

ENGINE SECTION 3

This service manual has been prepared to provide SUBARU service personnel with the necessary information and data for the correct maintenance and repair of SUBARU vehicles.

This manual includes the procedures for maintenance, disassembling, reassembling, inspection and adjustment of components and diagnostics for guidance of experienced mechanics.

Please peruse and utilize this manual fully to ensure complete repair work for satisfying our customers by keeping their vehicle in optimum condition. When replacement of parts during repair work is needed, be sure to use SUBARU genuine parts.

All information, illustration and specifications contained in this manual are based on the latest product information available at the time of publication approval.

FUEL INJECTION (FUEL SYSTEMS) FU(H4DOSTC)

EMISSION CONTROL (AUX. EMISSION CONTROL DEVICES) EC(H4DOSTC)

INTAKE (INDUCTION) IN(H4DOSTC)

MECHANICAL ME(H4DOSTC)

EXHAUST EX(H4DOSTC)

COOLING CO(H4DOSTC)

LUBRICATION LU(H4DOSTC)

SPEED CONTROL SYSTEMS SP(H4DOSTC)

IGNITION IG(H4DOSTC)

STARTING/CHARGING SYSTEMS SC(H4DOSTC)

ENGINE (DIAGNOSTICS) EN(H4DOSTC)

STARTING/CHARGING SYSTEMS

SC(H4DOSTC)

	Page
1. General Description	2
2. Starter	6
3. Generator	14
4. Battery	17



GENERAL DESCRIPTION

STARTING/CHARGING SYSTEMS

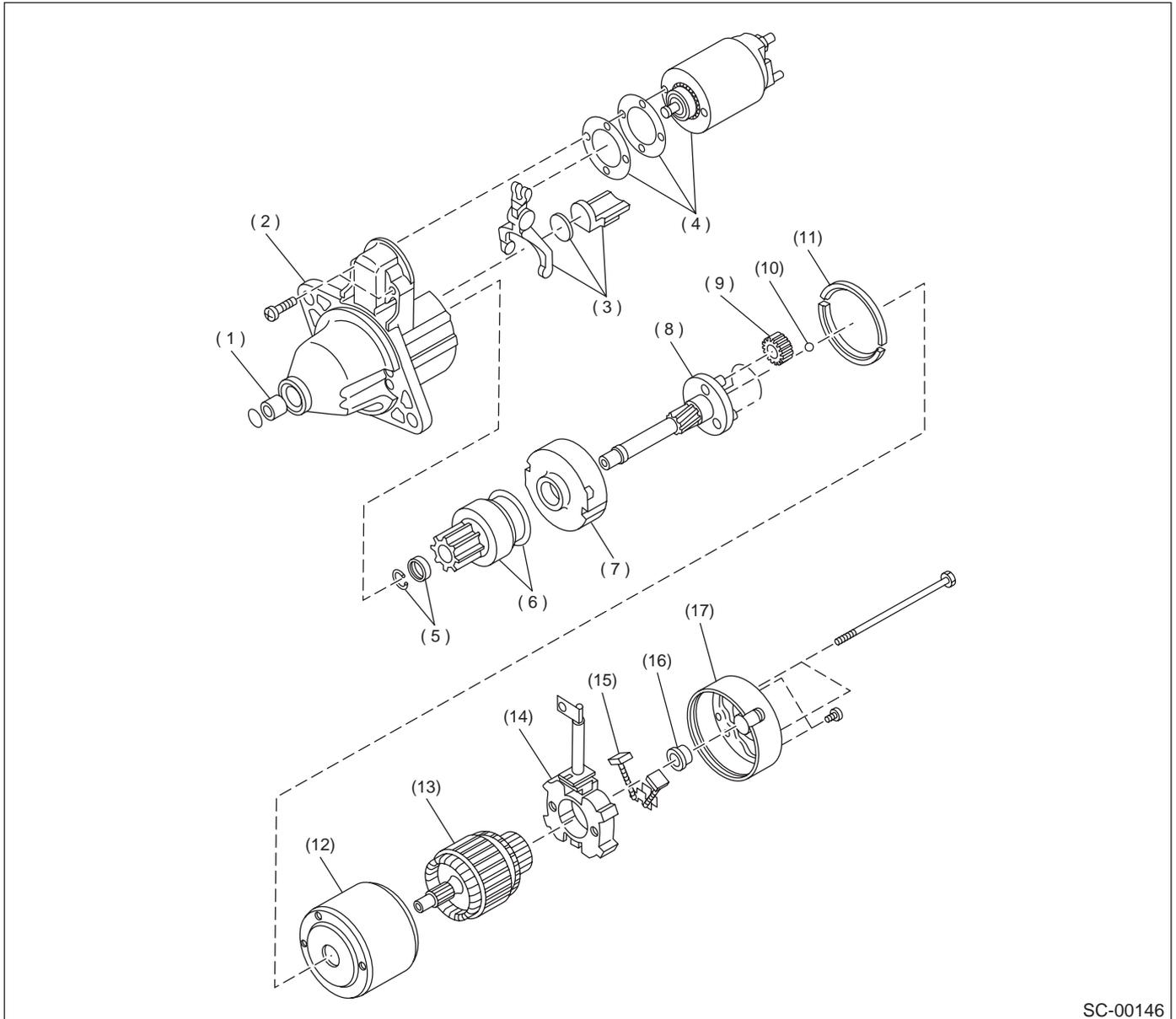
1. General Description

A: SPECIFICATIONS

Item		Designation		
Starter	Type	Reduction type		
	Vehicle type	MT vehicles	AT vehicles	
	Model	M000T83881	M000T86381	
	Manufacturer	Mitsubishi Electric		
	Voltage and output	12 V — 1.0 kW	12 V — 1.4 kW	
	Direction of rotation	Counterclockwise (viewed from pinion gear side)		
	Number of pinion teeth	8	9	
	No-load characteristics	Voltage	11 V	
		Current	90 A or less	
		Rotating speed	2,800 rpm or more	2,400 rpm or more
	Load characteristics	Voltage	7.5 V	7.7 V
		Current	300 A	400 A
		Torque	8.6 N (0.88 kgf, 6.4 lb) or more	16.0 N (1.63 kgf, 11.8 lb) or more
		Rotating speed	920 rpm or more	740 rpm or more
	Lock characteristics	Voltage	4 V	3.5 V
		Current	650 A or less	940 A or less
Torque		14.7 N (1.50 kgf, 10.8 lb) or more	28.9 N (2.95 kgf, 21.3 lb) or more	
Generator	Type	Rotating-field three-phase type, Voltage regulator built-in type, with load response control system		
	Model	LR1100-733		
	Manufacturer	HITACHI		
	Voltage and output	12 V — 100 A		
	Polarity on ground side	Negative		
	Rotating direction	Clockwise (viewed from pulley side)		
	Armature connection	3-phase Y-type		
	Output current	1,500 rpm — 49 A or more 2,500 rpm — 79 A or more 5,000 rpm — 102 A or more		
	Regulated voltage	14.1 — 14.8 V [20°C (68°F)]		

