STARTING/CHARGING SYSTEMS

SC

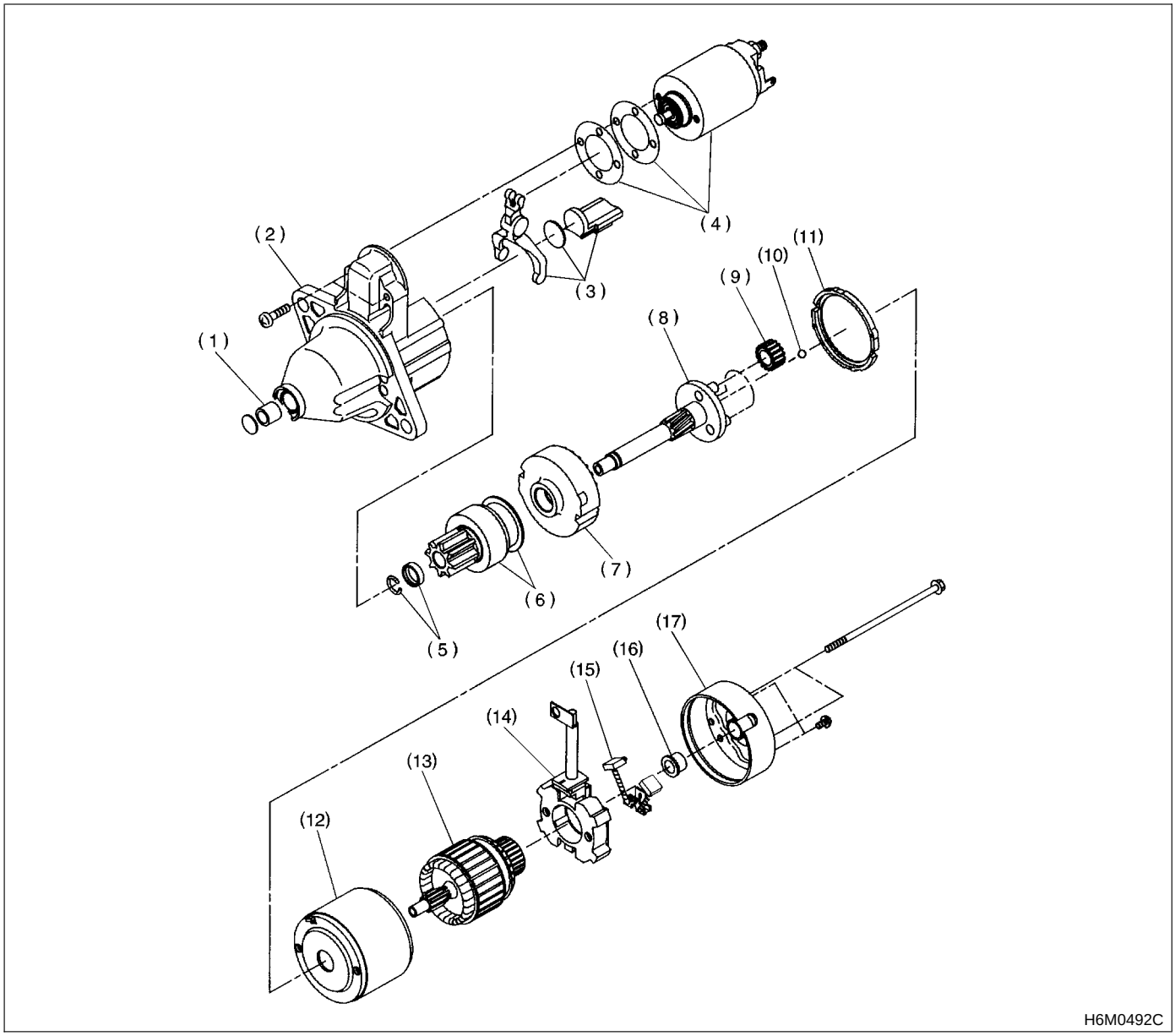
1. General Description S179001

A: SPECIFICATIONS S179001E49

Item			Designation	
Starter	Type		Reduction type	
	Vehicle type		MT vehicles	AT vehicles
	Model		M000T83981	M001T86481
	Manufacturer		Mitsubishi Electric	
	Voltage and output		12 V — 1.0 kW	12 V — 1.4 kW
	Direction of rotation		Counterclockwise (when observed from pinion)	
	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·m (0.88 kgf-m, 6.4 ft-lb) or more	16.0 N·m (1.63 kgf-m, 11.8 ft-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·m (1.50 kgf-m, 10.8 ft-lb) or more	28.9 N·m (2.95 kgf-m, 21.3 ft-lb) or more
Generator	Type		Rotating-field three-phase type, Voltage regulator built-in type, with load response control system	
	Model		A2TB6291	
	Manufacturer		Mitsubishi Electric	
	Voltage and output		12 V — 75 A	
	Polarity on ground side		Negative	
	Rotating direction		Clockwise (when observed from pulley side)	
	Armature connection		3-phase Y-type	
	Output current		1,500 rpm — 30 A or more 2,500 rpm — 64 A or more 5,000 rpm — 76 A or more	
	Regulated voltage		14.1 — 14.8 V [20°C (68°F)]	
Battery	Type and capacity	For Europe	12 V — 48 AH	12 V — 52 AH
		For Australia	12 V — 40 AH	
		Others	12 V — 40 AH	

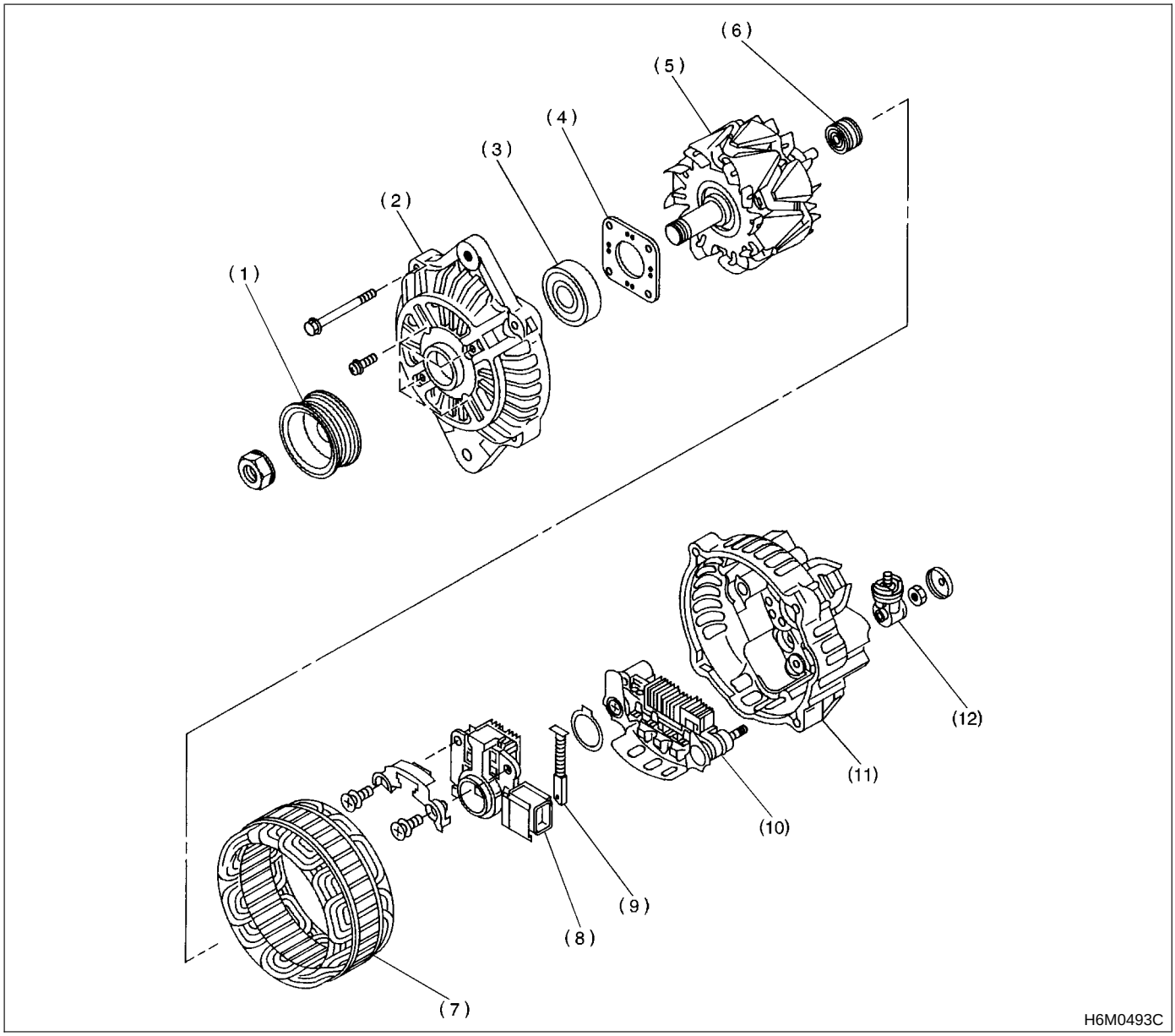
B: COMPONENT S179001A05

1. STARTER S179001A0501



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

2. GENERATOR S179001A0502



(1) Pulley
(2) Front cover
(3) Ball bearing
(4) Bearing retainer
(5) Rotor
(6) Bearing
(7) Stator coil
(8) IC regulator with brush
(9) Brush
(10) Rectifier
(11) Rear cover
(12) Terminal

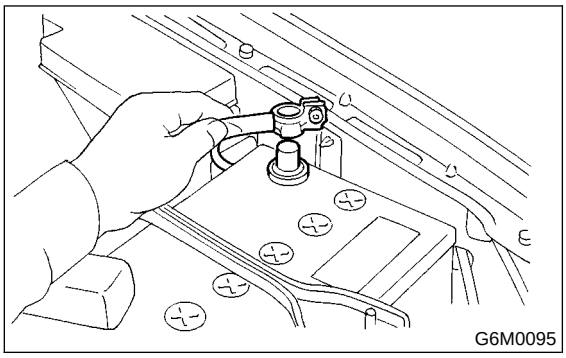
C: CAUTION S179001A03

- 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 negative terminal from battery.

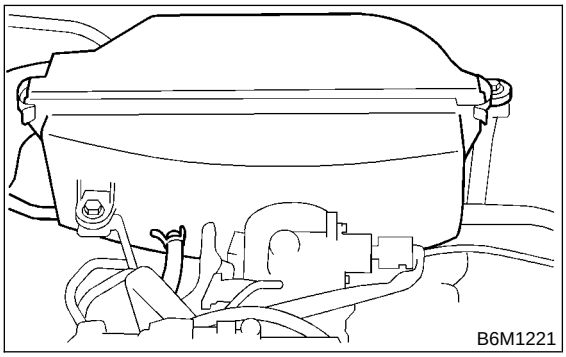
2. Starter S179012

A: REMOVAL S179012A18

1) Disconnect battery ground cable.

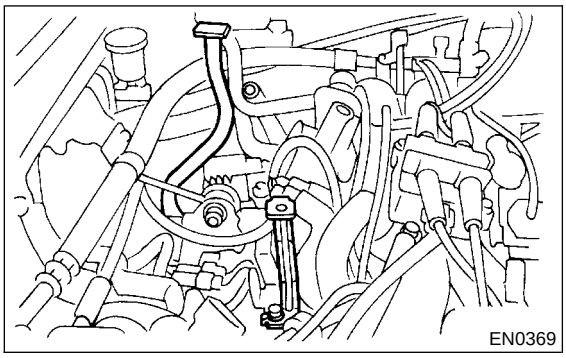


2) Remove air cleaner case. (Non-Turbo Model)

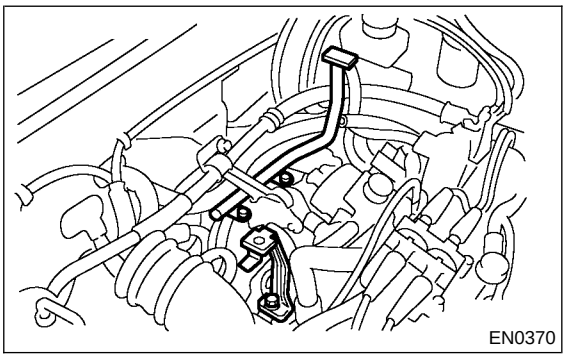


3) Remove intercooler. (Turbo Model) <Ref. to IN(DOHC TURBO) -10, REMOVAL, Intercooler.>
4) Remove air cleaner case stay. (Non-Turbo Model)

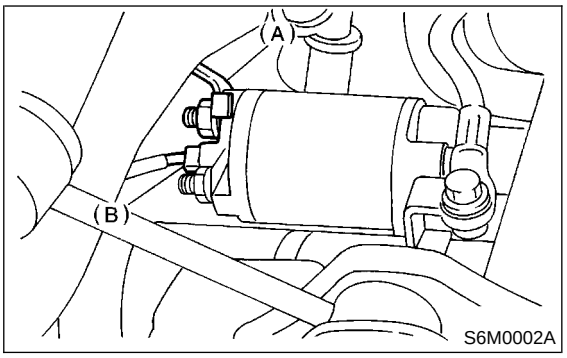
- MT vehicles



- AT vehicles

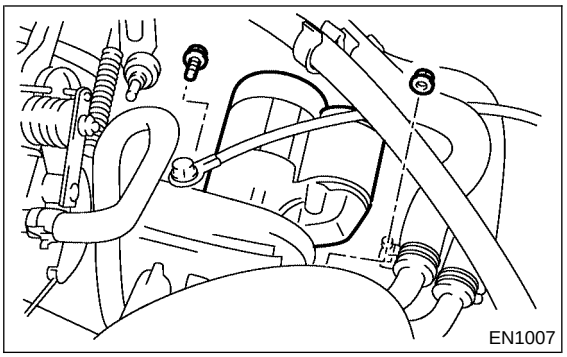


5) Disconnect connector and terminal from starter.



(A) Terminal
(B) Connector

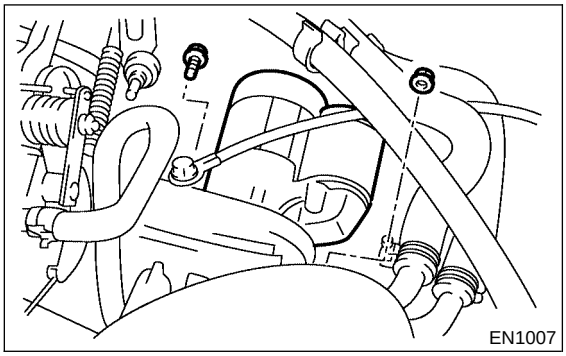
6) Remove starter from transmission.



B: INSTALLATION S179012A11

Install in the reverse order of removal.

Tightening torque:
50 N·m (5.1 kgf-m, 37 ft-lb)

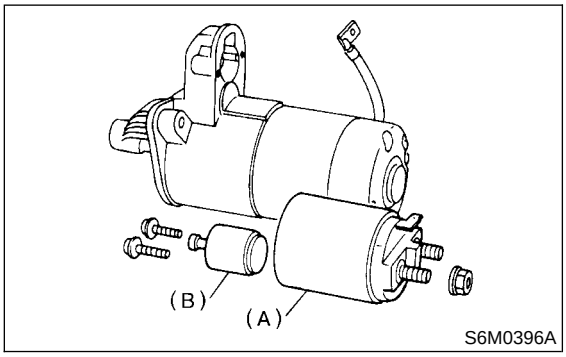


C: DISASSEMBLY S179012A06

1. STARTER ASSEMBLY S179012A0601

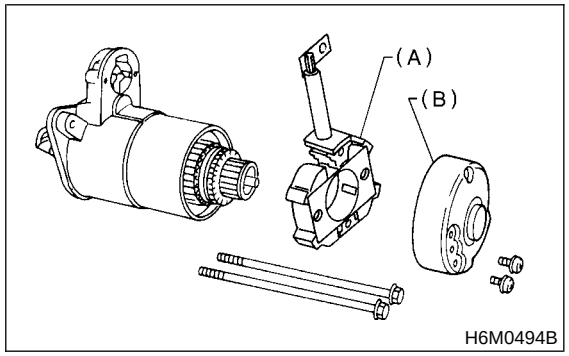
1) Loosen nut which holds terminal M of switch assembly, and disconnect connector.
2) Remove bolts which hold switch assembly, and remove switch assembly, plunger and plunger spring from starter as a unit.

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



(A) Switch ASSY
(B) Plunger

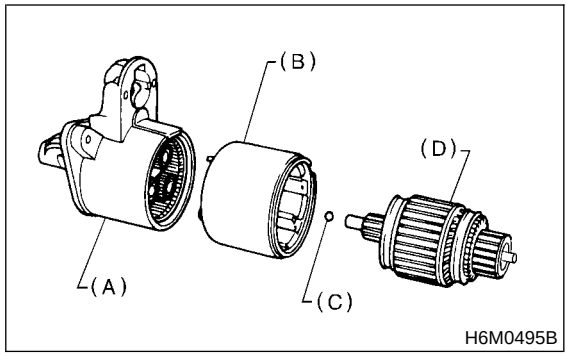
3) Remove both through-bolts and brush holder screws, and detach rear bracket and brush holder.



(A) Brush holder
(B) Rear bracket

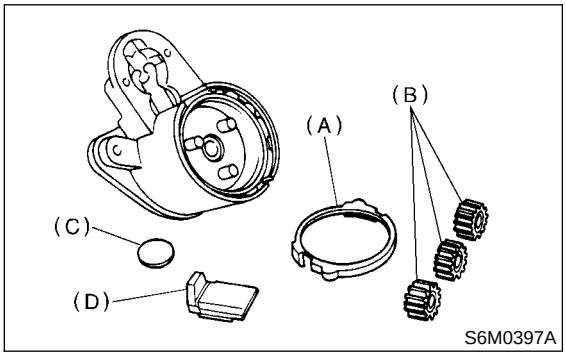
4) Remove armature and yoke. Ball used as a bearing will then be removed from the end of armature.

CAUTION:
Be sure to mark an alignment mark on yoke and front bracket before removing yoke.



(A) Front bracket
(B) Yoke
(C) Ball
(D) Awature

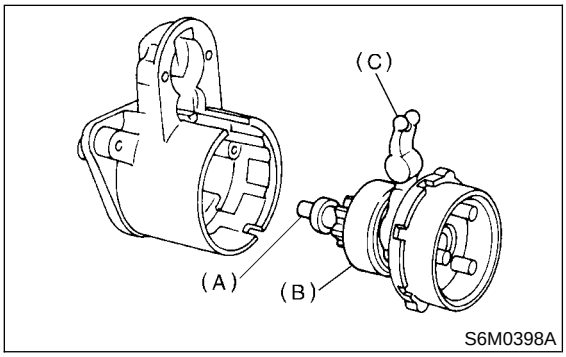
5) Remove packing A, three planetary gears, packing B and plate.



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

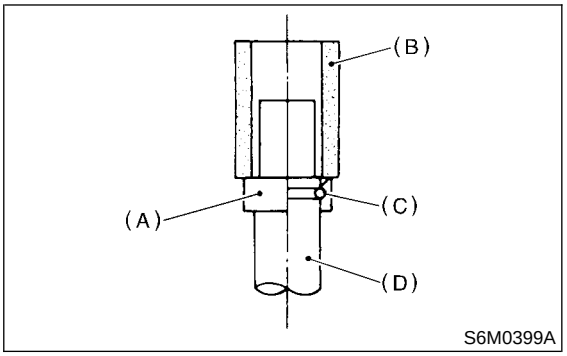
6) Remove shaft assembly and overrunning clutch as a unit.

CAUTION:
Record the direction of lever before removing.



(A) Shaft ASSY
(B) Overrunning clutch
(C) Lever

7) Remove overrunning clutch from shaft assembly as follows:
(1) Remove stopper from ring by lightly tapping a fit tool placed on stopper.
(2) Remove ring, stopper and clutch from shaft.

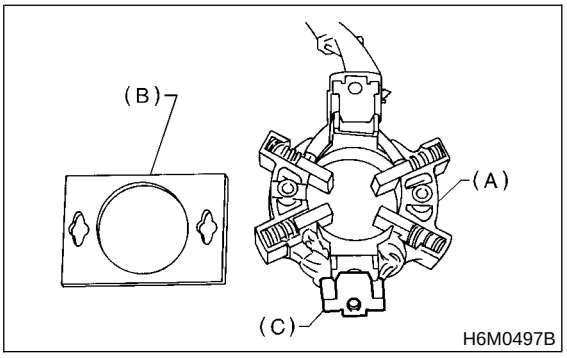


(A) Stopper
(B) Tool
(C) Ring
(D) Shaft

2. BRUSH HOLDER *S179012A0602*

Slightly open the metal fitting holding the insulating plate to the brush holder. Remove the insulating plate.

NOTE:
The brush and spring can be easily removed from the brush holder at this time.



(A) Brush holder
(B) Insulating plate
(C) Metal fitting

D: ASSEMBLY *S179012A02*

Assembly is in the reverse order of disassembly procedures. Do the following:
1) Carefully assemble all parts in the order of assembly and occasionally inspect nothing has been overlooked.
2) Apply grease to the following parts during assembly.
- 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

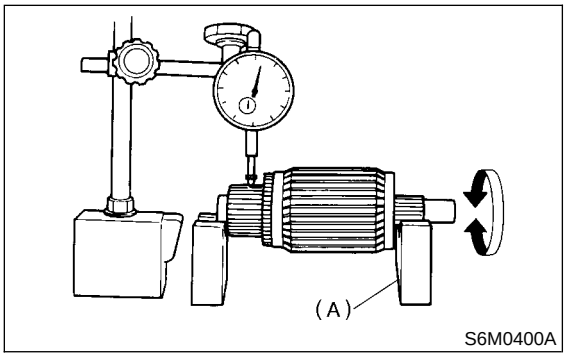
3) After assembling parts correctly, make sure starter operates properly.

E: INSPECTION S179012A10

1. ARMATURE S179012A1001

1) Check commutator for any sign of burns of 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 replace if it exceeds the limit.

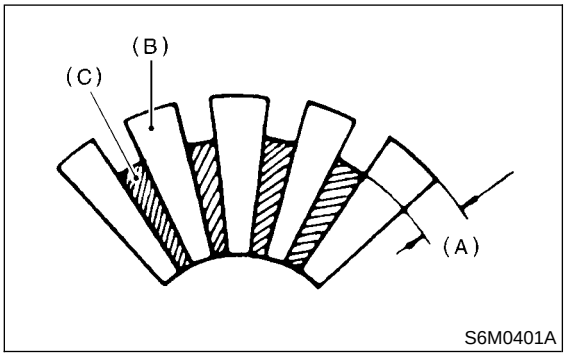
Commutator run-out:
Standard
0.05 mm (0.0020 in)
Service limit
Less than 0.10 mm (0.0039 in)



(A) V-block

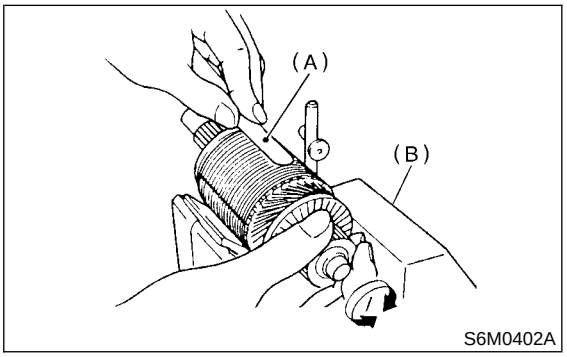
3) Depth of segment mold
Check the depth of segment mold.

Depth of segment mold:
0.5 mm (0.020 in)



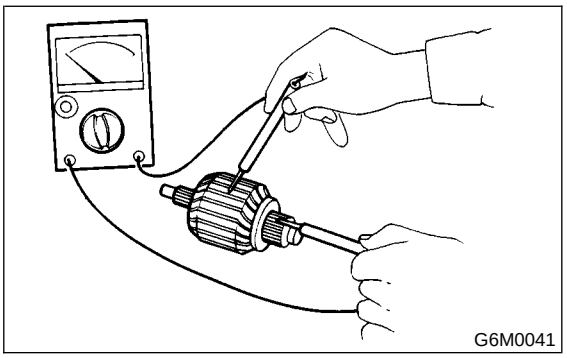
(A) Depth of mold
(B) Segment
(C) Mold

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



(A) Iron sheet
(B) Grower

5) Armature ground test
Using circuit tester, touch one probe to the commutator segment and the other to shaft. There should be no continuity. If there is a continuity, armature is grounded.
Replace armature if it is grounded.



2. YOKE S179012A1002

Make sure pole is set in position.

3. OVERRUNNING CLUTCH S179012A1003

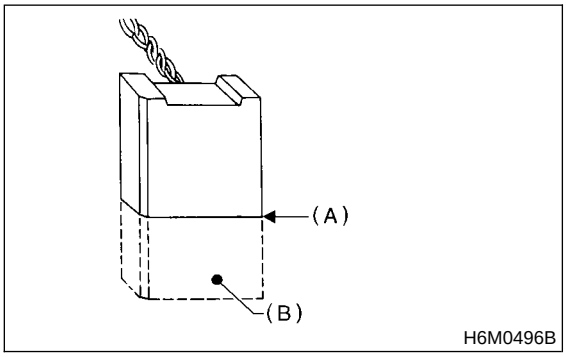
Inspect teeth of pinion for wear and damage. Replace if it is damaged. Rotate pinion in direction of rotation (counterclockwise). It should rotate smoothly. But in opposite direction, it should be locked.

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

4. BRUSH AND BRUSH HOLDER S179012A1004

1) Brush length
Measure the brush length and 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

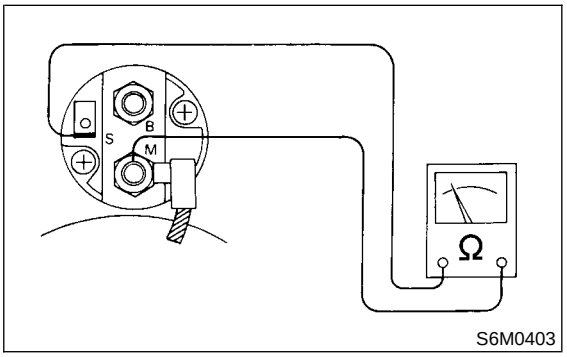
2) Brush movement
Be sure brush moves smoothly inside brush holder.
3) Brush spring force
Measure brush spring force with a spring scale. If it is less than the service limit, replace brush holder.

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 S179012A1005

Be sure there is continuity between 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



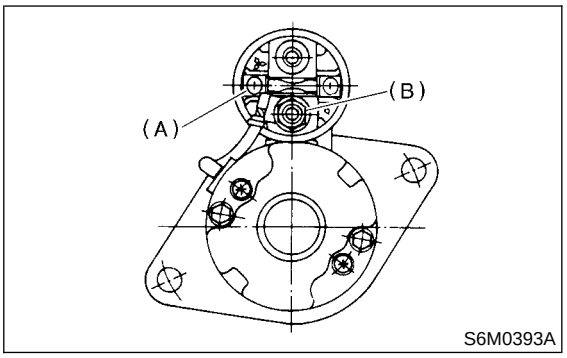
6. SWITCH ASSEMBLY OPERATION

S179012A1006

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

CAUTION:
With 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 connector from terminal M, and connect positive terminal of battery and terminal M using a lead wire and ground terminal to starter body.
In this test set up, pinion should return to its original position even when it is pulled out with a screwdriver.

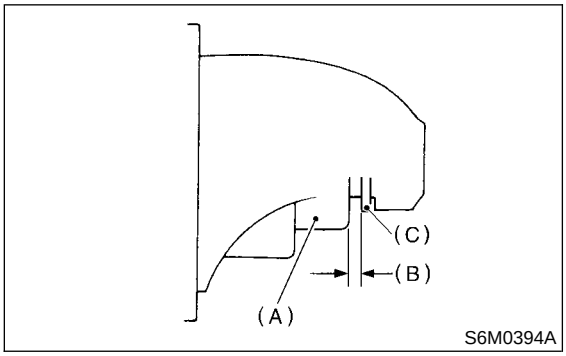


(A) Terminal S
(B) Terminal M

7. PINION GAP S179012A1007

1) Measure 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)

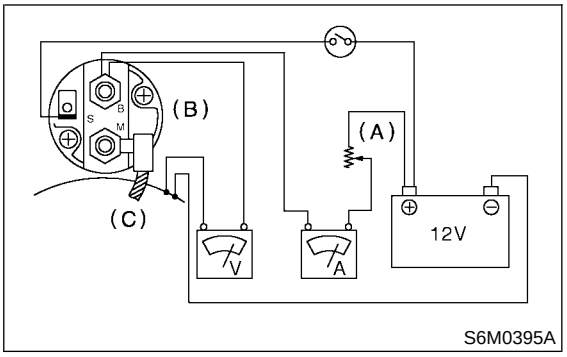


(A) Pinion
(B) Gap
(C) Stopper

If motor is running with the pinion forced endwise on the shaft, disconnect connector from terminal M of switch assembly and connect terminal M to ground terminal (−) of battery with a lead wire. Next, gently push pinion back with your fingertips and measure pinion gap.
2) If 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 S179012A1008

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 measure the starter speed. Compare these values with the specifications.

No-load test (Standard):

Voltage / Current
11 V / 90 A max.

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 specifications.

Load test (Standard):

Voltage / Load
MT vehicles
7.5 V/8.6 N·m (0.88 kgf-m, 6.4 ft-lb)
AT vehicles
7.7 V/16.0 N·m (1.63 kgf-m, 11.8 ft-lb)

Current / Speed
MT vehicles
300 A/920 rpm or more
AT vehicles
400 A/740 rpm or more

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

Lock test (Standard):

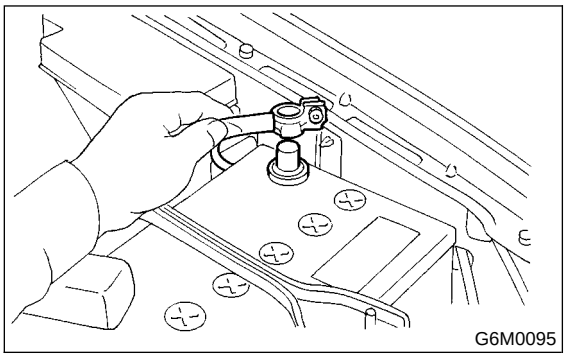
Voltage / Current
MT vehicles
4 V/650 A or less
AT vehicles
3.5 V/940 A or less

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

3. Generator S179008

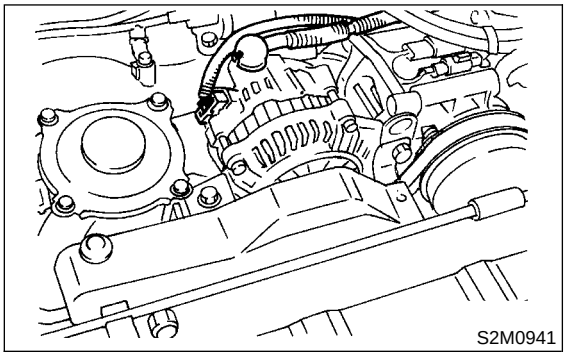
A: REMOVAL S179008A18

1) Disconnect battery ground cable.

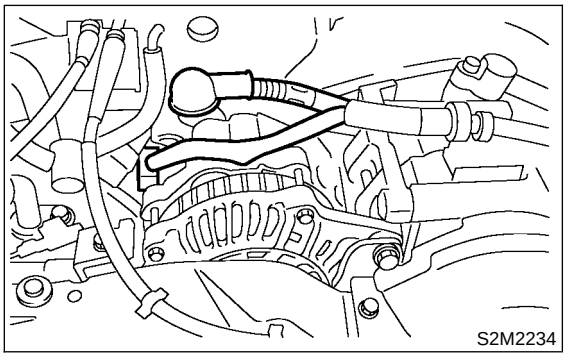

G6M0095

2) Disconnect connector and terminal from generator.

- Non-Turbo Model

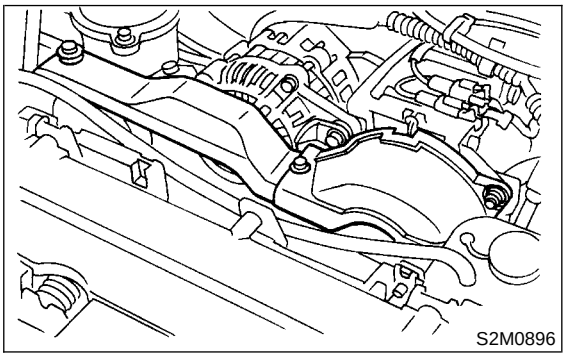

S2M0941

- Turbo Model

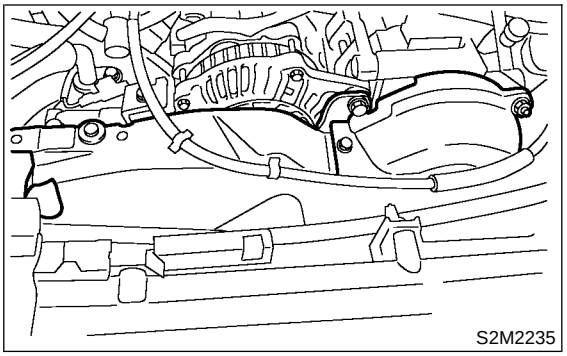

S2M2234

3) Remove V-belt cover.

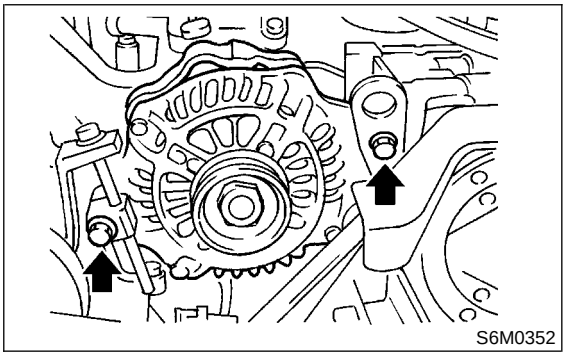
- Non-Turbo Model


S2M0896

- Turbo Model


S2M2235

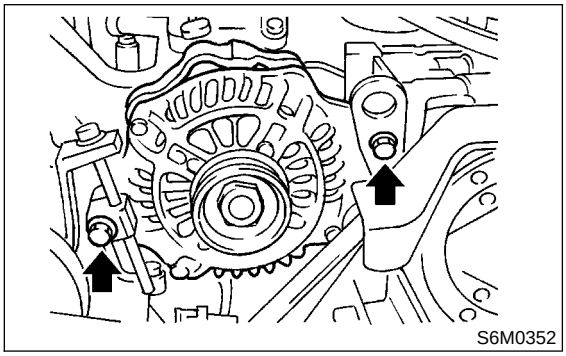
4) Remove front side V-belt.
<Ref. to ME(SOHC) -42, FRONT SIDE, REMOVAL, V-belt.> or <Ref. to ME(DOHC TURBO) -44, FRONT SIDE, REMOVAL, V-belt.>
5) Remove bolts which install generator onto bracket.


S6M0352

B: INSTALLATION S179008A11

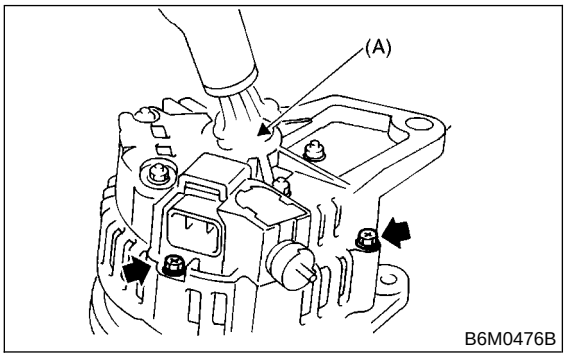
Install in the reverse order of removal.

CAUTION:
Check and adjust V-belt tension. <Ref. to ME(SOHC) -43, INSPECTION, V-belt.> and <Ref. to ME(DOHC TURBO) -45, INSPECTION, V-belt.>


S6M0352

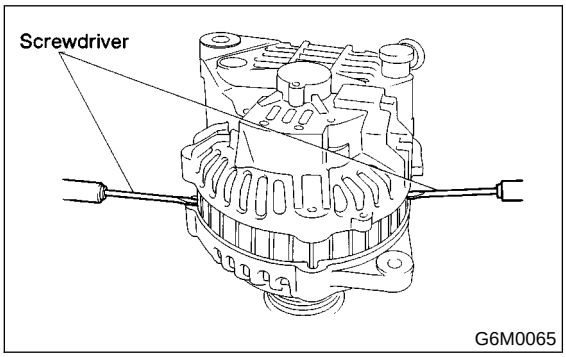
C: DISASSEMBLY S179008A06

1) Heat the portion (A) of rear cover to 50°C (122°F) with heater drier.



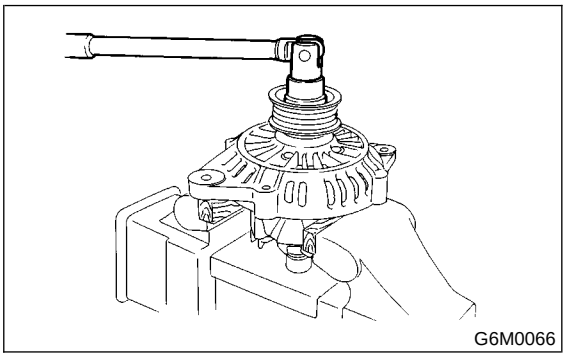
B6M0476B

2) Remove the four through bolts. Then insert the tip of a flat-head screwdriver into the gap between the stator core and front bracket. Pry then apart to disassemble.

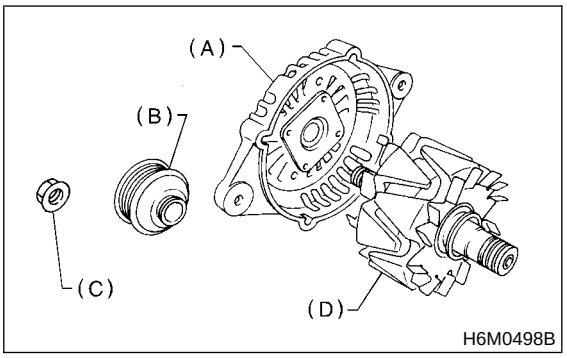


G6M0065

3) Hold rotor with a vise and remove pulley nut.


G6M0066

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

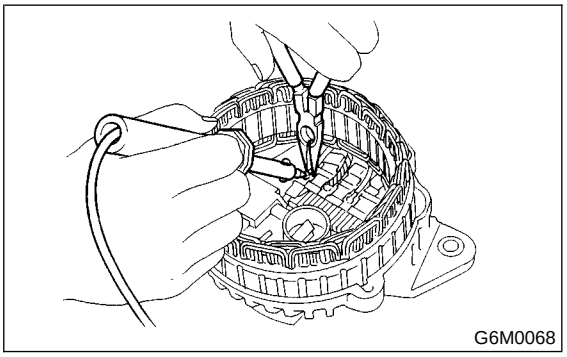


H6M0498B

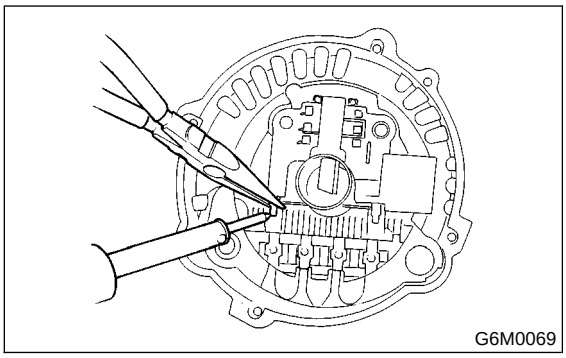
(A) Front bracket
(B) Pulley
(C) Nut
(D) Rotor

4) Unsolder connection between rectifier and stator coil to remove stator coil.

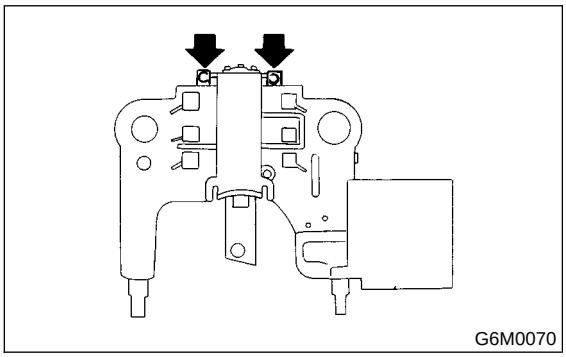
CAUTION:
Finish the work rapidly (less than three seconds) because the rectifier cannot withstand heat very well.


G6M0068

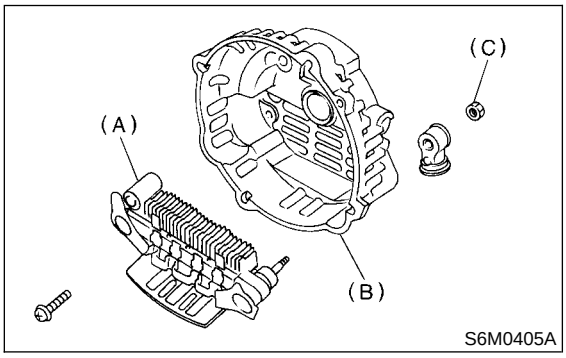
5) Remove screws which secure IC regulator to rear cover, and unsolder connection between IC regulator and rectifier to remove IC regulator.


G6M0069

6) Remove the brushes by unsoldering at the pigtails.


G6M0070

7) Remove the nut and insulating bushing at terminal B, and remove rectifier.



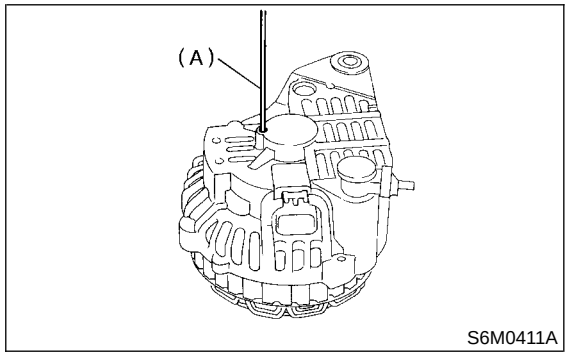
S6M0405A

(A) Ractifier
(B) Rear cover
(C) Nut

D: ASSEMBLY S179008A02

To assemble, reverse order of disassembly.
1) Pulling up brush
Before assembling, press the brush down into the brush holder with your finger and secure in that position by passing a [2 mm (0.08 in) dia. length 4 to 5 cm (1.6 to 2.0 in)] wire (A) through the hole shown in the figure.

CAUTION:
Be sure to remove the wire after reassembly.



S6M0411A

2) Heat the bearing box in the rear bracket [50 to 60°C (122 to 140°F)] and press the rear bearing into the rear bracket.

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

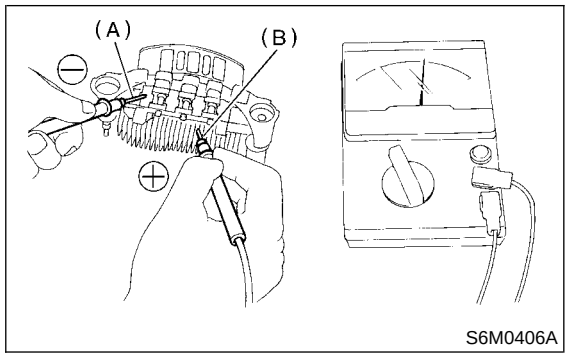
3) After reassembly, turn the pulley by hand to check that the rotor turns smoothly.

E: INSPECTION S179008A10

1. DIODE S179008A1001

CAUTION:
Never use a megger tester (measuring use for high voltage) or any other similar measure for this test; otherwise, the diodes may be damaged.

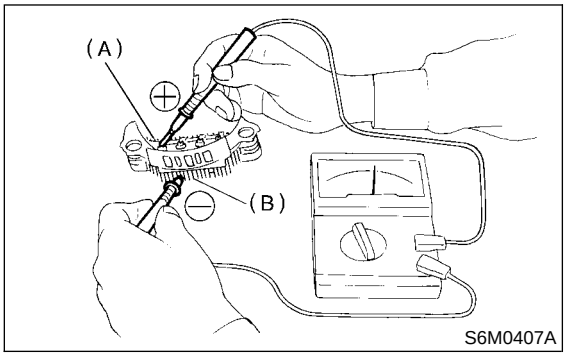
1) Checking positive diode
Check for continuity between the diode lead and the positive side heat sink. The positive diode is in good condition if continuity (1 Ω or less) exists only in the direction from the diode lead to the heat sink.



S6M0406A

(A) Diode lead
(B) Heat sink (Positive side)

2) Checking negative diode
Check for continuity between the negative side heat sink and diode lead. The negative diode is in good condition if continuity (1 Ω or less) exists only in the direction from the heat sink to the diode lead.



(A) Diode lead
(B) Heat sink (Negative side)

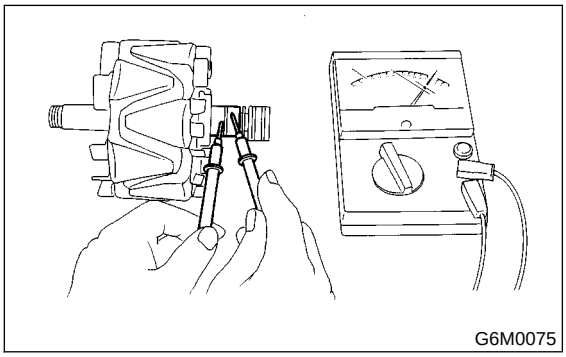
2. ROTOR S179008A1002

1) Slip ring surface
Inspect slip rings for contamination or any roughness of the sliding surface. Repair slip ring surface using a lathe or sand paper.
2) Slip ring outer diameter
Measure slip ring outer diameter. If slip ring is worn replace rotor assembly.

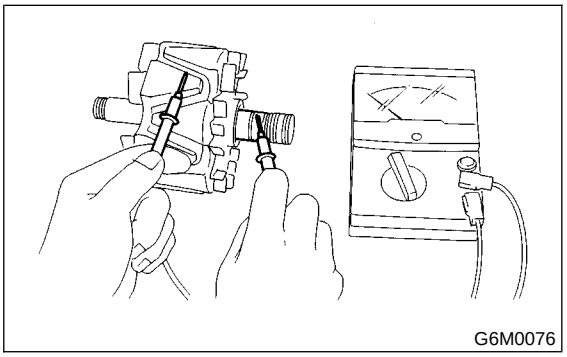
Slip ring outer diameter:
Standard
22.7 mm (0.894 in)
Limit
22.1 mm (0.870 in)

3) Continuity test
Check resistance between slip rings using circuit tester.
If the resistance is not within specification, replace rotor assembly.

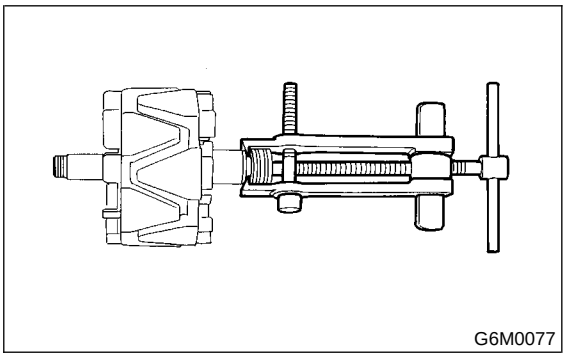
Specified resistance:
Approx. 2.7 — 3.2 Ω



4) Insulation test
Check continuity between slip ring and rotor core or shaft. If continuity (1 Ω or less) exists, the rotor coil is grounded, and so replace rotor assembly.

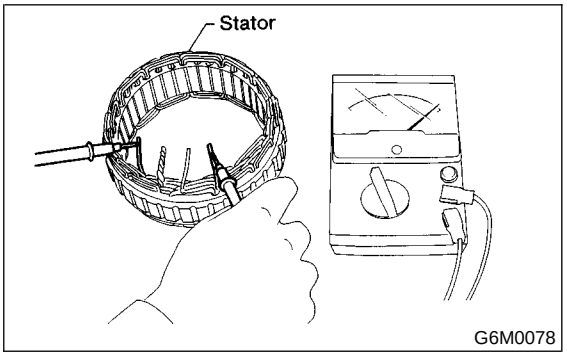


5) Ball bearing (rear side)
(1) Check rear ball bearing. Replace if it is noisy or if rotor does not turn smoothly.
(2) The rear bearing can be removed by using common bearing puller.

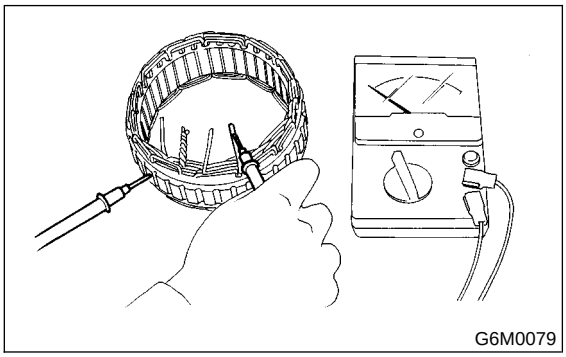


3. STATOR S179008A1003

1) Continuity test
Inspect stator coil for continuity between each end of the lead wires. If there is no continuity (1 Ω or more) between individual lead wires, the lead wire is broken, and so replace stator assembly.



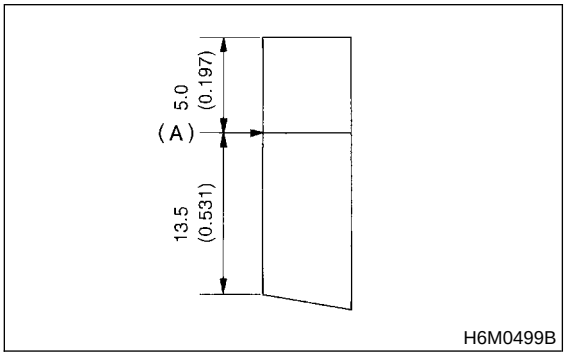
2) Insulation test
Inspect stator coil for continuity (1 Ω or less) between stator core and each end of the lead wire. If there is continuity, the stator coil is grounded, and so replace stator assembly.


G6M0079

4. BRUSH S179008A1004

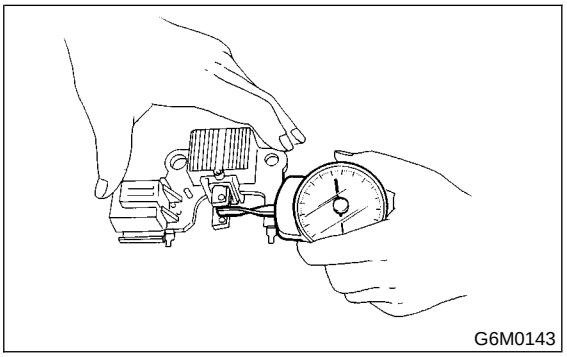
1) Measure the length of each brush. If wear exceeds the service limit, replace the brush. Each brush has the service limit mark (A) on it.

Brush length:
Standard
18.5 mm (0.728 in)
Service limit
5.0 mm (0.197 in)



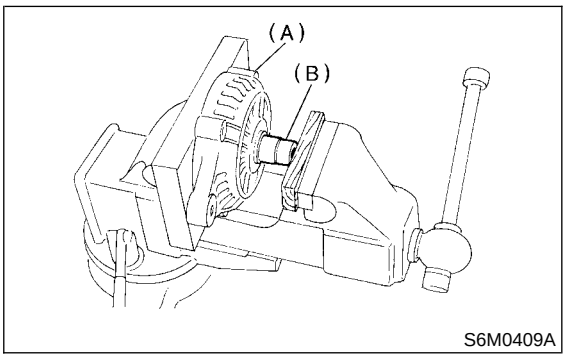
H6M0499B

2) Checking brush spring for proper pressure
Using a spring pressure indicator, push the brush into the brush holder until its tip protrudes 2 mm (0.08 in). Then measure the pressure of the brush spring. If the pressure is less than 2.648 N (270 g, 9.52 oz), replace the brush spring with a new one. The new spring must have a pressure of 4.609 to 5.786 N (470 to 590 g, 16.58 to 20.81 oz).


G6M0143

5. BEARING (FRONT SIDE) S179008A1005

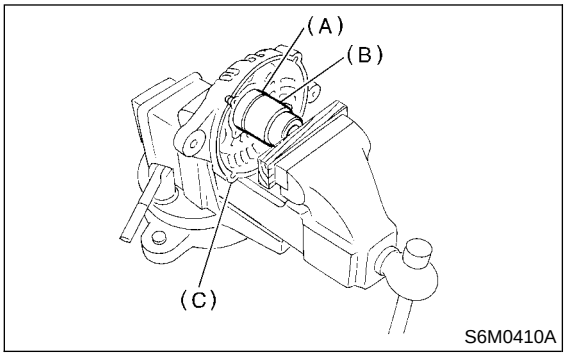
1) Check front ball bearing. If resistance is felt while rotating, or if abnormal noise is heard, replace the ball bearing.
2) Replacing front bearing
(1) Remove front bearing retainer.
(2) Closely install a fit tool on the bearing inner race. Press the bearing down out of front bracket with a hand press or vise. A socket wrench can serve as the tool.



S6M0409A

(A) Front bracket
(B) Socket wrench

(3) Set a new bearing and closely install a fit tool on the bearing outer race. Press the bearing down into place with a hand press or vise. A socket wrench can serve as the tool.
(4) Install front bearing retainer.

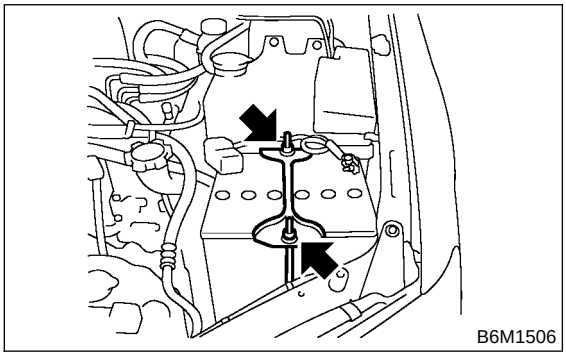


(A) Bearing
(B) Socket wrench
(C) Front bracket

4. Battery S179011

A: REMOVAL S179011A18

1) Disconnect the positive (+) terminal after disconnecting the negative (−) terminal of battery.
2) Remove flange nuts from battery rods and take off battery holder.



3) Remove battery.

B: INSTALLATION S179011A11

Install in the reverse order of removal.

Tightening torque:
3.4 N·m (0.35 kgf-m, 2.5 ft-lb)

NOTE:
● Clean battery cable terminals and apply grease to retard the formation of corrosion.
● Connect the positive (+) terminal of battery and then the negative (−) terminal of the battery.

C: INSPECTION S179011A10

WARNING:
● Electrolyte has toxicity; be careful handling the fluid.
● Avoid contact with skin, eyes or clothing. Especially at contact with eyes, blush 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 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: S179011A1001

Check for the existence of dirt or cracks on the 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.

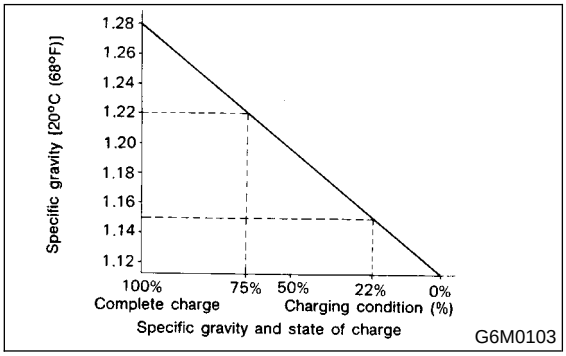
2. ELECTROLYTE LEVEL: S179011A1002

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: S179011A1003

1) Measure 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} = St + 0.0007 × (t − 20)
S_{20}: Specific gravity corrected at electrolyte temperature of 20°C
St : 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 the battery will disclose the state of charge of the battery. The relation between the specific gravity and the state of charge is as shown in figure.

D: MEASUREMENT S179011A14

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 battery electrolyte overflows while charging the battery.
● Observe 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 S179011A1401

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 S179011A1402

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 S179011A1403

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

4. QUICK CHARGING S179011A1404

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 the 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 1. NORMAL CHARGING.
● Never use more than 10 amperes when charging the battery because that will shorten battery life.

MEMO: