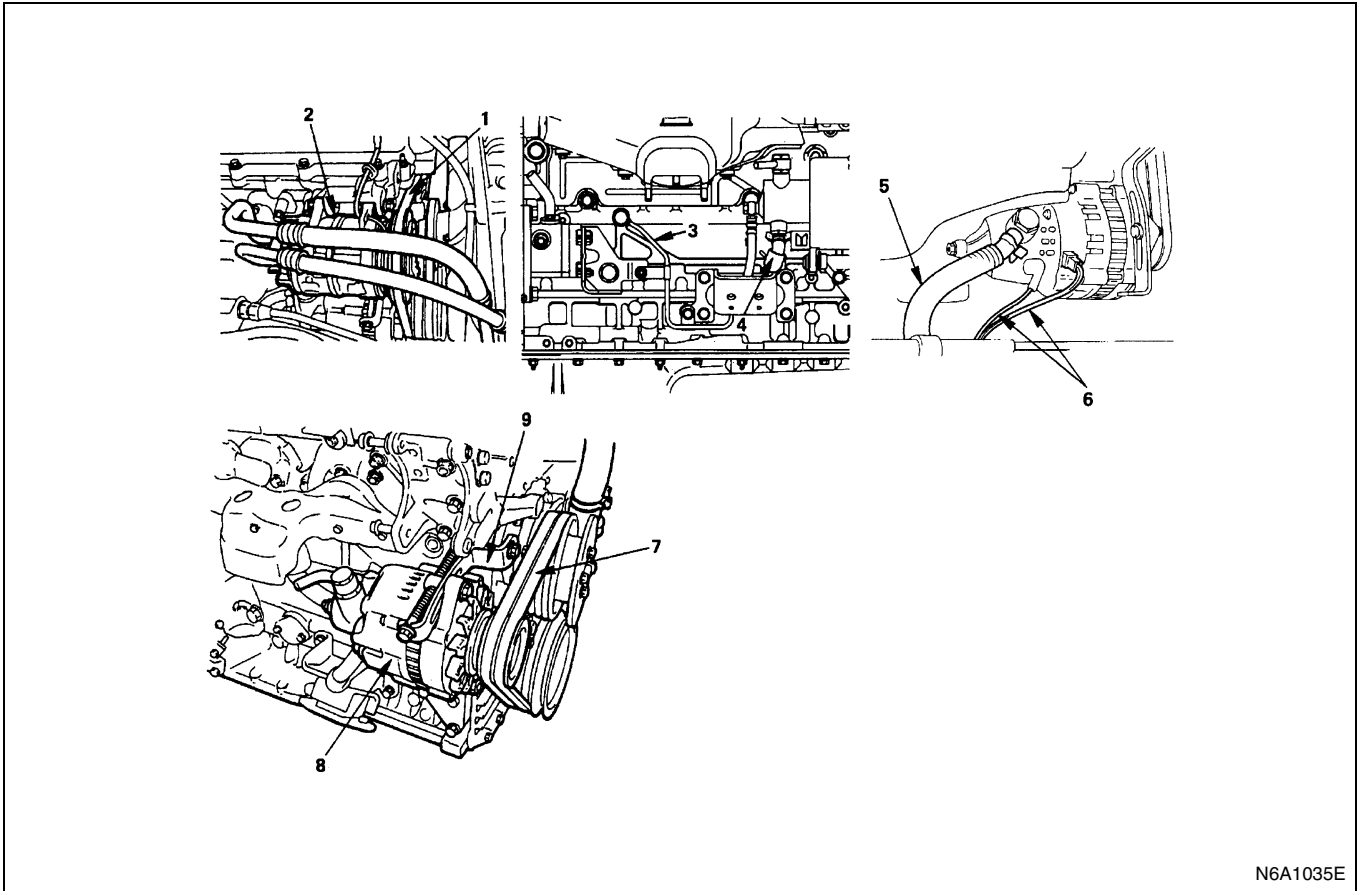
N6A1034E

1. Check visually the belt and wiring connector.
2. With the engine in stop status, turn the starter switch to "ON" position and observe the warning lamp.
 - If lamp does not come on:
Disconnect wiring connector from generator, and ground the terminal "L" on connector side.
 - If lamp comes on:
Repair or replace the generator.

ON-VEHICLE SERVICE

Component

Generator



N6A1035E

Legend

- | | |
|------------------------------|-----------------|
| 1. A/C compressor drive belt | 6. A/C harness |
| 2. A/C compressor | 7. Fan belt |
| 3. Vacuum pump oil pipe | 8. Generator |
| 4. Vacuum pump rubber hose | 9. Adjust plate |
| 5. Vacuum hose | |

Removal

Preparation

- Disconnect the battery ground cable.
 - Tilt the cab.
1. A/C Compressor Drive Belt (If equipped with A/C)
 2. A/C Compressor (If equipped with A/C)
 - After disconnecting the A/C compressor harness connector, demount the compressor from the A/C compressor bracket and fasten it with a wire to an appropriate location together with the hoses.

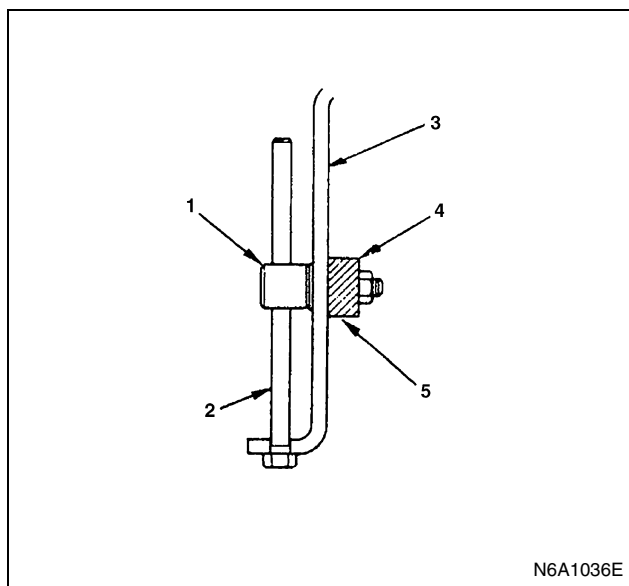
3. Vacuum Pump Oil Pipe
4. Vacuum Pump Rubber Hose
5. Vacuum Hose
6. A/C Harness

Disconnect the B terminal cable and harness connector from generator.

7. Fan Belt
8. Generator
9. Adjust Plate

Installation

1. Adjust Plate
Install the adjust plate as shown in the illustration.



Legend

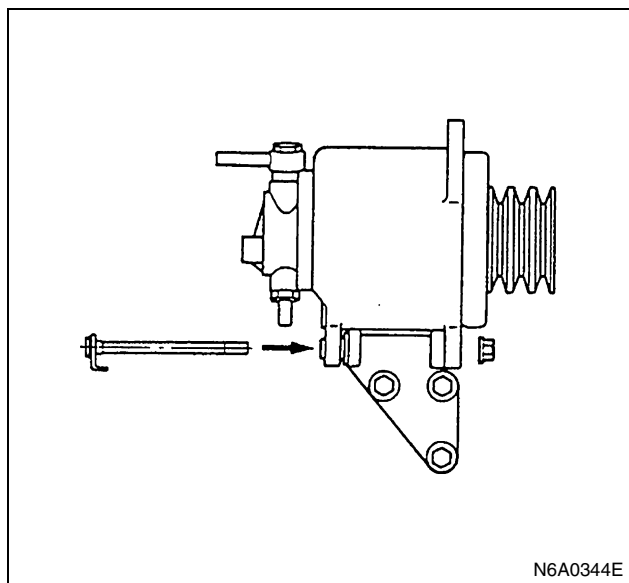
1. Sliding piece
2. Adjust bolt
3. Adjust plate
4. Nut
5. Generator

2. Generator

Notice:

Before tightening the generator, tighten in advance the fan belt temporarily after its adjustment.

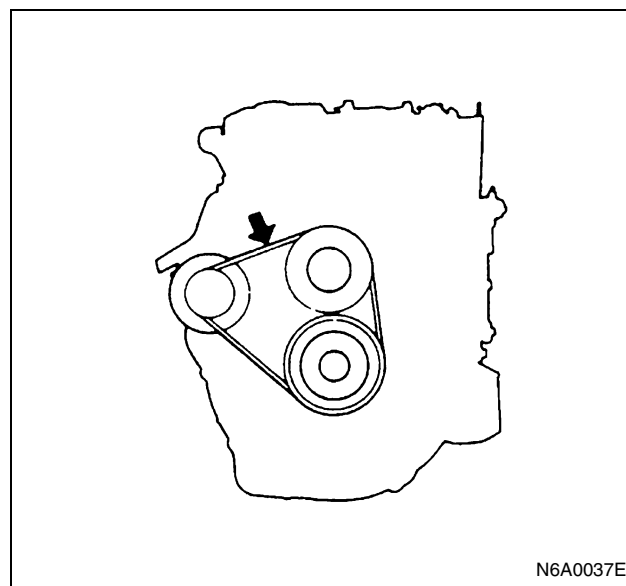
- Insert the lower fixing bolt from the rear side as shown in the illustration, and tighten it with a nut on the front side.



3. Fan Belt

Check the drive belt tension.

Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

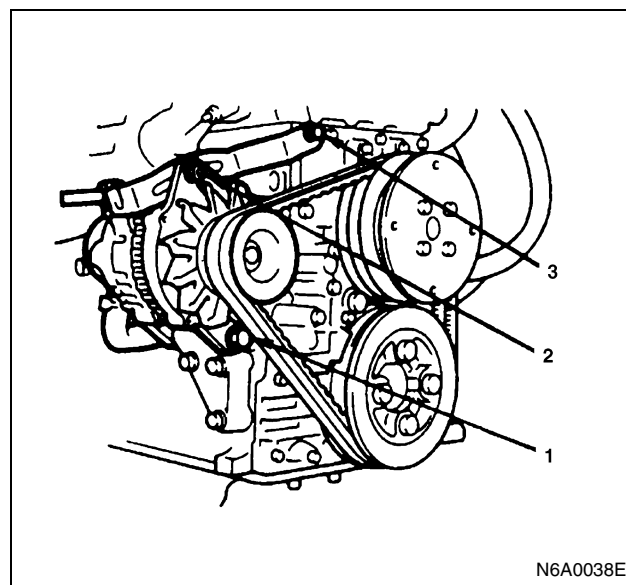


Drive Belt Deflection		mm (in)
New belt		8 — 12 (0.31 — 0.47)
Reuse belt		10 — 14 (0.39 — 0.55)

Check the drive belt for cranking and other damage.

Fan Belt Adjustment

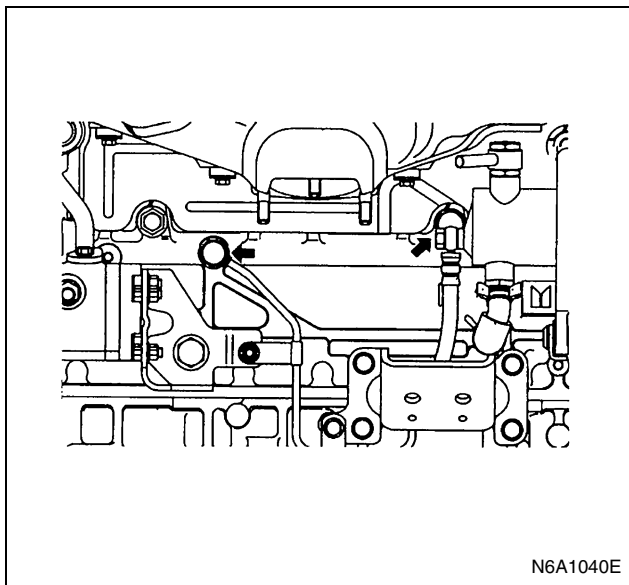
Fan belt tension is adjusted by moving the generator.



Tighten:

Bolt to

- (1): 40 N·m (4.1 kg·m / 30 lb·ft)
- (2): 24 N·m (2.4 kg·m / 17 lb·ft)
- (3): 46 N·m (4.7 kg·m / 34 lb·ft)
- 4. ACG Harness
- 5. Vacuum Hose
- 6. Vacuum Pump Rubber Hose
- 7. Vacuum Pump Oil Pipe

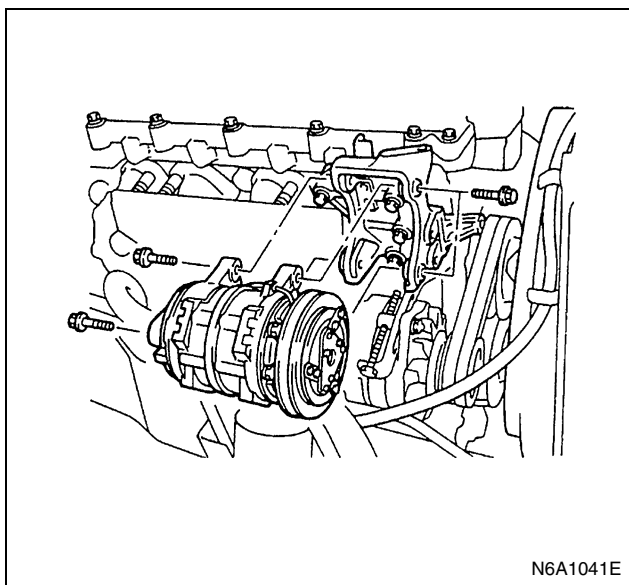


N6A1040E

Tighten:

Vacuum pump oil pipe to

- Cylinder body side: 41 N·m (4.2 kg·m / 30 lb·ft)
 - Generator side: 23 N·m (2.3 kg·m / 17 lb·ft)
8. A/C Compressor (If equipped with A/C)



N6A1041E

- Tighten the fixing bolts to the specified torque.

Tighten:

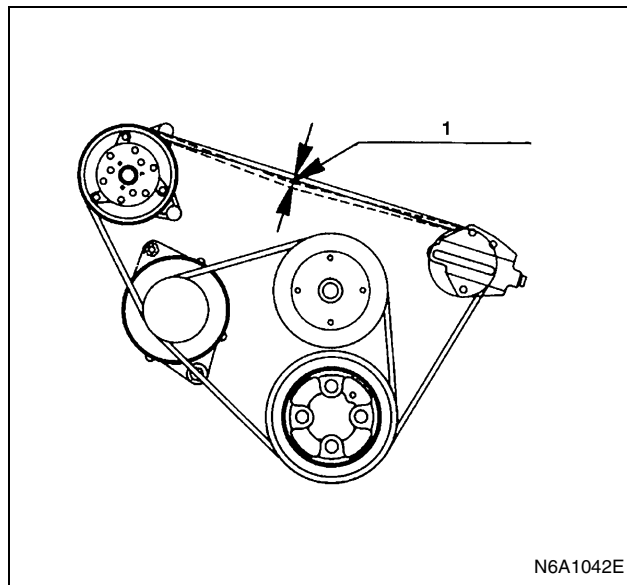
A/C compressor bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

Notice:

When installing the compressor fixing bolts, tighten first the 2 bolts on the rear side, and then the remaining 2 on the front side.

9. A/C Compressor Drive Belt (If equipped with A/C)

- Install the drive belt adjust belt tension by adjusting bolt and tighten the locking nut to the specified torque.
- Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.



N6A1042E

Legend

1. Belt deflection

Drive Belt Deflection		mm (in)
New belt		16 — 20 (0.63 — 0.79)
Reuse belt		18 — 22 (0.71 — 0.87)

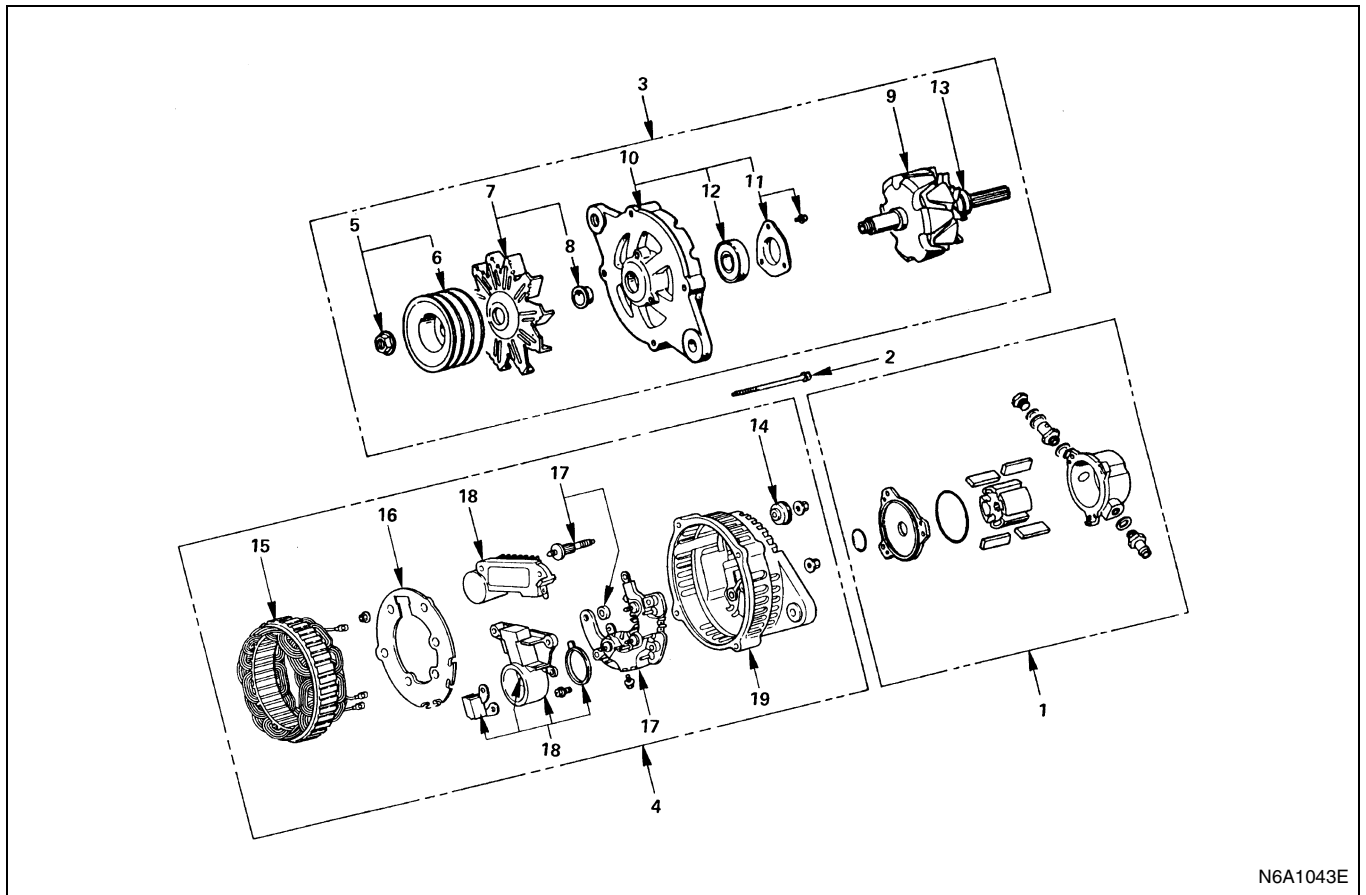
Tighten:

Locking nut to 27 N·m (2.8 kg·m / 20 lb·ft)

- Connect the negative battery cable.
- Lower the cab.

UNIT REPAIR

Component



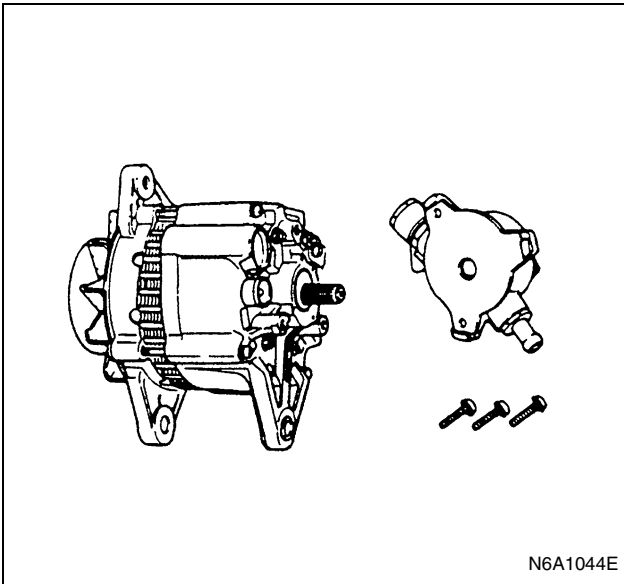
N6A1043E

Legend

- | | |
|-----------------------------------|----------------------------|
| 1. Vacuum pump assembly | 11. Bearing retainer |
| 2. Through bolt | 12. Front ball bearing |
| 3. Rotor and front cover assembly | 13. Rear ball bearing |
| 4. Stator and rear cover assembly | 14. Terminal nut and bolt |
| 5. Pulley nut | 15. Stator |
| 6. Pulley | 16. Fan guide |
| 7. Fan | 17. Rectifier |
| 8. Spacer | 18. Brush and IC regulator |
| 9. Rotor | 19. Rear cover |
| 10. Front cover | |

Disassembly

1. Vacuum Pump Assembly



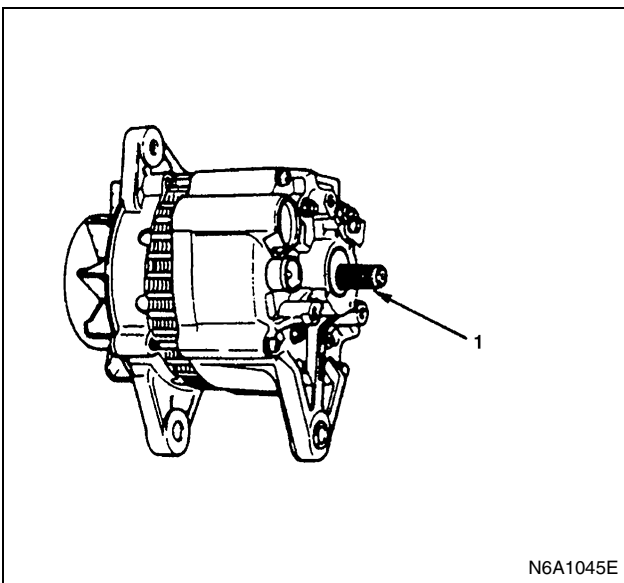
- 1) Loosen the vacuum pump fixing bolts.
- 2) Support the vacuum pump center plate.
- 3) Carefully remove the vacuum pump.

2. Through Bolt

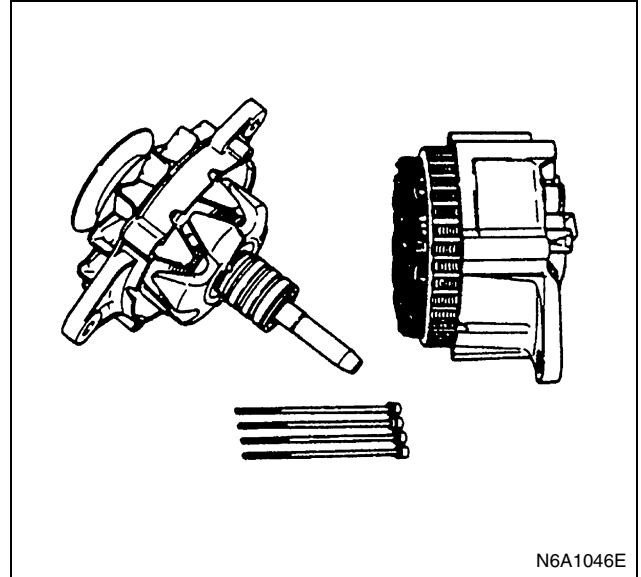
3. Rotor and Front Cover Assembly

4. Stator and Rear Cover Assembly

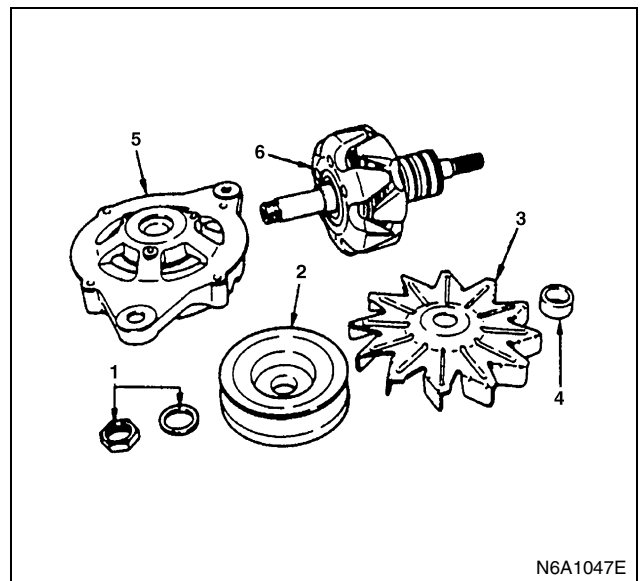
- 1) Loosen the through bolts.
- 2) Remove the rotor and front cover assembly from the stator and rear cover assembly. Do not allow the stator to separate from the rear cover. Take care not to damage the oil seal. Tape the rotor splines to protect them from damage.



5. Pulley Nut
6. Pulley
7. Fan
8. Spacer
9. Rotor



- 1) Carefully clamp the rotor assembly in a vice.

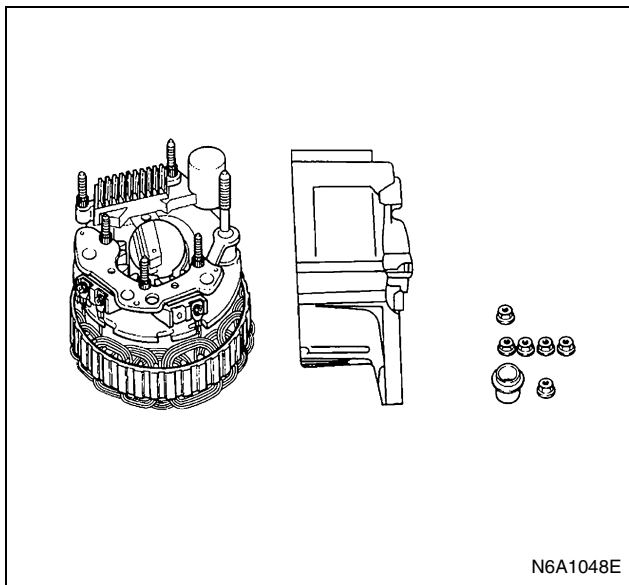


- 2) Loosen the pulley nut (1).
- 3) Remove the pulley (2), the fan (3), the spacer (4), the front cover (5) and the rotor (6).

10. Front Cover
11. Bearing Retainer
12. Front Ball Bearing
13. Rear Ball Bearing
14. Terminal Nut and Bolt
15. Stator

Legend

1. Taping



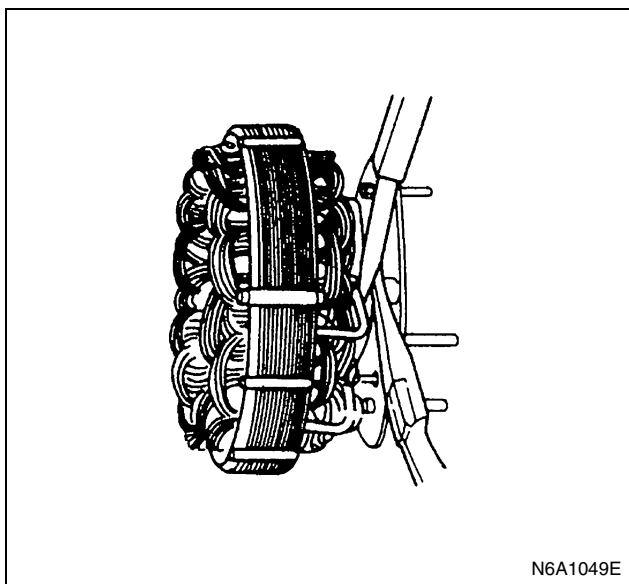
- 1) Loosen the terminal nuts and bolts.
- 2) Remove the lead wire, the insulators, and the washers.
- 3) Remove the stator and the IC regulator assembly from the rear cover.

16. Fan guide

17. Rectifier

18. Brush and IC Regulator

Disconnect the stator coil leads between each rectifier and the N-terminal by melting the solder connection.

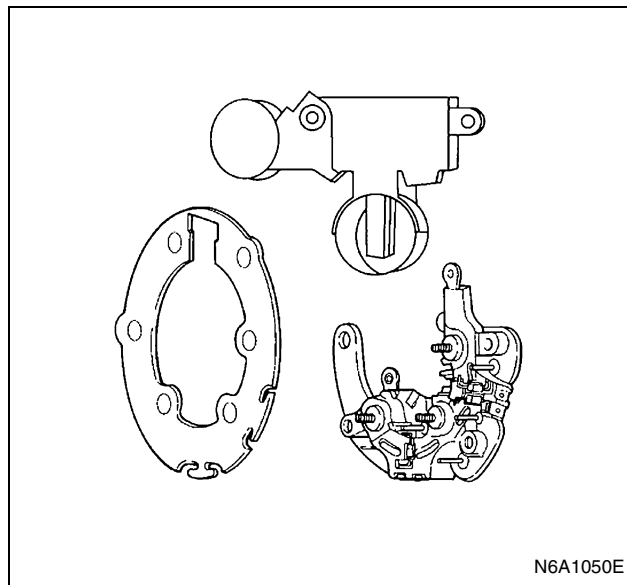


Notice:

Hold the lead wire between the solder and the rectifier with a pair of long nose pliers.

This will prevent heat transfer and resultant damage to the rectifier.

Refer to "INSPECTION AND REPAIR" for the IC regulator, the rectifier, the brush holder, and the condenser replacement procedures.



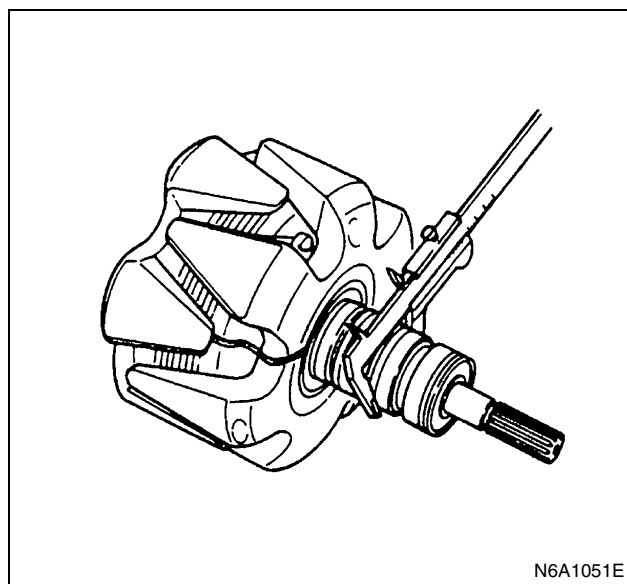
19. Rear Cover

Inspection and Repair

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

Rotor

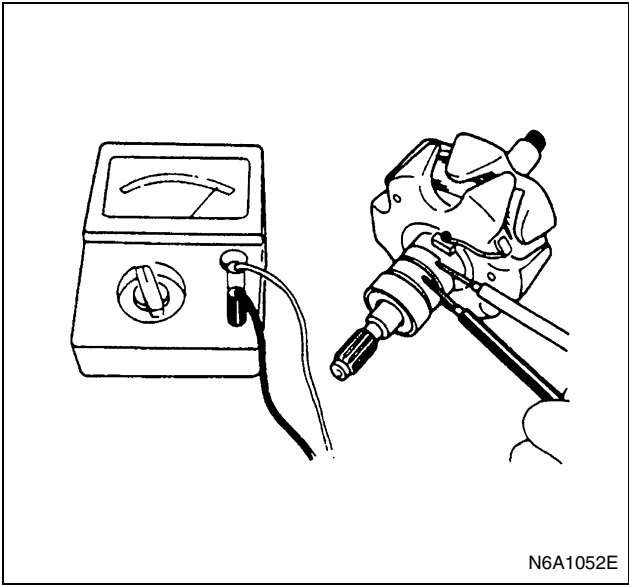
1. Inspect the slip ring faces for dirt and pitting. Wipe away any dirt with a clean cloth soaked in alcohol. Use a hand grinder to remove pitting.
2. Measure the slip ring diameter.



Slip Ring Diameter		mm (in)
Standard	Limit	
37.6 (1.480)	36.6 (1.441)	

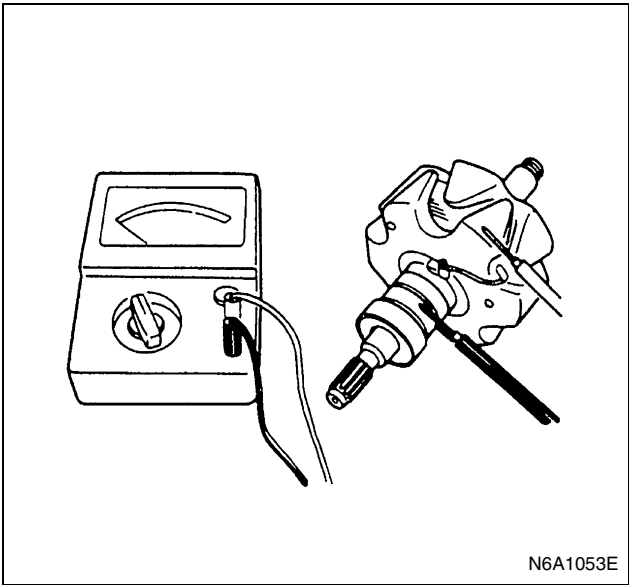
If the slip ring diameter is less than the specified limit, the slip rings must be replaced.

3. Measure the rotor coil resistance.



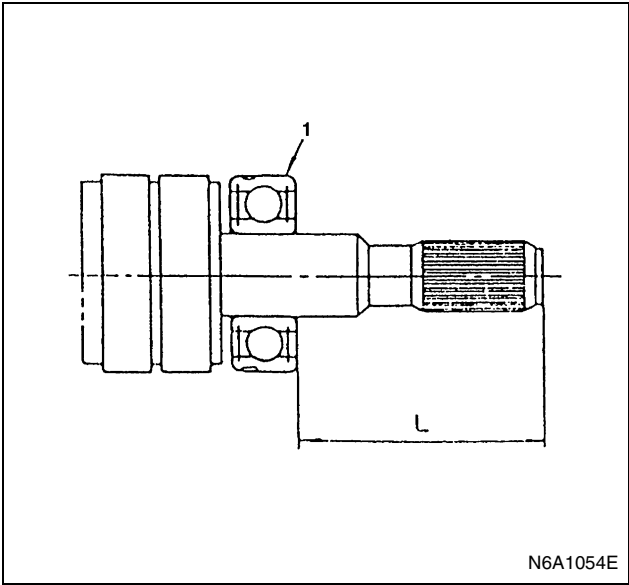
Rotor Coil Resistance at 20°C (68°F)		ohms
Standard		12.6

4. Check for continuity between the slip rings and the rotor core or shaft.



If there is continuity, the entire rotor assembly must be replaced.

5. Rear ball bearing



Legend

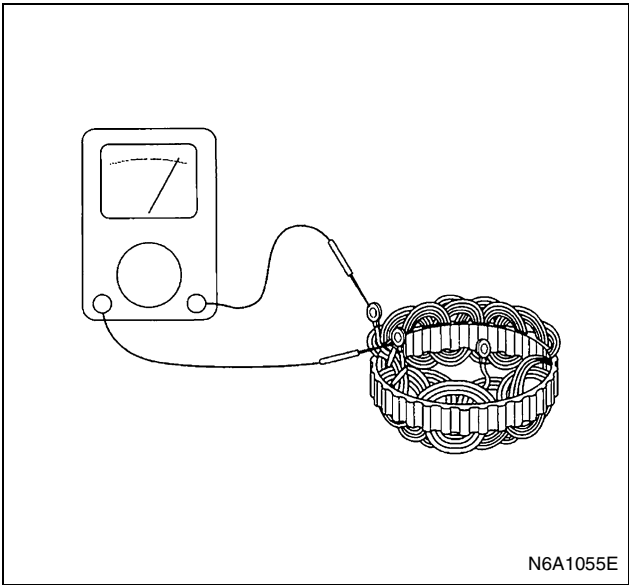
1. Ball bearing

- Check to see if the ball bearings rotate lightly with no noise heard.
- As the result of inspection, it is found that the ball bearing do not rotate lightly or any noises are heard, replace them with new ones.

Press-in measurement (L) when changing bearings		mm (in)
Standard		58.0 — 58.2 (2.283 — 2.291)

Stator

1. Check for continuity across the stator coils.

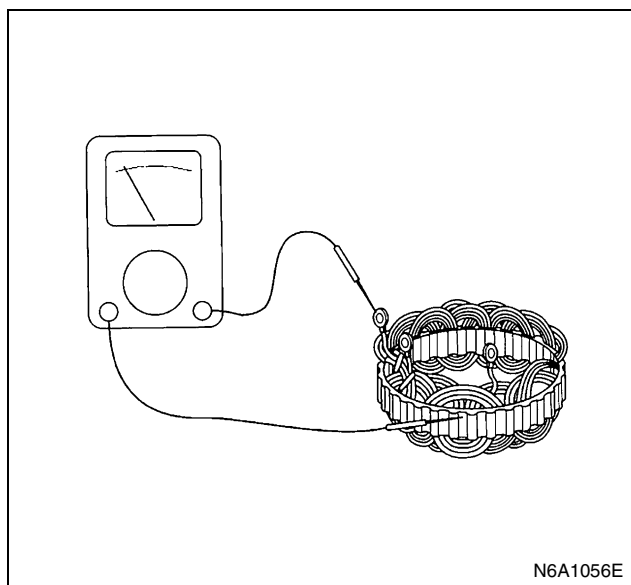


If there is no continuity, the stator coils must be replaced.

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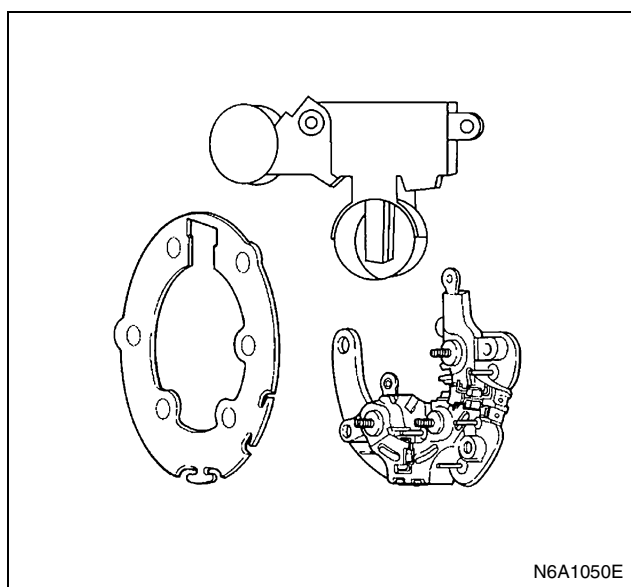
Resistance Between The Coil End "N" And The Each Coil Ends (Reference)		ohms
Standard		0.17

- Check for continuity between each stator coil and the stator core.



If there is continuity, the stator coils must be replaced.

Rectifier, IC Regulator, and Brush Holder Assembly Disassembly



- Disconnect the IC regulator and the rectifier by melting the solder connections.
- Loosen the terminal bolt to remove the rectifier.
- Disconnect the IC regulator, the brush holder, and the condenser by melting the solder connections.
- Remove the IC regulator from the terminal plates.

- Remove the stud bolts from the terminal plate.

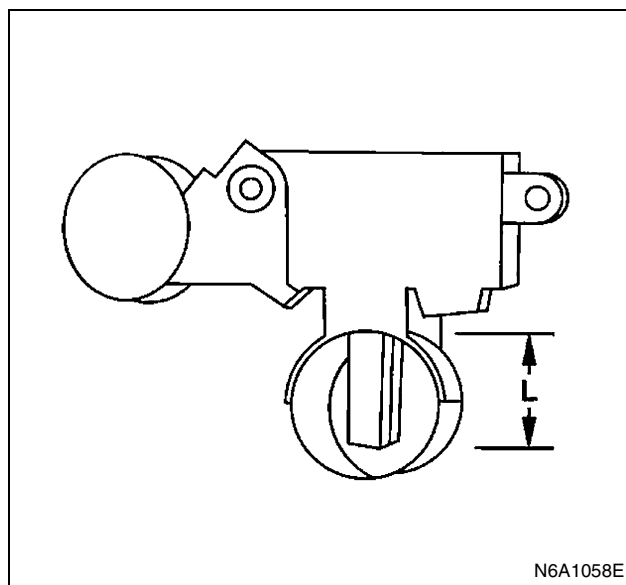
Notice:

If the brushed, brush holder, and the condenser to be re-used, do not remove the stud bolts.

- Remove the brush holder from the terminal plate.

Inspection

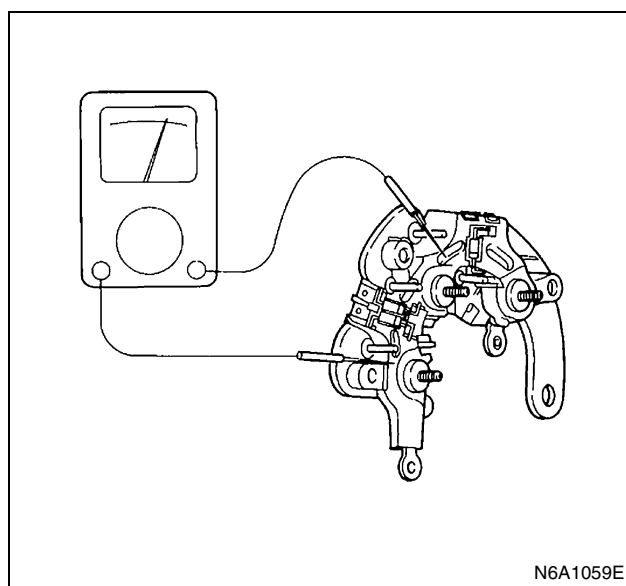
- Brush
Each brush has a line to indicate whether or not the brush is serviceable.

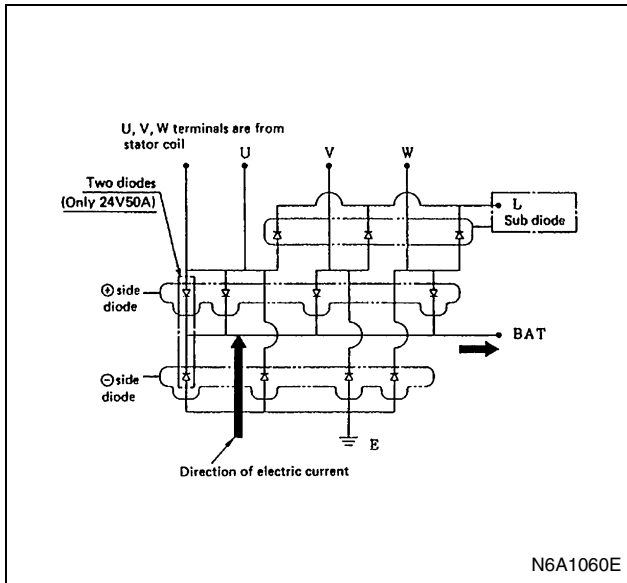


If the line is not visible, the brush must be replaced.

Brush Length (Reference)		mm (in)
Standard		Limit
25 (0.984)		6 (0.236)

- Rectifier





- 1) Check for continuity with a circuit tester between the battery and each of the three stator coil lead terminals.

If there is continuity from battery to each of the three stator coil lead terminals, the rectifier is normal.

If there is no continuity, the rectifier must be replaced.

Check for continuity with a circuit tester between the earth and each of the three stator coil lead terminals.

If there is continuity from each of the three stator coil lead terminals to earth, the rectifier is normal.

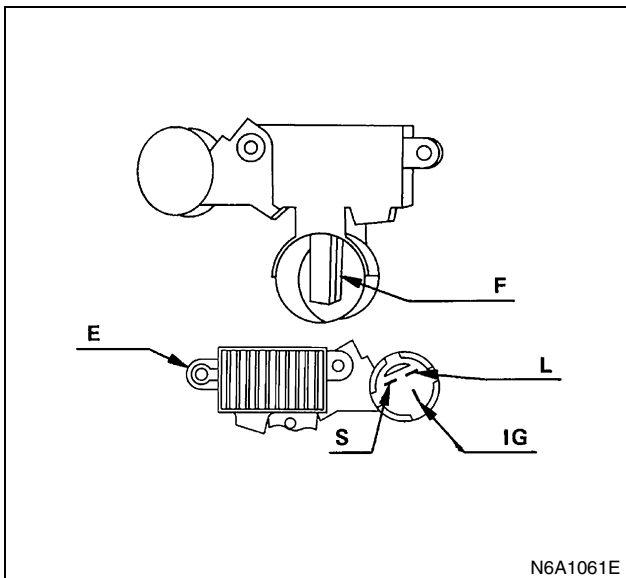
If there is no continuity, the rectifier must be replaced.

- 2) Reverse the polarity of the test probes.

If there is no continuity, the rectifier is normal.

If there is continuity, the rectifier must be replaced.

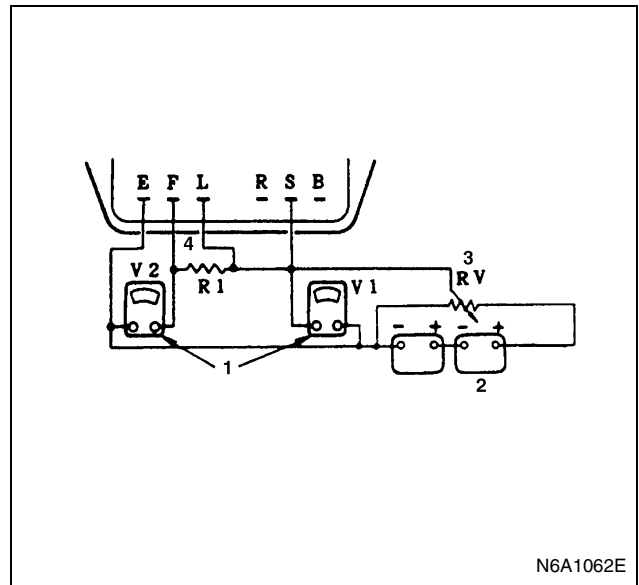
3. IC Regulator



The IC regulator may be tested with either a circuit tester or pair of standard voltmeters.

Refer to the illustration.

- 1) Circuit tester (or voltmeter) range is from 0 — 50 volts in 0.5 volt increments.
 - 2) Two twelve volt batteries are required.
 - 3) Note the variable resistor.
 - 4) This resistor is rated at 100 watts/3 ohms.
- #### 4. Testing the IC Regulator



Refer to the wiring diagram when testing the IC regulator.

- 1) Connect the batteries in series.
- 2) Measure the battery power (voltage).

Battery Power	V
28 — 29	

- 3) Connect the circuit tester (1) (or voltmeter V2) as shown in the illustration.

- 4) Set the variable resistor (3) to zero.

- 5) Slowly increase the resistance of the variable resistor toward the build-up point.

Measure the voltage between E and F.

As long as the resistance is below the build-up point, the voltage reading should be stable and less than two volts.

When the resistance exceeds the build-up point, the voltage reading should be two volts or greater.

If the voltage does not exceed two volts after reaching the build-up point, the IC regulator must be replaced.

- 6) Return the variable resistor (3) to zero.

- 7) Connect the circuit tester (or voltmeter V1) as shown in the illustration.

- 8) Measure the voltage at terminals S, L, and E.

- 9) Slowly increase the resistance of the variable resistor.

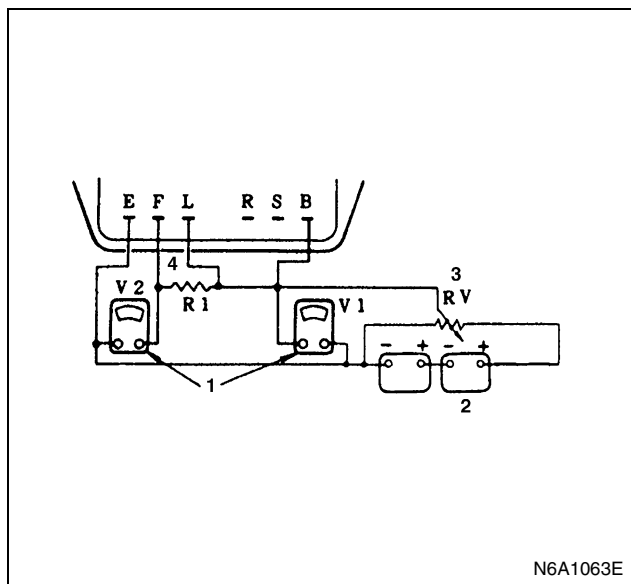
6D3-14 CHARGING SYSTEM

Note the point at which the voltage quickly builds up to between 2 and 6 volts.

This will indicate the point at which the voltage regulator begins to function.

If the measured voltage is outside the specified range, the voltage regulator must be replaced.

- 10) Repeat Steps 3 through 5 to measure the voltage between terminals B, L, and E.

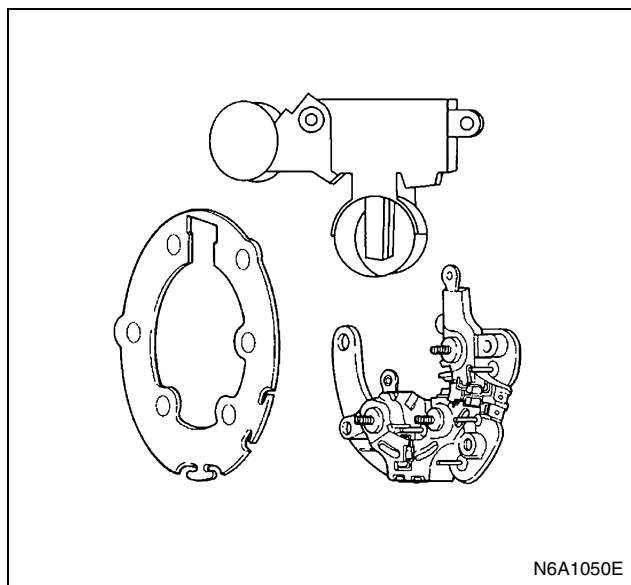


Refer to the wiring diagram.

The regulator voltage should be between 0.5 and 3 volts higher than the measured voltage.

If the regulator voltage is outside this range, the voltage regulator must be replaced.

Reassembly



1. Install the brush holder and the stud bolts to the terminal plate.
Check that the stud bolts fit properly.
2. Attach the IC regulator to the terminal plate.
3. Solder the IC regulator, the brush holder and the condenser.

Take care not to heat the IC regulator.

Over-heating will resulting damage to the IC regulator.

4. Set the rectifier to the IC regulator assembly.

5. Solder rectifier and IC regulator.

Take care not to heat the IC regulator.

Over-heating will resulting damage to the rectifiers and the IC regulator.

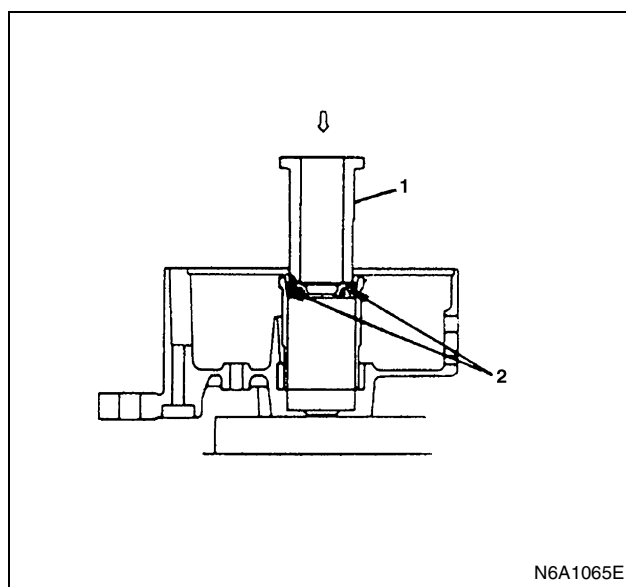
6. Tighten the rectifier terminal bolt.

Oil Seal

Check the rear cover oil seal bore for oil leakage.

Oil Seal Replacement

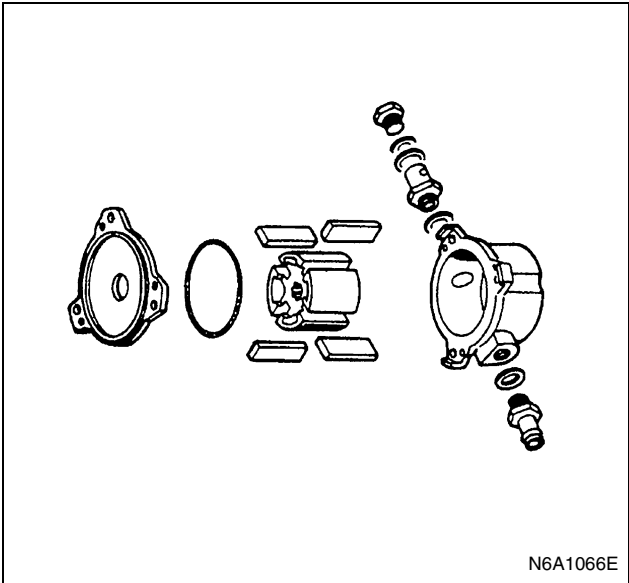
1. Use a screwdriver to remove the oil seal from the rear cover side.
Take care not to damage the oil seal bore.
2. Discard the used oil seal.
3. Use the oil seal installer to install the new oil seal.



Legend

1. Oil seal installer
2. Oil seal

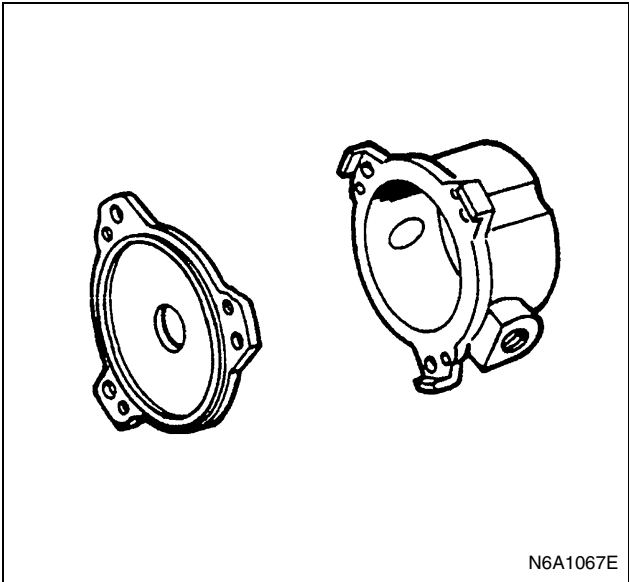
Vacuum Pump
Disassembly



1. Remove the center plate from the vacuum pump housing.
2. Remove the vacuum pump rotor and the vanes from the housing.

Inspection and Repair

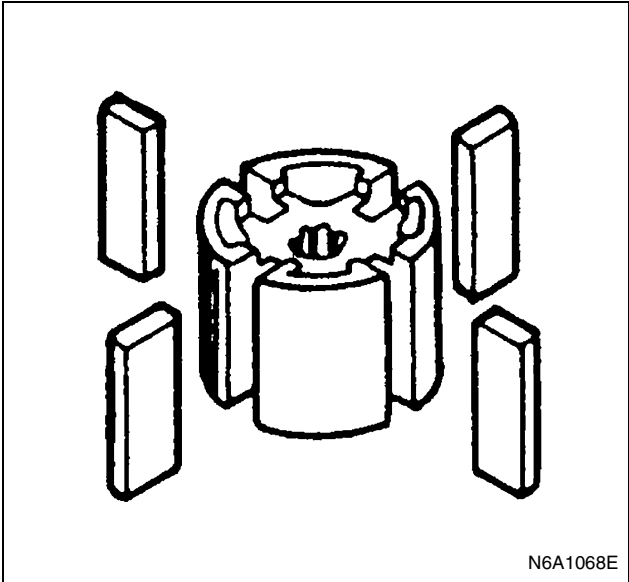
1. Vacuum Pump Housing and Center Plate



Inspect the vacuum pump housing and the center plate for excessive wear, abrasion, and scoring. If any of these conditions are present, the vacuum pump housing and center plate must be replaced. Inspect the vacuum pump housing inside for wear and damage. If the measured inside diameter is outside the specified range, replace the vacuum pump housing.

Vacuum Pump Housing Inside Diameter (Reference)		mm (in)
Standard		69.5 — 69.6 (2.736 — 2.740)

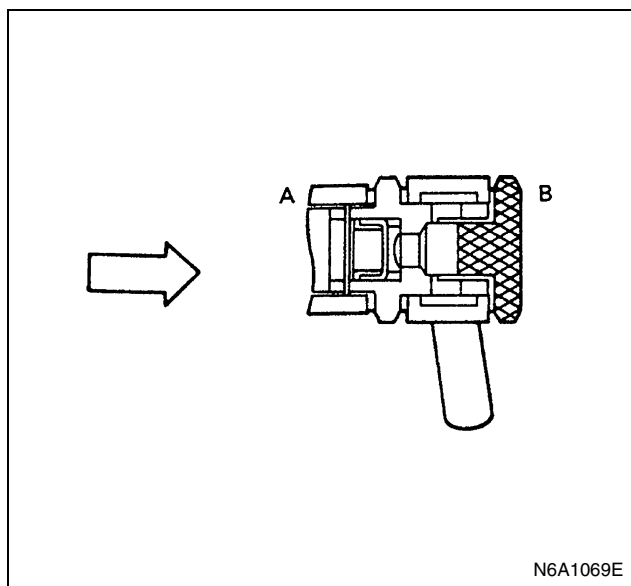
2. Vane



Inspect the vanes for excessive wear and damage. Replace all four vanes if either of these conditions are present. Never replace only one vane.

Vane Length (Reference)		mm (in)
Standard		18.0 (0.709)

3. Rotor
 - 1) Inspect the rotor for excessive wear, abrasion, and scoring. Pay particular attention to the internal spline. Replace the rotor if any of these conditions are present.
 - 2) Inspect the generator rotor shaft splines for backlash. Replace the rotor if backlash is present.
4. Check Valve
 - 1) Carefully force the valve from the “B” side as shown in the illustration.



The valve must move smoothly.

If it does not, the check valve must be replaced.

2) Apply compressed air to the "A" side.

Air Pressure	kPa (kg/cm ² /psi)
98 — 490 (1 — 5/14.22 — 71.10)	

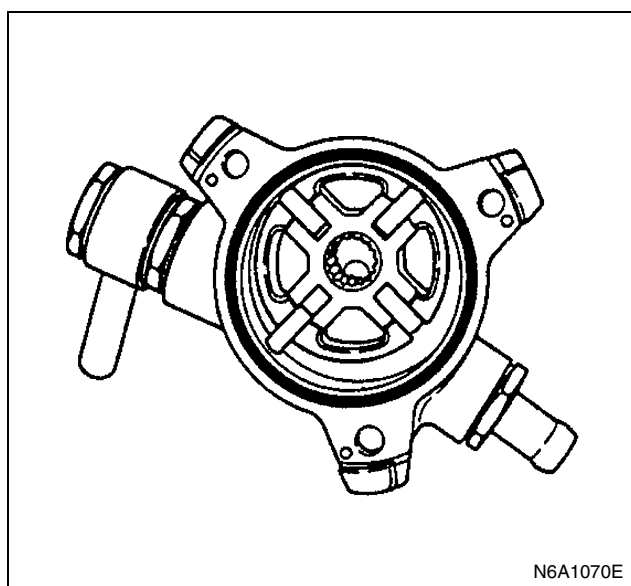
Check for air leakage from the check valve.

If there is air leakage, the valve must be replaced.

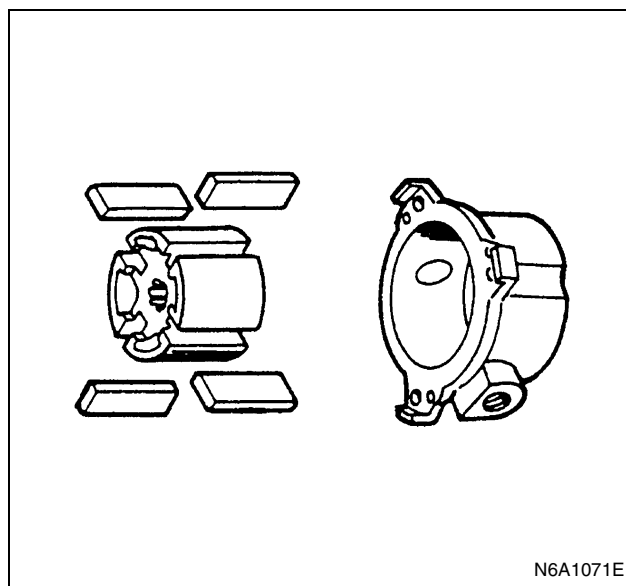
Reassembly

1. Install the vanes to the rotor slits.

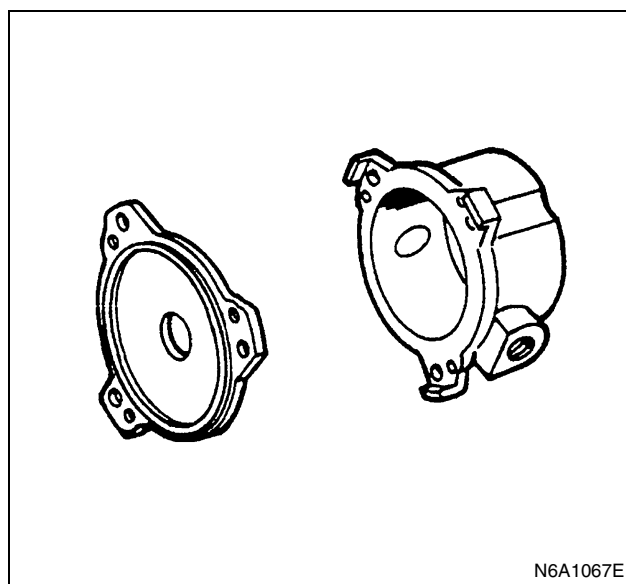
The rounded side of the vanes must be facing the rotor housing.



2. Install the rotor with the concave side facing the center plate.

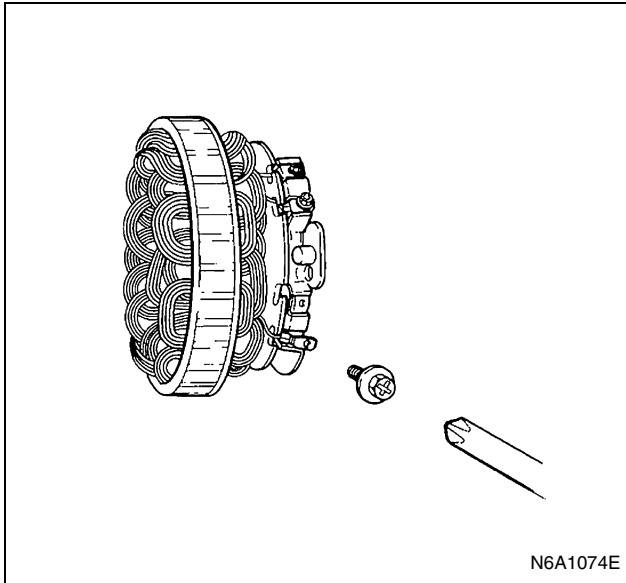


3. Install the center plate to the rotor housing.
Be sure to use a new O-rings.



Reassembly

1. Rear Cover
2. Brush and IC Regulator
3. Rectifier
4. Fan Guide
5. Stator



- 1) Solder together the rectifier and stator leads. Hold the rectifier lead near the rectifier with a pair of long-nose pliers to protect the rectifier from heat.

Complete the soldering procedure as quickly as possible.

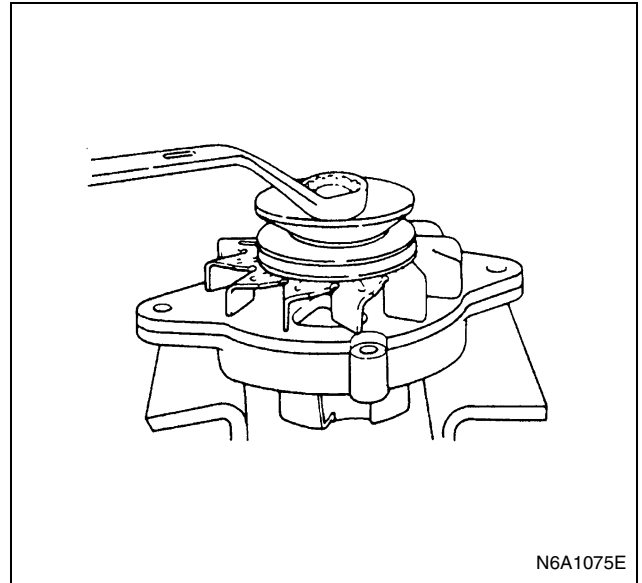
- 2) Install the IC regulator/stator assemblies to the rear cover.

Be absolutely sure that the washers and the insulators are reinstalled to their original positions.

Hold the stator coil against the rear cover.

6. Terminal Nut and Bolt
7. Rotor
8. Rear Ball Bearing
9. Front Cover
10. Front Ball Bearing
11. Bearing Retainer
12. Spacer
13. Fan
14. Pulley
15. Pulley Nut

- 1) Carefully clamp the rotor and cover assembly in a vise.
- 2) Install the pulley and the pulley nut.



- 3) Tighten the pulley to the specified torque.

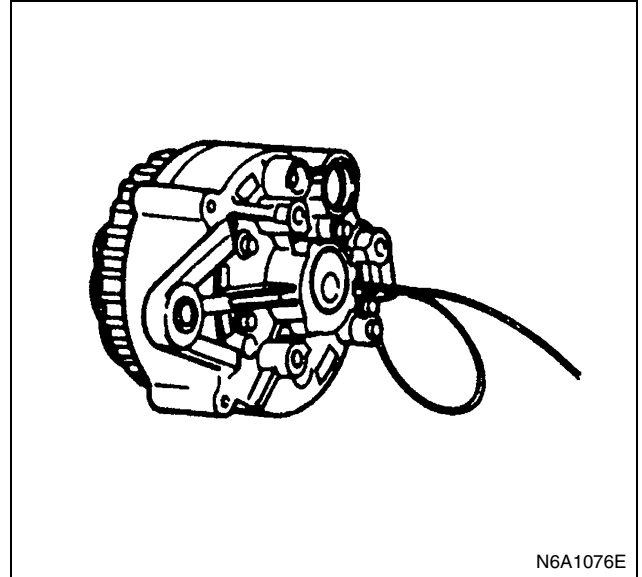
Tighten:

Pulley nut to 98 N·m (10.0 kg·m / 72 lb·ft)

Notice:

Take care not to damage the rotor when clamping it in a vise.

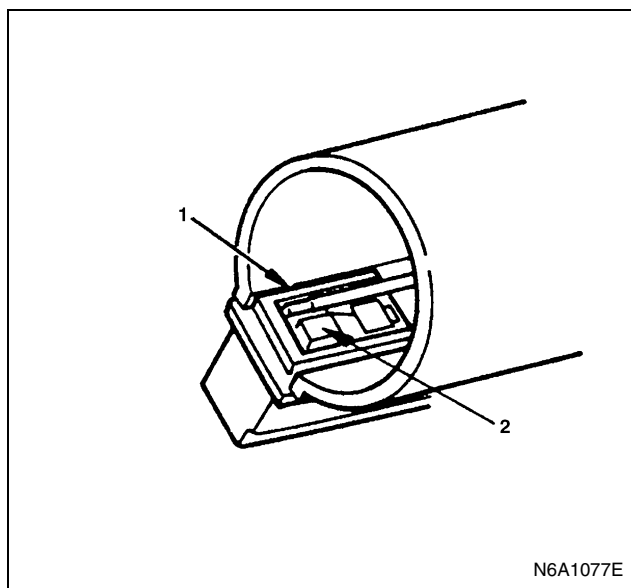
16. Stator and Rear Cover Assembly



17. Rotor and Front Cover Assembly

18. Through Bolt

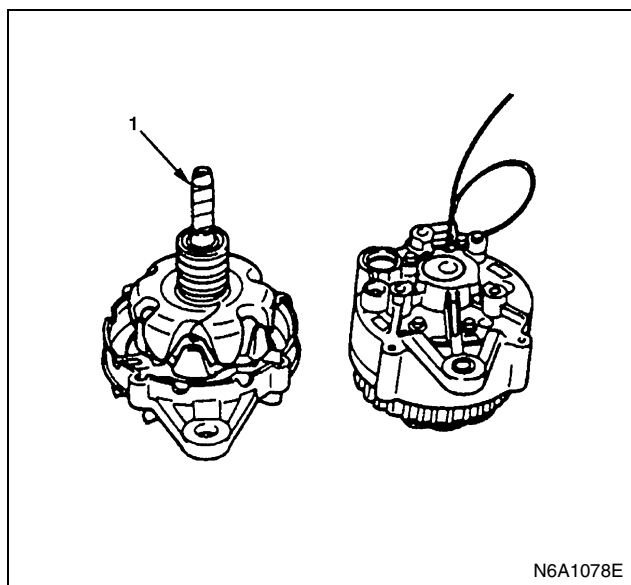
- 1) Prepare a brush holding wire or a pin.
- 2) Set the holding wire or the pin to the brushes from the vacuum pump side.
- 3) Push the brushes into the holder.



Legend

1. Brush holding wire or pin
2. Brush

- 4) Bend the wire end to hold the brushes. If the holding wire does not hold the brushes properly, the brushes will be damaged.
- 5) Tape the rotor shaft spline.

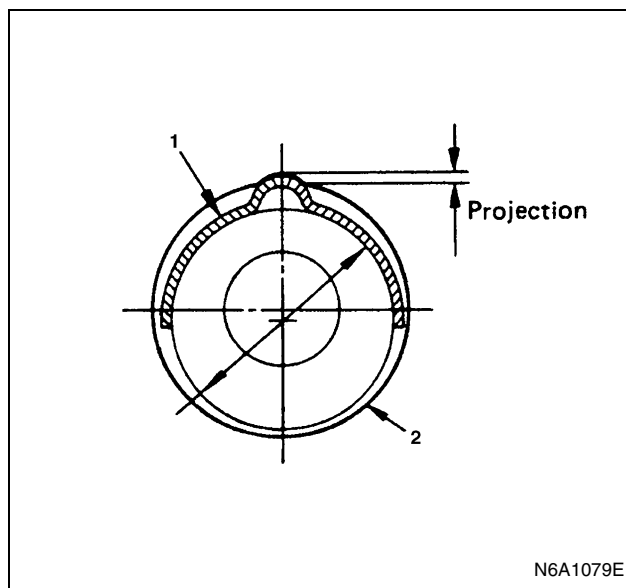


Legend

1. Taping

This will prevent oil seal damaged.

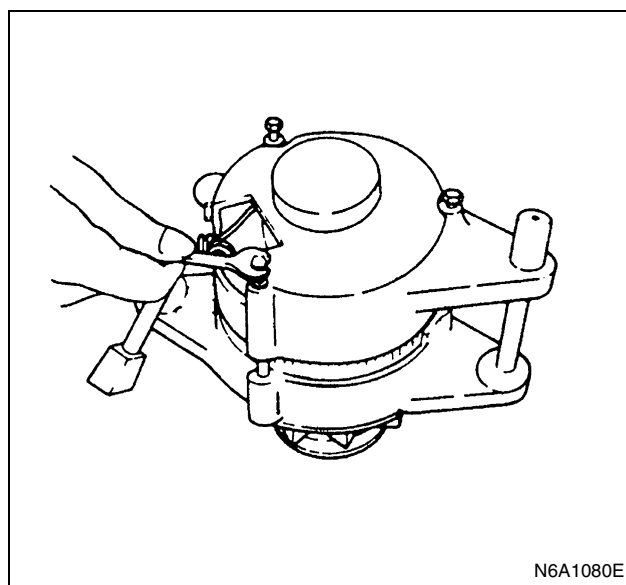
- 6) Place the bearing retainer ring. Ring projection must be less than 0.65 mm (0.025 in)



Legend

1. Retainer ring
2. Bearing outer race

- 7) Install the front cover and rotor assembly to the rear cover. Take care not to damage the rotor, the coil leads, the oil seal lip, and the splines.
- 8) Place the guide bar into the rear cover bracket hole. Align the front cover bracket hole with the guide bar.
- 9) Install the through bolts.
- 10) Tighten the through bolts to the specified torque.



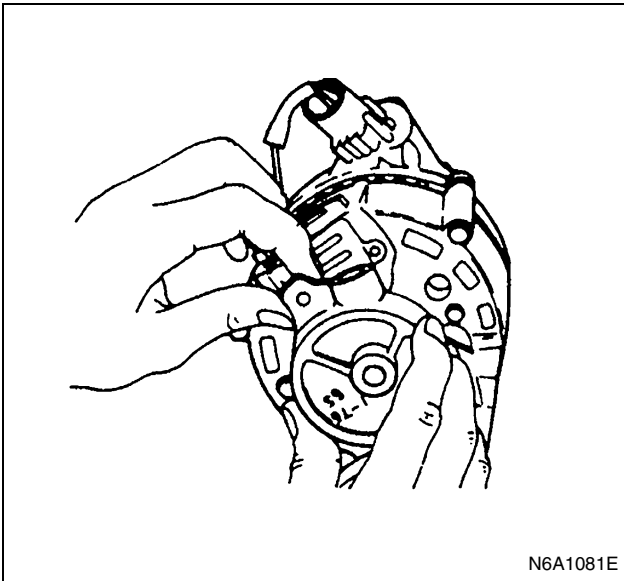
Tighten:

Through bolt to 4 N·m (0.4 kg·m / 35 lb·in)

- 11) Carefully remove the holding wire from the rear cover.

19. Vacuum Pump Assembly

- 1) Position the pump rotor together with the pump housing on the center plate.
The rotor serrated side must be facing up.



- 2) Rotate the rotor to align the rotor bore with the center plate bore.
- 3) Install the housing, the rotor, and the center plate.
The O-ring must not be projecting beyond the center plate slot.
Take care not to scratch the vanes.
- 4) Turn the housing to align it with the center plate.
- 5) Tighten the vacuum pump fixing bolts.

Tighten:

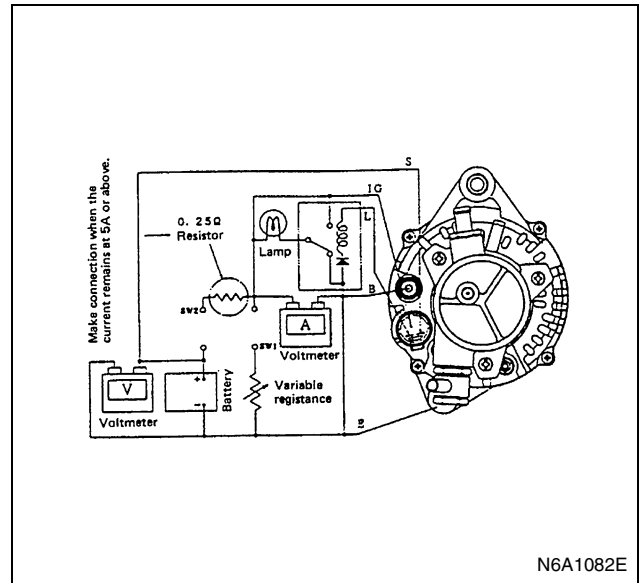
Vacuum pump fixing bolt to 7 N·m (0.7 kg·m / 61 lb·in)

- 6) Add 5cc of engine oil through the filler port.
- 7) Check that the generator spins smoothly by turning it with your hand.

Inspection**Performance Test**

1. Generator

- Connect the generator as shown in the illustration.



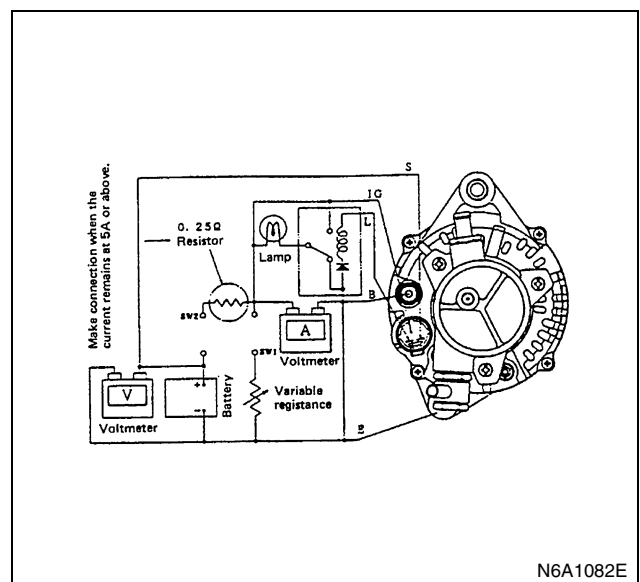
- Use a fully charged battery to conduct the measurement with the current outputted from the battery terminals at 5A or less.

Notice:

When conducting the performance test:

For the connection between the generator B terminal and the battery (+) terminal and between the E terminal and the battery (-) terminal, use a lead wire with a cross section of 8 mm² and the length of 2.5 m or less.

2. Adjusting voltage measurement



- Open SW1 and close SW2.
- With the number of the generator rotations raised up to its rated rotations of 5,000 rpm, measure the adjusting voltage.

Adjusting voltage = 28 - 29V

- Check to see if the fluctuation in the adjusting voltage is not caused by the increased number of rotations.

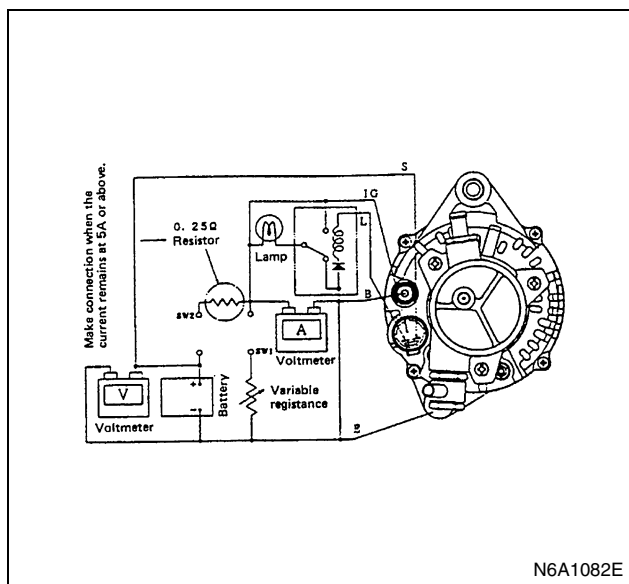
3. Measurement of the number of rotations at 27V

- Open SW1 and close SW2.

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- Increase the number of the generator rotations gradually until the reading of the voltmeter indicates 27V. Measure the number of rotations at this time.

4. Output current measurement



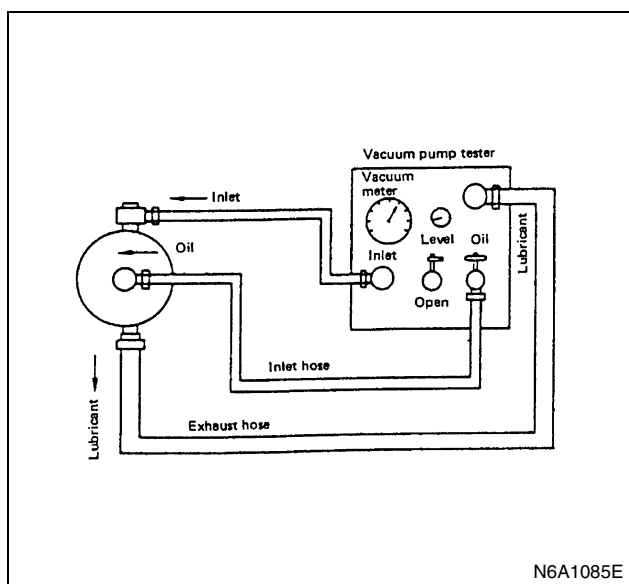
- Set the resistance of the variable resistor at the minimum, and rotate the generator with SW1 and SW2 closed.
- While keeping the voltage steady at 27V after adjusting the variable resistor, read the indicated value of the ammeter at the generator rotation of 5,000 rpm.

Current at 27V with 5,000 rpm = 35A or more (for 35A specification)

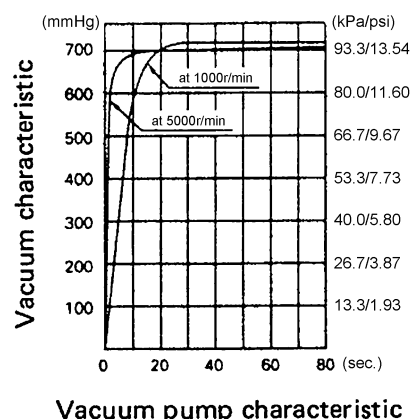
Current at 27V with 5,000 rpm = 45A or more (for 50A specification)

5. Unit test of vacuum pump

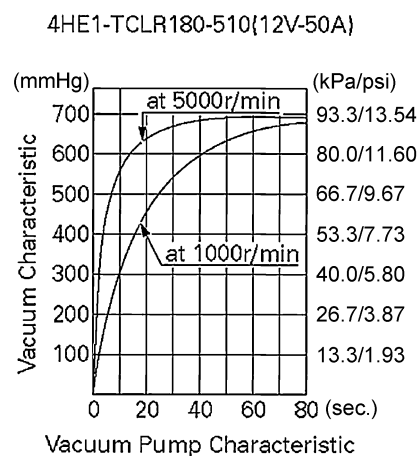
- With a pipe arrangement as shown in the illustration, use the vacuum pump tester to conduct the measurement.



- Pour about 20 liter (5.28 US gal/4.40 UK gal) of engine oil into the vacuum pump tester.
- Increase the generator rotations gradually, and check to see if the engine oil is fully circulated by discharging oil from the exhaust side of the vacuum pump.
- Close the release valve and measure the "vacuum characteristic" and the "vacuum drop characteristic (air tight characteristic)". Then check the obtained values based on the following table.



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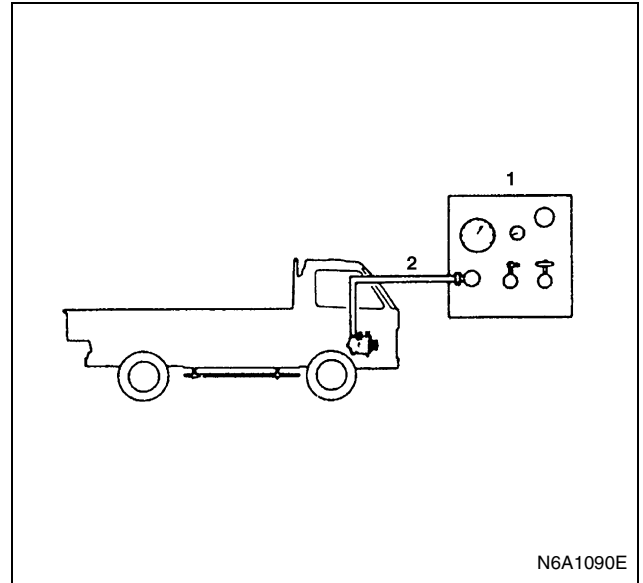
Item	Performance	Specifications
Vacuum characteristic	5000 rpm — 66.7 kPa (500 mmHg / 9.67 psi)	Less than 4 sec.
	Max. 5000 rpm	More than 90.7 kPa (680 mmHg / 13.15 psi)
Vacuum-down performance	Valve of vacuum-down 15 sec. after the vacuum pump is stopped at 53.3 kPa (400 mmHg / 7.73 psi).	Less than 2.67 kPa (20 mmHg / 0.39 psi)
Test condition	Oil used	Mobil oil #30
	Oil temperature	75±5°C (167±41°F)
	Oil pressure	441 kPa (4.5 kg/cm ² / 63.96 psi)

- 4HE1-TC LR180-510 (12-50A)

Item	Performance	Specifications
Vacuum characteristic	5000 rpm — 66.7 kPa (500 mmHg / 9.67 psi)	Less than 10 sec.
	Max. 5000 rpm	More than 90.7 kPa (680 mmHg / 13.15 psi)
Vacuum-down performance	Valve of vacuum-down 15 sec. after the vacuum pump is stopped at 53.3 kPa (400 mmHg / 7.73 psi).	Less than 2.67 kPa (20 mmHg / 0.39 psi)
Test condition	Oil used	Mobil oil #30
	Oil temperature	75±5°C (167±41°F)
	Oil pressure	441 kPa (4.5 kg/cm ² / 63.96 psi)

6. On-vehicle test of the vacuum pump

- Install the generator to the engine.
- With the engine idling, check to see if oil is being discharged sufficiently from the exhaust side of the vacuum pump.
- Idle the engine until the engine oil temperature gets to the range of 70 — 80°C (158 — 176°F).
- Connect the pipe only to the suction side of the vacuum pump tester, and conduct the test in the same manner as in the unit test. When the resulting value is outside the specified range, re-check the vacuum pump.



N6A1090E

Legend

1. Vacuum pump tester
2. Intake