B: COMPONENT

1. STARTER



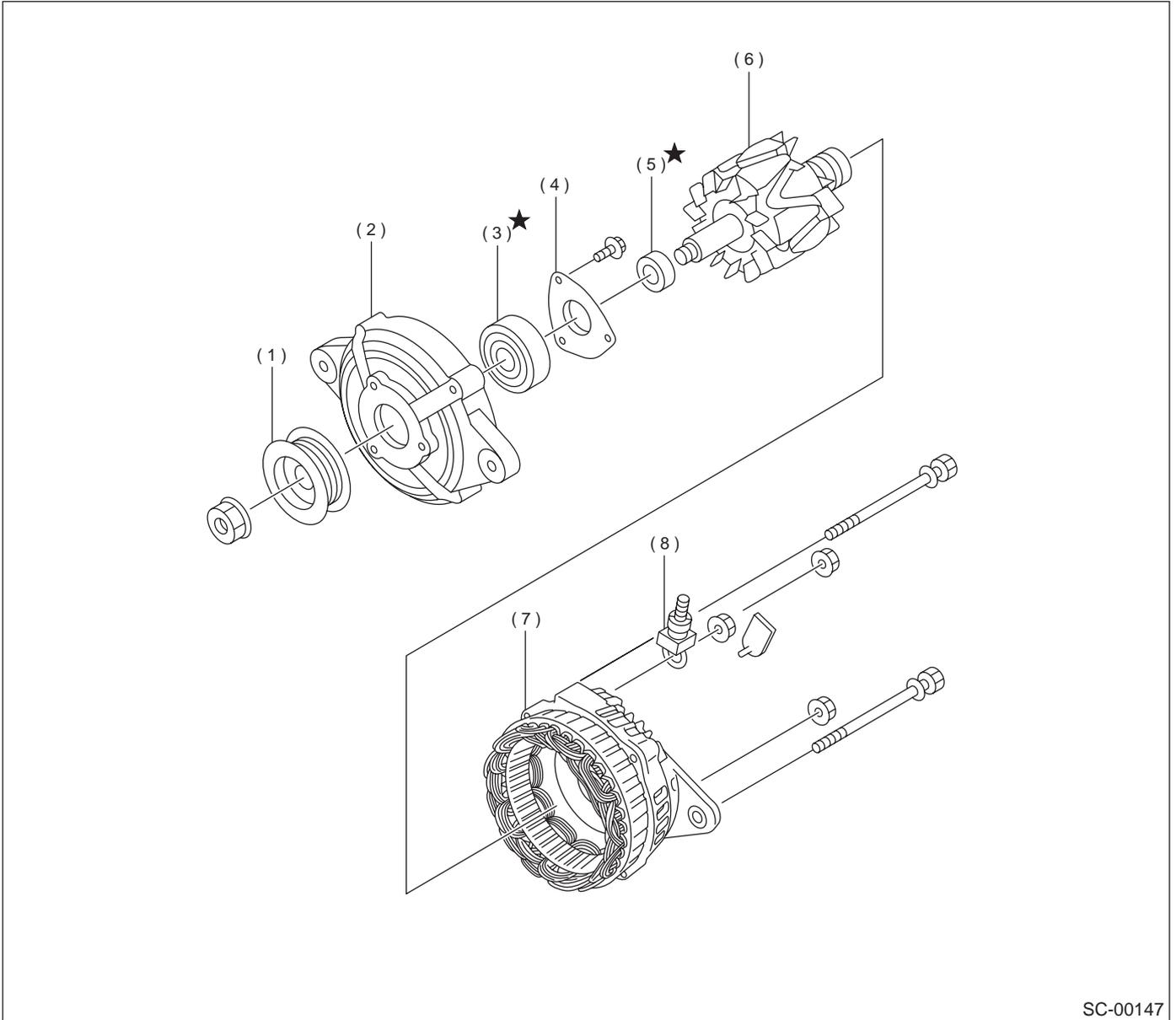
SC-00146

- | | | |
|-------------------------|------------------------|---------------------|
| (1) Sleeve bearing | (7) Internal gear ASSY | (13) Armature |
| (2) Front bracket | (8) Shaft ASSY | (14) Brush holder |
| (3) Lever set | (9) Shaft ASSY | (15) Brush |
| (4) Magnet switch ASSY | (10) Ball | (16) Sleeve bearing |
| (5) Stopper set | (11) Packing | (17) Rear bracket |
| (6) Over running clutch | (12) Yoke | |

GENERAL DESCRIPTION

STARTING/CHARGING SYSTEMS

2. GENERATOR



SC-00147

- | | | |
|------------------|----------------------|---------------------|
| (1) Pulley | (4) Bearing retainer | (7) Rear cover ASSY |
| (2) Front cover | (5) Ball bearing | (8) Terminal |
| (3) Ball bearing | (6) Rotor | |

C: CAUTION

- Wear working clothing, including a cap, protective goggles, and protective shoes during operation.
- Remove contamination including dirt and corrosion before removal, installation or disassembly.
- Keep the disassembled parts in order and protect them from dust or dirt.
- Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly, and replacement.
- Be careful not to burn your hands, because each part in the vehicle is hot after running.
- Be sure to tighten fasteners including bolts and nuts to the specified torque.
- Place shop jacks or safety stands at the specified points.
- Before disconnecting electrical connectors of sensors or units, be sure to disconnect the ground cable from battery.

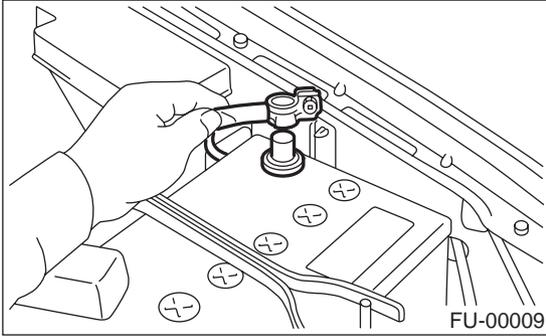
STARTER

STARTING/CHARGING SYSTEMS

2. Starter

A: REMOVAL

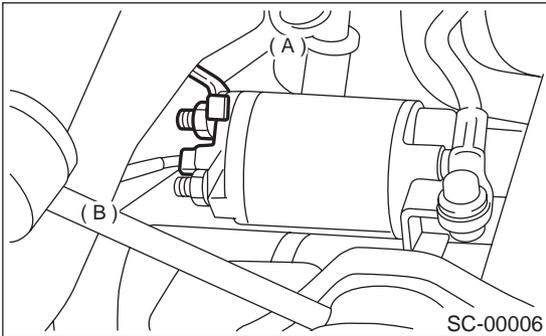
1) Disconnect the ground cable from battery.



2) Remove the intercooler.

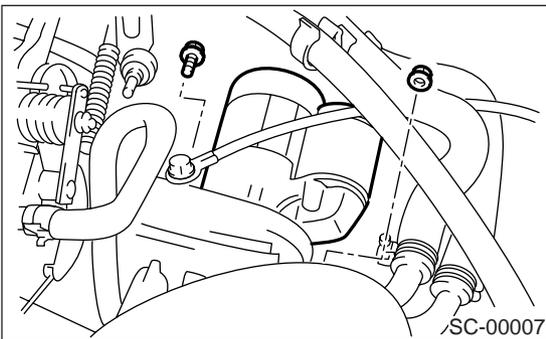
<Ref. to IN(H4DOSTC)-13, REMOVAL, Intercooler.>

3) Disconnect the connector and terminal from starter.



- (A) Terminal
- (B) Connector

4) Remove the starter from transmission.

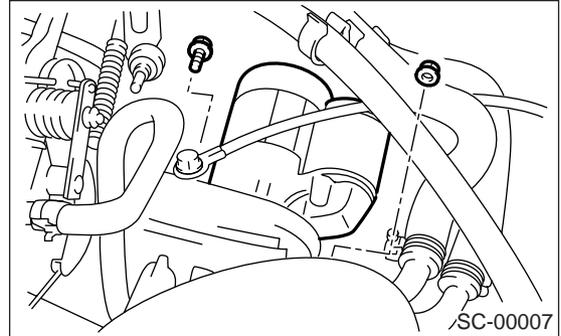


B: INSTALLATION

Install in the reverse order of removal.

Tightening torque:

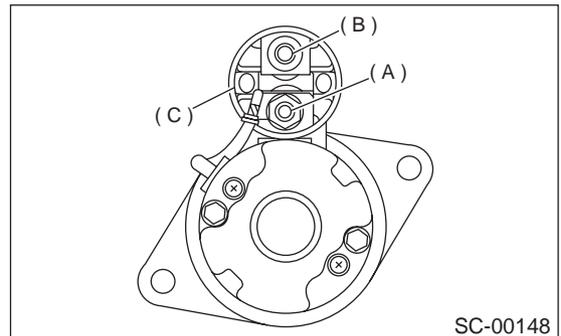
50 N·m (5.1 kgf·m, 37 ft·lb)



C: DISASSEMBLY

1. STARTER ASSEMBLY

1) Loosen the nut which holds terminal M of switch assembly, and then disconnect the connector.



- (A) Terminal M
- (B) Terminal B
- (C) Terminal S

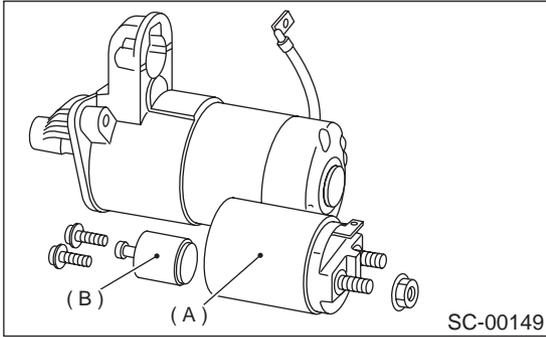
STARTER

STARTING/CHARGING SYSTEMS

2) Remove the bolts which hold switch assembly, and then remove the switch assembly, plunger and plunger spring from starter as a unit.

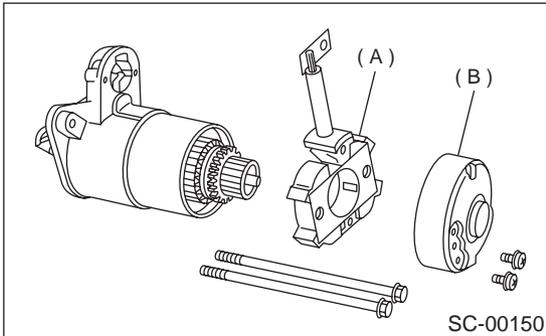
NOTE:

Be careful because the pinion gap adjustment washer may sometimes be used on the mounting surface of switch assembly.



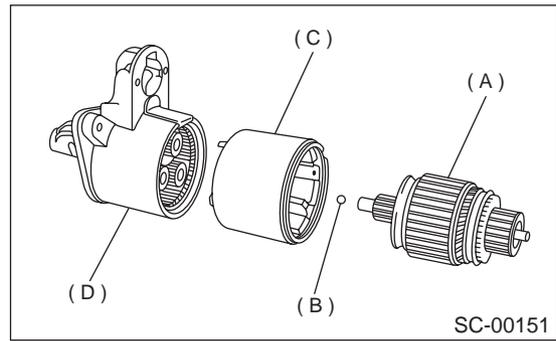
- (A) Switch ASSY
- (B) Plunger

3) Remove both through-bolts and brush holder screws, and then detach the rear cover and brush holder.



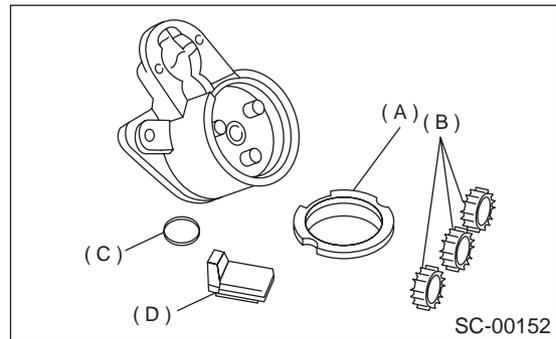
- (A) Brush holder
- (B) Rear bracket

4) Remove the armature and yoke from front bracket.



- (A) Armature
- (B) Ball
- (C) Yoke
- (D) Front bracket

5) Remove the packing A, planetary gear, packing B and plate.



- (A) Packing A
- (B) Planetary gear
- (C) Plate
- (D) Packing B

STARTER

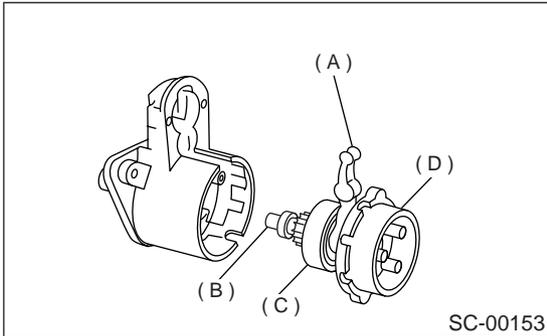
STARTING/CHARGING SYSTEMS

6) Remove the shaft assembly and overrunning clutch from front bracket as a unit.

NOTE:

Check the following points before removal.

- Lever direction
- Position of internal gear assembly

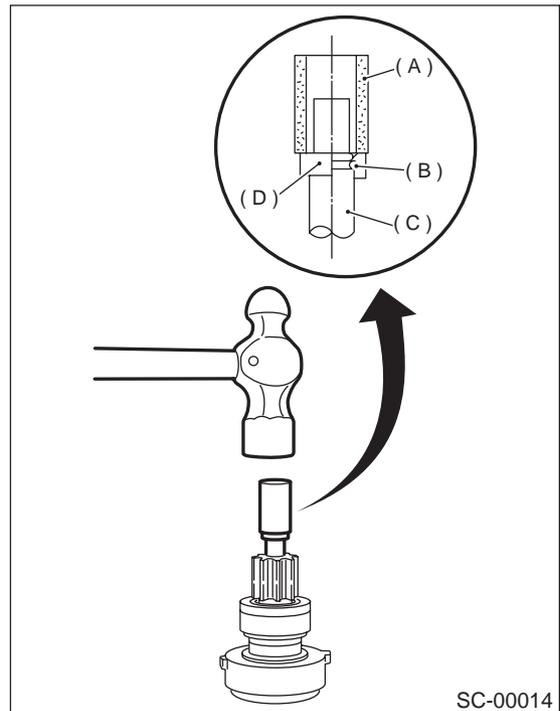


- (A) Lever
- (B) Shaft ASSY
- (C) Overrunning clutch
- (D) Internal gear ASSY

7) Remove the overrunning clutch from shaft assembly as follows:

(1) Remove the stopper from ring by lightly tapping the stopper with an appropriate tool (such as a fit socket wrench).

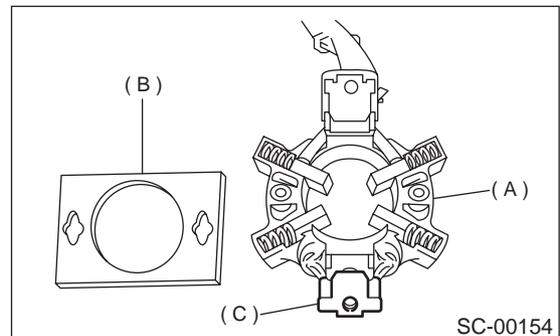
(2) Remove the ring, stopper and clutch from shaft.



- (A) Socket wrench
- (B) Ring
- (C) Shaft
- (D) Stopper

2. BRUSH HOLDER

Unlock metal clip fixing insulation plate to brush holder and remove insulation plate.



- (A) Brush holder
- (B) Insulation plate
- (C) Metal clip

D: ASSEMBLY

Assemble in the reverse order of disassembly. Do the following:

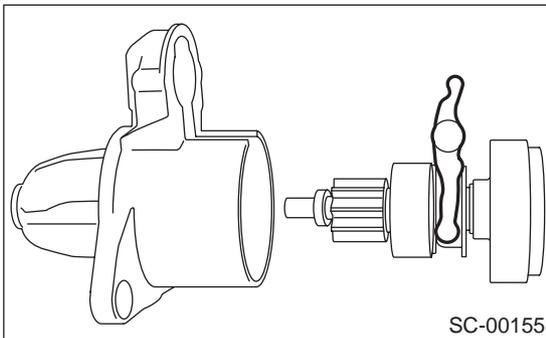
NOTE:

When assembling, apply grease to the following parts.

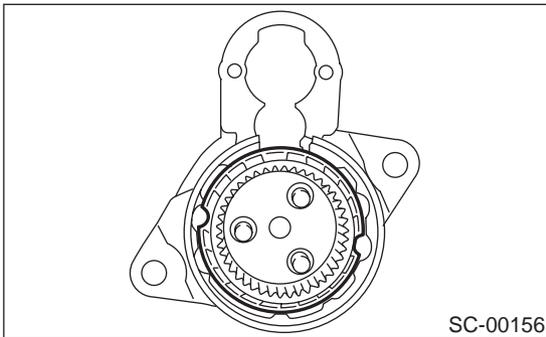
- Front and rear bracket sleeve bearing
- Armature shaft gear
- Outer periphery of plunger
- Mating surface of plunger and lever
- Gear shaft splines
- Mating surface of lever and clutch
- Ball at the armature shaft end
- Internal and planetary gears

1) When installing shaft assembly to front bracket, be careful of the following.

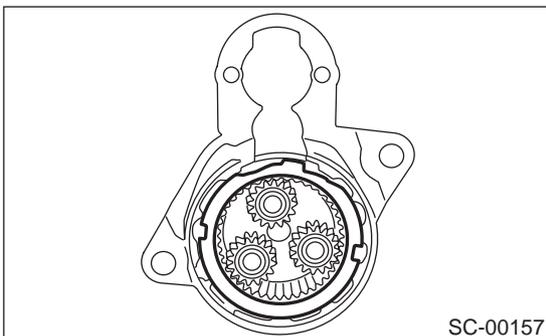
- Lever direction



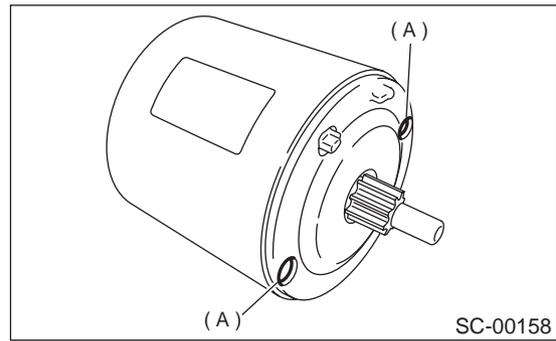
- Internal gear position



- Packing position

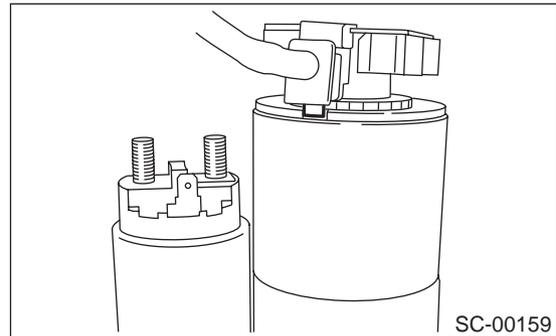


2) When installing yoke to the front bracket, match bolt hole.



(A) Bolt hole

3) When installing rear bracket, match brush holder and yoke's groove.



4) When installing switch assembly, catch plunger protrusion to lever edge.

5) After assembling parts correctly, make sure starter operates properly.

STARTER

STARTING/CHARGING SYSTEMS

E: INSPECTION

1. ARMATURE

1) Check the commutator for any sign of burns or rough surfaces or stepped wear. If wear is of a minor nature, correct it by using sand paper.

2) Run-out test

Check the commutator run-out, and then replace if it exceeds the limit.

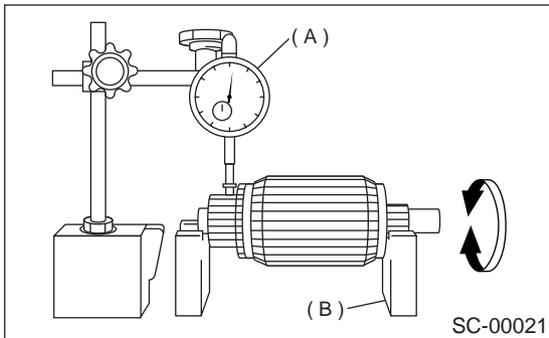
Commutator run-out:

Standard

0.05 mm (0.0020 in)

Service limit

Less than 0.10 mm (0.0039 in)



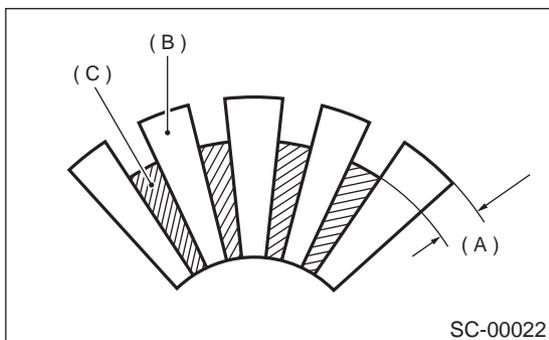
- (A) Dial gauge
- (B) V-block

3) Depth of segment mold

Check the depth of segment mold.

Depth of segment mold:

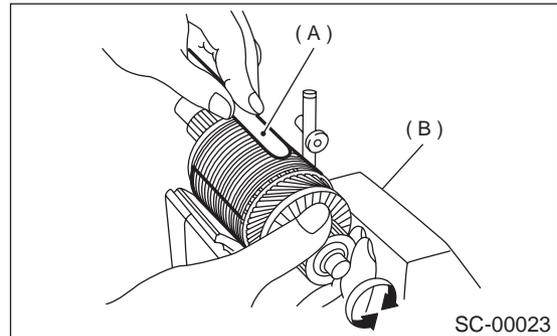
0.5 mm (0.020 in)



- (A) Depth of mold
- (B) Segment
- (C) Mold

4) Armature short-circuit test

Check the armature for short-circuit by placing it on growler tester. Hold a iron sheet against the armature core while slowly rotating armature. A short-circuited armature will cause the iron sheet to vibrate and to be attracted to core. If the iron sheet is attracted or vibrates, the armature, which is short-circuited, must be replaced or repaired.

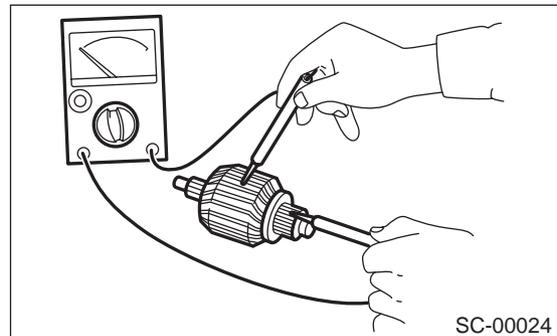


- (A) Iron sheet
- (B) Growler tester

5) Armature ground test

Using a circuit tester, touch one probe to the commutator segment and the other to shaft. There should be no continuity. If there is continuity, the armature is grounded.

Replace the armature if it is grounded.



2. YOKE

Make sure pole is set in position.

3. OVERRUNNING CLUTCH

Inspect the teeth of pinion for wear and damage. Replace if it is damaged. Rotate the pinion in direction of rotation (counterclockwise). It should rotate smoothly. But in opposite direction, it should be locked.

CAUTION:

Do not clean overrunning clutch with oil to prevent grease from flowing out.

4. BRUSH AND BRUSH HOLDER

1) Brush length

Measure the brush length, and then replace if it exceeds the service limit.

Replace if abnormal wear or cracks are noticed.

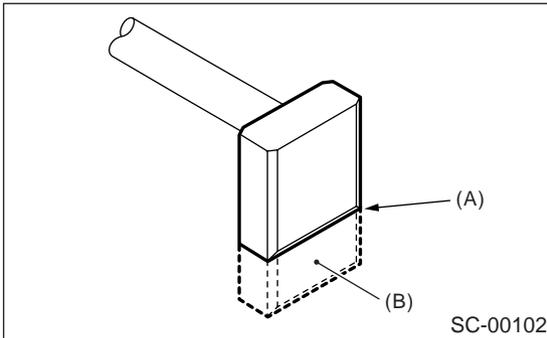
Brush length:

Standard

12.3 mm (0.484 in)

Service limit

7.0 mm (0.276 in)



(A) Service limit line

(B) Brush

2) Brush movement

Be sure the brush moves smoothly inside brush holder.

3) Brush spring force

Measure the brush spring force with a spring scale. If it is less than the service limit, replace the brush holder.

Brush spring force:

Standard

21.6 N (2.2 kgf, 4.9 lb) (when new)

Service limit

5.9 N (0.6 kgf, 1.3 lb)

5. SWITCH ASSEMBLY

Be sure there is continuity between the terminals S and M, and between terminal S and ground. Use a circuit tester (set in "ohm").

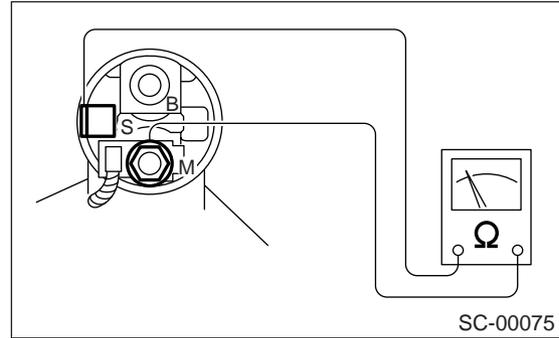
Also check to be sure there is no continuity between terminal M and B.

Terminal / Specified resistance:

S — M / Less than 1 Ω

S — Ground / Less than 1 Ω

M — B / More than 1 MΩ



6. SWITCH ASSEMBLY OPERATION

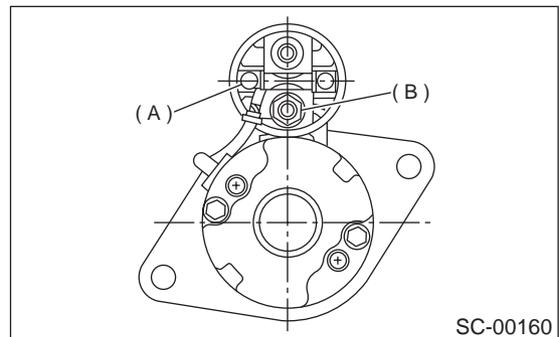
1) Connect the terminal S of switch assembly to positive terminal of battery with a lead wire, and starter body to ground terminal of battery. The pinion should be forced endwise on shaft.

CAUTION:

With the pinion forced endwise on shaft, starter motor can sometimes rotate because current flows, through pull-in coil, to motor. This is not a problem.

2) Disconnect the connector from terminal M, and then connect the positive terminal of battery and terminal M using a lead wire and ground terminal to starter body.

In this test set up, the pinion should return to its original position even when it is pulled out with a screwdriver.



(A) Terminal S

(B) Terminal M

STARTER

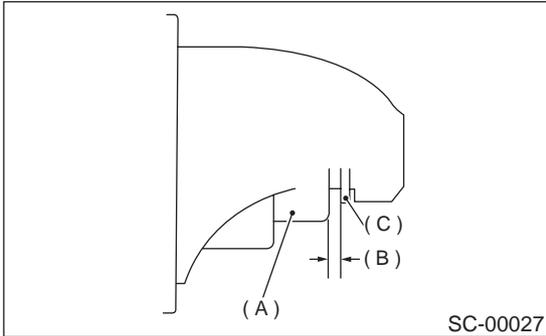
STARTING/CHARGING SYSTEMS

7. PINION GAP

1) Measure the pinion gap while the pinion is pulled out as shown in the figure.

Pinion gap:

0.5 — 2.0 mm (0.020 — 0.079 in)



- (A) Pinion
- (B) Gap
- (C) Stopper

If the motor is running with the pinion forced endwise on shaft, disconnect the connector from terminal M of switch assembly, and then connect terminal M to ground terminal (–) of battery with a lead wire. Next, gently push the pinion back with your fingertips, and then measure the pinion gap.

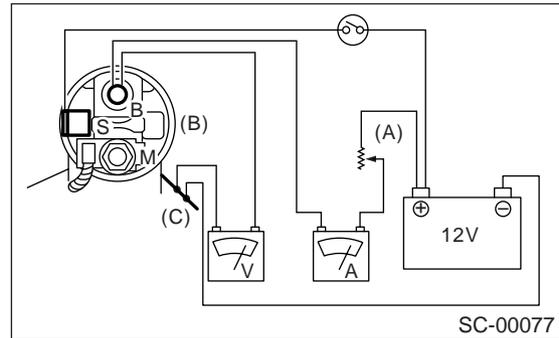
2) If the pinion gap is outside specified range, remove or add number of adjustment washers used on the mounting surface of switch assembly until correct pinion gap is obtained.

8. PERFORMANCE TEST

The starter should be submitted to performance tests whenever it has been overhauled, to assure its satisfactory performance when installed on the engine.

Three performance tests, no-load test, load test, and lock test, are presented here; however, if the load test and lock test cannot be performed, carry out at least the no-load test.

For these performance tests, use the circuit shown in figure.



- (A) Variable resistance
- (B) Magnetic switch
- (C) Starter body

1) No-load test

With switch on, adjust the variable resistance to obtain 11 V, take the ammeter reading, and then measure the starter speed. Compare these values with the specifications.

No-load test (Standard):

Voltage / Current

MAX. 11 V / 90 A

Rotating speed

MT vehicles

2,800 rpm or more

AT vehicles

2,400 rpm or more

2) Load test

Apply the specified braking torque to starter. The condition is satisfactory if the current draw and starter speed are within the specifications.

Load test (Standard):**Voltage / Road****MT vehicles**

7.5 V / 8.6 N (0.88 kgf, 1.94 lb)

AT vehicles

7.7 V / 16.0 N (1.63 kgf, 3.59 lb)

Current / Speed**MT vehicles**

300 A / 920 rpm or more

AT vehicles

400 A / 740 rpm or more

3) Lock test

With the starter stalled, or not rotating, measure the torque developed and current draw when the voltage is adjusted to the specified voltage.

Lock test (Standard):**Voltage / Current****MT vehicles**

4 V / 650 A or less

AT vehicles

3.5 V / 940 A or less

Torque**MT vehicles**

14.7 N·m (1.50 kgf-m, 10.8 ft-lb) or more

AT vehicles

28.9 N·m (2.95 kgf-m, 21.3 ft-lb) or more

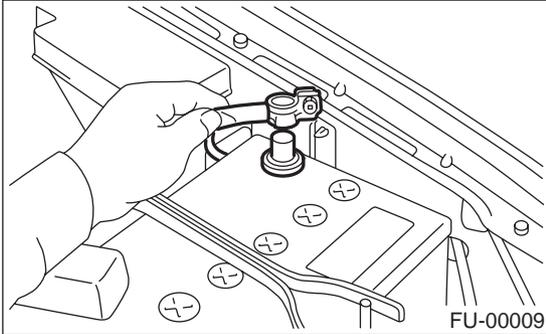
GENERATOR

STARTING/CHARGING SYSTEMS

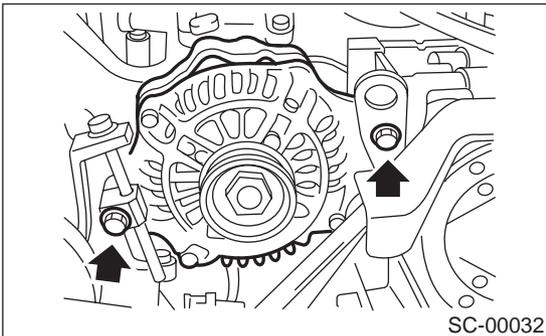
3. Generator

A: REMOVAL

- 1) Disconnect the ground cable from battery.



- 2) Disconnect the connector and terminal from generator.
- 3) Remove the V-belt cover.
- 4) Remove the front side V-belt.
<Ref. to ME(H4DOSTC)-42, REMOVAL, V-belt.>
- 5) Remove the bolts which install generator onto bracket.

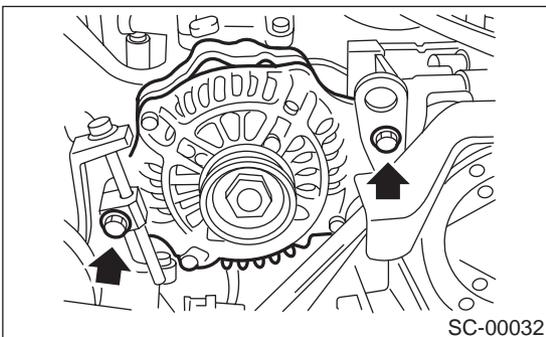


B: INSTALLATION

Install in the reverse order of removal.

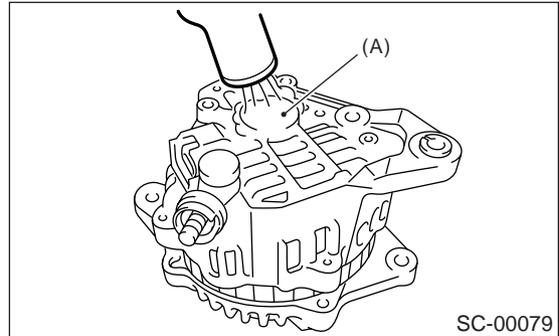
CAUTION:

Check and adjust the V-belt tension. <Ref. to ME(H4DOSTC)-43, INSPECTION, V-belt.>

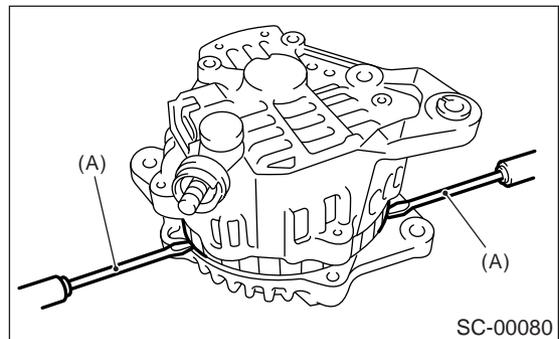


C: DISASSEMBLY

- 1) Remove the four through-bolts.
- 2) Heat the portion (A) of rear cover to 50°C (122°F) with heater drier.

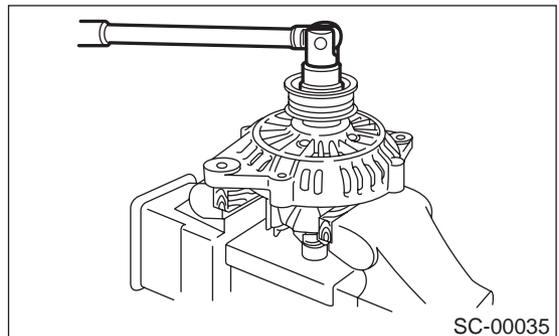


- 3) Then insert the tip of a flat tip screwdriver into the gap between stator core and front cover. Pry them apart to disassemble.



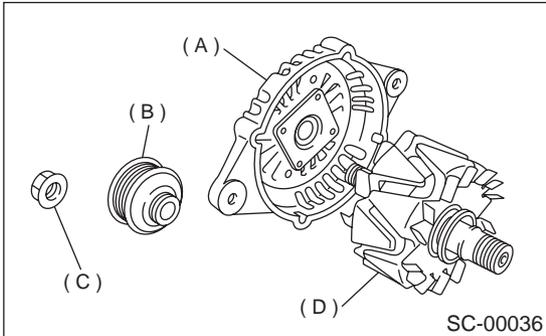
(A) Screwdriver

- 4) Hold the rotor with a vise and remove pulley nut.



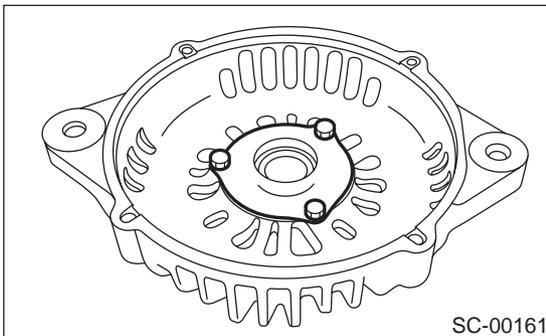
CAUTION:

When holding the rotor with vise, insert aluminum plates or wood pieces on the contact surfaces of vise to prevent rotor from damage.

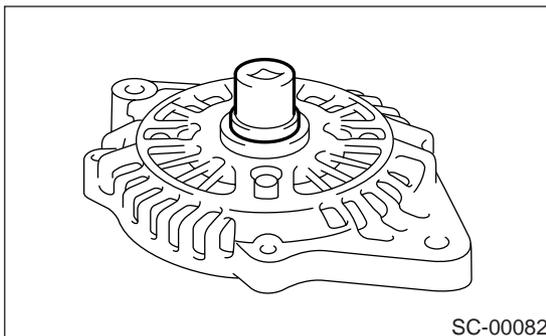


- (A) Front cover
- (B) Pulley
- (C) Nut
- (D) Rotor

- 5) Remove the ball bearing as follows.
 - (1) Remove the bolt, and then remove the bearing retainer.

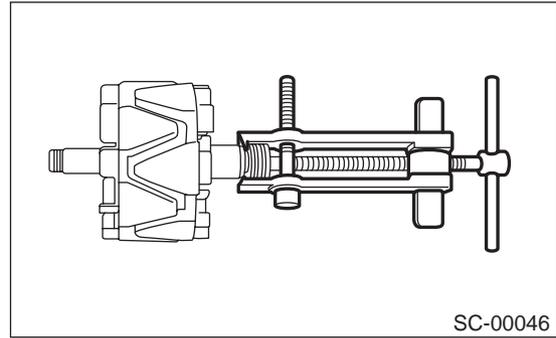


- (2) Firmly install an appropriate tool (such as a fit socket wrench) to bearing inner race.



- (3) Push the ball bearing off the front cover using a press.

- 6) Remove the bearing from rotor using a bearing puller.



D: ASSEMBLY

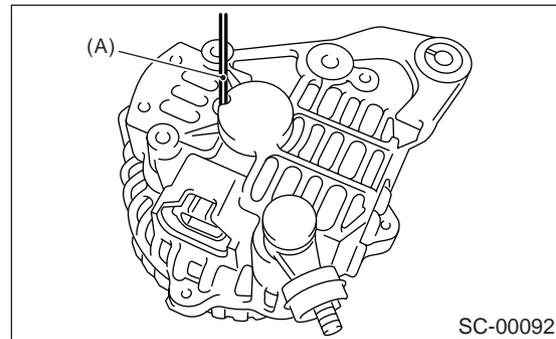
To assemble, reverse order of disassembly.

- 1) Pulling up brush

Before assembling, press the brush down into brush holder, and then fix them in that position by passing a [1 mm (0.08 in) dia. length 4 to 5 cm (1.6 to 2.0 in)] wire through the hole shown in the figure.

CAUTION:

Be sure to remove the wire after reassembly.



- (A) Wire

- 2) Install the ball bearing.

- (1) Set the ball bearing on the front cover, and then securely install an appropriate tool (such as a fit socket wrench) to the bearing outer race.
- (2) Press the ball bearing into the specified position using a press.
- (3) Install the bearing retainer.

- 3) Press the bearing (rear side) into the rotor shaft using a press to install.

- 4) Heat the bearing box in rear cover [50 to 60°C (122 to 140°F)], and then press the rear bearing into rear cover.

CAUTION:

Grease should not be applied to rear bearing. Remove the oil completely if it is found on bearing box.

- 5) After reassembly, turn the pulley by hand to check that rotor turns smoothly.

GENERATOR

STARTING/CHARGING SYSTEMS

E: INSPECTION

1. ROTOR

1) Slip ring surface

Inspect the slip rings for contamination or any roughness of the sliding surface. Repair the slip ring surface using a lathe or sand paper.

2) Slip ring outer diameter

Measure the slip ring outer diameter. If the slip ring is worn replace rotor assembly.

Slip ring outer diameter:

Standard

22.7 mm (0.894 in)

Limit

22.1 mm (0.870 in)

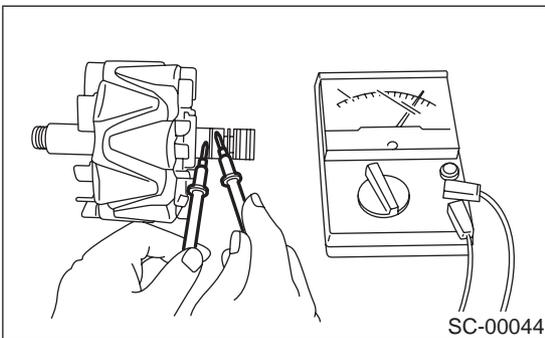
3) Continuity test

Check the resistance between slip rings using circuit tester.

If the resistance is not within specification, replace the rotor assembly.

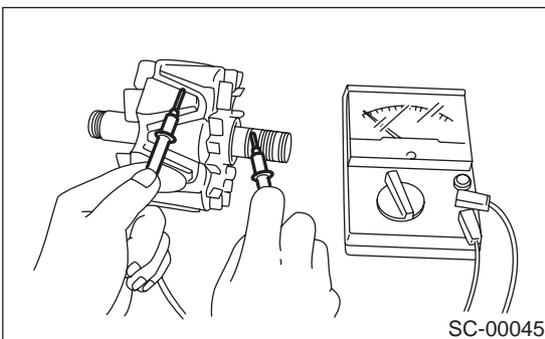
Specified resistance:

Approx. 1.8 — 2.2 Ω



4) Insulation test

Check the continuity between slip ring and rotor core or shaft. If resistance is 1 Ω or less, the rotor coil is grounded, and so replace the rotor assembly.



5) Ball bearing (rear side)

Check the rear ball bearing. Replace if it is noisy or if the rotor does not turn smoothly.

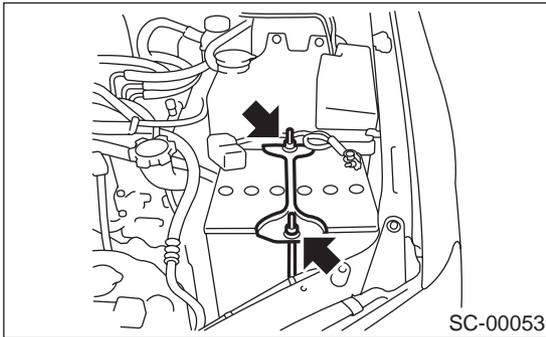
2. BEARING (FRONT SIDE)

Check the front ball bearing. If the resistance is felt while rotating, or if abnormal noise is heard, replace the ball bearing.

4. Battery

A: REMOVAL

- 1) Disconnect the positive (+) cable after disconnecting the ground (-) cable of battery.
- 2) Remove the flange nuts from battery rods, and then take off the battery holder.



- 3) Remove the battery.

B: INSTALLATION

Install in the reverse order of removal.

Tightening torque:

3.4 N·m (0.35 kgf·m, 2.5 ft·lb)

NOTE:

- Clean the battery cable terminals, and then apply grease to retard formation of corrosion.
- Connect the positive (+) cable of battery and then the ground (-) cable of battery.

C: INSPECTION

WARNING:

- Electrolyte has toxicity; be careful handling the fluid.
- Avoid contact with skin, eyes or clothing. Especially at contact with eyes, bluish with water for 15 minutes and get prompt medical attention.
- Batteries produce explosive gasses. Keep sparks, flame, cigarettes away.
- Ventilate when charging or using in enclosed space.
- For safety, in case an explosion does occur, wear eye protection or shield your eyes when working near any battery. Never lean over a battery.
- Do not let the battery fluid contact eyes, skin, fabrics, or paint-work because battery fluid is corrosive acid.
- To lessen the risk of sparks, remove rings, metal watch-bands, and other metal jewelry. Never allow metal tools to contact the positive battery terminal and anything connected to it while you are at the same time in contact with any other metallic portion of the vehicle because a short circuit will be caused.

1. EXTERNAL PARTS:

Check for the existence of dirt or cracks on battery case, top cover, vent plugs, and terminal posts. If necessary, clean with water and wipe with a dry cloth.

Apply a thin coat of grease on the terminal posts to prevent corrosion.

2. ELECTROLYTE LEVEL:

Check the electrolyte level in each cell. If the level is below MIN LEVEL, bring the level to MAX LEVEL by pouring distilled water into the battery cell. Do not fill beyond MAX LEVEL.

3. SPECIFIC GRAVITY OF ELECTROLYTE:

- 1) Measure the specific gravity of electrolyte using a hydrometer and a thermometer.

Specific gravity varies with temperature of electrolyte so that it must be corrected at 20°C (68°F) using the following equation:

$$S_{20} = S_t + 0.0007 \times (t - 20)$$

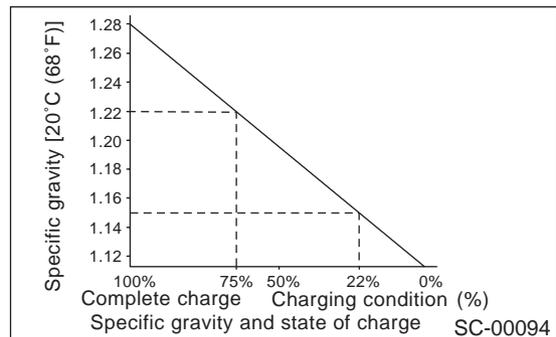
S_{20} : Specific gravity corrected at electrolyte temperature of 20°C

S_t : Measured specific gravity

t : Measured temperature (°C)

Determine whether or not battery must be charged, according to corrected specific gravity.

Standard specific gravity: 1.220 — 1.290 [at 20°C (68°F)]



- 2) Measuring the specific gravity of the electrolyte in battery will disclose the state of charge of battery. The relation between specific gravity and state of charge is as shown in the figure.

BATTERY

STARTING/CHARGING SYSTEMS

D: MEASUREMENT

WARNING:

- Do not bring an open flame close to the battery at this time.

CAUTION:

- Prior to charging, corroded terminals should be cleaned with a brush and common baking soda solution.
- Be careful since the battery electrolyte overflows while charging the battery.
- Observe the instructions when handling battery charger.
- Before charging the battery on vehicle, disconnect battery ground terminal. Failure to follow this rule may damage alternator's diodes or other electrical units.

1. JUDGMENT OF BATTERY IN CHARGED CONDITION

- 1) Specific gravity of electrolyte is held at a specific value in a range from 1.250 to 1.290 for more than one hour.
- 2) Voltage per battery cell is held at a specific value in a range from 2.5 to 2.8 volts for more than one hour.

2. CHECK HYDROMETER FOR STATE OF CHARGE

Hydrometer indicator	State of charge	Required action
Green dot	Above 65%	Load test
Dark dot	Below 65%	Charge battery
Clear dot	Low electrolyte	Replace battery* (If cranking complaint)

*: Check electrical system before replacement.

3. NORMAL CHARGING

Charge the battery at current value specified by manufacturer or at approx. 1/10 of battery's ampere-hour rating.

4. QUICK CHARGING

Quick charging is a method in which the battery is charged in a short period of time with a relatively large current by using a quick charger.

Since a large current flow raises electrolyte temperature, the battery is subject to damage if large current is used for prolonged time. For this reason, the quick charging must be carried out within a current range that will not increase the electrolyte temperature above 40°C (104°F).

It should be also remembered that the quick charging is a temporary means to bring battery voltage up to a fair value and, as a rule, a battery should be charged slowly with a low current.

CAUTION:

- Observe the items in 3. NORMAL CHARGING.
- Never use more than 10 amperes when charging the battery because that will shorten battery life.

MEMO: