ENGINE ELECTRICAL SYSTEM 6-1

1. Engine Electrical

A: SPECIFICATIONS

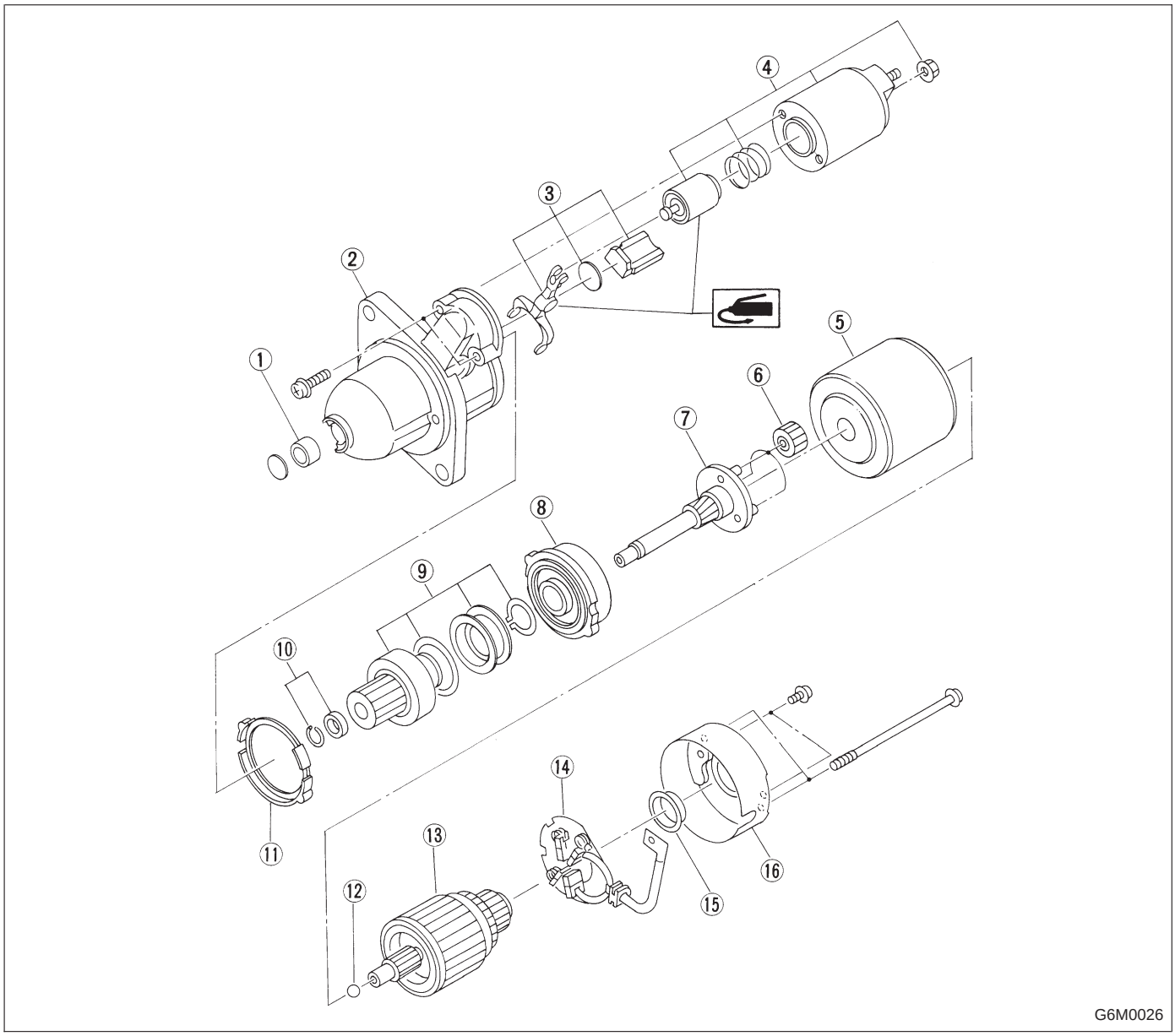
1. 1800 cc MODEL

Item			Designation	
Starter	Type		Reduction type	
	Model		MT M001T77181	AT M1T-75681
	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	3,000 rpm or more	
	Load characteristics	Voltage	8 V	7.7 V
		Current	280 A or less	300 A or less
		Torque	8.5 N·m (0.87 kg-m, 6.3 ft-lb)	10 N·m (1.0 kg-m, 7 ft-lb)
		Rotating speed	980 rpm or more	1,000 rpm or more
	Lock characteristics	Voltage	4 V	
		Current	780 A or less	980 A or less
		Torque	17.6 N·m (1.80 kg-m, 13.0 ft-lb) or more	23 N·m (2.3 kg-m, 17 ft-lb) or more
Generator	Type		Rotating-field three-phase type, Voltage regulator built-in type	
	Model		A2T39091	
	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)]	
Ignition coil	Model		CM12-100	
	Manufacturer		HITACHI	
	Primary coil resistance		0.63 — 0.77 Ω	
	Secondary coil resistance		10.4 — 15.6 kΩ	
	Insulation resistance between primary terminal and case		More than 10 MΩ	
Spark plug	Type and manufacturer		BKR6E-11 ..... NGK	
	Thread size	mm	14, P = 1.25	
	Spark gap	mm (in)	1.0 — 1.1 (0.039 — 0.043)	

2. 2200 cc MODEL

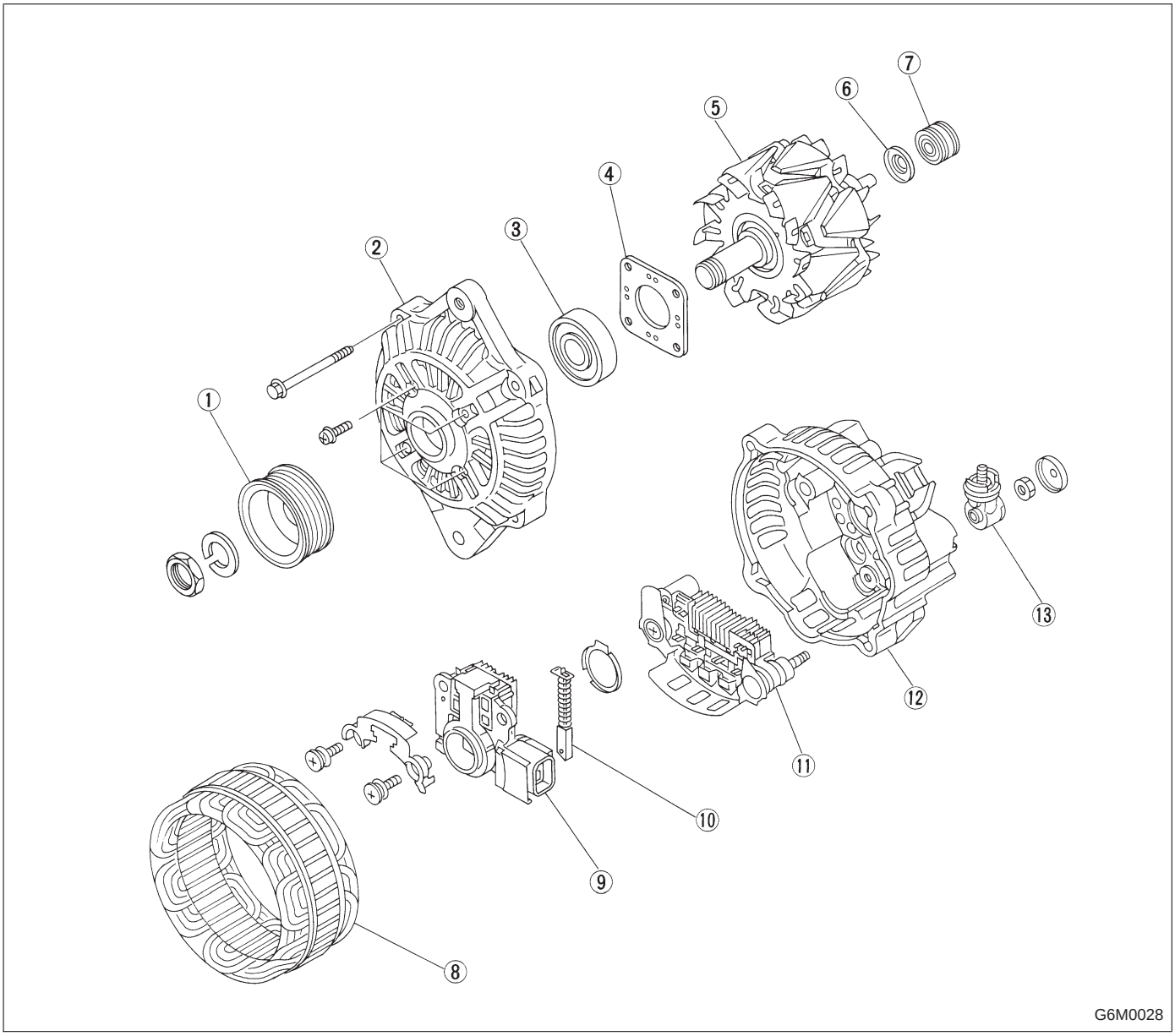
Item			Designation
Starter	Type		Reduction type
	Model		M001T75681
	Manufacturer		MITSUBISHI
	Voltage and output		12 V — 1.4 kW
	Direction of rotation		Counterclockwise (when observed from pinion)
	Number of pinion teeth		9
	No-load characteristics	Voltage	11 V
		Current	90 A or less
		Rotating speed	3,000 rpm, or more
	Load characteristics	Voltage	7.7 V
		Current	300 A
		Torque	9.81 N·m (1.001 kg-m, 7.236 ft-lb)
		Rotating speed	1,000 rpm or more
	Lock characteristics	Voltage	4 V
		Current	980 A or less
		Torque	23 N·m (2.35 kg-m, 17.0 ft-lb) or more
Generator	Type		Rotating-field three-phase type, Voltage regulator built-in type
	Model		A2T39091
	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		$14.5^{+0.3}_{-0.4}$ V [20°C (68°F)]
Ignition coil	Model		F-569-01R
	Manufacturer		Diamond
	Primary coil resistance		0.69 Ω±10%
	Secondary coil resistance		21.0 kΩ±15%
	Insulation resistance between primary terminal and case		More than 10 MΩ
Spark plug	Type and manufacturer		Alternate: RC10YC4 ..... CHAMPION (BKR6E-11 ..... NGK K20PR-U11 ..... NIPPONDENSO)
	Thread size mm		14, P = 1.25
	Spark gap mm (in)		1.0 — 1.1 (0.039 — 0.043)

1. Starter

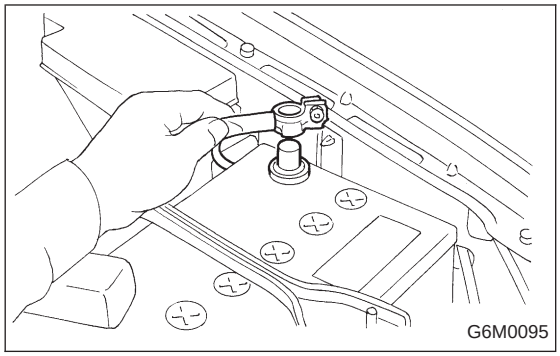


① Sleeve bearing
② Front bracket
③ Lever set
④ Magnet switch Assy
⑤ Yoke
⑥ Gear ASSY
⑦ Shaft ASSY
⑧ Internal gear ASSY
⑨ Over running clutch
⑩ Stopper set
⑪ Packing
⑫ Ball
⑬ Armature
⑭ Brush holder
⑮ Bearing
⑯ Rear bracket

2. Generator



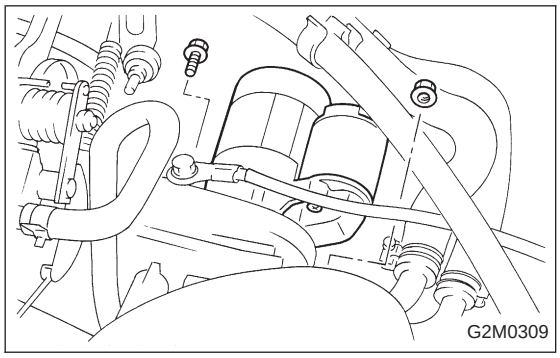
① Pulley
② Front cover
③ Ball bearing
④ Bearing retainer
⑤ Rotor
⑥ Holder
⑦ Bearing
⑧ Stator coil
⑨ Brush holder
⑩ Brush
⑪ IC regulator
⑫ Rear cover
⑬ Terminal


G6M0095

1. Starter

A: REMOVAL AND INSTALLATION

1) Disconnect battery ground cable.


G2M0309

2) Disconnect connector and terminal from starter.
3) Remove starter from transmission.
4) Installation is in the reverse order of removal.

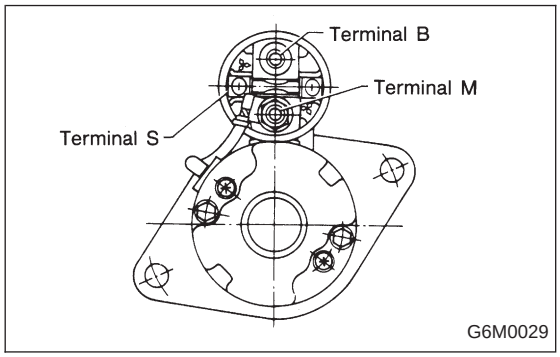
Tightening torque:
46 — 54 N·m (4.7 — 5.5 kg-m, 34 — 40 ft-lb)

B: TEST

1. SWITCH ASSEMBLY OPERATION

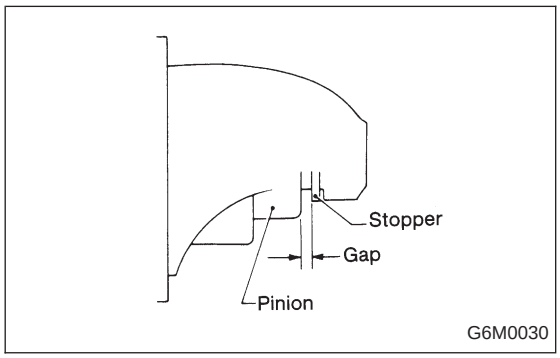
1) Connect terminal S of switch assembly to positive terminal of battery with a lead wire, and starter body to ground terminal of battery. Pinion should be forced endwise on shaft.

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.



G6M0029

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.



G6M0030

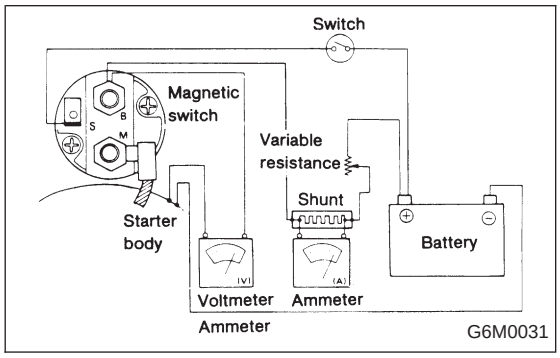
2. PINION GAP

1) With pinion forced endwise on shaft, as outlined in step 1) above, measure pinion gap.

Pinion gap:
0.5 — 2.0 mm (0.020 — 0.079 in)

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.



3. 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.

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.

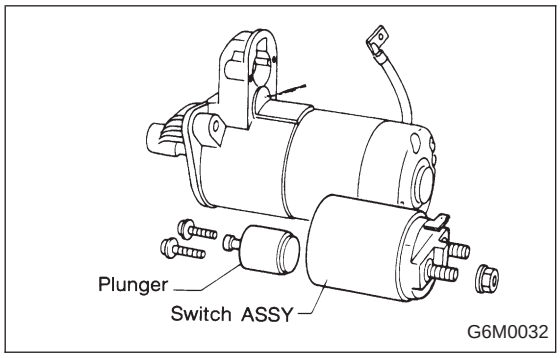
No-load test (Standard):
Voltage / Current
11 V / 90 A max.
Rotating speed
3,000 rpm / min.

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
7.7 V / 10 N·m (1.0 kg-m, 7 ft-lb)
Current / Speed
300 A max. / 1,000 rpm / min.

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.

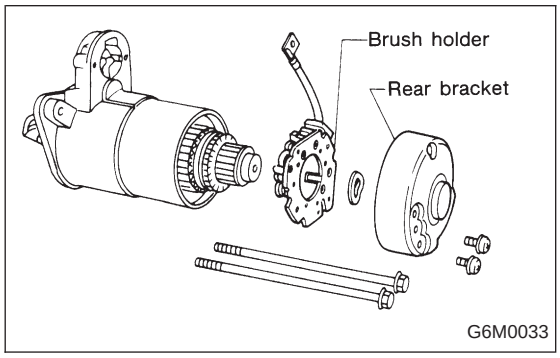
Lock test (Standard):
Voltage / Current
4 V / 980 A max.
Torque
23 N·m (2.3 kg-m, 17 ft-lb) min.



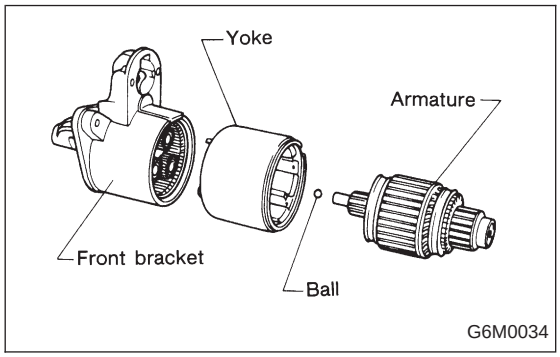
C: DISASSEMBLY

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.

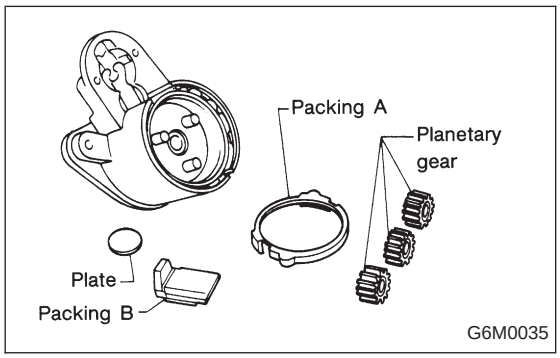


3) Remove both through-bolts and brush holder screws, and detach rear bracket and brush holder.

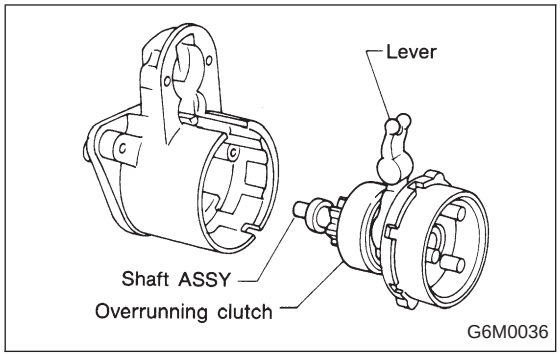


4) Remove armature and yoke. Ball used as a bearing will then be removed from the end of armature.

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

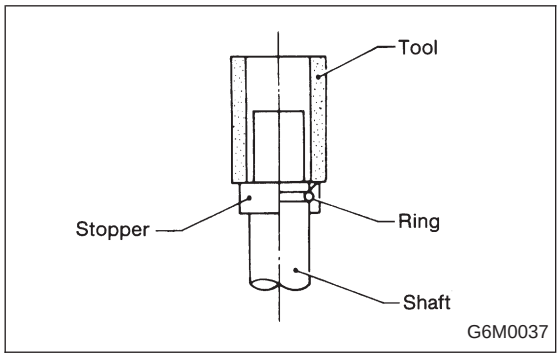


5) Remove packing A, three planetary gears, packing B and plate.



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

CAUTION:
Record the direction of lever before removing.



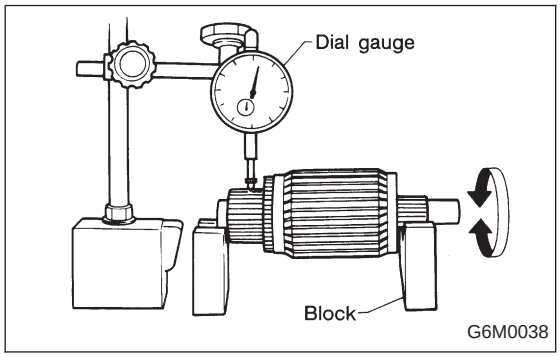
7) Remove overrunning clutch from shaft assembly as follows:

(1) Remove stopper from ring by lightly tapping a fit tool placed on stopper.
(2) Remove ring, stopper and clutch from shaft.

D: INSPECTION

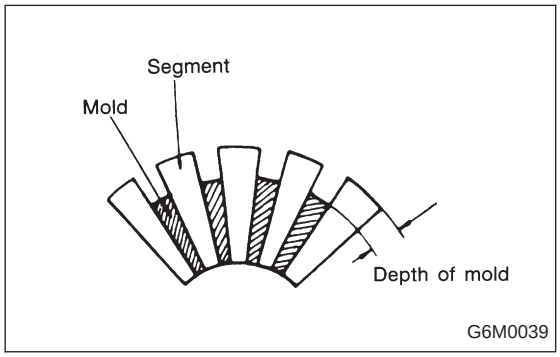
1. ARMATURE

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.



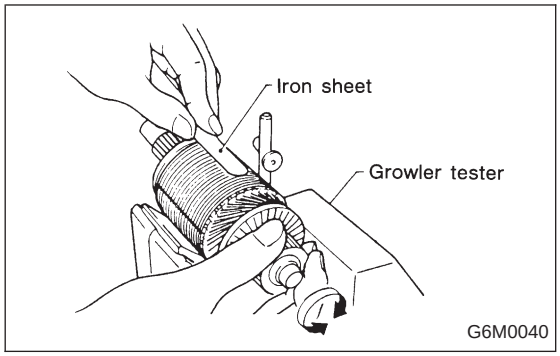
2) Run-out test
Check the commutator run-out and replace if it exceeds the limit.

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

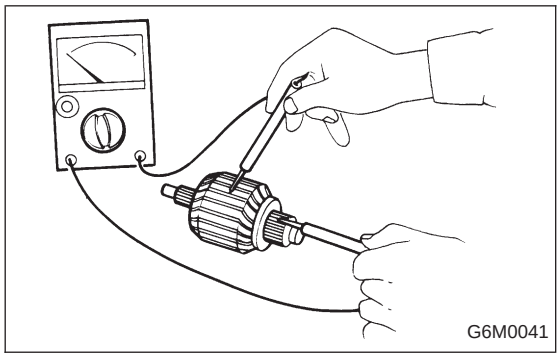


3) Depth of segment mold
Check the depth of segment mold.

Depth of segment mold:
0.5 — 0.8 mm (0.020 — 0.031 in)



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.



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.

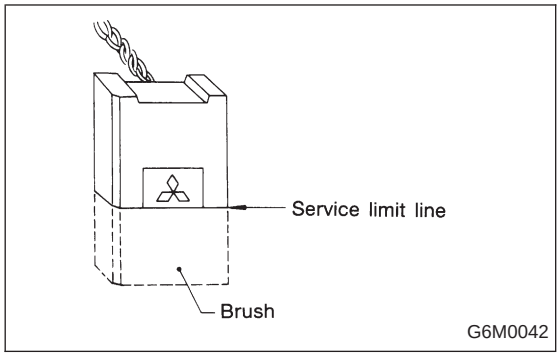
2. YOKE

Make sure pole is set in position.

3. OVERRUNNING CLUTCH

Inspect teeth of pinion for wear and damage. Replace if it damaged. Rotate pinion in direction of rotation (clockwise). 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 replace if it exceeds the service limit.

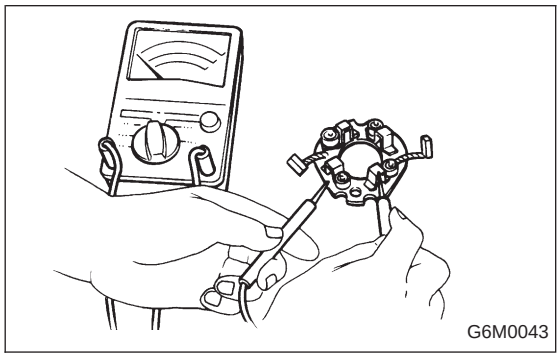
Replace if abnormal wear or cracks are noticed.

Brush length:

Standard	***17.0 mm (0.669 in)***
Service limit	***11.5 mm (0.453 in)***

2) Brush movement

Be sure brush moves smoothly inside brush holder.



3) Insulation resistance of brush holder

Be sure there is no continuity between brush holder and its plate.

4) Brush spring force

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

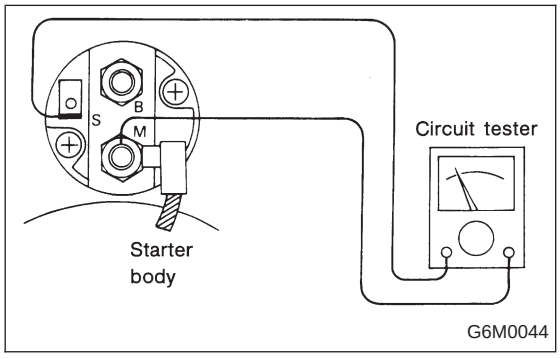
Brush spring force:

Standard

18.6 N (1.9 kg, 4.2 lb) (when new)

Service limit

6.9 N (0.7 kg, 1.5 lb)



5. SWITCH ASSEMBLY

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 / 10 Ω, max.

S — Ground / 10 Ω, max.

M — B / 1 MΩ, min.

E: ASSEMBLY

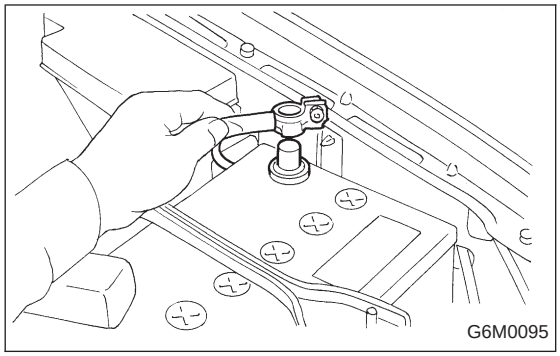
Assembly is in the reverse order of disassembly procedures. Observe the following:

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 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

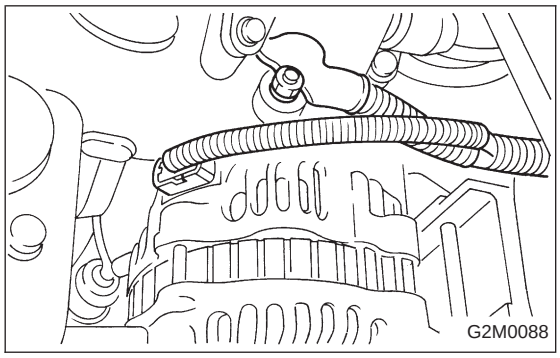
3) After assembling parts correctly, check to be sure starter operates properly.



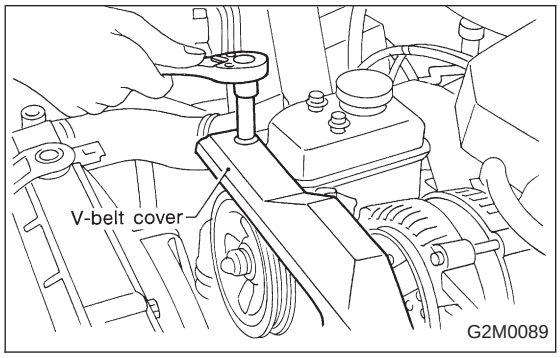
2. Generator

A: REMOVAL AND INSTALLATION

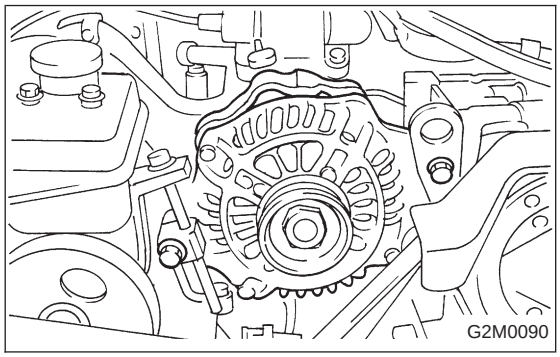
1) Disconnect battery ground cable.



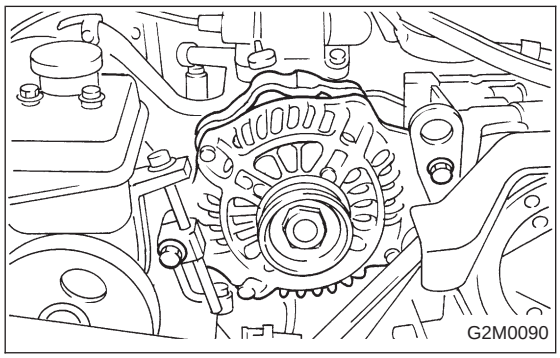
2) Disconnect connector and terminal from generator.



3) Remove V-belt cover.
4) Remove front side V-belt.

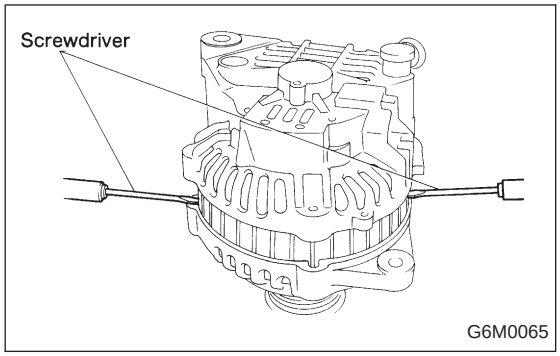


5) Remove bolts which install generator onto bracket.



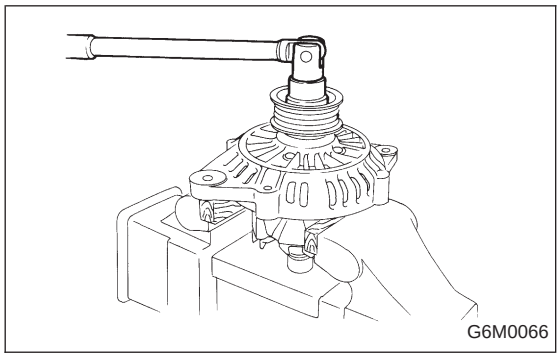
6) Installation is in the reverse order of removal.

CAUTION:
Check and adjust V-belt tension. <Ref. to 1-5 [W1A0].>

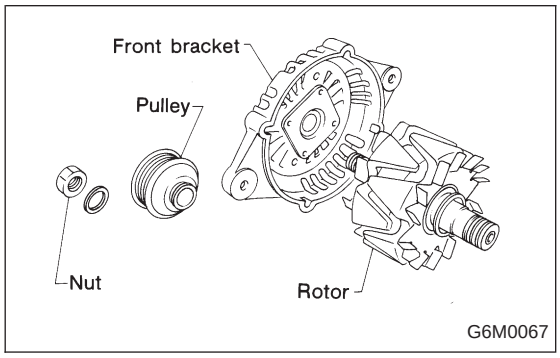


B: DISASSEMBLY

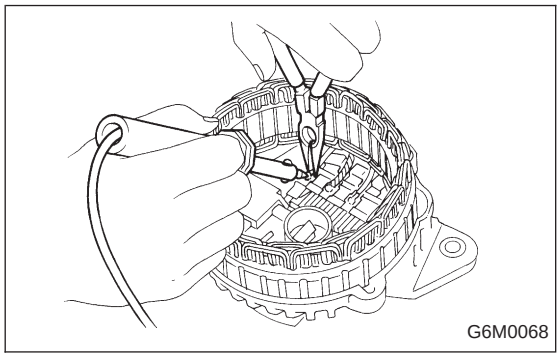
1) Remove the four through-bolts. Then insert the tip of a flat-head screwdriver into the gap between the stator core and front bracket. Pry then apart to disassemble.



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

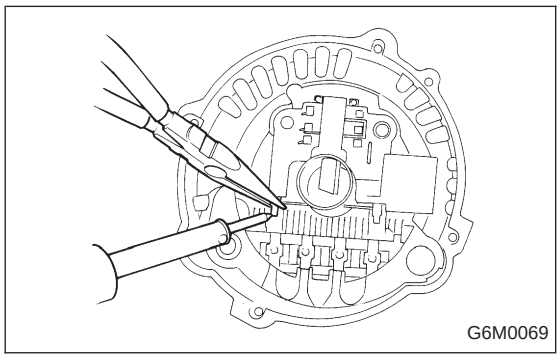


CAUTION:
When holding rotor with vise, insert aluminum plates or wood pieces on the contact surfaces of the vise to prevent rotor from damage.

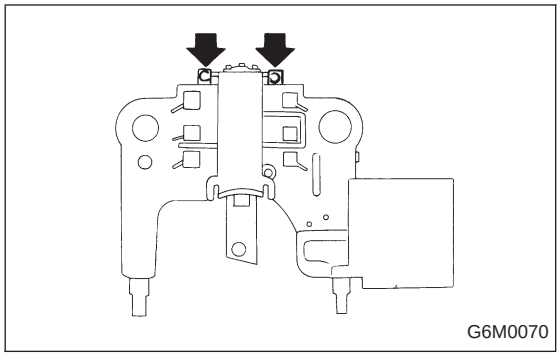


3) Unsolder connection between rectifier and stator coil to remove stator coil.

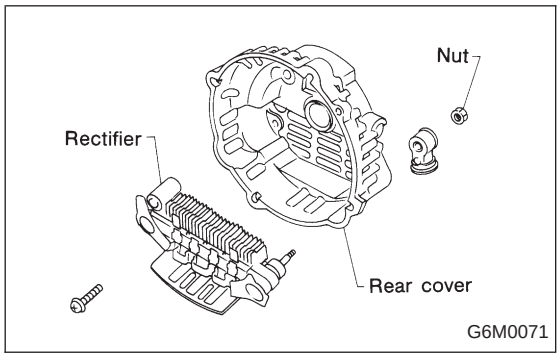
CAUTION:
Finish the work rapidly (less than three seconds) because the rectifier cannot withstand heat very well.



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


G6M0070

5) Remove the brushes by unsoldering at the pigtails.



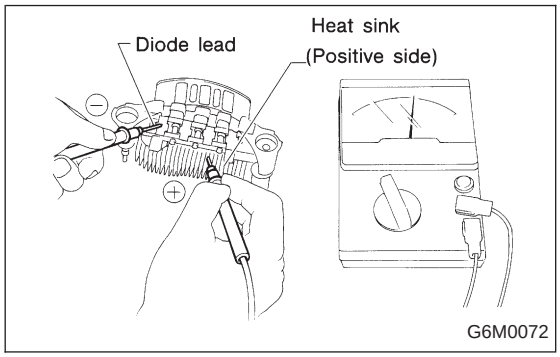
G6M0071

6) Remove the nut and insulating bushing at terminal B. Remove rectifier.

C: INSPECTION AND REPAIR

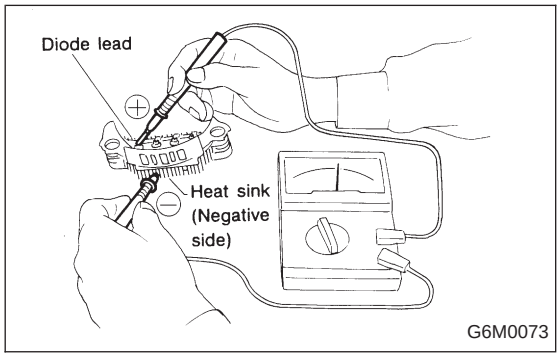
1. DIODE

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.



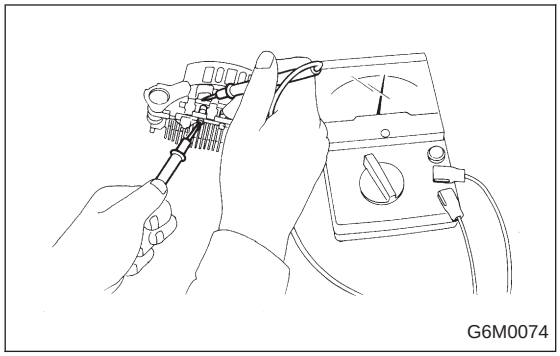
G6M0072

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 exists only in the direction from the diode lead to the heat sink.



G6M0073

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 exists only in the direction from the heat sink to the diode lead.


G6M0074

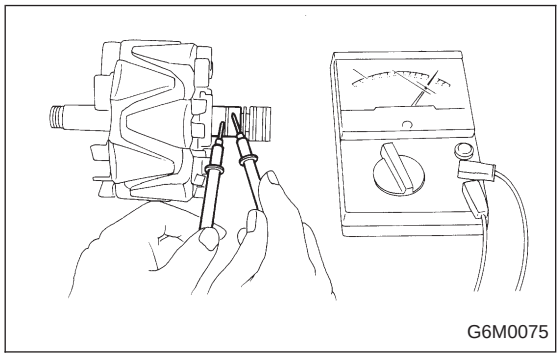
3) Checking trio diode
Check the trio diode using a circuit tester. It is in good condition if continuity exists only in one direction.

2. ROTOR

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.

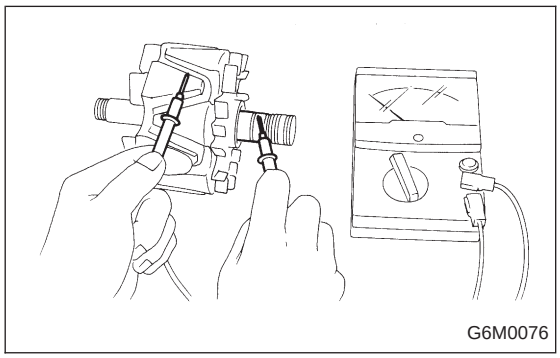
2) Slip ring outer diameter
Measure slip ring outer diameter. If slip ring is worn replace rotor assembly.

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

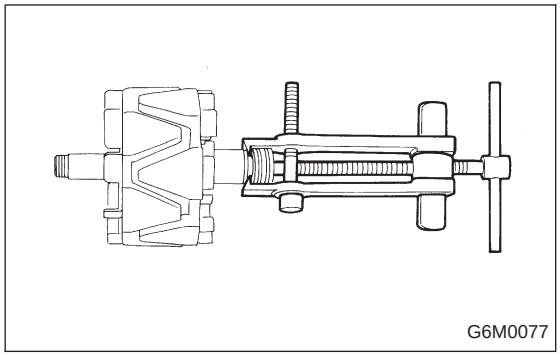

G6M0075

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

Specified resistance:
Approx. 3 Ω (A2T39091)
Approx. 2 — 6 Ω (A2T37291)


G6M0076

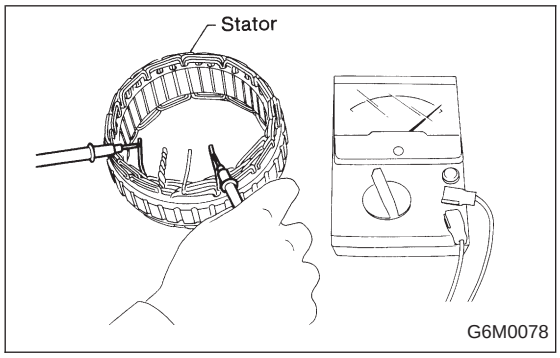
4) Insulation test
Check continuity between slip ring and rotor core or shaft. If continuity exists, the rotor coil is short-circuited, and so replace rotor assembly.


G6M0077

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.

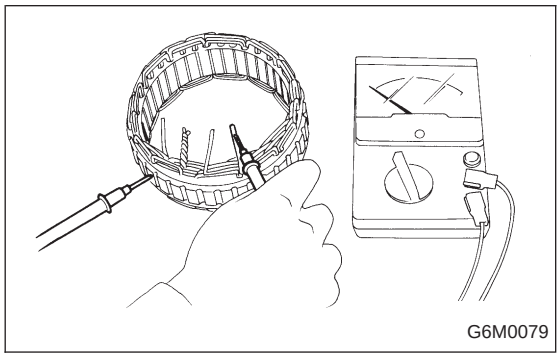


G6M0078

3. STATOR

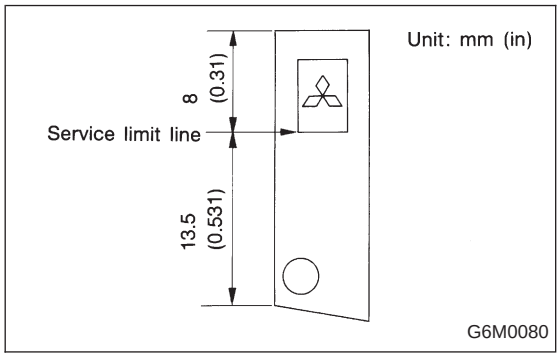
1) Continuity test

Inspect stator coil for continuity between each end of the lead wires. If there is no continuity between individual lead wires, the lead wire is broken, and so replace stator assembly.


G6M0079

2) Insulation test

Inspect stator coil for continuity between stator core and each end of the lead wire. If there is continuity, the stator coil is short-circuited, and so replace stator assembly.



G6M0080

4. BRUSH

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

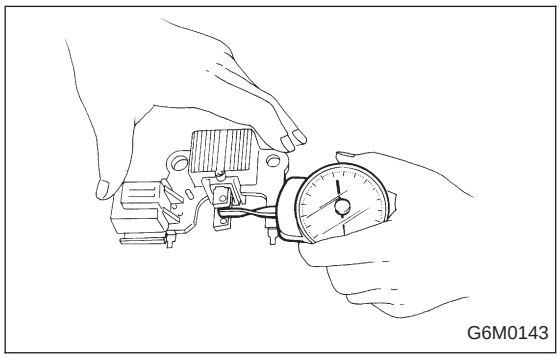
Brush length:

Standard

21.5 mm (0.846 in)

Service limit

8.0 mm (0.315 in)

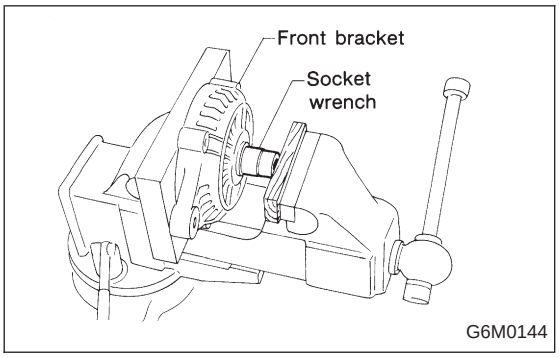

G6M0143

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 3.236 N (330 g, 11.64 oz), replace the brush spring with a new one. The new spring must have a pressure of 5.786 to 6.963 N (590 to 710 g, 20.81 to 25.04 oz).

5. BEARING (FRONT SIDE)

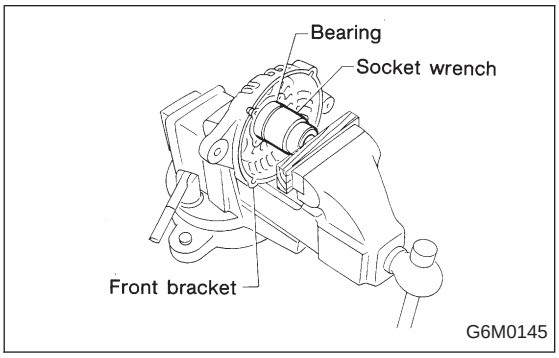
1) Check front ball bearing. If resistance is felt while rotating, or if abnormal noise is heard, replace the ball bearing.



2) Replacing front bearing

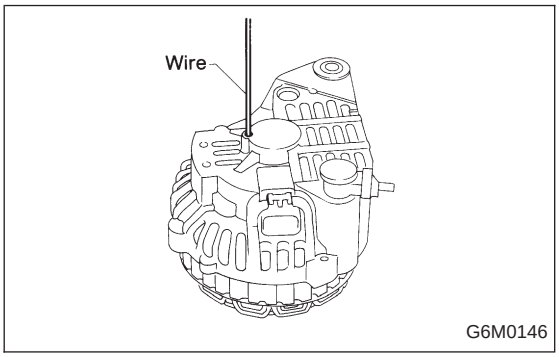
(1) Remove front bearing retainer.

(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.



(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.



D: ASSEMBLY

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 through the hole shown in the figure.

CAUTION:
Be sure to remove the wire after reassembly.

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

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

3. Spark Plug

A: REMOVAL AND INSTALLATION

CAUTION:
All spark plugs installed on an engine, must be of the same heat range.

Spark plug:
- ***1800 cc model***

NGK: BKR6E-11
CHAMPION: RC8YC4
- ***2200 cc model***

CHAMPION: R10YC4
(Alternate)
NGK: BKR6E-11
NIPPONDENSO: K20PR-U11

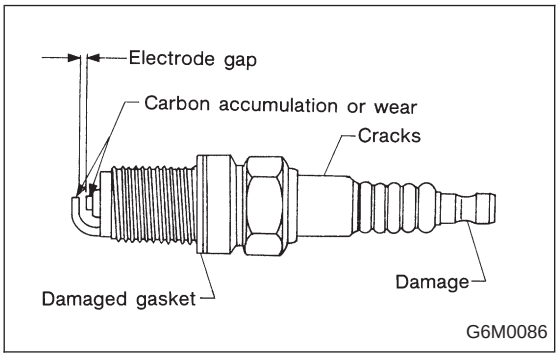
1) Remove spark plug cords by pulling boot, not cord itself.
2) Remove spark plugs.
3) When installing spark plugs on cylinder head, use spark plug wrench.

Tightening torque (Spark plug):
21±3 N·m (2.1±0.3 kg-m, 15.2±2.2 ft-lb)

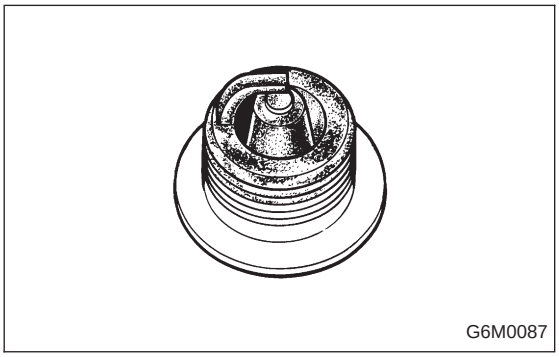
CAUTION:
The above torque should be only applied to new spark plugs without oil on their threads.
In case their threads are lubricated, the torque should be reduced by approximately 1/3 of the specified torque in order to avoid their over-stressing.

4) Connect spark plug cords.

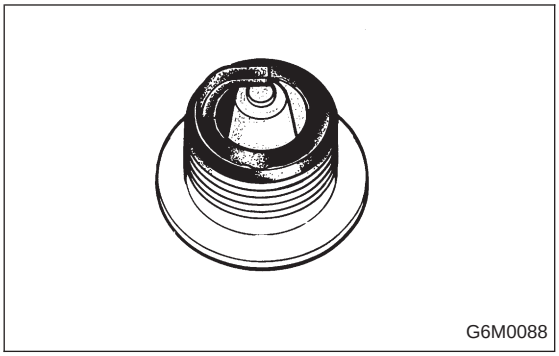
B: INSPECTION



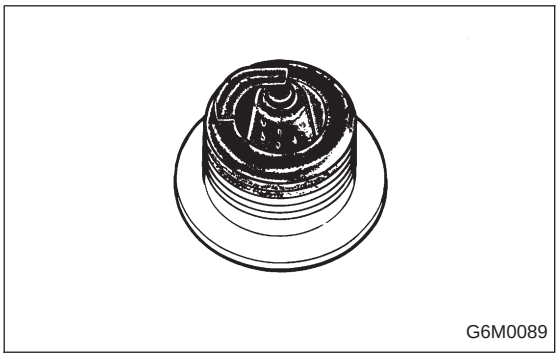
Check electrodes and inner and outer porcelain of plugs, noting the type of deposits and the degree of electrode erosion.



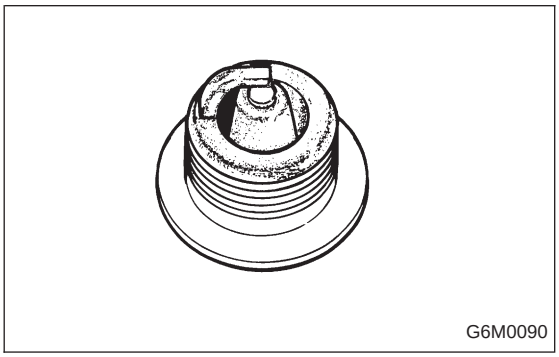
1) Normal
Brown to grayish-tan deposits and slight electrode wear indicate correct spark plug heat range.


G6M0088

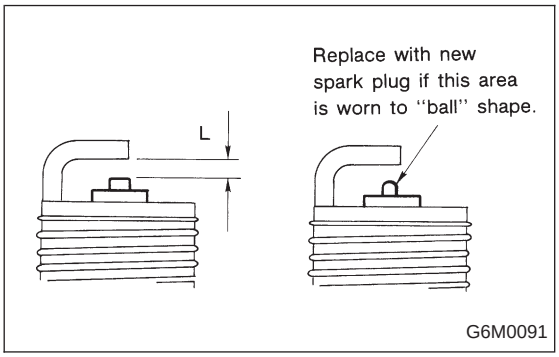
2) Carbon fouled
Dry fluffy carbon deposits on insulator and electrode are mostly caused by slow speed driving in city, weak ignition, too rich fuel mixture, dirty air cleaner, etc.
It is advisable to replace with plugs having hotter heat range.


G6M0089

3) Oil fouled
Wet black deposits show excessive oil entrance into combustion chamber through worn rings and pistons or excessive clearance between valve guides and stems. If same condition remains after repair, use a hotter plug.


G6M0090

4) Overheating
White or light gray insulator with black or gray brown spots and bluish burnt electrodes indicate engine overheating. Moreover, the appearance results from incorrect ignition timing, loose spark plugs, wrong selection of fuel, hotter range plug, etc. It is advisable to replace with plugs having colder heat range.

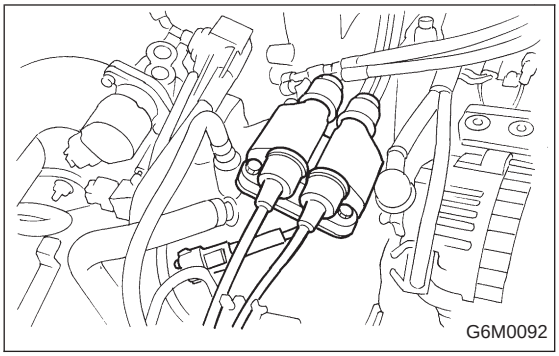


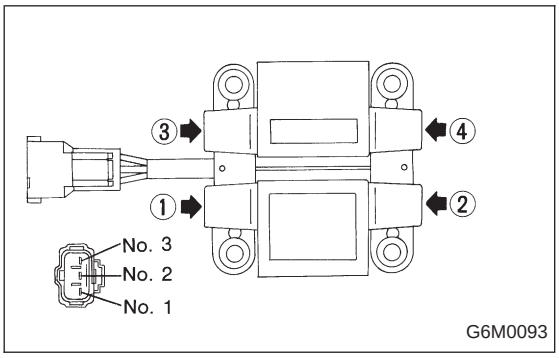
G6M0091

C: CLEANING AND REGAPPING

Clean spark plugs in a sand blast type cleaner.
Avoid excessive blasting. Clean and remove carbon or oxide deposits, but do not wear away porcelain.
If deposits are too stubborn, discard plugs.
After cleaning spark plugs, recondition firing surface of electrodes with file. Then correct the spark plug gap using a gap gauge.

Spark plug gap: L
1.0 — 1.1 mm (0.039 — 0.043 in)


G6M0092



G6M0093

4. Ignition Coil

A: REMOVAL AND INSTALLATION

1) Disconnect battery ground cable.
2) Disconnect connector from ignition coil.
3) Remove ignition coil.
4) Installation is in the reverse order of removal.

CAUTION:
Be sure to connect wires to their proper positions. Failure to do so will damage unit.

B: INSPECTION

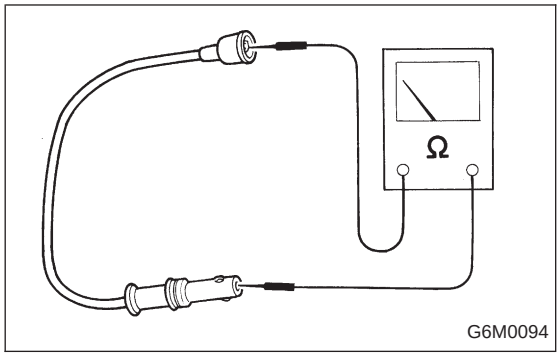
Using accurate tester, inspect the following items, and replace if defective.
1) Primary resistance
2) Secondary coil resistance

CAUTION:
If the resistance is extremely low, this indicates the presence of a short-circuit.

Specified resistance:

- ***1800 cc model***
  [Primary side]
  Between ① and ②
  Between ③ and ④
  MT model 0.62 — 0.76 Ω
  AT model 0.63 — 0.77 Ω
  [Secondary side]
  Between terminal No. 1 and No. 2
  Between terminal No. 2 and No. 3
  MT model 17.9 — 24.5 kΩ
  AT model 10.4 — 15.6 kΩ
- ***2200 cc model***
  [Primary side]
  Between ① and ②
  Between ③ and ④
  0.69 Ω±10%
  [Secondary side]
  Between terminal No. 1 and No. 2
  Between terminal No. 2 and No. 3
  21.0 kΩ±15%

3) Insulation between primary terminal and case: 10 MΩ or more.



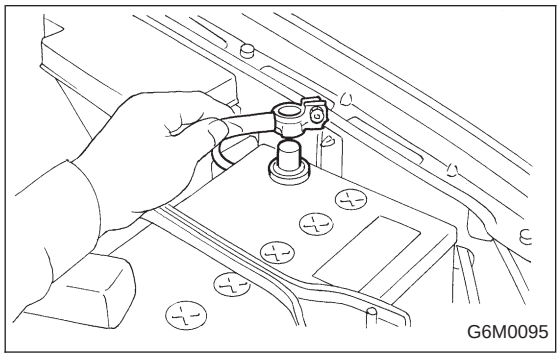
5. Spark Plug Cord

A: INSPECTION

Check for:
1) Damage to cords, deformation, burning or rust formation of terminals.
2) Resistance values of cords.

Resistance value:

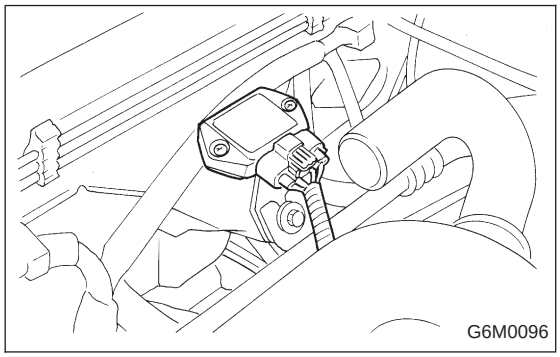
- ***1800 cc model***
  #1 and #3 cords 4.95 — 11.56 kΩ
  #2 cord 4.86 — 11.33 kΩ
  #4 cord 5.24 — 12.23 kΩ
- ***2200 cc model***
  5.12 — 12.34 kΩ



6. Ignitor

A: REMOVAL AND INSTALLATION

1) Disconnect battery ground cable.

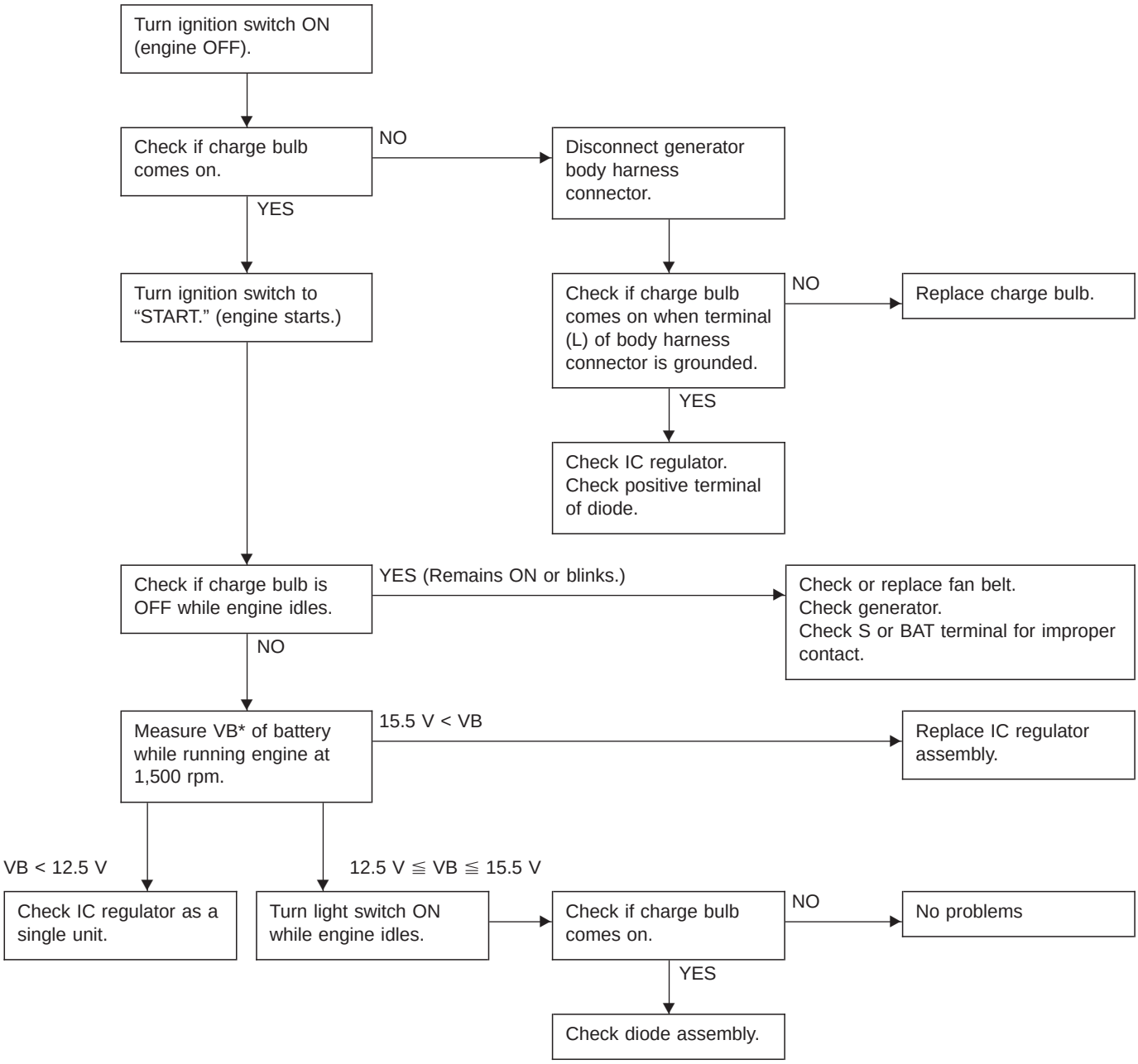


2) Disconnect connector from ignitor.
3) Remove screws which hold ignitor onto body.
4) Installation is in the reverse order of removal.

1. Starter

Trouble		Probable cause
Starter does not start.	Magnet switch does not operate. (no clicks are heard.)	Magnet switch poor contact or discontinuity of pull-in coil circuit
		Improper sliding of magnet switch plunger
	Magnet switch operates. (clicks are issued.)	Poor contact of magnet switch's main contact point
		Layer short of armature
		Contaminants on armature commutator
		High armature mica
		Improper grounding of yoke field coil
		Insufficient carbon brush length
		Insufficient brush spring pressure
Starter starts but does not crank engine.	Failure of pinion gear to engage ring gear	Worn pinion teeth
		Improper sliding of overrunning clutch
		Improper adjustment of stud bolt
	Clutch slippage	Faulty clutch roller spring
Starter starts but engine cranks too slowly.		Poor contact of magnet switch's main contact point
		Layer short of armature
		Discontinuity, burning or wear of armature commutator
		Poor grounding of yoke field coil
		Insufficient brush length
		Insufficient brush spring pressure
		Abnormal brush wear
Starter overruns.		Magnet switch coil is a layer short.

2. Generator



*: Terminal voltage